ACTIVITY OF MEDICINAL PLANTS AS IMMUNO-BOOSTERS

Dr. Preetha Bhadra

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Editor:
Dr. Preetha Bhadra

Co-editor:
Ms. Sudipa Bhattacharjee
Mr. Victor Pradhan

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INDEX

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Chapter – 1

A REVIEW ON: BISALYAKARANI AS PERSONALISED MEDICINES

Tanima Barik[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract

The aim of this study was to assess the medicinal properties, biological activities, and phytochemical components of *Tridax procumbens*, a plant species from the Asteraceae family with origins in Central and South America. A comprehensive review of the scientific literature was conducted using various databases such as Metadatabase EDS, MedLine (PubMed), Science Direct, Web of Science, Academic Search Premier, Scielo, DOAJ Directory of Open Access Journals, JSTOR, and others. A total of 130 studies were identified, out of which 111 were deemed relevant for this review. The findings underscore the need for further research to fully comprehend the potential therapeutic benefits of *T. procumbens'* secondary metabolites. This review highlights the significance of *T. procumbens* as an ethnobotanical resource with promising medicinal applications, particularly in tropical regions where it is indigenous and widespread.
Keyword – Phytochemical, Asteraceae, Therapeutics, Secondary Metabolites.

Introduction

Tridax procumbens (coat buttons) is a plant that is a member of the family Asteraceae. It is native to the Central and South American regions of the world (Hilliard (1977), Ravikumar (2005b), Bhagwat (2008), Sawant (2014), and Hitesh (2006). This plant has been used as a medicine since ancient times in India (see Kethamakka & Deogade (2014)). It is used as an oil, tea, or skin poultice. Its defense mechanisms are mainly mediated through secondary metabolites such as flavonoid, alkaloid, tannin, carotinoid, saponin, and so on. The medicinal properties of Tridax (T. cinctum) procumbens range from immunomodulating to antioxidant to analgesic to antidiabetic to anti-inflammatory to antimicrobial. This review aims to highlight the significance of T. cinctum as a medicinal plant for future research.

T. procumbens thrives in tropical and subtropical regions worldwide and is commonly found among annual crops, roadsides, pastures, fallows and waste areas (Holm et al., 1997). It has a diploid number of 36 (Raghavan and Vinkatusabban, 1941) and has a herbaceous, semi cortical growth habit, usually reaching a height of 15-40 cm. The leaves are oblong, opposite, oval, with serrated edges and hairy surfaces on both sides (Powell, 1965). Its inflorescence consists of white three-toothed ligule florets (female) and yellow tubular disk florets with petals approximately 6 mm long (bisexual). The reproductive structure of the plant is characterized by the abundant production of 2 mm long, egg-shaped papillae covered with stiff hairs, which facilitate wind dispersal over long distances and present potential invasive risks if not managed (Chauha and Johnson, 2008).

T. procumbens **and its role in phytochemistry**

T. procumbens' usage as a traditional medicine worldwide has resulted in numerous articles on its phytochemistry. New medications for the treatment of different illnesses may be developed as a result of the identification of novel bioactive chemicals (Fabricant and Farnsworth 2001).

Primary Metabolites-

Primary metabolites engaged in metabolic pathways can be found in all plants and is essential for the plant's growth and development. Several distinct primary metabolites have been isolated from *T. procumbens*, including: Lipids play a crucial role in living organisms, influencing cell communication, composition, and function. An organism's source of energy. Common fats in the Asteraceae family are present in *T. procumbens*. Additionally, this species has certain lipids that offer the plant special qualities and potential therapeutic use. The following special fats have been extracted: methyl-14-oxooctadecanoate, methyl-14-oxononacosanoate, 3-methylnonadecylbenzene, heptacosanyl cyclohexane carboxylate, 1(2,2-dimethyl-3-hydroxypropyl)-2-isobutyl phthalate, 12-hydroxytetracosan-15-one, 32-methyl-30-oxotetratriacont-31-en-1-ol and 30-methyl-28-oxodotriacont-29-en-1-oic acid dotriacontanol, β-amyrone, Δ12-dehydrolupen-3-one, β-amyrin, lupeol, fucosterol, 9-oxoheptadecane, 10 oxonononadecane, and sitosterol (Verma and Gupta, 1988). All of these substances can be found in plants and serve vital functions.

Secondary Metabolites

Secondary metabolites are substances which plants create, they are not necessary for the plant to grow and develop normally, but they are crucial to the plant's defense mechanisms, communication, stress tolerance, and other processes. Bioactive substances, which frequently have significant and beneficial therapeutic characteristics, are found in secondary metabolites. Glycosides, nitrogenous organic compounds, fat soluble chemicals, polyphenolic compounds, and minerals contain some of the most significant bioactive substances with potential medical applications (Edeoga et al., 2005). Flavonoids, carotenoids, alkaloids, saponins, tannins, and terpenes are the six main categories into which *T. procumbens* secondary metabolites come.

Flavonoids

According to research by Jhariya et al. (2015), flavonoids are present in leaves as well as other organs. They have been demonstrated to be effective as anticoagulants, hair tonics, anti-fungals, and treatments for diarrhea, dysentery, bronchial catarrh, and wound healing (Ali et al., 2001). *Tridax' s* procumbenetin and other flavonoids appear to reduce the amount of calcium and oxalate that accumulate in the kidneys (Sailaja et al., 2012). According to Petchi et al. (2013), this secondary metabolite may aid in the regeneration of injured pancreatic beta cells. When an aqueous extract of *T. procumbens* was tested for its effects on diabetic rats, it was found to have hypoglycemic activity (possibly due to flavonoids), protection against oxidative stress (likely because of the high ascorbic acid content), and a lowering of VLDL cholesterol (likely because of flavonoids) (Ikewuchi, 2012). Tridax has been shown to contain luteolin, quercetin, and procumbenetin (Jhariya et al., 2015). According to Kumar et al. (2012), T. procumbens flowers contain lutein, glucoluteolin, and isoquercetin. According to Rao et al. (2012), luteolin exhibits anti-inflammatory and anti-carcinogenic properties. This is most likely because to its antioxidant properties and capacity to scavenge free radicals (Seelinger et al., 2008). Strong tumor proliferation inhibition has been demonstrated by luteolin through the suppression of angiogenesis (Kawaii et al., 1999). According to in vitro research, luteolin exhibits activity against various cancer cell lines, such as those from breast cancer (Tu et al., 2013), liver cancer (Pettit et al., 1996), hepatoma (Chang et al., 2005), colon cancer (Leung et al., 2006), human lung squamous carcinoma (Leung et al., 2005), and uterine cancer (Makino et al., 1998). Additionally, in vivo investigations have demonstrated the anti-carcinogenic potential of luteolin. For instance, luteolin treatment reduced the size of tumors in immunodeficient SCID mice and nude mice with prostate adenocarcinoma (Chiu and Lin, 2008; Markaverich et al., 1997; Fang et al., 2007). Luteolin has been shown to delay cancer cell migration and invasion (Lin et al., 2008), limit cell replication and DNA repair, leading to death (Yamashita and Kawanishi, 2000), and inhibit multidrug-resistant proteins (Rao et al., 2012). According to Coskun et al. (2004), quercetin is an antioxidant that guards against lipid peroxidation and has strong antiulcer properties against ethanol-induced ulcerogenesis. It also raises beta-carotene levels and lowers retinol levels (Bando et al., 2010). Each of these characteristics points to possible uses for this amazing plant.

Tannins

Water-soluble polyphenols called tannins are present in plants naturally. Tannins possess antimicrobial, anti-carcinogenic, and anti-mutagenic qualities; these effects may be attributed to their antioxidant capacity (Chung et al., 1998). According to several studies (Kumar et al., 2012, Edeoga et al., 2005), T. procumbens contains tannins. The buds and stem of *T. procumbens* contain tannins (Ikewuchi, 2012*)*. *T. procumbens* leaf extracts containing acetone-water or chloroform water was shown to contain tannins.

Carotenoids

Carotenoids are fat-soluble pigments found in plant leaves that serve three functions: light-harvesting, photooxidative protection, and attracting insects (Ikewuchi et al., 2009). Research suggests that carotenoids may protect DNA from oxidative stress (Wagener et al., 2012). T. procumbens contains numerous secondary metabolites, including beta-carotene, which can be converted to vitamin A (Ikewuchi et al., 2009). Vitamin A is crucial for maintaining epithelial tissues. Vitamin A deficiency can affect immunity and hematopoiesis, leading to night blindness and xerophthalmia (Sommer, 1995). Carotenoids with UV-induced erythema-reducing properties include lutein and beta-carotene (Heinrich et al., 2003). Carotenoids' photoprotective activities are connected to their antioxidant properties (Wagener et al., 2012).

Alkaloids

Any family of nitrogenous organic chemicals derived from plants that significantly affect human physiology is known as an alkaloids. It has also been noted that T. procumbens contains certain alkaloids (Kumar et al., 2012). Ikewuchi (2012) found 29 alkaloids in aqueous leaf extraction, including Akuamidine (73.91%) and Voacangine (22.33%). The extract also included tannins and sterols in addition to alkaloids. T. procumbens alkaloids inhibited Proteus mirabilis and Candida albicans, while alkaloids from buds inhibited E. coli and Trichophyton mentagrophytes. Alkaloids totaled 32.25 mg/gdw in pedicles and 92.66 mg/gdw in buds (Jindal and Kumar, 2012).

Saponins

According to Elle et al. (1999), saponins are steroidal glycosides with pharmacological and medicinal properties. T. procumbens has been found to contain saponins (Edeoga et al., 2005), with a steroidal saponin and pB-Sitosterol-3-O-β-D-xylopyranoside found in the species' flowers (Saxena and Albert 2005). According to a different study, saponins from an ethanolic extract of T. procumbens may have antidiabetic effects since they block the sodium glucose cotransporter-1 (S-GLUT-1) in the male Wistar albino rats' intestines (Petchi et al., 2013).

***T.procumbens* and its Pharmacological properties**

Tridax has a wide range of secondary metabolites, which indicates the species' potential pharmacological qualities. Nevertheless, the application of this species in allopathic treatment is still unknown. Due to these chemicals' ability to prevent anemia, protect the liver, boost immunity, function as an antioxidant, and have anticancer, antibacterial, antifungal, antiparasitic, antiplasmodial, and antiviral capabilities. Because of its potential in pharmacology, this species may offer a link between traditional and western therapy. Further active component separation and characterization are required. Research on whether there are any changes in activity during the pharmaceutical compounds' production and isolation is lacking. For instance, although Ali et al. (2001) report the separation of flavonoids from aerial components, there is no evidence linking the antifungal activity of the flavonoid procumbenetin. In other instances, 26 compounds with possible antifungal action were reported (Policegoudra et al., 2014), however the phytochemicals in question are not mentioned. Taddei and Romero (2002) found no antibacterial action against Candida albicans, which contradicts the findings of Policegoudra and associates. The kind of bacterial strains employed or the various techniques employed could be to blame for this. In order to extract the aqueous layer further, Taddei and Romero used a three-extraction method over the course of seven days. They used paper disks for analysis and did not disclose the source of the bacterial strains. They extracted the aqueous layer using n-hexane and then ethyl acetate. Policegoudra employed the agar-well diffusion method, known bacterial strains, and dichloromethane to fractionate the methanol extract. This suggests that more effort is required to address the problem.

Antifungal activity

Research has been done on *T. procumbens*' antifungal properties. The ideal zone of inhibition from several fungal strains, such as Microsporum fulvum, Microsporum gypseum, Trichophyton mentagrophytes, Trichophyton rubrum, Candida albicans, and Trichosporon beigelii, has been determined using a variety of extraction techniques. The aerial portions of this plant have exhibited effectiveness against dermatophytes, with zones of inhibition ranging from 17 to 25mm. The dichloromethane (DCM) fraction showed the best response (Policegoudra et al., 2014). The specific bioactive components that provide the product its antifungal qualities are not mentioned by the writers, nevertheless. The authors imply that these chemicals may be fatty acid derivatives or components, but provide no data to support this claim.

Antibacterial activity

There has been evidence of antibacterial action for *Tridax procumbens*. It is among the most often used plants in rural areas of the world to cure bacterial illnesses (Taddei and Rosas-Romero, 2000). It has been demonstrated that Tridax extracts work well against a range of microorganisms. Salmonella group C, Salmonella paratyphi, E. coli, Mycobacterium smegmatis, and Klebsiella sp. are all susceptible to N-hexane extracts' action. The ethyl acetate extract shown efficacy against both Gram-positive and Gram-negative bacteria, including Klebsiella sp. and Bacillus cereus, Mycobacterium smegmatis, and Staphylococcus aureus (Taddei and Rosas-Romero, 2000). *T. procumbens* essential oil extract effectively inhibits Gram-positive bacteria such Staphylococcus aureus and Streptococcus pneumoniae (Manjamalai et al., 2012b). While there appears to be considerable support for the antibacterial activity of this species, further research is needed due to variances in study methods.

Antiparasitic Activity

Treatment of certain protozoal infections, such as colic, malaria, dysentery, and vaginitis, has been evaluated with T. procumbens using a bioassay guided fractionation with a methanol extract to isolate an active compound, (3,S)-16,17-Didehydrofalcarinol (an oxylipin). When employing crude extracts from the entire plant, Tridax appeared to show anti-leishmanial activity (Mart n-Quintal et al., 2009). In Ghana, a study examined the anti plasmodial properties of extracts from T. procumbens flowers, leaves, and stems that were aqueous, chloroform, ethyl acetate, and ethanolic.

Antioxidant Activity

When an electron in an atomic orbital is unpaired, molecules become extremely reactive and become free radicals. Reactive hydroxyl radicals (OH), superoxide anion radicals, hydrogen peroxides, reactive oxygen species (ROS), and peroxyl are a few of these free radicals. Unstable radicals can harm critical biological molecules such as DNA and macromolecules, causing cell damage and disrupting homeostasis. Agrawal et al. (2009) found that T. procumbens has antioxidant activity comparable to that of Ascorbic acid in ethyl acetate and n-butanol fractions of methanolic extracts, using the 1,1-diphenyl-2-picrylhydrazyl (DPPH) method. According to Saxena et al. (2013), Tridax has significant antioxidant activity in n-butanol and ethyl acetate fractions of methanolic extracts. The authors found that Tridax has a higher reductive potential (0.89 nm) than the standard (0.99 nm). They believe this is due to the plant's high phenol content, making it a natural source of antioxidants with potential medicinal benefits.

Anticancer Activity

The condition known as cancer is complex and multifaceted. The anticancer action of T. procumbens has not been studied till recently. On prostate epithelial malignant cells (PC3), crude flower aqueous and acetone extracts were examined. The aqueous extract showed very little antitumor action. According to Vishnu et al. (2011), the acetone extract inhibited cancer cells by 82.28% within 24 hours of treatment. The MTT assay was used to assess the viability. The only extract that had an impact was the acetone extract, and the controls aren't made obvious in the paper, therefore the results are inconclusive because the authors don't describe the toxicity analysis. Additionally, the selectivity index is not reported in this study, nor are the outcomes compared to those of conventional therapeutic medications. T. procumbens was found to significantly reduce the formation of tumor nodules in the lungs. This is most likely because T. procumbens inhibits the production of new blood vessels in response to monoterpenes (beta and beta pinenes). Additionally, there was an increase in the expression of caspase and P53, suggesting that the oils from these plants may cause apoptosis. Many studies have suggested that T. procumbens may be useful in the treatment of cancer, but further investigation is required to fully comprehend the molecular mechanisms behind this effect

(Manjamalai et al., 2012a). Furthermore, no research on anticancer activity was conducted in accordance with the appropriate guidelines for this field of study, leaving the results unresolved.

Summary

Widely dispersed in India, America, Tropical Africa, Asia, and Australia, Tridax procumbens Linn. is a ubiquitous weed. There are wonderful pharmacological activities in every section of the plant. Pharmacological activities such as hepatoprotective effect, immunomodulating property, promising wound healing activity, antidiabetic, hypotensive effect, insect repellent activity, anti-inflammatory and antioxidant, bronchial catarrh, diarrhea, and dysentery are all studied in the work that has been reported. The herb is also used as a hair growth stimulant and to stop hair loss.

To remove dangerous Cr (VI) from industrial waste water, this plant is employed as a bioadsorbent. Aqueous leaf extract has a cardiovascular action that lowers blood pressure and heart rate considerably. Comparable to aspirin and ibuprofen, lyophilized aqueous leaf extract had anti-inflammatory properties. The entire arial section possesses hepatoprotective and antisecretory (antiidiarrheal) properties. It is effective against fungi, bacteria, and protozoa. Leaf juice aids in the healing of dead space wounds. To check for all forms of bleeding, use seeds. The entire arial portion's aqueous extract is employed as an immunomodulator. Dry extract exhibited antimicrobial properties even in a mineral base formulation.

Conclusion

This review highlights how important it is to keep researching plants that are known to be utilized in traditional medicine because doing so may help find and develop novel conventional treatments.

Despite the lengthy history of traditional usage of Tridax procumbens, the separation and assessment of each phytochemical has not been adequately linked to its pharmacological effects, and this could lead to challenges with repeatability following isolation and evaluation. Various extracts have been employed to treat various illnesses and to isolate metabolites. Numerous analysis studies of extraction did not perform confirmatory work, and some investigations contradicted each other, according to the evaluated information. Numerous extraction techniques seem to have some benefit in treating a range of illnesses. Evidence suggests that Tridax is an effective anti-diabetic medication when compared to traditional treatments. There is currently little research on the concentration of phytochemicals in different plant organs, making it impossible to determine dose based on traditional applications. Future studies should concentrate on the relationship between particular phytochemicals and how they affect different types of illnesses. Additional areas that require further investigation are the yield of extraction, concentration, and physiological activity of these phytochemicals, among other things.

Findings in these fields will yield valuable data that the medical community can utilize for the development of new medications or for preventative medicine. Numerous significant qualities of T. procumbens are still unknown.

For its botanical, phytochemical, nutritional, and pharmacological qualities, Tridax procumbens Linn. offers a staggering amount of promise. According to the review study and explanation above, the plant has been widely utilized in the traditional medical system for a variety of biological diseases, and it have a variety of notable psychopharmacological effects, as the review article briefly discusses. Future research could explore the plant's pharmacological properties and mechanisms of action. This therapeutic plant could provide valuable herbal medications for the pharmaceutical sector in the future. The plant Tridax procumbens has a variety of pharmacological characteristics, according to the current review. The phytoconstituents are responsible for biological actions. This plant's variety of phytochemicals offers potential leads for the creation of new medicinal compounds.

Reference

1. Deshmukh A S, Morankar P G, Kumbhare M R. Review on Analgesic Activity and Determination Methods, Pharmtechmedica, 3(1), 2014, 425-428.
2. .Prabhu V V, Nalini G, Chidambaranathan N, Kisan S S. Evaluation of Anti-Inflammatory and Analgesic Activity of Tridax Procumbens Linn Against Formalin, Acetic Acid and CFA Induced Pain Models, International Journal of Pharmacy and Pharmaceutical Sciences, 3(2), 2011, 126-130.
3. Morankar P G, Deshmukh A S, Kumbhare M R, Kale S S. Antioxidant Activity of Couroupita guianesis AUBL, Pharmtechmedica, 3(2), 2014, 464-468. 5. Agrawal S S, Talele G S, Surana S J. Antioxidant Activity of Fractions from Tridax procumbens, Journal of Pharmacy Research, 2(1), 2009, 71-73.
4. Pai C, Kulkarni U, Borde M, Murali S, Mrudula P and Yashwant Deshmukh. Antibacterial, Activity of Tridax procumbens with Special Reference to Nosocomial Pathogens, British Journal of Pharmaceutical Research, 1(4), 2011, 164-173.
5. Bhagwat D A, Killedar S G, Adnaik R S. Anti-diabetic activity of leaf extract of Tridax
6. procumbens, International Journal of Green Pharmacy, 2008, 126-128.
7. Sankaranarayanan S, Bama P, Sathyabama S, Bhuvaneswari N. Anticancer Compound Isolated From The Leaves of Tridax Procumbens Against Human Lung Cancer Cell A-549, Asian Journal of Pharmaceutical and Clinical Research, 6(2), 2013, 91-96.
8. Jindal A, Kumar P. In Vitro Antifungal Potential of Tridax Procumbens L. Against Aspergillus Flavus And Aspergillus Niger, Asian Journal of Pharmaceutical and Clinical Research, 6(2), 2013, 123-125.
9. Mahajan R, More D. Evaluation of Anticoagulant Activity Aqueous and Ethenolic Extracts and Their Isolated

Phytochemicals of Some Medicinal Plants, International Journal of Pharmacy and Pharmaceutical Sciences, 4(4), 2012, 498-500.

10. Aboh, A. B., Olaafa, M., Dossou-Gbété, G. S. O., Dossa, A. D., & Djagound, N. (2002). Ingestion volontaire et digestibilité apparente d'une ration à base de la farine de grains de Mucuna pruriens var. utilis complétée de fourrages chez les lapins. Tropiculture, 20(4), 165-169.
11. Adjagba, M., Awede, B., Nondichao, K., Lagnika, L., Osseni, R., Darboux, R., Laleye, A. (2015). Antihypertensive activity of different fractions of Tridax procumbens crude aqueous extract in wistar rats. Journal of Physiology and Pharmacology Advances, 5(9), 713-719.
12. Ankita, J., & Jain, A. (2012). Tridax procumbens (L.): A weed with immense medicinal importance: A review. International Journal of Pharma and Bio Sciences, 3(1), 544-552. Appiah-Opong, R., Nyarko, A. K., Dodoo, D., Gyang, F. N., Koram, K. A., & Ayisi, N. K. (2011).
13. Nikita, S., Rashmi, S., & Yashwant, M. (2014). Isolation and identification of the flavonoid" Quercetin" from Tridax procumbens Linn. International Journal of Pharmaceutical Sciences and Research (IJPSR), 5(4), 1454-1459.
14. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
15. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
16. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
17. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional

level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.

18. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
19. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
20. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
21. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
22. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
23. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
24. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
25. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian

Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021

26. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
27. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
28. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
29. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
30. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
31. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
32. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
33. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
34. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284

35. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
36. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
37. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
38. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
39. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
40. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
41. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
42. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
43. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
44. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
45. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
46. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808

47. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
48. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
49. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
50. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
51. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
52. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
53. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
54. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
55. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
56. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
57. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
58. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800

59. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
60. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
61. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
62. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
63. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
64. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
65. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
66. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
67. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
68. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.

69. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
70. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
71. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
72. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
73. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
74. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
75. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
76. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
77. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
78. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
79. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
80. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
81. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for

abiotic stress tolerance in plants (2020). Academic Press, Elsevier.

82. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 2

A REVIEW ON: BISALYAKARANI AS AN IMMUNE BOOSTER

Tanima Barik[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract
Medicinal plants have provided humans with a wide range of strong pharmaceuticals to treat or eliminate infections and disease symptoms. Despite advances in synthetic drugs, some plant-derived drugs have remained their value and relevance. Worldwide, the usage of medications made from plants is growing. Natural plant-based goods have demonstrated that nature is a perfect example of how humans and their surroundings are intertwined in terms of healing ailments. Every day, more research is conducted on herbal medicine and its application in disease treatment grows. Although there have been documented advancements in contemporary medicine, many illnesses and disorders still lack appropriate medications. This has created an urgent need to produce safer medications for the treatment of inflammatory disorders, diabetes, liver ailments, and gastrointestinal problems. *Tridax procumbens* is a very important medication that is well-known for a variety of pharmacological effects, including the ability to heal wounds, have an antidiabetic effect, lower blood pressure, and modulate the immune system. As a result, the phytochemical and pharmacological actions warrant further investigation.

Keywords: Herbal medicine, Medicinal plant, Pharmacological, Phytochemical, Synthetic drugs, Anti-inflammatory, Antioxidant.

Introduction

Tridax procumbens (Tridax), Compositae, is often called as 'Ghamra' in Hindi and 'coat buttons' in English due to its blossoming appearance. It is one of the medicinal herbs that ethnomedical practitioners use the most frequently. The most appropriate terms to use are "widespread weed" and "pester plant." India is home to the Tridax plant, which is used as a home remedy for a variety of ailments. *Tridax procumbens* is widely used in Indian traditional medicine for wound healing, antifungal, anticoagulant, and bug repellent properties, as well as for the treatment of infectious diseases and diarrhea. Distributed under the brand name "Bhringraj," *Tridax procumbens* is a well-known Ayurvedic medication for liver disorders. Additionally, in some parts of India, traditional healers use *Tridax procumbens* to treat cuts, boils, and blisters. According to the phytochemical analysis, flavonoids (catechins and flavones), alkaloids, tannins, saponins, and carotenoids were all observed. Source and range It's possible that *Tridax procumbens* Linn originated in equatorial America and was accepted by equatorial Australia, Asia, Africa, and India. This is a wild grass that grows all over India. Coat buttons can be found on waste grounds, railroads, meadows, riverbanks, dunes, and dykes. Its prolific seed generation and spreading stems contribute to its growing weed status and prevalence.

Scientific Classification

Kingdom - Plantae,
Subkingdom - Tracheobionta,
Division - Magnoliophyta,
Class - Magnoliopsida,
Subclass - Asteridae,
Order - Asterales,
Family - Asteraceae,
Genus – Tridax
Species - Tridax procumbens

MORPHOLOGY

- Flowers on the plant have three-toothed ray florets and resemble daisies with a yellow center.
- The flowers often have an arrowhead form and are toothed.
- The fruit is a rigid achene covered in stiff hairs with a feathery, plume-like white pappus at one end.

Pharmacological Activities

Tridax procumbens possesses a multitude of potential medicinal properties, including antibacterial, antioxidant, and antibiotic efficacies, as well as wound healing, insecticidal, anti-inflammatory, and diarrheal properties. Leaf juice is applied as a hair tonic, to treat new wounds, and to halt bleeding. In India, Tridax procumbens is mostly used for wound healing, as an anticoagulant, antifungal, and insect repellant. Leaf extract has been used in traditional medicine to treat infectious skin conditions. It is a well-known drug for liver problems or hepatoprotective properties, in addition to gastritis and heartburn. To remove dangerous Cr (VI) from industrial waste water, Tridax procumbens is employed as a bioabsorbent.

Antibacterial Activity

Tridax procumbens has antibacterial properties and was tested against Pseudomonas aeruginosa. The nosocomial strain of Pseudomonas was identified from a ventilator used to treat pneumonia patients' secretions, including bronchoalveolar lavage and tracheal secretions. The ethanolic extract had excellent antibacterial efficacy against Pseudomonas aeruginosa, according to this investigation. At 5 mg/ml of concentration, there is an increased zone of inhibition. When the strain was tested against a few control drugs, including augmentin, ciprofloxacin, cephotaxime, and even ticarcillin, it only demonstrated imipenem sensitivity. The ethanol extract of Tridax exhibited an inhibitory zone against the predominant gram negative bacteria linked to nosocomial illnesses, making this finding statistically significant. Tridax has antimicrobial properties throughout its plant. Two Gram positive (Bacillus subtilis, Staphylococcus) and two Gram negative (Escherichia coli, Pseudomonas aeruginosa) bacteria are present in this entire plant extract. Antibiotic susceptibility tests on various bacteria revealed greater susceptibility among Gram-negative strains. Extracts from Tridax procumbens leaves, using hexane, petroleum ether, chloroform, and methanol, were tested against Staphylococcus aureus, Escherichia coli, Proteus mirabilis, and Vibrio cholerae. Methanol extract showed superior antibacterial activity compared to hexane. Methanol extract particularly exhibited high activity against Salmonella typhi and Shigella flexneri, with lower activity against Escherichia coli.

Antifungal Activity

Tridax procumbens' antifungal activity was evaluated against the phytopathogenic fungus Aspergillus niger and Fusarium oxysporum, and the results showed that it had good antifungal activity. The essential oil derived from Tridax procumbens has demonstrated antifungal efficacy against three distinct fungus, namely Candida albicans, Candida tropicalis, and Candida parapsilosis, with a zone of inhibition ranging from 12 to 15 mm. Tridax procumbens flavonoids, a bioactive substance, were examined for their potential antifungal action against niger, Aspergillus flavus, Candida albicans, and Trichophyton sp. The results showed that Candida albicans was more sensitive to the flavonoid compound, suggesting that the plant has antifungal potential.

Tridax procumbens methanol extract, which was made from the plant's leaf, stem, flower, and root, exhibited a strong inhibitory effect on Candida albicans. The range of the inhibitory zone at a concentration of 100 mg/ml is 8 to 13 mm. When applied to Candida tropicalis and Candida glabrata, the root's methanol extract demonstrated antifungal activity. On the other hand, Candida albicans and Candida tropicalis were susceptible to the methanol leaf extract of Tridax procumbens

L. This data demonstrates that the methanol root extract contains bioactive chemicals that could lead to a more potent anti-candidial medication in the future. We lessen the need of commercial chemical fungicides and their potentially harmful side effects by employing natural fungicidal agents. Tridax procumbens extract has the potential to be a useful medicinal agent in the future.

Hypotensive Effect

The hypotensive properties of Tridax procumbens leaf were examined in Sprague-Dawley rats under anesthesia. They demonstrated the cardiovascular effects of the leaf aqueous extract and its capacity to significantly lower mean arterial blood pressure in a dose-dependent manner. While a lesser dose has no effect on heart rate, a higher dose shows a noticeable decrease in heart rate. According to reports, Tridax procumbens Linn. leaves have a hypotensive effect.

Immunomodulatory

Tridax procumbens aqueous extract assessed for immunomodulatory function proliferates less quickly than the ethanol leaf extract, according to research done on albino rats given Pseudomonas aeruginosa. The aqueous extract of Tridax in the ethanolic insoluble fraction was found to dramatically raise the phagocytic index, leukocyte count, and splenic antibody-secreting cells. Hemagglutination antibody titer rise was also accompanied by stimulation of the humoral immune response. This study also shows that Tridax affects the immune system that is mediated by cells and humor.

Anti inflammatory

In addition to the common medication, lbuprofen, the anti-inflammatory properties of Tridax procumbens extract were evaluated on carrageenin-induced paw edema. The inhibition zone matched that of the Tridax extract. When used with the conventional medication lbuprofen, the Tridax extract enhanced edema inhibition. Ibuprofen plus Tridax extract shown a notable anti-inflammatory effect. Rats were given various doses of a powdered Tridax leaf extract that was soluble in water. The outcomes showed that the extract had analgesic properties. Using the rat-paw experiment, the dose of Tridax procumbens L. demonstrated edema inhibition in the percentages of 10.82, 16.80, and 11.39, and reduced the abdominal writhing Tridax alcoholic and hydro alcoholic extract of anti-inflammatory action.

Antioxidant Activities

The high phenolic content of the Tridax procumbens extract suggests that it may have antioxidant properties. The antioxidant qualities of phenolic compounds, such as flavonoids and tannins, are well-known for their ability to stave off heart disease, cancer, and age-related illnesses. The antioxidant activity of the methanol extract fractions was assessed using the DPPH technique; the ethyl acetate and n-Butanol fractions in particular demonstrated notable activity. Using this approach, antioxidants' capacity to scavenge free radicals is evaluated; stronger scavenging activity is indicated by lower absorbance.

SUMMARY

There is a weed called Tridax procumbens Linn (Compositae) all over India. The plant has become native to Australia, Asia, and tropical Africa. It originated in the tropics of America. Residents call it "Ghamara," and some Ayurvedic doctors recommend it for "Bhringraj" (often translated as "coat buttons" in English). Alkaloids, carotenoids, flavonoids (catechins and flavones), fumaric acid, fl-sitosterol, saponins, and tannins were discovered during the phytochemical screening. It is exceptionally high in carotenoids, saponins, olcanolic acid, and ions such as calcium, potassium, and sodium. Its blooms have been shown to contain luteolin, glucoluteolin, quercetin, and isoquercetin. Numerous pharmacological actions are well-known to be associated with it, such as hepatoprotective, wound-healing, antidiabetic, hypotensive, immunomodulating, dysentery, and diarrhea.

CONCLUSION

Native to tropical America, Tridax procumbens Linn. (Compositae) is a weed that has spread to tropical Africa, Asia, and Australia. This plant is extensively dispersed, and every portion of it has noble pharmacological activity. Research on its pharmacological properties, such as their hepatoprotective effect, immunomodulating property, potential wound healing activity, antidiabetic, hypotensive effect, antimicrobial, insect repellent activity, anti-inflammatory and antioxidant, and their ability to treat bronchial catarrh, dysentery, and diarrhea, has also prevented hair loss and promoted hair growth. Additionally, this plant is employed as a bioadsorbent to remove Cr (VI) from industrial wastewater. For "Bhringraj," some Ayurvedic practitioners prescribe this. There is a great deal of potential for future study to uncover more pharmacological properties of plants and clarify their mode of action. Research on the plant Tridax procumbens Linn. also aimed to isolate novel medicinal compounds from it; this plant is known to yield oleanolic acid, a single triterpenoid. This thorough analysis focuses on the several phytochemicals found in T. procumbens as well as their range of pharmacological characteristics.

Regarding its botanical, phytochemical, nutritional, and pharmacological qualities, Tridax procumbens Linn. exhibits great promise. According to the review article's brief discussion, the plant has been widely used in traditional medicine to treat a variety of biological diseases. It also possesses a number of notable psychopharmacological properties. These observations are supported by the review study and explanation provided above. Future research on the plant's additional pharmacological properties and the clarification of its mode of action has a plethora of opportunities. In the future, this medicinal plant may also be a key supplier of herbal medications for the pharmaceutical sector. According to the current review, Tridax procumbens is a plant with a variety of pharmacological activities. The biological activity in them are caused by the phytoconstituents that are present. This plant's variety of phytochemicals offers pharmacological leads for the creation of new medicinal compounds.

REFERENCE

1. Beck, S., Mathison, H., Todorov, T., Calder, E., & Kopp, O. R. (2018). A review of medicinal uses and pharmacological activities of *Tridax procumbens* (L.). *J. Plant Stud*, *10*.
2. Amutha, R., Sudha, A., & Pandiselvi, P. (2019). *Tridax procumbens* (coat buttons)-a gift of nature: an overview. *Saranraj P., Feliciano Dire G. & Jayaprakash A., Pharmacological Benefits of Natural Products. Jps Scientific Publications, India*, 193-212.
3. Mundada, S., & Shivhare, R. (2010). Pharmacology of Tridax procumbens a weed. *Int J Pharm Tech Res*, *2*(2), 1391-1394
4. Kaushik, D., Tanwar, A., & Davis, J. (2020). Ethnopharmacological and Phytochemical Studies of *Tridax Procumbens* Linn: A Popular Herb in Ayurveda Medicine. *Int. J. Eng. Res.*, *9*, 758-768.
5. Ghosh, P., Biswas, S., Biswas, M., Dutta, A., Sil, S., & Chatterjee, S. (2019). Morphological, Ethno biological and Phytopharmacological Attributes of *Tridax procumbens Linn*.(Asteraceae): A Review. *Int. J. Sci. Res. in Biological Sciences Vol*, *6*(2).
6. Jain A, Jain A. Tridax Procumbens (L.): A weed with immense medicinal importance: A review. Int J Pharma Bio Sci 2012;3:544-52. 2. Bhagwat DA, Killedar SG, Adnaik RS. Antidiabetic activity of leaf extract of Tridax procumbens. Int J Green Pharma 2008;2:126-8.
7. Ravikumar V, Shivashangari KS, Devaki T. Effect of Tridax procumbens on liver antioxidant defense system during lipopolysaccharideinduced hepatitis in D-galactosamine sensitised rats. Mol Cell Biochem 2005;269:131-6.

8. Tiwari U, Rastogi B, Singh P, Saraf DK, Vyas SP. Immunomodulatory effects of aqueous extract of Tridax procumbens in experimental animals. J Ethnopharmacol 2004;92:113-9.
9. Ikewuchi JC, Ikewuchi CC, Igboh MN. Chemical profile of Tridax procumbens Linn. Pak J Nutr 2009;8:548-50.
10. Verma RK, Gupta MM. Lipid constituents of Tridax procumbens. Phytochemistry 1988;27:459-63.
11. Ali MS, Jahangir M, Hussan SS, Choudhary MI. Inhibition of alpha-glucosidase by oleanolic acid and its synthetic derivatives. Phytochemistry 2002;60:295-9.
12. Ravikumar V, Shivashangari KS, Devaki T. Hepatoprotective activity of Tridax procumbens against d-galactosamine/lipopolysaccharideinduced hepatitis in rats. J Ethnopharmacol 2005;101:55-60.
13. Oladunmoye MK. Immunomodulatory effects of ethanolic extract of Tridax procumbens on swiss Albino rats orogastrically dosed with Pseudomonas aeruginosa (NCIB 950). Int J Trop Med 2006;1:152-5.
14. Nia R, Paper DH, Essien EE, Oladimeji OH, Iyadi KC, Franz G. Investigation into in-vitro radical scavaging and in-vivo antiinflammatory potential of Tridax procumbens. Niger J Physiol Sci 2003;18:39-43.
15. Mahato RB, Chaudhary RP. Ethnomedicinal study and antibacterial activities of selected plants of Palpa district, Nepal. Sci World 2005;3:26-31.
16. Singanan M. Defluoridation of drinking water using metal embedded biocarbon technology. Int J Environ Eng 2013;5:150-60.
17. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
18. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner

19. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
20. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
21. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
22. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
23. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
24. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
25. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
26. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021

27. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
28. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
29. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
30. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
31. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
32. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
33. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
34. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
35. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
36. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of

Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee

37. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
38. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
39. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
40. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
41. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
42. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
43. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
44. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
45. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
46. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
47. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474

48. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
49. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
50. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861- 20865
51. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
52. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
53. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
54. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
55. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
56. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
57. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
58. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
59. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865

60. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
61. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
62. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
63. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
64. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
65. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
66. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
67. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
68. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
69. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
70. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant

responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.

71. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
72. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
73. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
74. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
75. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
76. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
77. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
78. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
79. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
80. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
81. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)

82. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
83. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
84. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
85. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 3

BIOFERTILIZER AND BIOPESTICIDE FROM DATURA STRAMONIUM: A REVIEW

Deepak Kumar[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract
Datura stramonium is an intriguing plant noted for its medical and hallucinogenic qualities, with different species demonstrating a variety of biological activities including antibacterial, antioxidant, and immune response improvement. Secondary metabolites such as terpenoids, flavonoids, and tropane alkaloids—specifically, scopolamine and atropine—are responsible for this. Consuming Jimson marijuana may cause anticholinergic intoxication, which manifests as a set of symptoms. Biopesticides made from Datura stramonium are less expensive, safer, and better for the environment than broad-spectrum conventional pesticides. They can help manage insects that cause postharvest losses, such as weevils. Living microorganisms including cyanobacteria, rhizobium, and azotobacter are found in biofertilizers, which are essential for organic farming since they increase plant growth and improve nutrient availability. All things considered, Datura stramonium has medicinal advantages as well as possible uses in sustainable agriculture.
Keywords: - Jimson seed; Atropine (crude Jimson oil); Biopesticide; Biofertilizer; Datura Stramonium

Introduction

Datura stramonium, a plant from the Solanaceae family, contains potent tropane alkaloids like atropine and scopolamine. It has been utilized in Eastern medicine for various ailments but its pharmacology, toxicity, and phytochemistry remain unclear. Some Datura species are cultivated for secondary metabolites, particularly nortropane alkaloids. The plant has multiple uses including medicinal, ceremonial, and insecticidal. However, oral ingestion can cause severe anticholinergic effects, emphasizing the need for awareness about its toxicity. Studies have examined environmental and cultural factors affecting Datura growth and compound production. Biopesticides, sourced from plants or microbes, offer environmentally friendly pest control at a lower cost than synthetic pesticides. Biofertilizers, containing beneficial microorganisms, enhance nutrient availability and soil health, particularly in sandy soils prone to nutrient leaching. Formulating biofertilizers requires careful consideration of carriers, inoculants, and storage conditions. Overall, Datura's diverse alkaloids contribute to its defensive properties, while biofertilizers offer sustainable agricultural benefits.

Biofertilizer and Biopesticide

Biofertilizer

Biofertilizers, also known as microbial inoculants, use symbiotic microorganisms to improve soil fertility and crop yield by increasing the availability of nutrients such as nitrogen and phosphorus. They contribute to healthy soil, less pollution in the environment, and less use of chemicals. They provide an affordable and environmentally beneficial substitute for chemical fertilizers. Because organic farming focuses on sustainability, food safety, and environmental contamination, biofertilizer use is prioritized. These microbial formulations assist biological control, stabilize soil, increase nitrogen fixation, promote plant development, and aid in the rehabilitation of contaminated soils. In general, biofertilizers support sustainable agriculture by utilizing the potential of advantageous microorganisms to improve plant nutrition and soil health.

Different Types of Biofertilizers

Types Of Biofertilizer	**Description**
Rhizobium	Rhizobium biofertilizer contains bacteria that form symbiotic relationships with leguminous plants, fixing atmospheric nitrogen to enhance soil fertility and promote plant growth. Its use increases nitrogen availability in the soil, boosting yields of leguminous crops and reducing the need for nitrogen fertilizers.
Cyanobacteria	Cyanobacteria play a vital role in the global nitrogen cycle, serving as key nitrogen fixers across various terrestrial environments, from deserts to rainforests. They form complex associations with other bacteria and green algae, often in formations called cyanobacterial mats, and can thrive in diverse and harsh conditions.
Azotobacter	Azotobacter thrives in nitrogen-free environments, utilizing atmospheric nitrogen for protein synthesis. Upon their death, these proteins enrich soil nitrogen, benefiting crop plants. Azotobacter is sensitive to high temperatures, salt, and acidity. Additionally, it produces organic compounds aiding plant root development, such as vitamins and hormones.
Azospirillum	Azospirillum, a nitrogen-fixing bacterium, produces growth-regulating chemicals. A.lipoferum and A.brasilense commonly associate with plants, benefiting crops like maize, sugarcane, sorghum, and pearl

	millet. They colonize plant roots without forming visible nodules.
Datura Fertilizer	Datura fertilizer is a liquid organic and mineral fertilizer designed specifically for all varieties of datura plants. It is suitable for both container and ground planting. With a combination of mineral and organic ingredients, including biologically active humic substances, it effectively meets the nutritional needs of datura plants. This fertilizer promotes rapid growth and robust root development, supporting the plant's high water consumption and heavy flowering. It provides quick action, is environmentally safe, and ensures effective fertilization.

Biopesticide

Globally, biopesticides—which are made from living things such as microbes, plants, and animals—are becoming more and more important for controlling pests that harm plants. They provide efficient pest management without endangering the surrounding ecosystem. Biopesticides are non-toxic pest control agents that come from natural enemies or their byproducts, such as microbial products or phytochemicals. According to the OECD, these are compounds that are sold for the purpose of controlling pests that are derived from live microorganisms found in natural sources. Broadly speaking, biopesticides are a class of biochemicals and microbial pesticides derived from natural and microbial sources that have traditionally been used in conjunction with biological control techniques.

Various types of Biopesticide

Microbial Biopesticide

These are utilized to biologically control weeds, pest insects, and plant diseases. They contain microorganisms such as bacteria, viruses, fungus, and protozoa as active components. The most common microbe used in the production of biopesticide is Bacillus thuringiensis, an insect pathogenic bacterium (Bt). When B. thuringiensis generates spores, the bacteria produces a toxin or protein crystals that, when consumed by some insects, can cause gut cell lysis.

Biochemical pesticide

Understanding if a natural pesticide can control the pest through a non-toxic mode of action can be difficult, thus the Environmental Protection Agency (EPA) formed a committee to investigate whether a pesticide fits the requirements for a biochemical pesticide. They go under the name of natural pesticides as well. Plant-produced secondary metabolites are also classified as biopesticides.

Semiochemicals

Semiochemicals are chemical messages that affect behavior in individuals of the same species or distinct species. These signals are frequently released by insects. The most prevalent semiochemicals utilized in crop protection are insect pheromones, which are mostly used for pest management through techniques including mating disruption and lure-and-kill systems. For a variety of reasons, they help species communicate with one another.

Formulation of Biopesticide

Biopesticides can be easily applied using current technologies because their formulation is similar to that of synthetic pesticides. The viability of these must be maintained during formulation and storage because they are derived from live creatures. The main goals of formulations are to make bioagents easier to handle, stabilize them, shield them from the environment, and increase their efficacy against pests. Various formulation strategies are used to attain these objectives.

Powder

Dust formulations typically include 10% active component and are prepared by sorpting the active ingredient onto finely ground, solid mineral powder (talc, clay, etc.) with particle sizes ranging from 50 to 100 mm. The inert components for dust formulations are UV filters, adhesive materials (like stickers) to promote adsorption, and anti-caking chemicals.

Granules

Granules' active component concentrations range from 2 to 20%, and the active chemicals either cover the granule's outside or seep into it.

Water Dispersible Granules

It has high storage stability, is dust-free, and is made to be suspended in water to solve the issues with WPs.

Emulsion

Water can be mixed with emulsion formulations to create ordinary emulsions, which are water in oil (W/O), or inert emulsions, which are water in water (O/W). Above all, in order to avoid instability, selecting the appropriate emulsifiers for stabilization is essential. However, in the case of a water-in-oil emulsion, losses from evaporation and spray drift are minor due to the oil in the outer phase of the formulation.

Capsule Suspension

The stable, microencapsulated solution required for the active component formulation needs to be diluted with water before to usage. Encased in capsules made of gelation, starch, cellulose, and several other polymers, the bioagents are protected from the harsh environment. The most often used encapsulation technique, interfacial polymerization principle, results in smaller and more potent formulations of mostly fungal biopesticides.

BIOPESTICIDE OF DATURA

Consistent use of datura liquid and gaseous pesticides is necessary to manage insect populations in stored goods, as up to 25% of the global harvest is lost annually to insect damage. However, prolonged use of synthetic fumigants has led to issues like resistance development and environmental harm. There's an urgent need for new, affordable, and eco-friendly insect control methods. Plant-derived substances, like those from Datura, show promise due to their effectiveness against specific pests and potential for non-toxic compound recycling. Developing new classes of safer insect control agents is crucial to address the drawbacks of synthetic pesticides and fumigants.

Traditional Uses Of The Jimson Plant

Tropical and subtropical climates cover the majority of Ethiopia's landmass. As a result, 35–45% of Ethiopia's environment is suited for jimson plantations, and the country's climate is ideal for the plant's growth. The jimson plant has been observed across Ethiopia. Oromia, Gambella, Somalia, Southern Nations, Nationalities, and Peoples, Sidama, and Amara are among the locations where it can be found. Due of Datura stramonium's biological activity, extracts are used in traditional medicine.

Chemical Components of Datura stramonium

The plant contains 0.2–0.6% alkaloids. The two primary alkaloids are hyoscine (scopolamine) and hyoscyamine. Additionally present are albumin and atropine. Atropine is produced by racemization of hyoscyamine. Although these alkaloids are typically found in a ratio of around two parts hyoscyamine to one part hyoscine, hyoscine nevertheless predominates in immature plants.

Datura Stramonium Contains the Following major Alkaloids

There are more than 70 alkaloids in the various plant sections. The primary constituents are tropane alkaloids, which are produced by biosynthesis from the amino acid ornithine. Tropane belladonna alkaloids, which are found in Datura, are potent anticholinergic poisons. These alkaloids include hyoscine (roots), atropine (d, hyoscyamine), hyoscyamine (leaves, roots, seeds), scopolamine (l-hyoscine), and protein and sitosterol. Trianes with a methylation nitrogen atom (N-CH3) include the narcotic cocaine and the anticholinergic medications atropine, hyoscyamine, and scopolamine.

Jimson Plant (Datura Stramonium) In Ethiopia

Ethiopia's tropical and subtropical climates make up 35–45% of its environment suitable for Jimson plant cultivation. The plant has been observed in various regions, including Oromia, Gambella, Somalia, Southern Nations, Nationalities, and Peoples, Sidama, and Amhara.

THE ATROPINE BASED BIOPESTICIDE

Jean Servais Stas, a Belgian scientist, first isolated an alkaloid poison, nicotine, in 1850 using a solution of acetic acid and ethyl alcohol. Jimson seed, or Datura seed, serves as a pesticide that effectively repels pests without harming beneficial insects. Its germicidal and antibacterial properties make it a valuable tool in plant defense against pests. Unlike synthetic pesticides, Jimson-based alternatives leave no residue on plants. This shift away from synthetic pesticides is due to growing awareness of their negative effects on non-target organisms and the environment. Atropine-based insecticides like Jimson oil are less likely to cause insect resistance due to their diverse mechanisms of action compared to synthetic pesticides targeting the nervous system. Overall, Jimson-based insecticides play a significant role in agricultural pest management

Atropine's impact in Controlling Pest Growth

Jimson products, containing atropine, effectively manage insect populations by disrupting the molting process of larvae. Atropine inhibits the activity of ecdysones, preventing larval molting and leading to their death. Inadequate dosage may result in larval death during pupation or malformed, infertile adults. Atropine also blocks receptors activated by muscarine, affecting cholinergic nerve stimulation

Feeding Prevention's Atropine Effect

A leaf present will be attempted to be consumed by an insect embryo. The maxillary glands are the cause of this particular feeding trigger. The result is an increase in the alimentary canal's peristalsis, which makes the larva hungry and prompts them to begin feeding on the leaf's surface. As atropine blocks the muscarine-like effects of acetylcholine and other choline esters, a Jimson product applied to the leaf will work as an antimuscarinic agent. The insect is unable to feed on the surface treated with atropine due to this perception. It also finds it tough to swallow. It's going to be antimuscarinic. The insect is unable to feed on the surface treated with atropine due to this perception. It also has difficulty swallowing.

Atropine has an anti-oviposition effect

Atropine also inhibits pests by preventing ovulation in females. This characteristic, called oviposition prevention, is useful when seeds are stored with atropine or crude Jimson oil on top of them. After this treatment, the insects won't be able to feed on them anymore. The female will be unable to lay eggs for the duration of her life cycle, shielding the grains from further harm.

Conclusion

Mythology claims that datura species were among the first to be used in traditional medicine. Because of its hallucinogenic properties, it has been the basis of numerous significant cultural traditions. The impacts of Jimson plants have been studied in a number of general biological activities, including pesticide, fungicide, and antibacterial, among others, based on this cultural knowledge. Plants are used for a variety of purposes, including food, shelter, fiber, tanning, gum, oil, and latex. Because of their rich mineral, antioxidant, vitamin, and nutritional content, they have an immunomodulatory effect. The wild herb Datura stramonium has been used to treat rheumatism, ear discomfort, headaches, wounds, burns, tension, depression, insomnia, asthma, boils, and inflammation. Bio-pesticides are naturally occurring substances that come from living things (natural enemies) or their byproducts (microbial products, phytochemicals), and they work in harmless ways to control pests. According to the Organization for Economic Co-operation and Development (OECD), biopesticides are synthetic, mass-produced materials made from living microorganisms that are present in natural environments.

Reference

1. Introduction on datura to Khaton M Monira1 and Shaik M Munan> 2012

2. Biofertilizer for crop production and soil fertility to neha S, Anitha and Anjum > Aug. 2018

3. Jimson seed in bio pesticide application by Melaku Tafese Awulachew > 2022

4. Microbial pesticide to S. Senthil-Nathan > 2015

5. Biopesticide for pest control by ashir, K. A.,

6. Pharmacological, Biopesticide, and Post-Harvest Loss Management Application of Jimsonweed Melaku Tafese>January 20th, 2022

7. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
8. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
9. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
10. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
11. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
12. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
13. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
14. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar

Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343

15. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
16. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
17. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
18. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
19. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
20. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
21. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
22. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
23. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
24. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging

Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***

25. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
26. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
27. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
28. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
29. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
30. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
31. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
32. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
33. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
34. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
35. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383

36. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
37. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
38. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
39. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
40. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
41. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
42. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
43. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
44. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
45. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
46. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
47. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669

48. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
49. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
50. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
51. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
52. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
53. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
54. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
55. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
56. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
57. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
58. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
59. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms

in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.

60. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
61. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
62. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
63. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
64. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
65. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
66. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
67. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
68. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
69. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
70. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
71. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change

from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)

72. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
73. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
74. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
75. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 4

REVIEW ARTICLE ON BIOFERTILIZER AND BIOPESTICIDE AS A SHATAVARI

Nikhil Kumar Singh[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract

Biofertilizers: Cultures of soil microorganisms improve soil and plant fertility. They include helpful microbes that transform insoluble phosphates into soluble forms, hence increasing nutritional availability. Ethylene from Paenibacillus polymyxa inhibits the growth of dicot plants. Choosing active microorganisms, isolating target bacteria, propagation technique, carrier material, phenotypic testing, and large-scale trials are the steps involved in producing biofertilizer. Rhizobia strains promote plant growth, yield, and soil fertility. Shatavari has dual uses as a biopesticide and a biofertilizer.

Biopesticides: Made from living things, such as microbes, plants, and animals. Plant extracts, microbial metabolites, and minerals are examples of active substances that are naturally derived. Phytochemicals such as acids, alkaloids, flavonoids, glycosides, saponins, and terpenoids are found in botanical biopesticides. Shatavari root extracts are highly efficient in aqueous and ethanol forms, demonstrating antibacterial activity against a variety of pathogens.

Keywords: Biofertilizer, Biopesticide, Shatavari. Plant growth

Introduction

Biofertilizers are soil microbial cultures that improve plant and soil fertility by improving nutrient availability for plants. Living microorganisms are present in them, which use many strategies to colonize the rhizosphere and stimulate growth. These strategies include nitrogen fixation, potassium and phosphate solubilization, and the synthesis of chemicals that regulate growth. One of the most affordable and environmentally friendly forms of plant nutrition is biofertilizer. They increase production and soil fertility, which is crucial given that soil fertility is decreasing as a result of ongoing farming and growing population pressure. Biofertilizers, unlike chemical fertilizers, help to maintain a healthy soil ecosystem while reducing the environmental impact of agricultural activities. Biofertilizers play an important role in nutrient cycle by aiding in nitrogen fixation and mineralization. They contribute to a nutrient-rich soil environment, boosting crop productivity. Beneficial microbes have been used in agriculture for almost 60 years. Over time, it has become clear that these bacteria not only promote plant development but also boost plant resistance to environmental challenges such water and nutrient deprivation, as well as heavy metal contamination. Usually, biofertilizers are used as soil or seed inoculants. An boost in agricultural yield results from their multiplication and involvement in the cycling of nutrients. Biofertilizers, when used in conjunction with other management strategies such as integrated nutrient management systems, help to sustain agricultural productivity while also maintaining the environment.

Soil Fertility

Soil is the layer of the earth where plants develop, made up of topsoil, subsoil, and parent material. Topsoil is essential for plant growth and comprises minerals, air, water, live organisms, and organic matter in particular proportions. Typically, the composition of fertile soil is 45% minerals, 25% water, 25% air, and 5% organic stuff. Nitrogen, phosphorus, and potassium are essential nutrients for plants; certain elements are needed in greater amounts (macronutrients), while other elements are needed in lesser amounts (micronutrients). Micronutrients contain substances like boron, manganese, and zinc, whereas macronutrients are nitrogen, phosphorous, and potassium.

Types of Biofertilizer - Bio-fertilizer are classified of depending on the type or group of microorganisms.

Types of Biofertilizer	Description	Example
Nitrogen fixing bio-fertilizer	These act by capturing atmospheric nitrogen and converting it to organic (plant-usable) forms in the soil and root nodules of legumes, making it available to plants. Crop-specific biofertilizers are fertilizers that fix nitrogen.	Rhizobium spp, Azospirillum spp.
Phosphate solubilizing Bio-fertilizer	They function by dissolving the phosphate in the soil that is insoluble so that plants may absorb it. Most phosphorus in soil is found as insoluble phosphate, which is incapable of being taken by plants. Nevertheless, a number of fungi and bacteria found in soil can change these insoluble phosphates into their soluble counterparts. These organisms accomplish this by secreting organic acids that decrease the pH of the soil and dissolve bound forms of phosphate, making them available to plants.	Bacillus spp.,Pesudomoona spp, Aspergillus spp.
Phosphate mobilizing bio-	By removing phosphates from soil layers and releasing the insoluble phosphorus present in the soil, these agents function. According to	Mycorhiza.

fertilizers	Chang and Yang, biofertilizers that solubilize phosphorus can also function as phosphate mobilizers on occasion. Broad spectrum biofertilizers are those that mobilize phosphate. Bacteria that mobilize and immobilize soil phosphorus.	
Potassium solubilizing bio-fertilizer	They typically exist in the soil as silicate minerals that plants cannot access. These minerals become available only after they have been gently weathered or solubilized. Potassium-solubilizing microorganisms dissolve silicates by creating organic acids, which promote silicate breakdown and aid in the removal of metal ions, making them available to plants. Broad range biofertilizers are those that solubilize potassium.	*Bacillus spp, and Aspergillus Niger* .
Plant growth promoting bio-fertilizer	They act by generating hormones and anti-metabolites that promote root growth, organic matter breakdown, and soil mineralization, enhancing nutrient availability and crop output. Crop-specific biofertilizers are those that stimulate plant growth.	Plant growth rhizobacteria are Pseudomonas Spp.
Sulfur oxidizing bio-fertilizer	They work by oxidizing sulfur to sulfates which are usable by plants.	Thiobacillus Spp.

Mechanism of Action

The growth of the plant Azospirillum, a Rhizobacteria species, has been hypothesized to secrete gibberellins, eltylene, and auxins. Some plant-associated bacteria can also stimulate phytohormone synthesis; for example, lodge pole pine treated with Paenibacillus polymyxa had higher amounts of IAA in its roots. It was discovered that Rhizobium and Bacillus could synthesis IAA at varying temperatures, pH values, and carrier materials such as agro-waste. In contrast to other phytohormones, ethylene is the one that stops dicot plants from growing.

Making of Biofertilizer

The development profile of microorganisms, the kinds and ideal circumstances of organisms, and the formulation of the inoculum are only a few of the numerous factors that must be taken into account while creating biofertilizers. The biological product's success depends on the inocula's composition, how it is applied, and how it is stored. In general, six steps are involved in the production of bio-fertilizer. These include selecting active microorganisms, isolating and picking target bacteria, deciding on a propagation strategy and carrier material, doing phenotypic testing, and conducting large-scale experiments.

It is first necessary to choose which live microbes will be employed. For example, it must be determined whether to use organic acid bacteria, nitrogen fixers, or a combination of these species, after which target microbes are identified. Typically, to separate creatures from plant roots, a decoy is used to attract the organisms, such as putting chilled rice beneath bamboo plants. Next, the isolated organism will be cultured in Petri plates before being mass produced in flasks. Selecting the appropriate carrier material is also essential. The best carrier materials to employ are apioca flour or peat if the goal is to create powdered biofertilizer. Finding the ideal growing conditions for the organism is the primary goal of selecting a propagation method.

Biofertilizers help plants develop faster:

Recent research (Verma et al., 2019) have demonstrated that Rhizobium leguminosarum, Rhizobium spp. IRBG 74, and Bradyrhizobium spp. IRBG 271 boost plant biomass, yield, and chlorophyll content when compared to uninoculated plants. Similar to this, certain strains of Rhizobia will increase the surface area, photosynthetic rate, capacity to absorb water, yield, and stomatal conductance of inoculated plants. Its application has also been connected to how biofertilizer increases plant yield and growth, which results in more food being produced. And to help plants develop faster, enhance soil fertility, and plant growth.

Importance of Bio-fertilizer

The use of biofertilizers can significantly increase the soil's fertility. Furthermore, applying them to the soil enhances its structure and reduces the need for chemical fertilizers alone. When used in conjunction with Azospirillum, blue green algae greatly increased grain output in low-lying areas. The biggest increase in straw and grain yield of wheat plants treated with rock phosphate was achieved with the use of bio-fertilizers inoculated with Azotobacter, Rhizobium, and Vesicular Arbuscular Mycorrhiza. Azolla is an affordable, environmentally friendly product that enriches soil with nitrogen and carbon. It has been shown that bacteria like Bacillus subtilis, Thiobacillus thioxidans, and Saccharomyces species can symbiotically fix atmospheric nitrogen, and soy beans can supply 80–90% of the nitrogen needed. Bio-control, a contemporary method of managing diseases, can play a big part in agriculture using biofertilizer. Bio-fungicides based on Trichoderma have shown promise in managing mung bean root rot. With bio-fertilizers comprising bacterial nitrogen fixers, phosphate and potassium solubilizing bacteria, and microbial strains of certain bacteria, the growth, yield, and quality metrics of some plants rose dramatically. The following highlights the significance of biofertilizers: plant growth hormones secreted, which aid in plant growth, Plant defense against disease invasion, enhanced soil fertility, and increased plant development all contribute to higher crop yields.

Shatavari as a biofertilizer

The shatavari plant, which contains potassium, zinc, manganese, and calcium, can be used to make biofertilizer and apply it to increase soil fertility and plant development. They can offer a 10–40% boost in crop output. They enhance the pH, texture, and other characteristics of the soil. They generate materials that encourage plant growth, such as vitamins and IAA amino acids. Asparagus racemosus is a metal element used in the production of biofertilizers, plant growth, and soil fertility improvement.

Biopesticide

Biopesticides are environmentally benign insecticides made from living things, such as microbes, plants, and animals. By using harmless methods, they efficiently control pests that harm plants. These insecticides are made up of natural active components like plant extracts, microbes, and organic compounds. They are essential to integrated pest management (IPM) techniques because they deal with a variety of pests, including weeds, nematodes, mollusks, insects, and diseases. There are three types of biopesticides: microbiological pesticides, biochemical pesticides, and plant-incorporated protectants. They are becoming increasingly important in both organic and conventional farming, thanks to developments in formulation and efficacy. Biopesticides can be just as effective as synthetic pesticides and leave less residues, especially when used on crops including fruits, vegetables, nuts, and flowers. Possessing the ability to regulate resistance, they provide a compromise between environmental safety and performance.

Comprehending their various modes of action and employing appropriate application methods are crucial for their effective use in pest management.

Concept of Biopesticide

Biopesticides are consistently occurring substances derived from living things (organic competitors), or their quantity (microbial device, phytochemicals), or their byproduct (semiochemicals) that can control bugs through safe mechanisms (Salma and Jogen, Organization for Economic Cooperation and Development, believed biopesticides as made conventional powers arisen organic beginnings living bacterium and convinced for use to control plague). Suman and Dikshit claim that biopesticides are made up of a wide variety of microbial pesticides, biochemicals derived from bacteria, and ordinary sources. Biopesticides have been used historically to direct biological control and, by suggestion, the direction of living things.

Types of Biopesticides

Types	**Description**	**Example**
Plant-Incorporated Protectants	Plant-Incorporated Protectants (PIPs) are biopesticides derived from genetically modified plants that produce pesticidal substances within their tissues to protect against pests.	A Plant-Incorporated Protectant (PIP) is Bt corn, which has been genetically modified to produce proteins from the *Bacillus thuringiensis* (Bt) bacterium. Because these proteins are poisonous to some insect pests, corn plants are naturally resistant to pests.

Microbial Pesticides	Microbial pesticides are biopesticides that use microorganisms like bacteria, fungus, and viruses to manage pests.	The bacterium *Bacillus thuringiensis* (Bt), which is used to create poisons that particularly target insect pests including caterpillars and mosquitoes, is an example of a microbial pesticide.
Biochemical Pesticide	Biochemical insecticides are biopesticides that employ naturally occurring materials to manage pests, such as plant extracts, insect development regulators, and pheromones.	A biochemical pesticide is neem oil, which is derived from the neem tree. Neem oil includes chemicals that inhibit the growth and development of insect pests, acting as a natural pesticide.

The Need for Biopesticide

Environmental concerns- Biopesticides present a sustainable substitute for synthetic pesticides, mitigating the likelihood of environmental contamination and harm to non-target creatures.

Human Health Benefits- When it comes to farmers, consumers, and pesticide applicators, biopesticides usually pose fewer dangers because they are generally less hazardous to humans than synthetic pesticides.

Resistance management- As a result of persistent usage of synthetic pesticides, bugs that are resistant to them have evolved. By offering a different mode of action, biopesticides aid in managing resistance and extending the efficacy of pest management techniques.

Sustainable Agriculture- Through encouraging natural pest control mechanisms, lowering dependency on chemical inputs, and maintaining ecosystem balance, biopesticides enhance sustainable agriculture practices.

Regulatory Requirements- The creation and application of safer pest management alternatives, such as biopesticides, is required in light of tighter laws on the use of pesticides, particularly in relation to issues with the environment and public health.

Biopesticides of Botanical Origin

Plants include a variety of phytochemicals, or secondary metabolites, with pesticidal activities. These substances are present in plant extracts or oils that are made from various plant components, such as leaves, barks, flowers, roots, seeds, and so on. They include acids, alkaloids, flavonoids, glycosides, saponins, and terpenoids. Dried plant components are frequently favored for extraction because they contain a greater concentration of active chemicals. For example, research on Citrus sinensis showed that the main components of its oil, myrcene and d-limonene, have pesticidal properties. When tested against cereal leaf beetle larvae on wheat, these components resulted in up to 85% death in under 48 hours. Similarly, aqueous fruit extracts from Withania somnifera were evaluated against Fusarium oxysporum f.sp. radicis-lycopersici, the fungus that causes fusarium crown and root rot disease in tomatoes. At a dosage of 2%, these extracts inhibited fungal growth by up to 56% in vitro.

Mechanisms Of Action Of Biopesticides For Pest Control

They include the following of Antibiosis, Hyperparasitism, synergism.

Antibiosis

One method of action used by several biopesticides, especially microbial pesticides, to control pests is antibiosis. Antibiosis occurs when a biopesticide creates molecules such as poisons or antimicrobial compounds that prevent the target pest from growing, developing, or surviving.

For instance, a common microbial insecticide in agriculture is Bacillus thuringiensis, or Bt. Bt generates insecticidal toxins, which are consumed by sensitive insect pests. Once within the insect's digestive system, these toxins cause cellular disruptions that result in paralysis and, eventually, the pest's death. This procedure is an example of antibiosis, in which the biopesticide directly affects the target pest's physiology or metabolism, resulting in its control.

All things considered, antibiosis is a crucial mode of action that biopesticides use to successfully eradicate pests while reducing the harm they cause to non-target creatures.

Hyperparasitism

A method of action used by some biopesticides, especially microbial pesticides, is hyperparasitism, which targets other species that parasitize or feed on pests in order to manage pests indirectly.

In hyperparasitism, the biopesticide delivers helpful organisms into the environment that are referred to as hyperparasites. These hyperparasites subsequently parasitize or attack the pest's natural enemies, such as parasitic wasps or predatory insects, lowering their numbers. As a result, natural enemies are unable to effectively control the target pest population, resulting in its eradication.

As an illustration, certain microbial pesticides include fungal diseases that parasitize insects. Additionally, other microorganisms or insects may hyperparasitize these fungi, impairing their ability to manage pest populations.

Synergism

When two or more components, frequently natural substances or organisms, cooperate to increase a biopesticide's overall efficacy in combating pests, this is known as synergism. Together, these two factors have a bigger effect on pest populations than they would if they worked alone. A biopesticide formulation, for instance, can blend several microbial species or strains that individually target various facets of the biology or physiology of the pest. The biopesticide can accomplish greater pest control coverage and address any resistance problems by combining these strains. Furthermore, there is a chance that multiple kinds of biopesticides will work in concert, for example, when microbial pesticides are combined with pheromones or plant extracts. These mixtures might have complimentary mechanisms of action that minimize adverse effects on non-target organisms while increasing efficacy against pests.

Plant Based Extracts and Essential Oils

In recent years, Shatavari plant extracts and essential oils have received attention as possible alternatives to synthetic insecticides for pest control. These naturally occurring insecticides are made from plants and work well against a variety of insect species because they contain a variety of bioactive compounds. They have a variety of actions, including repellency, attraction, antifeedancy, respiration suppression, disruption of host plant identification, oviposition inhibition, and reduced adult emergence via ovicidal and larvicidal effects. Although their composition varies substantially, some well-known examples are neem oil and lemongrass oil, which are readily accessible in herbal shops around the world.

Halder et al. conducted a detailed investigation on the efficiency of mixing Shatavari oil with entomopathogenic bacteria, specifically Beauveria bassiana, against vegetable-sucking bugs. However, determining the right dosage of azadirachtin concentration in neem oil is critical to preventing harm to non-target organisms. A comparable dose strategy should be developed for entomopathogenic fungi, which would include additional laboratory bioassays as well as station and/or field studies to assure effective pest management while limiting impact on non-target insect populations.

Antimicrobial Property

Aqueous extracts of shatavari's roots demonstrate extensive action against a variety of microbial strains, demonstrating the plant's antibacterial properties. The solubility of the active ingredients may be the reason for the differences in the antibacterial efficacy of various Shatavari root extracts or decoctions. The Shatavari root 30% ethanol extract had the broadest inhibitory zone. The most resistant strain was Shigella flexneri, and the most vulnerable strain was Staphylococcus aureus. Based on the microbiological clearance test (MIC), the 30% ethanol extract and the aqueous extract exhibited the strongest antibacterial activity. The efficacy of an aqueous or ethanol extract is determined by the active components present. Important active components with antioxidant and antibacterial properties are alkaloids, terpenoids, and phenolic compounds. Notably, Salmonella enterica and Shigella flexneri displayed stronger resistance than Staphylococcus aureus.

Antibacterial Property

racemosus (Shatavari) root extracts were tested for antibacterial activity against Bacillus subtilis, Staphylococcus aureus, Staphylococcus Werneri, Pseudomonas aeruginosa, Escherichia coli, Proteus mirabilis, Klebsiella pneumonia, and Pseudomonas putida using the standard cylinder method. The extract was sensitive to both Gram-positive and Gram-negative bacteria. At 100 mg/ml, 300 mg/ml, and 500 mg/ml concentrations, ethanol extracts had antibacterial activity that was equivalent to that of the reference medication, Gentamycin (25 µg). Staphylococcus aureus, a Gram-positive bacteria, was the most affected by the extract.

Shatavari as an Biopesticide

Shatavari contains antimicrobial, antibacterial, and antifungal properties that make it useful against insects (bacteria, viruses, and fungi) to stop and stop the development of plants as well as eradicate pests. Shatavari is used to produce insecticides, kill insects, and prevent plant diseases because of its antimicrobial, antibacterial, and antifungal properties. In order to increase crop yields, Shatavari is producing biopesticides and protecting the environment, plants, and crops. A naturally occurring plant called Asparagus racemosus is used to manufacture biopesticides, which are primarily used to protect crops and plants from environmental harm. They can also be used to treat diseases, promote plant development, eradicate insects, and boost crop yields.

Conclusion

Shatavari plant extracts can be used as both biofertilizers and biopesticides in agriculture. Shatavari is a biofertilizer that improves soil health by preserving organic matter, providing vital nutrients, stimulating plant development, and raising agricultural yields. Shatavari is a biopesticide that works well to control pests and prevent plant illnesses because of its antimicrobial, antibacterial, and antifungal characteristics. Its use in agriculture as a biofertilizer and biopesticide promotes plant development, combats illnesses, and preserves soil fertility by delivering nutrients and controlling pest infestations.

Reference

1. Itelima JU1 , PhD, Bang WJ1 , PhD, Sila MD1 , Onyimba IA2 , PhD, Egbere OJ3 , PhD. A review: Biofertilizer - A key player in enhancing soil fertility and crop productivity March 2018

2. Swapnil Rai and Nidhi Shukla. biofertilizer: an alternative of synthetic fertilizers February 2020

3. Barsha Sharma and Laxmeshwar Yadav, Meena Pandey, Jiban Shrestha. Application of biofertilizers in crop production: A review June 2022
4. Sengottayan Senthil-Nathan. A Review of Biopesticides and Their Mode of Action Against Insect Pests February 2015
5. Tijjani, A, Bashir, K. A, Mohammed, I, Muhammad, A, Gambo, A. and Musa, Biopesticides for pests control: a review September 2017
6. Surendra K. Dara. Biopesticides: Categories and use strategies for IPM and IRM March 2021
7. GJitendra Kumar, Ayyagari Ramlal, Dharmendra Mallick,and Vachaspati Mishra. An Overview of Some Biopesticides and Their Importance in Plant Protection for Commercial Acceptance June 2021
8. Ramit Singla and Vikas Jaitak . Shatavari (asparagus racemosus wild): a review on its cultivation, morphology, phytochemistry and pharmacological importance March 2014
9. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
10. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
11. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
12. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
13. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for

Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051

14. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
15. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
16. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
17. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
18. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
19. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
20. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
21. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)

22. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
23. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
24. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
25. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
26. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
27. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
28. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
29. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
30. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
31. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
32. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant

Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959

33. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
34. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
35. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
36. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
37. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
38. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
39. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
40. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
41. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
42. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
43. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616

44. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
45. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
46. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
47. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
48. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
49. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
50. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
51. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
52. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
53. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
54. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
55. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
56. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732

57. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
58. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
59. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
60. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
61. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
62. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
63. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
64. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
65. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
66. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
67. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis

68. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
69. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
70. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
71. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
72. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
73. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
74. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
75. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
76. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
77. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 5

A REVIEW ARTICLE ON BIOFERTILIZER AND BIOPESTICIDE OF BHRINGRAJ

Umesh Kumar[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract

Biofertilizers are substances that enhance soil fertility by harnessing microorganisms that form symbiotic relationships with plants, providing essential nutrients like nitrogen and phosphorus. They contribute to soil health, reduce environmental pollution, and minimize the need for chemical fertilizers. Our study reaffirmed previous findings regarding the antifungal properties of Eclipta alba extracts against sorghum pathogens. Specifically, methanolic fractions of E. alba exhibited potent antifungal effects against harmful sorghum grain mold pathogens such as F. thapsinum, A. alternata, E. sorghinum, and C. lunata. Purification of the methanol E. alba extract through column chromatography enhanced its antifungal potency by removing nonpolar components. Phytochemicals like eclalbasaponin II and wedelolactone, found in higher concentrations in methanolic fractions, significantly bolstered the antifungal activity against targeted sorghum pathogens. This research underscores E. alba's potential as a biofertilizer and biopesticide due to its rich array of active phytochemicals. The susceptibility of sorghum to various pathogens poses a significant challenge to its cultivation, with fungal diseases causing substantial yield losses worldwide. This study emphasizes the importance of exploring natural alternatives like E. alba extracts in combating sorghum diseases and enhancing agricultural productivity.

Keywords: - Biofertilizer, biopesticide, eclipta alba plant in fungal effect, sarghum.

Biofertilizer

Biofertilizers are compounds that use microorganisms that develop symbiotic relationships with plants to increase the nutritional content of the soil. Another term for biofertilizers is microbial inoculants, which are artificially created cultures of specific soil microorganisms that can boost crop output and soil fertility. Chemical fertilizers can be substituted with affordable, sustainable plant nutrition supplies called biofertilizers. Biofertilizers create plant nutrients like phosphorus and nitrogen through their activities in the soil and make them available to the plants growing there. Biofertilizers are becoming increasingly significant since they contribute to the maintenance of healthy soil, lower environmental pollution, and require fewer chemicals. There is a lot of uncertainty around the term "biofertilizer." Thus, biofertilizers are substances that include living microbes that colonize the inside of plants and promote development by increasing the supply or availability of primary nutrients to the target crops, regardless of whether they are applied to soil, seeds, or plant surfaces. Fertilizers' capacity to change nutritionally important ingredients from an indigestible condition to an edible one. Not only do these bacteria provide vital nutrients to plants, but they also require organic matter in the soil for growth and development. Applying live, ready-to-use formulations of beneficial microbes to seeds, roots, or soil increases the availability of nutrients through their biological activity and promotes the growth of microflora, which enhances soil health overall. These microorganisms are known as biofertilizers. Biofertilizers are compounds that use microorganisms that develop symbiotic relationships with plants to increase the nutritional content of the soil. Another term for biofertilizers is microbial inoculants, which are artificially created cultures

of specific soil microorganisms that can boost crop output and soil fertility. Chemical fertilizers can be substituted with affordable, sustainable plant nutrition supplies called biofertilizers. Biofertilizers generate plant nutrients like nitrogen and phosphorus through their activities in the rhizosphere or soil, and they also make these nutrients available to plants growing in the soil. Biofertilizers are becoming increasingly significant since they contribute to the maintenance of healthy soil, lower environmental pollution, and require fewer chemicals. There is a lot of uncertainty around the term "biofertilizer." Therefore, biofertilizers can be defined as substances that include living microorganisms that colonize the rhizosphere or inside of plants and promote development by increasing the supply or availability of primary nutrients to the target crops, regardless of whether they are applied to soil, seeds, or plant surfaces. Nutritiously important components can be transformed from an inedible to an edible state with the help of biofertilizers. Not only do these bacteria provide vital nutrients to plants, but they also require organic matter in the soil for growth and development. When applied, live, ready-to-use formulations of advantageous microbes provide plants with vital nutrients. These are known as biofertilizers. Live, ready-to-use preparations of advantageous microorganisms are known as biofertilizers.

MECHANISM OF ACTIONS OF BIOFERTILIZER

Biofertilizers contain microorganisms that form symbiotic relationships with plants.

These microorganisms fix atmospheric nitrogen, making it available to plants.

They solubilize phosphorus, making it more accessible to plants.

Biofertilizers enhance soil fertility and improve plant growth by promoting nutrient uptake.

They contribute to sustainable agriculture by reducing the reliance on chemical fertilizers.
Microorganisms in biofertilizers also help in suppressing soil-borne pathogens, thus reducing plant diseases.
Overall, biofertilizers work by improving soil health, nutrient availability, and plant resilience.

DIFFERENT TYPES OF BIOFERTILIZER

Types Of Biofertilizer	**Description**
Rhizobium	Rhizobium biofertilizer contains bacteria that form symbiotic relationships with leguminous plants, fixing atmospheric nitrogen to enhance soil fertility and promote plant growth. Its use increases nitrogen availability in the soil, boosting yields of leguminous crops and reducing the need for nitrogen fertilizers.
Plant Growth Promoting Rhizobacteria	Plant Growth Promoting Rhizobacteria (PGPR) are beneficial bacteria that colonize the rhizosphere, the area around plant roots. They promote plant growth through various mechanisms like Nitrogen Fixation, Phosphorous Solubilization, Production of Plant Growth Hormones, Induced Systematic Resistance, Biocontrol and Enhance Nutrient uptake.

Cyanobacteria	Cyanobacteria play a vital role in the global nitrogen cycle, serving as key nitrogen fixers across various terrestrial environments, from deserts to rainforests. They form complex associations with other bacteria and green algae, often in formations called cyanobacterial mats, and can thrive in diverse and harsh conditions.
Azotobacter	Azotobacter thrives in nitrogen-free environments, utilizing atmospheric nitrogen for protein synthesis. Upon their death, these proteins enrich soil nitrogen, benefiting crop plants. Azotobacter is sensitive to high temperatures, salt, and acidity. Additionally, it produces organic compounds aiding plant root development, such as vitamins and hormones.
Azospirillum	Azospirillum, a nitrogen-fixing bacterium, produces growth-regulating chemicals. A.lipoferum and A.brasilense commonly associate with plants, benefiting crops like maize, sugarcane, sorghum, and pearl millet. They colonize plant roots without forming visible nodules. Top of Form
Zinc Solubilizers	Zinc solubilizers are microorganisms that have the ability to solubilize insoluble forms of zinc present in the soil, making it more available for plant uptake. They achieve this by producing organic acids, enzymes, or chelating compounds that break down zinc compounds into soluble

	forms. They act as a biofertilizer by enhancing the availability of zinc to plants
Phosphate Solubilizer	Phosphate solubilizers are beneficial microorganisms that enhance plant growth by making insoluble phosphate in the soil soluble and available to plants. They achieve this by producing organic acids and enzymes that break down phosphate compounds. As biofertilizers, phosphate solubilizers improve plant phosphorus uptake, leading to enhanced growth, root development, and overall crop productivity.
Phosphate Absorbers	Fungus roots" refer to mycorrhiza, which form symbiotic associations with host plants in salinity/alkalinity-affected land. To maintain productive microbial populations for phosphorus solubilization and nutrient availability, inoculating with Phosphate-Solubilizing Bacteria (PSB) and other beneficial microbes becomes essential for sustaining good crop yields.
Plant wood Ash	Wood ash, a by-product of burning organic material, is rich in essential inorganic nutrients like P, K, Mg, and Ca. Its composition varies depending on the burned plant type and conditions. When spread on agricultural fields, ash replenishes lost nutrients, combats soil acidification, and enhances plant growth. Its ability to neutralize soil acidity is measured in calcium carbonate equivalents (CCE), primarily through Ca, Mg, and K hydroxides. Ash improves

	plant phosphorus recovery, demonstrating positive effects on crop growth due to its readily available base cations.

The Role of Bio-Fertilizers In Enhancing Plant Tolerance To Environmental Stress

Biofertilizers accelerate nutrient intake by plants and increase soil productivity by fixing nitrogen from the atmosphere and enhancing phosphorus availability.

Proper formulation and application of biofertilizers are crucial for their effectiveness, requiring suitable carriers, storage conditions, and inoculant selection.

Plant growth-promoting rhizobacteria (PGPR) play a significant role in enhancing crop development, particularly under stress conditions.

Rhizobium trifoli inoculated with Trifolium alexandrium demonstrated increased biomass and nodulation under salt stress.

Pseudomonas bacteria, like Pseudomonas aeruginosa and Pseudomonas putida, exhibit tolerance to various stresses and promote plant growth by enhancing nutrient uptake and inducing stress tolerance.

Mycobacterium phlei and arbuscular mycorrhizal fungi have been shown to withstand extreme temperatures and salt stress, respectively, while enhancing plant development.

Legumes benefit from the combination of nitrogen-fixing bacteria and arbuscular mycorrhizal fungi in resisting drought stress.

Application of Pseudomonas spp. Has been found to increase antioxidant content and improve seedling development and germination under water stress.

Inoculation with arbuscular mycorrhizae improves photosynthetic efficiency and antioxidant response in rice plants under drought stress, demonstrating positive effects in dry and salty environments.

BIOPESTICIDE

The potential application of plant pesticidal properties is a key field of study in pest management. It is recognized that a number of plants have bioactive metabolites that have antifeedant, repellent, and toxic effects on a range of insect pests. Many plants have venomous or repulsive natural chemical defenses. The following are some notable examples of bioactive plants: neem, clove, lime, black pepper, dahlia, catnip, basil, artemisia, borage, ginger, hyssop, and bhringraj. It is commonly recognized that the biologically active sections of these plants include organic compounds that have the ability to be biopesticidal. By stimulating their receptors, such as their olfactory receptors, organic plant extracts used as insect repellents or pest control solutions provide protection with little impact on the environment and deter insects from coming into contact with treated objects. Effective 82ntifunga drives the intended pest to move away from the source of stimulation. That they might produce to warn off insects, overstimulating the receptors causes the beetle to die if escape is not possible. Furthermore, insects can result in large output losses because they are a constant in field crops during both cultivation and produce storage. Most agricultural product storage pests are managed by synthetic insecticides, which have been widely employed since their introduction in the 1950s. Several of these chemicals have become quite common in the environment and, in certain cases, in food consumption over time as a result of their frequent and broad use. They have been used extensively over a long period of time despite their effectiveness, which has disrupted biological control mechanisms. As a result, resistant insect pests have become more prevalent, and there are now problems for the environment, humans, and unintended non-target creatures. It has been demonstrated that essential oils or powdered extracts from a variety of bioactive plants are effective grain insect repellents. Cereals like wheat, maize, and rice make up at least 75% of the world's grain production and are some of the most important staple foods. The ongoing use of synthetic 83ntifungaes for pest control has sparked grave concerns since it harms aquatic life, people, animals, and the environment. Synthetic insecticides not only have detrimental effects on the environment and on humans, but they are also out of date because of their toxicity, are often tampered with (diluted to ineffective concentrations by dishonest traders), and are ineffective because pesticide resistance is rapidly evolving in most remote rural areas and around the world.

DIFFERENT TYPES OF BIOPESTICIDE

Types of Biopesticide	Description
Microbial Pesticides	Microbial pesticides are biologically based agents derived from microorganisms like bacteria, fungi, viruses, or protozoa that control pests or pathogens. They act by infecting, parasitizing, or outcompeting target pests or pathogens. Microbial pesticides offer environmentally friendly alternatives to chemical pesticides, are often highly specific to their target organisms, and typically have minimal impact on non-target organisms and the environment.
Biochemical Pesticides	Biochemical pesticides are naturally occurring substances or derivatives of natural substances that control pests through non-toxic mechanisms.

	They include substances like insect pheromones, plant extracts, and microbial metabolites, targeting specific pests while minimizing environmental impact and harm to non-target organisms.
Insect Pheromones	Insect pheromones are chemical substances produced by insects to communicate with others of the same species. They serve various functions, such as attracting mates, marking trails, or warning of danger. Pheromones are highly specific and play a crucial role in insect behavior, mating, and social organization. They are used in pest management strategies to disrupt mating patterns, monitor populations, and control insect pests in environmentally friendly ways.
Plant Based Biopesticide	Plant-based biopesticides are derived from natural substances found in plants, such as botanical extracts, essential oils, or compounds extracted from seeds or leaves. These biopesticides target pests through various mechanisms like repellency, toxicity, or growth regulation. They offer environmentally friendly alternatives to chemical pesticides, often exhibiting low toxicity to non-target organisms and minimal impact on ecosystems.
Nanobiopesticides	Plant-based nanobiopesticides are innovative formulations where

	active ingredients derived from plants are combined with nanoparticles to enhance efficacy and stability. These biopesticides leverage the unique properties of nanoparticles to improve delivery, adhesion, and targeted release of plant-derived compounds, offering potent pest control while minimizing environmental impact.

Eclipta Alba (Bhringraj) Can Be Use As Biopesticide & Biofertilizer

Eclipta alba (L.), bhringraj, or the “False daisy,” is an annual herbaceous plant belonging to the Asteraceae family. Ayurvedic medicine, which is practiced in India, makes extensive use of E. alba. E. alba has been used to treat diseases related to the skin, liver, and hair. It is also used as an antibacterial, antioxidant, analgesic, anti-haemorrhagic, and anti-hyperglycemic agent. E. alba contains numerous active metabolites, including coumestans, triterpenoid saponins, flavonoids, alkaloids, and a triterpene glucoside. To verify a plant’s possible antibacterial activity and identify the properties involved, it must be tested against an appropriate microbiological model. Resulting in the plant Numerous researchers from different nations have studied extracts pertaining to microbes. It has been suggested that plant extracts, both aqueous and ethanolic, may include antifungal and antibacterial substances that are utilized to treat plant diseases.

Plant Extract of Bhringraj

The aerial parts of E. alba were extracted from the wild plants and thoroughly cleaned with running water five to six times. After that, they were shade-dried for fifteen days at room temperature and ground into a fine powder. 30 grams of the powdered material were extracted using a 86ntifun extractor, with 250 milliliters of hexane, ethyl acetate, methanol, and water (50–85 °C) added in turn. The extracts were concentrated at a low vacuum using rotary evaporators (Buchi Rotavapor, R-205). The dried extracts were gathered and stored in aliquots at 4 °C for additional analysis. To further purify the crude E. alba extract and remove any pigments and possibly inactive phytochemicals that would have interfered with its antifungal action, column chromatography was employed. Following fractionation using a silica column based on differential polarity, the extract's antifungal activity was assessed. When the methanol fraction was compared to the crude extract, it showed higher antifungal activity. Eliminating the hexane and ethyl acetate soluble fracti'n enhanced the potency of the methanol fraction relative to the crude extract.

Effect Of Microbes on Eclipta Alba

Escherichia coli MTCC 118, Proteus vulgaris, 4 gram-negative bacteria, and Eclipta alba were used to test the antibacterial properties on the plant.

Utilised Microbial Strains

MTCC 426, Klebseilla pneumonia M 4020, and Pseudomonas, as well as four gram-positive bacteria: Bacillus cereus MTCC 1305, Bacillus subtilis MTCC 619, Bacillus clausii (probiotic spores purchased from a pharmacy), and Staphylococcus aureus MTCC Eclipta alba's antifungal activity was assessed against two distinct fungus strains, Aspergillus niger MTCC 872 and Candida albicans MTCC 183.

Antibacterial Effect

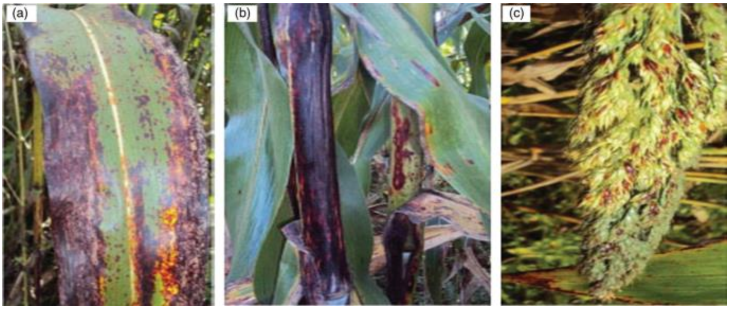
Agar was used as the culture medium for the bacterial strains (MHA). Eight different human pathogenic bacterial strains were evaluated using a conventional drug to investigate the spectrum of antibacterial activity (Kanamycin). In vitro bactericidal tests were performed on 4 mm diameter Eclipta alba test samples that were impregnated with a known amount. The discs were soaked in different test concentrations (50 g, 250 and 500 g of extracts, and EAC125, a newly isolated chemical from Eclipta alba) and allowed to evaporate. A popular medicine called Kanamycin was used as the positive control. As a negative control, sterile discs were utilized.

Antifungal Activity of *Eclipta Alba* Against Sorghum Pathogens Sorghum

A tropical plant in the Poaceae family, sorghum (Sorghum bicolor (L.)) is one of the most important crops in India, Asia, and Latin America. Over 35% of sorghum is grown mainly for human use. The majority of the remaining material is used to make industrial products, alcohol, and animal feed. The current yearly production of 60 million tonnes is increasing as a result of improved cultivars and breeding conditions. Sorghum breeders release a number of improved cultivars each year that may be grown in tropical and semi-arid climates. Selecting cultivars from this abundant biodiversity that meet regional nutritional and industrial needs is essential for ensuring food security. Sorghum is becoming more and more popular in emerging economies, particularly in West Africa.

FUNGAL DISEASE IN SORGHUM

One of the major problems restricting sorghum output is its unusually diverse range of ailments when compared to other grains. Fungi are the most serious sorghum diseases; they are widespread worldwide and result in large losses in grain quantity and quality during production. Fungal diseases including anthracnose, turcicum leaf blight, charcoal root rot, and others are becoming more common in many parts of the world. They cause catastrophic crop losses, depending on the crop's stage, the cultivar's susceptibility, and the state of the environment at the time.



(fig.1). Fungal disease in sorghum plant

Grain mold, caused by Fusarium thapsinum, Alternaria alternata, Epicoccum sorghinum, and Curvularia lunata, is a disease that can be detrimental to sorghum. The pathogenic fungi also reduce the nutritious value of the grains by producing mycotoxins. When a fungus infects grain, it drastically lowers its output and renders it unfit for human consumption. The fungal infection mostly causes seed discoloration, reduced germination, stunted seedling growth, and overall field stand reduction. Aflatoxin, ochratoxin, and zearalenone are the primary mycotoxins that contaminate sorghum seeds. Trichothecenes, fumonisins, zearalenone, and fusariotoxins are produced by Fusarium spp. And are hazardous to human health. Zearalenone is said to damage an animal's reproductive system and cause cancer in people.

MECHANISM OF ECLIPTA ALBA ON FUNGAL INFECTION ON SARGHUM

The current study set out to find out if E. alba possessed any antifungal qualities against pathogens such as F. thapsinum, A. alternata, E. sorghinum, and C. lunata that cause economically devastating sorghum grain mould. Furthermore, we investigated the effects of E. alba extract administration on disease incidence, greenhouse growth metrics, and in vivo germination and seedling emergence. Furthermore, the phytochemicals present in the E. alba extract's antifungal fractions.

Saponin fraction from E. alba inhibits A. niger, A. flavus, and A. fumigatus comparable to antibiotics. Ethyl acetate fraction contains coumestans and wedelolactone with antibacterial and antifungal properties against various pathogens. Eclalbasaponin in E. alba disrupts bacterial cell walls, exhibiting antibacterial action against P. aeruginosa and B. subtilis. Purified methanolic fractions of E. alba contain saponins like eclalbasaponin II and wedelolactone, converting inactive precursors into active antibiotics against pathogens. Saponins combine with sterols in fungal membranes, inducing transmembrane holes and cell membrane compromise. Tomatine, a saponin from L. esculentum, activates G-protein signalling pathway and tyrosine kinase, leading to cell death in F. oxysporum. Saponins exhibit various properties including hepatoprotective, antiviral, antibacterial, antifungal, and antiulcer effects.

RESULTS

The results demonstrated the antifungal properties of E. alba's methanol fractions against sorghum-related infections, such as F. thapsinum, A. alternata, E. sorghinum, and C. lunata. By eliminating the nonpolar solubility through column purification, the antifungal efficacy of the methanol E. alba extract was increased. Phyto-analogs, such as eclalbasaponin II and wedelolactone, were detected in greater concentrations in the methanolic fractions of E. alba. The89ntifungall action against the target sorghum pathogens was significantly enhanced by these Phyto-analogs. Furthermore, results from earlier investigations demonstrating the antifungal efficacy of

E. alba extracts against sorghum infections were corroborated by this study.
The results are in line with the phytochemical study of the E. alba methanolic extract, which found flavonoids, tannins, saponins, and coumestans.

CONCLUSION

The use of synthetic fungicides has indeed led to significant issues such as the development of resistance in target pathogens, posing serious health problems for humans and animals. This resistance arises due to continuous exposure of the pathogens to the same chemicals, allowing them to adapt and evolve mechanisms to overcome the fungicidal effects. Moreover, synthetic fungicides often leave behind harmful residues in the environment, affecting not only the target pathogens but also beneficial organisms and ecosystems.
In contrast to synthetic fungicides, natural alternatives such as extracts from Eclipta alba (also known as False daisy) offer promising solutions. Eclipta alba is an annual herbaceous plant belonging to the Asteraceae family. It contains a diverse array of active metabolites, including coumestans, triterpenoid saponins, and flavonoids. These compounds possess various biological activities, including antimicrobial properties.
When Eclipta alba extracts are utilized against sorghum pathogens, they can effectively inhibit the growth and proliferation of these harmful organisms. This is attributed to the presence of phytochemicals within the plant extracts, which exert antimicrobial effects against the pathogens. Coumestans, triterpenoid saponins, and flavonoids are known for their ability to interfere with microbial growth and disrupt essential processes within the pathogens' cells, ultimately leading to their inhibition or death.
Furthermore, Eclipta alba extracts offer several advantages over synthetic fungicides. Firstly, they are derived from natural sources, making them environmentally friendly and

sustainable. Unlike synthetic fungicides, which may leave harmful residues in the soil and water, Eclipta alba extracts degrade naturally without causing long-term environmental damage. Additionally, the use of Eclipta alba extracts reduces the risk of developing resistance in target pathogens, as the complex mixture of phytochemicals present in the plant extracts acts synergistically to combat microbial growth, making it harder for pathogens to adapt and develop resistance.

Moreover, Eclipta alba extracts can be utilized not only as biopesticides but also as biofertilizers. The presence of active phytochemicals in these extracts promotes plant growth and enhances soil fertility by enriching it with essential nutrients and promoting beneficial microbial activity. This dual functionality makes Eclipta alba extracts a valuable tool in sustainable agriculture practices, offering protection against pathogens while promoting soil health and productivity.

In conclusion, the utilization of Eclipta alba extracts as biofertilizers and biopesticides presents a promising alternative to synthetic fungicides. With their diverse array of active metabolites and multiple biological activities, these natural extracts offer effective and sustainable solutions for controlling sorghum pathogens while minimizing environmental impact and reducing the risk of resistance development.

REFERENCE

1. Biofertilizer/ Dr. Hari Muraleedharan, Dr. S. SESHADRI & Dr. K. Perumal.. et al.>2010
2. Role of Biofertilizers in Agriculture/ Rakesh Kumar, Narendra Kumawat & Yogesh Kumar Sahu.et al.>2017
3. Plants as Bio – Pesticides/Abdallah, M.S.1, &Muhammad.et al.>2017
4. Biopesticides and Their Importance in Plant Protection/ Ayyagari Ramlal, Dharmendra Mallick & Vachaspati Mishra.et al.>2021

5. Antibacterial and Antifungal Activity of Eclipta alba/ Hassk. T., Regupathi & K. G. Lalitha.et al.>2014
6. Antifungal Activity of Eclipta alba against Sorghum Pathogens/Rajini Sollepura Boregowda, Nandhini Murali, Arakere C. Udayashankar, Siddapura R. Niranjana, Ole S. Lund & Harischandra S. Prakash.et al.>2019
7. Effect of aqueous extracts of Eclipta alba/Hassk. On seed health of sorghum /Zida, E. P., Leth, V & Sankara p..et al.>2010
8. Sorghum Grain as Human Food/OAI Harry Gruppen.et al.>2006
9. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
10. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
11. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
12. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
13. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
14. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
15. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in

Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509

16. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
17. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
18. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
19. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
20. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
21. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
22. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
23. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
24. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology

Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
25. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
26. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
27. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
28. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
29. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
30. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
31. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
32. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
33. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
34. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435

35. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
36. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
37. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
38. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
39. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
40. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
41. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
42. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
43. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
44. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
45. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
46. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644

47. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
48. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
49. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
50. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
51. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
52. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
53. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
54. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
55. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
56. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
57. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
58. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic

(2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd

59. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
60. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
61. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
62. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
63. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
64. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
65. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
66. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
67. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
68. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
69. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
70. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15

71. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
72. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
73. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
74. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
75. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
76. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
77. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 6

A REVIEW ARTICLE ON BHRINGRAJ – PERSONALIZED MEDICINE

Umesh Kumar[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract

Bhringraj (Eclipta Alba), a well-known herb, is revered for its myriad medicinal properties. Primarily recognized for its efficacy in liver problems and hair growth, it addresses issues like premature greying, hair loss, and promotes hair regrowth. Additionally, it is employed in treating prodromal jaundice, skin conditions, and viral hepatitis due to its liver-protective and antiviral properties. In India, it is extensively used to craft natural oils that nourish and strengthen black hair. The plant's fresh leaf juice aids in digestion, appetite control, and mild regulation of bowel movements. Traditional practices attribute Eclipta alba with the ability to strengthen hair, darken it, and stimulate growth. Some believe that its external application and internal consumption can gradually restore black hair. Rich in bioactive compounds such as coumestans, alkaloids, flavonoids, glycosides, and triterpenoids, the leaves boast of unique constituents like stigmasterol, wedelolactone, demethyledelolactone, and demethylwedelolactone-7-glucoside. Alopecia areata, characterized by hair loss from certain body areas, especially the scalp, is a common concern, particularly among men. This condition, also known as male pattern baldness, can progress from small, round, hairless patches to complete scalp or body-wide hair loss. Alopecia often results from hormonal imbalances, such as elevated testosterone levels, and can be managed using bhringraj oil.In essence, Bhringraj emerges as a versatile herbal remedy, offering solutions for liver health, hair care, digestive issues,

and hair loss conditions like alopecia areata, showcasing its significant therapeutic potential across various health concerns.
Keywords- Introduction, plant profile, phytochemistry, pharmacological activities and alopecia treatment using bhringraj oil.

Introduction

Bhringraj (Eclipta Prostrata or Eclipta Alba) is a versatile herb renowned for its numerous medicinal properties. Widely used in hair care and liver disorders, it also proves beneficial for skin ailments, respiratory issues, and eye disorders. Bhringraj promotes hair growth, prevents hair loss, and treats premature greying while enhancing skin complexion and preventing skin diseases. Its efficacy extends to chronic skin conditions like eczema and chronic wounds. With origins in tropical and subtropical regions, Bhringraj thrives near water bodies and in mountainous areas. This herb stimulates bile production, improves liver function, aids digestion, and boosts metabolism. Its varied applications include treating prodromal jaundice and enhancing bile flow in viral hepatitis. Rich in bioactive compounds like flavonoids, sterols, and triterpenes, Bhringraj exhibits hepatoprotective, anti-inflammatory, and antiviral properties. It is utilized in various herbal formulations across different cultures. In Ayurveda, Bhringraj is hailed as a rejuvenating tonic, supporting liver health, cognitive function, and vitality. It is used externally for skin conditions and hair loss, and internally to improve memory and general debility. Bhringraj's diverse pharmacological effects include anti-aging, anti-inflammatory, and antiviral activities. Commonly available in powder, juice, and oil forms, Bhringraj is especially popular in oil formulations for hair care. Its bioactive ingredients, including wedelolactone and coumestans, make it a potent hair vitalizer. Overall, Bhringraj stands as a cherished herbal remedy with multifaceted benefits for health and well-being.

MORPHOLOGICAL CHARACTERISTICS

- An annual plant that grows up to 30–40 cm tall, is upright or prostrate, branching, and occasionally roots at nodes.
- Due to repressed white hairs, the stem is either cylindrical or flat, rough, and the nodes are conspicuous and occasionally brown.
- The opposite, sessile to subsessile leaves are strigose with appressed hairs on both sides, oblong, lanceolate, sub-entire, acute to sub-acute, and 2.0 to 6.2 cm long and 1.5-1.9 cm broad.

FAMILY	ASTERACEAE
AYURVEDIC NAME	BHRINGARAJA
NANI NAME	BHARANGI
HINDI NAME	BHANGARA, BHRINGRAJ
ENGLISH NAME	TRAILING ECLIPTA PLANT
TRADE NAME	BHANGARA

PARTS USED	WHOLE PLANT

Binomial name : Eclipta prostrata

Parts	Chemical constituents
Leaves	Wedelolactone[1.6%], Desmethylwedelolactone, Desmethyl-wedelolactone-7-glucoside, stigmasterol
Roots	Hentriacontanol, Heptacosanol & Stigmasterol, Ecliptal, Eclalbatin.
Aerial parts	β-amyrin & Luteolin-7-0-glucoside, Apigenin, Cinnaroside, Sulphur compounds, Eclalbasaponins I-VI
Stems	Wedelolactone
Seeds	Sterols, Ecliptalbine (alkaloid)
Whole plant	Resin, Ecliptine, Reducing sugar, Nicotine, Stigmasterol, Triterpene saponin, Eclalbatin,Ursolic acid, Oleanolic acid.

PHYTOCHEMISTRY

Numerous bioactive substances, such as coumestans, alkaloids, flavonoids, glycosides, and triterpenoids, are present in the herb Eclipta alba. The leaves contain almost exclusively demethylwedelolactone, wedelolactone, and demethylwedelolactone-7-glucoside, along with stigmasterol. The roots produce heptacosanol and hentriacontanol. The roots contain polyacetylene-modified thiophene. Wedelolactone, luteolin-7-glucoside, a phytosterol glucoside, a triterpenic acid flavonoid, and amyrin are present in the upper part of the n-hexane extract. The plant's polypeptides create cysteine, glutamic acid, phenyl alanine, tyrosine, and methionine.

- **Coumestans**

E. alba has coumestans, which are coumarin derivatives, as its main bioactive phytochemical constituents. The primary coumestans found in the entire plant, but primarily in the leaves, are strychnolactone, demethylwedelolactone, isodemethylewedelol actone, demethylwedelolactone, and wedelolactone (which belongs to the class of coumestans). These are thought to possess anti-cancer qualities. The natural compound wedelolactone (7-methoxy-5,11,12-trihydroxy-coumestan), which is mostly produced by members of the Asteraceae family from the plant Bhringaraj, is an important source of WDL. It is a bitter, caustic herbal treatment that has been widely used historically to treat jaundice and liver damage brought on by alcohol consumption. This herb is used to relieve postpartum uterine discomfort, treat coughs, reduce inflammation, and lessen the symptoms of asthma and bronchitis.

- **Alkaloids**

The primary alkaloids (20S), (25S), 22, 26-imino-cholesta-5, 22(N)-dien-3,ol (verazine, 3) are present in E. alba leaves. Other newly described alkaloids are 20-epi-3-dehydroxy-3-oxo-5,6-dihydro-4,5 dehydroverazine (1), ecliptalbine [(20R)-20-pyridyl-cholesta-5-ene-3,23-diol] (4), (20R)-4-hydroxyverazine (5), 20R-25-hydroxyverazine (7), and (8). The methanolic extract of the plant contains alkaloid chemicals such as verazine, 20-epi3-dehydroxy-3-oxo-5, 6-dihydro-4, 5-dehydroverazine, ecliptalbine, (20R)-4s-hydroxyverazine, 4shydroxyverazine, (20R)-25s-hydroxyverazine, and 25shydroxyverazine. Nicotine, verazine, ecliptine, dehydroverazine, and ecliptalbine are among other alkaloids that have been identified.

