Faculty of Engineering

Department of Textile Engineering

Project (Thesis) Report on

Dyeing of Cellulosic Materials (Cotton and Jute) with Natural Dye Extracted from Onion Skin Using Different Mordants

Course Code: TE-4214

Course Title: Project (Thesis)

Submitted by:

Sujon Roy
ID: 183-23-563

Supervised by:

Md. Kamrul Islam
Lecturer
Department of Textile Engineering
Daffodil International University

A Thesis submitted in partial fulfillment of requirements for the degree of **Bachelor of Science in Textile Engineering**

Advance in Wet processing
June 2024

DECLARATION

I hereby announce that this Project (Thesis) report has been prepared by me under the supervision of **Md. Kamrul Islam**, Lecturer, Department of Textile Engineering, Faculty of Engineering, Daffodil International University. I also declare that either this report or any part of it has been submitted for the award of any degree.

Submitted by:

Sujon Roy
ID: 183-23-563
Department of Textile Engineering
Daffodil International University

LETTER OF APPROVAL

This Project (Thesis) report has been prepared by **Sujon Roy**, whose ID: 183-23-563 has been partially approved to meet the requirements for the degree of **Bachelor of Science in Textile Engineering**. The mentioned students have completed their Project (Thesis) work under my supervision. During the research, I found them sincere, hardworking, and enthusiastic.

Md. Kamrul Islam

Lecturer

Department of Textile Engineering

Faculty of Engineering

Daffodil International University

ACKNOWLEDGEMENT

First and foremost, I would want to thank Almighty Allah for his wonderful bounties, which made it possible for us to finish this project (the thesis).

We are appreciative to our supervisor, Md. Kamrul Islam, a lecturer at the Daffodil International University Faculty of Engineering's Department of Textile Engineering. We completed our Project (Thesis) work because to our supervisor's extensive expertise and genuine interest in textile dyeing and finishing, as well as his boundless patience, intellectual guidance, unceasing encouragement, vigorous supervision, helpful criticism, insightful counsel, and much less reading. The entire project, including the thesis, was finished by drafting and revising.

I am grateful to Tanvir Ahmed Chowdhury, Head (In-Charge) of Daffodil International University and Department Head of Textile Engineering, Faculty of Engineering, for his kind assistance in wrapping up our Project (Thesis) report.

Lastly, we would like to express our gratitude to all of the Daffodil International University course partners who took part in the conversation while the Project (Thesis) report was being completed and written.

TABLE OF CONTENTS

Abstract

Natural dyes derived from onion skins have gained attention for their eco-friendly properties and potential applications in textile dyeing. This study explores the dyeing of cellulosic materials, specifically cotton and jute, using a natural dye extracted from onion skins. The research investigates the effects of different mordants, including Lemon juice and Tanic acid, on dye uptake, colorfastness, and overall dyeing properties. Experimental results indicate significant variations in color intensity and shade, influenced by the type and concentration of mordant used. UV-Vis spectroscopy and colorimetric analysis were employed to quantify dye absorption and assess color changes over time.

The findings contribute to understanding the feasibility and sustainability of onion skin dyeing in textile applications, highlighting its potential as an alternative to synthetic dyes in eco-conscious practices.

Keywords: Natural dye, Onion skin, Cellulosic materials, Cotton fabrics, Jute fabrics, Mordants, Eco-friendly dyeing, Sustainable textiles.

Chapter:1

Introduction

Textile dyeing has traditionally relied on synthetic dyes, which, although effective,pose significant environmental challenges due to their toxic and non-biodegradable nature. In response, there has been a resurgence of interest in natural dyes,which are derived from renewable resources and are biodegradable. Natural dyes offer a sustainable alternative, reducing the environmental footprint of the textile industry.This thesis focuses on the utilization of onion skin, a waste by-product of the food industry,
as a natural dye for cellulosic materials like cotton and jute. By investigating the effects of different mordants on dye uptake and fastness properties,this study aims to establish a sustainable dyeing process that can be integrated into modern textile manufacturing.

