Assessment of Dyeing Properties of Natural Dye Extracted from the Fruit of Myrobalan (Phan-Kha)

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Abstract

In this study, natural colorant extracted from the fruit of Myrobalan (Phan-kha) was applied on cotton fabric using alum, copper sulphate and potassium dichromate as mordant. The effects of mordant, dyeing time and dyeing temperature on the color strength of dyed cotton fabrics were measured. The fastness properties of dyed cotton fabrics such as washing fastness, rubbing fastness and light fastness were also evaluated. It was found that using the metal mordants increased the color strength of the dyed cotton fabrics. It was shown that all mordants increased in rubbing fastness and washing fastness of dyed cotton fabrics, but the light fastness increased in the used of copper sulphate and potassium dichromate mordants.

Keywords: Natural dye, Myrobalan, Mordant, Cotton fabric

Introduction

Natural dyes have a wide range of shades that can be obtained from various parts of plants, including roots, barks, leaves, flowers and fruits. Natural dyeing has been used by human for purposes varying from coloration of food, cosmetics and textiles to impart other function to them. Nowadays, in the use of natural dyes in textile industries has been developed (Abrahart, 1962).

Natural dyes are generally more eco-friendly than synthetic dyes. Synthetic dyeing methods causes pollution and most of diazo dyes are carcinogenic. The use of non-allergic, non-toxic and eco-friendly natural dyes on textile dyeing become a significant importance due to the increasing environmental problem. They are also used in order to avoid some hazardous chemical dyes (Indian Journal of Fiber & Textile Research, 2009).

The aims of this research were:

- to extract natural dye from myrobalan fruit
- to study the color fastness on cotton fabrics by using various dyeing methods and mordants
- to test the fastness of dyed cotton fabric by washing, rubbing and exposure to light
- to reduce the ecological and environmental problems due to the synthetic dyes
- to substitute the imported dyes

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Materials and Methods

Materials

In this study, fresh and mature myrobalan fruit (Phan-kha) (*Terminaliachebula*. Retz) was used as raw material for the extraction of natural dye. The raw materials were collected from Magwe Township, Magwe Region (from July to December, 2014).

Cotton fabrics were purchased from Amarapura Township, Mandalay Region and mordants such as the Alum, Copper sulphate and Potassium dichromate of commercial grades were purchased from Academy Chemical Market, Yangon Region.

Methods

Preparation of Raw Materials

Firstly, the fruits were washed with water to remove the impurities. Then, they were chopped into 2 millimeter-thick pieces of chips and they were dried under sunlight for about 2 days. After they became dry, they were ground to a fine powder by using mortar and pestle. Then the powder was sieved with (60) mesh screen to remove the large residues. After that it was used for the process of extraction.

Phytochemical Tests on the Fruit of Myrobalan

Preliminary Phytochemical tests for the fruit of Myrobalan were performed by phytochemical method.

Natural Dye Extraction from the Fruit of Myrobalan

About (3, 5, 7) g of myrobalan powder were put into a steel pot containing 400 ml of water. Then, the pot was boiled for 1 hour at 80ºC. The solution was cooled and filtered with filter cloth. Finally, 200 ml each of dye solution was obtained.

Scouring the Cotton Fabrics

Firstly, the fabric was washed for 30 min in hot water containing 1 g/L sodium carbonate and 2 g/L of non-ionic detergent to remove impurities. Then the fabrics were rinsed with water and finally dried at room temperature.

Mordanting

The scoured cotton fabrics were mordanted using different amounts (1, 3 and 5 %) of alum, copper sulphate and potassium dichromate mordants at 80ºC and material to liquid ratio of 1:20, for 45 minutes. During mordanting, the fabrics were frequently stirred to obtain good penetration of mordant into the fabric. After that the fabric was rinsed with water and dried at room temperature. Finally, the mordanted fabrics were obtained.

Dyeing

In the preparation of dyed cotton fabrics, (3, 5, 7) g of myrobalan (Phan-kha) powder were placed in a stainless steel pot containing 400ml of water. Then the dye solution was cooled and filtered with filter cloth. The pH of the dyebath was adjusted on 5 using acetic acid. The dyeing was started at 40ºC and the temperature was raised to final temperature (60, 70, 80,

90ºC) at the rate of 2ºC per minute. Then the samples remained in that condition for appropriate time (45, 60, 90 minute). After that, the fabrics were removed from the dyebath and allowed to cool. Finally, the dyed fabrics were rinsed with water and dried at room temperature.

Testing the Color Fastness Properties of Dyed Cotton Fabric

In this study washing fastness, rubbing fastness and light fastness were carried out to determine the color fastness of dyed cotton fabric. These operations were carried out with Test No.3 of ISO 105 and Test No.12 of ISO 105 method.

Results and Discussion

Preliminary Phytochemical investigation was carried out on the myrobalan fruit to determine the presence or absence of glycoside, saponin, tannin, starch, carbohydrate, phenolic compound, flavonoid and alkaloid. The results of Phytochemical tests were shown in Table 1. According to the results obtained, it was found that flavonoid, glycoside, tannin, phenolic compound, carbohydrate, alkaloids and saponin were present and starch was absent in the myrobalan fruit.

The effect of the amount of three mordants on the color strength of dyed cotton fabrics was shown in Table 2. The increase in *K/S* and decrease in *L** of sample shows that increasing of the amount of mordants from 0 to 5% caused more absorption of the dyed to the fibers and deeper shades. It was found that copper sulphate has the greatest effect on dye absorption when the amount of mordant increased from 1% to 5%. In the case of alum and potassium dichromate mordants, the increase of color strength when the amount of mordant increased from 1% to 3% is greater than when increased from 3% to 5%. So, the little effect of mordant was increased from 3% to 5%. Therefore, 3% is considered as the optimum amount of mordants.

