ECO-FRIENDLY DYEING OF COTTON USING NATURAL DYE FROM SWEITENIA MAHAGONI (BARK) AND EXAMINATION OF ANTI-MICROBIAL ACTIVITY – A Review

S.Natarajan[1] , A.Karunya [2], P.Hariprasath[3] , R.Narashima Gowtham[4]

[1]*Assistant Professor, Textile Technology, Kumaraguru College of Technology, Tamil Nadu, India*

[2,3,4]*Final Year B.Tech-Students ,Textile Technology, Kumaraguru College of Technology, Tamil Nadu ,India*

ABSTRACT

Around the last sixty years, natural dyes were out of practice and industries were into synthetic dyes, and now natural dyes are again becoming an object of consumer interests. The objective is to evaluate the potential of mahogany wood waste powder as a natural, plant- based antibacterial agent for use in textile applications. The findings suggested that mahogany wood waste powder has potential as a natural, plant-based antibacterial agent for use in textile applications. Most synthetic dyes used in the textile industry are non-biodegradable, carcinogenic, and significantly harm the environment. Natural colouring compounds were isolated using an aqueous extraction method, and organic cotton fabric was coloured with the extracts after being mordanted with several mordant types including ferrous sulphate, potassium aluminium sulphate, and stannous chloride. .Dyeing is a crucial textile technology procedure and all over the world the colouring of textile material is done with bleached fabric using natural and synthetic dyes. The wash, light, rubbing, and perspiration fastness qualities of coloured organic cotton fabric were investigated. The organic cotton fabric coloured with wood waste was found to have good to excellent fastness qualities. The scanning electron microscopy images revealed that the dye particles were present on the dyed fabric surfaces. Therefore, utilizing naturally derived dyes from mahogany wood waste to colour organic cotton fabric may be a good substitute for synthetic dyes in the textile sector due to environmental concerns.. The treated OCF is tested against Escherichia coli and Staphylococcus aureus using the agar disc diffusion method. The results showed that the treated fabric exhibited a significant antibacterial effect. The antibacterial activity decreased with repeated washing, but the treated fabric still showed some level of activity even after ten washes. Overall, Mahagoni serves as a sustainable substitute for synthetic antibacterial agents in the textile sector.

Keywords: *natural dye, mahagoni, dyeing, mordant, anti-bacterial*

INTRODUCTION:

Due to harmful nature of synthetic dyes natural dyes are highly preferred. The use of synthetic dyes can cause environmental pollution and is a hazardous material, because some dyes can be degraded into carcinogenic and toxic compounds. Recently many batik industries owner have switched to using natural dyes because synthetic dyes in the long time have a negative impact on the environment. Natural dyes that are widely used are mahogany (Swietenia Mahagony) bark dyes. Several researchers have worked on the development of nature based antibacterial agent to minimize the environmental issues caused by synthetic chemicals. Treating organic cotton fabric with mahogany wood waste powder can result in substantial antibacterial activity against Escherichia coli and Staphylococcus aureus. Natural dyes do not give excellent fastness properties since these organic dyes are not suitable for dyeing natural materials. Furthermore, global textile consumption is estimated to be around 30 millstones and is expected to grow at a rate of three times per year. Natural dyes can be used to dye a wide range of natural fibers. The shades produced by natural dyes/colourants are usually soft, lustrous and soothing to the human eye. The application of plasma treatment improves natural dyeing of different types of textile fibers. Generally natural dyes do not cause health hazards; on the contrary, they sometimes act as a

health-care substance. Therefore, instead of using violent technology for producing colours one can use natural mordants a eco-friendly way to achieve almost similar results.

PROPERTIES OF SWEITENIA MAHOGONI

Swietenia mahagoni, commonly known as mahogany, is a type of hardwood tree known for its high-quality wood, which is often used in furniture and wood working and serves as a natural dye. Textile dyeing primarily involves the application of dyes and chemicals to fabrics like cotton, silk, wool, or synthetic materials to achieve desired colours and patterns. Mahogany has been used in traditional dyeing practices, but it's important to note that not all parts of the tree may be suitable for dyeing, and the specific properties related to dyeing are limited. Colour: Mahogany wood and bark can yield brown and reddish-brown colours when used as a natural dye. The colour may vary depending on the specific part of the tree used, the preparation method, and the type of fabric. Mordants: Like many natural dyes, mahogany may require the use of mordants, such as alum or iron, to enhance colourfastness and make the dye adhere more effectively to the fabric. Preparation: To use mahogany as a dye, the bark or heartwood needs to be harvested and processed. The exact preparation process can vary depending on the desired colour and the type of fabric being dyed. It's important to remember that natural dyes like mahogany may not be as colourfast or consistent as synthetic dyes. Additionally, the specific properties can vary depending on the species of mahogany and regional variations.