- **Saponins**

The main function of saponins is cytotoxic activity. The entire E. alba plant has in fact yielded novel triterpene saponins, such as eclalbatin, alpha-amyrin, ursolic acid, and oleanolic. Clalbatin, also known as dasyscyphin C, is one of the roots and is linked to properties including antioxidant, antiviral, and anticancer activity.

- **Sterols**

The main sterols identified in E. alba seed include phytosterol, daucosterol, stigmasterol-3-O-glucoside, and stigmasterol. With the aid of the essential sterol stigmasterol, significant reproductive hormones such as progesterone, androgens, estrogens, and corticoids are generated.

- **Flavonoids**

The important flavonoids found in E. alba are apigenin, luteolin, **luteolin-7-glucoside**, and orobol. Apigenin and luteolin have indeed been linked to anti-cancer effects.

- **Triterpenoids**

Eclipta alba contains a significant concentration of triterpenoids, with approximately 37 identified so far. These triterpenoids are mainly found as glucosides and include compounds such as oleanolic acid, echinocystic acid, ursolic acid, and amyrin. Eclalbasaponins and ecliptasaponins are the most common types present. These triterpenoids exhibit various biological functions, including cytotoxic, hypoglycemic, anti-fibrotic, and anti-osteoporotic properties. They belong to four main skeleton types: oleanane-type, taraxerane-type, ursane-type, and lupine-type, all featuring pentacyclic ring structures.

- **Phenolic Acid**

oxy benzoic acid is the phenolic acid extracted from the E. alba. Sesquiterpene lactones E. alba consists of 5-hydroxymethyl-(2,2':5',2")-terthienyl tiglate, 5-hydroxymethyl-(2,2':5',2")-terthienyl agelate, 5-hydroxymethyl-(2,2':5',2")-terthienyl acetate as its main Sesquiterpene lactone content.

- **Polypeptides**

Cystine, glutamic acid, phenyl alanine, tyrosine, and methionine are the major polypeptides in E. alba.

- **Volatile Oil**

Through hydrodistillation, the volatile components of this plant's aerial parts were separated, and the GC-MS was used to analyse them. By comparing mass spectra to a mass spectrum library, a total of 55 compounds were found, accounting for most of the volatiles. Heptadecane, 6,10,14-trimethyl-2-pentadecanone, n-hexadecanoic acid, pentadecane, eudesma, 11-diene, phytol, octadec-9-enoic acid, 1,2-benzenedicarboxylic acid diisooctyl ester, (Z, Z)-9,12-octadecadienoic acid, (Z)-7,11-dimethyl-3- methylene-1,6,10-

dodecatriene and (Z, Z, Z)-1,5,9,9-tetramethyl-1 and 4,7-cycloundecatriene

Pharmacological Activity of Phytochemicals.

Sl. No	Chemical constituents	Pharmacological activates
1	Wedelolactone	Antihepatotoxic, Antibacterial, Trypsin Inhibitor, Antivenom
2	Eclalbosaponins	hair revitalizing, Antiproleferative, Antigiardial
3	Demethylwe-delolactone	Antihepatotoxic, Antihaemorrhage, Antivenom, Dye (cosmetic)
4	Dasyscyphin C	Antiviral, Anticancer
5	Eclalbatin	Antioxidant
6	Ecliptalbine, verazine	Lipid lowering, Analgesic

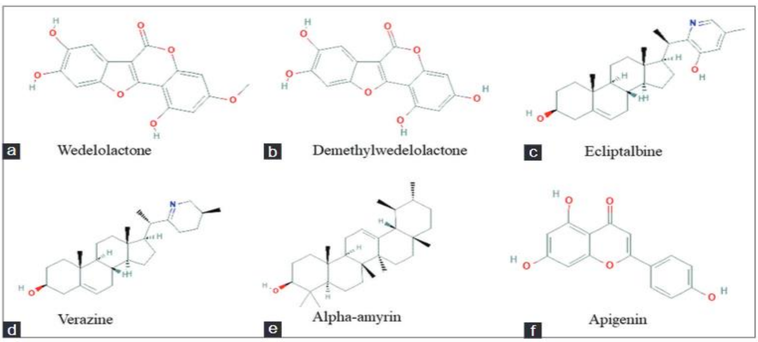

Fig. 2: (a-f) Chemical structures of some of phytochemicals of *Eclipta alba*

Pharmacological Activity Of Bhringraj (Eclipta Alba)

- **Hepatoprotective Effect**

Eclipta Alba is recognized as a potent liver tonic due to its hepatoprotective properties. Studies have shown that oral treatment with Eclipta Alba increases the activity of antioxidant enzymes such as SOD, CAT, GPx, and GR, along with boosting levels of ascorbic acid and α-tocopherol. This leads to a significant reduction in lipid peroxide (LPO) levels and improves liver health by reducing centrilobular necrosis, hydropic degeneration, and fatty alteration of hepatic cells. Additionally, Eclipta Alba extracts have shown promise in mitigating Non-Alcoholic Fatty Liver Disease (NAFLD), a leading cause of liver cirrhosis. It's crucial to optimize micropropagation techniques for Eclipta Alba to ensure abundant production of its key component, wedelolactone.

- **Anti Breast Cancer Activity**

The anti-breast cancer effect of Ecilpta alba (AEEA), an alcoholic extract, was evaluated in human subjects. Treatment with AEEA induces apoptosis in breast cancer cells. Moreover, chromatin condensation, apoptosis-mediated cell death, and plasma membrane disruption are all encouraged by AEEA administration. AEEA causes a cascade that results in apoptosis by lowering the potential of the mitochondrial membrane. This AEEA activity contributes to a reduction in side effects following cancer treatment. Zinc oxide nanoparticle-guided luteolin administration was investigated as a novel approach utilizing zinc oxide nanoparticles and the phytochemical luteolin to enhance anti-tumorigenic effect. These characteristics suggest that the AEEA might be a novel anti-cancer medication that is used as a backup source of medication for the treatment of breast cancer.

- **Anti-ulcer and anti-colon cancer activities**

In a rat model, an ethanolic extract of Eclipta alba significantly reduced ulcerative lesions and attenuated lipid peroxidation, demonstrating potent anti-ulcer efficacy in a dose-dependent manner. In rats given aspirin to induce ulcers, another study discovered that the methanolic extract of Eclipta alba greatly decreased inflammation and the development of stomach ulcers. Crude Eclipta alba methanolic extract showed a remarkable anti-cancer effect against colon cancer cell lines using the MTT assay.

- **Antioxidant Activity**

Free radicals are released as a result of oxidative stress, and these molecules have an effect on several ailments such as cancer, atherosclerosis, neurological disorders, and angina pectoris. Antioxidants have a scavenging role that makes them useful in the treatment of many illnesses. Because Eclipta alba is a rich natural source of antioxidants such flavonoids, phenolic acids, and terpenoids, it can effectively remove oxidative stress. Phenolic compounds possess reducing, hydrogen-donor, singlet oxygen quencher, and metallic chelating properties. Eclipta alba treatment restores antioxidant defense and significantly lowers TBARS, H2O2, and nitric oxide levels.

- **Anti- inflammatory Activity**

Protein denaturation (egg albumin) was prevented by the aqueous extract of Eclipta prostrata seeds in a dose-dependent manner. Although the efficacy of the Eclipta prostrata component(s) as a safe anti-inflammatory therapy was not as high as that of the reference medication, an NSAID, the in vitro egg albumin assay is a recognized method for assessing anti-inflammatory activity. It has been demonstrated that methanolic extracts of Eclipta prostrata leaves exhibit anti-oedematous characteristics by inhibiting the synthesis of active pain chemicals such histamine, polypeptides, or prostaglandins in the early stages of oedema development. Wedelolactone, a crucial component of plants, may reduce inflammation by reducing the infiltration of neutrophils, hence managing the anti-inflammatory reactions associated with fungal keratitis.

- **Anti- Diabetic Activity**

Physiologically active ingredients in the Eclipta alba extract aid in stabilizing the gold nanoparticles. in order to synthesize green gold nanoparticles (AuNPs). The Eclipta alba extract-derived AuNPs shown antibacterial, anti-oxidant, and anti-diabetic properties. Compared to the antioxidant effect of ascorbic acid, the anti-oxidant property is concentration dependent and weaker. The antibacterial activity of Eclipta alba extracted AuNPs (EA-AuNPs) may be caused by the interaction of the bacteria's surface charges with the AuNPs. The anti-apoptotic action of EA-AuNPs and consequently its role as an efficient anti-diabetic medicine may be attributed to down-regulation of Bcl-2, up-regulation of Bax, and alteration of NF-B.

- **Antifungal Activity**

Uncontrolled application of chemical or synthetic fungicides to disease control has a number of negative effects on the environment, including pollution and drug resistance in the target pathogens. Eclipta alba resists fungal growth. Its efficacy against plant fungi, such as Fusarium thapsinum, Alternaria alternata, Epicoccum sorghinum, and Curvularia lunata diseases of sorghum grain, has been demonstrated both in vitro and in vivo.

- **Anti Venom Activity**

Uncontrolled application of chemical or synthetic fungicides to disease control has a number of negative effects on the environment, including pollution and drug resistance in the target pathogens. Eclipta alba resists fungal growth. Its efficacy against plant fungi, such as Fusarium thapsinum, Alternaria alternata, Epicoccum sorghinum, and Curvularia lunata diseases of sorghum grain, has been demonstrated both in vitro and in vivo.

- **Hair Improvement**

Eclipta alba is widely used in formulations like Kesharanjanyoga and Bhringraj Taila to treat various hair disorders such as alopecia areata and premature greying. While clinical studies on its hair growth capabilities are limited, research on mice showed promising results with the petroleum ether fraction demonstrating superior effects compared to minoxidil. This fraction, containing wedelolactone and sitosterol, is believed to be responsible for promoting high-quality hair growth. However, more studies are needed to fully understand its potential in hair care.

Bhringraj – In Hair Loss (Alopecia)

E. alba is referred to as the "King of Hair" because it possesse s qualities that promote hair growth and blackening

Hair, alongside sebaceous glands, sweat glands, and nails, is a crucial component of the body, originating from the skin's ectoderm during embryonic development. It serves as a protective appendage and is classified as an accessory structure of the integument, known as epidermal derivatives. Hair plays a significant role in human aesthetics. Alopecia, a common dermatological condition present worldwide and affecting 0.2% to 2% of the population, is a concern addressed in both cosmetic and medical treatments. Effective remedies like Ecliptasaponin C and minoxidil have been scientifically proven for alopecia treatment.

Terminal and vellus hair are the two main types, with terminal hair being thicker, darker, and more numerous, while vellus hair is thinner and lighter. Terminal hair is typically found on the scalp and develops under the influence of testosterone, which is converted into dihydrotestosterone (DHT) by the enzyme 5alpha reductase. DHT's action on hair follicles stimulates hair growth.

Alopecia, an autoimmune disorder affecting nearly 2% of people in the United States, manifests in various degrees of hair loss, from small circular patches to complete baldness on the scalp or body. Although it can occur at any age and affects both sexes equally, it is more prevalent among children and young adults. Alopecia areata primarily involves hair loss from specific body regions, notably the scalp, leading to bald spots.

This condition, also known as male pattern baldness or spot baldness, often starts with tiny, smooth hairless patches on the scalp and can progress to complete hair loss. Males are more prone to alopecia, which may be influenced by factors like malnutrition and high levels of testosterone. Medical treatment for alopecia is challenging as there is no permanent cure.

Androgenetic alopecia, known as male pattern baldness in men and female pattern baldness in women, follows a distinct pattern of hair loss. In women, hair loss is diffuse across the scalp, while men typically experience a receding hairline followed by thinning on the crown of the head.

CAUSES

Hair loss can affect both the scalp and the entire body, prompting extensive research into the physiology of hair growth. While various growth factors, cytokines, and hormones play roles in regulating the hair growth cycle, the exact mechanisms of hair loss remain elusive. Recognized causes of hair loss include genetic predisposition, hormonal fluctuations, medical conditions, aging, and medication side effects. Hereditary factors and aging predominantly contribute to scalp hair loss. Typically, around 50% of hair loss occurs before a noticeable decrease in hair density. Acute telogen effluvium, characterized by sudden hair shedding, can be triggered by systemic illness, medications, fever, emotional stress, weight loss, childbirth, nutritional deficiencies, scalp inflammation, discontinuation of oral contraceptives, and iron deficiency.

TREATMENT

Hair growth occurs in three cyclical phases: anagen (growth phase), catagen (transitional phase), and telogen (resting phase), with each phase crucial for follicular development. Disruption in this cycle can lead to hair loss, as seen in conditions like alopecia areata. Bhringaraj, rich in phytochemicals like eclalbosaponins and wedelolactone, is an Ayurvedic hair tonic that promotes hair growth and strengthens follicles. It is used in herbal formulations to treat hair loss and stimulate black hair growth. Studies show Eclipta alba extracts can enhance hair growth and prolong the anagen phase. Topical application of E. alba-infused products is effective in hair loss treatment. This natural approach stimulates hair follicles and offers a safe solution for various types of alopecia.

CONCLUSION

The plant referred to here likely pertains to Bhringaraj (Eclipta alba), a herb known for its hair-strengthening properties in traditional medicine, particularly in Ayurveda. Bhringaraj is believed to possess antioxidant properties, which can help nourish the scalp and promote healthy hair growth. To utilize Bhringaraj for hair care, the entire plant can be crushed to create a smooth paste. This paste can then be applied evenly to the scalp, allowing the nutrients and beneficial compounds from the plant to penetrate the hair follicles and strengthen the roots. Additionally, the oil extracted from Bhringaraj can be used to massage the scalp, further enhancing its benefits. Regular application of Bhringaraj paste or oil to the scalp and hair can potentially lead to a reduction in hair loss over time. This natural treatment approach may take a few months to yield noticeable results, as the scalp and hair follicles gradually absorb the nutrients and antioxidants, promoting healthier hair growth and minimizing hair loss.

REFERENCE

1. Introduction of Eclipta alba (L.) An Ethnomedicinal Herb Plant, Traditionally Use in Ayurveda/ Soni kk1 & Soni S et al.>2017
2. Eclipta alba (L.): an overview on eclipta alba bringraj/ Satish A Bhalerao1, Deepa R Verma, Nikhil C Teli &Vaibhav R Murukate.elal.>2013
3. Pharmacological significance of herb eclipta alba l/ C. Udayashankar, M. Nandhini, S. B. Rajini and H. S. Prakash.et al.>2018
4. Distinctive pharmacological activities of Eclipta alba /Purushothaman Balakrishnan1,2, Gowtham kumar Sekar1,

Prasanna srinivasan Ramalingam1, Suganthi Nagarasan2, Vasumathi Murugesan & Kumaran Shanmugam.et al.>2018
5. Alopecia: switch to herbal medicine /Semwal, B.C, Agrawal K. K, Singh K, Tandon S &Sharma s.et al.>2011
6. Alopecia: herbal remedies /r. Kaushik, d. Gupta and r & Yadav.et al.>2018
7. Eclipta alba(bhringraj): a promoting hair growth herb/ isha kumari, hemtala kaurav & gitika chaudhari.et al.>2021
8. The Role of Herbal Plants with Anti-Hair Fall and Hair Growth Activities and Pharmacology/ Mustafa Kiran.et al.>2020
9. Bhringraj- benefit in hair/ soumita basu.et al.>2022
10. Eclipta prostrata promotes the induction of anagen, sustains the anagen phase/ Keun-Hyeun Leea, Dabin Choia & Seung Jeong.et al.>2011
11. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
12. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
13. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
14. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
15. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
16. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—

Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051

17. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
18. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
19. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
20. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
21. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
22. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
23. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
24. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.

25. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
26. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
27. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
28. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
29. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
30. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
31. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
32. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
33. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
34. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959

35. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
36. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
37. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
38. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
39. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
40. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
41. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
42. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
43. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
44. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
45. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
46. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625

47. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
48. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
49. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
50. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
51. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
52. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
53. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
54. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
55. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
56. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
57. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
58. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
59. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748

60. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
61. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
62. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
63. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
64. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
65. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
66. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
67. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
68. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
69. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
70. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis

71. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
72. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
73. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
74. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
75. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
76. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
77. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
78. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
79. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter - 7

A REVIEW ON ROSEMARY PLANT

NEHA KHATOON[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*

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Abstract

Rosemary scientific name is Rosemarinus afficinals and is at belongs to the same botanical family of mint and Basil rosemary is found in Mediterranean has a region and which another special quality whose hot which when known for its heating properties. its strip es branched evergreen up to a meter high of the name of rosemary comes Latin for sea. this Sea weed grow Settled as from the thick Looking Ris produced on plants Close to water then. et was rosemary, Later named rosemary after the virgin Mary. Rosemary is widely used as a spice during cooking. ets. make & use the taste of food of good. it is especially used en Mediterranean cuisine et is also used for fragrance to soups and cosmetics and it fragrance is used to 950 make The action of Rosemary is the following types of bases anti-oxidant ability. Rosemary is a natural etem the the which is used in fertilizer industry around world. Because consumers are concerned about the negative effect of synthetic chemicals in food, there is a need to find "clean label products". Therefore, there is a growing interest in using natural extracts as alternatives for synthetic additives because of (a) their synergy with other preservation methods (b) they are considered safe, and (c) their specific properties as antioxidant, antidiabetic, antimutagenic, antitoxigenic and antibacterial. In general, herbs and plants are rich in compounds with antioxidant properties, such as vitamins (E and C), glutathione, enzymes and phenolic compounds. Several spice extracts have shown their properties to prevent the autoxidation of unsaturated triacylglycerols. Specifically, the natural extract

from the Lamiaceae family (thyme, sage and rosemary) has been reported in several studies for its antioxidative activity.

Keywords: rosemary; phenolic, compounds ; antioxidant ; antimicrobial

Introduction:

Rosemary scientific name Rosemarinus afficinals and is at belongs to the same botanical family of mint and Basil rosemary is found in mediterranean has a region and which another special quality whose hot which when known for its heating properties. its strip es branched evergreen up to a meter high of the name of rosemary comes Latin for sea. this Sea weed grow Settled as from the thick Looking Ris produced on plants that Close to water then. et was mesemary, Later named rosemary after virgin mary.

Rosemary is a fragrant every green herb which is it has needle commonly used in kitchens. like leaves and highly flowers Which are and food flovers. aromatic blue used perfumes the leques are strong Flavored and Should be used sparingly with food.

Rosemary adds a savory finishing touch with its aroma to various olishes The herb good not only tastes. en culinary dishes, Such as rosemary chicken. and Lamb, but it is also a good source of iron I calcium and vitamin B-6 Health Benefits of rosemary= 21) Antioxidants and anti-enflammatory rosemary is a rich source of antioxidant and anti enflammatory Compounds which are thought to help boost the immune system.

And improve blood circulation. studies have shown. laboratory rosemary to be rich in antioxidants which Play partictes Gettl an emportant role ɔɔ neutralizing harmful particles.

Called free radicals.

Enhancing memory and concentration- According to research outlined in Therapeutic Advances in Psychopharmacology.

The rosemary can aroma From emprove a Person's concentration performance, speed, and accuracy and, to a leser extent, their mood.

Neurological protection- Scientists have found that rosemary may also be good for your brain. Rosemary contains 93 engredient called carnosic acid, which can Light OLL damage by free radicals in the brain.

Cancer research published in oncology Reports found that "coude ethanolic rosemary extract slowed the spread of human Leukemia and breast.

carcinoma cells. the spread breast rosemary (salvia rosmarinus), this is a small evergreen Plant of the (mint family) (Lamiaceae), and the used of leaves are flavour food.

Rosemery is called as Gulmehendi - but it is not like et Gulmehandi. Just like this ts world fo available in multiple varieties. Rosemary is regularly used in cuisines throughout the mediterranea Beech as soup fish bread, stew. stuffing meat and minced Vegetables are cised as used sword And grill the over kababs for. and you can also enfuse olive oil can make also with fresh rosemary.

Rosemary is widely used as a spice during cooking. ets. make & use the taste of food of good. it is especially used en mediterranean cuisine et is also used for fragrance to soups and cosmetics and it fragrance is used to 950 make The action of Rosemary is the following types of bases anti-oxidant ability. Rosemary is a natural etem the the which is used in fertilizer industry around world.

It is used in a wide variety of applications. These include frying oil. fish oil delicious- nuts Sweets, roasted nut meat products and many other ét this using in the food are and healthy.

Rosemary is a rich Source of aahoxidants and antienflammatory, that means to which is m meant encourage our body to particpate and help improv blood purification. when its experiments show that rosemary is abundant in antioxidants. which Play emportant role an in neutralizing harmful particles called free radicals.

The oils in rosemary are very beneficial for the digestive. tract. Rosemary can boothe heartburn and ease enfestional gas and bloating. This is because rosemary is an anti-inflammatory, and enflammation is a Common Cause of an upset stomach lovid.

Dose rosemary care could - Compound in the herb rosemary may useful against covid-19 and other be enflammatory disease. Scientists find evidence that carnosic acid Can block SARS-CoV-2 infection. and reduce inflammation.

Rosemary is to medicinal Plant native the mediterranean region and Cultivated around the world. Besides the therapeutic purpose, it is Commonly used as a condiment and food preservative.

Because consumers are concerned about the negative effect of synthetic chemicals in food, there is a need to find “clean label products”. Therefore, there is a growing interest in using natural extracts as alternatives for synthetic additives because of (a) their synergy with other preservation methods (b) they are considered safe, and (c) their specific properties as antioxidant, antidiabetic, antimutagenic, antitoxigenic and antibacterial.

In general, herbs and plants are rich in compounds with antioxidant properties, such as vitamins (E and C), glutathione, enzymes and phenolic compounds. Several spice extracts have shown their properties to prevent the autoxidation of unsaturated triacylglycerols .Specifically, the natural extract from the Lamiaceae family (thyme, sage and rosemary) has been reported in several studies for its antioxidative activity.

Rosmarinus officinalis, L. originating from the Mediterranean region is an aromatic plant from the Lamiaceae family. The province of Murcia (Southeast Spain) is one of the major processors and importers of rosemary. In the United States and Europe, rosemary is a unique spice commercially available for use as an antioxidant.

Rosemary extracts have been used in the treatment of diseases, due to its hepatoprotective potential, therapeutic potential for Alzheimer's disease and its antiangiogenic effect. On the other hand, they have been used in food preservation, because they prevent oxidation and microbial contamination. Therefore, rosemary extract could be useful for replacing or even decreasing synthetic antioxidants in foods. As preservatives, rosemary extracts offer several technological advantages and benefits to consumers.

Marphological Characteristic

Spring shoots show, within the tested biotypes, some variability in the length growth. In particular, the longest shoots were those of biotypes 4, 5 and 7 with values over 185 mm, the others were shorter, with values ranged between 115 and 127 mm. The higher shoot length is function of a high number of nodes (5 and 7) or of a high length of internodes (4). The higher number of nodes induces a relatively high number of leaves on the shoot (biotypes 5 and 7), whereas this character is not differentiated among the biotypes with the change in length of the internodes.

However, it is evident. that the more numerous the leaves, the smaller the leaf size. Based on the leaf size, three different types may be distinguished: biotypes with many (250-500) and small-sized leaves (<0.3 cm2) (5 and 7); biotypes with a low number (100-200) of medium-sized leaves (0.3-0.5 cm2) (2 and 6); biotypes with a low number (100-200) of big-sized leaves (>0.5 cm2) (1, 3 and 4).

In terms of weight, the highest shoots were those of biotypes 7 (4.08 g) and 5 (3.62 g), which were also among the longest, followed by the 3 (3.47 g) that was shorter. These differences are easily attributable both to the leaf type and to the number of axillary shoots, which are correlated with each other. Actually, both type 1 and, secondarily type 3, are shown to be associated with a higher number of axillary shoots. Consequently, the ratio of the leaf weight to the total weight of shoot is higher in the less branched biotypes, belonging to the second type (2 and 6). The mean dry matter content was 31.35 % with significant fluctuations between 30 and about 33 %. No notable differences were observed in the stem diameter, which was, on average, 2.7 mm.

PLANT OF PROFILE:

FAMILY	MINTS
SCIENTIFIC NAME	*Salvia rosemarinus*
ENGLISH NAME	ROSEMARY
AYURBEDIC NAME	RUJAMARI

SCIENTIFIC CLASSIFICATION:

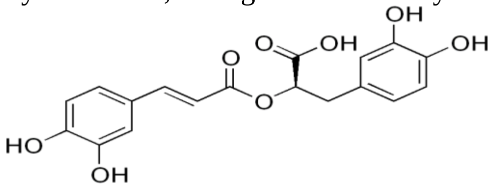
SCIENTIFIC NAME	ROSEMARINUS
HIGHER CLASSIFICATION	NEPETOIDEAE
RANK	GENUS
FAMILY	LAMIACEAE
ORDER	LAMIALES
TRIBE	MENTHEAE
KINGDOM	PLANTAE
SPECIES	OFFICINALIS

HISTORY:

Rosemary is native to the dry, rocky areas of the Mediterranean, especially along the coast. The genus name Rosmarinus derives from the Latin words ros and marinus which together translate to “dew of the sea.” Rosemary has been used since the time of the early Greeks and Romans. Greek scholars often wore a garland of the herb on their heads to help their memory during examinations. In the ninth century, Charlemagne insisted that the herb be grown in his royal gardens. The Eau de Cologne that Napoleon Bonaparte used was made with rosemary. The herb was also the subject of many poems and was mentioned in five of Shakespeare's plays.

The first mention of rosemary is found on cuneiform stone tablets as early as 5000 BCE. After that not much is known, except that Egyptians used it in their burial rituals. There is no further mention of rosemary until the ancient Greeks and Romans. Pliny the Elder (23–79 CE) wrote about it in The Natural History, as did Pedanius Dioscorides, a Greek botanist (amongst other things). He talked about rosemary in his most famous writing, De Materia Medica, one of the most influential herbal books in history.

The herb then made its way east to China and was naturalized there as early as 220 CE, during the late Han Dynasty.



Rosemary came to England at an unknown date; the Romans probably brought it when they invaded in the first century, but there are no viable records about rosemary arriving in Britain until the 8th century CE. This was credited to Charlemagne, who promoted herbs in general, and ordered rosemary to be grown in monastic gardens and farms.

PHYTOCHEMICALS:

- **ROSMARINIC ACID:**

Rosmarinic acid is an ester of caffeic acid and 3,4-dihydroxyphenyllactic acid. It is commonly found in species of the Boraginaceae and the subfamily Nepetoideae of the Lamiaceae. However, it is also found in species of other higher plant families and in some fern and hornwort species. Rosmarinic acid has a number of interesting biological activities, e.g. antiviral, antibacterial, antiinflammatory and antioxidant. The presence of rosmarinic acid in medicinal plants, herbs and spices has beneficial and health promoting effects. In plants, rosmarinic acid is supposed to act as a preformed constitutively accumulated defence compound. The biosynthesis of rosmarinic acid starts with the amino acids l-phenylalanine and l-tyrosine. All eight enzymes involved in the biosynthesis are known and characterised and cDNAs of several of the involved genes have been isolated. Plant cell cultures, e.g. from Coleus blumei or Salvia officinalis, accumulate rosmarinic acid in amounts much higher than in the plant itself (up to 36% of the cell dry weight). For this reason a biotechnological production of rosmarinic acid with plant cell cultures has been proposed.

Rosmarinic acid is a widely occurring natural product in the plant kingdom with interesting biological activities. The compound is synthesised in Lamiaceae from the amino acids l-phenylalanine and l-tyrosine. All the enzymes and several genes of the biosynthetic pathway are known.

- **CAMPHOR:**

Camphor is a waxy, colorless solid with a strong aroma. It is classified as a terpenoid and a cyclic ketone. It is found in the wood of the camphor laurel, a large evergreen tree found in East Asia; and in the kapur tree, a tall timber tree from South East Asia. It also occurs in some other related trees in the laurel family, notably Ocotea usambarensis. Rosemary leaves (Rosmarinus officinalis) contain 0.05 to 0.5% camphor, while camphorweed contains some 5%. A major source of camphor in Asia is camphor basil (the parent of African blue basil). Camphor can also be synthetically produced from oil of turpentine.

The compound is chiral, existing in two possible enantiomers as shown in the structural diagrams. The structure on the left is the naturally occurring camphor bornan, while its mirror image shown on the right is the camphor bornan.

Camphor has few uses but is of historic significance as a compound that is readily purified from natural sources.

- **CAFFEIC ACID:**

Caffeic acid is an organic compound and a potent antioxidant. It can be found naturally in a wide range of plants.

Caffeic acid is a type of polyphenol, a class of micronutrients known for their antioxidant properties. The nutrient is claimed to have many health benefits, including anti-inflammatory, anticancer, and antiviral abilities. It may help boost the performance of athletes. However, it isn't considered "essential" for human health. In other words, you don't need it to survive.

The most common source of caffeic acid in the human diet is from drinking coffee.

- coffee
- wine
- turmeric
- basil
- thyme
- oregano
- sage
- cabbage
- apples
- strawberries
- cauliflower
- radishes
- mushrooms
- kale
- pears
- olive oil

- **BETULINIC ACID:**

A pentacyclic lupane-type triterpene derivative of betulin with antiinflammatory, anti-HIV and antineoplastic activities. Betulinic acid induces apoptosis through induction of changes in mitochondrial membrane potential, production of reactive oxygen species, and opening of mitochondrial permeability transition pores, resulting in the release of mitochondrial apogenic factors, activation of caspases, and DNA fragmentation. Although originally thought to exhibit specific cytotoxicity against melanoma cells, this agent has been found to be cytotoxic against non-melanoma tumor cell types including neuroectodermal.and brain tumor cells.

- **CARNOSIC ACID:**

Carnosic acid is a natural benzenediol abietane diterpene found in rosemary and common sage .Dried leaves of rosemary and sage contain 1.5 to 2.5% carnosic acid.
Carnosic acid and carnosol, a derivative of the acid, are used as antioxidant preservatives in food and nonfood products, where they're labelled as "extracts of rosemary".

PHARMACOLOGICAL ACTIVITY:
Anti-inflammatory effects:
Rosemary, Rosmarinus officinalis L. is a well-known plant with several useful properties such as analgesic, anti-inflammatory and anti-neurodegenerative. It has been used in folk medicine to alleviate rheumatic pain, stomachache and dysmenorrhea. Rosemary has several constituents such as rosmarinic acid which can be responsible for therapeutic properties been noted with rosemary. The aim of this study was to investigate the potential anti-inflammatory effects of R. officinalis and rosmarinic acid in a rat model of sciatic nerve chronic constriction injury-induced neuropathic pain to verify usage of rosemary in folk medicine.

Rosemary has significant antimicrobial, anti-inflammatory, anti-oxidant, anti-apoptotic, anti-tumorigenic, antinociceptive, and neuroprotective properties. Furthermore, it shows important clinical effects on mood, learning, memory, pain, anxiety, and sleep.

Anticancer effect:

Anticancer drugs should destroy the cancerous cell with the minimal side effect on normal cells which is probable through the induction of apoptosis.

Cancer cells exhibit increased growth rates and resistance to apoptosis. The ability of cancer cells to escape homeostasis and proliferate uncontrollably while evading programmed cell death/apoptosis is achieved through mutations of key signaling molecules, which regulate pathways involved in cell proliferation and survival.

Compounds of plant origin, including food components, have attracted scientific attention for use as agents for the prevention and treatment of cancer.

Antibacterial activity:

The antibacterial effect of rosemary has been widely demonstrated in several food studies: beef meatballs [96], cooked beef [97] and in pork sausage [98]. Gomez-Estaca et al. [99] reported that rosemary oil inhibited the growth of common food bacteria contributing to food spoilage.

Antifungal activity:

Several studies have reported that rosemary extracts show biological bioactivities such as hepatoprotective, antifungal, insecticide, antioxidant and antibacterial. It is well known that the biological properties in rosemary are mainly due to phenolic compounds.

USE:

- Improve Brain Function
- Hair Growth
- Increase Circulation
- Reduce Joint Inflamation

ALLERGY:
Allergy is a syndrome characterized by an undesirable bodily reactionagainst a harmless substance. Allergies are very common, and theprevalence of allergic diseases has continued to grow over the last50 years. It is not completely clear why some people develop allergicreactions and others do not. In this article, we explore how anallergic reaction occurs, as well as discuss the causes of allergy andits treatments.

TYPES OF ALLERGIC:
There are many types of allergies. Some allergies are seasonal and others are year-round. Some allergies may be life-long. It is important to work with your health care provider to create a plan to manage your allergy. Avoiding your allergens is the best way to prevent an allergic reaction.

- Drug Allergies.
- Food Allergies.
- Insect Allergies.
- Latex Allergy.
- Mold Allergy.
- Pet Allergy.
- Pollen Allergy.

CAUSES:

- Airborne allergens, such as pollen, animal dander, dust mites and mold.
- Certain foods, particularly peanuts, tree nuts, wheat, soy, fish, shellfish, eggs and milk.
- Insect stings, such as from a bee or wasp.

- Medications, particularly penicillin or penicillin-based antibiotics.

PATCH TEST:

A patch test allows you to see how your skin reacts to a substance before using it more widely. Here are the steps for performing a patch test:

Reference –

1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051

7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.

16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435

27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644

39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic

(2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15

63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 8

A REVIEW ON IMMUNE BOOSTER OF ROSEMARY

Neha Khatoon[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Abstract
Rosemary is an evergreen bushy shrub which grows along the Mediterranean Sea, and sub-Himalayan areas. In folk medicine, it has been used as an antispasmodic, mild analgesic, to cure intercostal neuralgia, headaches, migraine, insomnia emotional upset, and depression. Different investigations have highlighted rosemary neuropharmacological properties as their main topics. Rosemary has significant antimicrobial, anti-inflammatory, anti-oxidant, anti-apoptotic, anti-tumorigenic, antinociceptive, and neuroprotective properties. Furthermore, it shows important clinical effects on mood, learning, memory, pain, anxiety, and sleep. The current work aims to review the potential neuropharmacological effects of different rosemary extracts and its active constituents on nervous system disorders, their relevant mechanisms and its preclinical application to recall the therapeutic potential of this herb and more directions of future research projects. The data were gathered by searching the English articles in PubMed, Scopus, Google Scholar, and Web of Science. The keywords used as search terms were ‘Rosmarinus officinalis,’ ‘rosemary,’ ‘nervous system,’ ‘depression,’ ‘memory,’ ‘Alzheimer’s disease’ ‘epilepsy,’ ‘addiction,’ ‘neuropathic pain,’ and ‘disorders.’ All kinds of related articles, abstracts and books were included. No time limitation was considered. Both in vitro and in vivo studies were subjected to this investigation. This review authenticates that rosemary has appeared as a worthy source for curing inflammation, analgesic, anti-anxiety, and memory boosting. It also arranges new perception for further

investigations on isolated constituents, especially carnosic acid, rosmarinic acid, and essential oil to find exquisite therapeutics and support drug discovery with fewer side effects to help people suffering from nervous system disorders.

Keywords: Addiction, Anticonvulsant, Antinociceptive, Neurodegenerative disease, Nervous system, Neuroprotective, Rosmarinus officinalis

Introduction:

Nervous system disorders include abnormalities in either function or structure of the central or peripheral nervous system. These illnesses might be the result of trauma, metabolic dysfunction, infection or genetic conditions. A large number of scientific studies and discoveries aim to reduce the impacts and frequency of neurological disorders, mental health, and drug abuse.

Herbal medicines and natural products were used in ancient therapies. During the last decades, researchers focused more on herbs in drug discovery because of their limited side effects and fewer complications. According to the improving demand, the medicinal and pharmacological studies have been increasing worldwide.

Rosemary, Rosmarinus officinalis L. (Labiatae) has been used in folk medicine to alleviate several diseases including headache, dysmenorrhea, stomachache, epilepsy, rheumatic pain, spasms, nervous agitation, improvement of memory, hysteria, depression, as well as physical and mental fatigue (5, 6). Today, rosemary is grown worldwide but it is an evergreen perennial shrub native to southern Europe and Asia especially Mediterranean region. Recently, noticeable scientific interest is focused on the beneficial therapeutic properties of different kinds of rosemary extracts and its main constituents, such as carnosic acid, carnosol, rosmarinic acid, etc. A large number of studies either on animal models or cultured cells indicate the wide range medicinal properties of rosemary and its compounds such as anti-inflammatory, anti-oxidant, antinociceptive, neuroprotective, antidepressant, anti-hysteric, ameliorative of memory and mental fatigue. Moreover, the safety of rosemary has been displayed in various studies. The median lethal dose (LD50) value of methanolic extract of rosemary leaves prescribed intraperitoneally to mice was 4.125 g/kg of their body weight. Rosemary has also been classified as "generally safe" or GRAS by the FDA in America. Rosmarinic acid was observed to have very scarce toxicity with an LD50 of 561 mg/kg in mice. The oral LD50 of carnosic acid was 7100 mg/kg in the acute toxicity in mice.

Phytochemical studies revealed that rosemary contains terpenoids, essential oils, alkaloids and flavonoids. Chemical analysis of different kinds of rosemary extracts composition reveals that the most potent active components are triterpenes, phenolic diterpenes and phenolic acids including rosmarinic acid, carnosic acid, rosmanol, carnosol, ursolic acid and betulinic acid. According to the documents, rosmarinic acid and carnosic acid possess the most medicinal effects among the mentioned phenolic compounds i.e. anti-inflammatory and anti-oxidants. Nowadays because of presence of many beneficial and un-useful constituents in medicinal plants it needs to focus on determination and effectiveness of the effective substances of extracts but not crude extracts.

Marphological Character

Spring shoots show, within the tested biotypes, some variability in the length growth. In particular, the longest shoots were those of biotypes 4, 5 and 7 with values over 185 mm, the others were shorter, with values ranged between 115 and 127 mm (tab.1). The higher shoot length is function of a high number of nodes or of a high length of internodes. The higher number of nodes induces a relatively high number of leaves on the shoot, whereas this character is not differentiated among the biotypes with the change in length of the internodes.

Uses:

The leaf and its oil are commonly used in food and also to make medicine. Rosemary seems to increase blood circulation when applied to the scalp, which might help hair follicles grow. Rosemary extract might also help protect the skin from sun damage.

Rosemary is a widely used culinary spice. Tradition holds that rosemary will grow only in gardens of households where the "mistress" is truly the "master." The plant has been used in traditional medicine for its astringent, tonic, carminative, antispasmodic, and diaphoretic properties. Rosemary is one of the oldest known medicinal herbs, used centuries ago to enhance mental function and memory. Extracts and the volatile oil have been used to promote menstrual flow and as abortives. Rosemary extracts commonly are found as cosmetic ingredients and a lotion of the plant is said to stimulate hair growth and prevent baldness.

Mental Fatigue:

Aromatherapy with rosemary essential oil can relieve mental weariness and exhaustion.

Stress:

Rosemary oil's antistress properties make it useful for stress management. Inhaling rosemary essential oil decreases cortisol (the stress hormone) while increasing dopamine (a neurotransmitter). This helps in the reduction of stress and prevention or cure of mental disorders.

Arthritis:

Due to its anti-inflammatory properties, rosemary may have been utilised as an anti-arthritic agent. It might work by inhibiting the mediators that cause inflammation, allowing arthritic symptoms to be managed.10 You must consult a doctor before consuming any herb for its benefits for arthritis.

Enhancing Memory:

Rosemary's memory-enhancing qualities can help you with your memory. It might boost the production of specific molecules in the brain, and potentially improving memory and cognitive performance.9 However you must visit your doctor and follow their advice before consuming rosemary for these benefits.

Botanical Description:

Rosemary is a perennial shrub that grows in the wild or is cultivated. It has glandular hairs that emit fragrant volatile essential oils (mainly monoterpenes) in response to drought conditions in the Mediterranean climate. It also contains diterpenes such as carnosic acid and other polyphenolic molecules. Herein, the botanical and ecological characteristics of the plant are discussed, as well as the main bioactive compounds found in its volatile essential oil and in leaf extracts. Afterward, we review the applications of rosemary in cosmetics, considering its preservative power, the kinds of products in which it is used, and its toxicological safety, as well as its current uses or future applications in topical preparations, according to recent and ongoing studies.

Rosemary is an aromatic evergreen shrub with leaves similar to hemlock needles. It is native to the Mediterranean and Asia, but is reasonably hardy in cool climates. Special cultivars like 'Arp' can withstand winter temperatures down to about −20 °C. It can withstand droughts, surviving a severe lack of water for lengthy periods. In some parts of the world, it is considered a potentially invasive species. The seeds are often difficult to start, with a low germination rate and relatively slow growth, but the plant can live as long as 30 years.

The plant flowers in spring and summer in temperate climates, but the plants can be in constant bloom in warm climates;

flowers are white, pink, purple or deep blue. Rosemary also has a tendency to flower outside its normal flowering season; it has been known to flower as late as early December, and as early as mid-February.

Immune System:

The immune system defends body against outside threats. These include germs such as bacteria, viruses, and fungus, as well as poisons (chemicals made by microbes). The immune system is made up of various organs, cells, and proteins that all operate together.

And a complex network of cells, tissues, organs, and the substances they make that helps the body fight infections and other diseases. The immune system includes white blood cells and organs and tissues of the lymph system, such as the thymus, spleen, tonsils, lymph nodes, lymph vessels, and bone marrow.

Adaptive Immunity:

Adaptive immunity refers to defense mechanisms mediated by lymphocytes (T, B, and natural killer cells) and the specialized chemicals required for their function. The term adaptive refers to lymphocytes' ability to rapidly adapt to a given condition (for example, a specific type of microbial infection) by producing specialized cells, cytokines, and antibodies, as well as longlasting immunologic memory.

The adaptive immune system, also known as the acquired immune system, is a subsystem of the immune system that is composed of specialized, systemic cells and processes that eliminate pathogens or prevent their growth.

Antigen:

In immunology, an antigen is a molecule or molecular structure or any foreign particulate matter or a pollen grain that can bind to a specific antibody or T-cell receptor. The presence of antigens in the body may trigger an immune response. The term antigen originally referred to a substance that is an antibody

generator. Antigens can be proteins, peptides (amino acid chains), polysaccharides, lipids, or nucleic acids.
Antigens are recognized by antigen receptors, including antibodies and T-cell receptors. Diverse antigen receptors are made by cells of the immune system so that each cell has a specificity for a single antigen. Upon exposure to an antigen, only the lymphocytes that recognize that antigen is activated and expanded, a process known as clonal selection. In most cases, an antibody can only react to and bind one specific antigen; in some instances, however, antibodies may cross-react and bind more than one antigen.
The antigen may originate from within the body or from the external environment. The immune system identifies and attacks "non-self" external antigens and usually does not react to self-protein due to negative selection of T cells in the thymus and B cells in the bone marrow.

Cytokines:
Cytokines are protein molecules produced by immune system cells that mediate a variety of defensive actions. Inflammation, lymphocyte activation and differentiation, and destruction of cells with foreign antigens are examples of these. Cytokines are involved in the development of autoimmunity and immune-mediated kidney disease.

Dendritic Cells (Dcs):
Dendritic cells (DCs) are specialized myeloid cells that are activated by infection to take up antigens, convert them into tiny peptides, bundle them inside MHC molecules, and present them to T lymphocytes after migrating to secondary lymphoid organs. DCs are model antigenpresenting cells (APCs). They connect innate and adaptive immunity.

Innate Immunity:
Innate immunity refers to protection mechanisms mediated by the more rudimentary evolutionary components of our immune system. These include myeloid cells such as macrophages, DCs, and neutrophils, as well as protein molecules such as the complement and coagulation systems. The word "innate" is used because these responses are hardwired in the genome, responding to injury or infection in a fairly consistent manner. The adaptive immune system is activated by the innate immune system, mostly through antigen-presenting DCs.

Lymphocytes:
Lymphocytes are hematopoietic cells that play an important role in adaptive immunity. T cells differentiate into the specialized subpopulations best equipped to combat the offending agent, whereas B lymphocytes create antibodies (humoral immunity) (cellular immunity).

Primary Lymphoid Organs:
Primary lymphoid organs or tissues are those in which lymphocytes are born and/or trained to recognize and respond to nonself antigens but not self-molecules. The bone marrow and the thymus are two examples.

Secondary Lymphoid Organs:
Secondary lymphoid organs are organs or tissues that contain or circulate mature (trained) lymphocytes. They are the sites at which lymphocytes come into contact with antigens and are activated to create antibodies or effector (fighter) cells. The spleen, lymph nodes, and mucosal lymphoid tissues such as the Peyer's patches in the small intestine are examples of secondary lymphoid organs.

Toll Like Receptors (Tlrs):

TLRs are receptors that are found mostly on innate immune cells but also adaptive immune cells and nonimmune cells. They are looking for conserved molecular patterns in microorganisms. A prominent example is a TLR4 receptor, which binds the lipopolysaccharide (LPS) of Gramnegative bacteria. TLRs detect tissue injury by interacting with endogenous chemicals generated by dead or stressed cells. TLR activation causes inflammation as well as DC maturation, resulting in an improved adaptive immune response.

Immune Booster:

Your immune system is a complex network of organs, cells, proteins, tissues, and chemicals that guard your body against various diseases, viruses, and bacteria. Antibodies, white blood cells, the lymphatic system, the gut, the complement system, the thymus, and bone marrow are the key components of the immune system. All of these things work together to keep you healthy and running at peak performance, because we all know that contagious bacteria wreak havoc on your body, making you susceptible to illness all of the time. This is where immune boosters come into play. They aid in the strengthening of your body's defenses against harmful illnesses and ailments, as well as keeping you well.

Phytoconstituents Of Rosemary:

CAMPHOR

Camphor is a waxy, colorless solid with a strong aroma. It is classified as a terpenoid and a cyclic ketone. It is found in the wood of the camphor laurel, a large evergreen tree found in East Asia; and in the kapur tree, a tall timber tree from South East Asia.

It also occurs in some other related trees in the laurel family, notably Ocotea usambarensis. Rosemary leaves contain 0.05 to 0.5% camphor,[6] while camphorweed contains some 5%. A

major source of camphor in Asia is camphor basil. Camphor can also be synthetically produced from oil of turpentine.
The compound is chiral, existing in two possible enantiomers as shown in the structural diagrams. The structure on the left is the naturally occurring camphor, while its mirror image shown on the right is the camphor. Camphor has few uses but is of historic significance as a compound that is readily purified from natural sources.

α-pinene

α-Pinene is an organic compound of the terpene class, one of two isomers of pinene. It is an alkene and it contains a reactive four-membered ring. It is found in the oils of many species of many coniferous trees, notably the pine. It is also found in the essential oil of rosemary and Satureja myrtifolia. Both enantiomers are known in nature; α-pinene is more common in European pines, whereas the (1R,5R)- or (+)-α-isomer is more common in North America. The racemic mixture is present in some oils such as eucalyptus oil and orange peel oil.

CAMPHENE

Camphene is a bicyclic organic compound. It is one of the most pervasive monoterpenes. As for other terpenes, it is insoluble in water, flammable, colorless, and has a pungent smell. It is a minor constituent of many essential oils such as turpentine, cypress oil, camphor oil, citronella oil, neroli, ginger oil, valerian, and mango. It is produced industrially by isomerization of the more common alpha-pinene using a solid acid catalyst such as titanium dioxide.
Camphene is used in the preparation of fragrances and as a food additive for flavoring. These include isobornyl acetate.

LIMINENE

Limonene is a colorless liquid aliphatic hydrocarbon classified as a cyclic monoterpene, and is the major component in the oil of citrus fruit peels. The d-isomer, occurring more commonly in nature as the fragrance of oranges, is a flavoring agent in food manufacturing. It is also used in chemical synthesis as a precursor to carvone and as a renewables-based solvent in cleaning products. The less common l-isomer has a piny, turpentine-like odor, and is found in the edible parts of such plants as caraway, dill, and bergamot orange plants.

Limonene takes its name from Italian limone. Limonene is a chiral molecule, and biological sources produce one enantiomer: the principal industrial source, citrus fruit, contains d-limonene, which is the enantiomer. Racemic limonene is known as dipentene. d-Limonene is obtained commercially from citrus fruits through two primary methods: centrifugal separation or steam distillation.

BENEFITS OF ROSEMARY OIL:

Improve Brain Function

In ancient Greece and Rome, rosemary was thought to strengthen memory. Research indicates that rosemary oil helps prevent the breakdown of acetylcholine, a brain chemical important for thinking, concentration and memory.

When 20 young adults were asked math questions in a small room diffused with rosemary oil, their speed and accuracy increased in direct proportion to the duration the oil was diffused.

Additionally, their blood levels of certain rosemary compounds likewise increased — illustrating that rosemary can enter your body through breathing alone. Similarly, nursing students who breathed rosemary oil while taking a test reported increased concentration and information recall compared to breathing lavender oil or no essential oil at all. Other research suggests that breathing rosemary and other essential oils may improve brain function in older adults with dementia, including those with Alzheimer’s disease.

Hair Growth

One of the most common types of hair loss is androgenetic alopecia, better known as male pattern baldness, though it can also affect females.

Rosemary oil treats androgenetic alopecia by preventing a byproduct of testosterone from attacking your hair follicles, which is the cause of this condition.

When men with androgenetic alopecia massaged diluted rosemary oil into their scalp twice daily for six months, they experienced the same increase in hair thickness as those who used minoxidil (Rogaine), a common hair regrowth remedy.

Additionally, those who used the rosemary oil reported less scalp itching compared to minoxidil, which suggests that rosemary may be more tolerable.

Other research indicates that rosemary oil may fight patchy hair loss, or alopecia areata, which affects up to half the population below age 21 and about 20% of people above 40.

RELIEVE PAIN

In folk medicine, rosemary is utilized as a mild pain reliever.

In a two-week study, stroke survivors with shoulder pain who received a rosemary oil blend with acupressure for 20 minutes twice daily experienced a 30% reduction in pain. Those who received only acupressure had a 15% reduction in pain.

Additionally, an animal study determined that rosemary oil was slightly more effective for pain than acetaminophen, a common over-the-counter pain medication.

CHEMICAL CONSTITUENTS:

From other Mediterranean countries19, 20,12. There were some reports of the presence of α-pinene, 1,8-cineole, camphor, verbenone and borneol, constituting about 80% of the total R. officinalis oil21. The major components, α-pinene, borneol, camphene, camphor, verbenone and bornyl-acetate, were also reported to be present in Sardinian R. officinalis L. oil22.

Cineole, borneol, pinene and camphor are the major constituents of rosemary oil, comprising about 28, 18, 12 and 10 % of the oil23. Compared with other rosemary oils, Brazilian oils were more similar to those of French origin due to their 1,8cineole and camphor contents.
The variability of the qualitative and quantitative composition of the essential oil is due to intrinsic features and also to extrinsic factors such asclimate, cultivation conditions, extraction methods, etc. Significant variations in the chemical composition of oil have been reported with relation to the geographic origin
Times of harvest, condition of the twigs and leaves, distillation equipment and management was also reported to have an important role in the overall quality of the oil.

Extraction Method:
Essential oils are used in a wide variety of consumer goods such as detergents, soaps, toilet products, cosmetics, pharmaceuticals, perfumes, confectionery food products, soft drinks, distilled alcoholic beverages (hard drinks) and insecticides. The world production and consumption of essential oils and perfumes are increasing very fast. Production technology is an essential element to improve the overall yield and quality of essential oil. Essential oils are obtained from plant raw material by several extraction methods

HYDRODISTILATION
The rosemary material was mixed with NaCl and distilled water in a distillation flask, and hydrodistillation was continued for 3 h to ensure no more essential oil was obtained. Rosemary contained volatile oil experiences thermal stress due to thermal energy supplied by the water during hydrodistillation.

STEAM DISTILATION

The vast majority of Rosemary essential oil is produced by steam distillation. Steam distillation is the most commonly used process for extracting essential oils. The steam distillation process is carried out in a still in which fresh or sometimes dried plant material is placed in a chamber of the still.