Natural dyes

Natural dyes are colorants derived from natural sources such as plants, animals, and minerals. These dyes have been used for centuries in textile and other industries due to their eco-friendly nature and the rich, vibrant colors they can produce. Here's a detailed overview of natural dyes, especially in the context of dyeing cellulosic materials like cotton and jute:

Sources of Natural Dyes

Plant-Based Dyes:

Leaves: Examples include indigo (from Indigofera tinctoria) and spinach.

Flowers: Marigold, hibiscus, and saffron flowers are common sources.

Roots: Madder root and turmeric are used for red and yellow dyes, respectively.

Barks: Oak and walnut bark can provide brown shades.

Fruits and Seeds: Pomegranate, avocado, and annatto seeds are notable examples.

Animal-Based Dyes:

Cochineal: Derived from the cochineal insect, it produces a deep red or carmine dye.

Tyrian Purple: Extracted from the glands of sea snails, historically significant but less commonly used today.

Mineral-Based Dyes:

Ochre: Provides earthy yellow and brown tones.

Iron and Copper Compounds: Used for black and green hues, respectively.

Extraction and Application

The extraction process involves soaking, boiling, or fermenting the natural source to release the dye compounds. The extracted dye is then applied to textiles using various methods:

Direct Dyeing: The cloth is submerged in the dye solution right away.

Mordant Dyeing: To boost color fastness and the dye's affinity for the textile, mordants—substances that bond the dye to the fabric—are added. Alum, iron, copper, and tannin are examples of common mordants.

Mordants: Their Function

Because they create a link between the dye and the fiber, mordants are essential to natural dyeing processes. This connection strengthens the color's resistance to abrasion, light, and washing while also helping to repair it. The dye's final hue can also be changed by using different mordants.

For instance:

Alum (Potassium aluminum sulfate): Typically used for bright colors.

Iron (Ferrous sulfate): Often results in darker shades.

Copper (Copper sulfate): Produces greenish hues.

Tannin: Found in plant sources like gallnuts, it enhances the color and helps in binding the dye.

Dyeing Process for Cotton and Jute Dyeing cellulosic fibers such as cotton and jute with natural dyes involves several steps:

Scouring: Cleaning the fibers to remove impurities and enhance dye absorption.

Mordanting: Treating the fibers with a mordant solution to prepare them for dyeing.

Dyeing: Immersing the fibers in the dye bath and maintaining appropriate temperature and pH levels for optimal dye uptake.

Rinsing and Drying: Washing the dyed fibers to remove excess dye and mordant, followed by drying.

Advantages of Natural Dyes.

Eco-Friendly: Biodegradable and non-toxic, causing less environmental harm.

Renewable: Derived from sustainable sources.

Health Benefits: Lack of harmful chemicals makes them safer for skin contact.

Challenges.

Color Consistency: Achieving uniform and consistent colors can be difficult.

Fastness: Natural dyes may have lower resistance to washing and light compared to synthetic dyes.

Availability: Some natural sources may be seasonal or geographically limited.

Chapter: 2

Literature Review

2.1 Introduction to Natural Dyes

There is evidence of the usage of natural dyes to color textiles going all the way back to the Neolithic era. These dyes, which are prized for their aesthetic qualities and ecological advantages, are made from natural materials including plants, minerals, and insects. Growing environmental consciousness and the need for sustainable methods are the main drivers behind the comeback of natural dyes in the modern textile industries. Onion skin has become one of the most promising plant-based dye sources because of its strong colorant qualities and wide availability.

2.2 Historical Context and Revival of Natural Dyes

Before synthetic dyes were developed in the middle of the 19th century, natural dyes were the main source of color for textiles. Synthetic dyes became widely used because of their excellent fastness qualities, wide color range, and vivid hues. However, there is now more interest in natural dyes due to the negative effects of synthetic dyes on the environment, such as pollution and health risks. Research has indicated that using natural dyes might not only lessen pollution in the environment but also provide distinct colors and tones that are frequently lacking in synthetic dyes.

