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A Study on the Extraction of ECO – Friendly Natural Dyes from Hibiscus Rosa Sinensis and Clitoria Ternatea for Dyeing

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Abstract: *Natural dyes are derived from plants, invertebrates, or minerals. The majority of natural dyes are vegetable dyes from plant sources-roots, berries, bark, leaves, and wood—and other organic sources such as fungi and lichens. Natural dyes are mostly used to dye natural fibers like cotton, wool, silk, jute etc. In this study, the Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) plant extract is dyed with cotton fabrics by different mordanting techniques with different mordant. After dyeing, the dyed cotton is subjected to different fastness tests.This study will help in improving the natural dye resources and replace them with synthetic dyes, consequently leading to a safe environment.*

Keywords: *Hibiscus Rosa Sinensis, Clitoria Ternatea, Colour fastness, extraction of natural dyes.*

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I. Introduction

Dyes are generally used in textile, paper, cosmetic, food, pharmaceutical and leather industries. Water pollution due to discharge of non-biodegradable coloured effluents from textile dye manufacturing and textile-dyeing sill is one of the major environmental concerns in the world today. Strong colour imparted by synthetic dyes to the receiving aquatic ecosystems poses aesthetic and serious ecological problems such as inhibition of benthic photosynthesis and carcinogenicity.

This effluent of textile processing discharge in environment, which spoils the living condition of human being, other animals and plant life. The serious environmental problems of public health concern related to colored waste waters containing synthetic dyes have diverted researchers promptly to look for eco-friendly products[1]. So to recover our living condition we need to introduce environment friendly materials to use in textile processing that can accomplish the consumer's requirement as well as economy of country. We can generate interest in natural dyes instead of synthetic dyes which are biodegradable as well as non-toxic and non-allergic to human body.

Natural dyes are known for their use in colouring of food substrate, leather, wood as well as natural fibers like wool, silk, cotton and flax as major areas of application since ancient times.Natural dyes may have a wide range of shades, and can be obtained from various parts of plants including roots, bark, leaves, flowers, and fruit. Since the advent of widely available and cheaper synthetic dyes in 1856 having moderate to excellent colour fastness properties, the use of natural dyes having poor to moderate wash and light fastness has declined to a great extent. However, recently there has been revival of the growing interest on the application of natural dyes on natural fibers due to worldwide environmental consciousness [2].

Nowadays, fortunately, there is increasing awareness among people towards natural dyes. Natural dyes are preferred in developed countries, because they are non-allergic, non-carcinogenic and have lower toxicity and better bio degradability than the synthetic dyes[3].

The study aims at finding out the dyeing ability and fastness of natural dye extraction of the Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) plant extract on cotton fabrics.

II. Material and Methods

2.1. Dye extraction:

Flowers of Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) are collected from the areas in and around Erode District near Thindal. Extraction of dye from Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT). The petals of the flowers of Hibiscus Rosa Sinensis and Clitoria Ternatea are plucked early in the morning. These petals are cut into small pieces and placed in a vessel containing methanol and allowed to simmer for about one hour. The collected dye extract is evaporated to remove the solvent. The plant Extract of

HRS and CT are shown in Figure 1. In each case the dye was obtained in a pasty form, from this paste a dye solution of required concentration was prepared for various dyeing operations.

Figure 1.Plant Extract of HRS and CT

Cotton

The cotton fabric in grey form was resized, scoured and bleached well. It was cut into small pieces for dyeing with the dye extracts.

Chemicals Used

Alkali used : Glauber's salt

Exhausting Agent: Sodium Chloride

Metal salts

- Aluminum Sulphate
- Iron (II) Sulphate
- Nickel (II) Sulphate
- Magnesium Chloride
- Zinc Chloride
- Potassium Dichromate
- Manganese (II) Sulphate
- Lead (II) Fluoride

Dyeing procedure: The cotton samples were dyed with dye extract keeping M: L ratio such 1:20. Dyeing was carried out different temperatures such as 40°C, 60°C and 80°C and continued for 1 hour.

Mordanting: The cotton fabrics were treated with different chemical and natural mordants by following three methods[4].

Post mordanting (POM): In this method, dyed cotton fabrics were treated with solution of different chemical and natural mordants.

