

Dyeing of Cotton Fabrics with Natural Dye Obtained from Jackfruit Tree Bark

Soe Win*

Abstract

Natural dye materials are traditionally used to dye textile in Myanmar. Natural dye can be extracted from various parts of plants such as flowers, leaves, fruits and barks. In this research, Jackfruit Tree (Pein-ne) bark was used for the preparation of natural dyes. Dyes were extracted from plant barks using water and then the color produced on cotton fabrics dyed with various dyeing methods and mordants, and also the fastness properties of the dyed cotton fabrics were studied.

An attempt was also made on the dyeing of cotton fabrics with natural dyes using different mordants such as alum, slaked lime and copper (II) sulphate. Among these mordants, copper (II) sulphate demonstrated relatively more attractive colors and acceptable fastness on cotton fabric in all dyeing methods as indicated. Moreover, fastness tests especially for light, rubbing and washing on dyed cotton fabrics were carried out. Staining and changing in color were assessed by using standard grey scale and the results were recorded.

Key word: natural dye, mordant, cotton fabric, dyeing, fastness properties

Introduction

A dye can generally be described as a colored substance that has an affinity to the substrate to which it is being applied. It is usually used as an aqueous solution, and may require a mordant to improve the fastness of the dye on the fiber. The use of dyes to color textiles is generally considered to be about 2000 years old. Primitive men made the dyes from flowers, nuts, berries and other forms of vegetable and plant life, as well as from mineral and animal sources. These sources have provided such "natural dyes" throughout civilization. They are still used in oriental countries to a certain extent for rug dyeing and in many parts of the world for native handicraft,

All natural substances contain some amount of pigment, but effective dyes can only be made from a limited range of materials because natural dye pigments must be a stable chemical structure so that they can withstand such conditions as exposure to sunlight, laundering, wear, and tear. Natural dyes are pleasing to the eye and soothing to the mind because natural dyes use pigments derived from nature. Moreover, these environment-friendly dyes can help to reduce pollution and promote good health. Consequently, enterprises all over the world are now developing environment-sensitive products that incorporate natural dyes. Nowadays, with growing recognition of the seriousness of water pollution worldwide, natural dyes made from organic ingredients are enjoying a dramatic revival (Clark,1997).

Fabrics dyed with natural dyes can also provide medicinal effects. Because most natural dyes are closely related to traditional herbal medicines, they are well suited for fabrics that come into direct contact with the skin, like underwear, children's clothing, bedding, and diapers.

* Demonstrator,Dr., Industrial Chemistry Department, Yadanabon University

Nowadays, there has been increasing interest in natural dyes, as the public becomes aware of ecological and environmental problems related to the use of synthetic dyes. Uses of natural dyes cut down significantly the amount of toxic effluent resulting from the synthetic dye process. Sometimes they act as health cure because they have the antibacterial, insecticidal and healthy properties which are due to the origin of them-extracted from herb plants. So, the uses of natural dyes in textile dyeing process are very welcoming and the clothes dyed with natural dye produce attractive colors (Birren, 1955).

This research concerned with the extraction of natural dye from the bark of jackfruit tree and application on cotton fabrics. The effect of dyeing on cotton material promotes to small and medium enterprises in textile.

The aim of the present study is to study the color produced on cotton fabrics with various dyeing methods and to study the fastness properties of dyed cotton fabrics.

Materials and Methods

Materials

In this study, the bark of Jackfruit tree (*Artocarpus Heterophylls*. Lam) (Yangon Region), was used as raw materials for the extraction of natural dye. Cotton fabrics were purchased from Win Thuzar Shop, Ministry of Industry and mordants such as alum, slaked lime and copper (II) sulphate (commercial grade) were purchased from local market (Academy Chemical Market).

Extraction of Natural Dye from Jackfruit Tree Bark

The dye was extracted from the stem bark powders by using water as aqueous medium. Powder of dried bark (3g, 5g, 7g) were weighed and placed in the stainless steel pot. Then (90ml, 150ml, 210ml) of water was added. (solid to liquid ratio of 1:30). The stainless steel pot was heated slowly to boiling point at which it was simmered for 45 minutes. Then the extracted solution was allowed to cool and filter. After that, the bark powders on the filter were squeezed out and removed. The extraction process was carried out at the Development Center for Textile Technology in Ministry of Industry.

Mordanting the Cotton Fabrics

In this research, alum, slaked lime and copper (II) sulphate were used as mordant. Before dyeing the cotton fabrics with natural dye, the bleached cotton fabrics were soaked in water for one hour.

Dyeing the Cotton Fabrics

Dye powder (3g, 5g, 7g) was placed in a beaker and dissolved in a little amount of warm water. Warm water (38°C) was added to a material to liquid ratio of 1:30. The solution was heated to a temperature of 80°C. Then, cotton fabric to be dyed was added into this solution and frequently stirred to obtain good penetration of dye molecules into the fabric. Dyeing process was done at 80°C for about 30 minutes.

