TO STUDY THE DYEING BEHAVIOUR OF ROSE & HIBISCUS NATURAL DYED COTTON FABRIC USING PRE, POST & SIMULTANEOUS MORDANTING METHODS

ASTHA[1], SAPNA KUSHWAHA[2] & NEERAJ BALA[3]

[1,2&3] Department of Textile Engineering, Panipat Institute of Engineering & Technology, Panipat 132 102, India

Abstract: *In the present work, an attempt has been made to study dyeing behaviour of cotton fabric with rose and hibiscus floral natural dyes (shade 30% owf) by using different types of mordants. Abundance of Rosa (rose flower) and Hibiscus Rosa Sinensis (hibiscus flower), used in idol worship forms a temple waste and there is tremendous potential to use this waste as a natural dye.100% cotton fabric samples were dyed with rose and hibiscus flower extract using mordants i.e. alum (20% owf) and copper sulphate (4% owf). In this study, an aqueous extraction method has been applied for dye extraction from rose & hibiscus flower. Pre mordanting, post mordanting and simultaneous mordanting method is followed along with exhaust dyeing of fabric. To assess the dyeing behaviour of cotton fabric, colour strength (K/S), L*a*b* colour space coordinates, washing and rubbing fastness were assessed using computer colour matching system.*

Keywords: *Alum, Cotton Fabric, CIE L*a*b* Colour Space, Colour Strength, Copper Sulphate, Rose flower, Hibiscus flower, Rubbing fastness & Wash fastness*

1. Introduction

Save the earth to save future is today's most important call due to concern of the environmental and health hazards associated with the wide variety of chemicals, auxilliaries required in the synthesis and processing of synthetic dyes leading to the generation of enormous amount of effluent[1,2,8].The characteristics such as value addition, look and desire of the customer's need to be taken into consideration for the colouration of textile material. India has a ironic practice in the use of natural dyes[3,4]. In earlier times, natural dyes were used as dyestuff. Due to ready obtainability of synthetic dyes without limitations of shade range and better standard operating procedures give dyeing with synthetic dyes reproducibility.Now a days, people are moving towards sustainable and ecofriendly prooducts. Natural dyes are ecofriendly and preferred by environmentally conscious consumers[5]. Natural dyes are obtained from plants, animals and minerals. Natural dyes can be used as a colouring matter for food, leather, wool, silk and cotton products. Since, prehistoric times natural dyes may have a extensive range of shades and can be obtained from various part of plants including roots, barks, leaves, flowers and fruits[6,16].Natural dyes have better biodegradability with the environment.They are non-hazardous, non-allergic to skin,non-carcinogenic, easily available and renewable. In india, there is common practice of throwing temple's flower once used in idol worship into river which itself as a major factor of water pollution.The use of temple waste as a source of natural dye which not only reduces pollution and but also cost effective towards textile processing[7,8].

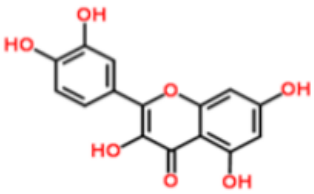
1.1 Hibiscus Rosa Sinensis

The plant Hibiscus Rosa Sinensis belongs to the family 'Malvaceae' and subkingdom 'Magnoliophyte. It is mainly found in China, India and Philippines [9]. This beautiful and bold flower usually only last for one day, opening in the morning and wilting late afternoon [10,11]. Anthocyanin is the major pigment responsible for the colouration with dye ranging from orange, pink, red, violet to blue in the flowers and fruits [12]. Different chemical constituents such as cyaniding, quercetin, hentriacontane, calcium oxalate, thiamine, riboflavin, niacin and ascorbic acids have been isolated from this plant [13]. It is an ornamental plant which is used as hair's decoration, eyeliner and in shoe blacking [14].

Figure 1.1: Phenotypes of Hibiscus Rosa Sinensis flower (red, pink, white, orange and yellow) [13]

1.2 Rosa

Rosa belongs to the family of 'Rosaceae', also known as king of flowers, 'Gulab' and considered as a character of love, warmth, purity and spiritulaity one of oldest , most important cultivation plant. It is native to Central Asia, North America and Northwest Africa. Rose is used for decorative purpose, in weddings, funerals and religious ceremonies. Anthocyanin is the coloring mater for rose petal[15].



a.

b.