Colour fastness: The colour fastness of the dyed fabrics was tested according to IS standards. Colour fastness to washing, light and rubbing were determined from standard test methods IS-687-79, IS-2454-85 and IS-766-88 respectively [5].

III. Results and Discussion

The dye extracts are obtained from plant source Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) and their dyeing properties with cotton studies has shown some interesting results.

Quantum Yield of Dye Extract

The quantum yield of the coloring matter from Hibiscus Rosa Sinensis (HRS) has been found to be 3% and from Clitoria Ternatea (CT) has been found to be 4%. The color of the dye extract of the flower of Hibiscus Rosa Sinensis (HRS) is red. The color of dye extract of the flower of Clitoria Ternatea (CT) is blue.

Dyeing Properties

The natural dyes from the flower of Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) are found to be suitable for dyeing of cotton. These fabrics are dyed with metallic salts. These well known organic molecules are found to be mordant with metal ions to yield different colors on yarn and fabrics.

Effects Of Metal Salts

The dye extracts of Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) has been applied on cotton fabrics individually with eight metal salts.

The cotton yarn also treated with both dye extract along with eight metal salts and the hue are compared and the results are displayed in Table (1 to 3). The well establish method of dyeing post – mordanting are carried out.

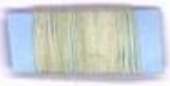
The different metal salts with dye extracts produce different colors and hues. The identification of the colors is done with the shade cards available in the market.

Effect Of Exhausting Agent

Sodium chloride has been used as an exhausting agent. It has been observed that it has no effect on dye uptake. But the levelness of dyeing is found to be good.

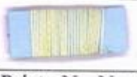
Table - 1

Colors obtained on cotton with different metal salts using Hibiscus Rosa Sinensis (HRS) Extract (Red Portion)

Metal salts	Shades / colors	Fabrics
Aluminium sulphate	PENELOPE PINK (NP)	
Iron (II) sulphate	YELLOW TULIP (N)	
Nickel (II) sulphate	IRIS TIP (AP)	
Magnesium chloride	GRAY DOLPHIN (DP)	
Zinc chloride	LIGHT WINGS (AP)	
Potassium dichromate	LEATHER 658 (N)	
Manganese(II) sulphate	ASH WHITE (R)	
Lead (II) fluoride	SOOTHING BLUE (DP)	

AP - Asian Paints, DU – Dulux Paints, N – Nerolac Paints, NP – Nippon Paints, R - Rohini Paints

Table - 2
Colors obtained on cotton with different metal salts using Clitoria Ternatea (CT) Extract (Blue Portion)

Metal salts	Shades / colors	Fabrics
Aluminium sulphate	PRIVACY PINK (NP)	
Iron (II) sulphate	NATURAL OAK (AP)	
Nickel (II) sulphate	LIGHT PEWTER (DU)	
Magnesium chloride	GREY DEW (N)	
Zinc chloride	RESERVED WHITE (NP)	
Potassium dichromate	NATURAL OAK NP N1871 T (AP)	
Manganese(II) sulphate	TIMIND PINK (DU)	
Lead (II) fluoride	COOL HINT (R)	

AP - Asian Paints, DU – Dulux Paints, N – Nerolac Paints, NP – Nippons Paints, R - Rohini Paints

Table - 3
Colors obtained on cotton with different metal salts using Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT) Extract (Pink Portion)

Metal salts	Shades / colors	Fabrics
Aluminium sulphate	CHERRY PINK (NP)	
Iron (II) sulphate	SAPLING NPN (AP)	
Nickel (II) sulphate	COOL DRIFT (N)	
Magnesium chloride	TIP OF ICE BERG (DU)	
Zinc chloride	WHITE CONCRETE (NP)	
Potassium dichromate	LEATHER (R)	
Manganese(II) sulphate	CLOUD FORMATION (N)	
Lead (II) fluoride	COOL HINT NP (NP)	

AP - Asian Paints, DU – Dulux Paints, N – Nerolac Paints, NP – Nippon Paints, R - Rohini Paints

Effect of Temperature

It has been observed that an increase in temperature increase the dye uptake. Whereas the dyeing of sample started at 40^0C and completed at 80^0C yields better results rather than at room temperature.

Fastness Properties

The light and rubbing fastness properties of these dyed fabrics are studied [6].