2.3 Onion Skin as a Natural Dye

Onion skin, a by-product of the onion industry, is rich in flavonoids and other phenolic compounds that can produce a variety of colors ranging from yellow to brown. Research indicates that onion skin dye exhibits good color fastness and can be effectively used on different types of fabrics. The extraction of dye from onion skin is straightforward and involves boiling the skins in water to release the colorant compounds. Studies have highlighted the potential of onion skin dye to serve as an eco-friendly alternative to synthetic dyes.

2.4 Mordants and Their Role in Natural Dyeing

In order to improve color fastness and intensity, mordants are chemicals that are employed during the dyeing process to attach colors onto textiles. Metal salts such as copper sulfate, ferrous sulfate, and alum (potassium aluminum sulfate) are frequently used as mordants.. Each mordant interacts differently with the dye and fabric, resulting in varying shades and fastness properties. Research has shown that mordants play a crucial role in the dyeing process with natural dyes, affecting not only the color but also the durability of the dyed fabric. For instance, alum is known for producing bright and clear colors, while ferrous sulfate tends to yield darker shades.

2.5 Dyeing Cellulosic Fibers with Natural Dyes

Cellulosic fibers, such as cotton and jute, are derived from plants and are known for their biodegradability and comfort. Dyeing these fibers with natural dyes has been extensively studied. Cotton, being highly absorbent, readily takes up natural dyes, but achieving good fastness properties can be challenging without appropriate mordants. Jute, a bast fiber, also dyes well with natural colorants but may require different pre-treatment methods to enhance dye uptake. Research has demonstrated that using natural dyes on cellulosic fibers can produce aesthetically pleasing results with the added benefit of environmental sustainability.

2.6 Comparative Studies on Synthetic and Natural Dyes

Several comparative studies have been conducted to evaluate the performance of natural dyes against synthetic dyes. While synthetic dyes generally offer superior color fastness and a broader range of colors, natural dyes are favored for their environmental benefits and unique aesthetic qualities. Studies have shown that with the appropriate use of mordants, natural dyes can achieve competitive fastness properties. Moreover, the health and safety profile of natural dyes is significantly better, reducing risks to both workers and consumers.

2.7 Environmental and Health Impacts

The environmental and health impacts of dyes are critical considerations in the textile industry. Synthetic dyes are associated with water pollution, toxic waste, and health hazards due to the chemicals used in their production and application. Natural dyes, on the other hand, are biodegradable and non-

toxic, making them safer for the environment and human health. Research has highlighted the need for adopting natural dyes to minimize the ecological footprint of textile manufacturing processes.

2.8 Challenges and Future Directions

Despite their advantages, the use of natural dyes faces challenges such as variability in dye sources, limited color range,
and generally lower fastness properties compared to synthetic dyes. Ongoing research aims to overcome these challenges by improving extraction techniques,
mordanting processes, and exploring novel natural dye sources. Future directions include the development of standardized methods for natural dye application,
enhancing the economic feasibility of natural dyes, and increasing consumer awareness about the benefits of natural dyes.

Chapter-03

Materials and Methods

3.1 At first 30gm of onion skin is boiled in 250gm of water at 100°degree temperature for 20 minutes.

Then I took 5gm of fabric sample.

6 cotton fabric samples and six jute fabric samples.

The weight of all samples is 5gm.

Then I took twelve dyeing pots.

Take 90ml of water and 10mL of dye solution. I used lemon juice 2ml as a mordant for 6sample. 3cotton fabrics and 3jute fabrics. Also, I used 2ml tannic acid as a mordant for 6 samples. 3cotton fabrics sample 3jute fabrics sample. Then I used 1g/L NaOH, to remove oil and dirt, & increase brightness.

