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TEAK LEAVES: HARNESSING NATURE'S BENEFITS

Biotechnology

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ABSTRACT

With the rapid development of industrialization, pollution has been a great concern nowadays. It has been reported that many industries cause pollution including water pollution by discharging waste into water sources. Thus, contaminating water leads to harmful effects on aquatic organisms as well as human beings. Synthetic dyes are the major cause for this. Natural dyes can be the best substitute for this problem. Tectonagrandis (Teak tree) is a hardwood tree known for its timber value but its leaves are great sources of dye due to the presence of anthocyanin pigment and phytochemicals including alkaloids, tannins, antioxidants, etc. These beneficial properties of teak leaves make it potential as a source of natural dye and to promote wastewater treatment. They are ultimately helping to reduce water pollution and promote more plantation of trees. Thus, contributing to environmental sustainability.

KEYWORDS

Pollution, Textile dyes , Natural dye, *Tectonagrandis*

INTRODUCTION

Water, the basic need of life has contaminated over the past years with increase in demand of different industries causing several environmental issues. Release of any harmful material into an environmental source gives rise to a kind of pollution. The rising population utilizes an enormous amount of water and its discharge into water bodies leads to water pollution.(Lin et al., 2022) One of the most powerful pollutants of ground and surface water reservoirs is the textile industry which utilizes large amounts of water.

A report of the World Bank estimates that 17-20% of water pollution is caused due to textile industries during dyeing and finishing procedures.. Effluents containing dyes from the textile industry are heavily colored and thus visually noticeable.. In water, several dyes are evident at very low concentrations of 1 mg/L ..Dyeing industries depended on synthetic dyes ever since and started to expand globally, attaining nearly 8×10^5 tons of synthetic dyes produced per year..The textile dyes, along with a large number of industrial pollutants, are highly toxic and potentially carcinogenic, so that they are related to environmental degradation and various diseases in animals and humans.(Lellis et al. (2019)) Textile effluents containing synthetic dyes are highly visible due to their intense coloration, often appearing in water bodies even at low concentrations (1 mg/L), which can significantly disrupt aquatic ecosystems by reducing sunlight penetration and inhibiting photosynthesis (Chavan & Adivarekar, 2018). Several dyes are very toxic and mutagenic in nature, and their presence in aquatic environments may resist penetration of sunlight and prevent vegetative photosynthesis, leading to O_2 deficiency and limiting beneficial uses of rivers such as drinking and irrigation.. The use of synthetic dyes in textiles has been linked to various environmental and health issues, including:

1. Impact on Water Quality: Synthetic dyes can degrade water quality by altering its pH, oxygen levels, and light penetration, disrupting aquatic ecosystems and biodiversity.

2. Health Risks: Some synthetic dyes contain carcinogenic or toxic compounds, posing risks to both environmental and human health through water contamination. (Al-Tohamy et al.,2022)

In response to these concerns, there has been a growing interest in natural dyes as a sustainable alternative. Natural dyes are derived from plants, minerals, and even some insects, and they offer several environmental advantages.

Hence, natural / vegetable dyes are the best alternative for this concern. The use of leafs, peels and other agricultural waste can reduce the overall cost of dyeing production and also lower down the burden of planting a specific plant.

One of the great source for these dyes are teak leaves.Teak (*Tectonagrandis*) is a large, deciduous tree commonly known as sagwan (Hindi), saka (Sanskrit) and teak tree (English)..The bark has a pale grayish-brown color. Large, glossy, opposing, and elliptic leaves characterize the plant (Miranda et al., 2011). The leaf's underside is grey and covered in glandful hairs. The floral arrangements are small, bisexual, white, and resemble big panicles. The fruit is a green, drupe that is unevenly shaped, hairy, and woody.. Teak leaves containing anthocyanin pigment serve as natural dyes which produce more various and attractive colors..serves as natural dye ultimately lower down the use of synthetic dyes.

Teak leaf natural dyes offer multiple benefits that underscore their role in sustainable textile production. Firstly, these dyes capitalize on teak leaves, a byproduct of forestry and agriculture, thereby reducing waste and fostering sustainable practices in the industry. Their utilization not only mitigates environmental impact but also supports the circular economy by repurposing agricultural and forestry residues.

Fig: Teak tree and leaves

Compared to synthetic counterparts, teak leaf natural dyes exhibit superior environmental credentials. They are biodegradable and possess lower toxicity profiles, thus minimizing adverse effects on water quality and aquatic ecosystems. This characteristic underscores their role in promoting healthier environments and aligning with

global sustainability goals.

Furthermore, from an economic perspective, the use of agricultural and forestry waste, such as teak leaves, presents an opportunity for cost savings in dyeing production. By leveraging readily available natural resources, industries can potentially reduce expenses associated with procuring and processing synthetic dyes. This approach not only enhances economic viability but also reduces the overall environmental burden associated with intensive farming practices aimed solely at dye production.

