OPTIMIZATION OF MORDANTING PROCESS WITH BIO MORDANT (BANANA PSEUDOSTEM SAP) AND DYEING WITH ACACIA CATECHUON MERINO WOOL AND SOYA PROTEIN FABRIC

Jyoti Gupta*; Prof. Sangita Deodiya**

*Research Scholar,
Dept. of Home Science,
VKM, BHU, INDIA
Email id: guptakajal835@gmail.com

**Professor,
Dept. of Home Science,
VKM, BHU, INDIA
Email id: vkm.sangita@gmail.com

DOI:10.5958/2278-4853.2024.00012.X

ABSTRACT

Textile materials are dyed with the aim of enhancing their qualities and making them attractive. Nature is full of various attractive colours, and these colours have been used by humans since ancient times. Colours derived from nature possess various properties, such as being renewable, biodegradable, non-polluting, non-carcinogenic, eco-friendly, and having medicinal benefits. The aim of the study is to develop different colours using natural dye (Acacia catechu) and bio mordant (banana pseudostem sap) and to optimise the change in shades by changing the method of mordanting. In this, it was found that the pre-mordanting method was providing a deeper shade than the other two methods (simultaneous and post mordanting). It was noticed that in the pre-mordanting process, the colour absorption capacity of the wool fabric was higher than that of the soya protein fabric, and the colour shades obtained were also darker. In this way, natural dyes and biomordants are great choices from an environmental protection point of view, and a soothing, soft, and attractive colour palette can be developed using different methods of mordanting.

KEYWORDS:*Acacia Catechu, Bio Mordant, Eco-Friendly, Methods of Mordanting.*

1.Natural dyeing is the ancient art of extracting colours from organic substances and applying those colours to fibres, yarns, and fabrics to enhance their appearance(Begum, 2023), Natural dyes can be extracted from multiple parts of plants, like roots, bark, leaves, stems, fruits, and flowers.All these parts produce many kinds of colour shades, which are wide-ranging, soft, and shooting. With the discovery and use of synthetic dyes in 1856(Tiwari & Srivastava, 2018), the use of natural dyes almost disappeared (Verma, 2017) because synthetic dyes are less expensive and exhibit bright and stable colour fastness compared to natural dyes.The current situation shows that only about 1% of textiles are dyed with natural dyes, which is mainly done by traditional artisans and small-scale textile dyers in the cottage industry(Kumar Samanta, n.d.). Nearly all synthetic dyes produced from petrochemicals affect plants, animals, and human health (Sharma, 2017). For this reason, in many nations, the prohibition on synthetic dyes started in Germany because of their deleterious effects, such as skin irritation and dermatitis(Pooja Sanku Professor Jayashankar et al., 2020). In fact, there has been a significant resurgence in interest in natural dyes in recent years. This change is primarily due to growing awareness about the environmental and health concerns associated with synthetic dyes(Judia Harriet Sumathy, 2013). Natural dyes offer several advantages, including being less toxic, having pharmacological effects, being obtained from renewable sources, being safer, biodegradable, and cost-effective.They also harmonise with nature and can produce a range of colours by using various mordants. However, they have limitations such as limited availability, unstable colour yield, complexity of textile dyeing, and need for standardised shade(Kumar Gupta, n.d.) Therefore, natural dyes are a secure substitute for synthetic dyes due to their non-polluting, non-carcinogenic, and eco-friendly nature(Barber, 1991).

Natural dyes have poor affinity because they do not contain bonding groups to fix the colours to the fabric, and their fastness properties are low. Hence, mordants are used to fix the colour to the fabric. These mordanting agents are of various types, such as metallic mordants, tannins, tannic acid, and oil mordants. The type of mordant employed influences the dye's fastness quality and alters the shade that is acquired after dyeing. Some metallic mordants are also toxic. Along with this, it is also not good for human health. Therefore, the use of bio mordants is a better option(Kumar Gupta, n.d.).

Banana is commonly grown in India, and the production of its fruits produces a large amount of biomass or stem, which is thrown away as waste. Banana pseudostem is filled with a thick, brown liquid called banana pseudostem sap (BPS). In recent years, banana pseudostem sap has been used as a bio-mordant(Aloevera and Banana Sap as Biomordant for Dyeing Bamboo Fabric with Natural Dyes, n.d.). Banana pseudo-stem sap contains tannins. That’s why it is being used as a fixing agent in dyeing.

Soya protein fiber is a new and environmentally friendly fiber. The textiles made from these fibres have both natural and synthetic properties and are affordable and environmentally sustainable, as there is no pollution in their production. Soyabean fibre is available in a variety of shapes and colours and contains 40% protein and21% oil. Soya protein fibre has many functional benefits, including providing anti-bacterial, anti-static, and UV protection(Divya & Jayakumari, 2017).