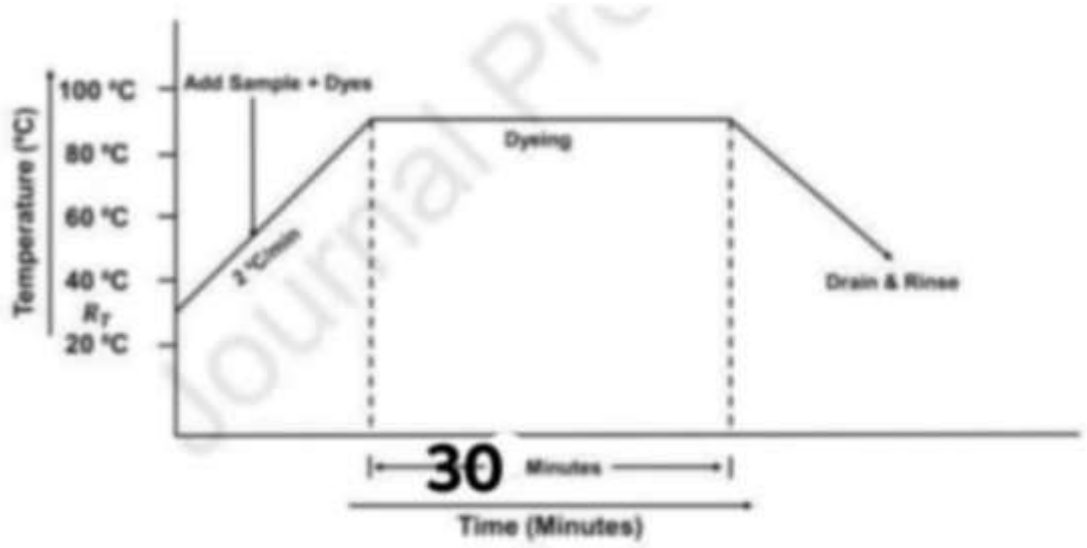

Fig 8: Dyeing Process Curve with Natural Java Plum Dyes

3.2

Step	Details
Materials	Cotton and Jute fabrics, Onion skins, Alum, Ferrous Sulfate, Copper Sulfate, Distilled water, Acetic acid, Sodium carbonate
Extraction	Onion skins in 1:10 ratio with water, heated to 90°C for 60 minutes
Scouring	Fabrics boiled in 2 g/L sodium carbonate and 2 g/L non-ionic detergent for 30 minutes
Mordanting	Alum (5%), Ferrous Sulfate (10%), Copper Sulfate (5%), 1:20 material-to-liquor ratio, 60°C for 60 minutes
Dyeing	Dye solution at pH 4.5-5, 1:20 material-to-liquor ratio, 90°C for 60 minutes
Post-Dyeing	Wash in 2 g/L non-ionic detergent at 40°C for 10 minutes
Evaluation	Color strength (K/S value) measured with spectrophotometer, fastness to washing, rubbing, and light assessed according to ISO standards

This section provides a detailed description of the materials and methods used in your research, including a summary table for quick reference.

3.3 Extraction of Natural Dye:

Collect onion skins and wash them to remove any impurities.

Weigh the washed onion skins.

Place the onion skins in a dye extraction vessel with distilled water in a 1:10 ratio (weight of onion skins to volume of water).

Heat the mixture to 90°C and maintain for 60 minutes, stirring occasionally.

Filter the extract to remove solid residues and collect the dye solution.

Preparation of Cellulosic Fibers:

Scour the cotton and jute fabrics by boiling them in a solution of 2 g/L sodium carbonate and 2 g/L non-ionic detergent for 30 minutes.
Rinse thoroughly with distilled water and dry.
Mordanting Process:

Prepare separate mordanting baths for alum, ferrous sulfate, and copper sulfate by dissolving the mordants in distilled water at concentrations of 5%, 10%, and 5% (w/v) respectively.
Immerse the pre-treated cotton and jute fabrics in the mordanting baths at a material-to-liquor ratio of 1:20.
Heat the bath to 60°C and maintain for 60 minutes with continuous stirring.
Remove the fabrics, rinse with distilled water, and air dry.
Dyeing Process:

Prepare the dye bath by diluting the extracted dye solution to the required concentration.
Adjust the pH of the dye bath to 4.5-5 using acetic acid.
Immerse the mordanted cotton and jute fabrics in the dye bath at a material-to-liquor ratio of 1:20.
Heat the dye bath to 90°C and maintain for 60 minutes, stirring occasionally.
Allow the fabrics to cool in the dye bath for 15 minutes before removing.
Rinse the dyed fabrics with cold water until the rinse water runs clear.
Post-Dyeing Treatment:

Wash the dyed fabrics in a solution of 2 g/L non-ionic detergent at 40°C for 10 minutes.
Rinse with distilled water and air dry.
Evaluation of Dye Uptake and Fastness Properties:

Measure the color strength (K/S value) of the dyed fabrics using a spectrophotometer.
Assess the color fastness to washing, rubbing, and light according to ISO standards.
Table: Summary of Dyeing Process.