In essence, teak leaf natural dyes exemplify a sustainable solution for the textile industry, balancing environmental stewardship, economic efficiency, and ecological responsibility. Their adoption represents a proactive step towards achieving more sustainable and resilient textile manufacturing practices globally.

MATERIALS AND METHODS

Sample Collection-

Young and mature leaves (about 100 gm) of teak tree were collected from Kondhane village in Karjat, Raigad district. The leaves are then washed with tap water followed by distilled water to remove impurities such as dust particles.

Dye extraction -

Young teak leaves (about 50 grams) were crushed using a domestic mixer with a minimum addition of distilled water (20 -25 ml). The mixture was then filtered out through muslin cloth and collected in a beaker. The extracted dye was stored at room temperature.

Fig: Phytochemical Analysis

Fig: Teak Leaf Infusion

Phytochemical Tests –

The phytochemical test was performed by a qualitative method using various reagents. (Table -1)

Dyeing Ability -

The extracted dye was checked for its dyeing ability on a cotton T-shirt and a handkerchief. Both these fabrics were soaked in the dye for 90-120 mins and allowed to air dry.

Dyeing Ability On Fabrics -

In the above experiment, the cotton fabric was colored and turned into brick-red fabric.These fabrics showed long-lasting color as it does not discolor after frequent washing and hence can be replaced with synthetic dyes in various industries .The use of a fixative agent enhances the ability of the dye to color and the color soaked in a darker shade.

Test For Color Fastness To Laundering -

10 g of detergent was mixed in a 1500 ml tap water. The fabrics were washed thoroughly with the detergent solution and then air dried.

Phytochemical Test- (Table -1)

Sr no.	Phytochemicals	Inference
1	Anthocyanin	Present
2	Tannin	Present
3	Protein	Present
4	Carbohydrate	Present
5	Steroid	Present

DISCUSSION

The introduction provides a comprehensive overview of the environmental challenges posed by synthetic dyes in the textile industry, emphasizing their role in water pollution and environmental degradation. It highlights the urgent need for sustainable alternatives, such as natural dyes derived from renewable sources like teak leaves.

Environmental Benefits

Teak leaf natural dyes offer significant environmental benefits compared to synthetic dyes. They are biodegradable and have lower toxicity profiles, minimizing adverse impacts on water quality and aquatic ecosystems. This characteristic is crucial for reducing the ecological footprint of textile dyeing processes, aligning with global sustainability goals and regulations aimed at protecting water resources.

Economic Viability And Resource Efficiency

The use of agricultural and forestry waste, such as teak leaves, presents economic advantages for textile industries. It potentially lowers production costs by utilizing readily available natural resources that would otherwise be discarded or underutilized. This approach enhances economic viability while reducing the environmental burden associated with intensive farming practices focused solely on dye production.

Experimental Findings And Application

The experimental section details the process of extracting natural dye from teak leaves, including sample collection, dye extraction methods, and phytochemical tests. It demonstrates the feasibility and efficacy of teak leaf natural dyes through dyeing experiments on cotton fabrics. The results show that teak leaf dyes produce vibrant colors that are colorfast even after repeated washings, indicating their suitability as a viable substitute for synthetic dyes in various textile applications.

Conclusion And Future Directions

In conclusion, the research underscores the potential of teak leaf natural dyes as a sustainable solution for the textile industry. It balances environmental stewardship, economic efficiency, and ecological responsibility, paving the way for more sustainable and resilient manufacturing practices globally. Future research could explore optimization strategies for dye extraction and application, as well as scalability and commercial viability in industrial settings.

Implications For Industry And Policy

The findings have implications for industry practices and regulatory policies concerning textile dyeing processes. Embracing natural dyes like those derived from teak leaves can contribute to meeting sustainability targets and reducing the environmental impact of textile production. Policymakers may consider incentives or regulations that promote the adoption of natural dyes as part of broader efforts to achieve sustainable development goals.

Contribution To Knowledge

This research contributes to expanding the knowledge base on sustainable textile dyeing practices by demonstrating the efficacy and benefits of teak leaf natural dyes. It provides empirical evidence supporting the feasibility and environmental advantages of natural dye alternatives, encouraging further innovation and adoption in the textile industry.

CONCLUSION

Natural dye was extracted from the leaves of *Tectona grandisLinn* commonly known as teak tree. The dye showed brick-red color which

indicates the presence of anthocyanin pigment which can be confirmed by phytochemical testing. The phytochemical test is confirmed by the presence of anthocyanin followed by different secondary metabolites such as tannins, steroids, carbohydrates and proteins.

Thus, from phytochemical testing, it can be concluded that it will enhance the use of teak tree leaves as a source of natural dye as well as source of different secondary metabolites. The dyeing ability was determined by color fastness. Fabric when washed with detergent solution, the color retains after frequent washing. From the results obtained, it can be concluded that instead of textile dye at large scale, this dye can be used.