According to fastness tests on cotton fabrics, Table 6.showed that color fastness to rubbing was very good for all the samples but color fastness to washing was not good for all samples that has shown in Table 4. It was also found that assessment result for color change was very good in case of the pre-mordanting method for 5% alum and 5% copper sulphate, in meta-mordanting method for both 3% and 5% potassium dichromate and post-mordanting method for 3% and 5% potassium dichromate. The result was found to be good for color change in pre-mordanting method for 3% alum and 3% copper sulphate, 1% and 3% potassium dichromate, in meta-mordanting method for 5% alum, 5% copper sulphate and 1% potassium dichromate and in post-mordanting method for 5% alum, 3% and 5% copper sulphate and 1% potassium dichromate. It was also found that assessment result for color staining was very good for all samples which were very suitable for dyeing of cotton fabrics.

Table (1) Results of Phytochemical Test on the Fruit of Myrobalan

Test	Types of Extract	Reagent	Observation	Inference
Glycosides	H_2O	10% NaOH solution	White ppt.	+
Saponins	H_2O	Vigorously shaken with H_2O	Frothing	+
Tannin	H_2O	1% Ferric chloride solution & Gelatin	White ppt.	+
Alkaloids	H_2O	Wagner's reagent, Dragendroff's reagent	Brown ppt.	+
Phenolic Compounds	H_2O	10% Ferric chloride solution	Black color	+
Flavonoids	C_2H_5OH	Concentrated H_2SO_4 + Mg ribbon	Pink color	+
Starch	H_2O	Iodine solution	No. bluish black color	–
Carbohydrate	H_2O	10% α-naphthol	Purple ring	+

Note : (+) = Present (-) = Absent

Table (2) Color Coordinates of Scoured Cotton Fabrics

Mordant	*L**	*a**	*b**
No mordant	54.20	-0.43	11.56
Alum	83.09	-0.23	11.78
Copper sulphate	66.54	-7.87	13.98
Potassium dichromate	70.12	3.76	20.45

Table (3) Color Coordinates of Dyed Samples after Mordanting with Different Amount of Mordants

Mordant	Concentration (%)	*L**	*a**	*b**
Alum	1	62.01	-0.22	41.23
	3	54.34	-2.96	34.67
	5	53.76	-2.98	30.78
Copper sulphate	1	73.43	0.34	48.02
	3	71.91	2.17	47.43
	5	67.98	2.04	46.87
Potassium dichromate	1	66.02	1.60	46.22
	3	64.22	4.22	43.19
	5	63.18	3.54	43.32

Table (4) Washing Fastness Result for Color Change on Cotton Fabric

Mordant	Concentration (%)	Pre-mordanting	Post-mordanting	Meta-mordanting
Alum	1	3	3	2
	3	4	3	3
	5	5	4	4
Copper sulphate	1	3	3	2
	3	4	4	3
	5	5	4	4
Potassium dichromate	1	4	4	4
	3	4	5	5
	5	3	5	5

Note: 1 = very poor, 2= poor, 3=fair, 4= good, 5= excellent

Table (5) Washing Fastness Result for Color Staining on Cotton Fabric

Mordant	Concentration (%)	Pre-mordanting	Post-mordanting	Meta-mordanting
Alum	1	4-5	4-5	4-5
	3	4-5	4-5	4-5
	5	4-5	4-5	4-5
Copper sulphate	1	4-5	4-5	4-5
	3	4-5	4-5	4-5
	5	4-5	4-5	4-5
Potassium dichromate	1	4-5	4-5	4-5
	3	4-5	4-5	4-5
	5	4-5	4-5	4-5

Table (6) Rubbing Fastness Result for Color Change on Cotton Fabric

Mordants	Concentration (%)	Rubbing fastness	Pre-mordanting	Post-mordanting	Meta-mordanting
Alum	1	Dry	5	5	5
		Wet	4	4	4
	3	Dry	5	5	5
		Wet	4	4	4
	5	Dry	5	5	5
		Wet	4	4	4
Copper sulphate	1	Dry	5	5	5
		Wet	4	4	4
	3	Dry	5	5	5
		Wet	4	4	4
	5	Dry	5	5	5
		Wet	4	4	4
Potassium dichromate	1	Dry	5	5	5
		Wet	4	4	4
	3	Dry	5	5	5
		Wet	4	4	4
	5	Dry	5	5	5
		Wet	4	4	4

Table (7) Light Fastness Result for Color Change on Cotton Fabric

Mordant	Concentration (%)	Pre-mordanting	Post-mordanting	Meta-mordanting
Alum	1	4	4	5
	3	4	4	5
	5	4	4	5
Copper sulphate	1	5	5	5
	3	5	5	5
	5	5	5	5
Potassium dichromate	1	5	5	5
	3	5	5	5
	5	5	5	5

Conclusion

The natural dye extracted from Myrobalan fruit used with different mordants as natural dyeing for cotton fabrics which showed excellent fastness properties and high dye uptake condition. In the application of natural dye on cotton fabric, mordanting with copper sulphate in all dyeing method can produce attractive color and acceptable fastness on cotton fabric. It can be concluded that pre-mordanting with myrobalan powder (7 g) and meta- mordanting with myrobalan powder (7 g) gave the best color fastness. According to cost estimation, meta-mordanting method using copper sulphate and potassium dichromate mordant with myrobalan powder (7 g) was more saving cost and time than pre-mordanting method. Natural dyes are not only having dyeing ability but also having the wide range of medicinal properties. Due to their non-toxic properties, less side effects, more medicinal properties, natural dyes are the most suitable for dyeing industries.

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