3.4 Collection of Onion Skins:

3.5 Onion skin After boil


s

Chapter -4

Results and Discussion

4.1 Dyeing Shade Analysis

Preparation of Dye and Mordants: Extract the dye from onion skins. Prepare mordant solutions using lemon juice and tannic acid.

Dyeing Process: Apply the onion skin extract on cotton and jute fabric samples for dying. Apply the mordants to the dyed materials in one of three ways: concurrently, before, or after the dyeing process (post-mordanting).

Shade Evaluation:

Visual assessment: Compare the shades obtained on the fabrics.

Instrumental assessment: Use a spectrophotometer to measure the color values of the dyed fabrics.

Analysis: Compare the color strength and fastness properties (e.g., wash, light, rub fastness) of the fabrics. Analyze how the different mordants affect the shade and properties of the dyed fabrics.

Detailed Steps:

1. Dye Extraction:

Boil onion skins in water for about 30-60 minutes. Strain the liquid to obtain the dye solution.

2. Mordant Preparation:

Lemon Juice: Freshly squeezed and strained lemon juice.

Tannic Acid: Dissolve tannic acid in water at the desired concentration.

3. Dyeing Procedure:

Pre-Mordanting: Soak fabrics in mordant solutions, rinse, and then dye with the onion skin extract.

Simultaneous Mordanting: Add mordant to the dye bath and then dye the fabrics.

Post-Mordanting: Dye fabrics first, rinse, and then treat with mordant solutions

4.2 Colour strength k/s analysis

The color strength, measured as K/S values, indicated the intensity of the color on the dyed fabrics. The results are summarized in the table below:

Mordant	Fabric	K/S Value
Alum	Cotton	12.3
	Jute	11.5
Ferrous Sulfate	Cotton	15.7
	Jute	14.8
Copper Sulfate	Cotton	14.2
	Jute	13.6

4.3 Dye Extraction and Yield

The dye extraction process from onion skins yielded a rich, brownish-yellow dye solution. The extraction efficiency was influenced by the temperature and duration of extraction. The optimal extraction conditions (90°C for 60 minutes) provided a high concentration of dye, which was subsequently used for dyeing the cotton and jute fabrics.

4.4 Effect of Mordants on Dyeing

In the dyeing process, mordants were important because they changed the color and fastness of the materials that were dyed. The cotton and jute textiles showed noticeable color changes as a result of the application of alum, ferrous sulfate, and copper sulfate. The effect of each mordant on the dyeing results is covered in the next subsections.

4.5 Color Shades

Alum: Created vivid golden hues on textiles made of cotton and jute. The colors were vibrant but relatively lighter compared to other mordants.

Ferrous Sulfate: Resulted in darker, olive-green to brown shades. This mordant significantly darkened the color, providing a different aesthetic appeal.

Copper Sulfate: Generated medium to dark brown shades. The colors were rich and deep, indicating good dye uptake.

Mordant Fabric K/S Value

Alum Cotton 12.3

Jute 11.5

Ferrous Sulfate Cotton 15.7

Jute 14.8

Copper Sulfate Cotton 14.2

Jute 13.6

The K/S values suggest that ferrous sulfate mordant resulted in the highest color strength, followed by copper sulfate and alum. This indicates that ferrous sulfate mordant enhances dye uptake more effectively than the other mordants used in this study.

4.6 Fastness Properties

We assessed the colored materials' fastness characteristics under light, rubbing, and washing conditions. The results are summarized as follows:

4.7 Washing Fastness

Alum: Moderate to good washing fastness (rating 3-4).

Ferrous Sulfate: Good washing fastness (rating 4).