Rubbing Fastness

The rubbing fastness of the dyed samples is assessed by a crock meter using cotton rubbing fabrics. These results of both wet and dry rubbing fastness are correlated well under controlled conditions. The evaluation of the grade of fastness is done visually by using grey scale. The results are presented in the following Tables (4 and 5).

Light Fastness

The light fastness of the dyed samples are assessed by exposing the dyed samples to the sunlight for 8, 12 and 16 hours and then extend of fading is assessed and grading are given. The results are presented in the following Tables (4 and 5).

It has been seen that invariably good fastness properties has been observed in almost all samples.

It has touched a low value when cotton fabrics were in post - mordanting method particularly with metal salts Nickel Sulphate, Potassium Dichromate and Magnesium Chloride.

The same level of light and rubbing fastness properties are followed in both cases of dye extracts from Hibiscus Rosa Sinensis (HRS) (Red portion) and Clitoria Ternatea (Blue portion) source.

It is inferred that the metal ions has a direct influence on the light and rubbing fastness properties of dyed cotton fabrics.

The hexavalent Aluminium [Al(VI)], bivalent Nickel [Ni(II)] and Magnesium ion [Mg(II)] have shown greater impact on the fiber-dye bond which in turn leads to poor fastness property.

Table - 4

Fastness Properties Of Cotton Dyed By Post Mordanting Method WithHibiscus Rosa Sinensis (HRS) (Red Portion)

Methods	Metal Salts	Rubbing Fastness		Light Fastness		
		Dry	Wet	8 hrs	12hrs	16hrs
Post – Mordanting Method	Aluminium sulphate	4-5	3-4	6	6	5
	Iron(II)sulphate	4-5	4-5	6	6	5
	Nickel(II)sulphate	3-4	2-3	6	5	4
	Magnesium chloride	3-4	2-3	6	5	4
	Zinc chloride	4-5	3-4	6	5	5
	Potassium dichromate	3-4	2-3	5	4	3
	Manganese(II)sulphate	4-5	4-5	6	6	5
	Lead (II)fluoride	4-5	3-4	6	5	5

Table - 5

Fastness Properties Of Cotton Dyed By Post MordantingMethod WithClitoria Ternatea (Ct) (Blue Portion)

Methods	Metal Salts	Rubbing Fastness		Light Fastness		
		Dry	Wet	8 hrs	12hrs	16hrs
Post – Mordanting Method	Aluminium sulphate	3-4	2-3	6	5	4
	Iron(II)sulphate	4-5	4-5	6	5	4
	Nickel(II)sulphate	3-4	2-3	5	4	3
	Magnesium chloride	3-4	2-3	5	4	4
	Zinc chloride	3-4	2-3	5	4	3
	Potassium dichromate	3-4	2-3	5	4	3
	Manganese(II)sulphate	4-5	3-4	6	5	4
	Lead (II)fluoride	3-4	3-4	5	4	4

IV. Conclusion

An attempt has been made to obtain dye extracts from Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT). These dyes has been applied on bleached cotton fabrics. The dye uptake with temperature, its light fastness and rubbing fastness has been studied in detail.

These dye extracts produce excellent method colors and hues on cotton fabrics with metal salts. Post-mordanting has been tried on these fabrics.

The dyed samples along with the two plant extracts with Aluminium Sulphate, Iron(II)Sulphate, Nickel(II)Sulphate, MagnesiumChloride, ZincChloride, Potassium Dichromate, Manganese(II)Sulphate, Lead(II)Fluoride metals should be a good hues on cotton yarn and displayed in the Table (1 to 3).

The samples has shown good light fastness and rubbing fastness characteristics in most samples. The samples shows poor light and rubbing fastness properties when dyed with Al^{VI}, Ni^{II} and Mg^{II} ions.

The post – mordanting method are carried out with each class of dye extracts and also with the combination of two dye extracts from Hibiscus Rosa Sinensis (HRS) and Clitoria Ternatea (CT). They have yielded appreciable results.

The exact molecular structure of these dye substances could be unraveled by employing instrumental methods such as UV, IR, H^1 NMR, ^{13}C NMR, Gas Chromatography (GC) and Mass spectrometry (MS). Such a study would throw more light on the exact nature of the molecules. This would further facilitate the research study to utilize these substances extensively to all kinds of yarns and fabrics. A step in this direction would lead to the long march in achieving large – scale preparation of natural dyes.

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