Figure 1.2: Chemical Structures of Anthocyanin and Rosa flower: a. Chemical Structure of Quercetin [13], and b. Structure of typical Rosa Flower

2. Materials and Methods

2.1 Materials

For this study, ready for dyeing (RFD) cotton fabric having warp count-81s, weft count- 65s, EPI-99, PPI-115 and 112-GSM was procured form HSPS Textile Pvt Ltd, New Delhi. Rose and Hibiscus flowers were collected from local market of Panipat. Alum and Copper Sulphate (laboratory grade) were used as mordants.

2.2 Extraction of natural dyes and mordants

2.2.1 Preparation of alum mordant

A 10 % stock solution of alum mordant solution was prepared by dissolving 10g alum in 100ml of water.

2.2.2 Preparation of copper sulphate mordant

A 4% copper sulphate mordant solution was made by dissolving, 4 g of mordant in 100 ml of water.

2.2.3 Extraction of natural dyes

Rose and Hibiscus flower sources were first dried by exposing to sunlight. The aqueous technique was used to get the coloured solution/dye. The 5% stock solution was prepared by boiling 5 gm of floral petals in 100 ml of water for 60min then solution was filtered and made up to to 100ml.

2.2.4 Mordanting and Dyeing Process

The cotton samples were mordanted with mordants by following three mordanting methods.
(i) Pre-mordanting
(ii) Simultaneous mordanting
(iii)Post mordanting

1) **Pre-mordanting method**- In this method, cotton fabric samples were treated with mordants and then dyed with dye extract.
2) **Simultaneous mordanting method**- In this method, cotton fabric samples were simultaneously mordanted and dyed in the same bath.
3) **Post mordanting method**- In this method, cotton fabric samples were first mordanted and then dyed with dye extract.

The mordanting process was carried out in a laboratory rota dyeing machine. The mordanting of cotton fabric was carried at material to liquor ratio of 1:30 with alum (20% owf) and copper sulphate (4% owf) as a mordants separately. The fabric was introduced into the mordant solution at room temperature and the

temperature was gradually raised to 85°C. The mordanting was continue at this temperature for 1 hour. Mordanted cotton sample was immediately used for dyeing because some mordants are sensitive to light. After mordanting, the fabrics were squeezed and dyed with rose & hibiscus dye extract separately for shade 30% owf. The dyeing was continued at 85°C for 1hr. After dyeing, the fabrics squeezed and washed with cold water.

2.3 Testing & Analysis

2.3.1 Measurement of Colour Strength and L*a*b* colour value

Evaluation of dyeing was done by determination of K/S and L*a*b* colour values using Premier Colour scan, UV spectrophotometer. The spectral reflectance of flower extract cotton fabrics was measured in terms of Kubleka Munk equation.

$K/S= (1-R)^2/2R$

where 'K' is absorption coefficient, 'S' is scattering coefficient and 'R' is the reflectance of the dyed fabric at the wavelength of the maximum absorption.

The dyed samples were simultaneously evaluated in terms of CIE L*a*b* colour space values. The higher the depth of colour indicates the values of L*. L* corresponds to brightness (100-White and 0-Black). a* corresponds to redness and greenness. +a means redness and -a means greenness and b* corresponds to yellowness and blueness +b means yellowness, -b means blueness. The entire coordinate gives the tonal variations of colours.

2.3.2 Measurement of Washing Fastness

ISO-105-CO2 test method was used for washing fastness. A solution containing 5 gpl non-ionic soap solution was used as a washing liquor and samples were treated for 45 min at 50^{o}C using a material to liquor ratio 1:50 in laundrometer. After rinsing and drying, samples were assessed by means of grey scale for staining.

2.3.3 Measurement of Rubbing Fastness

ISO-105-X12 test method was used to carried out rubbing fastness test. Dry and wet rubbing test was carried out using "crock-meter" with 10 strokes of rubbing and evaluated for staining using grey sale ratings.

3. Results & Discussion

3.1 Evaluation of colour strength (K/S) and colour coordinates (L*a*b*)

Table 3.1, shows the result of colour strength and L*a*b* colour space coordinates on dyed cotton fabric with rose and hibiscus dyes using alum and copper sulphate via pre mordanting, simultaneous and post mordanting techniques.