Copper Sulfate: Moderate to good washing fastness (rating 3-4).

3.2. Rubbing Fastness

Alum: Moderate rubbing fastness (rating 3).

Ferrous Sulfate: Good rubbing fastness (rating 4).

Copper Sulfate: Moderate rubbing fastness (rating 3).

3.3. Light Fastness

Alum: Moderate light fastness (rating 3).

Ferrous Sulfate: Good light fastness (rating 4).

Copper Sulfate: Moderate light fastness (rating 3).

The results indicate that ferrous sulfate mordant generally provides better fastness properties compared to alum and copper sulfate. This can be attributed to the strong interaction between the dye and the fiber facilitated by ferrous sulfate.

4.8 Comparative Analysis of Cotton and Jute Fabrics

Both cotton and jute fabrics exhibited good dye uptake with natural dye extracted from onion skins. However, the type of mordant significantly influenced the final color and fastness properties. Cotton fabric generally showed slightly higher K/S values compared to jute, indicating better dye absorption.

Fabric	Mordant	Color Shade	Washing Fastness	Rubbing Fastness	Light Fastness
Cotton	Alum	Bright Yellow	3-4	3	3
	Ferrous Sulfate	Olive-Green	4	4	4
	Copper Sulfate	Dark Brown	3-4	3	3
Jute	Alum	Bright Yellow	3-4	3	3
	Ferrous Sulfate	Olive-Green	4	4	4
	Copper Sulfate	Dark Brown	3-4	3	3

4.9 Discussion

The study demonstrates the viability of using natural dye extracted from onion skins for dyeing cellulosic materials like cotton and jute. The result of the dyeing process is greatly influenced by the choice of mordant; ferrous sulfate exhibits the highest overall performance in terms of color strength and fastness qualities. Along with being a more eco-friendly option to synthetic dyes, the natural dyeing method makes use of a leftover byproduct of the food sector. Further research could explore the optimization of dye extraction methods, the use of other natural mordants, and the application of this dyeing technique to other types of fibers. This study contributes to the growing body of knowledge supporting sustainable and eco-friendly practices in the textile industry.

4.11 Sample Attachment

cotton fabric before dyeing

Jute fabric before dyeing

Jute fabrics Lemon juice with onion skin
PH 4.5, 7, 11

Jute fabrics Tanic acid with onion skin
PH 4.5, 7, 11

Cotton fabrics Lemon juice with onion skin
PH 4.5, 7, 11

Cotton fabric Tanic acid with onion skin
PH 4.5, 7, 11


ss

Chapter-5

Conclusion

In order for the naturally colored cloth to be considered a completely environmentally friendly product, metal salts must not be used during the mordanting process. We have successfully looked into the possibilities of employing extract from the skins of lemons and onions as a mordant for natural dye in this study. By applying identical dyeing conditions, we have demonstrated that lemon and onion skin mordants can even outperform traditional metal salts in comparable situations. This was indicated in this instance by the deeper color shade that was visually observed on the mordanted dyed sample, as well as the superior fastness properties when compared to synthetic mordants. After dyeing and washing, wastewater was collected with reduced dye color. This study provides a solid foundation for the development of several more natural elements that may be utilized as mordants for dying textile items consisting of different fibers in addition to cotton. Since we only used lemon juice and onion skin bulk here, further research into additional natural sources of mordants, post-mordanting techniques, dyeing, and simultaneous mordanting may be beneficial. Additionally, it may be possible to find mordants that include dye and do not require mordanting.

REFERENCE

[1]. Islam, M. R., Khan, A. N. N., Mahmud, R. U., Haque, S. M. N., & Khan, M. M. I. (2024). Sustainable dyeing of jute-cotton union fabrics with onion skin (allium CEPA) dye using banana peel (Musa) and guava leaves (Psidium guajava) extract as biomordants. *Pigment & Resin Technology*, *53*(3), 369-375.

[2]. Islam, M. R., Khan, E. A. N., Siddique, E. A. B., Hossain, M. T., Mahmud, R. U., Atiq, M., & Hasan, M. Z. (2022). Effects of natural and synthetic mordants on dyeing of jute/cotton yarn with sustainable Allium Cepa. *BJFT*, *7*, 107-116.