After dyeing, the dyed fabrics were lifted out and squeezed by hand. They were rinsed with warm water and then rinsed in cold water to remove the unfixed dyes. Finally, the fabrics were dried at room temperature and ironed.

In this research, pre-mordanting method, post-mordanting method and simultaneous mordanting and dyeing method were used. In pre-mordanting method, mordanting process was done before dyeing operation. In post-mordanting method, mordanting process was done after dyeing operation. In simultaneous mordanting and dyeing method, mordant, dye and fabric were added in a pot and treated together.

Testing the Color Fastness of Dyed Fabrics

After dyeing, color fastness on dyed fabrics were tested to determine the fastness properties. In the dyeing of textile substrates, the following fastness tests were used. There were fastness to sea water, fastness to perspiration, fastness to gas fume, storage, rubbing, light and washing. In this study, light fastness, washing and rubbing fastness tests were carried out to determine the color fastness on dyed fabric.

To evaluate the color fastness of the dyed fabric, the changes of color due to the conditions of test were compared with the color of original fabric. And then the color transfer and staining on cotton and polyester/ cotton blend fabrics were determined by using Grey Scales (Harwood and Bramhall,1987).

Results and Discussion

Jackfruit tree dye show the good dry rubbing fastness and light fastness in all cotton fabrics dyed by all of the mordants used. However, good wet rubbing fastness were found in cotton fabric dyed by slaked lime mordant in pre-mordanting method. In post-mordanting and simultaneous mordanting method, the wet rubbing fastness were the same. But the change of shade in washing fastness test, the copper (II) sulphate mordant gave comparatively better fastness than the other mordants used. Color fastness results of dyed cotton fabrics for each group of mordant were shown in Table (1) to Table (3) and color development of cotton dyed with jackfruit tree bark were shown in Figure (1), (2) and (3).

From these results, copper (II) sulphate mordant demonstrated relatively more attractive colors and acceptable fastness on cotton fabric in all dyeing methods because it is a versatile chemical with an extensive range of used in industry.

Table 1. Effect of Mordant on Changes in Color Fastness of Cotton Fabrics Dyed with Jackfruit Tree Bark Using Pre-mordanting Method

Sr. No	Types of Mordant	Sample Code	**Rubbing Fastness		**Washing Fastness			**Light Fastness
			Dry	Wet	Change of Shade	Staining on		
						cotton	p/c	
1.	Alum	D ₁₁	4	3 - 4	1	4 - 5	4 - 5	4
		D ₁₂	4	3 - 4	2	4 - 5	4 - 5	4
		D ₁₃	4	4	1	4 - 5	4 - 5	4
2.	Slaked lime	E ₁₁	4	4	1	4 - 5	4 - 5	4
		E ₁₂	4	4	1	4 - 5	4 - 5	4
		E ₁₃	4	4	1	4 - 5	4 - 5	4
*3.	Copper (II) sulphate	F ₁₁	4	3 - 4	2	4 - 5	4 - 5	4
		F ₁₂	4	3	2	4 - 5	4 - 5	4
		F ₁₃	4	3 - 4	2	4 - 5	4 - 5	4

Table 2. Effect of Mordant on Changes in Color Fastness of Cotton Fabrics Dyed with Jackfruit Tree Bark Using Post-mordanting Method

Sr. No	Types of Mordant	Sample Code	**Rubbing Fastness		**Washing Fastness			**Light Fastness
			Dry	Wet	Change of Shade	Staining on		
						cotton	p/c	
1.	Alum	D ₂₁	4	3 - 4	1	4 - 5	4 - 5	4
		D ₂₂	4	3 - 4	2	4 - 5	4 - 5	4
		D ₂₃	4	3	1	4 - 5	4 - 5	4
2.	Slaked lime	E ₂₁	4	3 - 4	1	4 - 5	4 - 5	4
		E ₂₂	4	4	2	4 - 5	4 - 5	4
		E ₂₃	4	3	1	4 - 5	4 - 5	4
*3.	Copper (II) sulphate	F ₂₁	4	3 - 4	2	4 - 5	4 - 5	4
		F ₂₂	4	3 - 4	2	4 - 5	4 - 5	4
		F ₂₃	4	3	2	4 - 5	4 - 5	4

Table 3. Effect of Mordant on Changes in Color Fastness of Cotton Fabrics Dyed with Jackfruit Tree Bark Using Simultaneous-mordanting Method

Sr. No	Types of Mordant	Sample Code	**Rubbing Fastness		**Washing Fastness			**Light Fastness
			Dry	Wet	Change of Shade	Staining on		
						cotton	p/c	
1.	Alum	D ₃₁	4	3 - 4	1	4 -5	4 -5	4
		D ₃₂	4	3 - 4	2	4 -5	4 -5	4
		D ₃₃	4	3	1	4 -5	4 -5	4
2.	Slaked lime	E ₃₁	4	3 - 4	1	4 -5	4 -5	4
		E ₃₂	4	4	1	4 -5	4 -5	4
		E ₃₃	4	3 - 4	1	4 -5	4 -5	4
*3.	Copper (II) sulphate	F ₃₁	4	3	2	4 -5	4 -5	4
		F ₃₂	4	3	2	4 -5	4 -5	4
		F ₃₃	4	3	2	4 -5	4 -5	4

These experiments of Table (1), (2) and (3) were conducted at Development Centre for Textile Technology in Ministry of Industry, Yangon Region.