NATURAL DYE EXTRACTION METHODS

The characteristics and solubility of colouring components should be observed before the extraction process. There are several methods to extract natural dyes 1. Simple Aqueous Extraction Methods 2. Complicated Solvent Extraction 3.Super-Critical Fluid Extraction 4. Ultra-Sonic and Micro-Wave Assisted Extraction 5. Alkali or Acid Extraction[1].The collected mahogany wood waste is washed with normal water for removing dust. Then, it is placed in the direct sunlight to make them dry. After drying, a grinding machine is used to grind the wood waste for 1 min and made it in the powder form. The powder was then taken in a beaker and add water with a 1:10 liquor ratio to prepare the extraction of dyes in aqueous medium. The extraction is done in a reaction chamber with a temperature of 90 ◦C for 60 min. To get a liquid dye solution, the extracted dyes are filtered twice through fine filter paper. The extracted dyes are then stored for further dyeing process [5].The traditional chemical separation method is commonly used for the extraction and separation of natural products, which is still used up to date. It is mainly designed according to the principles of different solubility of active components in different solvents, and crystallization [5] Extractor-evaporator tanks, stoves and raw materials are used to make the extract of mahogany bark. Method: Put 1 kilogram of material, then put water into the extractor-evaporator tank. Heat until the temperature reaches 100 ºC. After the process is complete, turn off the stove and the stirring motor. Open the extractor cover and cooled down for 30 minutes. Extracting the extract through the tap at the bottom of the extractor, then storing the extract in a bucket and inserting it into the jerry can. Take the residue in the form of the remaining mahogany bark which is accommodated in the filter tank in the extractor set tools[3].

MORDANTING TECHNIQUE

Simultaneous mordanting: The dye and mordant are combined and applied simultaneously. Prior to applying the mordant, the dye is applied. Dyeing comes initially, followed by mordanting in post-mordanting Tannin or tannic acid is the most frequent mordant for cotton. The addition of boric acid stops the breakdown process[1]. Mordanting was done using mordanting chemical with a weight of 5% and liquor ratio of 1:30 at temperature 85 ◦C for 50 min. After mordanting, the mordanted fabric was dyed using oscillating sample dyeing machine at temperature 90 ◦C for 60 min and material to liquor ratio was 1:20. The dyeing recipe of organic cotton fabric was a 10% of natural dye solution, 2 g/L of wetting agent, 2 g/L of levelling agent, and 1 g/L of sequestering agent. To promote dyeing exhaustion, sodium sulphate (Na2SO4) = 5 g/L was added throughout the dyeing process. The coloured organic cotton fabric was washed in cold water after dyeing and dried in a dryer[4]**.**Mordanting solution: 10 litters of water, 100 grams of alum and 30 grams of soda ash and the solution is boiled. After the water was boiled, the fabric that has been soaked overnight is boiled in a mordanting solution for ± 15 minutes. The mordanting solution and the fabric were left on overnight, then the fabric was dried.

DYE FIXATION AND AFTER TREATMENT

Processing of cotton fabric was done at 100°C for 60 minutes using a mordant (alum) and natural colouring material derived from turmeric and neem in a liquor ratio of 1:40. The dyeing solution was applied to the fabric sample while submerged in a water bath set at 40°C[1].The dyeing recipe of organic cotton fabric was a 10% of natural dye solution, 2 g/L of wetting agent, 2 g/L of levelling agent, and 1 g/L of sequestering agent. To promote dyeing exhaustion, sodium sulphate (Na2SO4) = 5 g/L was added throughout the dyeing process. The coloured organic cotton fabric was washed in cold water after dyeing and dried in a dryer.[4].For studying the effect of dyeing process the conditions provided were: dyeing time 30-130 min, temperature 70-100 degrees, M:L ratio 1:50, mordant concentration 10-40%, wood extract 10-40%,common salt concentration 5-20 gpl and pH 4.5-12.0[5].Colour fastness is assessed by comparing the colour changes that occur with colour change standards issued by the International Standards Organization (ISO) and made by the Society of Dyers and Colourists (S.D.C) in the United Kingdom and the American Association of Textile Chemists and Colourists (AATCC) in the United States. The colour change standard issued is the gray scale standard to assess the colour change of the laundry and the staining scale to assess the colour change due to staining on the white fabric. From the analysis results will be obtained figures that indicate the level of fastness[5].Previous studies have shown that nitrogen plasma treatment introduced an amount of amide and carboxyl groups on the acrylic fiber surface. The introduction of these polar groups led to enhanced moisture penetration and binding on the fiber surface, reduced water contact angle, and enhanced surface energy. Also, the surface roughness increased, leading to an increase in the specific surface area.[10]