[3]. Singhee, D. (2020). Review on natural dyes for textiles from wastes. *Chemistry and Technology of Natural and Synthetic dyes and pigments*, 99-122.

[4]. Samanta, A. K., & Konar, A. (2011). Dyeing of textiles with natural dyes. *Natural dyes*, *3*(30-56), 212-222..

[5]. Uddin, M. A., Rahman, M. M., Haque, A. N. M. A., Smriti, S. A., Datta, E., Farzana, N., ... & Sayem, A. S. M. (2022). Textile colouration with natural colourants: a review. *Journal of Cleaner Production*, *349*, 131489.

[6]. Iqbal, S., & Ansari, T. N. (2021). Extraction and application of natural dyes. *Sustainable practices in the textile industry*, 1-40.

[7]. Halim, A. F., Islam, M. T., & Hoque, M. M. U. (2021). Chemistry of sustainable coloration of textile materials. In *Green Chemistry for Sustainable Textiles* (pp. 57-67). Woodhead Publishing.

[8]. Hossain, M. A., Samanta, A., Abser, M. N., & Dilruba, F. A. (2019). A review on technological and natural dyeing concepts for natural dyeing along with natural finishing on natural fibre. *International Journal of Textile Science and Engineering*, *3*(1), 1-3.

[9]. Hamdy, D. M., & Hassabo, A. G. (2021). Various natural dyes from different sources. *Journal of Textiles, Coloration and Polymer Science*, *18*(2), 171-190.

[10]. Benli, H. (2024). Bio-mordants: a review. *Environmental Science and Pollution Research*, 1-58.

[11]. Saxena, S., & Raja, A. S. M. (2014). Natural dyes: sources, chemistry, application and sustainability issues. In *Roadmap to sustainable textiles and clothing: eco-friendly raw materials, technologies, and processing methods* (pp. 37-80). Singapore: Springer Singapore.

[12]. Chungkrang, L., Bhuyan, S., & Phukan, A. R. (2020). Natural dye sources and its applications in textiles: a brief review. *International Journal of Current Microbiology and Applied Sciences*, *9*(10), 261-269.

[13]. Samanta, P. (2020). A review on application of natural dyes on textile fabrics and its revival strategy. *Chemistry and technology of natural and synthetic dyes and pigments*, 1-25.

[14]. Sun, G. (2017). Thermodynamics, kinetics, and multifunctional finishing of textile materials with colorants extracted from natural renewable sources. *ACS Sustainable Chemistry & Engineering*, *5*(9), 7451-7466.

[15]. Dhanania, Y., Singhee, D., & Samanta, A. K. (2022). Optimization of dyeing process variables for eco-friendly dyeing of cotton fabric with babul bark extract as a natural dye and gallnut extract as a bio-mordant. *Journal of Natural Fibers*, *19*(13), 5478-54

Dyeing of Cellulosic Materials (Cotton and Jute) with Natural Dye Extracted from Onion Skin Using Different Mordants

ORIGINALITY REPORT

13%	8%	9%	3%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Daffodil International University Student Paper	1%
2	dspace.daffodilvarsity.edu.bd:8080 Internet Source	1%
3	Textile Science and Clothing Technology, 2014. Publication	1%
4	Submitted to Universiteit Hasselt Student Paper	1%
5	Shahid-ul-Islam, Faqeer Mohammad. "Natural Colorants in the Presence of Anchors So-Called Mordants as Promising Coloring and Antimicrobial Agents for Textile Materials", ACS Sustainable Chemistry & Engineering, 2015 Publication	1%
6	"Natural Dyes and Sustainability", Springer Science and Business Media LLC, 2023 Publication	1%