Merino is a high-quality natural fibre derived from the Merino fleece. This breed is known for its soft and fine texture. The fineness of the Merino fleece is measured in microns. The finer the Merino wool, the more luxurious it is considered. Generally, the fineness of Merino wool is 17–24 microns. This wool is highly breathable, allows for moisture, and keeps the wearer dry. It keeps the body warm in winters as it has natural insulating properties. Along with this, it also has natural elasticity, which helps the garment maintain its shape. Merino wool is a renewable resource that is also biodegradable. For many consumers seeking high quality natural fibres, merino wool is a great choice for comfort, performance, and sustainability. Merino wool has a unique moisture-absorbing capacity that is higher than that of most other apparel. Wool fibres are similar to human skin as both are composed of keratin proteins and both are highly hygroscopic.

This study aims to apply Acacia catechu (Kattha) dye to Merino wool and soya protein fabric with bio mordant (banana pseudostem sap) and three mordanting methods: pre mordanting, simultaneous mordanting, and post mordanting, which are applied in different proportions to optimise various colour shades.

2.MATERIALS:

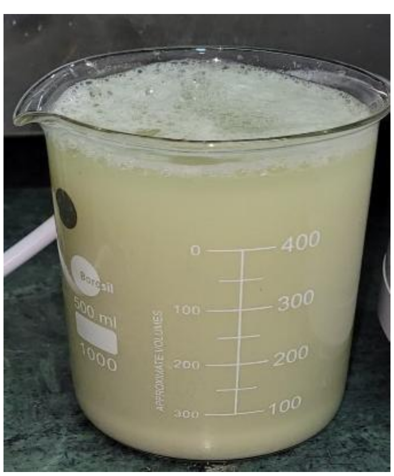
2.1: Selection of Fabrics: Protein fabric was chosen for the present study. These fabrics are eco-friendly but different in nature, as merino wool is an animal-source fabric and soya protein fabric are a vegetable-source fabric. Both fabrics were purchased from PAHARTAH FASHION LLP, Himachal Pradesh.

Table: 1

Physical Properties	Fabrics	
	Wool	SPF
Ends/inch	70	65
Picks/inch	41	68
Weave	Diamond twill	Plain

2.2: Biosurfactant: Reetha (Sapindus mukurossi) was selected for the scouring process and used in powder form. Reetha is a bio-surfactant that has been used for cleaning cloths since ancient times. (Sarma et al., 2012)

2.3: Natural dye: Acacia catechu (Kattha) is used as a natural dye. Selected dyes are purchased from Sodhani Biotech Private Limited, Jaipur, Rajasthan. Kattha dye has medicinal properties as well as antibacterial properties. (Muthumanickam et al., 2010)



2.4: Mordant: In this research,banana pseudostem sap (BPS) has been used as a biomordant for the mordanting of both fabrics. According to Barhanpurkar et al. (2015), it contains 2.06% tannin, which improves the natural dyeing process. The sap of the pseudo stem is a thick liquid, initially cream-coloured when fresh, but after a few days, it changes to a light brown colour.

3: Experimental Methods:

3.1: Pre-treatment of fabric: Reetha was ground into powder form for fabric scouringwith a 1:40 material-to-liquid ratio. 20% reetha powder was taken according to the weight of the fabric and soaked in 200 ml of distilled water for 15 minutes. The rest of the water was heated to 70^{0} C after that, soaked reetha solution was added to the hot water and mixed well. The fabric was poured into solution and then treated at 80-85^{0}C for 30 minutes. The fabric was washed thoroughly with normal water and dried.

3.2: Extraction of dye: In this study, the aqueous extraction method was adopted for dye extraction. The M:L ratio was kept at 1:40, with different percentages of dye taken based on the weight of the fabric, *i.e.,* 30% and 60%. The dye was soaked with distilled water for 30 minutes and heated at 80 °Cfor 45 minutes. After 45 minutes, the solution was allowed to cool and filtered with a double-muslin cloth. The solution was filtered with a double-muslin cloth.

3.3: Dyeing process: Through the extraction procedure, the dye extract was obtained by the aqueous method. The extracted dye solution was transferred to another container. Before the dyeing process, fabrics were poured into a solution, stirred properly, and allowed to rest for 15 minutes. Then, the container was placed in a dye bath and heated to 80 °C for 45 minutes. The container was taken out of the dye bath and allowed to cool. After cooling the dye solution material, it was removed and thoroughly washed with tap water.

3.4: Mordanting: In the study, three mordanting techniques were adopted for treating both fabrics: pre-mordanting, simultaneous mordanting, and post-mordanting. For mordanting of both fabrics, a ratio of 1:40 was used while maintaining the temperature at 80 °C for 40 minutes.