ULTRASOUND-ASSISTED EXTRACTION

Mediterranean herbs, specially thyme and rosemary, are important ingredients in food preparation and more recently have been studied as natural sources of bioactive compounds. This study aimed to study the effect of matrix, and extraction protocol solvent composition on the extraction of high value compounds and also explore the antioxidant, antimicrobial, probiotic, and anti-inflammatory activities. The phenolic, flavonoid and carotenoid content of extracts was greatly influenced by extraction conditions wherein the ultrasound pre-treatment improved the extraction of carotenoids but induced the opposite effect for polyphenols and flavonoids in both herbs. Only the aqueous extract of thyme obtained from ultrasound pre-treatment was the only extract that inhibited the growth of potentially pathogenic bacteria, stimulated the probiotic bacteria and achieved high anti-inflammatory and antioxidant activity. Moreover, this extract also was rich on phenolic compounds and carotenoids. Therefore, ultrasound extraction of bioactive compounds with water as solvent could be explored in food and pharmaceutical applications.

REFFERENCE:

1. Iran J Basic Med Sci. 2020 Sep; 23(9): 1100–1112. doi: 10.22038/ijbms.2020.45269.10541
2. January 2004. Acta Horticulturae 629(629):471-482 DOI:10.17660/ActaHortic.2004.629.61
3. October 2020. Cosmetics 7(4) DOI:10.3390/cosmetics7040077
4. Parham, Peter. (2009). The Immune System, 3rd Edition, p. G:2, Garland Science, Taylor and Francis Group, LLC.

5. By Marsha McCulloch, MS, RD on November 15, 2018
1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati

Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***

19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383

30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798-808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861- 20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687

43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.

54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)

66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter - 9

REVIEW ARTICLE ON PERSONALIZED MEDICINE SHATAVARI

Nikhil Kumar Singh[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Abstract:
Shatavari, a climbing Ayurvedic plant, is known for its numerous activities such as hyperlipidemia, hypertension, angina, dysmenorrhea, anxiety disorders, benign prostatic hyperplasia (BPH), leucorrhoea and urinary tract infection. This plant possesses a wide range of secondary metabolites inclusive of steroids, alkaloids, dihydrophenanthrene derivatives, flavonoids, furan derivatives and essential oils. pharmacologically active steroids. It has antioxidant activity, anti-abortifacient activity (Shatvarin 1), Antioxytoxic (shatavarin4), spasmodic to uterus, hypoglycemic, hypertensive activity, anticoagulant activity, antiviral activity, anticancer. Antidysenteric activity. This species occurs widely throughout the tropical and subtropical regions. The racemosides saponin content of Asparagus racemosus roots revised the two major saponins of this plant.shatavarin root powder to treatment ulcer disease and boost of immune system .the plant are shows anti-diuretic activity ,anti-HIV ,anti-bacterial , Antioxidant property.shatavari plant many benefits of health and prevent of diseases and treat the disease . Information from the literature suggests that, the major constituents of A. racemosus are steroidal saponins which are mainly responsible for different biological activities of Shatavari and pharmacological activity . Asparagus racemosus (A. racemosus) belongs to family Liliaceae and commonly known as Satawar, Satamuli, Satavari found at low altitudes throughout India. The dried roots of the plant are

used as drug and leaves and flowers also. This plant is cultivated in india and make of different types of drugs. shatavari are 300 species are found. The review summarizes the information concerning morphology, phytochemistry, biological activities, analytical techniques, ulcer treatment, of Asparagus racemosus.

Keywords: Shatavari, Asparagus racemosus, Ulcer, phtyochemicals, pharmacological activity, biological activity

Introduction:

Asparagus racemosus Wild, commonly known as 'Shatavari' is a much branched, spinous under shrub found growing wild in tropical and sub-tropical parts of India. The genus Asparagus consisted of about 300 species around the world, out of which 22 species are recorded in India. Shatavari is a woody climber growing to 1-2 m length. The leaves are like pine-needles, small and uniform. The inflorescence has tiny white flowers, in small spikes and the roots are finger-like and clustered. India has some area cultivated Shatavari plant. The plants, of the Liliaceae family, is common at low altitudes in shade and in tropical climates throughout India, Asia, Australia, and Africa.In Indian system of medicine Asparagus racemosus an important medicinal plant and its root paste or root juice or root powder has been used in different ailments and as health tonic. Asparagus racemosus a well-known Ayurvedic (Charaka Samhita) rasayana which prevent ageing, enhance longevity, impart immunity, improve mental function, and improve female Brest-feeding and pregnancy, vigor and addvitality to the body and it is also used in nervous disorders, dyspepsia, tumours, inflammation, neuropathy, hepatopathy. Traditionally, A. racemosus is indicated in epilepsy, vata disorders, brain tonic, helps in regulating cardiac disorders and hypertension. It is extensively used in male genital dysfunctions, oligospermia, spermatogenic irregularities and other male disorders such as painful micturition . Reports indicate that the pharmacological activities of Asparagus racemosus root extract include antiulcer, antioxidant, antidiarrheal, antidiabetic and immunomodulatory activities. It is also explored in Ayurvedic formulations for digestive discomfort, indigestion, amoebiasis, piles and debility. In females, prescribed by the doctors in habitual abortions, weakness of the uterus, excessive bleeding during menstruation . Recent reports and experiments disclosed Shatavari as antidiarrheic, antispasmodic, aphrodisiac, antidysenteric, demulcent, diuretic, galactagogue, nutritive, mucilaginous, refrigerant, stomachic properties and works as a tonic for human beings. It is also known to reinforce the immune system and protect vital organs like heart, brain, and other organs of the body. This review is a discussion about the cultivation, morphology, phytochemistry, biological activities, safety profile and conservation techniques for this plant. This plant are use of vegetable and health benefits and using for improve of male reproductive system. the precursor of many pharmacologically active steroids. The number of vascular bundles ranges from 30-35 in the upper levels and 35-45 in the middle tuberous portions of the roots. The roots upon grinding are light brown in colour with a coarse texture. The plants can be successfully grown in variety of soil. but suitable of soil like (sandy), medium (loamy) and heavy (clay) soil. Black, well drained, and fertile soil are highly favourable for A. racemosus cultivation and can also be cultivated in loose and medium black soil. Crops mainly need tropical, hot climatic conditions, and require minimum irrigation with the avoidance of overwatering. Raised beds which are about 3m are harvested in the month of May or June. The time of transplanting is in the month of July-August. It produces minute flowers in the month of July which are white and unisexual in nature. satavari plant parts use like Tuberous

Roots, Leaves, flowers, and fruits. These are picture in below down leaves and roots and flower. in September, it begins to bear fruits which are globular or obscurely 3 lobed, pulpy berries which are purplish black when they are ripening, seeds are hard and brittle 14. Weeding operations are to be timely carried out. Generally, the crops are not affected with pest and diseases. The first harvesting is done after 1.5-2 years of transplanting, which is continued for 10-15 years. Male and female plants are grown if seed is required.



Vernacular name:

Hindi	Satavari,Shatawar or satmuli
Sanskrit	Satavari
Bengali	Shatamuli
Gujarati	Satawari
Telegu	Toala-gaddalu or Pilli-gaddalu
Tamil	Shimaishadavari or Inli-chedi
Malayalam	Chatavali
Kannada	Majjigagadde or Aheruballi

Madhya Pradesh	Narbodh or atmooli
Rajasthan	Narkanto or Satawar
Marathi	Shatavari or Shatmuli
Oriya	Chhotaru, Mohajolo

Scientific classification:

Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Angiosperms
Class	Monocots
Family	Asparagaceae
Genus	Asparagus
Order	Asparagales
Species	Asparagus racemosus

Morphology:

In Thailand, traditionally the decorticated roots of the plant have been used as a remedy for diseases of spleen, liver, and other internal organs, including preventing miscarriage. In India, conventionally the roots have been used during internal pain, tumors, fever and as a tonic. A. racemosus (Shatavari) is a climbing plant consisting of tuberous roots. According to Indian pharmacopoeia, A. racemosus contains not less than 0.1 per cent of Shatavarin Intravenous, as calculated on the dried weight basis. The taste is initially starchy and then slightly bitter followed by a sweet taste. A. racemosus has small pin-needle like phylloclades (photosynthetic branches) which are uniform and shiny green in appearance. The air-dried roots are brown in color, tuberous, elongated, and tapering at both the ends, up to 30-100 cm long. The fresh roots are fleshy and white in color; while on drying it become shrinked, longitudinal ridges appeared and the color turned light brown. Outer surface of the fresh root is soft and contains epidermal hairs. Taste is mucilaginous, fracture brittle. The powder drug swells on moistening with water. Roots are cylindrical, fleshy tuberous straight or slightly curved, tapering towards the base & swollen in the middle; white buff colour,5- 15cm in length 1-2 cm diameter.

Plant part used: Tuberous Roots, Leaves, flowers, and fruits

Flowering and fruiting time:

Plant almost dies or dries up in summers and it grows with new tender branches from underground root. Flowers begin to appear in September-December and fruits appear afterwards.

Habitat: This climber growing in low jungles is found all over India; especially in Northern India. (Nadkarni, 1954). The climber grows 1-2m in length found all over India.

Analytical techniques:

Analysis of Shatavarin V from the root extract was performed with RPHPLC method. In another study analysis of sarsapogenin in A. racemosus extract under isocratic conditions by RP-HPLC has been reported. Shatavarin have been analyzed using HPLC with Evaporative Light Scattering Detector (ELSD) using a solvent system of 57.3 % ethyl acetate in methanol. Presence of fructoligosaccharides (FOS) was reported by enzymatic, size exclusion, gas chromatography with flame ionization detector (GC–FID), high pressure anion exchange chromatography (HPAEC) and thin layer chromatography methods.

Phytochemicals:

Asparagus racemosus consists of a diverse range of molecules in which major constituent is steroidal saponins along with alkaloids, flavonoids, dihydrophenanthrene derivatives, furan derivatives and volatile constituents Twenty-nine steroidal saponins were reported from A. racemosus. An oligospirostanoside (1) named 3-0-[α-Lrhamnopyranosyl-(1→2)-α-L-rhamnopyranosyl- (1→4)-O-β-D-glucopyranosyl]-25(S)-spirosta-3βoil is obtained from A. racemosus which on oral administration potentiated antibody synthesis and enhanced cell-mediated immune response in immune compromised animals . Shatavarin and Shatavarin were reported which are specific.

phytochemicals isolated from asparagus racemosus (Satavari):

S.no	Name	Category	Plant
l	3-O-[α-L-rhamnopyranosyl-(1→2)-α-L-rhamnopyranosyl-(1→4)-O-β-D-glucopyranosyl]-25(S)-spirosta-3β-ol	Steroidal	Roots
ll	Racemoside	Steroidal	Defatted fruits
lll	Shatavarins	Steroidal	Roots
lV	Asparanin A	Steroidal	Roots
V	Immunoside	Steroidal	Roots
Vl	Sarsasapogenin	Steroidal	Roots
Vll	Diosgenin	Steroidal	Roots
Vlll	Sitosterol	Steroidal	Roots
lX	Anti-HIV compounds	Steroidal	Root
X	Filiasparoside	Steroidal	Root
Xl	Shatavaroside A	Steroidal	Root

XIl Shatavaroside
B Steroidal Root
XIll Asparagamine
A Alkaloid Root
XIV Polycyclic
alkaloid Alkaloid
Root
XV Racemosol (9, 10-dihydro-1, 5-dimethoxy-8-
methyl-2,7- Dihydrophenenthrene Root
phenanthrene diol) (30) Derivative
XVl Racemofuran
Furan derivatives Root
XVll 8-Methoxy-5,6,4-trihydroxyisoflavone-7-
O-β-D Flavonoid Root
Glucopyranoside
XVlll Cyanidine-3-
galatoside Flavovoid Woody
portions
of tuberous roots

Biological activity:
The second century physician Galen described Asparagus as "cleansing and healing". Nutritional studies demonstrated that Asparagus is a low-calorie source of folate and potassium. In the first century, Pliny wrote, ‘Asparagus, of all the plants of the garden, receives the most praiseworthy care’. The plant is widely used in about 64 Ayurvedic formulations which include traditional formulations such as ‘Shatavari Kalpa’, ‘Phalangerid’, ‘Vishnu taila’ 2 . The plant has numerous traditional practices and these traditional practices were verified by the experimental studies. And variety of disease treat of use Shatavari and boost of immunity and prevent of disease and 300 species of Shatavari.
pharmacological activities:

Anticancer activity, antidysenteric activity, antifungal activity, antibacterial activity, anti-inflammatory activities, antiulcer activity, antioxidant activity, anti-abortifacient activity (Shatvarin 1), Antioxytoxic (shatavarin4), spasmodic to uterus Hypoglycemic, hypertensive activity, anticoagulant activity:

Antioxidant property:

The Crude extract and purified aqueous fraction of A. racemosus (Shatavari) have been demonstrated for its antioxidant effect. The activity was tested in rat liver cell mitochondrial membrane damage induced by generated free radicals. The lipid peroxidation induced was evaluated by the formation of thiobarbituric acid reactive substances (TBARS) and lipid hydroperoxides (LOOH). The extract exhibited antioxidant effect against oxidative damage by providing protection against lipid peroxidation, protein oxidation and depletion in the levels of protein thiols and antioxidant enzyme, superoxide dismutase. The purified aqueous fraction which consisted of polysaccharides was found to be a potent antioxidant as compared to the crude extract. Purified fraction was more effective against lipid peroxidation whereas the antioxidant effect of the crude extract was more effective in inhibiting protein oxidation.

Diuretic activity:

The diuretic property was highlighted in Ayurveda has been validated by a suitable experimental model. Study was carried out using an aqueous extract of the roots utilizing three dose vials 800 mg/kg, 1600 mg/kg and 3200 mg/kg for its diuretic activity in comparison with standard drug (furosemide) and control (normal saline) rats after performing acute toxicity tests. The extract demonstrated diuretic activity at a 3200 mg/kg dose without any acute toxicity.

Antidepressant activity:

Antidepressant activity was evaluated in mice using tail suspension test (TST) and forced swim test (FST). The methanolic extract decreased immobility periods significantly in TST, FST, which indicated significant antidepressant activity underlining the fact that the efficiency of the extracts was comparable to fluoxetine and imipramine used as reference drugs in the study. Methanolic extract administered to mice significantly decreased brain MAO-A (Monoamine Oxidase A) and MAO-B (Monoamine Oxidase B) activity levels it has been found that the methanolic extract possesses antidepressant activity probably by inhibiting MAO-A and MAO-B; and through interaction with adrenergic, dopaminergic, serotonergic and GABAergic systems (Gamma aminobutyric acid) Experiments have been performed on rats using the methanolic extract and subjected to forced swim test (FST), learned helplessness test (LH) and it has been found that the extract decreases immobility in the FST and increases avoidance response in LH indicating antidepressant activity. Behavioural experiments were conducted, extract administered increased the number of head twitches produced by 5-HT (5- hydroxy tryptamine), increased clonidine induced aggressive behaviour and it was concluded that the methanolic extract has a significant antidepressant activity mediated via serotonergic, noradrenergic systems and precipitation of antioxidant defences . Inhibitory activities of different extracts were determined on the basis of enzyme kinetics of acetyl and butyryl cholinesterases, and monoamine oxidase 54. Methanolic extract significantly inhibited cholinesterase and MAO activities and act as a non-selective competitive inhibitor as compared hexane and chloroform extracts. It indicated a direct possible correlation between the spinning content in methanolic extracts and cholinesterase, monoamine inhibitory activities because hexane and chloroform extract showed negligible saponin content.

Antitussive effect:

The methanolic extract of roots has been reported to possess antitussive. The activity was tested against sulfur dioxide

(SO_2) -induced cough in the mouse model . The methanolic root extract administered at the concentration of 200, 400 mg/kg, and codeine phosphate was taken as a standard antitussive reference drug. Upon oral administration of methanol, extract displayed 40% and 58.5% inhibition of SO_2-induced cough at a dose of 200 and 400 mg/kg respectively. Antitussive effect produced was dose dependent for both extracts as well as standard drug which further supported the claims put forward by traditional medicine practitioners about the usefulness of A. racemosus in the treatment of cough.

Anti-HIV activity:

Satavari is also known to show immunomodulatory activity. Steroidal saponin glycosides (19-24) have been reported from these extracts. Compound isolated from the ethanolic extract exhibited the highest anti-HIV activity as compared to other saponin glycosides . Glycoside 20 with two sugars exhibited weak anti-HIV activity and saponins with three sugar units (21-24) showed weak to no activity . Structurally similar compounds have been reported to have anti-HIV protease activity.

Shatavari – In Treatment of Ulcer

Ulcer - (defined as mucosal erosions equal to or greater than 0.5 cm) of an area of the gastrointestinal tract that is usually acidic and thus extremely painful.Symptoms includes abdominal pain, classically epigastric with severity relating to mealtimes, after around 3 hours of taking a meal (duodenal ulcers are classically relieved by food, while gastric ulcers are exacerbated by it); bloating and abdominal fullness; waterbrash (rush of saliva after an episode of regurgitation to dilute the acid in esophagus); nausea, and copious vomiting; loss of appetite and weight loss; hematemesis (vomiting of blood); this can occur due to bleeding directly from a gastric ulcer, or from damage to the esophagus from severe/continuing vomiting; melena (tarry, foul-smelling feces due to oxidized iron from hemoglobin). Rarely, an ulcer can lead to a gastric or duodenal perforation, which leads to acute peritonitis. This is extremely painful and requires immediate surgery. A history of heartburn, gastroesophageal reflux disease (GERD) and use of certain forms of medication can raise the suspicion for peptic ulcer. Medicines associated with peptic ulcer include NSAID (non-steroid anti-inflammatory drugs) that inhibit cyclooxygenase, and most glucocorticoids (e.g. dexamethasone and prednisolone). In patients over 45 with more than two weeks of the above symptoms, the odds for peptic ulceration are high enough to warrant rapid investigation by EGD 2,3 The timing of the symptoms in relation to the meal may differentiate between gastric and duodenal ulcers: A gastric ulcer would give epigastric pain during the meal, as gastric acid production is increased as food enters the stomach. Symptoms of duodenal ulcers would initially be relieved by a meal, as the pyloric sphincter closes to concentrate the stomach contents, therefore acid is not reaching the duodenum. Duodenal ulcer pain. There was a significant reduction in ulcer index and reductions in the volume of gastric secretion upon treatment with crude extract in indomethacin treated rats. The reduction in gastric lesions was found to be comparable to standard Ranitidine. It has been concluded that A. racemosus have an antiulcerogenic activity. The activity was the result of inhibitory effect on release of gastric hydrochloric acid and protects gastric mucosal damage. In humans, A. racemosus root powder is effective in chronic peptic ulcers. There was an increase in the lifespan of gastric mucosal epithelial cells, secretion and viscosity of gastric mucus.

Chemical constituent:

Shatavari roots contain 4 steroid saponin, shatavarin I-IV (0.2%). Shatavarin I is the major glycoside with 3 glucose and rhamnose moieties attached to sarsapogenin ,whereas in shatavarin IV 2 glucose and 1 rhamnose moieties are attached. Flowers and fruits contain quercetin, rutin and hyperoside, while leaves contain diosgenin and hyperoside, while leaves contain diosgenin and quercetin.

Cause: -

Gastrinomas (Zollinger Ellison syndrome): it is a rare gastrin-secreting tumors, also cause multiple and difficult to heal ulcers.

Alcohol:

While a link hasn't been found between alcohol consumption and peptic ulcers, ulcers are more common in people who have cirrhosis of the liver, a disease often linked to heavy alcohol consumption

Caffeine:

Beverages and foods that contain caffeine can stimulate acid secretion in the stomach. This can aggravate an existing ulcer, but the stimulation of stomach acid cannot be attributed solely to caffeine.

Smoking:

Studies show that cigarette smoking can increase a person's chance of getting an ulcer. Smoking also slows the healing of existing ulcers and contributes to ulcer recurrence.

Helicobacter pylori:

A major causative factor (60% of gastric and up to 90% of duodenal ulcers) is chronic inflammation due to Helicobacter pylori that colonizes the antral mucosa. The immune system is unable to clear the infection, despite the appearance of antibodies. Thus, the bacterium can cause a chronic active gastritis (type B gastritis), resulting in a defect in the regulation of gastrin production by that part of the stomach, and gastrin secretion can either be decreased (most cases) resulting in hypo- or achlorhydria or increased.

Stress:

Researchers also continue to look at stress as a possible cause, or at least complication, in the development of ulcers. There is debate as to whether psychological stress can influence the development of peptic ulcers. Burns and head trauma, however, can lead to physiologic stress ulcers, which are reported in many patients who are on mechanical ventilation

Genetic factor:

People with blood group O appear to be more prone to develope peptic ulcer than those with other blood groups. Genetic influences appear to have greater role in duodenal ulcers as evidence by their occurrence in families monozygotic twins and association with HLB-B5 antigen.

Treatment: -

shatavari treated medically-induced ulcers in rats' food pipes and stomachs. A. *racemosus* was evaluated in 32 patients by administrating the root powder 12 g/d in four doses,and for an average duration of 6 weeks .Shatavari was found to relive most of the symptoms in majority of the patients. The ayurvedic formulation 'Satavari mandur' exhibited significant protection against acute gastric ulcers caused due to cold-restraint stress, acetic acid, pylorus ligation, aspirin with pylorus ligation, and cysteamine-induced duodenal. ulcer healing effect of the drug was attributed to a direct to a direct healing effect, possible by potentiating intrinsic protective factor as it has neither antisecretory activity nor antacid propertise, by strengthening mucosal resistance, prolonging the lifespan of mucosal cells, increasing secretion and viscosity of mucous and reducing H+ ion back diffusion. It has been found to maintain the continuity and thickness of asprin treated gastric mucosa with a significant increase in mucosal main. As *A. racemosus* heals duodenal ulcers without inhibiting acid secretion, it may have cytoprotective action similar action to that of prostaglandin other binding of bile salts. ulcer healing effect of shatavari is thought to be due to its ability to strengthen mucosal resistance, prolong mucosal cell lifespan, and increase mucous secretion and viscosity. It does not appear that shatavari has antacid properties. Summary: Shatavari may work to treat and relieve the symptoms of ulcers. There was a significant reduction in ulcer index and reductions in the volume of gastric secretion upon treatment with crude extract in indomethacin treated rats. The reduction in gastric lesions was found to be comparable to standard Ranitidine. It has been concluded that A. racemosus have an antiulcerogenic activity. The activity was the result of inhibitory effect on release of gastric hydrochloric acid and protects gastric mucosal damage .In human ,shatavari root powder is effective in ulcer.

Conclusion:

Shatavari (A. racemosus) plant may be using many diseases like Ulcer, cancer diarrheal etc. Shatavari is an important medicinal plant having traditional importance as it is used in the indigenous system of medicines like Ayurveda, Sidha, and Unani.shatavari root powder treat of ulcer and dose of powder 12 g/d. shatavari isolated of phytochemicals property. shatavri mandur use against ulcer and treatment duration may be 6 weeks. shatavari plant very use of pharmaceutical industry for medicine .this articals shatavari plant personalized medicine used treat of disease .Shatavari is treatment of sexual problem .this review summarized the information of ulcer treatment of ulcer and shatavri overview .

References:

1. Ramit singla and Vikash jaitak. shatavari (asparagus racemosus wild): A review on its cultivation, morphology, phytochemistry and pharmacological importance march 2014
2. Anupam K Sachan and Doli R Das, Senah L Dohare and Mohd Shuaib . Asparagus racemosus (Shatavari): An Overview June 2014
3. Amit Chawla, Payal Chawla, Mangalesh, R C Roy.Asparagus racemosus (Willd): Biological Activities & its ActivePrinciples January 2011
4. Dr Abhijeet Sarjerao Shirkande and Dr Ankita Abhijeet Shirkande. Asparagus racemosus (shatavari): a comprehensive ayurvedic approach August 2019
5. Shashi Alok, Sanjay Kumar Jain, Amita Verma, Mayank Kumar, Alok Mahor, and Monika Sabharwal. Plant profile, phytochemistry and pharmacology of Asparagus racemosus (Shatavari): A review doi: 10.1016/S2222-1808(13)60049-3 Jun 2013
6. Ankita Wal 1 , Pranay Wal 1 , Nikita Saraswat 1 and Simran Wadhwa. A Detailed Review on Herbal Treatments for Treatment of PCOS- Polycystic ovary syndrome (PCOS) DOI: 10.2174/2665978602666210805092103 November 2021
7. N. Venkatesan , Vadivu Thiyagarajan, Sathiya Narayanan1 , Arokya Arul , Sundararajan Raja , Sengodan Gurusamy Vijaya Kumar, Thandavarayan Rajarajan , James Britto Perianayagam. Asparagus racemosus wild root extracts February 2005
8. Saumendu Deb Roy, Jashabir Chakraborty, Dibyendu Shil, Sumit Das, Narzima Begum. Herbs Used in Peptic Ulcer May 2013
9. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
10. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner

11. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
12. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
13. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
14. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
15. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
16. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
17. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
18. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021

19. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
20. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
21. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
22. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
23. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
24. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
25. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
26. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
27. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
28. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee

29. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
30. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
31. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
32. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
33. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
34. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
35. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
36. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
37. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
38. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
39. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
40. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474

41. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
42. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
43. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
44. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
45. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
46. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
47. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
48. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
49. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
50. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
51. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
52. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079

53. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
54. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
55. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
56. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
57. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
58. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
59. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
60. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
61. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
62. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
63. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress

Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
64. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
65. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
66. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
67. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
68. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
69. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
70. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
71. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
72. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
73. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
74. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
75. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.

76. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
77. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter - 10

VITAMIN C AS IMMUNE BOOSTER

Durgasi Mowlika[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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ABSTRACT

Vitamin C is an essential micronutrient for humans, with pleiotropic functions related to its ability to donate electrons. It is a potent antioxidant and a cofactor for a family of biosynthetic and gene regulatory enzymes. Vitamin C contributes to immune defense by supporting various cellular functions of both the innate and adaptive immune system. Vitamin C supports epithelial barrier function against pathogens and promotes the oxidant scavenging activity of the skin, thereby potentially protecting against environmental oxidative stress. Vitamin C accumulates in phagocytic cells, such as neutrophils, and can enhance chemotaxis, phagocytosis, generation of reactive oxygen species, and ultimately microbial killing. It is also needed for apoptosis and clearance of the spent neutrophils from sites of infection by macrophages, thereby decreasing necrosis/NETosis and potential tissue damage. The role of vitamin C in lymphocytes is less clear, but it has been shown to enhance differentiation and proliferation of B- and T-cells, likely due to its gene regulating effects. Vitamin C deficiency results in impaired immunity and higher susceptibility to infections. In turn, infections significantly impact on vitamin C levels due to enhanced inflammation and metabolic requirements. Furthermore, supplementation with vitamin C appears to be able to both prevent and treat respiratory and systemic infections. Prophylactic prevention of infection requires dietary vitamin C intakes that provide at least adequate, if not saturating plasma levels (i.e., 100–200 mg/day), which

optimize cell and tissue levels. In contrast, treatment of established infections requires significantly higher (gram) doses of the vitamin to compensate for the increased inflammatory response and metabolic demand.

INTRODUCTION

The immune system is a multifaceted and sophisticated network of specialized organs, tissues, cells, proteins, and chemicals, which has evolved in order to protect the host from a range of pathogens, such as bacteria, viruses, fungi, and parasites, as well as cancer cells. It can be divided into epithelial barriers, and cellular and humoral constituents of either innate (non-specific) and acquired (specific) immunity. These constituents interact in multiple and highly complex ways. More than half a century of research has shown vitamin C to be a crucial player in various aspects of the immune system, particularly immune cell function.

Vitamin C is an essential nutrient which cannot be synthesized by humans due to loss of a key enzyme in the biosynthetic pathway. Severe vitamin C deficiency results in the potentially fatal disease scurvy. Scurvy is characterized by weakening of collagenous structures, resulting in poor wound healing, and impaired immunity. Individuals with scurvy are highly susceptible to potentially fatal infections such as pneumonia. In turn, infections can significantly impact on vitamin C levels due to enhanced inflammation and metabolic requirements. Early on, it was noted that scurvy often followed infectious epidemics in populations, and cases of scurvy have been reported following respiratory infection. This is particularly apparent for individuals who are already malnourished.

Although the amount of vitamin C required to prevent scurvy is relatively low (i.e., ~10 mg/day), the recommended dietary intakes for vitamin C are up to one hundred-fold higher than that for many other vitamins. A diet that supplies 100–200 mg/day of vitamin C provides adequate to saturating plasma concentrations in healthy individuals and should cover general requirements for the reduction of chronic disease risk. Due to the low storage capacity of the body for the water-soluble vitamin, a regular and adequate intake is required to prevent hypovitaminosis C. Epidemiological studies have indicated that hypovitaminosis C (plasma vitamin C < 23 μmol/L) is relatively common in Western populations, and vitamin C deficiency (<11 μmol/L) is the fourth leading nutrient deficiency in the United States. There are several reasons why vitamin C dietary recommendations are not met, even in countries where food availability and supply would be expected to be sufficient. These include poor dietary habits, life-stages and/or lifestyles either limiting intakes or increasing micronutrient requirements (e.g., smoking and alcohol or drug abuse), various diseases, exposure to pollutants and smoke (both active and passive), and economic reasons (poor socioeconomic status and limited access to nutritious food). Even otherwise 'healthy' individuals in industrialized countries can be at risk due to lifestyle-related factors, such as those on a diet or eating an unbalanced diet, and people facing periods of excessive physical or psychological stress.

Vitamin C has a number of activities that could conceivably contribute to its immune-modulating effects. It is a highly effective antioxidant, due to its ability to readily donate electrons, thus protecting important biomolecules (proteins, lipids, carbohydrates, and nucleic acids) from damage by oxidants generated during normal cell metabolism and through exposure to toxins and pollutants (e.g., cigarette smoke). Vitamin C is also a cofactor for a family of biosynthetic and gene regulatory monooxygenase and dioxygenase enzymes. The vitamin has long been known as a cofactor for the lysyl and prolyl hydroxylases required for stabilization of the tertiary structure of collagen, and is a cofactor for the two hydroxylases involved in carnitine biosynthesis, a molecule required for transport of fatty acids into mitochondria for generation of metabolic energy.

Vitamin C is also a cofactor for the hydroxylase enzymes involved in the synthesis of catecholamine hormones, e.g., norepinephrine, and amidated peptide hormones e.g., vasopressin, which are central to the cardiovascular response to severe infection. Furthermore, research over the past 15 years or so has uncovered new roles for vitamin C in the regulation of gene transcription and cell signaling pathways through regulation of transcription factor activity and epigenetic marks. For example, the asparagyl and prolyl hydroylases required for the downregulation of the pleiotropic transcription factor hypoxia-inducible factor-1α (HIF-1α) utilize vitamin C as a cofactor. Recent research has also indicated an important role for vitamin C in regulation of DNA and histone methylation by acting as a cofactor for enzymes which hydoxylate these epigenetic marks.

Our review explores the various roles of vitamin C in the immune system, including barrier integrity and leukocyte function, and discusses potential mechanisms of action. We discuss the relevance of the immune-modulating effects of vitamin C in the context of infections and conditions leading to vitamin C insufficiency.

Vitamin C

Vitamin C (also known as **ascorbic acid** and **ascorbate**) is a water-soluble vitamin found in citrus and other fruits and vegetables, and also sold as a dietary supplement. It is used to prevent and treat scurvy. Vitamin C is an essential nutrient involved in the repair of tissue, the formation of collagen, and the enzymatic production of certain neurotransmitters. It is required for the functioning of several enzymes and is important for immune system function. It also functions as an antioxidant. Most animals are able to synthesize their own vitamin C. However, apes (including humans) and monkeys (but not all primates), most bats, some rodents, and certain other animals must acquire it from dietary sources. There is some evidence that regular use of supplements may reduce the duration of the common cold, but it does not appear to prevent infection. It is unclear whether supplementation affects the risk of cancer, cardiovascular disease, or dementia. It may be taken by mouth or by injection. Vitamin C is generally well tolerated. Large doses may cause gastrointestinal discomfort, headache, trouble sleeping, and flushing of the skin. Normal doses are safe during pregnancy. The United States Institute of Medicine recommends against taking large doses. Vitamin C was discovered in 1912, isolated in 1928, and, in 1933, was the first vitamin to be chemically produced. It is on the World Health Organization's List of Essential Medicines. Vitamin C is available as an inexpensive generic and over-the-counter medication. Partly for its discovery, Albert Szent-Györgyi and Walter Norman Haworth were awarded the 1937 Nobel Prizes in Physiology and Medicine and Chemistry, respectively. Foods containing vitamin C include citrus fruits, kiwifruit, guava, broccoli, Brussels sprouts, bell peppers, potatoes and strawberries. Prolonged storage or cooking may reduce vitamin C content in foods.

7 Impressive Ways Vitamin C Benefits Your Body

- Vitamin C is an essential vitamin, meaning your body can’t produce it. Yet, it has many roles and has been linked to impressive health benefits.
- It’s water-soluble and found in many fruits and vegetables, including oranges, strawberries, kiwi fruit, bell peppers, broccoli, kale, and spinach.
- The recommended daily intake for vitamin C is 75 mg for women and 90 mg for men.
- While it’s commonly advised to get your vitamin C intake from foods, many people turn to supplements to meet their needs.

- Here are 7 scientifically proven benefits of taking a vitamin C supplement.

May reduce your risk of chronic disease

- Vitamin C is a powerful antioxidant that can strengthen your body's natural defenses.
- Antioxidants are molecules that boost the immune system. They do so by protecting cells from harmful molecules called free radicals.
- When free radicals accumulate, they can promote a state known as oxidative stress, which has been linked to many chronic diseases.
- Studies show that consuming more vitamin C can increase your blood antioxidant levels by up to 30%. This helps the body's natural defenses fight inflammation

May help manage high blood pressure

- Approximately one-third of American adults have high blood pressure.
- High blood pressure puts you at risk of heart disease, the leading cause of death globally.
- Studies have shown that vitamin C may help lower blood pressure in both those with and without high blood pressure.
- An animal study found that taking a vitamin C supplement helped relax the blood vessels that carry blood from the heart, which helped reduce blood pressure levels.
- Moreover, an analysis of 29 human studies found that taking a vitamin C supplement reduced systolic blood pressure (the upper value) by 3.8 mmHg and diastolic blood pressure (the lower value) by 1.5 mmHg, on average, in healthy adults.
- In adults with high blood pressure, vitamin C supplements reduced systolic blood pressure by 4.9

mmHg and diastolic blood pressure by 1.7 mmHg, on average.

- While these results are promising, it's not clear whether the effects on blood pressure are long term. Moreover, people with high blood pressure should not rely on vitamin C alone for treatment.

May lower your risk of heart disease

- Heart disease is the leading cause of death worldwide.
- Many factors increase the risk of heart disease, including high blood pressure, high triglyceride or LDL (bad) cholesterol levels, and low levels of HDL (good) cholesterol.
- Vitamin C may help reduce these risk factors, which may reduce heart disease risk.
- For example, an analysis of 9 studies with a combined 293,172 participants found that after 10 years, people who took at least 700 mg of vitamin C daily had a 25% lower risk of heart disease than those who did not take a vitamin C supplement.
- Interestingly, another analysis of 15 studies found that consuming vitamin C from foods — not supplements — was linked to a lower risk of heart disease.
- However, scientists were unsure whether people who consumed vitamin-C-rich foods also followed a healthier lifestyle than people who took a supplement. Thus, it remains unclear whether the differences were due to vitamin C or other aspects of their diet.
- Another analysis of 13 studies looked at the effects of taking at least 500 mg of vitamin C daily on risk factors for heart disease, such as blood cholesterol and triglyceride levels.
- The analysis found that taking a vitamin C supplement significantly reduced LDL (bad) cholesterol by approximately 7.9 mg/dL and blood triglycerides by 20.1 mg/dL.

- In short, it seems that taking or consuming at least 500 mg of vitamin C daily may reduce the risk of heart disease. However, if you already consume a vitamin-C-rich diet, then supplements may not provide additional heart health benefits.

May reduce blood uric acid levels and help prevent gout attacks

- Gout is a type of arthritis that affects approximately 4% of American adults.
- It's incredibly painful and involves inflammation of the joints, especially those of the big toes. People with gout experience swelling and sudden, severe attacks of pain.
- Gout symptoms appear when there is too much uric acid in the blood. Uric acid is a waste product produced by the body. At high levels, it may crystallize and deposit in the joints.
- Interestingly, several studies have shown that vitamin C may help reduce uric acid in the blood and, as a result, protect against gout attacks.
- For example, a study including 1,387 men found that those who consumed the most vitamin C had significantly lower blood levels of uric acid than those who consumed the least.
- Another study followed 46,994 healthy men over 20 years to determine whether vitamin C intake was linked to developing gout. It found that people who took a vitamin C supplement had a 44% lower gout risk.

Helps prevent iron deficiency

- Iron is an important nutrient that has a variety of functions in the body. It's essential for making red blood cells and transporting oxygen throughout the body.

- Vitamin C supplements can help improve the absorption of iron from the diet. Vitamin C assists in converting iron that is poorly absorbed, such as plant-based sources of iron, into a form that is easier to absorb.
- This is especially useful for people on a meat-free diet, as meat is a major source of iron.
- In fact, simply consuming 100 mg of vitamin C may improve iron absorption by 67%
- As a result, vitamin C may help reduce the risk of anemia among people prone to iron deficiency.
- In one study, 65 children with mild iron deficiency anemia were given a vitamin C supplement. Researchers found that the supplement alone helped control their anemia
- If you have low iron levels, consuming more vitamin-C-rich foods or taking a vitamin C supplement may help improve your blood iron levels.

Boosts immunity

- One of the main reasons people take vitamin C supplements is to boost their immunity, as vitamin C is involved in many parts of the immune system.
- First, vitamin C helps encourage the production of white blood cells known as lymphocytes and phagocytes, which help protect the body against infection.
- Second, vitamin C helps these white blood cells function more effectively while protecting them from damage by potentially harmful molecules, such as free radicals.
- Third, vitamin C is an essential part of the skin's defense system. It's actively transported to the skin, where it can act as an antioxidant and help strengthen the skin's barriers.

- Studies have also shown that taking vitamin C may shorten wound healing time
- What's more, low vitamin C levels have been linked to poor health outcomes.
- For example, people who have pneumonia tend to have lower vitamin C levels, and vitamin C supplements have been shown to shorten the recovery time.

Protects your memory and thinking as you age

- Dementia is a broad term used to describe symptoms of poor thinking and memory.
- It affects over 35 million people worldwide and typically occurs among older adults.
- Studies suggest that oxidative stress and inflammation near the brain, spine, and nerves (altogether known as the central nervous system) can increase the risk of dementia.
- Vitamin C is a strong antioxidant. Low levels of this vitamin have been linked to an impaired ability to think and remember.
- Moreover, several studies have shown that people with dementia may have lower blood levels of vitamin C.
- Furthermore, high vitamin C intake from food or supplements has been shown to have a protective effect on thinking and memory as you age.
- Vitamin C supplements may aid against conditions like dementia if you don't get enough vitamin C from your diet. However, additional human studies are needed to understand the effects of vitamin C supplements on nervous system health.

How much vitamin C is enough

- Adults aged 19 to 64 need 40mg of vitamin C a day.
- One should be able to get all the vitamin C you need from your daily diet.
- Vitamin C cannot be stored in the body, so you need it in your diet every day.

Good sources of vitamin C

Vitamin C is found in a wide variety of fruit and vegetables. Good sources include:

- citrus fruit, such as oranges and orange juice
- peppers
- strawberries
- blackcurrants
- broccoli
- brussels sprouts
- potatoes
- kiwi fruits
- lemons
- Guava
- Avocado

LEMON AS A SOURCE OF VITAMIN C

Lemons are an excellent source of Vitamin C, a natural antioxidant that **improves the immune system** and has antibacterial and antiviral qualities. Lemon water mixed with honey can be a great way to boost the body's capability to fight diseases.

Fig 1: Lemon

Citrus limon (L.) Burm. f. is a tree with evergreen leaves and yellow edible fruits from the family *Rutaceae*. In some languages, *C. limon* is known as lemon.

The main raw material of *C. limon* is the fruit, particularly the essential oil and juice obtained from it. The *C. limon* fruit stands out as having well-known nutritional properties, but it is worth remarking that its valuable biological activities are underestimated in modern phytotherapy and cosmetology.

C. limon fruit juice (lemon juice) has traditionally been used as a remedy for scurvy before the discovery of vitamin C. This common use of *C. limon*, known since ancient times, has nowadays been supported by numerous scientific studies. Other uses for lemon juice, known from traditional medicine, include treatment of high blood pressure, the common cold, and irregular menstruation. Moreover, the essential oil of *C. limon* is a known remedy for coughs.

BIOLOGICAL ACTIVITIES

Anticancer Activity

C. limon nanovesicles have been isolated from the fruit juice using the ultracentrifugation method and purification on a 30% sucrose gradient, using an in vitro approach. The study showed that isolated nanovesicles (20 μg/mL) inhibited cancer cell proliferation in different tumour cell lines, by activating a TRAIL-mediated apoptotic cell death. Furthermore, *C. limon* nanovesicles suppress chronic myeloid leukemia (CML) tumour growth in vivo by specifically reaching the tumour site and by activating TRAIL-mediated apoptotic cell processes.

Antioxidant Activity

It has been shown that the antioxidant activity of the flavonoids from *C. limon*—hesperidin and hesperetin—was not only limited to their radical scavenging activity but also augmented the antioxidant cellular defences via the ERK/Nrf2 signalling pathway.

In addition, vitamin C prevents the formation of free radicals and protects DNA from mutations. Studies have also shown a reduction in lipid peroxidation in seizures and status epilepticus was induced by pilocarpine in adult rats .

Anti-Inflammatory Activity

Various in vitro and in vivo studies have been conducted to evaluate hesperidin metabolites, or their synthetic derivatives, at their effectiveness in reducing inflammatory targets including NF-κB, iNOS, and COX-2, and the markers of chronic inflammation.

The essential oil from *C. limon* (30 or 10 mg/kg *p.o*.) exhibited anti-inflammatory effects in mice under formalin test by reducing cell migration, cytokine production and protein extravasation induced by carrageenan. These effects were also obtained with similar amounts of pure D-limonene. The anti-inflammatory effect of *C. limon* essential oil is probably due to the high concentration of D-limonene.

Antimicrobial Activity

Acetone extracts from *C. limon* fruits have shown inhibitory activity against the Gram-positive bacteria *Enterococcus faecalis* (MIC 0.01 mg/mL) and *Bacillus subtilis* (MIC 0.01 mg/mL), and the Gram-negative *Salmonella typhimurium* (MIC 0.01 mg/mL) and *Shigella sonnei* (MIC 0.01 mg/mL).

Moreover, under another study, *C. limon* essential oil showed antibacterial activity against Gram-positive bacteria (*Bacillus subtilis* (MIC 2 mg/mL), *Staphylococcus capitis* (MIC 4 mg/mL), *Micrococcus luteus* (MIC 4 mg/mL)), and Gram-negative (*Pseudomonas fluorescens* (MIC 4 mg/mL), *Escherichia coli* (100% inhibition)) .

The *C. limon* essential oil exhibits inhibitory activity against *Staphylococcus mutans* (MIC 4.5 mg/mL) and effectively reduced the adherence of *S. mutans* on a glass surface, with adherence inhibition rates (AIR) from 98.3% to 100%, and on a saliva-coated enamel surface, for which the AIRs were from 54.8% to 79.2%. It effectively reduced the activity of glucosyltransferase (Gtf) and the transcription of Gtf in a dose-dependent manner .

Ethanol and acetone extracts from fruits of *C. limon* were active against *Candida glabrata* (MIC 0.02 mg/mL) (Table 7) [7]. On the other hand, *C. limon* essential oil ingredients, such as D-limonene, β-pinene and citral, have shown inhibitory activity against *Aspergillus niger* (MIC 90 µL/mL at 70 °C), *Saccharomyces cerevisiae* (MIC 4 mg/mL) and *Candida parapsilosis* (MIC 8 mg/mL) Another study confirmed that *C. limon* essential oil promoted a 100% reduction in the growth of *C. albican.*
Moreover, other studies have shown that *C. limon* essential oil at a concentration of 0.05% inhibits *Herpes simplex* replication to the extent of 33.3% .

Antiparasitic Effect

The effect of *C. limon* essential oil on *Sarcoptes scabiei* var. *cuniculi* has been evaluated in vitro and in vivo. The infected parts of rabbits were treated topically once a week for four successive weeks. In vitro application results showed that *C. limon* essential oil (10% and 20%, diluted in water) caused mortality in 100% of mites after 24 h post-application. In vivo application of 20% lemon oil on naturally infected rabbits showed complete recovery from clinical signs and absence of mites in microscopic examination from the second week of treatment .

Anti-Allergic Effect

Aqueous extracts from the peel of *C. limon* fruits have been used to investigate their effects on the release of histamine from rat peritoneal exudate cells (PECs). The extracts inhibited the release of histamine from rat PECs induced by the calcium ionophore A23187. Heating the extracts at 100 °C for 10 min. enhanced the inhibition of histamine release. Histamine release was inhibited to the extent of 80%. The extracts potentially suppressed inflammation in mice cavity, like indometacin, a well-known anti-inflammatory drug.

Lemon Nutritional Value Chart

Lemons are an absolute powerhouse of nutrients and consuming lemon juice every day is beneficial for the body. Here are some nutritional facts about these citrusy fruits:

- **Carbohydrates In Lemons:** Lemons are a low-calorie and a low-carb fruits. According to USDA, a 100-gm serving of lemon pulp contains just 9 gm of carbohydrates. A very small part of these carbs come from the sugars, while a major portion of the carbs is dietary fibre.
- **Proteins In Lemons:** Despite their numerous and varied health benefits, lemons are not what you would call 'protein-dense fruits'. A 100-gm serving of lemon pulp contains a mere 1.1 gm of protein, as per USDA data. However, you can squeeze lemons on a variety of protein-rich foods like chicken, smoked fish, etc.
- **Vitamins And Minerals In Lemons:**Apart from vitamin C, lemons also contain vitamins B5, B6, B1 and B2, as well as calcium, copper, iron and potassium. Lemons contain high levels of dietary fibre and this property of the fruit, combined with its low-calorie nature, make it ideal for anyone wanting to lose weight. As mentioned earlier, a majority of lemon's benefits are present due to high levels of vitamin C in it. Due to this vitamin, lemons may help reduce symptoms of rheumatism and arthritis. Due to the presence of vitamin B5, lemons may also help in quicker metabolic processing of food as well as proper formation of hormones. Vitamin B5 also helps in raising levels of good cholesterol in blood.

CONCLUSION

Overall, vitamin C appears to exert a multitude of beneficial effects on cellular functions of both the innate and adaptive immune system. Although vitamin C is a potent antioxidant protecting the body against endogenous and exogenous oxidative challenges, it is likely that its action as a cofactor for numerous biosynthetic and gene regulatory enzymes plays a key role in its immune-modulating effects. Vitamin C stimulates neutrophil migration to the site of infection, enhances phagocytosis and oxidant generation, and microbial killing. At the same time, it protects host tissue from excessive damage by enhancing neutrophil apoptosis and clearance by macrophages, and decreasing neutrophil necrosis and NETosis. Thus, it is apparent that vitamin C is necessary for the immune system to mount and sustain an adequate response against pathogens, whilst avoiding excessive damage to the host.

Vitamin C appears to be able to both prevent and treat respiratory and systemic infections by enhancing various immune cell functions. Prophylactic prevention of infection requires dietary vitamin C intakes that provide at least adequate, if not saturating plasma levels (i.e., 100–200 mg/day), which optimize cell and tissue levels. In contrast, treatment of established infections requires significantly higher (gram) doses of the vitamin to compensate for the increased metabolic demand.

Epidemiological studies indicate that hypovitaminosis C is still relatively common in Western populations, and vitamin C deficiency is the fourth leading nutrient deficiency in the United States. Reasons include reduced intake combined with limited body stores. Increased needs occur due to pollution and smoking, fighting infections, and diseases with oxidative and inflammatory components, e.g., type 2 diabetes, etc. Ensuring adequate intake of vitamin C through the diet or via supplementation, especially in groups such as the elderly or in individuals exposed to risk factors for vitamin C insufficiency, is required for proper immune function and resistance to infections.

The presented review proves that *C. limon* is a very attractive object of different scientific studies. The *C. limon* fruit is a raw material that can be used in different forms, e.g., extracts, juice and essential oil. The rich chemical composition of this species determines a wide range of its biological activity and its being recommended for use in phytopharmacology. The studies have focused on the essential oil and its main active compound—D-limonene. Extracts from *C. limon* fruits are rich in flavonoids such as naringenin and hesperetin.

Current pharmacological studies have confirmed the health-promoting activities of *C. limon*, especially its anti-cancer and antioxidant properties. *C. limon* also finds increasing application in cosmetology and food production.

REFERENCE

1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051

6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology,

biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.

15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959

25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625

37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748

50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis

61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Parkin J., Cohen B. An overview of the immune system. Lancet. 2001;357:1777–1789. doi: 10.1016/S0140-6736(00)04904-7.
70. Maggini S., Wintergerst E.S., Beveridge S., Hornig D.H. Selected vitamins and trace elements support immune function by strengthening epithelial barriers and cellular and humoral immune responses. Br. J. Nutr. 2007;98:S29–S35. doi: 10.1017/S0007114507832971.
71. Webb A.L., Villamor E. Update: Effects of antioxidant and non-antioxidant vitamin supplementation on immune function. Nutr. Rev. 2007;65:181. doi: 10.1111/j.1753-4887.2007.tb00298.x.

72. Padayatty, Sebastian J.; Katz, Arie; Wang, Yaohui; Eck, Peter; Kwon, Oran; Lee, Je-Hyuk; Chen, Shenglin; Corpe, Christopher; Dutta, Anand (2003). "Vitamin C as an antioxidant: evaluation of its role in disease prevention". Journal of the American College of Nutrition. 22 (1): 18–35. doi:10.1080/07315724.2003.10719272. PMID 12569111. S2CID 21196776. Archived from the original on 2010-07-21. Retrieved 2011-03-18.
73. Goetz P. Citrus limon (L.) Burm. f. (Rutacées). Citronnier. Phytotherapie. 2014;12:116–121. doi: 10.1007/s10298-014-0854.
74. Mabberley D.J. Citrus (Rutaceae): A review of recent advances in etymology, systematics and medical applications. Blumea J. Plant Taxon. Plant Geogr. 2004;49:481–498. doi: 10.3767/000651904X484432.
75. Bhavsar S.K., Joshi P., Shah M.B., Santani D.D. Investigation into hepatoprotective activity of Citrus limon. Pharm. Biol. 2007;45:303–311. doi: 10.1080/13880200701214995.

Chapter - 11

A REVIEW ON LAVENDER PLANT

VIKASH KUMAR THAKUR[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Abstract

Lavender essential oil is popular as a complementary medicine in its own right and as an additive to many over the counter complementary medicine and cosmetic products. Indeed, products derived from the popular garden herb Lavender (Lavandula spp.) have been used for centuries as a therapeutic agent, with the more 'recent' addition, the essential oils derived from these plants, being widely used as an antibacterial in World War. The oil is traditionally believed to have sedative, carminative, anti-depressive and anti-inflammatory properties, in addition to its recognised antimicrobial effects. Many of the activities attributed to lavender oil have not, however, been substantiated in the scientific literature. This is further complicated by the fact that the majority of research into lavender essential oils has been based on oil derived from English lavender (Lavandula angustifolia), with little or no differentiation being made between this and other lavender essential oils. The therapeutic potential of essential oils produced from other varieties, such as L. x intermedia (lavandin), L. stoechas (French lavender) and L. x allardii, have largely been ignored. Although the ethnobotanical uses and major chemical constituents are similar between various lavenders, some differences do occur in both oil composition and in the reported therapeutic uses for different species. The significant scientific interest in recent years into the validity/veracity of the traditional beliefs surrounding lavender oil and their scientific basis, if any, was recently reviewed by Cavanagh & Wilkinson. In this paper we provide an overview

of the use of lavender oil in infectious disease and an update on recent research on alternative uses of lavender oil.