**Note : p/c = polyester + cotton , 1 = very poor, 2 = poor, 3 = fair, 4 = good and 5 = excellent,

* = the most suitable condition

Method of Dyeing	Sample Code	3% Dye Solution	Sample Code	5% Dye Solution	Sample Code	7% Dye Solution
Pre-mordanting Method	D ₁₁		D ₁₂		D ₁₃	
Post-mordanting Method	D ₂₁		D ₂₂		D ₂₃	
Simultaneous-mordanting Method	D ₃₁		D ₃₂		D ₃₃	

Figure 1. Color Development of Cotton Dyed with Jackfruit Tree Using Alum Mordant

Method of Dyeing	Sample Code	3% Dye Solution	Sample Code	5% Dye Solution	Sample Code	7% Dye Solution
Pre-mordanting Method	E ₁₁		E ₁₂		E ₁₃	
Post-mordanting Method	E ₂₁		E ₂₂		E ₂₃	
Simultaneous-mordanting Method	E ₃₁		E ₃₂		E ₃₃	

Figure 2. Color Development of Cotton Dyed with Jackfruit Tree Using Slaked Lime Mordant

Method of Dyeing	Sample Code	3% Dye Solution	Sample Code	5% Dye Solution	Sample Code	7% Dye Solution
Pre-mordanting Method	F ₁₁		F ₁₂		F ₁₃	
Post-mordanting Method	F ₂₁		F ₂₂		F ₂₃	
Simultaneous - mordanting Method	F ₃₁		F ₃₂		F ₃₃	

Figure 3. Color Development of Cotton Dyed with Jackfruit Tree Using Copper (II) Sulphate Mordant

Conclusion

In the application of natural dye on cotton fabric, mordanting with copper (II) sulphate in all dyeing methods can produce attractive colors and acceptable fastness on cotton fabric.

The rubbing and light fastness of dyed fabric by jackfruit tree dye were good and washing fastness of fabrics using copper (II) sulphate mordant was also good.

Natural dye extracted from stem bark of jackfruit tree was a type of adjective dye or mordant dye because they have no direct affinity for unmordanted material and they have to be applied by the use of a mordant. It can also be concluded that cotton fabrics dyed by using simultaneous mordanting and dyeing method was the best for color fastness and cost effectiveness.

Acknowledgements

I am grateful to Professor Dr. Khin Maung Oo, Rector, Professor Dr. Si Si Hla Bu and Professor Dr. Maung Maung Naing, Pro-Rectors, Yadanabon University and Dr. Yi Yi Myint, Professor and Head of Department of Industrial Chemistry, Yadanabon University, for their permission to submit this article. I would like to express my gratitude to supervisor Dr. Khin Thet Ni, Professor and Head of Department of Industrial Chemistry, University of Yangon, for her close supervision, invaluable suggestions, advice, constant guidance during this research.

References

- Abrahart, E.N. 1962, Dyes and Their Intermediate. New York: Chemical Publishing.
- Billmeyer, F.W., and Saltzman, M .1966, Principal of Color Technology. New York: Interscience Publishers, John Wiley and Sons, Inc.
- Birren, F. 1955, New Horizons in Color. New York: Reinhold Publishing Corporation, Printed in USA.
- Clark, G.L. 1973, The Encyclopedia of Chemistry. 2nd Edition, New York :Van Nostrand Reinhold Company.
- Dasture, J.F. 1962, “Medical Plants of India and Pakiston”, D.B. Taraporevila Sons and Co private Ltd., Dr. D.Naoroji Road Bombay.
- Grae, Ida, 1974, Natures Colors, 1st Printing Collier-Macnillan Canada Ltd., Printed in the United States of America.
- Gulajani, M.L. 1992, Introduction to Natural dyes, Indian Institute of Technology, New Delhi.
- Gulrajani, M.L., 1992, Present Status of Natural Dyes, Indian Institute of Technolgoy, New Delhi.
- Hall, A.J. 1965, The Standard Handbook of Textiles, The English Language Book Society and Heywood Books, London.
- Harwood, R.J., and Bramhall, A.T.1987, Dyeing and Printing of Cotton and Polyester/Cotton Fabrics. Volume I , Scottish College of Textiles.