From Fig 3.1(a), It is apparent that out of three mordanting techniques, alum mordanted rose dyed cotton fabric gave highest K/S (1.167) values in pre & simultaneous mordanting method, whereas hibiscus dyed sample gave highest K/S (0.729) value in post mordanting method. While using copper sulphate as a mordant, rose dyed cotton fabric samples gave highest K/S (1.143) in pre and post mordanting method whereas, hibiscus dyed sample gave highest K/S (1.167) in post mordanting method. Mordants play very important role in imparting colour to the fabric.

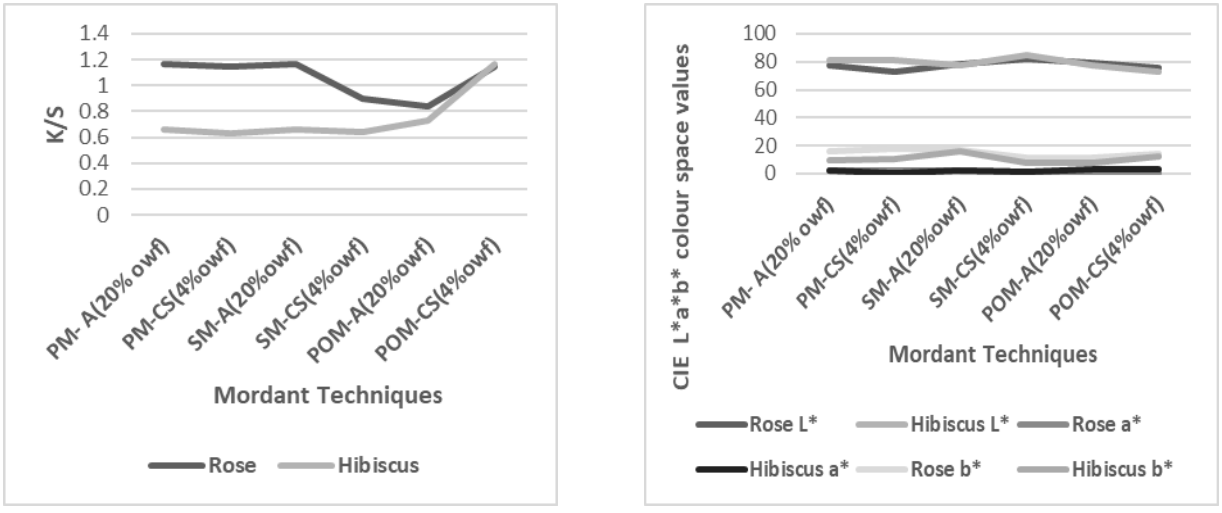
The enhancement in depth of dyeing is attributed to greater availability of the dye molecules to mordanted samples, thereby helping to make bond with fibre. Better colour strength results are dependent on the metal salt used.

From Fig3.1(b) For L*(Lightness) value, alum mordanted rose dyed cotton sample gave darker tone in terms of lightness (78.079) in pre and simultaneous mordanting whereas, hibiscus dyed sample gave L* value (77.407) in post mordanting method.

On the other hand, copper sulphate mordanted rose dyed cotton fabric gave darker tone in terms of L* (75.869) in post mordanting whereas, hibiscus dyed cotton sample gave L* value (73.099) in post mordanting.

Table 3.1: Colour strength and L*a*b* values of cotton fabric with rose and hibiscus fabric with alum and copper sulphate as mordants by different mordanting techniques

Mordanting used	Dye shade% (30%owf)	Mordant used	K/S	L*	a*	b*
Pre-mordanting	Rose	Alum(20%owf)	1.167	77.615	2.003	16.337
		Copper Sulphate(4%owf)	1.143	72.494	2.514	17.830
	Hibiscus	Alum(20%owf)	0.660	81.207	1.933	9.385
		Copper Sulphate(4%owf)	0.627	81.504	0.469	10.084
Simultaneous mordanting	Rose	Alum(20%owf)	1.167	78.079	2.086	17.310
		Copper Sulphate(4%owf)	0.90	82.346	1.299	11.061
	Hibiscus	Alum(20%owf)	0.657	77.659	2.003	16.337
		Copper Sulphate(4%owf)	0.642	85.198	1.587	7.673
Post mordanting	Rose	Alum(20%owf)	0.839	79.377	1.698	11.209
		Copper Sulphate(4%owf)	1.143	75.869	0.597	14.404
	Hibiscus	Alum(20%owf)	0.729	77.407	3.202	7.646
		Copper Sulphate(4%owf)	1.167	73.099	2.962	11.891



a. b.