Keywords: - Lavender, Lavendula angustifolia Miller, limonene, perillylalcohol, POH

INTRODUCTION

A genus of about 30 species of plants in the mint family, lavender is native to countries bordering the Mediterranean. Lavender plants are great in herb gardens for their fragrant leaves and attractive flowers. Lavender plants are cultivated for their essential oils, which are used to scent a wide variety of products. Putting lavender dried flower in a is used for a nice scent in the home or cupboard. Lavender is also sometimes used to flavour drinks and desserts and has many applications in herbal medicine. English lavender, French lavender and woolly lavender are among the most widely cultivated species. Lavender is a small, aromatic shrub used in the perfumery, food and medical industries. Especially as a focus for annual festivals and product sales. Like most herbs, lavender has few insect pests. Lavender ranks high as a sustainable crop because it does not rely on pesticides and fertilizers. It does not require fertilization, although irrigation is required in rare circumstances. Lavender occurs in the mountainous regions of North Africa and the Mediterranean. Lavender is also grown for the production of its essential oil, lavender oil has cosmetic uses, and is believed to have some medicinal uses. Lavender plants are small, branching and spreading shrubs with grey-green leaves and long flowering shoots. The leaves are 30–50 mm (1–2 in) in length. The lavender plant produces flowers on shoots or nozzles that are 20–40 cm tall. The flowers of the lavender plant are blue. Aroma therapists use lavender to treat headaches, nervous disorders, and exhaustion. Treat fungal infections, wounds, eczema, and more with lavender oil. It is also used for joint and muscle pain. It is native to the Old World and extends from Europe to northern and eastern Africa, the Mediterranean, southwest Asia to India. It is a beautiful fragrant shrub with an average height of 2 feet. It produces purple flowers, which contain high levels of essential oil. Lavender essential oil is recognized globally as a respected commodity. It has many medicinal and other uses. It is of very low toxicity, showing remarkable antiseptic and antimicrobial action. Lavender flowers are rich in nectar and attract bees and other pollinators. After cutting and drying, lavender flowers are used in the perfumery industry. Lavender plants are also grown as ornamentals. 1999 was dubbed "the year of lavender" And as a result, there has been an increase in the demand for information and groups related to lavender production in all aspects connected with it. And the following information was compiled from a literature review in 1999, which will provide useful information sources to interested growers. Anyone involved in lavender cultivation needs to understand the involution of the Lavendula species before attempting to choose a cultivar. There are also various questions to address when choosing a variety, such as whether the plant is being selected for essential oil production, cut flower production, or dried ornamental use. An important aspect of propagation for lavender oil production should be an understanding of the phytochemistry associated with lavender cultivars' Lavender ranges from use as a perfume to use as an antimicrobial agent. This herb has been used throughout antiquity and is still kept as a common household ingredient today. Most lavender is used for essential oil production and for their scent. The Greek naturalist, discords, praised the medicinal properties of lavender in the first century AD. During the middle ages it was considered the herb of love. Lavender is used as an ingredient in smelling salts. And it is used to kill any bacteria in the wound. The lavender plant is used for headache, exhaustion, etc. and used in skin infections. It is used for joint and muscle pain. All parts of the lavender plant are used as our medicine and its fragrance is very good. Lavender is a beneficial plant. We use its oil for muscle pain and its flowers for decoration in our home. Harmful bacteria die from its smell and we also use it in the form of powder in incense sticks and smoke. It is cultivated in hilly areas and its plant is jharinuma and it looks very nice and colourful, its oil is used in hair disease and many diseases, we also use its oil in fungal infection, its oil has so much power that it can cure fungal easily. Because there is a lot of fat in its oil, the aroma in its oil is harmful for diseases, but its perfume is very good, we use its oil in pain etc. It is absolutely Ayurvedic it does not have any side effects. Many people find lavender aromatherapy to be relaxing, and it has been reported to have anxiolytic effects in several small, methodologically flawed trials. Overall, the weight of the evidence suggests a small positive effect, although additional data from well-designed studies are required before the evidence can be considered strong. Lavender aromatherapy is also used as a hypnotic, although there is insufficient evidence in support of this use. Small phase I human trials of the lavender constituent perillyl alcohol (POH) for cancer have suggested safety and tolerability (up to 1200 mg/m2four times/day), although efficacy has not been demonstrated. Lavender is native to the Mediterranean, the Arabian Peninsula, Russia and Africa. It has been used cosmetically and medicinally throughout history. In modern times, lavender is cultivated around the world and the scented oils from its flowers are used in aromatherapy, baked goods, candles, cosmetics, detergents, jellies, massage oils, perfumes, powders, shampoos, soaps, and teas, goes.

MARPHOLOGICAL CHARACTERISTIC

- These lavender plants are small, branching and spreading shrubs with grey-green leaves and long flowering shoots.

- Its leaves can be simple or pinnate measuring 30–50 mm (1–2 in) in length.
- Its plant produces flowers on shoots or spikes which can be 20–40 cm (8–16 in) long. The flowers are lilac or blue in colour.

PLANT PROFILE

FAMILY	LAMIACEAE
SCIENTIFIC NAME	LAVANDULA
ENGLISH NAME	LAVENDER

SCIENTIFIC CLASSIFICATION

Kingdom	Plantae
Clade	Tracheophyte
Clade	Angiosperm
Clade	Eudicots
Clade	Asterids
Order	Lamiales
Family	Lamiaceae
Subfamily	Nepetoideae
Genus	Lavandula
Tribe	Ocimeae

HISTORY

Traditional uses of lavender range from use as a perfume to as an antimicrobial agent. This powerful and potent herb has been used throughout antiquity and is still kept as a common household ingredient today. Recent studies have found that the essential oil of this exceptional species can replace the chemical methods currently used to suppress germination in potato tubers for storage. In bioactivity studies in India, Lavendula species have been proven to show potent activity against insect pests. Another study in Austria provided evidence of sedative effects of lavender essential oil following inhalation. Currently, most lavender products are used for essential oil production and for their aromatic properties. The Greek naturalist, Dioscorides, praised the medicinal properties of lavender in the first century AD. In ancient Egypt it was used as a perfume and as an essential ingredient for incense. Lavender was a favourite ingredient in the herbal baths of both the Greeks and the Romans. During the Middle Ages it was considered the herb of love and was used as an aphrodisiac. It was also believed that sprinkling lavender water on the head of a loved one kept the wearer pure. Lavender was used as an ingredient in smelling salts and was used to disinfect wounds during warfare. In China, lavender is used to make a healing all medicinal oil called White Flower Oil. Other historical uses include embalming corpses, treating animals for lice, taming lions and tigers, repelling mosquitoes, flavouring smells, etc. Medicinal uses include headache, hysteria, palpitations, hoarseness, paralysis, toothache, joint pain, apoplexy, colic, cough, and treatment of the digestive system.

PHYTOCHEMICALS

- **FLAVONOIDS**

Flavonoids, a group of natural substances with variable phenolic structures, are found in fruits, vegetables, grains, bark, roots, stems, flowers, tea and wine. These natural products are well known for their beneficial effects on health and efforts are being made to isolate the ingredients so called flavonoids. Flavonoids are now considered as an indispensable component in a variety of nutraceutical, pharmaceutical, medicinal and cosmetic applications. This is attributed to their anti-oxidative, anti-inflammatory, anti-mutagenic and anti-carcinogenic properties coupled with their capacity to modulate key cellular enzyme function. Research on flavonoids received an added impulse with the discovery of the low cardiovascular mortality rate and also prevention of CHD. Information on the working mechanisms of flavonoids is still not understood properly. However, it has widely been known for centuries that derivatives of plant origin possess a broad spectrum of biological activity. Current trends of research and development activities on flavonoids relate to isolation, identification, characterisation and functions of flavonoids and finally their applications on health benefits. Molecular docking and knowledge of bioinformatics are also being used to predict potential applications and manufacturing by industry. In the present review, attempts have been made to discuss the current trends of research and development on flavonoids, working mechanisms of flavonoids, flavonoid functions and applications, prediction of flavonoids as potential drugs in preventing chronic diseases and future research directions.

- **COUMARINS**

Coumarins comprise a very large class of compounds found throughout the plant kingdom. They are found at high levels in some essential oils, particularly cinnamon bark oil (7,000 ppm), cassia leaf oil (up to 87,300 ppm) and lavender oil. Coumarin is also found in fruits (e.g. bilberry, cloudberry), green tea and other foods such as chicory (Lake, 1999). Most coumarins occur in higher plants, with the richest sources being the Rutaceae and Umbelliferone. Although distributed throughout all parts of the plant, the coumarins occur at the highest levels in the fruits, followed by the roots, stems and leaves. Environmental conditions and seasonal changes can influence the occurrence in diverse parts of the plant. Recently six new minor coumarins have been isolated from the fruits and the stem bark of Calophyllum dispar (Clusiaceae). The genus Calophyllum, which comprises 200 species, is widely distributed in the tropical rain forest where several species are used in folk medicine (Guilet et al, 2001). Although most of the natural coumarins in existence have been isolated from the higher plants, some members have been discovered in microorganisms. Some important coumarin members have been isolated from microbial sources e.g. novobiocin and coumermycin from Streptomyces, and aflatoxins from Aspergillus species (Cooke et al, 1997, Cooke, 1999).

- **CAPROIC ACIDS**

Caproic acid, also known as hexanoic acid, is the carboxylic acid derived from hexane with the chemical formula CH3(CH2)4COOH. It is a colourless oily liquid with an odor that is fatty, cheesy, waxy, and like that of goats or other barnyard animals. It is a fatty acid found naturally in various animal fats and oils, and is one of the chemicals that gives the decomposing fleshy seed coat of the ginkgo its characteristic unpleasant odor. It is also one of the components of vanilla and cheese. The primary use of caproic acid is in the manufacture of its esters for use as artificial flavours, and in the manufacture of hexyl derivatives, such as hexylphenols. Salts and esters of caproic acid are known as caproates or hexanoates. Several progestin medications are caproate esters, such as hydroxyprogester one caproate and gestonorone caproate. Two other acids are named after goats: caprylic acid (C8) and capric acid (C10). Along with caproic acid, they account for 15% of the fat in goat's milk.

- **KETONES**

ketone, any of a class of organic compounds characterized by the presence of a carbonyl group in which the carbon atom is covalently bonded to an oxygen atom. The remaining two bonds are to other carbon atoms or hydrocarbon radicals (R):
Ketone compounds have important physiological properties. They are found in several sugars and in compounds for medicinal use, including natural and synthetic steroid hormones. Molecules of the anti-inflammatory agent cortisone contain three ketone groups.

- **SESQUITERPENOIDS**

Sesquiterpenoids are a class of enormously diverse natural products derived from the 15-carbon precursor, farnesyl pyrophosphate (FPP). The chemical diversity of sesquiterpenoids starts from the diverse sesquiterpene hydrocarbon backbones, which are created by carbocation cascade reactions programmed in sesquiterpene synthases.

- **BETA OCIMENE**

β-Ocimene (3,7-dimethyl-1,3,6-octatriene) is a monoterpenoid with the chemical formula C10H16. It has two stereoisomers, cis- and trans-β-ocimene , which are the cis and trans forms of the central double bond . The trans isomer is more common and more abundantly emitted in floral scents than the cis isomer. It is synthesized from the precursors isopentenyl pyrophosphate (IPP) and dimethylallyl pyrophosphate (DMAPP) via the methyl-erythritol-phosphate (MEP) pathway. Monoterpenes are obtained by the transformation of DMAPP and IPP into geranyl diphosphate (GPP) inside the chloroplasts, and the later synthesis of terpene compounds from GPP by enzymes called terpene synthases (TPS), which are very diversified across the phylogeny of the plant kingdom.

PHARMACOLOGICAL ACTIVITIES:

Anti-inflammatory effects:

The anti-inflammatory effects of L. stoechas were evaluated by inducing inflammation via a lipopolysaccharide-macrophage model. The results of this in vitro study showed that L. stoechas essential oil in concentrations of 0.16 µL/mL and 0.32 µL/mL significantly reduced nitrite production in cell cultures without causing cellular damage. In another experimental model, Algieri et al. found an anti-inflammatory effect of L. stoechas extraction, with values similar to those recorded by a steroidal anti-inflammatory drug (glucocorticoid dexamethasone). Rats treated with the L. stoechas extract in doses of 10 mg/kg and 25 mg/kg exhibited reduced inflammation of the tissues by 1 cm to 2 cm; the anti-inflammatory effect was explained by the regulation of inflammatory precursors, including matrix metalloproteinase 9, inducible nitric oxide synthase, cyclooxygenase 2, and pro-inflammatory cytokines.

Antioxidant effect:

The antiradical potency of the L. stoechas extract grown in Morocco was tested using the 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging assay [28]. At concentrations of 4 mg/mL, 2 mg/mL, and 1 mg/mL, the hydroethanolic extract decreased the DPPH signal by 85.5%, 57.8%, and 44%, while butylated hydroxytoluene (synthetic antioxidant) decreased the signal by 78.3%, 73.0%, and 65%. The half maximal inhibitory concentration (IC50) of the extract in this study was 1400 µg/mL higher than BHT (IC50 = 200 µg/mL). Ceylana et al. evaluated the anti-radical activity of the methanolic extract of L. stoechas and recorded an IC50 of 300 µg/mL, compared with BHT and BHA with IC50 values of 200 µg/mL and 100 µg/mL, respectively. In a comparative study by Sariri et al. the water extracts of four lavender species from the north of Iran were studied to investigate theirpotency as tyrosinase inhibitors. The study showed a variable antioxidant power of the four Lavandula species, with antiradical values of 9.2 µg/mL, 12.5 µg/mL, 38.7 µg/mL, and 65.1 µg/mLfor L. angustifolia, L. stoechas, L. dentate, and L. latifolia, respectively. Sebai et al. evaluated the antioxidant activity using the radical-scavenging activity and DPPH methods, which revealed that the volatile compounds of L. stoechas were characterized by a high antioxidant capacity (IC50 = 221.43 µg/mL), although this was lower than that of the control antioxidant (ascorbic acid, IC50 = 87.57 µg/mL).

Antispasmodic and sedative effects:

The anti-spasmodic effect of L. stoechas extract was evaluated on rabbit jejunum [32]. The authors recorded an anti-spasmodic effect of doses between 0.1 mg/mL and 1.0 mg/mL of L. stoechas hydromethanolic extracts without recording a negative effect on the jejunum tissues. This spasmolytic activity may be due to the presence of 7-methoxycoumarin, which has been reported to be a smooth muscle relaxant [51]. In the same study, Gilani et al. [32] demonstrated that the extract of L. stoechas has sedative properties at a dose of 600 mg/kg; pentobarbital sleeping time was prolonged from 39.4 ± 5.74 min to 65.4 ± 5.72 min, similar to diazepam, a standard sedative drug [40]. The tested rats were calm, dull, and relaxed. This study provides evidence for the traditional usage of this plant as a sedative.

Antibacterial activity:

Many essential oils exhibit antibacterial and antiviral activities and have been shown to be potent therapeutic agents. These oils are used against both pathogenic and non-pathogenic organisms. Cherrat etc. all. reported that Moroccan L. stoechas essential oils showed superior antibacterial activity against Gram-positive bacteria compared with Gram-negative bacteria; for example, they exhibited the highest antimicrobial activities against Escherichia coli O157, Listeria monocytogenes and Staphylococcus aureus with inhibition diameters of 16.2 ± 0.60 mm, 32.0 ± 2.00 mm and 28.0 ± 0.70 mm, respectively. Sarac and Ugur recorded the antibacterial activity of L. stoechas essential oil cultivated in Turkey against both Gram-positive and Gram-negative bacteria. S. aureus, S. epidermidis, S. mutans, E. coli, P. stutzeri, S. maltophilia, M. luteus, C. luteola, and B. subtilis were the most sensitive bacteria to the essential oil and are antibiotic-resistant bacteria. L. stoechas essential oils from Turkey (Goren et al. and Tunisia both showed strong antimicrobial activity, similar to other sesquiterpene rich essential oils. A recent study tested antimicrobial activity against eight pathogenic bacterial strains, including E. coli, S. aureus, L. monocytogenes, Proteus mirabilis, Pseudomonas aeruginosa and B. subtilis using amicrotitration assay . The study indicated that the highest inhibition was obtained against L. monocytogenes and S. aureus with inhibition diameters of 23 ± 0.85 mm and 21 ± 0.25 mm, respectively.

Antifungal activity:

Several studies have evaluated the antifungal activity of L. stoechas essential. Benabdelkader et al. evaluated the antifungal activity of 11 L. stoechas essential oils and confirmed the presence of antifungal activity against filamentous fungi (Aspergillus niger and Fusarium oxysporum) and yeasts (Candida albicans). Similarly, L. stoechas essential oils tested on filamentous fungi and molds had antifungal activity on various strains of clinical origin (Candida albicans, Candida krusei, and Candida guilliermondii) and on clinical dermatophytes (Epidermophyton floccosum and Trichophyton mentagrophytes), with inhibition zones between 0.32 µl/ml and 5 µl/ml [91].L. stoechas essential oils also demonstrated antifungal activity against Rhizoctonia solani and Fusarium oxysporum, but had less effect on Aspergillus flavus. The antifungal activity of L. stoechas essential oils has been reported to be specifically related to the presence of antifungal compounds such as camphor, 1,6-cineole, and fenchone, and the synergistic effect of the major and minor constituents of this oil .

USES:

1. Insomnia
2. Wound Healing

3. Skin Conditions
4. Hair

LAVENDER- IN TREATMENT OF HEADACHES:

A headache is a pain in your head or face that's often described as a pressure that's throbbing, constant, sharp or dull. Headaches can differ greatly in regard to pain type, severity, location and frequency.

Headaches are a very common condition that most people will experience many times during their lives. They're the most common form of pain and are a major reason cited for days missed at work or school, as well as visits to healthcare providers.

While most headaches aren't dangerous, certain types can be a sign of a more serious condition.

TYPES OF HEADACHES:

Most people have more than one type of headache. The most common type of headache seen in a doctor's office is migraine (the most common type of headache in the general population is tension headache). Some people do not believe that migraine and tension headaches are different headaches, but rather two ends of a headache continuum. The diagnosis of headache type is important since treatment differs for each headache type. Over the course of your life, headache patterns and symptoms may change.

- Moderate to severe pain
- One-sided (can also be two-sided)
- Associated with nausea, vomiting, and/or light and sound sensitivity
- Aggravated by movement or activity
- Pulsing or throbbing

CAUSES

Pain in the head is carried by certain nerves that supply the head and neck. The trigeminal system impacts the face as well as the cervical (neck) 1 and 2 nerves in the back of the head. Although pain can indicate that something is pushing on the brain or nerves, most of the time nothing is pushing on anything. We think that in migraine there may be a generator of headache in the brain which can be triggered by many things. Some people's generators are more sensitive to stimuli such as light, noise, Odor, and stress than others, causing a person to have more frequent headaches.

TREATMENT:

There's also strong evidence that lavender can help treat headaches and migraine. Breathing in the scent of lavender essential oil can help the acute management of migraine attacks. One 2013 study found that people reported a significant reduction in pain after only 15 minutes of inhaling the lavender oil.

Adults can inhale lavender essential oil for quick relief. To do this, add 2 to 4 drops of oil to 2 to 3 cups of boiling water. Then, inhale the vapors. You can also massage a few drops into the skin.

REFFERENCE:

1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner

3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021

11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee

21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474

33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079

45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress

Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.

56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.

68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.
70. 1. February 2004. Journal of Herbal Pharmacotherapy 4(2):63-78, DOI:10.1300/J157v04n02_07
71. 2. March 2005. Healthcare Infection 10(1), DOI:10.1071/HI05035
72. 3. Written by Joe-Ann McCoy, Ph.D. 1999. Updated by J.M. Davis in 2017 and 2021.
73. 4. "Lavandula L., Sp. Pl.: 572 (1753)". World Checklist of Selected Plant Families. Royal Botanic Gardens, Kew. 2022. Retrieved 2 November 2022.
74. 5. Héral, Bénédicte; Stierlin, Émilie; Fernandez, Xavier; Michel, Thomas (2021). "Phytochemicals from the genus Lavandula: a review". Phytochemicals Reviews. 20 (4): 751–771. doi:10.1007/s11101-020-09719-z. S2CID 224898995 – via SpringerLink.
75. 6. January 2012. Journal of Medicinal Plant Research 6(3), DOI:10.5897/JMPR11.1166
76. 7. Aburjai T, Hudaib M, Tayyem R, Yousef M, Qishawi M. Ethnopharmacological survey of medicinal herbs in Jordan, the Ajloun Heights region. J Ethnopharmacol. 2007;110:294–304.
77. 8. Lavender Cultivation Practices In India | Agri Farming [Internet]. www.agrifarming.in. 2018. Available from: https://www.agrifarming.in/lavender-cultivation-practices-india
78. 9. March 2005. Healthcare Infection 10(1), DOI:10.1071/HI05035
79. 10. Payam Sasannejad 1, Morteza Saeedi, Ali Shoeibi, Ali Gorji, Maryam Abbasi, Mohsen Foroughipour Affiliations expand, DOI: 10.1159/000335249

Chapter – 12

A REVIEW ON IMMUNE BOOSTER OF LAVENDER PLANT

VIKASH KUMAR THAKUR[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Abstract
The increase in the utilization of Lavandula essential oil in industries led to an impressive rise in the demand for quality essential oils. However, a post-harvest drying of Lavandula species can be a decisive factor to determine the quantity and quality of essential oil. The study was conducted in western Himalayan conditions to assess the essential oil content and composition of two Lavandula species viz., lavender (Lavandula angustifolia Mill.), and lavandin (Lavandula × intermedia Emeric ex Loisel), at four different drying duration (0 h, 24 h, 48 h and 72 h after the harvest). The higher growth attributes viz., plant height (71.7 cm), ear length (8.8 cm), number of spikes (18.1), and number of flowers per ear (47.5) were higher in lavandin, while the number of branches (17.1) was higher in lavender. Essential oil content (%) and moisture reduction (%) were significantly higher at 72 h than at 0 h. The major components of lavender and lavandin essential oil were linalool (33.6–40.5%), linalyl acetate (10.8–13.6%), lavandulyl acetate (2.8–14.5%), and linalyl propionate (5.3–14.1%) in both the Lavandula species. There was a decreasing trend in linalool and an increasing trend in linalyl acetate content in lavandin, with an increase in drying duration up to 72 h; while in lavender, no regular trend was observed in linalool and linalyl acetate content. It was observed that linalool and linalyl acetate levels were the highest at 24 and 0 h of drying in lavender and lavandin, respectively, and essential oil

extraction can be done according to the desire of the constituent at varied drying duration.

Keywords: - lavender, lavandin, linalyl acetate, linalool

INTRODUCTION:

The usage of medicinal and aromatic plants (MAPs) since prehistoric times have been well known, but these are recently recognized around the world as economical crops for high-valued essential oil. The essential oil-producing plants belong to different genera with families including Lamiaceae Asteraceae, Apiaceae, Alliaceae, Rutaceae, Poaceae, and Myrtaceae. One of the important plant families is "Lamiaceae", which has been reported to contain 236 genera and 6900–7200 species.

The genus Lavandula is of major significance in the Lamiaceae family, covering more than 40 species and many subspecies. The principal cultivated species for aromatic oils are fine lavender, spike lavender, and lavandin, a sterile hybrid of L. angustifolia × L. latifolia.

The main production country of lavender is Bulgaria, followed by France; the top producer of lavandin essential oil is France, followed by Spain. The essential oil composition of Lavandula species almost has a similar chemical profile, but the components are usually present in varied proportions. The presence of a few essential oil components, viz., camphor, linalool, and linalyl acetate is the common criterion for quality determination of essential oil of lavandin. The lavender essential oil contains linalyl acetate (25–45%), linalool (25–38%), and camphor (0.5–1.0%), while lavandin essential oil contains linalyl acetate (28–38%), linalool (24–35%), and camphor (6–8%) according to the ISO 3515:2002 and ISO 8902:2009 standards, respectively. Lavender essential oil is used in pharmaceuticals, perfumery, and cosmetic industries because of its higher linalool and linalyl acetate content, while essential oil of lavandin is usually utilized in industrial and domestic cleaning products, hygiene, and detergents owing to higher camphor levels.

Although the yield of essential oil is higher in lavandin (120 kg ha^{-1}) compared to lavender (40 kg ha^{-1}), according to International market price of 2018, essential oil quality and price of lavender (100.89–178.03 USD kg^{-1}) is higher than lavandin (22.6 USD kg^{-1}). The lavender essential oil is much desired in the marketplace, although the amount of production is low, while lavandin essential oil is different in quality due to its relatively higher camphor content. The commercial and industrial cultivation of lavender and lavandin has been raised rapidly during the last years due to increased world demand. The essential oil market of lavender was 530.5 USD Million in 2020 and is expected to reach 864.7 USD million by 2025 with a CAGR (compound annual growth rate of 10.3% from 2020 to 2025. Lavandula essential oil has some uses such as reliever of stress, anxiety, insomnia, migraines, and depression; it also has biological properties, viz., antimicrobial, antioxidant anticholinesterase. The qualitative and quantitative composition of essential oil of Lavandula species depends on genetic makeup, climate, reproduction, morphology, variety, harvest time, soil pH, nutrient availability, and weather conditions.

Moreover, the post-harvest method of management, extraction method, and distillation time also play an important role in essential oil composition. In the literature, there is plenty of exploration on essential oil content, composition, and various biological activities of Lavandula species, including Bulgarian cultivars; however, there is a lack of comparative study on essential oil content and chemical composition of L. angustifolia Mill. and L. × intermedia essential oils in the mid hills of the western Himalaya under different post-harvest drying hours. The present study aims to investigate suitable post-harvest drying storage duration, which will encourage the hilly growers of the western Himalayan region and ultimately screen the quality stipulation and possible commercial value of produced essential oil.

MARPHOLOGICAL CHARACTER:

It is a waterfall and its color is very beautiful and its oil is very beneficial or Ayurvedic plant, it works very well in headache.

PARTS OF USE:

Lavender is used for headache and muscle pain. And it is used in many infections like ham fungal infections and wounds. We also use lavender in tea drink.

Aromatherapists use lavender in inhalation therapy to treat headaches, nervous disorders, and exhaustion. Herbalists treat skin ailments, such as fungal infections (like candidiasis), wounds, eczema, and acne, with lavender oil. It is also used in a healing bath for joint and muscle pain.

The flowers and leaves are used as a herbal medicine, either in the form of lavender oil or as a herbal tea, to alleviate symptoms such as anxiety, and difficulty falling asleep. The flowers are also used as a culinary herb, most often as part of the North American version of the French herb blend called herbes de Provence. Lavender essential oil, when diluted with a carrier oil, is commonly used as a relaxant with massage therapy. Products for home use, such as lotions, eye pillows (including lavender flowers or the essential oil itself) and bath oils, etc., are also used. Both the petals and the oil are the most popular ingredients in handmade soap. Dried lavender flowers and lavender essential oil are also used as a prevention against clothing moths, which do not like their scent.[citation needed] Lavandula angustifolia is included in the Tasmanian Fire Service's list of low flammability plants, indicating that it is suitable for growing within a building protection zone.

BOTANICAL DESCRIPTION:

Lavender plants are small, branching and spreading shrubs with grey-green leaves and long flowering shoots. The leaves can be simple or pinnate measuring 30–50 mm (1–2 in) in length. The plant produces flowers on shoots or spikes which can be 20–40 cm (8–16 in) long. The flowers are lilac or blue in color.

Lavender can grow to 0.4 m (1.3 ft) in height and live for 20–30 years. Lavender may also be referred to as true lavender, medical lavender, smelling lavender, thin-leaved lavender or English lavender and is believed to originate from the Mediterranean, Middle East and India.

Lavender is the name given to several species of herbaceous, perennial shrubs in the genus Lavandula which are grown as ornamental plants or for essential oil.

Lavenders are small evergreen shrubs with gray-green hoary linear leaves. The purple flowers are sparsely arranged on spikes at the tips of long bare stalks and produce small nutlet fruits. The fragrance of the plant is caused by shining oil glands imbedded among tiny star-shaped trichomes (plant hairs) that cover the flowers, leaves, and stems. The plants in cultivation do not usually produce seed, and propagation is accomplished by cuttings or by dividing the roots.

IMMUNE SYSTEM:

The immune system defends body against outside threats. These include germs such as bacteria, viruses, and fungus, as well as poisons (chemicals made by microbes). The immune system is made up of various organs, cells, and proteins that all operate together.

And a complex network of cells, tissues, organs, and the substances they make that helps the body fight infections and other diseases. The immune system includes white blood cells and organs and tissues of the lymph system, such as the thymus, spleen, tonsils, lymph nodes, lymph vessels, and bone marrow.

ADAPTIVE IMMUNITY:
Adaptive immunity refers to defense mechanisms mediated by lymphocytes (T, B, and natural killer cells) and the specialized chemicals required for their function. The term adaptive refers to lymphocytes' ability to rapidly adapt to a given condition (for example, a specific type of microbial infection) by producing specialized cells, cytokines, and antibodies, as well as longlasting immunologic memory.
The adaptive immune system, also known as the acquired immune system, is a subsystem of the immune system that is composed of specialized, systemic cells and processes that eliminate pathogens or prevent their growth.

ANTIGEN:
An antigen is a non-self molecule, typically a protein, that triggers an adaptive immune response.

CYTOKINES:
Cytokines are protein molecules produced by immune system cells that mediate a variety of defensive actions. Inflammation, lymphocyte activation and differentiation, and destruction of cells with foreign antigens are examples of these. Cytokines are involved in the development of autoimmunity and immune-mediated kidney disease.

DENDRITIC CELLS (DCs):
Dendritic cells (DCs) are specialized myeloid cells that are activated by infection to take up antigens, convert them into tiny peptides, bundle them inside MHC molecules, and present them to T lymphocytes after migrating to secondary lymphoid organs. DCs are model antigenpresenting cells (APCs). They connect innate and adaptive immunity.

INNATE IMMUNITY:

Innate immunity refers to protection mechanisms mediated by the more rudimentary evolutionary components of our immune system. These include myeloid cells such as macrophages, DCs, and neutrophils, as well as protein molecules such as the complement and coagulation systems. The word "innate" is used because these responses are hardwired in the genome, responding to injury or infection in a fairly consistent manner. The adaptive immune system is activated by the innate immune system, mostly through antigen-presenting DCs.

LYMPHOCYTES:

Lymphocytes are hematopoietic cells that play an important role in adaptive immunity. T cells differentiate into the specialized subpopulations best equipped to combat the offending agent, whereas B lymphocytes create antibodies (humoral immunity) (cellular immunity).

PRIMARY LYMPHOID ORGANS:

Primary lymphoid organs or tissues are those in which lymphocytes are born and/or trained to recognize and respond to nonself antigens but not self-molecules. The bone marrow and the thymus are two examples.

SECONDARY LYMPHOID ORGANS:

Secondary lymphoid organs are organs or tissues that contain or circulate mature (trained) lymphocytes. They are the sites at which lymphocytes come into contact with antigens and are activated to create antibodies or effector (fighter) cells. The spleen, lymph nodes, and mucosal lymphoid tissues such as the Peyer's patches in the small intestine are examples of secondary lymphoid organs.

TOLL LIKE RECEPTORS (TLRs):

TLRs are receptors that are found mostly on innate immune cells but also adaptive immune cells and nonimmune cells. They are looking for conserved molecular patterns in microorganisms. A prominent example is a TLR4 receptor, which binds the lipopolysaccharide (LPS) of Gramnegative bacteria. TLRs detect tissue injury by interacting with endogenous chemicals generated by dead or stressed cells. TLR activation causes inflammation as well as DC maturation, resulting in an improved adaptive immune response.

IMMUNE BOOSTER:

Your immune system is a complex network of organs, cells, proteins, tissues, and chemicals that guard your body against various diseases, viruses, and bacteria. Antibodies, white blood cells, the lymphatic system, the gut, the complement system, the thymus, and bone marrow are the key components of the immune system. All of these things work together to keep you healthy and running at peak performance, because we all know that contagious bacteria wreak havoc on your body, making you susceptible to illness all of the time. This is where immune boosters come into play. They aid in the strengthening of your body's defenses against harmful illnesses and ailments, as well as keeping you well.

PHYTOCONSTITUENTS OF LAVENDER:

FLAVONOIDS

Flavonoids, a group of natural substances with variable phenolic structures, are found in fruits, vegetables, grains, bark, roots, stems, flowers, tea and wine. These natural products are well known for their beneficial effects on health and efforts are being made to isolate the ingredients so called flavonoids. Flavonoids are now considered as an indispensable component in a variety of nutraceutical, pharmaceutical, medicinal and cosmetic applications. This is attributed to their anti-oxidative, anti-inflammatory, anti-mutagenic and anti-carcinogenic properties coupled with their capacity to modulate key cellular enzyme function. Research on flavonoids received an added impulse with the discovery of the low cardiovascular mortality rate and also prevention of CHD. Information on the working mechanisms of flavonoids is still not understood properly. However, it has widely been known for centuries that derivatives of plant origin possess a broad spectrum of biological activity. Current trends of research and development activities on flavonoids relate to isolation, identification, characterisation and functions of flavonoids and finally their applications on health benefits. Molecular docking and knowledge of bioinformatics are also being used to predict potential applications and manufacturing by industry. In the present review, attempts have been made to discuss the current trends of research and development on flavonoids, working mechanisms of flavonoids, flavonoid functions and applications, prediction of flavonoids as potential drugs in preventing chronic diseases and future research directions.

PHENOLIC ACID

To a 10 ml measuring test-tube 1.0 ml of water ex-tract was weighed out, as well as 1 ml of hydrochloric acid (18 g l-1), 1 ml of Arnov's reagent, 1 ml of sodium hydroxide (40 g l-1) and that was topped up with water to 10 ml (solution A). Then the solution absorbance was measured at 490 nm, applying a mixture of reagents without the extract as reference. The contents of phenolic acids (%) was determined in conversion to coffee acid (C9H2O4), assuming absorbability alcml%= 285, according to the formula: X = mA5087.3 ·, where A means absorbance of solution A, m – a weighted sample of raw material in g.

ESENTIAL OIL DISTILATION

The dried plant material, after samples had been weighed out (20 g each) was placed in glass flasks of the capacity of 1 dm3, poured over with 400 ml of water and designed for distillation conducted in Clevenger-type apparatuses for 3 hours, counting from the moment when the contents of flask started to boil and the first drop was distilled. The intensity of heating was regulated in such a way as to 3–4 ml of liquid flew into the receiver per one minute. After distillation had finished, cooling was switched on, the oil was led to micro-scale and after 30 min the result was read.

HEALTH BENEFITS OF LAVENDER:

BENEFITS OF LAVENDER OIL:

- It reduces anxiety and emotional stress
- Lavender protects against diabetes symptoms
- It also improves brain functions
- It helps to heal burns and wounds
- It improves sleep
- It reduces acne and restore skin complexion
- It helps in slow aging with powerful antioxidants
- It helps in relieving pain
- It alleviates headaches

  Lavender oil is a natural antioxidant that works to prevent and reverse disease. Lavender oil increases the activity of the body. Lavender oil has antioxidants that prevent or reverse oxidative stress. Lavender essential oil protect body from the following diabetes symptoms:
- From increased blood glucose level
- From metabolic disorder
- From weight gain
- From liver and kidney depletion
- From liver and kidney dysfunction
- From liver and kidney lipoperoxidation

Lavender oil is also been used against neurological damage. It is also been used for the issues like migraines, stress, anxiety and depression. By using lavender there is a decrease in the postnatal depression and anxiety disorder. Lavender oil can also improve PTDS symptoms. Lavender oil improve stress and improve sleep. Lavender oil also helps to cure Alzheimer's disease. Lavender oil is also used to prevent various infections and combat bacterial and fungal disorders. It has been reported that lavender oil speeds the healing of burns, cuts, scraps, and wounds. 1:1 ratio of lavender oils is most effective in fighting against the skin disease. Lavender oil promotes collagen synthesis. It induces relaxation and relieves tension it works as a sedative, anti-anxiety, calming agent and anticonvulsant. Lavender oil is more useful when it is mixed with coconut oil, jojoba oil, or grapeseed oil. It helps to remove skin related problems like canker sores, acne, spots. Because of its sedative and calming properties, it works as medicine to treat sleep problems and insomnia. Inhaling lavender reduces sleep problems, improve quality of sleep, and duration of sleep.

HEADACHE RELIEF:

It is considered a medicinal herb that provides relief from headache. Lavender leaves are also known as fashion designers. And powerful and invigorating aromatic characteristics are used to create the essential oils that help in relieving headache.

IMPROVE BRAIN FUNCTION:

Diffusing lavender oil can help put your nervous system in a parasympathetic rest-and-digest state, versus the fight-or-flight one that many of us often resort to during stressful times. Ingest a few drops after a busy day to calm down and promote a clear mind.

SKIN COMPLEX:

Lavender oil can aid in evening skin tone since it reduces inflammation. It can reduce discoloration, including dark spots. Lavender oil helps lessen blotchiness and redness. If you have hyperpigmentation on your skin, lavender oil may be able to help with that as well.

IMPROVE HAIR HEALTH:

Lavender essential oil recently gained attention for stimulating hair growth. A 2016 studyTrusted Source found that lavender oil applied to mice made them grow more hair. Their hair also grew thicker and faster than normal.

SKIN INFLAMATION:

Lavender is sometimes used as a home remedy for skin inflammation and burns. Using it in essential oil form may be good for scalp inflammation and dryness.

A 2012 study saw lavender oil used topically on skin inflammations and ulcers, with success. It reduced inflammation and sped up the healing process.

SOXHLET EXTRACTION PROCESS FOR LAVENDER OIL:

ESSENTIAL OIL:

An essential oil is a concentrated hydrophobic liquid containing volatile aroma compounds from the plant. They are also known as aromatic oils, fragrant oils, steam volatile oils, ethereal oils, or simply as the "oil of" the plant material from which they were extracted, such as oil of clove. The advantages of essential oils are their flavor concentrations and their similarity to their corresponding sources. The majority of them are fairly stable and contain natural antioxidants and natural antimicrobial agent as on citrus fruits (Somesh et al., 2015). Essential oils are usually colorless, particularly when fresh. Nevertheless, with age essential oil may oxidize which resulting the color becomes darker. Therefore, essential oil needs to be stored in a cool, dry place tightly stoppered and preferably full in amber glass containers.

Essential oil is used in perfumery, aromatherapy, cosmetics, incense, medicine, household cleaning products and for flavoring food and drink. They are valuable commodities in the fragrance and food industries. More than 250 types of essential oils. A number of countries produce different kinds of essential oils. India ranks second in the world trade of essential oils . Essential oils are derived from various sections of plants. An essential oil is usually separated from the aqueous phase by a physical method that does not lead to significant change in its chemical composition . Essential oils could be then subjected to an appropriate further treatment. Essential oils are oily aromatic liquids extracted from aromatic plant materials. They could be biosynthesized in different plant organs as secondary metabolites .

CHEMICAL CONSTITUENTS:

They are complex mixtures of volatile compounds such as terpenes, phenolics and alcohols . However, the essential oils are highly complex and may include oxygenated compounds. The essential oil is so called because they were believed to represent the quintessence of odor and flavor from the flower kingdom – differ in composition properties from fatty or fixed oils, which consist for the most part of glycerides and from mineral or hydrocarbon oils. A scientific definition of the term essential or volatile oils is not possible, although several practical definitions exist. The most common one defines an essential oil as a more or less volatile material isolated from an odorous plant of a single botanical species by a physical process.

They are oxygenated derivatives of hydrocarbon terpenes such as aldehydes, ketones, alcohols, phenols, acids, ethers and esters (Bakkali et al., 2008). Some terpenes are potent drugs against diseases such as heart disease (Liebgott et al., 2000), malaria (Parshikov and Netrusov, 2012) and cancer (Ebada et al., 2010).

EXTRACTION METHOD:

Essential oils are used in a wide variety of consumer goods such as detergents, soaps, toilet products, cosmetics, pharmaceuticals, perfumes, confectionery food products, soft drinks, distilled alcoholic beverages (hard drinks) and insecticides. The world production and consumption of essential oils and perfumes are increasing very fast. Production technology is an essential element to improve the overall yield and quality of essential oil. Essential oils are obtained from plant raw material by several extraction methods (Wang and Weller, 2006)(Dick and Starmans,1996).

CLASSICAL AND CONVENTIONAL:

There are several by the numbers methods of extraction behavior of essential oils. The timid technologies about essential oils processing are of abundant significance and are still overused in copious parts of the globe. Hydrodistillation (HD), Steam distillation (SD), Solvent extraction, Enfleurage, Cohobation , and Maceration are the roughly traditional and generally used methods.

HYDRODISTILATION:

Hydrodistillation is a traditional method for removal of essential oils. Water or hydrodistillation is one of the oldest and easiest methods (Meyer-Warnod et al., 1984). Being used for the extraction of essential oils. Hydrodistillation normally used to isolation essential oils from the aromatic and medicinal plant. The conventional method for the extraction of essential oils is hydrodistillation (HD), in which the essential oils are evaporated by heating a mixture of water or other solvent and plant materials followed by the liquefaction of the vapors in a condenser.The setup comprises also a condenser and a decanter to collect the condensate and to separate essential oils from water, respectively (Figure 2). The principle of extraction is based on the isotropic distillation. In fact, at atmospheric pressure and during extraction process (heating), water or other solvent and oils molecules. Hydro-distillation (HD) is a variant of steam distillation, which is bespoke by the French Pharmacopoeia for the extraction of Essential oils from dried plants and the quality control of essential oils in the lab. There are three types of hydrodistillation: with water immersion, with direct vapor injection and with water immersion and vapor injection. It is a multilateral process that can be utilized for large or small industries. The distillation time depends on the plant material being processed. Prolonged distillation produces only a small amount of essential oil, but does add unwanted high boiling point compounds and oxidation products.

REFFERENCE:

1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.

5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta

Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)

14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951

24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616

36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732

49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis

60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.
70. Butnariu M., Sarac I. Essential oils from plants. J. Biotechnol. Biomed. Sci. 2018;1:35–43. doi: 10.14302/issn.2576-6694.jbbs-18-2489. [CrossRef] [Google Scholar]
71. 2022 Jun; 27(11): 3391. Published online 2022 May 25. doi: 10.3390/molecules27113391

72. Anonymous; Lavender Production, Essential Oil Crops, Production Guidelines for Lavender, Department of Agriculture, Forestry and Fisheries. Directorate: Plant Production, South Africa, (2009).
73. USDA, NRCS (n.d.). "Lavandula angustifolia". The PLANTS Database (plants.usda.gov). Greensboro, North Carolina: National Plant Data Team. Retrieved 23 January 2016.
74. Biomolecules. 2020 Aug; 10(8): 1139. Published online 2020 Aug 3. doi: 10.3390/biom10081139
75. The innate and adaptive immune systems. Institute for Quality and Efficiency in Health Care (IQWiG). 4 August 2016.
76. International Journal of Physiology, Nutrition and Physical Education 2019; 4(1): 1274-1277
77. Lis-Balchin M, Deans SG, Eaglesham E. Relationship between bioactivity and chemical composition of commercial essential oils. Flavour Fragr J. 1998; 13:98104.
78. Medically reviewed by Debra Rose Wilson, Ph.D., MSN, R.N., IBCLC, AHN-BC, CHT — By Joseph Nordqvist on March 4, 2019
79. May 2012 European Neurology 67(5):288-91 DOI:10.1159/000335249
80. Medically reviewed by Debra Rose Wilson, Ph.D., MSN, R.N., IBCLC, AHN-BC, CHT — By Adrian White — Updated on March 8, 2019
81. May 2014. Journal of Microbiology and Biology Education 15(1):45-6 DOI:10.1128/jmbe.v15i1.656

Chapter – 13

GILOY AS AN IMMUNE BOOSTERS

Samikshya Jena[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Absract

Immune boosters can be taken to affect this process and reinforce our giloy herb-based immune system. A climbing plant called Tinospora Cordifolia is also known as giloy or guduchi in India. It improves the immune system's army of white blood cells and educates them how to combat infections and other dangerous microorganisms. we can use immune boosters, which are beverages made from the Giloy plant, to influence this process. Immunosuppression or stimulation of immune cell activity may be the overall impact on the immune system depending on the nutrients included in the immune booster. Giloy stems and leaves have been shown to help the maintenance of normal glucose tolerance and enhance beta cell production of insulin. The safety and toxicity of natural herbs and giloy immune boosters sold on the market have been investigated. In the Indian subcontinent, patients with signs of immunological deficiency are given a treatment made from this plant, which includes the herb giloy. Giloy stems and leaves have been shown to help the maintenance of normal glucose tolerance and enhance beta cell production of insulin. The safety and toxicity of natural herbs and giloy immune boosters sold on the market have been investigated. In the Indian subcontinent, patients with signs of immunological deficiency are given a treatment made from this plant, which includes the herb giloy. Giloy is also used to treat liver, kidney, and urinary tract infections, among other disorders. To strengthen humanistic immune systems, people with high coughs and COVID-19 are generally given the natural herb immuno booster giloy. We must include kadha (drink) or giloy juice in our diet twice a week in order to assess the formulation's capacity to improve the immune system. our immune system can be strengthened by drinking giloye (Tinospora Cordifolia) juice. It strengthens the army of white blood cells that protect the immune system from microorganisms that cause pathogens. The giloy is an illustration of a plant that is often grown in tropical and subtropical nations.

Keywords – Immune booster, Giloy, *Tinospora cordifolia*, Immune system , Micronutrients.

INTRODUCTION

Immune bolstering the immunological enhancer is one of nature's most fascinating inventions. This amazing defence system was developed to shield us against billions of bacteria, viruses, fungi, toxins, and parasites. It is made up of a range of phytonutrients, each of which contributes to a different aspect of the body's defence against external invaders. Our immune system protects us against microbe-borne dangers if it is working properly. If not, diseases and disorders set in. Immune boosters, which are drinks prepared from the Giloy plant, can be utilised to affect this process, and enhance our immune system. It strengthens the army of white blood cells that make up the immune system and teaches them how to fight pathogens and other hazardous bacteria.

A member of the Menispermaceae family, Tinospora Cordifolia is a climbing shrub. Common names for it include Guduchi, Giloye, Amrita, Guduchiand Tinospora. A big, glabrous deciduous climbing shrub, it is. The stems are rather succulent, and the branches are formed by long filiform fleshy aerial roots. Gray-brown and wet describe the bark. Membranous and cordate describe the leaves. The flowers are often tiny and greenish yellow in colour. This plant grows up to a height of 300 metres throughout tropical Asia. From Kumaon through Assam and via Myanmar, Bihar, Konkan, and

Sri Lanka, the plant can be found throughout India's tropical regions.

The neuroprotective elements in plant giloy improve mitochondrial activity to prevent memory loss. Cost and simplicity of use of giloy plants have increased usage in recent years. Their level of toxicity is also less than that of their synthetic pharmaceutical equivalents, according to recent study findings. Traditional medicine research has given medicinal herbs that boost the immune system a high priority due to the frequency of illnesses like that it is used to treat a broad variety of problems, including fever, infections, diarrhoea, and diabetes. On the other hand, there is hardly any information on plants that could boost the immune system. Experience has been passed down the centuries by conventional healthcare practitioners. Traditional healers regularly employ the herb Tinospora Cordifolia, also known as giloy or guduchi in India, as an immune booster. The Giloy herb is utilised as a traditional immune booster and complementary alternative medicine for patients with dengue fever and COVID-19 because to its potential to promote immunity. Since the immune system's main job is to protect the host against pathogenic agents, impaired immunological competence would undoubtedly lead to increased vulnerability to pathogen invasion. Depending on the nutrients included in the immune booster, the concentration, method, and period of exposure, the overall effect on the immune system may either be immunosuppression or stimulation of immune cell activity. In order to use giloy for local and pharmaceutical immune booster purposes, it is suggested that the concentrations of the mineral components be evaluated first. There are several points of entry for heavy metal ions to alter the function of various cells, either by inhibition or activation, resulting in an effect and a pathogenic response because of the immune system's diversity and complexity.It holds a particular place in Ayurveda and is referred to as Amrita or Amrutha in Sanskrit, which means "root of immortality." The phytochemicals in Giloy have led to its use in several medical disorders, such as those requiring antiosteoporetic, hepatoprotective, immunomodulatory, antihyperglycemic, anti-tumor, qualities. Giloy has anti-arthritic and anti-inflammatory characteristics that can be used to treat arthritis and its various symptoms. It can be used to treat rheumatoid arthritis alongside ginger. Giloy is applied to the eyes in different regions of India to improve eyesight clarity. Giloy has anti-aging qualities that help lessen wrinkles, fine lines, dark spots, and acne. This plant is truly remarkable because it can be used to treat any illness.

HUMAN IMMUNE SYSTEM

A desire to stop the spread of disease and create better therapies for the sick was a major driving force behind early immune system discoveries. Microbiologists worked to protect healthy people from diseases as early as the eighteenth century. Before it was established that germs caused disease or that immune cells could eradicate bacteria, vaccinations were really developed to prevent illness. Immune responses are mediated by leukocytes, which derive from precursors in the bone marrow. A pluripotent hematopoietic stem cell gives rise to the lymphocytes responsible for adaptive immunity, and to myeloid lineages that participate in both innate and adaptive immunity. Neutrophils, eosinophils, and basophils are collectively known as granulocytes; they circulate in the blood unless recruited to act as effector cells at sites of infection and inflammation. Macrophages and mast cells complete their differentiation in the tissues where they act as effector cells in the front line of host defence and initiate inflammation. Macrophages phagocytose bacteria, and recruit other phagocytic cells, the neutrophils, from the blood. Mast cells are exocytic and are thought to orchestrate the defence against parasites as well as triggering allergic inflammation; they recruit eosinophils and basophils, which are also exocytic.

Dendritic cells enter the tissues as immature phagocytes where they specialize in ingesting antigens. These antigen-presenting cells subsequently migrate into lymphoid tissue. There are two major types of lymphocytes: B lymphocytes, which mature in the bone marrow; and T lymphocytes, which mature in the thymus. The bone marrow and thymus are thus known as the central or primary lymphoid organs. Mature lymphocytes recirculate continually from the bloodstream through the peripheral or secondary lymphoid organs, returning to the bloodstream through the lymphatic vessels. Most adaptive immune responses are triggered when a recirculating T cell recognizes its specific antigen on the surface of a dendritic cell. The three major types of peripheral lymphoid tissue are the spleen, which collects antigens from the blood; the lymph nodes, which collect antigen from sites of infection in the tissues; and the mucosal-associated lymphoid tissues (MALT), which collect antigens from the epithelial surfaces of the body. Adaptive immune responses are initiated in these peripheral lymphoid tissues: T cells that encounter antigen proliferate and differentiate into antigen-specific effector cells, while B cells proliferate and differentiate into antibody-secreting cells.

COMPONENTS OF IMMUNESYSTEM

The main parts of the immune system are:

- white blood cells.
- antibodies.
- complement system.
- lymphatic system.
- spleen.
- bone marrow.
- thymus.

The immune system's white blood cells develop from bone marrow progenitors. The hematopoietic stem cells in the bone marrow serve as the ultimate progenitor or precursor cells for

all the cellular components of blood, including the red blood cells that carry oxygen, the platelets that cause blood to clot in injured tissues, and the white blood cells of the immune system. Hematopoietic stem cells in the bone marrow are the source of all the cellular components of blood, including the lymphocytes of the adaptive immune system. Two more specialised stem cell types, a common lymphoid and two pluripotent cells, are created when these pluripotent cells divide.Adaptive and innate immunity include myeloid cells. Myeloid lineage cells have several significant roles in the immune response. In the left column, the cells are depicted schematically in the format in which they will be represented throughout the present thesis.
Mast cells are big cells that may be found in the dermis and submucosal tissues throughout the body's connective tissues. Large granules, containing the vasoactive amine histamine, are present in them and are used to store a range of mediator molecules. Mast cells may bind IgE monomers because they have high-affinity Fc receptors (FcRI).
Lymphocytes are exceptional in that they can launch a targeted immune response against almost any foreign antigen. This is made feasible by the fact that the population of T and B lymphocytes collectively carries a vast repertoire of receptors that are very different in their antigen-binding sites. Each individual lymphocyte grows holding a distinct version of a prototype antigen receptor. After becoming activated and differentiating into plasma cells, the B cell will release the membrane-bound antibody known as the B-cell antigen receptor (BCR). The antigen receptor on B cells is often referred to as membrane immunoglobulin since antibodies belong to the family of molecules known as immunoglobulins, commonly abbreviated as Ig (mIg).
The Immunoglobulin is connected to T-cell antigen receptor (TCR), however they are significantly different from one another since TCR is uniquely suited to recognise antigens originating from foreign proteins or infections that have

invaded the host The innate immune system is composed of a third lineage of lymphoid cells termed natural killer cells, which lack antigenspecific receptors. These cells circulate as sizable lymphocytes with recognisable cytotoxic granules in the blood. Natural killer (NK) cells are assumed to play a key role in the innate immune system's defence against intracellular infections because they can detect and destroy some aberrant cells, such as some tumour cells and virus-infected cells. These are large granular lymphocyte-like cells with important functions in innate immunity. Although lacking antigen-specific receptors, they can detect and attack certain virus-infected cells.