3.5: Pre-mordanting: First, the two fabric samples were treated separately in containers containing 40% and 60% banana pseudostem sap solutions (owf). After the mordanting process, the fabrics were dried. The mordanted fabrics were dyed with extracted katha dyes in various percentages of dye shades, like 30% and 60%. The dyeing temperature was 80 °C for 45 minutes. After the dyeing period, the dye solutions were allowed to cool. The fabrics were removed from the dye solution, rinsed thoroughly, and dried.

3.6: Simultaneous Mordanting: In this method, dyeing and mordanting are done in the same bath. Both fabrics were dyed in a bath containing mordant banana pseudo-stem sap (40% and 60% owf) and extracted katha dye (30% and 60%) in different containers. After 45 minutes of the dyeing process, the dyed fabrics were washed with water and dried.

3.7: Post Mordanting: In the post mordanting method, the fabric samples were dyed with different percentages of extracted katha dye in separate containers at 30% and 40%. Dyeing was carried out under standardised conditions: dyed fabrics were taken out of the dye bath, washed properly with tap water, and dried. Then dyed fabric samples were treated with a banana stem sap solution (40% and 60% owf) for the mordanting process in different containers. Both fabrics were immersed in a separate container and treated for 45 minutes at 80 °C. Afterward, the mordanted fabric was allowed to cool, rinsed with water, and dried.

4: RESULTS AND DISSCUSSION:

MERINO WOOL

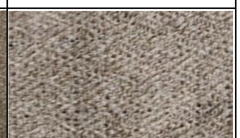
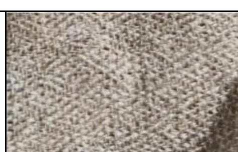
Dye % Shade		
Pre-mordanting		
	30%	**60%**
40% BPS		
60% BPS		
Simultaneous mordanting		
40% BPS		
60% BPS		
Post-mordanting		
40% BPS		
60% BPS		

Table: 2

SOYA PROTEIN FABRIC

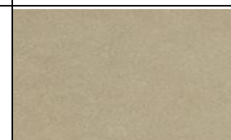
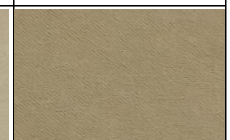
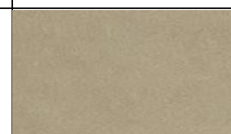
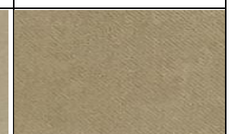
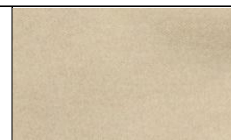
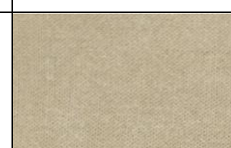
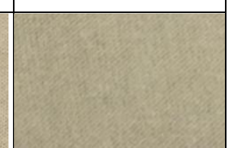
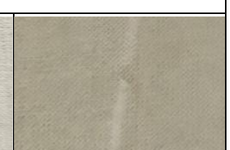
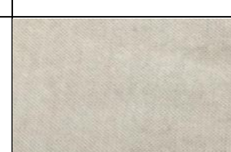
Dye % Shade		
Pre-mordanting		
	30%	**60%**
40% BPS		
60% BPS		
Simultaneous mordanting		
40% BPS		
60% BPS		
Post-mordanting		
40% BPS		
60% BPS		

Table: 3

To investigate the effect of mordanting methods and different dye concentrations on the merino wool and soya protein fabric, it was determined based on visual assessment. This includes factors such as brightness of colour, depth of colour shades, intensities, evenness of dye, appearance, and texture of samples. The results in tables 2 and 3 indicate that both fabrics dyed through the pre-mordanting method gave good colour as compared to both other methods of mordanting. Numerous studies discovered on the mordanting methods found that samples dyed with premordanting showed the best shade of colour as compared to simultaneous and post mordanting(Jain & Vasantha, 2016). It was found that colour shades came out evenly on the wool fabric, whereas some patches were visible on the soya protein fabric. It was observed that different mordanting methods and dye concentrations gave different intensities and shades to both fabric samples. It is also observed in this study that the weave of the fabric and the source of origin of the fabric can also affect the colour shades of the samples, as both fabrics were proteinbased fabrics and the method of mordanting, dye concentration, and recipe were kept the same, but in the result of the study, it is easily visible that both fabrics had different dye uptake properties and gave different colour shades, and it is very clearly seen in Tables 2 and 3 that all the fabric samples produced brown and grey colour shades in various ranges.