Since the dye retains color like synthetic dyes and contains various secondary metabolites, teak leaves can be the best substitute. This transforms agricultural waste into a valuable resource for sustainable dye production.

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REFERENCES:

1. Appannagari, R. R. R. (2017, August 20). Environmental Pollution Causes and Consequences: A Study. ResearchGate. https://www.researchgate.net/publication/323944189.
2. Al-Tohamy, R., Ali, S. S., Li, F., Okasha, K. M., Mahmoud, Y. A. G., Elsamahy, T., Jiao, H., Fu, Y., & Sun, J. (2022, February). A critical review on the treatment of dye-containing wastewater: Ecotoxicological and health concerns of textile dyes and possible remediation approaches for environmental safety. Ecotoxicology and Environmental Safety, 231, 113160 . https://doi.org/10.1016/j.ecoenv.2021.113160
3. Babuji, P., Subramani, T., Karunanidhi, D., & Gopinathan, P. (2023, July 10). Human Health Risks due to Exposure to Water Pollution: A Review. Water. https://doi.org/10.3390/w15142532
4. Dwivedi, A. K. (2017, January 31). RESEARCHES IN WATER POLLUTION: A REVIEW. ResearchGate. https://doi.org/10.13140/RG.2.2.12094.08002
5. Godghate, A., & Sawant, R. (2014, January 1). Phytochemical analysis of leaves of tectona grandis linn. ResearchGate. https://www.researchgate.net/publication/279534517
6. Islam, T., Islam, T., Islam, T., & Repon, M. R. (2022, August 8). Synthetic Dyes for Textile Colouration: Process, Factors and Environmental Impact. Textile & Leather Review. https://doi.org/10.31881/tlr.2022.27
7. Khan, S. A., Hussain, D., & Khan, T. A. (2021, January 22). Recent Advances in Synthetic Dyes. https://doi.org/10.1002/9781119710288.ch3
8. Kolli, P. K., Obbalareddy, S., Yejella, R. P., Athili, L. D., & Ponnada, S. (2022, August 25). A REVIEW ON TECTONA GRANDIS. International Journal of Research in Pharmacy and Chemistry, 12(3), 39–39 https://doi.org/10.33289/ijrpc.12.3.2022.12(39)
9. Lellis, B., Fávaro-Polonio, C. Z., Pamphile, J. A., & Polonio, J. C. (2019, July). Effects of textile dyes on health and the environment and bioremediation potential of living organisms. Biotechnology Research and Innovation, 3(2), 275–290. https://doi.org/10.1016/j.biori.2019.09.001
10. Lin, L., Yang, H., & Xu, X. (2022, June 30). Effects of Water Pollution on Human Health and Disease Heterogeneity: A Review. Frontiers in Environmental Science, 10. https://doi.org/10.3389/fenvs.2022.880246
11. Miranda, I., Sousa, V., & Pereira, H. (2011, June). Wood properties of teak (Tectona grandis) from a mature unmanaged stand in East Timor. Journal of Wood Science, 57(3), 171–178.
12. Rosyida, A., & Suranto. (2018, March). Use of Tectona grandis Leaf Extract in Colouring Silk Cloth Material Based on pH and Mordant Variations. IOP Conference Series: Materials Science and Engineering, 333, 012051. https://doi.org/10.1088/1757-899x/333/1/012051
13. Slama, H. B., Chenari Bouket, A., Pourhassan, Z., Alenezi, F. N., Silini, A., Cherif-Silini, H., Oszako, T., Luptakova, L., Golińska, P., & Belbahri, L. (2021, July 6). Diversity of Synthetic Dyes from Textile Industries, Discharge Impacts and Treatment Methods. Applied Sciences, 11(14), 6255. https://doi.org/10.3390/app11146255
14. Sharma, J., Sharma, S., & Soni, V. (2021, June). Classification and impact of synthetic textile dyes on Aquatic Flora: A review. Regional Studies in Marine Science, 45,101802. https://doi.org/10.1016/j.rsma.2021.101802
15. Vankar, P. S., Tiwari, V., & Shanker, R. (2003, April 1). Dyeing cotton, wool and silk with tectona leaves dye. ResearchGate. https://www.researchgate.net/publication/293529127
16. Vankar, P. S., Tiwari, V., & Shanker, R. (2003, April 1). Dyeing cotton, wool and silk with tectona leaves dye. ResearchGate. https://www.researchgate.net/publication/293529127
17. Yaseen, D. A., & Scholz, M. (2018, November 27). Textile dye wastewater characteristics and constituents of synthetic effluents: a critical review. International Journal of Environmental Science and Technology. https://doi.org/10.1007/s13762-018-2130-z