EXAMINATION OF ANTI MICROBIAL ACTIVITY

The antibacterial action was due to the presence of natural chemicals with antibacterial capabilities in the mahogany wood extract[9].According to the findings of this study, treating organic cotton fabric with mahogany wood waste powder can result in substantial antibacterial activity against Escherichia coli and Staphylococcus aureus[3]The majority of natural colours are key components of ayurveda and pharmaceutical medicines, they are regarded as nature's blessings[4].Overall, the results indicated that mahogany wood waste powder may be used as an antibacterial agent in textile applications. In addition, the other cellulosic textiles will be taken into consideration for future antibacterial activity utilizing natural dyes from mahogany wood waste because it provides favorable outcomes for the functionalization of OCF.[9]

CONCLUSION

The commercialization of plant dyes for colouration of textiles material is needed and is highly useful for the local rural dyers and plant cultivators. The uses of natural dyes are often linked to term of fastness properties mainly wash and light fastness. This can be improved by proper selection of natural mordants and extraction along with best application of technology and ecological process. The development of modern extraction process and user-friendly approach will draw the attention of different industries and entice them to use natural dyes in their supply chain. According the result from the value of R% (colour aging) and colour fastness test against wet and dry rubbing, it can be concluded that alum and calcium oxide are the strong fixators and the optimal concentration is 60 g / L in dyeing batik fabric by natural dye of mahogany bark However, further research is required to optimize the treatment strategy and completely comprehend the underlying mechanisms of antibacterial action. Real-world testing is also required to establish how well the treated OCF works in actual applications. Overall, the results of this study indicated that mahogany wood waste powder may be used as an antibacterial agent in textile applications. In addition, the other cellulosic textiles will be taken into consideration for future antibacterial activity utilizing natural dyes from mahogany wood waste because it provides favourable outcomes for the functionalization of OCF. A combination of plasma treatment and natural dyeing is a green and environmentally friendly approach for sustainable coloration of textiles. In addition, comparative life cycle assessment of synthetic and natural dyes can also be studied by the researchers to reveal the advantages in brief. Finally, utilizing state-of-the-art technology can overcome the drawbacks associated with natural dye extraction as well as its application. As the natural dyes derived from mahogany wood waste provide excellent results for the dyeing of organic cotton fabrics, therefore, the other cellulosic fabrics will be taken into consideration for future dyeing study using natural dyes. Thus, natural dyeing of textiles by industrial processes in large scale dyeing unit is now a reality in the textile market of products that are eco-friendly.

REFERENCES

[1] Harini, N., & Santhi, N. (2023). Challenges and opportunities in product development using natural dyes. *The Scientific Temper (2023) Vol. 14 (1): 211-215*, *14*(01), 211–215. https://doi.org/10.58414/scientifictemper.2023.14.1.26

[2] Sk, M. S., Mia, R., Haque, M. A., & Shamim, A. M. (2021). Review on extraction and application of natural dyes. *Textile & Leather Review*. https://doi.org/10.31881/tlr.2021.09

[3] Lutfi, I., Fatoni, R., & Fatimah, S. (2020). The application of mahagony bark (Swietenia Mahagony L.) for natural dyeing. *Advance Sustainable Science, Engineering and Technology (ASSET)*, *2*(1). https://doi.org/10.26877/asset.v2i1.6017

[4] Mia, R., Bakar, M. A., Islam, M. R., & Ahmed, T. (2023b). Eco-friendly coloration from mahogany wood waste for sustainable dyeing of organic nonwoven cotton fabric. *Results in Engineering*, *17*, 101032. https://doi.org/10.1016/j.rineng.2023.101032

[5] Gumbira-Sa'id, E. (2013). *Design Process of Extraction and Natural Dye Powder Production from Swietenia mahagoni and its Application in Textile Dyeing*. http://repository.ipb.ac.id/handle/123456789/65760

[6] Prabhu, K., & Bhute, A.S. (2012). Plant based natural dyes and mordnats: A Review. *Journal of Natural Product and Plant Resources*, *2*, 649-664. http://scholarsresearchlibrary.com/archive.html

[7] Samanta, A. K., Agarwal, P., & Datta, S. (2007). Dyeing of jute and cotton fabrics using Jackfruit wood extract: Part I - Effects of mordanting and dyeing. . . *ResearchGate*. https://www.researchgate.net/publication/287178785_

[8] Ghaheh, F. S., Moghaddam, M. K., & Tehrani, M. (2021). Comparison of the effect of metal mordants and bio-mordants on the colorimetric and antibacterial properties of natural dyes on cotton fabric. *Coloration Technology*, *137*(6), 689–698. https://doi.org/10.1111/cote.12569

[9] Mia, R., Das, S., Banna, B. U., Ahmed, T., & Bakar, M. A. (2023). Enhancing antibacterial properties of organic cotton fabric using mahogany wood waste. *Case Studies in Chemical and Environmental Engineering*, *8*, 100387. https://doi.org/10.1016/j.cscee.2023.100387

[10] Haji, A., & Naebe, M. (2020). Cleaner dyeing of textiles using plasma treatment and natural dyes: A review. *Journal of Cleaner Production*, *265*, 121866. https://doi.org/10.1016/j.jclepro.2020.121866