5: CONCLUSION:

In banana cultivation, pseudostem sap remains waste after harvesting. These stems can be utilised in various areas to develop other things like paper and other textile industries, etc. But generally, these stems are disposed of by burning, which creates air pollution and environmental waste. This study examines the possibility of using banana pseudostem sap as a biomordant, which may be a safer substitute for metallic mordants that cause many kinds of health risks. The entire result indicates that banana pseudostem sap serves as an eco-friendly source of biomordant and also enhances the dyeing process. Various methods of mordanting give different colour shades. As the colour of banana sap is brown, it is not giving any kind of colour to both fabrics. To produce cloths with completely eco-friendly colours, the use of metal salts has to be eliminated. This research was done as an effort in this context, and it was successfully found that eco-friendly products can be produced using natural resources. Even using the same percentage of dye shade, mordant, and recipe, different colours were achieved by variations in their mordanting methods. Based on the above study, it was concluded that the banana pseudostem sap was used as a biomordant to develop an eco-friendly and sustainable fabric.

6: REFERENCES:

1. Aloevera and Banana Sap as Biomordant for Dyeing of Bamboo Fabric with Natural Dyes. (n.d.).
2. Barber, E. J. W. (1991). Prehistoric textiles: the development of cloth in the Neolithic and Bronze Ages with special reference to the Aegean. Princeton University Press.
3. Aloevera and Banana Sap as Biomordant for Dyeing of Bamboo Fabric with Natural Dyes. (n.d.).

4. Barber, E. J. W. (1991). Prehistoric textiles: the development of cloth in the Neolithic and Bronze Ages with special reference to the Aegean. Princeton University Press.
5. Barhanpurkar, S., Bhat, P., Kumar, A., Purwar, R., & professor, A. (2015). Studies of Banana SAP used as mordant for natural dye. In
6. International Journal on Textile Engineering and Processes (Vol. 1).
7. Begum, N. (2023). A study of Natural Dyes and Dye Yielding Plants and its application on Textile in Ancient India. ~ 102 ~
8. International Journal of Home Science, 9(1), 102–114. https://www.homesciencejournal.com
9. Divya, R., & Jayakumari, M. (2017). Impact Factor: RJIF 5.22 www.nationaljournals.com Volume 2; Issue 3. In National Journal of Multidisciplinary Research and Development. www.nationaljournals.com
10. Jain, H., & Vasantha, M. (2016). Eco Friendly Dyeing with natural dye-Areca nut; enhancing colour fastness with natural mordants (Myrobalan, Lodhra and Pomegranate) and increasing the Antibacterial Activity. In Scholars Research Library Archives of Applied Science Research (Vol. 8, Issue 8). http://scholarsresearchlibrary.com/archive.html
11. Judia Harriet Sumathy, V. (2013). Extraction of Natural Dyes from Plants. Int. J. Chem. Pharm. Sci., International Journal of Chemistry and Pharmaceutical Sciences IJCPS, 1(8), 502–509. www.pharmaresearchlibrary.com/ijcps
12. Kumar Gupta, V. (n.d.). Fundamentals of Natural Dyes and Its Application on Textile Substrates. www.intechopen.com
13. Kumar Samanta, A. (n.d.). Bio-Dyes, Bio-Mordants and Bio-Finishes: Scientific Analysis for Their Application on Textiles. www.intechopen.com
14. Muthumanickam, A., Rao, K., Kumar, K., & Chetty, C. (2010). Medicinal importance of natural dyes-a review. In Article in International Journal of PharmTech Research (Vol. 2, Issue 1). https://www.researchgate.net/publication/265043367
15. Pooja Sanku Professor Jayashankar, L., Pooja Sanku, L., Padma, A., & Professor, R. (2020). Identifying the Viability Of Natural Dye Sources From India: A Review. In Article in International Journal of Current Research in Science Engineering & Technology. www.irjmets.com
16. Sarma, M. B., Borgohain Gogoi, S., Devi, D., & Goswami, B. (2012). Degumming of muga silk fabric by biosurfactant. In Journal of Scientific & Industrial Research (Vol. 71).
17. http://en.wikipedia.org/wiki/Critical_micelle_concentration
18. Sharma, A. (2017). Hazardous Effects of Petrochemical Industries: A Review. Recent Advances in Petrochemical Science, 3(2).
19. https://doi.org/10.19080/rapsci.2017.03.555607

20. Tiwari, A., & Srivastava, M. (2018). Cotton Khadi fabric dyeing with natural dye extracted from the petals of Butea monosperma Flower using different mordants. ASIAN JOURNAL OF HOME SCIENCE, 13(1), 187–194. https://doi.org/10.15740/has/ajhs/13.1/187-194

21. Verma, C. (2017). Printing of cotton and silk fabric with marigold flower dye and guar gum. ~ 511 ~ International Journal of Home Science, 3(2), 511–517. www.homesciencejournal.com