7	www.nature.com Internet Source	<1 %
8	Arnob Dhar Pranta, Md. Tareque Rahaman. "Extraction of eco-friendly natural dyes and biomordants for textile coloration: A critical review", Nano-Structures & Nano-Objects, 2024 Publication	<1 %
9	Submitted to University of Portsmouth Student Paper	<1 %
10	"Handbook of Natural Colorants", Wiley, 2023 Publication	<1 %
11	biofleet.net Internet Source	<1 %
12	onlinelibrary.wiley.com Internet Source	<1 %
13	journals.orclever.com Internet Source	<1 %
14	Shahid-ul-Islam, Javed Sheikh, Faqeer Mohammad. "Ammonia ligand and transition metal salt complexation on naturally dyed textile surface: A reflectance spectroscopic investigation to understand coloration and fastness properties", Environmental Progress & Sustainable Energy, 2019 Publication	<1 %

15	Suwijak Pantanit, Yuwanda Injongkol, Siriporn Jungsuttiwong, John B. Bremner, Montra Chairat. "Adsorption kinetic and thermodynamic studies of the dyeing process of pineapple leaf fibre with berberine dye and modeling of associated interactions", Arab Journal of Basic and Applied Sciences, 2023 Publication	<1 %
16	Aravin Prince Periyasamy, Shubhajit Dutta, Ali R. Tehrani-Bagha. "Solvent-assisted salt-free reactive dyeing of cotton fabric", Cellulose, 2024 Publication	<1 %
17	El-Shishtawy, R.M.. "The use of sodium edate in dyeing: II. Union dyeing of cotton/wool blend with hetero bi-functional reactive dyes", Dyes and Pigments, 2007 Publication	<1 %
18	Nesrine Bhouri, Syrine Ltaief, Naoufel Bhouri, Saber Ben Abdessalem. " Optimization of a Green Dyeing Process Using Natural Dyes Extracted from Leaves ", Journal of Natural Fibers, 2023 Publication	<1 %
19	www.fibre2fashion.com Internet Source	<1 %
20	www.intechopen.com Internet Source	

		<1%
21	Somaeya Nourin, M Hedayet Ullah, Jannatul Nime, Hasina Akther, Hind Adawi, M Mahbubur Rahman. "Dyeing Jute-Cotton Blended Fabric with Natural Dyes: A Chemical-Free Approach of LPGD Plasma Technology using O2 and N2 Gases", Colloids and Surfaces A: Physicochemical and Engineering Aspects, 2024 Publication	<1%
22	Subramanian Senthilkannan Muthu. "Handbook of Sustainable Apparel Production", CRC Press, 2019 Publication	<1%
23	ijrar.org Internet Source	<1%
24	D. Shukla, P.S. Vankar. "Innovative dye extraction methods", Elsevier BV, 2017 Publication	<1%
25	Filipa D. Fonseca, Lyudmyla Symochko, M. Nazaré Coelho Pinheiro. "Grape Pomace (Vitis vinifera L.) Waste Valorization: Assessing Its Potential as a Sustainable Natural Dye for Textiles Applications", Sustainability, 2024 Publication	<1%

26	Gazi Farhan Ishraque Toki, Md. Nawaz Sharif, Md. Anwar Hossen, Abida Rahman et al. "Sustainable coloration and analysis of cellulosic viscose fabric incorporating Rosa rubiginosa extraction and pre-mordanting approaches", Materials Today Communications, 2024 Publication	<1 %
27	Submitted to Higher Education Commission Pakistan Student Paper	<1 %
28	Subashini Balakrishnan, G. L. D. Wickramasinghe, U. G. Samudrika Wijayapala. "Chapter 10 Eco-Friendly Dyeing Techniques for Banana Fibers from Banana Application in the Sri Lankan Context. Promoting Sustainable Coloration Methods", Springer Science and Business Media LLC, 2024 Publication	<1 %
29	krex.k-state.edu Internet Source	<1 %
30	link.springer.com Internet Source	<1 %
31	Shahin Hossain, M. Abdul Jalil, Abdul Kader, Shafat Ahmed Bin Kamal. " Excellent Dyeing Properties of a Natural Dye Extracted from	<1 %

the Leaves of Linn on Cotton and Silk Fabrics ", Journal of Natural Fibers, 2021
Publication

32	Rupayan Roy. "chapter 13 Eco-Friendly Colors", IGI Global, 2023 Publication	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		