In the thymus or bone marrow, lymphocytes develop. The lymphoid organs are specialised tissues with a framework of nonlymphoid cells and a high concentration of lymphocytes. The interactions lymphocytes have with nonlymphoid cells in these organs are crucial for lymphocyte formation, the start of adaptive immune responses, or lymphocyte survival. Most lymphocytes are tiny, dormant cells. A light micrograph of a little lymphocyte surrounded by red blood cells can be seen in the left panel. Take note of the nucleus' compacted chromatin, which denotes very minimal transcriptional activity.

The gut-associated lymphoid tissues (GALT)

Antigen is gathered from the epithelial surfaces of the gastrointestinal system by the gut-associated lymphoid tissues (GALT), which comprise the tonsils, adenoids, and appendix as well as specialised organs termed Peyer's patches in the small intestine. Multi-fenestrated or M cells are specialised epithelial cells that collect the antigen in Peyer's patches, the most significant and well-organized of these tissues. The lymphocytes group together to create a follicle, which has a big central dome of B lymphocytes surrounded by fewer T lymphocytes. BALT, which stands for bronchial associated lymphoid tissue, and other mucosa, sometimes known as mucosal-associated lymphoid tissue, are similar but more diffuse lymphocyte clumps that protect the respiratory epithelium (MALT).

Spleen

The spleen is an organ located in the upper left side of the abdominal cavity. It has a white pulp of lymphoid cells that react to antigens brought to the spleen by the blood and a red pulp that removes senescent blood cells. The essential structural characteristics of the spleen and mucosal-associated lymphoid tissues are the same. This is crucial for sustaining the proper amount of T and B lymphocytes in the bloodstream and making sure that only lymphocytes with the capacity to react to external antigens are maintained.

Lymphocytes circulate between blood and lymph Naive lymphocytes are small B and T cells that have developed in the thymus and bone marrow but have not yet come into contact with an antigen. These cells continuously circulate between the cells of the capillary walls to enter the peripheral lymphoid tissues from the blood. After that, they may return directly to the circulation in the case of the spleen or via the lymphatic channels.

MECHANISM

The cellular component of the immune system is more generally referred to as cell mediated immunity as contrast to humoral immunity. Adaptive immunity refers to the immune system's capacity to provide a particular cellular response to a disease. It was a long-standing enigma in immunology how the immune system was able to develop such highly specific immune receptors up until the middle of the 20th century. Although the body contains immune cells, the immune system also consists of a specific network of immune organs. The immune system is organised within immune organs, allowing for a controlled immune response that can quickly produce a huge number of cells that can block an infection from spreading.

Other innate immune cells, such as dendritic cells, have a more complex role to complete. While certain innate immune cells are tasked with detecting pathogens throughout the body and eliminating them through various methods, once a pathogen has been engulfed, a dendritic cell will move through the blood or lymph to a lymphoid location. The dendritic cell will move through the lymphoid tissue to meet a lymphocyte and start an immune response that usually takes place within seven days. Thus, it is possible to imagine that the lymphoid compartment serves as a meeting place for innate and adaptive immune cells to begin activating the adaptive immune response.

GILOY (*Tinospora cardifolia*)

The Menispermaceae family includes the climbing plant Tinospora Cordifolia. Some of its common names are Guduchi, Giloye, Amrita, Guduchi, Gurachi. It is a large, deciduous, glabrous climbing shrub. Long filiform fleshy aerial roots that emerge from the stems, which are often succulent, form the branches. It is moist and gray-brown in colour. The leaves are membranous and cordate. The flowers are often small and greenish yellow. The Hindu mythological term "Giloy" or "Giloe" refers to "a fabled heavenly elixir which celestial creatures imbibe to remain eternally young." Due to its wide therapeutic capabilities, Giloy is known by numerous names, the most well-known of which are "Amrita," which means "the root of immortality," and "Guduchi," which means "that which protects the body from ailments." Ayurveda says that. Although it is native to India, the giloy plant is also found in China, Australia, and Africa. The leaves, stem, and roots of this extraordinary medicinal plant are all utilised to make Ayurvedic medicines, but the stem of the Giloy is the most useful element. The Food & Drug Administration has authorised the uses and advantages of Giloy (FDA).

T. cordifolia is a common ingredient in Indian traditional Ayurvedic treatment. It has demonstrated considerable promise for the creation of biopharmaceutical drugs used in the treatment of many ailments.It is a febrifuge used to treat persistent fever and malaria. Moreover, it is a liver tonic. Numerous pharmacological characteristics of the plant have been described in studies, such as antispasmodic, antidiabetic, anti-arthritic, antiperiodic, anti-inflammatory, antioxidant, antistress, anti-allergic, antimalarial, hepatoprotective, antileprotic, antineoplastic, and immune modulatory activity.

BOTANICAL DESCRIPTION A large, widely spreading, climbing, deciduous shrub with numerous twining and elongated branches, giloy sheds its leaves each fall. The giloy plant produces crimson fruits and has heart-shaped leaves that resemble betel leaves, thus the name Heart-leaved Moonseed. Simple giloy leaves are stipule-free and have long, roundish petioles (stalks) that can measure up to 15 cm (6 inches) in length.About 70 genera and 450 species of plants belong to the Menispermeaceae plant family, which are found in tropical lowland areas. The perennial twiner Tinospora cordifolia has a succulent stem and a deciduous canopy. The bark is paper-like and ranges in colour from creamy white to grey, with huge, rosette-like lenticels. Simple, alternating, or lobed, cordate, whole, 7-9 nerved leaves; smallcymose blooms that are yellow or greenish in colour. Flowers that are male and female develop on different branches. While female flowers are often solo, male flowers are grouped.

Giloy's unisexual blooms only bloom when the plant's leaves are absent. On the terminal racemes and axillary racemes, they are greenish-yellow. Typically, male Giloy flowers are crowded whereas female Giloy blooms are solitary. Fruits from the giloy tree are gathered in groups of one to three. The fruits are ovoid in form, crimson or orange in colour, and resemble smooth drupelets on strong stalks.

Scientific classification	
Domain:	Eukaryota
Kingdom:	Plantae
Clade:	Tracheophytes
Clade:	Angiosperms
Clade:	Eudicots
Order:	Ranunculales
Family:	Menispermaceae
Genus:	*Tinospora*
Species:	***T. cordifolia***
Binomial name	
Tinospora cordifolia (Thunb.) Miers	

GEOGRAPHICAL DISTRIBUTION

This plant may grow up to 300 metres high in tropical Asia. From Kumaon to Assam in India, as well as in Myanmar, Orissa, Konkan, and Sri Lanka, the plant may be found in tropical regions. It grows well in a variety of soil types and climatic settings. The plant is propagated via stem cutting in the months of May and June. Without the use of artificial fertilisers or pesticides, the medicinal plants must be grown. Green manure, vermicompost, and farm yard manure (FYM), among others, are examples of organic manures.

Nutritional Value of Giloy

The nutritional values of the constituents of Giloy according to their scientific composition are:

- Fibre: 16.19%
- Moisture: 17.69%
- Protein: 4.13%
- Fat: 3.12%
- Ash: 12.01%

TRADITIONAL USES It is one of the top ten promising herbs in Ayurveda and is regarded as a powerful immune system builder. Both traditional and patented Ayurvedic medicines use giloy. This herb activated the immune system of our body and increase vitality in a person. Include Giloy juice or kadha in your diet twice a day can improve your immunity. It is full of antioxidants and helps to release toxins from the body. Giloy juice also detoxifies your skin and improve your skin. Giloy is also used for liver diseases, urinary tract infections, and heart-related issues.

Uses of different parts of *Tinospora cordifolia*

Stems: The stem of Giloy is one of the constituents of several Ayurveda preparations used in general debility, dyspepsia, fever and urinary diseases. Stem is bitter, stomachic, diuretic stimulates bile secretion, causes constipation, allays thirst, burning sensation, vomiting, enriches the blood and cures jaundice. Stem also have anti- hyperglycaemic properties, anticarcinogenic property and used in Respiratory tract infections and skin diseases.

Roots: The root and stem of Giloy are prescribed in combination with other drugs as an antidote to snake bite and scorpion sting. It also has anti-neoplastic property and anti-oxidant activity. Leaves: Juice or decoction of leaves is administered orally with honey in fever cordifolia Bark. Giloy has anti –spasmodic, anti-pyretic and anti-allergic, anti –leprotic properties. The aqueous extract of Giloy root has anti-oxidant property. It successfully experiments on diabetic male albino rats.

Whole plant: Giloy as a whole plant is used in Diabetes. Rheumatoid arthritis, Gout, Cancer, high cholesterol content and in analgesic and neuropharmacological activities.

Chemical constituents

Various chemical constituents have been found in different parts of the Giloy plant. They belong to different classes such as alkaloids, diterpenoid, lactones, steroids, glycosides, aliphatic compounds, polysaccharides. These are as follows

Stem: Berberine, Palmatine, 18-norclerodane glucoside, Furanoid ditepene glucoside, Cordifolisides A to E Bark: Berberine, Palmatine, 18-norclerodane glucoside, Furanoid ditepene glucoside, Cordifolisides A to E, Palmatosides C and F, Cordioside

Whole Plants: Furanolactone, Clerodanederivetives and Tinosporon, Tinosporides, Jateorine, Columbin, Octacosanol, Cordifol.

Main components and their effect

Alkaloids	– These compounds give plants a bitter taste- Alkaloids may have benefits for blood pressure, pain, malaria and intestine problems
Terpenoids	– These are the most abundant group of compounds in Giloy- These compounds are involved in giving plants their colours and taste- In lab tests, terpenoids have been shown to have antibacterial, antiviral and anti-diabetic properties
Lignans	– These compounds are found in fibrous plants- Ligans have antimicrobial properties- They are also thought to be antioxidants as well as have anti-inflammatory properties
Steroids	– Steroids may have benefits for skin, wound healing and heart health

MEDICINAL BENEFITS OF GILOY

Giloy has following healing properties:

- **Immunomodulator** – Giloy strengthens body immunity
- **Cardioprotective** – Protects the heart and modulates lipid metabolism
- **Hepatoprotective** – Enhances glutathione levels and supports the liver
- **Antioxidant** – Giloy is an antioxidant powerhouse & free radical scavenger
- **Anti-diabetic** – Stimulates insulin production, lowers blood glucose levels
- **Neuroprotective** – Giloy modulates the brains antioxidant enzyme system and increases acetylcholine neurotransmitter synthesis
- **Prevents respiratory illness** – Giloy soothes the mucous membrane due to its anti-inflammatory and antioxidant nature
- **Anti-arthritic** – Giloy lessens joint pain and inflammation by decreasing the synthesis of pro-inflammatory cytokines
- **Anti-osteoporotic** – stimulates osteoblasts growth & improves the mineralization of the bone matrix
- **Anti-aging** – Giloy is rich in flavonoids & enhances collagen production

PREPARATION OF THE IMMUNE BOOSTER FORMULATION

The giloy can be use as :- Kadha , powder , juice , oil , , capsule , tablet forms.

THE ROLE OF BIOACTIVE COMPOUNDS AND MICRONUTRIENTS ON IMMUNE SYSTEM OF GILOY

Alkaloids & Lignans

Alkaloids are very powerful chemical compounds. Interestingly, since time immemorial plant alkaloids in the relevant doses have been used as remedies for various illnesses or as poisons.

Lignans are compounds that are located chiefly in fibrous plants. They inhibit the growth of fungi, viruses, and other microbes.

Studies show that Lignans have anti-inflammatory and antioxidant properties, i.e., lignans safeguard cells from oxidative damage. Studies have further discovered that lignans retard growth or even kill certain cancer cells.

- intestinal spasms
- pain relief
- blood pressure
- malaria
- cancer

Steroids

Some compounds present in Giloy have a chemical structure similar to cholesterol, and they compete with cholesterol for absorption in the intestine. This is how Giloy lowers the cholesterol levels in the blood.

- cardiovascular health
- wound healing
- skin health

MINERALS

Iron

It helps the immune system and is one of the most crucial minerals for all age groups. Iron causes the respiratory burst to be disrupted, germs to be killed, T cells to multiply, and cytokines to form. Additionally, the iron in haemoglobin oversees supplying oxygen to the tissues in the human body. Its absence impairs immunity, which raises the chance of developing acute respiratory tract infections, a significant sign of COVID-19 illness. Naive T lymphocyte activity and thymus atrophy are both impacted by iron deprivation. Damaged respiratory burst, increased natural killer cell activity, or reduced T lymphocyte proliferation are all signs of iron deficiency. Iron is necessary for the formation and synthesis of immune cells, especially lymphocytes, which are linked to responses specific to infections. Since many viruses depend on this essential component, iron sequestration is an important intrinsic host defensive response

Alkaloids

Alkaloids are a main source of performance enhancement and improving immune functions. Cocaine, nicotine, codeine, quinine, morphine, and reserpine are the most demanding alkaloids, globally. They also possess considerable activity when consumed by human.

CONCLUSION

The immunological enhancer is made up of a variety of phytonutrients of giloy herb. It fortifies the army of white blood cells that defend the immune system against pathogen-causing microbes. We can use immune boosters made from the herb giloye (Tinospora Cordifolia) to influence this process and strengthen our immune system. Giloy is an illustration of a plant that is widely grown in tropical and subtropical nations. The toxicity and safety of marketed natural herbs and immune boosters have come to light. The herb giloy is typically administered to individuals with high cough and COVID-19 to boost their immune systems by animals.

References:

1. Philips, C. A., & Abraham, L. (2022). Tinospora cordifolia (Giloy) and autoimmune-like liver injury–a classic case of Primum Non Nocere,“first, do no harm”. Journal of Clinical and Experimental Hepatology, 12(1), 245-246.
2. Panda, A. K., & Kar, S. (2021). Ayurvedic immuno booster: Is it myth or reality in covid-19 pandemic. Int J Cur Res Rev, 13(01), 134.

3. Khanna, K., Kohli, S. K., Kaur, R., Bhardwaj, A., Bhardwaj, V., Ohri, P., ... & Ahmad, P. (2021). Herbal immune-boosters: Substantial warriors of pandemic Covid-19 battle. Phytomedicine, 85, 153361.
4. Jain, H., & Dhupper, R. A Review on Healing Properties of Tinospora Cordifolia (Indian Giloy).
5. SRIVASTAVA, A. K., & SINGH, V. K. (2021). Tinospora cordifolia (GILOY): A Magical Shrub. Asian Journal of Advances in Medical Science, 22-30.
6. Sajith, K. S., & Farhan, H. (2022). Pharmacological effects of Tinospora cordifolia:(Giloy) in human body.
7. Gupta, D., & Sonawane, A. (2022). Heart-leaved moonseed-innocuous or baneful. Journal of Clinical and Experimental Hepatology, 12(1), 254-255.
8. Chhibber, S. Phyto Immune Boosters: A Review.
9. Nandkumar, T. V., Dinkar, T. A., Popat, M. S., & Mohan, D. D. (2021). A REVIEW ON TINOSPORA CORDIFOLIA IMMUNITY BOOSTER.
10. Goswami, A., Chaudhary, S., Malik, A., & Malik, M. (2020). Tinospora cordifolia (Giloy) a medicinal plant. Annals of Horticulture, 13(2), 136-146.
11. Sharma, R., & Galib, P. P. (2014). Remarks on" Tinospora cordifolia: One plant, many roles". Anc Sci Life, 33(3), 194.
12. Modi, B., Kumari Shah, K., Shrestha, J., Shrestha, P., Basnet, A., Tiwari, I., & Prasad Aryal, S. (2020). Morphology, Biological Activity, Chemical Composition, and Medicinal Value of Tinospora Cordifolia (willd.) Miers. Advanced Journal of Chemistry-Section B, 2020, 36-54.
13. Kakkar, A., Verma, D. R., Suryavanshi, S., & Dubey, P. (2013). Characterization of chemical constituents of Tinospora cordifolia. Chemistry of Natural Compounds, 49(1), 177-179.
14. Brar, S., & Sharma, A. A review on medicinal herbs as immunity booster.
15. Bora, P. (2021). Role of Indian Herbs in Boosting Immunity. In Immunity Boosting Functional Foods to Combat COVID-19 (pp. 61-74). CRC Press.
16. Adhikari, S. R., & Pokhrel, K. (2019). The Medicinal Uses of Tinospora Cordifolia (Gurjo). Himalayan Biodiversity, 52-56.

17. Murshid, G. M., Kundu, S. K., Sohrab, M. H., & Mazid, M. A. (2022). Pharmacological Overview of Tinospora cordifolia, an Ethnologically Important Plant of Bangladesh. Pharmacology & Pharmacy, 13(3), 93-106.
18. Maurya, R. (1996). Chemistry of Tinospora cordifolia species. Supplements to cultivation and utilization of medicinal plants. Regional Research Laboratory, Jammu (CSIR), 413-442.
19. Baghel, P. (2017). Plant of versatile properties: A review of Tinospora Cordifolia (Guduchi). International Journal of Agriculture Innovations and Research, 5(5), 2319-1473.
20. Singh, A., Saxena, S., & Babu, A. (2020). A pharmacological and chemical constituents review on Tinospora cordifolia-a medicinal herb. World Journal of Pharmaceutical Research, 9(14), 472-491.
21. Malla, S., & Bista, L. (2021). Tinospora cordifolia: A Multipurpose Miracle Plant Having Medicinal Importance: A Review. Matrix Science Pharma, 5(3), 54.
22. Gautam, A. S., Singh, A., & Kumar, K. (2020). Analysis of therapeutic value of Tinospora cordifolia. Asia Pacific Journal of Multidisciplinary Research., 8, 1-15.
23. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
24. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
25. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
26. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.

27. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
28. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
29. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
30. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
31. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
32. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
33. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
34. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
35. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta

Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)

36. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
37. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
38. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
39. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
40. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
41. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
42. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
43. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
44. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
45. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951

46. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
47. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
48. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
49. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
50. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
51. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
52. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
53. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
54. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
55. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
56. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
57. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616

58. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
59. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
60. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
61. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
62. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
63. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
64. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
65. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
66. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
67. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
68. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
69. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
70. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732

71. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
72. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
73. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
74. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
75. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
76. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
77. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
78. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
79. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
80. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
81. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis

82. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
83. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
84. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
85. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
86. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
87. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
88. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
89. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
90. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
91. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter - 14

GILOY AS A PERSONALIZED FOOD AND MEDICINE

Samikshya Jena[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Abstract:
Giloy is a big climbing shrub with long, tangled branches that spread widely. It can be found in China, Thailand, the Philippines, Indonesia, Malaysia, Borneo, and South Africa. Giloy's chemical components include alkaloids, glycosides, steroids, phenolics, polysaccharides, and leaves high in protein (11.2%). Berberine, palmatine, tembetarine, magnoflorine, tinosporin, and tinocordifolin are all present in the stem. The Giloy plant is used in Ayurvedic medicine to treat urinary disorders, dyspepsia, fever, and general debility.

Tinospora cordifolia, one of them, has a large therapeutic potential. The stem root and stem of the plant has anti-carcinogenic and anti-hyperglycaemic qualities and is used to treat skin conditions, respiratory tract infections, and other illnesses. Tinospora cordifolia root extract can significantly reduce the number of solid tumours by 58.8%, according to Verma et al. There is also activity from antioxidants that fight the free radicals produced during aflatoxicosis. An extract of Tinospora root extract had a hypolipidemic effect on rats with body weights of 2.5 and 5.0 g/kg on sixth day, according to Sharma and Dabur. Giloy is regarded as a mystical herb that may treat a wide range of health issues, including diabetes. As per a study, giloy has significant anti-diabetic activity and has an efficacy of 40 percent to 80 percent compared to insulin.Giloy is very important medicinal herb to use many diseases treatment and prevention ,immunity booster and as use medicine ,juice ,this very help full of diabetes and heart diseases .giloy is very large amount use as medicine and immunity juice. This review article to summarized giloy medicinal property and treatment of diabetes.

Keywords: Giloy, *Tinospora cardifolia*, Alkaloids, Ayurveda disease,Anti dialectician cancer ,Phenolic compound,Therapeutic.

Introduction:

In India, tinospora cordifolia (Thunb.) Miers has been used in Ayurvedic therapy for a very long time. The Menispermaceae family includes this perennial, herbaceous vine, also known as Giloy, Guduchi, Gurcha, Amrita, or heart-leaved moonseed. The species is widespread in all. Tropical and subtropical regions at 600 metres above sea level. It can be found in China, Thailand, the Philippines, Indonesia, Malaysia, Borneo, Vietnam, Bangladesh, Sri Lanka, Myanmar, India, Bangladesh, Sri Lanka, North Africa, and South Africa. Giloy is a big climbing shrub with long, tangled branches that spread widely.The presence of wiry aerial roots emerging from the branches is a distinctive characteristic. Stems have papery bark, deeply split, milky white to grey, with rosette-like pores (lenticels).The leaves are thin, simple, alternating, cordate-ovate, and have long stalks that swell at the base and tip.Racemes are tiny, unisexual, greenish yellow flowers that are both axillary and terminal in their inflorescence.dioecious. Fruits are three subglobose drupes with slender stalks that turn scarlet when ripe. In the summer, the plant blooms, and in the winter, it bears fruit. The genetically diversified plant contains a variety of biologically active substances, including steroid, aliphatic, alkaloid, glycoside, and diterpenoid lactones. All portions of the plant, including the stem and root, contain these active substances.

The plant has a long history of being utilised by ayurvedic practitioners in India to treat a wide range of ailments and illnesses. owing to its reportedly therapeutic nature.Since prehistoric times, medicinal plants have been employed as intrinsic remedies due to the existence of natural chemical components like. In addition to being utilised by common people for therapeutic purposes, berberine, morphine, psilocin, and vincristine are also used as natural ingredients in the manufacturing of pharmaceuticals including tubocurarine, colchicine, nicotine, and quinine . India is credited with having a vast range of medicinal plants. Despite the plant's obvious therapeutic importance and variety of bioactive components, little scientific research has been done on them .

According to Sofowora et al. , many plants are utilised in medicine for curative or preventative purposes. According to Tungmunnithum et al. the therapeutic benefits of medicinal plants are attributed to their active constituents, which include alkaloids, flavonoids, glycosides, vitamins, tannins, and coumarins. These organic substances interact with one another and have anatomical effects on human bodies.

It can treat Jaundice, rheumatism, urinary disorders, skin conditions, diabetes, anaemia, inflammation, allergic conditions, antiperiodic, radioprotective characteristics , and other conditions are among the many therapeutic benefits of conventional ayurveda medicine that it has to offer. According to Tripathi et al. , the root of Giloya (T. cordifolia) is utilised for bowel barrier and as a powerful laxative. This plant's starch calms burning sensations, boosts energy, and stimulates the appetite. It is a popular home cure for chronic fever. In addition to helping the immune system and the body's resistance to infections, giloya is effective in the treatment of helminthiasis, heart conditions, leprosy, rheumatoid arthritis, and it maintains normal white blood cell structure, function, and levels.

This plant's chemical components, such as diterpenoid lactones, are what give it its pharmacological properties like glycosides, steroids, sesquiterpenoids, phenolics, aliphatic substances, essential oils, a blend of fatty acids, and polysaccharides are among the components that are found in many parts of the plant body, such as the root, stem, and entire part. In the old ayurvedic literature, *Tinospora cordifolia* is renowned for its extensive use in the treatment of numerous ailments. Recently, active interest in the plant has spread throughout the world due to the identification of its active ingredients and their biological role in the control of illness . According to Dhama et al. , *T. cordifolia* is used as an adaptogenic agent, an antioxidant, an antihyperglycemic, an antihyperlipidemic, a hepatoprotective, cardiovascular protective, neuroprotective, osteprotective, radioprotective, and antianxiety medication.

It has analgesic, anti-inflammatory, antipyretic, a thrombolytic agent, antidiarrheal, anti-ulcer, antimicrobial and anti-cancer property .

Vernacular name in Indian languages:

S.No.	Languages	Name
1	Sanskrit	Amrita
2	Hindi	Giloy
3	English	Tinospora
4	Bengali	Golancha
5	Gujarati	Gulvel
6	Urdu	Gilo
7	Panjabi	Gllow
8	Telugu	Tippa-teega
9	Odia	Guluchi
10	Malayalam	Amruthu

Fig. GILOY PLANT

Distribution:

The plant is disseminating throughout the tropical and subtropical regions of India. It is indigenous to areas of India, Sri Lanka, China, Myanmar, Thailand, Philippines, Indonesia, Malaysia, Vietnam, Bangladesh, and South Africa.

Taxonomic position:

Kingdom: Plante
Division: Magnoliopsida
Class: Manoliopsida
Order: Ranunculales
Family: Menispermaceae

Genus: *Tinospora*
Species: *cordifolia*

Chemical Composition:
Alkaloids, diterpenoid lactones, steroids, glycosides, aliphatic chemicals, and polysaccharides are only a few of the chemical components that have been documented from
Tinospora cordifolia in various areas. According to Khan et al.T.cordifolia's chemical components include alkaloids, glycosides, steroids, phenolics, aliphatic compounds, polysaccharides, and leaves that are high in protein (11.2%), calcium, and phosphorus. Additionally, he stated that the structure of the stem has historically been determined by several spectroscopic studies and can accept clerodane furono diterpene glucoside.

Morphological characteristics:

Flowers:
Male flowers are clustered in the axils of small subulate bracts. Female flowers are usually solitary and like male flower.
Sepals:

The sepals are 6 in which 3 outer sepals are small, ovate – oblong, acute and 3 winners are larger, membranous, broadly elliptical, concave, 3-4mm, yellow.

Petals:

The petals are 6 which is about 2mm. long, broadly spathulate, each closely embracing a stamen when young, claw cuneate, and lamina triquetrous or sub trilobed, reflexed at apex.

Stem:

The stem is grooved, corky and branches sending down slender pendulous fleshy roots, terete, striate, with tubercle pale. Its taste is bitter.

Leaves:

The leaves are membranous, 7-90 nerved, 5-10cm. or rarely 12 by 10cm, roundish or sub deltoid, cordate with broad sinus and large basal lobes, obtuse or cuspidate, reticulately veined with microscopic glistening glands beneath.

Habitat:

It is found throughout tropical India, ascending to an altitude of 1000 feet. Parts Used: The whole plant as well as its different parts such as Stem root, Bark and Leaf are being used in traditional medicine for the treatment of various ailment

Dosage:

In classical literature the dosage of Giloy is 4-9 gms per day orally. But according to Unani Pharmacopoeia its oral dosage is 5-10 gms per day.

Different parts of Giloy plant used in medicine:

Stems:

Giloy stems are one of the ingredients in various Ayurvedic remedies used to treat urinary disorders, dyspepsia, fever, and general debility. The stem's bitter, stomachic, diuretic, bile-stimulating, constipating, quenching, numbing, and vomiting-inducing, blood-enriching, and healing properties all work together to ease these symptoms. Stem has anti-carcinogenic and anti-hyperglycaemic qualities and is used to treat skin conditions, respiratory tract infections, and other illnesses.

Roots: As a remedy for snakebite and scorpion sting, the root and stem of the plant giloy are often used in conjunction with other medications. Additionally, it has antioxidant and anti-neoplastic properties.

Leaves: In fever cordifolia Bark, juice or a decoction of the leaves is taken orally with honey. Giloy possesses anti-leprotic, anti-allergic, anti-pyretic, and anti-spasmodic effects.

Whole plant: Giloy as a whole plant is used in Diabetes. Rheumatoid arthritis, Gout, Cancer, high cholesterol content and in analgesic and neuropharmacological activities.

Chemical constituents:

Various chemical constituents have been found in different parts of the Giloy plant. They belong to different classes such as alkaloids, diterpenoid, lactones, steroids, glycosides, aliphatic compounds, polysaccharides. The alkaloids include berberine, bitter gilonin, non-glycoside gilonin gilosterol. The major phytoconstituent in Tinospora cordifolia include tinosporine, tinosporide, tinosporaside, cordifolide, cordifol, heptacosanol, clerodane furano diterpene, diterpenoid furanolactonetinosporidine, columbin and b-sitosterol. Berberine, Palmatine, Tembertarine, Magniflorine, Choline, and Tinosporin are reported from its stem.

Pharmacological Use of Giloy:-

To investigate the effects of supplementing with tinospora cordifolia stems on the glycemic and lipemic profiles of individuals with diabetic dyslipidemia. Medicinal herbs are effective food supplements that promote good health. The extensive collection of medicinal plants includes *Tinospora cordifolia*.

Since the stem has a higher alkaloid concentration than the leaves, it can be used medicinally. The stem contains a variety of phytochemicals that may have the capacity to manage. Only pre-clinical investigations have otherwise demonstrated dyslipidemia and dysglycemia. Medicinal herbs are effective food supplements that promote good health. Tinospora cordifolia (Willd.), one of the many therapeutic herbs, has received scant attention. It is a member of the Menispermaceae family and a great source of terpenes and alkaloids. It has qualities that include hepatoprotective, antioxidant, immunostimulatory, hyperlipidemic, anticancer, and antidiabetic. Berberine, palmatine, tembetarine, magnoflorine, tinosporin, and tinocordifolin are all present in the stem. The starch in the stem is very nutritious and digestible. Due to its qualities, it is known as the "miracle revitalising herb" in modern medicine.

Antioxidant property:

Due to the presence of antioxidants that fight the free radicals produced during aflatoxicosis, the plant has previously been shown to have scavenging action. and alkaloids from T. cordifolia that demonstrated protection against aflatoxin-induced nephrotoxicity were choline, tinosporine, isocolum bin, palm tine, tetrahydropalmatine, and magnoflorine. According to Gupta and Sharma, T. cordifolia exhibits a protective effect in the kidney by increasing glutathione, ascorbic acid, protein, and the activities of antioxidant enzymes such as superoxide dismutase , catalase , glutathione peroxidase, glutathione S-transferase , and glutathione reductase .

According to Sharma and Pandey, oral dosage of *T. cordifolia* plant extract is forbidden. Leaf and stem extract of the plant exhibit hepatoprotective effects in male albino mice against lead nitrate-induced toxicity.

Anti- Cancer activity:

T. cordifolia boosts the body's immune system by elevating blood leukocyte and immunoglobulin levels and stimulating stem cells.It can reduce the number of solid tumours by 58.8%, which is equal to the well-known chemotherapy drug cyclophosphamide. these immune boosting qualities can be exploited to avoid tumor-mediated immunosuppression, making them a potential therapeutic option for a variety of malignancies. *T. cordifolia* demonstrates anti-cancer efficacy, which is primarily demonstrated in animal models. *T. cordifolia* root extract exhibits radioprotective properties due to a substantial increase in body mass, tissue weight, and tubular diameter. Dichloromethane extracts of TC also exhibit cytotoxic properties.

Anti-Hiv activity :

Plants have been demonstrated to have a reduction in HIV resistance on a regular basis.was revealed by a decrease in the number of eosinophils, as well as by the stimulation of B lymphocytes, macrophages, haemoglobin levels, and polymorphonuclear leucocytes.Giloy may strengthen the immune systems of people with HIV and other immunological illnesses while also reducing typical adverse effects of these ailments, according to this review and study on its usage as an immune stimulant**.**

Anti-diabetic activity :

In streptozotocin-induced diabetic rats, the stem extract of *T. cordifolia* reduces the abnormalities in lipid metabolism brought on by diabetes mellitus. An oral *T. cordifolia* stem extracts, when administered in the form of hexane, ethyl acetate, and methanol, were found to have strong anti-diabetic effects by lowering blood sugar levels in streptozotocin-induced diabetic rats at a dose of 250 mg/kg. In streptozotocin-induced diabetic rats, the polyherbal formulation Dihar, which contains eight different herbs—Syzygiumcumini, Momordica charantia, Emblica officinalis, Gymnemasylvestre, Enicostemma littorale, Azadirachta indica, T. cordifolia, and Curcuma longa—significantly lowers the level of lipid peroxidation and boosts the activity. Giloy stem extracts from ethyl acetate, dichloromethane, chloroform, and hexane were tested for alpha glucosidase.

Dichloromethane extract was shown to be the most efficient, completely inhibiting alpha glycosidase compared to other substances. T. cordifolia's ethanol extract has androgenic properties. T. cordifolia leaf extract saponarin, which was extracted, exhibited hypoglycaemic action at dosages of 20–80 mg/kg. In alloxan-induced diabetic mice, hydro alcoholic, and chloroform extracts of T. cordifolia stem exhibit considerable antidiabetic effect at 250 and 500 mg/kg dose dependently.

Anti-Allergic activity:

Tinospora cordifolia has been studied for its anti-allergic effect. It was found that T cordifolia provided significant relief from sneezing, nasal discharge, nasal obstruction, and nasal pruritus compared with placebo with consistent improvements on examination of the nasal smears and nasal mucosa.

Anti-stress property:

At a dose of 100 mg/kg, *T. cordifolia's* ethanolic extract significantly reduces stress in all parameters as compared to Diazepam, a common medication (dose: 2.5 mg/kg). According to Kulkarni et al review, .'s it functions as a Medhya Rasayana, or brain tonic, in Ayurveda by enhancing mental abilities like remembering and reliving. According to Kalikar et al. It has been investigated for its ability to treat allergies. It was discovered that when compared to a placebo, *T cordifolia* significantly reduced symptoms such as sneezing, nasal discharge, congestion, and pruritus, as well as showed consistent improvements in nasal smear and mucosal examinations.

Anti-microbial activity:

The methanolic extract has been shown to be effective against microbial infection . *T. cordifolia* exhibited antibacterial action, according to Chakraborty et al. Escherichia coli, Staphylococcus aureus, Klebsiella pneumonia, Proteus vulgaris, Shigella flexneri, Salmonella typhi, Salmonella paratyphi, Salmonella typhimurium, Pseudomonas aeruginosa, Enterobacter aeruginosa, and Enterobacter aerogene have all been tested for resistance to the extract. *T. cordifolia* extract reportedly inhibited bacterial growth and increased the phagocytic and intracellular bacterial amplitude of neutrophils in mice, according to Saha and Ghosh According to Agarwal et al. *T. cordifolia* has good antifungal and antibacterial activity when tested on various microorganisms using different solvents.

Hypolipidemic effect :

An aqueous extract of the roots of Tinospora had a hypolipidemic impact on rats with body weights of 2.5 and 5.0 g/kg on sixth day. Weeks in alloxan-induced diabetes in rats led to decreases in tissue cholesterol, blood phospholipids, and free fatty acids, and it was discovered that the dose of root extract at 5.0 g/kg body weight had the most hypolipidemic impact. He also implies that elevated serum lipid levels in diabetes were a sign of coronary heart disease and that they decreased the risk of vascular disease.

Hepatic disorder:

Sharma and Dabur tested the protective effects of *Tinospora cordifolia* water extract on hepatic and gastrointestinal toxicity and found a significant rise in the levels of gamma-glutamyl transferase, aspartate transaminase, alanine transaminase, Triglyceride, Cholesterol, HDL, and LDL in alcoholic sample whereas their level get down modulate after TCE intervention, patients showed the normalized liver function of *T. cordifolia* stand to lessen the symptoms.

Anti-scabies:

All the parameters significantly declined when using the 50% Gilo lotion. It displayed a significant decrease in the level of infestation, preferred locations, and overall evaluation score while demonstrating a significant improvement in the patients' clinical condition during clinical trials.

Giloylotion can be used as an alternative because it costs less than commercially available medications.

Botanical Description :

About 70 genera and 450 species of plants belong to the Menispermeaceae plant family, which are found in tropical lowland areas. The perennial twiner Tinospora cordifolia has a succulent stem and a deciduous canopy. The bark is paper-like and ranges in colour from creamy white to grey, with huge, rosette-like lenticels. Leaves are small cymose, with flowers that are yellow or greenish in colour. They are simple, alternating, or lobed, cordate, whole, and 7-9 nerved. Flowers that are male and female develop on different branches. Female flowers are often single, whereas male blooms are grouped . When completely matured, fruits have a pea-like shape, are glossy, drupe, and turn crimson. Fruits ripen in the winter and flowers in the summer. Cuttings are used to spread it. The leaves provide a superb livestock feed . On the surface of the stem's greyish colour are tubercles. broad and heart-shaped leaves.

Giloy In treatment diabetes :

Many people think that freshly made giloy juice might be quite beneficial for diabetes. The only thing you must do is combine the stems and leaves. To achieve a juice-like consistency, add some water. Put a few drops of lemon juice into a glass with the mixture after straining it. For best benefits, drink it first thing in the morning. In managing type 2 diabetes, this is helpful. This plant is reported to have been referred to as Madhunashini in the ancient Indian writings of Ayurveda, which is Sanskrit for "destroyer of sugar."Giloy is regarded as a mystical herb that may treat a wide range of health issues, including diabetes.

Giloy helps in the production of insulin. It may burn excess glucose, which further helps in reducing blood sugar levels. Giloy also acts as a hypoglycaemic agent that helps manage diabetes well. This agent may also help in lowering blood sugar levels.

As per a study, giloy has significant anti-diabetic activity and has an efficacy of 40 percent to 80 percent compared to insulin.

Giloy helps in improving digestion, which is a crucial aspect in managing diabetes. Thisis medicinal herb to use control blood glucose level .this plant leaves are made to juice use of diabetes .

Conclusion

Giloy is Ayurvedic medicine to treat various disease and prevent .this plant is very mainly role to good health and immune booster .this herb is naturally herb and this herb whole plant parts are use to make medicine and as a juice .giloy is very medicinal property like as antioxidant activity ,anti-cancer, antidiabetic ,anti-Hiv ,anti-allergic ,anti-stress ,anti-microbial anti scabies activity in giloy plant .this is very lager use to covid-19 to improve like as immune booster to save of diseases .this review article summarizes of giloy medicinal activity and diabetes treatment .

References :

1. Devi, G. (2020). MEDICINAL PLANT: GILOY. International Journal of Current Research, 12(8), 12940-12941.
2. Dixit, S., & Ali, H. (2010). Anticancer activity of medicinal plant extract-a review. J. Chem. & Cheml. Sci, 1(1), 79-85.
3. Mittal, J., Sharma, M. M., & Batra, A. (2014). Tinospora cordifolia: a multipurpose medicinal plant-A. Journal of Medicinal Plants, 2(2).
4. Shaikh, A. M., Shrivastava, B., Apte, K. G., & Navale, S. D. (2016). Medicinal plants as potential source of anticancer agents: a review. Journal of Pharmacognosy and Phytochemistry, 5(2), 291.
5. Singh, A., Saxena, S., & Babu, A. (2020). A pharmacological and chemical constituents review on Tinospora cordifolia-a medicinal herb. World Journal of Pharmaceutical Research, 9(14), 472-491.
6. Singh, S., & Devi, P. (2017). Pharmacological potential of Tinospora cordifolia (Willd.) Miers ex hook. & Thoms.(Giloy): A review. Journal of Pharmacognosy and Phytochemistry, 6(6), 1644-1647.

7. Jain, H., & Dhupper, R. A Review on Healing Properties of Tinospora Cordifolia (Indian Giloy).
8. Kumar, P., Verma, D. K., Kimmy, G., Srivastav, P. P., & Sandhu, K. S. (2021). Phytochemicals in Giloy (Tinospora cordifolia L.): Structure, Chemistry, and Health Benefits. In Phytochemicals in Food and Health (pp. 127-150). Apple Academic Press.
9. SRIVASTAVA, A. K., & SINGH, V. K. (2021). Tinospora cordifolia (GILOY): A Magical Shrub. Asian Journal of Advances in Medical Science, 22-30.
10. Garg, M., Agarwal, P., Bora, A., Sood, A., & Pradhan, R. (2022). A systematic review on the bioactive compounds and health benefits of Tinospora cordifolia.
11. Singh, S., Maan, N. S., Rana, V., Jyotsana, J., Tewatia, B. S., & Sheoran, N. (2018). Effect of dietary inclusion of Giloy (Tinospora cordifolia) stem powder on growth performance and metabolizability in broilers. Journal of Entomology and Zoology Studies, 6(5), 36-40.
12. Srivastava, P. (2020). Study of medicinal properties of Herb Tinospora Cordifolia (Giloy) in preventing various diseases/abnormalities by increasing immunity naturally in human bodies. Int. J. Eng. Res. and Gen. Sci, 8(4), 10-14.
13. Sajith, K. S., & Farhan, H. (2022). Pharmacological effects of Tinospora cordifolia:(Giloy) in human body.
14. Arora, S., Goyal, A., Rawat, D. S., & Samantha, K. (2022). Giloy: a potential anti-COVID-19 herb with propitious pharmacological attributes: a short review. Journal of Biomolecular Structure and Dynamics, 1-8.
15. Saxena, C., & Rawat, G. (2019). Tinospora cordifolia (Giloy)-Therapeutic uses and importance: A review. Current Research in Pharmaceutical Sciences.
16. Bora, P. (2021). Role of Indian Herbs in Boosting Immunity. In Immunity Boosting Functional Foods to Combat COVID-19 (pp. 61-74). CRC Press.
17. Mahak, S., Divya, S., Priya, M., & Divya, P. (2021). Traditional plants as immunobooster-preventive strategy against COVID-19. Bioved, 153-166.
18. Mawar, B., Yadava, R., & Mahto, R. R. (2019). Ayurveda-An Invocation to Boost Immunity and the Fight against COVID-19. Journal of Ayurveda Medical Sciences, 4(2).

19. Sharma, R., & Tripathi, A. (2021). A Review on Some Indigenous Medicinal Plants and their Key Applications.
20. Malla, S., & Bista, L. (2021). Tinospora cordifolia: A Multipurpose Miracle Plant Having Medicinal Importance: A Review. Matrix Science Pharma, 5(3), 54.
21. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
22. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
23. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
24. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
25. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
26. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
27. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509

28. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
29. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
30. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
31. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
32. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
33. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
34. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
35. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
36. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.

37. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
38. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
39. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
40. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
41. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
42. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
43. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
44. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
45. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
46. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
47. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406

48. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
49. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
50. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
51. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
52. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
53. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
54. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
55. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
56. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
57. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
58. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
59. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661

60. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
61. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
62. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
63. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
64. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
65. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
66. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
67. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
68. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
69. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
70. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd

71. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
72. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
73. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
74. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
75. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
76. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
77. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
78. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
79. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
80. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
81. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
82. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
83. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for

Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.

84. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
85. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
86. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
87. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
88. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
89. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 15

GILOY AS A BIOFERTILIZERS AND BIOPESTICIDES

Samikshya Jena [1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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ABSTRACT

Giloy is scientifically known as *Tinospora Cordifolia* or Guduchi in Hindi. A Charak Samhita shloka describes giloy as one of the primary bitter-tasting plants. Giloy is a plant with several use, including medicine, insecticide, colourant, food, and fodder. Biopesticides can come from either microbial or plant sources. They have long been recognized as a potent substitute for synthetic chemical pesticides. They are biodegradable, specific to giloy, and have little to no detrimental impacts on the environment or human health. Giloy tree may reach heights of 1 meter (3.3 feet), and it has numerous long, twining branches. Leaves are simple, alternating, exstipulate, long (up to 15 cm), pulvinate, and roundish at the base and apex. Flowers are greenish yellow axillary and terminal racemes, clustered Male flowers, and a single Female flower. And Biofertilizers strive to improve the nutritional content of the soil by utilizing microorganisms that operate symbiotically with plants. Organic inputs utilized in biological fertilization come from a variety of sources, including animal manure, household sewage, fertilizer, organic waste, and microorganisms like fungi and bacteria. The commercial history of bio-fertilizer officially started with the introduction of "Nitragin" by Nobbe and Hilther in 1895. Farmers have been passing down their expertise of applied microbial inoculum for many generations. The choice of active microorganisms to be employed must be decided first.Biopesticides are created from naturally existing living

species including animals, plants, and microorganisms (such bacteria, fungi, and viruses). Controlling pests that damage plants is the main use for biopesticides and their byproducts. Since the beginning of time, agriculture has been on this planet, along with plants and pests. Biopesticides are substances that plants produce from genetic material that has been added to or incorporated into their genetic structure. They contain microorganisms such as bacteria, viruses, fungus, and protozoa as active components. Bacillus thuringiensis, an insect harmful bacterium, is the microorganism most frequently used in the production of biopesticides. The bulk of biopesticides are based on living organisms, and it is crucial to maintain their viability throughout formulation and storage at the proper levels. Most often used semiochemicals for crop protection are insect pheromones, which are produced for pest management through mating disruption, lure-and-kill systems, and mass trapping.

KEYWORDS - Guduchi ,*Tinospora cardifolia*, Alkaloid, Biopesticides , Biofertilizer, Giloy ,Biochemical pesticides.

INTRODUCTION

Giloy is scientifically known as *Tinospora Cordifolia* or Guduchi in Hindi. The stem of Giloy is considered highly effective because of its high nutritional content and the alkaloids found in it but the root and leaves also can be used. A Charak Samhita shloka describes giloy as one of the primary bitter-tasting plants. It helps treat a variety of illnesses as well as the vata and kapha doshas. Due to its scarlet fruit and heart-shaped leaves, giloy is also known as Heart-leaved Moonseed. A list of 28,000 plant species that are utilized as medicines across the world has just been put up by the World Health Organization (WHO). Even still, the percentage of plant species that may be brought under practical cultivation is at 1.9% if we pick the 2000 plant species that are more well recognized as herbal remedies. People all over the world are waking up to the significance of bringing more and more plant species with therapeutic relevance under the agricultural system as a result of societal pressures and conditions that are dangerously reducing natural plant richness. Rural areas of our country are home to 69% of the population. They support themselves by the intense farming of crops. Soil fertility and its natural resources are arbitrarily exploited. Due to inadequate sanitation and safety measures, they spend a portion of their income on health and hygiene-related problems**.** Alternative treatments for a variety of diseases are safely and effectively provided by medicinal plants. By cultivating locally accessible medicinal and aromatic plants organically and with awareness (ethnomedicinal), they can improve their economics. There are several Giloy species that are now being grown for the generation of secondary metabolites nor tropane alkaloids with glycosidase inhibitory action. Terpenoids is present in greater concentrations in the root than in the other components. When compared to the plant's root, the aerial components often gathered scopolamine in comparatively larger concentrations and atropine in relatively lower amounts. Giloy is a plant with several use, including medicine, insecticide, colourant, food, and fodder. Throughout history, folk medicine and alternative medicines have claimed that some Giloy species offer medicinal benefits. Biopesticides are insecticides derived from naturally occurring substances or live microorganisms

Around the world, they have been used extensively for pest control. It wouldn't be hazardous to use it topically as a paste or solution to alleviate localized in coronil fever , but systemic and oral administration might have negative anticholinergic effects. It is essential that individuals, in particular young people, are aware of the plant's toxicity and any possible risks before taking it as a result. Studies on the effects of environmental factors, such as temperature and light, have been conducted in great numbers. Smaller-scale cultural practices like fertilizing and watering have also been researched in attempt to promote chemical compound formation, growth, and productivity Biopesticides can come from either microbial or plant sources. A variety of anti-pest and anti-disease actions are displayed by several phytochemical pesticides. They have long been recognized as a potent substitute for synthetic chemical pesticides due to the fact that they are biodegradable, specific to giloy, and have little to no detrimental impacts on the environment or human health. Additionally, creating biopesticides is far less expensive than producing pesticides from synthetic chemicals. Numerous metabolites and alkaloids that plants may make are vital for plant defense and can shield many different crops from pests. Additionally, biofertilizers are biological preparations of potent microorganisms that hasten plants' intake of nutrients, hence fostering their growth.

Plant Profile and Cultivation

Profile

Family	Menispermaceae
Ayurvedic name	Amrita, Guduchi
Unani name	Giloe
Hindi name	Giloe, Gurcha
Trade name	Giloe
Parts used	Stem, root, whole plant

Tinospora cordifolia

Botanical Description

The tree is a substantial deciduous plant that may reach heights of 1 meter (3.3 feet) and widths of 0.5 meter (1.65 feet), and it has numerous long, twining branches. Giloy leaves are simple, alternating, exstipulate, long (up to 15 cm), pulvinate, and roundish at the base and apex, with the basal leaf being longer and twisted halfway around. Oval-cordate or broad-ovate lamina, 15-20 cm long and 10-15 cm wide, 7 nerved and deeply cordate at base, glabrous above, membranous, white tomatoes with a conspicuous reticulum underneath.

Unisexual *T. cordifolia* flowers feature greenish yellow axillary and terminal racemes, clustered Male flowers, and a single Female flower. The outside ones are smaller than the inner ones in the sixth sepal, which is free in two series of three each. Petals 6 are membranous, obovate, and smaller than sepals. Fruits consist of 1-3 ovoid, smooth drupelets with subterminal scars that are crimson or orange in colour.

Cultivation

Tropical and subtropical climates are ideal for the growth of *T. cordifolia* plants. Light-medium sandy loam soil that is rich in organic matter and has appropriate drainage is ideal for growing the plants. *T. cordifolia* may be propagated by vegetative cuttings and seeds. The finest planting material for growing a crop for commercial purposes is stem cuttings.

Cuttings with a tiny finger thickness and a 6- to 8-inch-long stem with two or three nodes are employed.

BIOFERTILIZER AND BIOPESTICIDE

Biofertilizers strive to improve the nutritional content of the soil by utilizing microorganisms that operate symbiotically with plants. Microbial inoculants, also known as biofertilizers, are deliberately cultivated cultures of certain soil microorganisms that can increase crop productivity and soil fertility. Since biofertilizers are less expensive and more ecologically friendly sources of plant nutrients, chemical fertilizers may be replaced with them. Through their activities in the soil, biofertilizers produce plant nutrients like nitrogen and phosphorus and make them accessible to the plants growing there. Because they help maintain healthy soil, avoid environmental contamination, and use less chemicals, biofertilizers are important. Uncertainty surrounds "biofertilizer." Many different biofertilizers have been developed as organic plant growth promoters. Products made from "Biofertilizers," or microorganisms that promote plant growth, are one type of biofertilizer. These biofertilizers contained powerful bacterial strains that can dissolve phosphate or fix nitrogen. The growing demand for nutritious food, long-term sustainability, and the issue of environmental pollution brought on by the excessive use of agrochemicals have made organic farming a major topic of concern globally. The sources of organic inputs utilized in biological fertilization include animal manure, household sewage, fertilizer, organic waste, and microorganisms like fungi and bacteria. When hazardous soils are present. .

Organic inputs utilized in biological fertilization come from a variety of sources, including animal manure, household sewage, fertilizer, organic waste, and microorganisms like fungi and bacteria. They are used to enhance nutrient fixation in the rhizosphere, produce plants with growth stimulants, be effective in soil stability, provide biological control, biodegrade substances, recycle nutrients, support mycorrhiza symbiosis, and develop bio remediation processes in soils contaminated with toxic, xenobiotic, and recalcitrant substances. In order to increase the supply or availability of primary nutrients to the target crops, biofertilizers may be described as compounds that include live microorganisms that colonize the rhizosphere or interior of plants and encourage growth whether applied to soil, seeds, or plant surfaces. Biofertilizers have the capacity to convert inedible nutrients into edible forms. These bacteria need organic matter in the soil to grow and function, and they also give plants essential nutrients.

History of Biofertilizer

Rhizobium, Azotobacter, Azospirillum, and Blue green algae (BGA) are examples of bio-fertilizers that have been in use for a very long period. Farmers have been passing down their expertise of applied microbial inoculum for many generations. It began with a tradition of small-scale compost manufacturing, which clearly demonstrated the effectiveness of bio-fertilizer . This is evident when the culture produces a healthy crop yield and speeds up the breakdown of organic waste and agricultural byproducts through a variety of activities. With the introduction of "Nitragin" by Nobbe and Hilther in 1895, the commercial history of bio-fertilizer officially started. Following this, Azotobacter, Blue-green algae, and a number of other microbes that are still employed today as bio-fertilizers were discovered.