Figure 3.1: Colour strength and L* a* b* colour space values: a. Effect of colour strength on cotton fabric dyed rose and hibiscus flower with different mordanting techniques, and b. Effect of L*a*b* colour space values on cotton fabric dyed with rose and hibiscus flower with different mordanting techniques

3.2 Evaluation to colour fastness to washing

From Table 3.2, shows the result of washing fastness on dyed cotton fabric with rose and hibiscus dyes using alum and copper sulphate via pre mordanting, simultaneous and post mordanting techniques.

The study reveals that washing fastness for both i.e. alum and copper sulphate gave very good ratings on rose and hibiscus dyes. This may be due to better complex bond formation between rose and hibiscus dye. The washing fastness ratings with respective mordants exhibited in between 4-5. There was no significant change in ratings of washing fastness of both the dyes using with all techniques of mordanting.

3.3 Evaluation to colour fastness to rubbing

From the Table 3.2 the results indicate irrespective of mordanting method, alum treated rose & hibiscus dyed cotton sample gave very good to excellent dry and wet rubbing fastness ratings. However, both rose and

Table 3.2: Washing and Rubbing fastness of cotton fabric with rose and hibiscus fabric with alum and copper sulphate as mordants by different mordanting techniques

Mordanting Used	Dye shade% (30%owf)	Mordant used	Wash fastness	Rubbing fastness	
				Dry	Wet
Pre-mordanting	Rose	Alum(20%owf)	4-5	5	4-5
		Copper Sulphate(4%owf)	4-5	3	3
	Hibiscus	Alum(20%owf)	5	4-5	4-5
		Copper Sulphate(4%owf)	4-5	4-5	4-5
Simultaneous mordanting	Rose	Alum(20%owf)	4-5	4	4-5
		Copper Sulphate(4%owf)	5	5	4
	Hibiscus	Alum(20%owf)	5	4-5	4
		Copper Sulphate(4%owf)	4-5	4-5	4-5
Post mordanting	Rose	Alum(20%owf)	4-5	3-4	4
		Copper Sulphate(4%owf)	4-5	4	4
	Hibiscus	Alum(20%owf)	4-5	4	4
		Copper Sulphate(4%owf)	4-5	3	3-4

hibiscus dyed fabric treated with copper sulphate mordant, gave good to excellent dry and wet rubbing fastness ratings in simultaneous mordanting method.

4. Conclusion

The herbal dyeing was carried out using rose and hibiscus flower extracts along with alum and copper sulphate mordants at pre-mordanting, simultaneous and post mordanting methods on cotton fabric. Natural dyes with the use of different mordants, give a different tone of colour. The colour strength of dyed cotton mordanted with alum with rose flower extract gave better colour yield in pre and simultaneous mordanting. Using copper sulphate as a mordant, rose dyed cotton fabric samples gave highest colour depth in pre and post mordanting method. On the other hand, hibiscus dyed sample gave highest K/S in post mordanting method. The washing fastness properties on cotton fabric gave very good overall fastness with three mordanting techniques for both the natural dyes. The alum treated rose & hibiscus dyed fabric treated with copper sulphate mordant, gave good to excellent dry and wet rubbing fastness in simultaneous mordanting method. The process of extraction of dyeing is environmentally friendly and causes minimum environmental pollution.

5. Future Scope

Use of other mordants, combination of mordants may also be considered for improving the fastness of dyed cotton fabric. Also, for further research on extraction method of dyes will help to explore the important properties of dye extracted from flowers of rose and hibiscus using different mordants shows potential source of natural dye.

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7. Corresponding Address

Ms Astha
Assistant Professor
Department of Textile Engineering
Panipat Institute of Engineering & Technology, Haryana
Pin: 132102
E-Mail: asthabecool@gmail.com