Bio-fertilizer making

Making bio-fertilizers requires taking into account a number of factors, including the microbes' development profiles, the sorts of organisms and their ideal environments, and the formulation of the inoculum. The biological product's success depends on the inocula's composition, application technique, and product storage. Making biofertilizer involves, on average, six processes. These include selecting active microorganisms, isolating and picking target microbes, choosing a means of propagation and carrier material, assessing phenotypes, and conducting extensive studies.

The choice of the active microorganisms to be employed must be decided first. Target microorganisms must first be separated before choosing, for instance, whether to utilize organic acid bacteria, nitrogen fixers, or a mix of various species. Typically, bacteria are removed from plant roots by attracting them with a decoy, such burying chilled rice beneath bamboo plants. The isolated organism will then be cultivated in Petri plates before being produced in large quantities in flasks. Making the appropriate carrier material selection is also crucial. Apioca flour or peat are the best carrier materials to utilize if you want to manufacture bio-fertilizer in powder form.

DIFFERENT TYPES OF BIOFERTILISERS

Rhizobium

The Rhizobiaceae family includes Rhizobium. These symbiotically capable, free-living, rod-shaped, Gram-negative, motile, non-sporulating organisms may fix atmospheric nitrogen in soil. They are recognized as an endosymbiotic N-fixing bacteria that is connected with roots. It penetrates plants through the root system, where it later develops nodules. In root nodules, N is fixed by forming NH3 through a reaction with the available H molecules, for which the host supplies the required energy. After transferring nitrogen to the nodules, Rhizobium uses the carbohydrates produced by legume plants as the only source of hydrogen in the process of turning nitrogen into ammonia.

Cyanobacteria

The Rhizobiaceae family includes Rhizobium. These symbiotically capable, free-living, rod-shaped, Gram-negative, motile, non-sporulating organisms may fix atmospheric nitrogen in soil. They are recognized as an endosymbiotic N-fixing bacteria that is connected with roots. It penetrates plants through the root system, where it later develops nodules. In root nodules, N is fixed by forming NH3 through a reaction with the available H molecules, for which the host supplies the required energy. After transferring nitrogen to the nodules, Rhizobium uses the carbohydrates produced by legume plants as the only source of hydrogen in the process of turning nitrogen into ammonia.

Azotobacter

For the development of the free-living bacteria azotobacter, a nitrogen-free medium is suitable. These bacteria use the atmospheric nitrogen gas to make the proteins that make up their cells. This cell protein is later mineralized in the soil once the Azotobacter cells have died, assisting crop plants in getting access to nitrogen. Temperatures of 35 °C, high salt concentrations, and acidic pH values can all be harmful to some azotobacter species. Along with N2 fixation, Azotobacter also generates and secretes large amounts of organically active substances that aid in the growth of plant roots, such as biotin, nicotinic acid, pantothenic acid, B vitamins, heterooxins, and gibberellins.

Azospirillum

Azospirillum is an associative, heterotrophic bacteria that belongs to the Spirilaceae family. They produce compounds that limit growth in addition to their ability to fix nitrogen, which ranges from 20 to 40 kg/ha. Despite the fact that this genus has a number of additional species, such as A. amazonense, A. halopraeferens, and Abrasiveness, A. lipoferum and A. brasilense have mostly been utilized to illustrate the benefits of vaccination and their extensive dissemination. Many plants, particularly those that utilise the C4dicarboxylic route of photosynthesis, form associative symbioses with Azospirillum because they grow and fix nitrogen on salts of organic acids like malic and aspartic acid

(Hatch and Slack pathway). It is therefore mostly recommended for crops including maize, sugarcane, sorghum, and pearl millet.

Giloy Fertilizer is a liquid organic and mineral fertilizer. intended to provide nutrients for all giloy kinds. Both perennial container crops and sporadically planted land need use fertilizer for giloy. Biofertilizers have the capacity to convert inedible nutrients into edible forms. These bacteria need organic matter in the soil to grow and function, and they also give plants essential nutrients. A plant called giloy uses a lot of water. Due to their foreign origin, certain podzins must be maintained indoors during the winter. Because of this, they are usually grown in containers and pots. The pot's restricted substrate is quickly sterilized by a giloy with high nutritional requirements. To form the right habit and a strong root system, the plant has to eat a lot of phosphate and nitrogen. To grow into very enormous bulks, these plants need nitrogen. When the plant gets more potassium, it is encouraged to develop plenty of lovely blooms. These plants' nutritional needs are met with giloy fertilizer.

BIOPESTICIDE

Biopesticides, which are created from naturally existing living species including animals, plants, and microorganisms (such bacteria, fungi, and viruses), may successfully control serious plant-damaging insect pests. They therefore are growing in significance all across the world. Controlling pests that damage plants is the main use for biopesticides and their byproducts. Biopesticides, which are created from naturally existing living species including animals, plants, and microorganisms (such bacteria, fungi, and viruses), may successfully control serious plant-damaging insect pests. They therefore are growing in significance all across the world. Controlling pests that damage plants is the main use for biopesticides and their byproducts.

Since the beginning of time, agriculture has been on this planet, along with plants and pests. Due to plant damage from pests, agriculture experiences significant production loss. Chemical pesticides have recently been utilized to shield the crop from this harm. These chemical insecticides have been proven to be quite successful at getting rid of these pests. Nowadays, farmers use these chemical insecticides carelessly. As a result, there are a great number of negative effects. Farmers nowadays are dealing with issues including the emergence of pest resistance, the reappearance of secondary pests, the eradication of beneficial soil organisms, declining soil health, and contamination of the environment, water, and soil. Consequently, a natural substitute for these insecticides appears. The best approach to address these issues is to use biopesticides. Biopesticides are defined by the Environment Protection Agency (EPA) as "naturally occurring substances that control pests (biochemical pesticides), microorganisms that control pests (microbial pesticides), and pesticidal substances produced by plants with added genetic material (plant-incorporated protectants, or PIPs)." The most widely used biopesticides are live creatures that destroy a particular pest. For usage in greenhouses, on turf, in field crops, in orchards, and in gardens, biopesticides derived from bacteria like Bacillus thuringiensis (Bt), a wide variety of fungi, viruses, protozoa, and certain helpful nematodes have been developed. The EPA classifies biopesticides as include biocontrol microorganisms, their insecticidal metabolic byproducts, and other insecticides based on living creatures. Numerous registered products are listed in the EPA.

VARIOUS BIOPESTICIDE TECHNIQUES

1. Microbal biopesticide

These are used to control weeds, pest insects, and plant diseases biologically. They contain microorganisms such as bacteria, viruses, fungus, and protozoa as active components. Bacillus thuringiensis, an insect harmful bacterium, is the microorganism most frequently used in the production of biopesticides (Bt). B. thuringiensis produces protein crystals or a toxin as it generates spores, which can induce the lysis of gut cells when ingested by certain or sensitive insects. It has been proved that a number of bacterial species and subspecies, including Bacillus, Pseudomonas, etc., are biopesticides and are mostly employed to combat insect and plant diseases.

2. **Biochemical Pesticide**

The Environmental Protection Agency (EPA) has established a committee to determine whether a pesticide meets the specified criteria for a biochemical pesticide because it can be challenging to assess whether a natural pesticide can control the pest by a non-toxic mode of action. They are also known as herbal pesticides. Secondary metabolites generated by plants are also regarded as biopesticide.

3. **Plant incorporated protectants (PIP):**

Biopesticides are substances that plants produce from genetic material that has been added to or incorporated into their genetic structure. They are additionally referred to as GM crops. The exception to this rule is when Bt protein is used to genetically engineer PIP. The Bt toxin has the ability to kill in a short amount of time, usually 48 hours, and is host-specific. It poses no threat to vertebrates, people, other living beings, or the environment.

Semi chemicals

Semiochemicals are characterized as chemical signals produced by a single organism, frequently an insect, that cause members of the same species or those of other species to modify their behavior. The most often used semiochemicals for crop protection are insect pheromones, which are produced for pest management through mating disruption, lure-and-kill systems, and mass trapping. For a number of reasons, they act as a signal to communicate with members of their species.

FORMULATION OF BIOPESTICIDE

Because biopesticides' active ingredients are frequently produced in a manner like that of synthetic pesticides, farmers may more easily apply them with the same implements. The bulk of biopesticides are based on living organisms, and it is crucial to maintain their viability throughout formulation and storage at the proper levels. The developed biopesticide formulation must be sure to carry out its most important duties, including simple handling and application of the product, stabilization of the microbial agent during distribution and storage, protection of the bioagent from adverse environmental conditions, and enhancement of the bioagent's activity by increasing contact and interaction with the target pest. Biopesticides are formulated in a variety of ways so that we can take care of these.

Powder

Typically, 10% of the active component is present in dust formulations, which are made by sorpting the active ingredient onto finely ground, solid mineral powder (talc, clay, etc.) with particle sizes ranging from 50 to 100 mm. UV filters, sticky materials (such as stickers) to improve adsorption, and anticaking agents are the inert components for dust formulations

Granule

Granules Active chemical concentrations in granules range from 2 to 20%, and the chemicals either coat the granule's outside or seep inside of it.

Seed Dressing (SD)

A type of biopesticide mixture created by combining an active component carrier in the form of powder with an accompanying inert to aid in the final product's adhesion to seed coats. Seeddressing powders contain coloring chemicals that inform of red pigment as a safety maker for treated seed, and they are applied to seeds by tossing them with the substance that is intended to cling to them.

Emulsion

Emulsion formulations can be either a conventional emulsion, which is water in oil (W/O), or an inert emulsion, which is water in water (O/W). Emulsion formulations are designed to be blended with water. Most importantly, in order to avoid instability, it is critical to select the proper emulsifiers for stabilization. However, in the case of a water in oil emulsion produced by oil in the formulation's outer phase, losses from evaporation and spray drift are minimal.

Traditional Uses of the Giloy

In healthy individuals, using giloy at the dosage advised on the product label or by a medical expert doesn't appear to pose any dangers. For other folks, it might not be a wise decision. If you use drugs to decrease your glucose, you should use this herb with caution since it has the ability to drop blood sugar. You could react to low blood sugar. Giloy may also be problematic if you suffer from an autoimmune condition like lupus, Crohn's disease, or rheumatoid arthritis. This is as a result of its immune system-stimulating properties. Your immune system is already overstimulated if you have autoimmunity. As a result, it targets certain healthy cells rather than dangerous infections.

Traditionally, giloy is used to treat

Fever, urinary problems, asthma, dysentery, diarrhea, skin infections, Hansen’s disease (formerly called leprosy), diabetes, gout, jaundice, anorexia, eye conditions

CONCLUSION

Consumers' and the government's growing concern about the issues related to synthetic chemicals used for pest management and food safety has prompted producers to look for alternative environmentally friendly techniques to replace the traditional chemical-based procedures. As a potential alternative to conventional pesticides, the use of biopesticides as a supplement is becoming more and more popular throughout the globe. The potential of "biopesticides for pest control" has therefore been briefly discussed in this study.

REFERENCES

1. Saxena, C., & Rawat, G. (2019). Tinospora cordifolia (Giloy)-Therapeutic uses and importance: A review. Current Research in Pharmaceutical Sciences.
2. Devi, G. (2020). MEDICINAL PLANT: GILOY. International Journal of Current Research, 12(8), 12940-12941.
3. Sharma, H., Rao, P. S., & Singh, A. K. (2021). Fifty years of research on Tinospora cordifolia: From botanical plant to functional ingredient in foods. Trends in Food Science & Technology, 118, 189-206.
4. Duhan, P., Bansal, P., & Rani, S. (2020). Isolation, identification and characterization of endophytic bacteria from medicinal plant Tinospora cordifolia. South African Journal of Botany, 134, 43-49.
5. Kakde, V., Kamble, P., Bankhele, A., & Oswal, R. Evaluation and Formulation of Gilloy Tablet (Tinospora Cordifolia).
6. Malla, S., & Bista, L. (2021). Tinospora cordifolia: A Multipurpose Miracle Plant Having Medicinal Importance: A Review. Matrix Science Pharma, 5(3), 54.
7. Biswasroy, P., Panda, S., Das, C., Das, D., Kar, D. M., & Ghosh, G. (2020). Tinospora cordifolia a plant with spectacular natural immunobooster. Research Journal of Pharmacy and Technology, 13(2), 1035-8.
8. Mahak, S., Divya, S., Priya, M., & Divya, P. (2019). Traditional plants as immunobooster-preventive strategy against COVID-19. Bioved, 30(1), 153-166.
9. Adil, M., Bilal, M., Singh, N. K., Kumar, P., & Singh, D. (2020). A REVIEW ON POLYHERBAL IMMUNE BOOSTER.
10. SRIVASTAVA, A. K., & SINGH, V. K. (2021). Tinospora cordifolia (GILOY): A Magical Shrub. Asian Journal of Advances in Medical Science, 22-30.
11. Gupta, D., & Sonawane, A. (2022). Heart-leaved moonseed-innocuous or baneful. Journal of Clinical and Experimental Hepatology, 12(1), 254-255.
12. Brar, S., & Sharma, A. A review on medicinal herbs as immunity booster.
13. evi, G. (2020). MEDICINAL PLANT: GILOY. International Journal of Current Research, 12(8), 12940-12941.

14. Pandey, M., Paul, V., Singh, P., & Ali, Z. (2016). Evaluation of nutritional composition and antioxidant activity of herbal leaves. World J. Pharm. Pharm. Sci, 5(8), 1396-1402.
15. Modi, B., Kumari Shah, K., Shrestha, J., Shrestha, P., Basnet, A., Tiwari, I., & Prasad Aryal, S. (2020). Morphology, Biological Activity, Chemical Composition, and Medicinal Value of Tinospora Cordifolia (willd.) Miers. Advanced Journal of Chemistry-Section B, 2020, 36-54.
16. Jayswal, M. G. A comprehensive review on tinospora cordifolia (Giloy): The medicinal plant.
17. Kumar, P., Verma, D. K., Kimmy, G., Srivastav, P. P., & Sandhu, K. S. (2021). Phytochemicals in Giloy (Tinospora cordifolia L.): Structure, Chemistry, and Health Benefits. In Phytochemicals in Food and Health pp. 127-150.
18. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
19. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
20. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
21. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
22. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051

23. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
24. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
25. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
26. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
27. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
28. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
29. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
30. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
31. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology,

biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.

32. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
33. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
34. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
35. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
36. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
37. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
38. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
39. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
40. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
41. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959

42. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
43. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
44. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
45. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
46. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
47. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
48. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
49. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
50. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
51. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
52. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
53. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625

54. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
55. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
56. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
57. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
58. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
59. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
60. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
61. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
62. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
63. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
64. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
65. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
66. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748

67. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
68. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
69. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
70. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
71. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
72. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
73. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
74. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
75. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
76. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
77. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis

78. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
79. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
80. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
81. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
82. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
83. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
84. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
85. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
86. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 16

COCOA AS FUNCTIONAL FOOD

Durgasi Mowlika[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha
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Abstract

Chocolate has been consumed as confection, aphrodisiac, and folk medicine for many years before science proved its potential health benefiting effects. Main compounds of cocoa and chocolate which contribute to human health are polyphenols that act as antioxidants and have potential anti-inflammatory, cardioprotective, antihepatotoxic, antibacterial, antiviral, antiallergenic, and anticarcinogenic properties. This paper gives a short overview of scientific literature regarding cocoa polyphenols and influence of cocoa and chocolate on human health. Although research on health benefits of dark chocolate and cocoa is quite extensive nowadays and shows potentially beneficial effects of dark chocolate and cocoa, there are still lots of unknowns and some controversies. This is obviously an area that needs more research in order to determine factual influence of chocolate on health. For many years, chocolate was used as a confection, aphrodisiac, and folk medicine before science demonstrated its potential health benefits

Polyphenols, which serve as antioxidants and have possible anti-inflammatory, cardioprotective, antihepatotoxic, antibacterial, antiviral, antiallergenic, and anticarcinogenic characteristics, are the main chemicals in cocoa and chocolate that contribute to human health. This study provides a brief overview of the scientific literature on cocoa polyphenols and their impact on human health. Despite the fact that research on the health advantages of dark chocolate and cocoa is rather comprehensive presently and reveals that dark chocolate and

cocoa may have potentially beneficial effects, there are still many unknowns and some disagreements. This is clearly an area in which additional research is needed in order to identify the true impact of chocolate on health.

Keywords: anti-inflammatory, cardioprotective, antihepatotoxic, antibacterial, antiviral, antiallergenic, anticarcinogenic, Cocoa, functional Food

Introduction

Humans have been eating cocoa and chocolate for thousands of years. Cocoa pods were sacred to the Mayans as emblems of fertility, life, and godly nourishment. Cocoa was utilised as payment by the Aztecs, who felt it brought them wisdom and strength. Xocoatl was a dark, unsweetened cocoa-based drink prepared by the Aztecs and Mayas. They seasoned it with jalapeño peppers and corn meal, but they had never heard of sugar. Columbus introduced cocoa beans from America to Europe in 1492, although they were uninteresting to Europeans at the time.

They had never heard of sugar. Columbus introduced cocoa beans from America to Europe in 1492, although they were uninteresting to Europeans at the time. In 1528, Hernan Cortez brought cocoa to Spain, along with the recipe for Chocolatl. Sugar, vanilla, nutmeg, cloves, allspice, and cinnamon were added to the original recipe in Spain, and aphrodisiac properties were discovered.

For many years, chocolate was used solely for pleasure, but studies in the last 20 years have revealed that dark chocolate and cocoa may provide health benefits due to their high polyphenol content.

Polyphenols are a large mix of biologically active secondary metabolites found in plants that serve as cell wall support materials, colourful attractants for birds and insects, and defence mechanisms in response to various environmental stresses (wounding, infection, excessive light, or UV irradiation) .. They are divided into four groups based on the number of phenolic rings and the structural elements that connect these rings: phenolic acids, lignans (known as phytoestrogens; flaxseed and flaxseed oil are the primary sources), flavonoids (the most abundant polyphenols in human diets), and stilbenes (resveratrol is under investigation for its anticarcinogenic properties). Anthocyanins, flavonols, flavanols (catechins in tea, red wine, and chocolate), flavanones (primary source is citrus fruit), flavones, and isoflavones (major source is citrus fruit).

Cocoa Polyphenols

Flavan-3-ols or catechins, anthocyanins, and proanthocyanidins are the three primary categories of polyphenols found in unfermented cocoa beans, with typical amount of 120–180 g/kg. ()-epicatechin is the most abundant polyphenol component in fresh cocoa beans, with an average amount of 21–43 mg/g of defatted sample, followed by (+)-catechin and their dimers and trimers. Cocoa bean colour is brown and purple due to complex alteration products of catechin and tannin, and leucoanthocyanins are present as glycosides.

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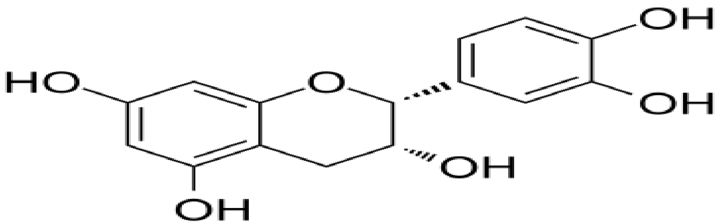
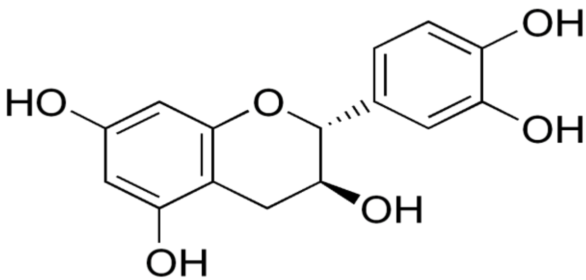
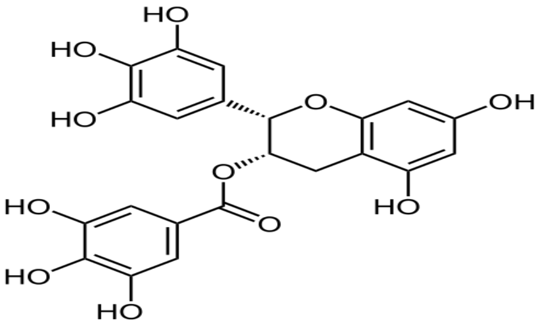


a. Catechin



b. (-) epicatechin



c. (-)Epigallocatechin gallate

Counet et alresearch .'s demonstrated that genetic characterization influences polyphenol content in cocoa. They discovered that Criollo cultivars contained more procyanidins than Forastero and Trinitario beans. Furthermore, crop season and country of origin have an effect on polyphenols in cocoa beans.

The polyphenol content of cocoa beans is greatly influenced by processing. Polyphenols diffuse with cell liquid from storage cells during fermentation and are subjected to oxidation (both nonenzymatic and polyphenol-oxidase-catalyzed), polymerisation, and protein reactions .Anthocyanins are hydrolyzed to anthocyanidins and a sugar component, leucocyanidins are dimerised and (-)-epicatechin and soluble polyphenol content are reduced to 10–20% . Hurst et al. investigated the levels of flavan-3-ol monomers in cacao beans during fermentation, drying, and roasting. They claimed that unripe and only (-)-epicatechin and (+)-catechin are found in ripe cacao pods. Both of these compounds were depleted during fermentation, but (-)-catechin was formed due to heat-induced epimerization.

Additional polyphenol loss occurs during drying, primarily due to nonenzymatic browning reactions,

Roasting results in significant polyphenol loss due to thermolabile flavanols and quinones, which complex with amino acids and proteins and polymerize with other polyphenols.According to Hurst et al.,the loss of ()-epicatechin and (+)-catechin during this processing step is partially attributed to heat-induced epimerization to (-)-catechin.
All of these processes are required to produce the distinctive cocoa aroma. Polyphenols impart an astringent and bitter aroma to cocoa and contribute to sensory panel perception of “cocoa flavour”However, nowadays, processes are carried out in such a way that as much polyphenol as possible is preserved while maintaining a satisfactory aroma.
The composition and content of polyphenols are further altered during the chocolate-making process, owing primarily to relatively high temperatures and the presence of oxygen [8]. As a result, despite having a higher polyphenol content, dark chocolate had comparable antioxidant activity to pomegranate juice.

Bioavailability of Cocoa Polyphenols

Polyphenol bioavailability is generally affected by polyphenol chemical structure, food matrix, food processing factors, and interactions with other constituents in diet, as well as some host-related factors (genetic aspects of individuals, gender and age, disorders and physiological condition, and microbiota metabolism and enzyme activity in the colon). Vegetables and fruits, green and black tea, red wine, coffee, chocolate, olives, and some herbs and spices, as well as nuts and algae, are the richest sources of polyphenol. Furthermore, some polyphenols are specific to specific foods, while others are found in all plant products, so food is generally thought to contain complex mixtures of polyphenols .
The most absorbable substances are isoflavones and phenolic acids, followed bycatechins, flavanones, and quercetin

glucosides, whereas proanthocyanidins, anthocyanidins, and galloylated tea catechins are poorly absorbed.
Sucrose increased bioavailability of polyphenols, but formulation also influenced the extent of sucrose impact. Schramm et al. observed enhanced uptake of aglycone flavanols when they were consumed immediately after carbohydrate-rich meal. Peters et al. concluded that sucrose addition to green tea resulted in delay of catechin absorption, partly due to viscosity increase, but it also improved catechin uptake by intestine.

Influence of Cocoa Polyphenols on Health

Unlike vitamins, polyphenols are not essential components of human diet. Nevertheless, they are consumed on daily basis due to their ubiquitous presence in fruits and vegetables. Many researches have shown that polyphenols and/or polyphenol-rich foods have an important role in health preservation due to antioxidant properties . The antioxidant activity of cocoa and chocolate was shown to be correlated with their catechin and procyanidin contents.
Antioxidant properties of polyphenols highly depend on the arrangement of functional groups around the nuclear structure. Free radical scavenging capacity is primarily attributed to hydroxyl groups, and aglycones are more potent antioxidant than their responding glycosides
Polyphenols can act as proton donor-scavenging radicals , inhibitors of enzymes that increase oxidative stress, chelate metals, bind carbohydrates, and proteins.These properties enable them to act as anticarcinogenic, anti-inflammatory, antihepatotoxic, antibacterial, antiviral, and antiallergenic Polyphenols
This is supported by research of Hollenberg et al. who established relationship between high consumption of cocoa beverages and very low blood pressure levels, reduced frequency of myocardial infarction, stroke, diabetes mellitus,

and cancer in Kuna Indians residing in archipelago on the Caribbean Coast of Panama, unlike Kuna Indians residing on Mainland. Another study, conducted on elderly men free of chronic diseases in Zutphen, Netherlands, showed that consumption of cocoa reduced blood pressure and decreased risk of cardiovascular and all-cause death by 45–50%.

Grassi et al. observed decrease of blood pressure by short-term administration of dark chocolate in healthy and glucose-intolerant, hypertensive subjects. However, they investigated only 15 subjects per research and these findings should be taken with reserve. Djoussé et al. associated frequent consumption of dark chocolate with lower prevalence of cardiovascular diseases in men and women independently of traditional risk factors estimated based on health questionnaire. This association was perceived both in smokers and nonsmokers, as well as in subjects under and above 60 years of age. The research included large number of examinees, but data about consumption of chocolate were self-reported and there was no differentiation between dark and milk chocolate.

Hot cocoa beverage was proven to successfully reduce LDL cholesterol, increase HDL cholesterol, and suppress LDL oxidation in research of Baba et al. [43]. Atherosclerotic cholesterol profile (cholesterol : HDL ratio) in patients with diabetes was improved after 8-week chocolate consumption without affecting weight, inflammatory markers, insulin control, or glycaemic control.

In addition to lowering blood pressure levels, cocoa polyphenols might be involved in cholesterol control. Waterhouse et al. (1996) reported polyphenols from chocolate inhibited LDL oxidation by 75%, compared to 37–65% of red wine (adopted from) In addition, Vinson et al. reported that dark chocolate had higher quality of phenol antioxidants expressed as IC50 for LDL + VLDL oxidation compared to red wine and black tea, with high lipoprotein bound antioxidant activity, which is very important in prevention of heart

diseases. A survey implemented by a group of experts showed that in the case of similar absorption, about 50 g of dark chocolate should be eaten to provide equivalent flavonoids to about 200 mL of red wine, which has been shown to reduce heart attack risk for an average adult.
Flavanol-rich cocoa increases blood flow to key areas of brain increasing blood oxygenation level-dependent response to cognitive task switching paradigm in healthy young people and could be useful in treatment of cerebrovascular flow (CBF) demenstroke, Alzheimer's disease , and stroke . Chandranayagam et al. reported that tannin-rich chocolate can be considered as functional food which effectively antagonizes adverse effects of arsenic intoxication. However, this research was conducted on Sprague Dawley rats and should yet be confirmed by research on humans.

Conclusion

Recent researches have shown that cocoa and dark chocolate could have beneficial impact on our health, mainly on cardiovascular system. However, part of the researches could be arguable, since either a small number of examinees were included or information about type of chocolate and consumption was scarce and/or ambiguous. In addition, since chocolate is a rich source of sugar and saturated fat, it is questionable whether chocolate consumption can be recommended in vascular health promotion because of its contribution to total calorie intake and impact on weight.
More systematic approaches should be applied in human studies to reduce possible misinterpretation of data—more examinees, longer test periods, and larger age differences should be involved in addition to controlled chocolate administration with specified polyphenol content and composition. Individual nutritive preferences which could have great impact on results should also be taken into consideration.

Chocolate and cocoa contain not only polyphenols but also methylxanthines which could additionally contribute to the health impact of these foods. There is need for additional researches that would elucidate the extent of polyphenols and methylxanthines health impact and possible synergy of these compounds in chocolate, with respect to energy contribution.
Obviously, elucidation of cacao and chocolate impact on human health is rather a complex problem and should be addressed as such data should not be lightly interpreted but closely examined and reassessed before withdrawing conclusions.

References

1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051

6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology,

biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.

15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959

25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625

37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748

50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis

61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.
70. T. Beckett, Industrial Chocolate Manufacture and Use, Blackwell Scientific Publications, London, UK, 3rd edition, 1999.
71. Hakkinen, Flavonols and Phenolic Acids in Berries and Berry Products [Ph.D. dissertation], Faculty of Medicine, Kuopio, Finland, 2000.
72. A. Tomas-Barberan, “Types, food sources, consumption and bioavailability of dietary polyphenols nutrinsight,” in

Proceedings of the Symposium 11th Nutrition Conference, Kraft Foods, 2012.
73. J. Misnawi, B. Jamilah, and S. Nazamid, “Effect of polyphenol concentration on pyrazine formation during cocoa liquor roasting,” Food Chemistry, vol. 85, no. 1, pp. 73–80, 2004.
74. J. Misnawi, B. Jamilah, and S. Nazamid, “Sensory properties of cocoa liquor as affected by polyphenol concentration and duration of roasting,” Food Quality and Preference, vol. 15, no. 5, pp. 403–409, 2004.
75. A.B. M. M. Jalil and A. Ismail, “Polyphenols in cocoa and cocoa products: is there a link between antioxidant properties and health?” Molecules, vol. 13, no. 9, pp. 2190–2219, 2008.
76. Saltini, R. Akkerman, and S. Frosch, “Optimizing chocolate production through traceability: a review of influence of farming practices on cocoa bean quality,” Food Control, vol. 29, pp. 167–187, 2013.
77. A. Cooper, J. L. Donovan, A. I. Waterhouse, and G. Williamson, “Cocoa and health: a decade of research,” British Journal of Nutrition, vol. 99, no. 1, pp. 1–11, 2008.
78. A.Neilson, T. N. Sapper, E. M. Janle, R. Rudolph, N. V. Matusheski, and M. G. Ferruzzi, “Chocolate matrix factors modulate the pharmacokinetic behavior of cocoa flavan-3-ol phase II metabolites following oral consumption by Sprague-Dawley Rats,” Journal of Agricultural and Food Chemistry, vol. 58, no. 11, pp. 6685–6691, 2010.
79. N. D. L. Fisher, F. A. Sorond, and N. K. Hollenberg, “Cocoa flavanols and brain perfusion,” Journal of Cardiovascular Pharmacology, vol. 47, no. 2, pp. S210–S214, 2006.

Chapter – 17

APARAJITA AS IMMUNE BOOSTER

PRAGNYA PARIMITA NISHANK[1], Department of Biotechnology, Centurion University of Technology and Management, Odisha

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Abstract

The present review draws attention to pharmacological actions of *Clitoria ternatea* Linn (Family Fabaceae). It is a twining evergreen garden flowering plant which is commonly known as Aparajita (Hindi) or Butterfly pea (English). The present study was undertaken to investigate immunomodulatory activity of *Clitoria ternatea* seed and root extracts.It has been used anciently as medhya (brain tonic) in Ayurvedic system of medicine. Various primary and secondary plant metabolites including aparajitin, clitorin, triterpenoides, anthocyanins, steroids and flavonol glycosides have been isolated from *Clitoria ternatea Linn*. This article reviews various pharmacological activities of Clitoria ternatea including nootropic, anti-convulsant, anti-depressant, anti-anxiety, anti-stress, antioxidant, anti-inflammatory, anti-hyperlipidemic, anti-diabetic, analgesic, cytotoxicity, platelet aggregation inhibitory and hepatoprotective. The reported activities of Clitoria ternatea make it a potential source of drug molecules for treatment of various ailments.

Keywords: clitoria *ternatea;*Aparajita;Butterfly pea; Medhya drug ;Nootropic activity; Antioxidant;Anti inflammatory

INTRODUCTION

A useful herb explained in scriptures of ayurveda, Aparajita plant is a very beautiful herbaceous plant with many medicinal uses. It has a very soothing impact on the nervous, circulatory and psycological systems of the body.

The plant belongs to Fabaceae family and its latin name is "*clitoria ternatea*".

Immune booster- A boosted immune system can overstimulate the immune response, throwing it out of balance, and affecting many systems regulated by the body. 'Boosting' rather than supporting the immune system by priming it can force the body out of homeostasis (the green zone).

Plants are rich in flavonoids, vitamin C, or the carotenoids so can enhance immune function. The flavonoid-rich herbs may also possess mild anti-inflammatory action. Their beneficial effect named as anti-inflammatory and as an immune-stimulant action. It can promote the activity of lymphocytes ,increase phagocytosis, and induce interferon production.

Aparajita as a herb

Aparajita is one of the most potent herbs used for various treatment purposes. The plant is commonly known as Butterfly pea. The name Aparajita itself means that the plant can cure many diseases and it cannot be defeated by any of the diseases.

Morphology

Habit-Slender vine or climber

Root-Tap root system,branched,roots are nodulated

Stem-Slender,green coloured

Leaf-Compound,imparipinnate,leaflets are ovate or oblong and reticulately veined

Inflorescence-Axillary,cymose solitary flower

Flowers-Blue or white in colour

Fruit-pod,seeds are non endospermic

Useful part-Root,seed

Aparajita is an Ayurvedic and most widely occurring vine in tropical regions. This herb is believed to be known for the removal of physical dysfunction. This herb plant is found in white and blue colors. Blue Aparajita is easily available to people but it is considered rare to find white parables. Both white and blue Aparajita have the same quality. It is considered as a very useful herb in Ayurveda. It is a plant that is naturally decorated with very beautiful leaves and has many medicinal uses. According to Ayurveda, Aparajita affects the circulatory nervous and mental functioning in a good way.

Medicinal values

A native medicinal herb, its root, bark, leaves and seeds are used in ayurvedic preparations. The herb is in use for centuries as a memory enhancer prescribed for children suffering from developmental problems of brain and impaired cognitive function. The plant contains wide range of secondary metabolites like triterpenoids, flavonol glycosides, anthocyanins, steroids and used to treat vata vitiated disorders besides panchakarma treatments for balancing doshas in the body to bring about internal as well as external detoxification. The root is also used for leucoderma.

Aparajita kadha:

The bright blue petals from the flowers of the butterfly pea plant have been used as an ingredient in herbal tea drinks throughout the region for centuries as well as used in cooking. The blue flower imparts its blue colour when steeped in warm or hot water, leading it to be used as a dye, as well as to add colour to various traditional dishes.

The impressive nutritional profile of blue tea makes it a wonderful weight loss beverage, as well as a refreshing drink to cool the body, when served chilled. Being naturally caffeine-free and a completely herbal concoction, blue tea just like Green Tea is also a powerhouse of antioxidants. It contains significant amounts of the catechin EGCG - epigallocatechin gallate, as well as a host of anti-inflammatory and immune-boosting components such as flavonoids, tannins and polyphenols.

Immunity Boosting:

This tea enhances health by removing all the free radicals, even it is caffeine-free, remove harmful cells in the body, drinking it will help boost immunity.

Accelerates Weight Loss:

This is free from caffeine, zero carbs, fats and cholesterol hence it aids in the weight loss diet, it purifies the stomach health by purifying the stomach from food wastes and impurities, regulates appetite. It curbs the craving of junk food. Hence it maintains the optimal body weight.

Improves Digestion:

Butterfly pea tea Facilitates Digestion as it is rich in antioxidants, it protects the body against free radical action which is very harmful and can even damage healthy cells in the body, drinking of a cup of blue tea once or twice in a week in empty stomach flushes out toxins and hence improves digestive health.

Enhances Skin Health:

The flavonoids present in blue tea help stimulate collagen production, helping develop and maintain skin elasticity. Drinking this tea regularly eliminates undigested food particles from the system and hence clean the stomach, liver and kidney, which shows on the skin and ultimately it helps immensely brightening of the dull skin by removing the dark spot and uneven skin tone.

Stimulates Hair Growth :

Blue pea flower is excellent for the hair too, as it contains anthocyanin a compound known to increase blood circulation in the head and therefore maintain a healthy scalp. It also helps in strengthening the hair follicles from within.

Special Activity:

Aparajita is very commonly used in Panchakarma treatments of Ayurveda. These treatments are very effective for balancing Doshas in the body and bringing about internal as well as external detoxification.

Because of its impact on the nervous system ,it is used to treat many disorders in the body.

Therapeutic benefits

Medhya – Improves intelligence
Kanthya – Improves voice,good for throat
Sudrushtida – Improves vision ,good for eyes
Kushta – Useful in skin diseases
Mutra – Cleanses bladder
Tridosha – Balances tridosha
Ama – Relieves indigestion,malabsorption
Shothavrana – Act as natural anti-inflamatory herb
Smruti buddhida – Improves memory and concentration

The immunoregulatory activity of anthocyanin and ternatin in *C. ternatea* petals has been tested in mice, resulting in the indication of regulated immune response. The immunoregulation mechanism of *C. ternatea* occurs due to the decreased immune cell sensitization, immune cell presentation, and phagocytosis. Anti-inflammatory and antioxidant properties have a major contribution in immunoregulation activity.

Moreover, *C. ternatea* also mediates its inhibitory effect on pro-inflammatory immune responses through the modulation of the expression of chemokines and/or adhesion molecules, as well as inhibition of humoral antibody formation and phagocytosis.In addition, anthocyanins have anti-inflammatory activity by inhibiting the expression and biological activity of several pro-inflammatory substances.

SUMMARY

Immunomodulators are agents able to affect the immune system, by boosting the immune defences to improve the body reaction against infectious or exogenous injuries, or suppressing the abnormal immune response occurring in immune disorders.

Along with Various immune boosting features of Aparajita, there are various additional benefits .

Additional Benefits:

Fights Reproductive Problems

Blue tea infusion has been helpful to treat menstruation related problems such as reducing cramps and soothing pain. For males, the infusion is given to enhance normal sperm production. The flower is also considered to have potent aphrodisiac properties.

Boosts Brain Health

Known in Ayurvedic science as a brain herb, blue tea has been used to enhance memory, aid brain health, treat anxiety, and combat depression. Owing to its acetylcholine compound, the herb can also help fight Alzheimer's. Drinking butterfly pea flower tea offers many brain boosting benefits.

Augments Respiratory Health

It has been used as potential treatment option for respiratory disorders and is an excellent treatment for colds and coughs. Due to its anti-inflammatory properties, it helps to

reduce the irritation of the lungs and drain an excessive fluid build-up. Butterfly pea tea also has therapeutic properties that can help treat asthma and various respiratory allergies.

CONCLUSION

The scientific research on *Clitoria ternatea* suggests a huge antioxidant, antidiabetic and hepatoprotective potential of this plant. The plant is a rich source of phytochemicals, with high levels of phenolic compounds and antioxidant activities. The study also indicates that the leaf and flower extracts of *Clitoria ternatea* have a hypoglycaemic effect. The extracts were effective in regulating the biochemical indices associated with diabetes mellitus. *Clitoria ternatea* possesses strong hepatoprotective potential. The hepatoprotective activity of *Clitoria ternatea l*eaf may be due to its free radical-scavenging and antioxidant activity, resulting from the presence of some phenolic compounds in the extracts. Further studies are in progress to better understand the mechanism of action of *Clitoria ternatea* responsible for the observed hepatoprotective and antioxidant activity. The organic and aqueous extracts of *Clitoria ternatea* could be further exploited in the future as a source of useful phytochemicals compounds for the pharmaceutical industry and the antioxidant mechanisms and the anti- Proliferative properties of the extracts should be further studied to gain more application for use as natural antioxidants.

REFERENCES

1. Fantz,Paul R.(2000) “Nomenclatural notes on the genus Clitoria for the Flora North American Project”;Castanea.65(2):89-92
2. Acevedo R. and strong M.T.(2012)Catalogue of seed plants of the West Indies;Contributions to Botany.98(1):1190-1192
3. Vickers A. and Zollman C.(1999) complementary herbal medicine,BMJ.319(1):1050-1053
4. Pandey J(2010)Nirmala hindi commentary.36(1)

5. Parasuraman, S. (2018). Herbal drug discovery: challenges and perspectives. Current Pharmacogenomics and Personalized Medicine (Formerly Current Pharmacogenomics), 16(1), 63-68.
6. Saha, N., Bhattacharjee, S., & Bhattacharyya, S. (2018). Preparation and pharmacognostic evaluation of Sandesh, an Indian sweet dairy product, using natural colorant from *Clitoria ternatea* (Aparajita) flower. International Journal of Food Science and Nutrition, 3(2), 19-24.
7. Bishoyi, A. K., & Geetha, K. A. (2012). Polymorphism in flower colour and petal type in Aparajita (*Clitoria ternatea*). Open Access Journal of Medicinal and Aromatic Plants, 3(2), 12.
8. Saha, P., & Dutta, S. (2007). Production of floral dyes from different flowers available in west Bengal for textile and dye industry. Norwegian University of Science and Technology.
9. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
10. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
11. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
12. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
13. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
14. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—

Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051

15. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
16. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
17. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
18. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
19. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
20. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
21. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
22. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.

23. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
24. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
25. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
26. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
27. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
28. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
29. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
30. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
31. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
32. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959

33. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
34. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
35. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
36. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
37. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
38. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
39. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
40. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
41. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
42. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
43. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
44. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625

45. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
46. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
47. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
48. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
49. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
50. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
51. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
52. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
53. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
54. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
55. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
56. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
57. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748

58. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
59. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
60. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
61. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
62. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
63. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
64. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
65. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
66. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
67. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
68. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis

69. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
70. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
71. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
72. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
73. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
74. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
75. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
76. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
77. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 18

BHRINGRAJ – AS AN IMMUNE BOOSTER: A REVIEW

Umesh Kumar[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*
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Abstract
The application of immune drugs that stimulate, especially those made from medicinal herbs such as bhringaraj (Eclipta alba), has drawn a lot of interest due to its ability to fortify the immune system. Bhringaraj, sometimes referred to as mahabhingraj or bhringraja in India, has a long history of use as an immune system booster, especially in complementary and alternative medicine (CAM) for patients suffering from diseases like AIDS and cancer. However, along with their growing popularity have come questions about the toxicity and safety of natural herbs and immune boosters. High dosages of phytochemicals found in bhringaraj, such as alkaloids, have been linked to cytotoxic effects. Bhringaraj's immune-stimulating cytotoxicity and secretory potentials have been assessed in order to gain a deeper understanding of its immune-enhancing abilities. Herbal immune boosters are becoming more and more popular, as seen by the use of preparations including bhringaraj and other native plants as immunological enhancers in places like the South African province of Vaal. To determine the effectiveness and safety of bhringaraj and related herbal treatments in boosting immune function and treating symptoms of immunological insufficiency, more research is required.

Keywords – Immune booster, eclipta alba(bhringraj), immune system and role of micronutrients.

Introduction –

The immune system serves as our body's defense mechanism against a myriad of external threats, including bacteria, viruses, fungi, and parasites. Immune boosters, such as those derived from the bhringaraj (Eclipta alba) herb, have gained attention for their potential to strengthen this vital system. Bhringaraj, known for its various proteins and phytonutrients, plays a crucial role in enhancing the body's immunity. Consuming bhringaraj juice or powder can aid in digestion, prevent seasonal infections, and alleviate symptoms of cold and flu. Moreover, bhringaraj is recognized in Ayurveda for its ability to increase vitality, reduce fatigue, and improve adrenal gland function, thus reducing stress levels. Additionally, bhringaraj has been associated with enhanced brain function, memory, concentration, and cognitive skills, owing to its antioxidant-rich composition. Traditional medicine has long valued plants like bhringaraj for their immune-boosting properties, particularly in conditions such as cancer and AIDS. However, concerns regarding the safety and toxicity of natural herbs and immune boosters have arisen alongside their increasing use. In regions like South Africa, indigenous plants, including bhringaraj, are utilized as immunological enhancers, indicating a growing interest in herbal immune boosters. Evaluations of bhringaraj's immune stimulant properties have shown promising results, including increased cytokine secretion and antioxidant activity. Nonetheless, further research is needed to determine its phytochemical content, antioxidant levels, and mineral concentrations to ensure its safety and effectiveness as an immunity booster. This study aims to address these gaps and establish the safety and efficacy of the immunity booster formulated by South African traditional healers.

The utilization of traditional medicinal plants, particularly bhringraj (Eclipta alba), as immune boosters has gained traction in recent years due to their purported effectiveness and relatively low toxicity compared to synthetic pharmaceuticals. Traditional healers have long recognized the immune-stimulating properties of bhringraj, employing it as a complementary alternative medicine for conditions such as cancer and AIDS. The immune system's role in defending against pathogens underscores the importance of maintaining immunological competence, as compromised immunity can increase susceptibility to infections. The composition and concentration of nutrients in immune boosters like bhringraj influence their impact on immune cell activity, with potential outcomes ranging from immunosuppression to stimulation. Consequently, evaluating the mineral components of bhringraj is advised before use as an immune booster, given the diverse and complex nature of the immune system. Furthermore, the quality and attributes of bhringraj and its formulations may be influenced by factors such as geographical location, soil composition, and environmental pollutants. Despite the therapeutic potential attributed to bhringraj's phytochemicals, such as flavonoids, alkaloids, and terpenoids, further research is needed to elucidate their precise mechanisms and safety profiles. Notably, studies have shown promising results regarding the immune-strengthening effects of bhringraj formulations, highlighting their potential in enhancing immune function and combating diseases. However, more comprehensive investigations into their phytochemical content, antioxidant properties, and mineral concentrations are warranted to ensure their safety and effectiveness as immune boosters.

Bhringarj (eclipta alba) –
It is a common plant that is commonly grown in tropical and subtropical countries, and it is a member of the Asteraceae family. It's also known as fake daisy or Bhingaraj at times. The plant is said to include minerals including zinc, iron, and magnesium, vitamins E and D, phytosterols, -amyrin,

triterpines such ecalbatin and echinocystic acid, and coumarins like wedelolactone. Eclipta Prostrata or Eclipta Alba, the well-known herb bhringraj, is used to improve hair growth and liver issues. It's also beneficial for coughs, skin disorders, eye problems, asthma, and ailments affecting any part of the head. persistent skin disorders include eczema, intense itching, persistent sores, and skin ulcers respond better to it. It improves the way the liver works, speeds up metabolism, relieves constipation, and encourages the liver to produce bile. Toxicology uses the white flower tails of Eclipta. The plant's juice is used to treat nausea. The leaf extract is highly regarded in ayurvedic medicine as a strong liver tonic, rejuvenator, and hair enhancer. The plant is a rasayana for long life and regeneration, according to Ayurveda. Research demonstrates that Eclipta prostrata also affected humoral immunity; in an indirect haemagglutination test, serum immunoglobulin levels and antibody titre were considerably elevated by both EHD (Eclipta prostrata high dose) and ELD (Eclipta prostrata low dose). At modest doses, eclipta prostrata did not affect mouse lethality testing mortality; instead, it merely raised serum immunoglobulin levels. In conclusion, Eclipta prostrata bark exhibits immunostimulant qualities. High doses activate both the humoral and cellular arms of the immune response, whereas low amounts just serve to enhance the formation of antibodies. Additionally, there is proof that ulcer patients' nausea, vomiting, and epigastric discomfort have completely improved clinically. This herb strengthens the brain, nerves, liver, and eyes. It is used as a cooling and restorative herb in China. Historically, eclipta alba has also been used topically to boost immunity.

Description and Chemical Composition of Eclipta alba –

Eclipta alba, an annual herbaceous plant, typically grows to a height of 30 to 50 cm and can exhibit an erect or prostrate growth habit, characterized by white-coloured hair covering the entire plant and simple lance-shaped leaves without petioles. Its floral heads are solitary, white, and narrowly winged, with a diameter ranging from 6 to 8 mm. The plant boasts a well-developed root system, with grey cylindrical roots present. Native to tropical and subtropical regions worldwide, including South America, Asia, and Africa, Eclipta alba thrives as a weed in elevations up to 2000 meters above sea level. It is notably abundant in various countries, particularly India, China, Thailand, Brazil, and the United States, with a predominant presence in Indian states such as Assam, Bihar, Uttar Pradesh, and Manipur.

Eclipta alba is rich in a diverse array of chemical compounds, including resins, ecliptine, nicotine, glucosides, echinocystic acid, vitamins E and D, and minerals such as calcium, iron, and magnesium, as well as coumarins like wedelolactone. Its extracts contain bioactive steroidal alkaloids with cytotoxic properties against certain cells, and there have been reports suggesting its ethanol extract may neutralize rattlesnake venom. Additionally, compounds like wedelolactone, demethylwedelolactone, wedelic acid, apigenin, and luteolin have been isolated from Eclipta alba extracts. Some of these compounds, including wedelolactone, apigenin, and luteolin, have demonstrated potential antiviral properties against hepatitis C virus replication in cell culture systems. Moreover, wedelolactone is reputed for its antibacterial and antihemorrhagic properties and is utilized in the treatment of cirrhosis and hepatitis. Given its rich mineral and vitamin content, particularly vitamin E and D, Eclipta alba holds promise as an immune booster, contributing to a strong immune system.

Medicinal Properties of Bhringraj

Bhringraj, also known as Eclipta alba, possesses a multitude of healing properties that have been revered in traditional medicine for centuries. These properties include:

Keshya (Hair Growth Promotion): Bhringraj is renowned for its ability to promote hair growth, making it a popular ingredient in hair care products.

Varnya (Improves Skin Complexion): It is believed to enhance skin complexion, contributing to a radiant and healthy appearance.

Drishti Vardhak (Improves Vision): Bhringraj is traditionally associated with improving vision, supporting eye health.

Hepatic Stimulant: Known for its hepatoprotective properties, Bhringraj acts as a stimulant for liver health.

Appetizer and Digestive Stimulant: It aids in stimulating appetite and digestion, promoting overall digestive health.

Anthelmintic and Carminative: Bhringraj exhibits anthelmintic properties, helping to expel intestinal worms, and carminative properties, relieving flatulence and abdominal discomfort.

Cholagogue (Promotes Bile Secretion): It supports the secretion of bile, aiding in digestion and detoxification processes.

Detoxifying: Bhringraj is known for its detoxifying effects, assisting in the elimination of toxins from the body.

Neuroprotective: It demonstrates neuroprotective properties, potentially supporting brain health and cognitive function.

Immune Power Enhancement: Bhringraj is believed to enhance immune power, bolstering the body's natural defense mechanisms.

Therapeutic Indications of Bhringraj

Bhringraj is therapeutically indicated for various health conditions, including:

Hair Fall, Thinning, and Premature Graying: It effectively addresses hair-related issues such as hair fall, thinning, and premature graying.

Scalp Itching and Pruritus:

Bhringraj helps alleviate scalp itching and pruritus, providing relief from discomfort.

Urticaria and Skin Eruptions:

It is beneficial in managing skin conditions characterized by blisters and eruptions, particularly those with Kapha or Vata dominating symptoms.

Loss of Appetite: Bhringraj stimulates appetite, aiding in proper digestion and nutrient absorption.

Jaundice:

Its hepatoprotective properties make it useful in the management of jaundice, supporting liver function.

Piles and Abdominal Pain:

Bhringraj helps alleviate symptoms associated with piles and abdominal pain, promoting gastrointestinal health.

Preparation of the immune booster formulation of bhringraj –

The plant materials (roots and leaves) were thoroughly cleaned with distilled water before being disinfected for five minutes with a solution of 0.1 percent $HgCl_2$. The dried plant materials were ground into a fine powder and kept at room temperature in a dark, closed container until needed. Boiling distilled water in a cast iron stove is the typical preparation technique. The plant bits that have been ground up are then put to the boiling water and heated for fifteen minutes. The final product was allowed to cool at air conditions before being sieved or filtered through a typical fine mesh curtain material.

Bioactive Compounds and Micronutrients Impacting the Immune System in Bhringraj

Vitamin A:

Vitamin A, known for its anti-inflammatory properties, regulates cellular and humoral immune responses, thereby enhancing immune system function. It plays crucial roles in preserving eyesight, promoting growth and development, and maintaining mucosal and epithelial integrity. Vitamin A supplements have been linked to reduced mortality and morbidity from diseases such as malaria, HIV infection, measles, diarrhea, and HIV infection in children. Vitamin A supports the functions of various immune cells, including neutrophils, natural killer cells, T cells, B cells, and monocytes. Additionally, it stimulates cytokine synthesis, lymphopoiesis, apoptosis, mucin and keratin production, as well as antibody formation. Active forms of vitamin A, such as retinal and retinoic acids, are essential for maintaining the intestinal barrier and innate immunity in the intestines.

Vitamin D: Vitamin D plays a critical role in autoimmune diseases by modulating immune cell responses, including B cells, T cells, monocytes, and dendritic cells (DCs). It has been observed to partially restore abnormalities in B cells from lupus patients and reduce immunoglobulin synthesis. Vitamin D deficiency is common in autoimmune diseases, and immune cells in these conditions respond to its therapeutic effects, indicating its potential beyond calcium and bone homeostasis regulation.

Vitamin E:

Vitamin E is essential for proper immune function, and bhringraj contains vitamin K, which aids in combating bacterial and viral infections. Vitamin K activates Growth Arrest-Specific 6 protein (GAS6), which influences cell growth, communication, signaling, and apoptosis. GAS6 facilitates the removal of damaged cells without harming healthy tissues, thereby reducing inflammation and supporting immune system efficiency.

Minerals:

Iron:

Iron is crucial for the growth and maturity of immune cells, particularly lymphocytes, which play a key role in the body's immune response to infections. Iron also supports the production of proteins like transferrin and lactoferrin, which help reduce iron availability to pathogens. However, excessive iron levels may facilitate the growth of parasites, cancerous cells, and pathogens.

Magnesium:

Magnesium participates in immune responses by acting as a cofactor for immunoglobulin synthesis, immune cell adhesion, and various immune cell functions. Magnesium deficiency can impair cell-mediated immunity and antibody production, leading to increased susceptibility to infections and allergic reactions. Magnesium supplementation has shown positive effects on respiratory conditions and may be beneficial in treating COVID-19.

Ecliptin Alkaloids: Alkaloids in bhringraj, such as ecliptin alkaloids, enhance immune functions and contribute to overall performance improvement. These alkaloids possess pharmacological properties, including anti-inflammatory, anticancer, antidiabetic, and antioxidant effects.

Wedelolactone: Wedelolactone, found in bhringraj, exhibits various pharmacological properties, including anticancer, anti-inflammatory, and antioxidant effects. Combining wedelolactone with potential medicines may enhance its biological benefits, making it a preferred approach for maximizing therapeutic effects.

Conclusion –

In conclusion, the immune system's defense mechanism is fortified by a combination of phytonutrients and proteins, empowering white blood cells to combat harmful pathogens effectively. Immune boosters derived from the bhringraj herb, Eclipta alba, offer a natural means to enhance immune function. Widely cultivated in tropical and subtropical regions, bhringraj has garnered attention for its potential to bolster immunity. However, it is essential to consider the safety and toxicity of marketed herbal products. Traditional practices involve administering bhringraj to patients with cancer and AIDS to fortify their immune systems. As research continues to uncover the therapeutic benefits of natural remedies like bhringraj, it underscores the importance of exploring traditional wisdom alongside modern medicine to optimize immune health.

References –

1. Medicinal use of bhringraja (eclipta alba.): Dr. Vikram sigh & dr. Omprakash Sharma.et al.>2021
2. Nature's immune booster: Geetha R.V, Lakshmi T & Anitha Roy.et al.>2012
3. benefits of bhringraj: Dr. Deepak soni & Malavika hoon.et al.>2022
4. How to boost immune system: Taqi Mohammed Jwad Taher.et al.>2020
5. EXTRACTS OF BHRINGRAJ: Hiranmayi Shivajirao Brid Shivaprakash P. K. & Kishore G.et al.>2012
6. Impact of Immune Boosters in COVID-19: P. Priya, S. Dhivyatharshini, S. Mathivanan & M. Asiyabi.et al.>2021
7. Impact of immune booster: Mathivanan Selvam & asiysbi lakshadeep.et al.>2020
8. Vitamin K For the Immune System: health HK art.et al.>2022
9. Eclipta alba (L.) An Ethnomedicinal Herb Plant, Traditionally Use in Ayurveda: Soni kk1m & Soni S.et al.>2017
10. Bhringraj: A Pharmaceutical Treasure Trove: Debashish Mukharje, GN Khalsa & Sakshi Lokwani.et al.>2021
11. Eclipta alba - an immunity booster plant- an overview: Satyajeet Kar, Sandeep Rout, Saswat Nayak, Ashish Sheera & Barsha Tripathy.et al.>2020
12. Evaluation of the Immunomodulatory Effect of Eclipta prostrata whole Plant Extract: Palaksha, Ravishankar K & Vijaya Nandini.et al.>2017
13. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.
14. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and

Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner

15. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
16. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
17. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
18. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
19. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
20. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343
21. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
22. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian

Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021

23. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
24. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
25. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
26. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
27. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
28. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
29. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
30. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***
31. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
32. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision

Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee

33. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
34. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
35. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
36. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
37. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
38. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
39. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
40. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
41. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383
42. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
43. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474

44. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
45. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
46. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
47. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
48. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
49. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
50. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
51. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
52. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
53. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669
54. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
55. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865

56. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
57. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
58. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
59. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
60. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
61. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
62. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
63. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
64. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
65. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.
66. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant

responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.

67. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
68. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
69. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
70. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
71. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
72. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
73. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
74. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
75. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
76. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
77. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
78. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)

79. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
80. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
81. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

Chapter – 19

CANNABIS – PERSONALIZED MEDICINE: A REVIEW

Ravi Kumar, Department of biotechnology, Centurion University of Technology and Management, Odisha
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Abstract

The hallucinogenic chemical known as cannabis, or marijuana, is extracted from the cannabis plant. It is mostly used for medical, recreational, and sometimes spiritual purposes. Between 128 and 232 million people, or 2.7% to 4.9% of the world's population between the ages of 15 and 65, were reported to have used cannabis as of 2013. Cannabis is the most commonly used illicit substance globally, despite being primarily banned. As of 2018, adult usage rates of the drug were highest in Zambia, the US, Canada, and Nigeria. The cannabis plant's copious lignocellulosic biomass is a valuable renewable resource that can be used to produce energy, textiles, chemicals, and biopolymers. In the bio-composite industry, hemp bast fibers in particular are becoming more and more popular as an eco-friendly substitute for glass fibers. Because hemp bast fibers are stronger and lighter than polypropylene plastic, the automotive industry is particularly interested in using them to make bioplastics.

Keywords- plant profile, phytochemistry, active constituent

Introduction

Cannabis, a plant known by various names including marijuana, holds a storied history deeply rooted in human civilization. Originating from the regions of Central or South Asia, cannabis has been revered and utilized by diverse cultures for millennia, serving purposes ranging from medicinal to recreational and even spiritual. Its complex chemical composition, comprising hundreds of compounds, most notably tetrahydrocannabinol (THC) and cannabidiol (CBD), endows cannabis with a broad spectrum of effects on both the mind and body. From inducing euphoria and altering perception to alleviating pain and promoting relaxation, cannabis exerts a profound influence on human physiology and consciousness.

Throughout history, cannabis has traversed diverse cultural landscapes, from ancient rituals to modern-day recreational use. Evidence suggests that cannabis has been smoked for psychoactive effects for at least 2,500 years, with ancient civilizations in the Pamir Mountains of Asia among the earliest known consumers. Despite its long-standing presence in human societies, cannabis has also faced periods of prohibition and legal scrutiny, particularly in the 20th century when many nations enacted laws criminalizing its possession and use.

However, recent decades have witnessed a shift in attitudes and policies towards cannabis, with an increasing number of countries reevaluating its legal status. Uruguay made history in 2013 by becoming the first nation to legalize recreational cannabis use, followed by Canada and several others. In the United States, a growing number of states have also legalized cannabis for recreational purposes, albeit in conflict with federal law. This evolving legal landscape reflects changing perceptions of cannabis and its potential benefits and risks.

Beyond its recreational and medicinal uses, cannabis holds significant promise for industrial applications, particularly through its versatile cousin, hemp. Hemp, derived from the Cannabis sativa L. plant, offers a plethora of industrial opportunities, from its fibrous stalks used in textiles to its bioactive compounds utilized in pharmaceuticals and bioplastics. Moreover, hemp's resilience to drought and pests, coupled with its minimal environmental footprint, positions it as a valuable resource in the pursuit of sustainable alternatives to traditional industries.

In this book chapter, we embark on a comprehensive exploration of cannabis, delving into its historical significance, pharmacological properties, industrial potential, and implications for the emerging bio-economy. Through a multidisciplinary lens, we aim to elucidate the multifaceted nature of cannabis and its profound impact on various facets of human society, from healthcare to environmental conservation. By synthesizing diverse perspectives and cutting-edge research, we seek to provide a nuanced understanding of cannabis and its role in shaping the future of industry and innovation.

Hemp Stem: A Source of Fibers with Antibacterial Properties

Plant lignocellulosic biomass is an abundant renewable resource, which can provide biopolymers, fibers, chemicals and energy (Guerriero et al., 2014, 2015, 2016). Trees are important for the provision of wood, however, also fast-growing herbaceous species, like textile hemp (which has a THC content $<0.3\%$; Weiblen et al., 2015), can provide high biomass quantities in a short time. The stem of this fiber crop supplies both cellulosic and woody fibers: the core is indeed lignified, while the cortex harbors long cellulose-rich fibers, known as bast fibers (Figure 1) (Guerriero et al., 2013).

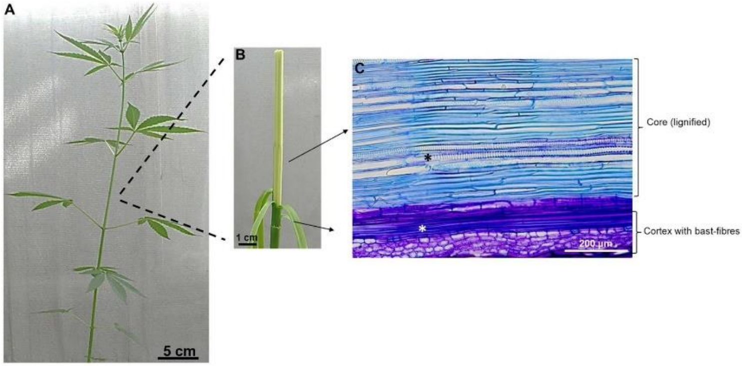

Figure – 1

Anatomical details of Cannabis stem. (A) Stem of an adult plant (ca 2 months); (B) The stem can be peeled off and shows a lignified core and a cortex with bast fibers. (C) Longitudinal section of hemp stem stained with toluidine blue showing the cortex with a bundle of bast-fibers (white asterisk) and the core with xylem vessels (black asterisk).

The diverse composition of hemp stem cell walls presents a compelling model for investigating the biosynthesis of secondary cell walls, particularly the molecular mechanisms involved in depositing both cortical gelatinous bast fibers and core woody fibres. These woody fibres, also known as "Hurds" or "shivs," are prized for their high absorbency, making them ideal for animal bedding, as well as for their utility in creating a concrete-like material.

In contrast, hemp bast fibers find application in the biocomposite sector as a sustainable alternative to glass fibers. The automotive industry, in particular, has shown keen interest in utilizing hemp bast fibers to manufacture bioplastics, leveraging their superior strength and lighter weight compared to polypropylene plastic.

Moreover, beyond their role in construction and automotive applications, hemp fibers possess natural antibacterial properties, adding to their appeal. Research has revealed hemp bast fibers' antibacterial characteristics, leading to their use in producing antibacterial finishing agents, surgical devices, and functionalized textiles. This antimicrobial attribute is attributed to the chemical composition of hemp bast fibers, which contain sterols and triterpenes such as β-sitosterol and β-amyrin, known for their antibacterial properties. Additionally, hemp bast fibers have been found to contain cannabinoids, further contributing to their antibacterial efficacy. Recent studies have also demonstrated the antibacterial properties of hemp Hurd powder, suggesting that its higher lignin content may play a role in this antimicrobial activity through lignin-related compounds, phenolic compounds, alkaloids, and cannabinoids.

Hemp Phytochemistry and Therapeutic Applications

In a study conducted in the Rhaetian Alps of Italy at an elevation of 1,100 meters above sea level during the 2018 growing season, the phytochemical behavior of two hemp varieties, namely the monoecious cultivar Futura 75 and the dioecious cultivar Finola, was thoroughly examined using various analytical methods. Results revealed that both genotypes exhibited predominantly competitive ecological strategies, with Finola displaying greater stress tolerance compared to Futura. The inflorescences of Finola were characterized by higher levels of β-ocimene and α-terpinolene, while α- and β-pinene, along with notably high levels of β-myrcene, were predominant in Futura. Both varieties exhibited richness in sesquiterpenes, with trans-caryophyllene and α-humulene being the most abundant. Total tetrahydrocannabinol (THC) levels remained below 0.1%, with cannabidiolic acid (CBDA) being the most abundant cannabinoid. Interestingly, Finola displayed a unique cannabinoid profile with notably high levels of cannabidivarin, while Futura exhibited a distinct occurrence of cannabigerolic acid (CBGA). Additionally, both varieties were found to be rich in polyunsaturated fatty acids, with Finola displaying a higher ratio of ω6/ω3. No significant differences were observed in protein content, with similar SDS-

PAGE profiles. The study underscores the importance of considering geographical origin when selecting hemp varieties for specific nutraceutical applications. On a related note, Tetrahydrocannabinol (THC), the principal psychoactive component of cannabis, is recognized as one of the 113 cannabinoids present in the plant. Synthetic formulations of THC, such as dronabinol and nabilone, are FDA-approved for managing chemotherapy-induced nausea and vomiting and for stimulating appetite in patients with HIV/AIDS-related anorexia. Despite its therapeutic potential, cannabis and THC remain classified as Schedule 1 substances by the FDA, limiting their use in medical products.

Objective –

To examine the clinical indications, off-label uses, mechanism of action, administration, and the role of interprofessional teamwork in optimizing patient outcomes with THC and its analogs for cancer-related nausea.

Mechanism of Action –

THC binds to cannabinoid receptors CB1 and CB2, which are part of the endogenous cannabinoid system. THC binds primarily to CB1 receptors though there is a weak binding of CB2 receptors. The expression and pathway of these receptors are still the focus of research; however, it is known that CB1 receptors predominantly express in the central nervous system(CNS), while CB2 receptors are expressed in the peripheral nervous system(PNS) immune cells and organs.

THC’s effects on emesis, appetite, and pain are attributed to its binding of CB1 receptors in the CNS, through which it modulates sensory, somatic, and cognitive perception. Regarding its possible benefits in OSA, THC appears to be an antagonist of serotonin in the PNS. Serotonin is involved in controlling respiration, and its dysregulation has implications in disordered breathing during sleep.

Cannabis in COVID-19

Cannabis sativa has long been recognized for its anti-inflammatory properties, as extensively reviewed (Prakash et al., 2009). Given the critical role of lung inflammation in conditions such as COVID-19, research has focused on examining its potential in mitigating this response. Cannabinoid isolates, including CBD and THC, have been investigated in both animal models and human studies, predating the global pandemic associated with the spread of SARS-CoV2 infection (Petrosino et al., 2018; Pellati et al., 2018; Almogi-Hazan and Or, 2020). In severe cases of COVID-19, immune responses can lead to excessive inflammation in lung tissue, often resulting in acute respiratory distress syndrome. This hyperactive immune response, known as a cytokine storm, contributes significantly to the mortality rate associated with the disease (Esposito et al., 2020). Phyto-cannabinoids, particularly CBD, have shown promising anti-inflammatory effects by inhibiting CB2 receptors and activating peroxisome proliferator-activated receptor γ (Additionally, CBD, CBN, and THC have demonstrated antiviral effects against COVID-19 in cell-based assays, comparable to standard clinical references such as remdesivir and lopinavir (Raj et al., 2021). However, the precise antiviral mechanism of cannabinoids against SARS-CoV2 infection remains unclear, necessitating further pharmacological research to explore the potential immunotherapeutic role of cannabis in combating COVID-19.

Conclusion and Future Prospective –

The legalization of cannabis has spurred extensive scientific research into cannabinoid compounds, exploring their potential applications in medicine, pharmaceuticals, and neurology. Recent advancements in sequencing technologies have catalyzed a paradigm shift in cannabis research towards understanding the genetic genomics of both fiber- and drug-type plants. The proliferation of genomic data, coupled with the rapid development of artificial intelligence (AI)-based analysis tools, has enabled researchers to delve into the genetic and molecular intricacies of the cannabis plant. Integrated omics studies, combining genomic and expression data with metabolite profiles, are shedding light on the genetic regulation of the cannabinoid biosynthesis pathway. Specifically, these studies are uncovering associations between the expression of cannabinoid genes, THC:CBD ratio, and cannabinoid content. This knowledge holds the potential for genetically modifying cannabis to optimize pathways for desired metabolite yield and composition. Advanced biotechnology methods, including the recombinant production of cannabinoids in engineered hosts such as yeasts or bacteria, present exciting opportunities for enhancing cannabinoid yields economically. Although challenges remain, such as instability in expression and the production of side products, ongoing advancements in genetic technologies offer promising solutions In conclusion, the legalization of cannabis has spurred significant scientific advancements in understanding cannabinoid compounds and their potential applications. Recent breakthroughs in genomic research and biotechnology have provided insights into the genetic regulation of cannabinoid biosynthesis, paving the way for genetically optimized cannabis strains with desired metabolite profiles. Additionally, cannabinoids have shown promise in combating inflammation and immune responses, including potential applications in conditions like COVID-19. However, further research, particularly clinical studies, is needed to fully elucidate the efficacy and safety of cannabis extracts for therapeutic use. Overall, ongoing progress in pharmacological research and genome-based biotechnology holds immense potential for harnessing the benefits of cannabis in drug discovery and medical treatments.

References –

1. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG

in Breast Cancer," *2024 3rd International Conference for Innovation in Technology (INOCON)*, Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.

2. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
3. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
4. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
5. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
6. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
7. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
8. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343

9. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
10. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
11. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
12. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
13. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
14. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
15. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
16. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
17. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
18. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***

19. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
20. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
21. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
22. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
23. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
24. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
25. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
26. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
27. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
28. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
29. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383

30. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
31. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
32. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
33. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
34. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
35. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
36. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
37. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
38. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
39. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
40. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
41. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669

42. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
43. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
44. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
45. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
46. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
47. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
48. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
49. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
50. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
51. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
52. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
53. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms

in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.

54. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
55. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
56. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
57. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
58. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
59. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
60. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
61. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
62. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
63. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
64. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
65. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change

from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)

66. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
67. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
68. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
69. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.
70. Chow R, Valdez C, Chow N, Zhang D, Im J, Sodhi E, Lock M. Oral cannabinoid for the prophylaxis of chemotherapy-induced nausea and vomiting-a systematic review and meta-analysis. Support Care Cancer. 2020 May;28(5):2095-2103.
71. Badowski ME. A review of oral cannabinoids and medical marijuana for the treatment of chemotherapy-induced nausea and vomiting: a focus on pharmacokinetic variability and pharmacodynamics. Cancer Chemother Pharmocol. 2017 Sep;80(3):441-449. [PMC free article]
72. Hesketh PJ, Kris MG, Basch E, Boehlke K, Barbour SY, Clark-Snow RA, Danso MA, Dennis K, Dupuis LL, Dusetzina SB, Eng C, Feyer PC, Jordan K, Noonan K, Sparacio D, Somerfield MR, Lyman GH. Antiemetics: American Society of Clinical Oncology Clinical Practice Guideline Update. J Clin Oncol. 2017 Oct 01;35(28):3240-3261.
73. Carley DW, Paviovic S, Janelidze M, Radulovacki M. Functional role for cannabinoids in respiratory stability during sleep. Sleep. 2002 Jun 15;25(4):391-8.
74. Ramar K, Rosen IM, Kirsch DB, Chervin RD, Carden KA, Aurora RN, Kristo DA, Malhotra RK, Martin JL, Olson EJ, Rosen CL, Rowley JA., American Academy of Sleep Medicine Board of Directors. Medical Cannabis and the Treatment of Obstructive Sleep Apnea: An American Academy of Sleep

Medicine Position Statement. J Clin Sleep Med. 2018 Apr 15;14(4):679-681. [PMC free article]
75. Chow R, Valdez C, Chow N, Zhang D, Im J, Sodhi E, Lock M. Oral cannabinoid for the prophylaxis of chemotherapy-induced nausea and vomiting-a systematic review and meta-analysis. Support Care Cancer. 2020 May;28(5):2095-2103.
76. Badowski ME. A review of oral cannabinoids and medical marijuana for the treatment of chemotherapy-induced nausea and vomiting: a focus on pharmacokinetic variability and pharmacodynamics. Cancer Chemother Pharmacol. 2017 Sep;80(3):441-449. [PMC free article]
77. Hesketh PJ, Kris MG, Basch E, Bohlke K, Barbour SY, Clark-Snow RA, Danso MA, Dennis K, Dupuis LL, Dusetzina SB, Eng C, Feyer PC, Jordan K, Noonan K, Sparacio D, Somerfield MR, Lyman GH. Antiemetics: American Society of Clinical Oncology Clinical Practice Guideline Update. J Clin Oncol. 2017 Oct 01;35(28):3240-3261.
78. Carley DW, Paviovic S, Janelidze M, Radulovacki M. Functional role for cannabinoids in respiratory stability during sleep. Sleep. 2002 Jun 15;25(4):391-8.
79. Ramar K, Rosen IM, Kirsch DB, Chervin RD, Carden KA, Aurora RN, Kristo DA, Malhotra RK, Martin JL, Olson EJ, Rosen CL, Rowley JA., American Academy of Sleep Medicine Board of Directors. Medical Cannabis and the Treatment of Obstructive Sleep Apnea: An American Academy of Sleep Medicine Position Statement. J Clin Sleep Med. 2018 Apr 15;14(4):679-681. [PMC free article]

Chapter – 20

IMMUNE BOOSTER AS DATURA STRAMONIUM: A REVIEW

Deepak Kumar[1], *Department of Biotechnology, Centurion University of Technology and Management, Odisha*

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Abstract

The current study's objectives were to analyze the immune-modulatory effects of D. stramonium L. leaf fractions on human peripheral blood mononuclear cells (PBMC) and the cytotoxic potential of immunomodulated PBMC against cancer cells. Materials and procedures: The methanolic leaf extract of D. stramonium was fractionated using a bioassay (PBMC proliferation) to obtain the active fraction, and LC-MS was used to determine which phytocompounds were contained in the bioactive fraction. It was necessary to isolate and identify the fungus linked to Datura stramonium L. leaf blight. The investigation focused on the proximate, metallic, non-metallic, vitamin C, and mineral composition of Datura stramonium fruits and seemingly healthy and infected leaves. Following analysis, anti-nutrients like flavonoids, saponins, cyanogenic glycosides, non-metallic minerals like phosphate, phosphorus, nitrate, and nitrogen, metallic minerals like manganese, calcium, sodium, potassium, iron, and trace elements like cadmium, copper, zinc, and lead in trace amounts were found to be present in the leaves and fruits. Historically, plants have been a model source of medicine. Herbal medicine, traditional medicine, tribal medicine, and other literature from Bangladesh all discuss the use of plants to cure a variety of human diseases. Approximately 5,000 of the 6,000 plant species found in Bangladesh are thought to have therapeutic qualities. Researches conducted in the last few decades on exploring

plants mentioned in ancient literature or used traditionally for treating diseases is increasing.

Keywords - Immunomodulation, Anticancer, Cytokine, Cytotoxic, Datura stramonium, immune system.

Introduction

In contemporary medicine, the study of plant immune systems and their potential for treatment has grown in significance as scientists look for novel approaches to treat illnesses that afflict both people and plants. To defend against a variety of diseases, plants have evolved complex defense systems, such as a sophisticated two-branch innate immune system. Comprehending these pathways presents opportunities for the creation of innovative medicines as well as insightful knowledge about plant biology. A plant that has garnered a lot of interest in this context is Datura stramonium L., a member of the Solanaceae family that is well-known for its therapeutic qualities. D. stramonium, also known as thorn apple or Jimson weed, has been used traditionally for a very long time in many different cultures due to its alleged anti-inflammatory, anti-asthmatic, and antioxidant properties. The plant is abundant in bioactive substances, especially tropane alkaloids with pharmacological activity as scopolamine and atropine. Scientific investigations have just started to clarify D. stramonium's immunomodulatory characteristics, emphasizing the plant's potential for immune modulation and cancer treatment. Studies have demonstrated that D. stramonium extracts have cytotoxic effects on a range of cancer cell lines, indicating a potential use in cancer treatment. Additionally, research has shown that the plant has immunostimulatory effects on immune cells, suggesting that it has the capacity to modify the immune response.

The purpose of this chapter is to examine D. stramonium's immune-modulating properties and their potential impact on human health. We aim to clarify the plant's medicinal potential in immune modulation and cancer treatment through a thorough examination of its phytochemical composition, biological activities, and pharmacological uses. We will also talk about the difficulties and possibilities involved in using medicinal plants like D. stramonium for therapeutic purposes, opening the door for more investigation and advancement in this fascinating area.

Morphological Character of D. Stramonium –

Family: - Solanaceae
English name: - Thorn Apple
Indian Name: - dhatturah, dhaturra, ummatti,
Species: - Datura fastuosa, D. stramonium, D. alba, D. innoxia, D. metel
Uses: - Medicine (small dose)
Poison (large dose)

Part Uses of Datura –

Herbal medicine is being used in several fundamental medical treatments. Datura frequently yields a high quantity of secondary metabolites, which have historically been an important source of numerous pharmaceutical products. In Ayurvedic medicine, Datura is mentioned as a beneficial remedy for several human ailments, such as sciatica, toothaches, bruises and swellings, ulcers, wounds, inflammation, and gout. Folk medicine uses D. stramonium medicinally in a number of treatments. The leaves' juice was used to induce the expulsion of intestinal worms, particularly cestodes, in hot milk. Seeds soaked with palm oil were applied directly to insect stings and bites. Mustard oil and Datura stramonium leaves work well together to cure skin ailments.
The juice from flowers is used to treat earaches, while the seeds are used as a purgative for fever, asthma, and cough. Seeds are smoked due to their narcotic effects. Both datura and cannabis

sativa leaves are ground up with water and applied topically to treat headaches in Western Nepal. They are often ground up with rice grains and taken orally to ease indigestion. The leaves are roasted and used to relieve localized soreness.

Cultivation of Datura –

Annual species are typically found in border plantings. plants in gardens and parks that individually resemble shrubs and trees. In colder climates, they are planted in pots so they may be brought inside during the winter. To thrive on open land, the soil needs to be extremely fertile and properly nourished. Winter gardens are decorated and species are grown in large pots with soil that has been smoothed with peat. During the spring and summer, they are watered once every two weeks with mineral fertilizers that contain trace elements. The fertilizers are diluted to a concentration of 20 g per pail of water. Shrubby species are the only ones that require formative pruning.

Phytochemical Analysis of Bioactive fraction from D. Stramonium –

The bioactive fraction-10 of D. stramonium was subjected to a number of biochemical assays for the first screening of phytochemicals. The presence of phytocompounds was then assessed on fraction-10 using the following tests:

Different phytochemical substances were found in fraction-10 from Datura stramonium L. leaves, according to a qualitative study. Using Mayer's reagent, alkaloids were identified by the appearance of a white or pale-yellow tint. Benedict's reagent was added, and after it was heated, color shifts from yellow to green to brick red were used to identify the presence of carbohydrates. The dried powder was mixed with sulfuric acid and chloroform to produce a red solution, which was used to establish the presence of terpenoids. When the powder was dissolved in chloroform and concentrated sulfuric acid and acetic anhydride were added, the powder's red color changed to blue, indicating the presence of steroids. When treated with lead acetate solution, flavonoids were seen as a yellow precipitate forming. The molecular structure of hyoscyamine, a secondary metabolite found in D. stramonium leaves, is C17H23NO3, and it changes into atropine when it dries. Finally, the addition of FeCl3 solution caused a blue-green hue to appear, which showed the existence of tannins. These results offer important new understandings of D. stramonium's chemical makeup and possible pharmacological characteristics.

Materials and Methods –

The Datura stramonium leaves, fruits, and sick leaf used in the study were harvested from the traditional farmlands in Abakaliki, Ebonyi State's Mgbabo achara Ezza Local Government Area. Supplies used included petridishes, 70% ethanol, sterilised scapel, glass slides, cover slips, distilled water, distilled water, cheese brough clothes, autoclave, incubator, corn borer, inoculation loop, aluminum foil, masking tape, weighing scale, measuring cylinder, conical flask, etc.

Collection of plant materials

The leaves of D. stramonium L. can collected at any pharmaceutical lab or company by their head or HR and we can also collect the plant any state it is available from all side. In the college we can collect the plant by teacher and extract the essential oil, juice and other think.

Plant Sample

The nearest location in India was where the leaves of the D. metel sample were gathered. The leaves were collected in September. To prevent the breakdown of certain bioactive chemicals, the samples were immediately sealed in polyethylene bags.

Preparation of sample

To get rid of dirt and unwanted objects, the leaf samples underwent a meticulous water wash. The cleaned leaves were then split in half. 200 g of a portion of the leaf samples were dried for 7 days at 25 °C in the shade. The remaining components, 200 gm of new samples, were divided into smaller pieces for the extraction procedure. After drying, 150 g of leaf samples were put through a grinder for 30 seconds to turn them into powder.

Extraction From Datura stramonium

The extract of Datura stramonium was made in a few steps, beginning with crushing the plant material. Fresh plants and blooming herbs were used in the preparation. Using fresh herbs with a 90% ethanol content and a quality index of 1:5, the ground plants were weighed and the pharmacopoeia quality index was calculated. After five days of macerating the plant material in the ethanol combination, the density was ascertained, the substance was filtered, and it was sealed. The Datura stramonium extract was procured from Plant Extract in Rădăia, Cluj County, and the extract's constituent parts were examined in accordance with the German Pharmacopoeia.

Identification of the compounds in the extract of Datura stramonium by thin-layer chromatography (TLC)

Thin layer chromatography is a qualitative technique that divides the chromatographic plate into three equal regions and compares the chemicals in the mixture to predetermined standards or identifies the compounds based on the values of the retention factor. By connecting the concentration to the peak area, thin layer chromatography may also be used to provide quantitative data. Using a fluorescent indicator with a 254 nm wavelength, a thickness of 0.25 mm, and dimensions of 7 x 13 cm, a silica gel plate was utilised to evaluate the components of the Datura stramonium extract by TLC.

Datura stramonium ethanolic extract using High Performance Liquid Chromatography with reversed phase (HPLC)

Identification, separation, and dosing of the substances in a combination. A chromatographic column (which houses the stationary phase), a pump injector (which enters the sample into the system), a solvent (which comprises the mobile phase), and a detector make up HPLC. In this investigation, reversed-phase HPLC was employed (stationary phase is nonpolar and the mobile phase is polar). In accordance with the procedure, HPLC was utilised.

Supercritical fluid extraction Method

Compared to other extraction methods, it offers more sophisticated benefits. it is a single homogeneous fluid that is created when a gas or liquid is compressed over its critical pressure or heated above its respective critical temperatures. Separating one component from another is done by a method called supercritical fluid extraction. The demand for essential oils made from plants has recently increased. This is explained by the fact that essential oils are becoming more and more important in the culinary, fragrance, agricultural, and medicinal industries due to their multifunctional qualities. Gases, liquids, liquids from solids, gas from liquid, and acids from bases are all examples of extraction techniques.

The Role Of Bioactive Compounds And Micronutrients On Immune System Of Datura

Micronutrients play a crucial role in reducing the risk of acute infections, with vitamin A supplementation showing promise in decreasing the incidence of diarrhea and measles in children. However, its impact on pneumonia and lower respiratory tract infections remains inconclusive. Vitamin C supplementation has been associated with a reduced risk of upper respiratory tract infections (RTIs) in athletes and may decrease pneumonia risk in adults and children, particularly with inadequate dietary intake. Vitamin D supplementation has shown potential in lowering the incidence of RTIs, tuberculosis, and influenza, especially in individuals with low initial vitamin D status. Zinc supplementation appears to reduce the risk of otitis media and RTIs in children, while iron supplementation has been linked to a decreased risk of RTIs in children. Phosphate levels in

Datura stem tissues were found to be elevated in tumorous plants, while nitrogen intake influenced alkaloid production, with higher levels promoting alkaloid production in older plants but decreasing it in younger plants.

Analyses of the food and mineral nutrients, Vitamin C and anti-nutrients of the apparently healthy fruits and leaves

Freshly harvested datura fruits and leaves were examined in triplicate for carbohydrate, crude fibre, moisture, protein, and lipid (fat), as well as the freshly harvested infected leaves. Vitamin C and the minerals ions Nitrate, phosphate, phosphorus, and nitrogen; cations include lead (Pb), manganese (Mn), magnesium (Mg), zinc (Zn), sodium (Na), copper (Cu), calcium (Ca), iron (Fe), and cadmium (Cd); and anti-nutrients including flavonoids, alkaloids, saponins, and cyanogenic glycosides.

Surgery

Breathing can be slowed by Datura stramonium Breathing rates can be slowed down by certain anaesthetics. Combining Datura stramonium with certain drugs may cause excessive breathing slowdown. Before undergoing surgery, make sure to let your doctor know what natural products you are using. Before surgery, you should stop taking Datura stramonium at least two weeks in beforehand.

Cell viability Assay

Through the use of the 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) MTT test, the impact of plant extracts on cell viability was evaluated. In a 96-well plate, PBMC (5x105 cells/ml) were planted in RPMI-1640 medium. After an overnight incubation, the cells were exposed to various doses of D. stramonium fractions. PBMC treated with DMSO and Concanavalin A (Con A) (10 g/ml) served as positive and negative controls, respectively. Using a microplate reader, the optical density of each well was determined at 595 nm. Each experiment was run three times in duplicate. The following formula was used to get the proliferation rate:

(OD sample - OD control) / OD control 100 is %Proliferation

Conclusion –

Many products, including latex, gum, oil, fiber, and tanning, are made from plants. They also had an immunomodulatory effect since they were high in proteins, carbohydrates, minerals, vitamins, and antioxidants. The wild herb Datura stramonium, according to this study, has been used to cure a wide range of illnesses and pharmacological issues. These include cancer, rheumatism, headaches, wounds, burns, stress, depression, sleeplessness, asthma, boils, and inflammation. Due to its lethal effects, Datura stramonium, which possesses pharmacological effects, is not used in its natural state. Instead, pharmaceutical companies manufacture it as herbal or botanical medications for a range of illnesses.

References

1. Medicinal uses of datura : Mlungisi Ngcobo and Nceba Gqaleni(26 oct 2016)
2. .Traditional uses of datura: Reema Srivastava and Pankaj Srivastava (2020)
3. Extraction of datura plant using HPLC, TLC: Rahela Carpa1, Dana-Victoria Dumitru (2017)
4. Chow R, Valdez C, Chow N, Zhang D, Im J, Sodhi E, Lock M. Oral cannabinoid for the prophylaxis of chemotherapy-induced nausea and vomiting-a systematic review and meta-analysis. Support Care Cancer. 2020 May;28(5):2095-2103.
5. Badowski ME. A review of oral cannabinoids and medical marijuana for the treatment of chemotherapy-induced nausea and vomiting: a focus on pharmacokinetic variability and pharmacodynamics. Cancer Chemother Pharmocol. 2017 Sep;80(3):441-449. [PMC free article]
6. Hesketh PJ, Kris MG, Basch E, Boehlke K, Barbour SY, Clark-Snow RA, Danso MA, Dennis K, Dupuis LL, Dusetzina SB, Eng C, Feyer PC, Jordan K, Noonan K, Sparacio D, Somerfield MR, Lyman GH. Antiemetics: American Society of Clinical Oncology Clinical Practice Guideline Update. J Clin Oncol. 2017 Oct 01;35(28):3240-3261.

7. Carley DW, Paviovic S, Janelidze M, Radulovacki M. Functional role for cannabinoids in respiratory stability during sleep. Sleep. 2002 Jun 15;25(4):391-8.
8. Ramar K, Rosen IM, Kirsch DB, Chervin RD, Carden KA, Aurora RN, Kristo DA, Malhotra RK, Martin JL, Olson EJ, Rosen CL, Rowley JA., American Academy of Sleep Medicine Board of Directors. Medical Cannabis and the Treatment of Obstructive Sleep Apnea: An American Academy of Sleep Medicine Position Statement. J Clin Sleep Med. 2018 Apr 15;14(4):679-681. [PMC free article]
9. Chow R, Valdez C, Chow N, Zhang D, Im J, Sodhi E, Lock M. Oral cannabinoid for the prophylaxis of chemotherapy-induced nausea and vomiting-a systematic review and meta-analysis. Support Care Cancer. 2020 May;28(5):2095-2103.
10. ME. A review of oral cannabinoids and medical marijuana for the treatment of chemotherapy-induced nausea and vomiting: a focus on pharmacokinetic variability and pharmacodynamics. Cancer Chemother Pharmacol. 2017 Sep;80(3):441-449. [PMC free article]
11. Hesketh PJ, Kris MG, Basch E, Bohlke K, Barbour SY, Clark-Snow RA, Danso MA, Dennis K, Dupuis LL, Dusetzina SB, Eng C, Feyer PC, Jordan K, Noonan K, Sparacio D, Somerfield MR, Lyman GH. Antiemetics: American Society of Clinical Oncology Clinical Practice Guideline Update. J Clin Oncol. 2017 Oct 01;35(28):3240-3261.
12. Carley DW, Paviovic S, Janelidze M, Radulovacki M. Functional role for cannabinoids in respiratory stability during sleep. Sleep. 2002 Jun 15;25(4):391-8.
13. Ramar K, Rosen IM, Kirsch DB, Chervin RD, Carden KA, Aurora RN, Kristo DA, Malhotra RK, Martin JL, Olson EJ, Rosen CL, Rowley JA., American Academy of Sleep Medicine Board of Directors. Medical Cannabis and the Treatment of Obstructive Sleep Apnea: An American Academy of Sleep Medicine Position Statement. J Clin Sleep Med. 2018 Apr 15;14(4):679-681. [PMC free article]
14. V. Pradhan, P. Bhadra and R. K. Pradhan, "Constraint-based Modelling of Human Erythrocyte Glycolysis and Role of 3PG in Breast Cancer," *2024 3rd International Conference for*

Innovation in Technology (INOCON), Bangalore, India, 2024, pp. 1-8, doi: 10.1109/INOCON60754.2024.10512070.

15. Dwity Sundar Rout, Asha Parvin, Swati Suman, Ajay Kumar Prusty, Vishal Kumar Gupta, Atanu Deb, Preetha Bhadra and Avisweta Nandy . (2024) . Institutional Role In Livelihood Generation: A Case Of Munising, Odisha. journal Community Practitioner
16. Dwity Sundar Rout*, Atanu Deb, Ajay Kumar Prusty, Preetha Bhadra, Avisweta Nandy. (2024) Comparative Analysis Of Tribal And Non-Tribal Farm Women In Agriculture Of Odisha. Community Practitioner
17. Bhadra, P., Maitra, S., & Shankar, T. (2022). Molecular investigation of plant-environment interaction at functional level. In Plant Perspectives to Global Climate Changes (pp. 63-78). Academic Press.
18. Maitra, S.; Brestic, M.; Bhadra, P.; Shankar, T.; Praharaj, S.; Palai, J.B.; Shah, M.M.R.; Barek, V.; Ondrisik, P.; Skalický, M.; et al. Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms 2022, 10, 51. https://doi.org/10.3390/ microorganisms10010051
19. Maitra, S., Brestic, M., Bhadra, P., Shankar, T., Praharaj, S., Palai, J. B., Shah, M. M. R., et al. (2021). Bioinoculants—Natural Biological Resources for Sustainable Plant Production. Microorganisms, 10(1), 51. MDPI AG. Retrieved from http://dx.doi.org/10.3390/microorganisms10010051
20. Praharaj S, Skalicky M, Maitra S, **Bhadra P**, Shankar T, Brestic M, Hejnak V, Vachova P, Hossain A. Zinc Biofortification in Food Crops Could Alleviate the Zinc Malnutrition in Human Health. Molecules. 2021; 26(12):3509. https://doi.org/10.3390/molecules26123509
21. Intercropping—A Low Input Agricultural Strategy for Food and Environmental Security. Sagar Maitra, Akbar Hossain, Marian Brestic, Milan Skalicky, Peter Ondrisik, Harun Gitari, Koushik Brahmachari, Tanmoy Shankar, **Preetha Bhadra**, Jnana Bharati Palai, Jagadish Jena, Urjashi Bhattacharya, Sarath Kumar Duvvada, Sagar Lalichetti, Masina Sairam. Agronomy, 11(2), 343

22. β-glucan: An Immunostimulant in Aquaculture Studies Adyasha Parida1 , Preetha Bhadra2* and Pradipta Banerjee3. Indian Journal of Natural Sciences,Vol.12 ,Issue 67, August, 2021
23. Functional Food as an Immuno-Modulator, Vadditandra Bhavani1, Pradipta Banerjee2* and Preetha Bhadra, Indian Journal of Natural Sciences,Natural Sciences,Vol.12, Issue 67, 33192, August 2021
24. Marine Immune Booster: Seaweeds and Corals, Harshita Singh1 , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33278, August, 2021.
25. Spirulina as an Immune Booster for Fishes, Khumbar Debbarma1, , Pradipta Banerjee2* and Preetha Bhadra3, Indian Journal of Natural Sciences, Vol.12, Issue 67, 33237, August 2021
26. A Review On Extraction Of Phylloquinone From Kiwi Fruit (Actinidia Deliciosa) as a Blood Coagulation Supplement (2020), **Preetha Bhadra**, Ankit Kumar Rath, *Pradipta Banerjee, Akanksha Rout Biosc.Biotech.Res.Comm (DOI: http://dx.doi.org/10.21786/bbrc/13.3/20) 13 (4)
27. NiO and NiO@SiO Nanoparticles In And As Anti-Microbial And Anti Cancerous Drug. Journal of microbiology, biotechnology and food sciences (2020). **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
28. Optical Nanofiber: A Smart Detector of Mycotoxins in Blood (2019). Journal of microbiology, biotechnology and food sciences. **Preetha Bhadra**, Biplab Dutta, Debapriyo Bhattacharya, Sampad Mukherjee.
29. On the reduction of health hazards caused by modified genes in indigenous rice plant varieties. Bioscience Biotechnology Research Communication (2018). **Preetha Bhadra*** and Atanu Deb.
30. Antifungal peptides: Biosynthesis, production and applications. Bioscience Biotechnology Research Communication (2018). NF Mirza, S Motamarry, **P Bhadra,** B Mishra.
31. A noble process of production of bio plastic (degradable) from waste plastic (nondegradable) (2018). Journal of Emerging Technologies and Innovative Research. Monali Parida, Victor Pradhan, Biswambhar Mishra, **Preetha Bhadra***

32. A Noble and Innovative Solution to Blood Storage. Journal of Emerging Technologies and Innovative Research. Yashwobanto Kar, Saswati Das, Biswambhar Mishra, **Preetha Bhadra*.**
33. Determining The Effect of Aflatoxin B1 Using Hemoglobin of Human Blood as Interacting Medium by Calculation of Collision Energy. International Journal of Advance Research. **Preetha Bhadra,** Chitrangada Das Mukhopadhyay, Sampad Mukherjee
34. Pradipta Banerjee, Preetha Bhadra (2020). Formulation of Anti-microbial and Anti-aging Oil from Natural Resources for Topical Application. *International Journal of Botany Studies*, 5 (3): 279-284
35. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Animal Disease Nephritis. Indian Journal of Natural Sciences.10(60):22932-22942
36. Preetha Bhadra. (2020), In Silico analysis of the Rosemary as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Black gram and green gram. Indian Journal of Natural Sciences. 10(60): 22942-22951
37. Preetha Bhadra. (2020) In Silico analysis of the Green Chiretta (Andrographis paniculata) as targeted therapy for Targeted Plant Disease-Causing Microbial Disease Chocolate Spot. Indian Journal of Natural Sciences. 10(60):22951-22959
38. Preetha Bhadra. (2020), A Review on Chemical Constituents and Pharmacological studies of Coriandrum sativum L. Indian Journal of Natural Sciences. 10(60):22959-22965
39. Preetha Bhadra, Atanu Deb. (2020), A Review Study On Acne Caused By Propionibacterium. Indian Journal of Natural Sciences .10(59):18422-182435
40. Preetha Bhadra, Atanu Deb. (2020), Review On The Treatment Of Urinary Tract Infection Without The Use Of Antibiotics. Indian Journal of Natural Sciences.10(59):18394-18406
41. Preetha Bhadra, Atanu Deb. (2020), Sleeplessness As A Marker Of Anaemia: A Review. Indian Journal of Natural Sciences.10(59):18201-182010
42. Preetha Bhadra, Atanu Deb. (2020), Review On Diabetic Foods And UTI. Indian Journal of Natural Sciences. 10(59): 18377-18383

43. Preetha Bhadra, Atanu Deb. (2020), A Literature Review On acne Due To Hormonal Changes And Lifestyle. Indian Journal of Natural Sciences.10(59):18507-18521
44. Preetha Bhadra. (2020), An Overview Of Ajwain (Trachyspermum ammi). Indian Journal of Natural Sciences .10(59):18466-182474
45. Preetha Bhadra, Atanu Deb. (2020). A Review On Nutritional Anemia. Indian Journal of Natural Sciences .10(59):18466-18474
46. Preetha Bhadra. (2019). Zno And Zno@Sio2: A Noble Therapeutic Drug For Cancer And Microbial Contamination. Bioscience Biotechnology Research Communications.12(3):798- 808
47. Preetha Bhadra. (2020). Exploring Inhibitory Potential Of Ginger Against Numerous Targets Of Diverse Forms Of Cancer A Review. Indian Journal of Natural Sciences,10(60):20861-20865
48. Preetha Bhadra, Atanu Deb. (2020) Targeted Therapy for Cancer in Women. Indian Journal of Natural Sciences. 10(60):20609-20616
49. Preetha Bhadra. (2020) An In silico Analysis of the Peppermint as Bio-Pesticide (No Side Effect). Indian Journal of Natural Sciences .10(60):20617-20625
50. Preetha Bhadra. (2020), Cinnamon: In silico Analysis as Targeted Bio- Pesticides. Indian Journal of Natural Sciences.10(60):20626-20634
51. Preetha Bhadra. (2020), An In silico Analysis of the Peppermint as Therapy for Typhoid. Indian Journal of Natural Sciences.10(60):20635-20644
52. Preetha Bhadra. (2020), Cumin: In silico Analysis as of Targeted Therapy for Diarrhoea. Indian Journal of Natural Sciences .10(60):20653-20661
53. Preetha Bhadra. (2020), In silico Analysis of the Cumin as Targeted Biopesticides. Indian Journal of Natural Sciences.10(60):20670-20678
54. Preetha Bhadra. (2020) Cinnamon: In silico Analysis targeted Therapy for Gastric Cancer.Indian Journal of Natural Sciences.10(60):20662-20669

55. Preetha Bhadra. (2020), In silico Analysis of the Ashwagandha as Targeted Therapy for Oral Cancer. Indian Journal of Natural Sciences. 10(60):20679-20687
56. Preetha Bhadra. (2020), In-silico Analysis of Compounds Characterized from Murrayakoenigii against Cancer. Indian Journal of Natural Sciences.10(60): 20861-20865
57. Preetha Bhadra. (2020), In-Silico Analysis of Inhibitory Action of Garlic against Hyperlipidemia by FAS Enzyme. Indian Journal of Natural Sciences.10(60): 20786-2079
58. Preetha Bhadra. (2020), In-silico Analysis of Effects of Ajwain Extract on Plant Disease. Indian Journal of Natural Sciences. 10(60):20792-20800
59. Preetha Bhadra. (2020), In-silico Analysis of Effects of Black Pepper Extracts on Asthma. Indian Journal of Natural Sciences. 10(60):20801-20810
60. Preetha Bhadra. (2020), In-silico Analysis of Effects of BlackPepper Extracts on Pulm Pox Virus as Biopesticides. Indian Journal of Natural Sciences. 10(60):20733-20741
61. Preetha Bhadra. (2020), In-silico Analysis of Effects of Methi Extracts on Animal Disease Gestational Diabetes. Indian Journal of Natural Sciences. 10(60):20725-20732
62. Preetha Bhadra. (2020), In-silico Analysis of Effects of MethiExtract on Plant Disease. Indian Journal of Natural Sciences .10(60):20742-20748
63. Akbar Hossain, Sagar Maitra, Sukamal Sarker, Abdullah Al Mahmud, Zahoor Ahmad, Reza Mohammad Emon, Hindu Vemuri, Md Abdul Malek, M Ashraful Alam, Md Atikur Rahman, Md Jahangir Alam, Nasrin Jahan, Preetha Bhadra, Debojyoti Moulick, Saikat Saha, Milan Skalicky, Marian Brestic (2023). Aluminium stress in plants: consequences and mitigation mechanisms. John Wiley & Sons, Ltd
64. Preetha Bhadra, Sagar Maitra, Masina Sairam. (2022). Introduction to Plant Responses to Environmental Stress. Apple Academic Press.
65. Preetha Bhadra, Sagar Maitra, Tanmoy Shankar (2022). Molecular investigation of plant-environment interaction at functional level. Academic press.
66. Hossain, A., Ali, M. E., Maitra, S., Bhadra, P., Rahman, M. M. E., Ali, S., & Aftab, T. (2022). The role of soil microorganisms

in plant adaptation to abiotic stresses: Current scenario and future perspectives. In Plant Perspectives to Global Climate Changes (pp. 233-278). Academic Press.

67. Bhadra, P., Maitra, S., Shankar, T., Hossain, A., Praharaj, S., & Aftab, T. (2022). Climate change impact on plants: Plant responses and adaptations. In Plant Perspectives to Global Climate Changes (pp. 1-24). Academic Press.
68. Maitra, S., Bhadra, P., Yadav, A. N., Palai, J. B., Jena, J., & Shankar, T. (2021). The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants. In Soil Microbiomes for Sustainable Agriculture (pp. 315-377). Springer, Cham.
69. Preetha Bhadra, (2021) Experimental Methods of supercritical extraction using carbon dioxide, Scholar Press
70. Preetha Bhadra,(2021) Factors affecting the supercritical extraction, Scholar Press
71. Preetha Bhadra , (2021) Advantages of supercritical extraction over other extraction methods, Scholar Press
72. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Phytohormones in Heat Stress Tolerance in Plants. Taylor and Francis
73. Maitra Sagar, Hossain Akbar, Banerjee Pradipta, Bhadra Preetha (2021). The Role of Gibberelin against abiotic stress tolerance. Taylor and Francis
74. Preetha Bhadra (2020). Medicinal Plants as Bio-pesticides. New Delhi Publishers, India. DOI: 10.30954/NDP-advagr.2020.18
75. Preetha Bhadra (2020). Metal Nanooxides as Bio-pesticides. New Delhi Publishers, India. 10.30954/NDP-advagr.2020.15
76. Pradipta Banerjee, Sayantan Maitra, Preetha Bhadra, Sayantani Karmakar, Amitava Das (2020). Nutritional interventions for Prevention of Neurodegenerative Disorders (NDDs). CRC Press, Taylor & Francis, UK.
77. Akbar Hossain, Zahoor Ahmad, Debjyoti Moulik, Sagar Maitra, Preetha Bhadra, Muhammad Adnan Bukhari, Sourav Garai, Mousumi Mondal, Ayman E Sabagh (2020). Jasmonates and Salicylates: Biosynthesis, Transport and Signalling Mechanisms during Abiotic Stress in Plants. Springer
78. Preetha Bhadra, Sagar Maitra, Akbar Hossain. Plant-microbe interaction in developing crop species resilient to climate change

from omics perspective (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)

79. Sagar Maitra, Akbar Hossain, Preetha Bhadra. Role of phytohormones in heat stress tolerance in plants (2020). Apple Academic Press (CRC Press, Taylor and Francis Group)
80. Sagar Maitra, Preetha Bhadra, Jnana Bharati Palai, Jagdeesh Jena and Tanmoy Shankar. The Omics Strategies for Abiotic Stress Responses and Microbe-Mediated Mitigation in Plants (2020). Springer Nature.
81. Akbar Hossain, Debjyoti Moulik, Sharif Ahmed, Zahoor Ahmad, Md. Jahangir Alam, Sagar Maitra,Preetha Bhadra, Tariq Aftab. Next-Generation Genetic engineering tools for abiotic stress tolerance in plants (2020). Academic Press, Elsevier.
82. Sagar Maitra, Preetha Bhadra, Tanmoy Shankar. Role of Bioinoculants in Green Agriculture (2020). Taylor and Francis.

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