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Natural dye printing with *Eclipta prostrata* on Cotton

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Abstract

Eclipta Prostrata is considered as weed plant by many farmers in India. And it is also used by many folks as herbal source to dye hair, and to treat skin, fever, wounds, etc. Considering its dye efficiency, the present study is taken up to treat the cotton fabric with *Eclipta Prostrata* plant dye. Very good color strength was observed, from the research, and gave ocher and black shades with the use of different mordants (SnCl_2 and FeSO_4). The dye is fixed with two types of gum sources, *Cassia tora* (CT) (2.5% and 5%) and Mango kernel (MT) (3 and 5%) in two percentages, among which cassia tora gum have good affinity to dyes. Both gums sources are have shown good penetration on cotton fabric with block and screen printing methods. However, 2.5% CT and 3 % MT gum concentrations are good for block printing; where as 5% concentration of both gums is giving accurate design outline for screen printed samples. The samples have shown good acceptance by the costumers through visual evaluation and colorfastness analysis.

Keywords: *Eclipta prostrata* dye; *Cassia tora* gum; mango kernel gum; eco-friendly textile printing

Introduction

Eclipta prostrata is one such natural source, commonly known as false daisy/Bhangra/Bringaraj. It is an annual herb plant, but most actively grown during summer and has high tolerance at anaerobic conditions [1]. Traditionally, the plant is used in ayurveda to endorse bile excretion and to protect liver. The extracts of chloroform have significant activity as antidiabetic [2, 3]. It grows very rapidly, especially as weed in paddy fields. It has also known for its range of medicinal properties like Antiseptic, Astringent, Depurative, emetic, Febrifuge, Ophthalmic, Purgative, Styptic, Tonic, Deobstruent Oil and is commonly used to treat during anemia, tooth loss, coloring premature hair, hair loss, dermatitis, wounds, scorpion stings, jaundice, catarrhal problems and liver problems [4]. When Wasule D. D. 2011, analyzed for qualitative chemicals viz phytochemical of the dried *Eclipta* source, they have found presence of Alkaloids, Saponins, Phenolic compounds and Tannins. In his study, occurrence of black colored precipitate with Ferric Chloride suggests the dye potentiality in the source [5]. Shikha Sharma, Richa and Harsimran have also explored the phytochemicals of the *Eclipta Prostrata*, where they have analysed for anatomy and HPCL studies, which referred the source as medicinal herbal plant [6]. A review article by Rownak Jahan, *et.al.* 2014, *Eclipta* plant have diverse medicinal value to treat problems like gastrointestinal disorders, respiratory tract disorders (including asthma), fever, hair loss and graying of hair, liver disorders (including jaundice), skin disorders, spleen enlargement, and cuts and wounds [7]. This makes the source more potential to be finished on textiles for imparting the herbal property. And also raised synthetic materials, especially the colorants for textiles from industries are degrading the environment and their production process delivers maximum effluents. To combat this issue, scientists are exploring more and more natural resources. Natural dyeing and printing is one such area where the research to explore and develop new dye sources at its crucial need, particularly to meet the Eco-friendly parameters. In the Indian history, plant sources were used as natural colorants, which were however replaced by the synthetic once. So, now researchers and scientists are working to get back those heydays of the natural sources.

According to Ethno-medicinal reports, this plant parts and the plant as whole were used by folk and tribal medical practitioners for different diseases. In the present study, taking into consideration of prospective characteristics,

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Eclipta Prostrata was selected as a natural herbal dye source for printing the textiles. Natural sources like *Cassia tora* and mango kernel gum were used as binding agent in the printing process to maintain the organic approach.

Materials and Methods

Materials used for printing

- Kora cotton and pure silk fabrics
- *Eclipta prostrata* plant
- *Cassia tora* and Mango kernel as natural thickening agents
- Myrobalan for pre treating the textile material
- Ferrous Sulphate, Copper Sulphate, Stannous Chloride and Alum as mordants
- Blocks and Screens

Material preparation

Desizing of the cotton fabric is done through boiling the fabric for 1 to 2 hours in a solution containing 2grams of Sodium Carbonate and 1gram Sodium hydroxide per liter of water. During the process the fabric was frequently stirred. Degumming of silk fabric was done through boiling the fabric in a solution containing 2g of non ionic detergent with MLR ratio of 1:50 for 45 minutes.

Myrobalan Treatment

The prepared materials were pretreated with 15grams of Myrobalan with 1:20 MLR, which was later sundried. (Note:

printing should be done on the sun exposed side).

Print paste preparation

Firstly 60 grams of dried *Eclipta Prostrata* plant (see Fig 1.) was boiled in one liter distilled water for around 45 minutes. The extracted dye was filtered and condensed (see Fig 2.). Later, natural binding agents, *Cassia tora* and Mango kernel gums were prepared in 2.5% and 3 % respectively. Commercially available gum acacia was made in both the percentages to compare with the respective percentages of natural gum sources. All the gums were also prepared in 5%. Finally, concentrated dyes with cassia tora gum or mango kernel gum are mixed in 1:2 and 1:1 ratios respectively. To these solutions, according to the mordant color yielding capacity, 0.5 to 3 per cent mordant is added which reflects a particular hue. Different consistencies can be tried, depend on the required, until the print is smudge free.

Printing preparation

Prior to printing, check for the quality of screens and blocks. Printing table and bed should be prepared before printing. New blocks were soaked in oil for around 24 hours, for good quality printing. Screens should also be checked for the clear design area and outlines, and they should be kept away from dirt and dust.

Around 40ml of condensed dye, about 80ml of gum and selected mordant were winced together. This printing paste, later, printed on the textile material (see Fig 3.).



Fig 1: Eclipta dried source



Fig 2: Dye preparation



Fig 3: Printing with Eclipta dye

After treatment

It is essential to treat the printed samples to retain the quality of its printing. To do so, initially, the printed swatches were steamed at 100°C for about 30 minutes. Then cotton and silk samples were treated with 5% sodium chloride and 2 % acetic acid, respectively for about 30 minutes. At the end, the swatches were washed with neutral soap, rinsed with water and dried in shade.

Colour fastness tests

The color fastness tests are intended to evaluate the fastness of the color from the textile material during rubbing, washing, exposing to sunlight and perspiration. Bureau of Indian Standard Test Series IS 768-1976 for color change and IS 769-1956 for color staining, the standard test procedures, were followed to evaluate the fastness properties. The test procedures used for different type of fastnesses were as follows

1. Colour fastness to sunlight - AATCC 16-2004
2. Colour fastness to washing - IS 687-1979
3. Colour fastness to crocking - IS 766-1956

4. Colour fastness to perspiration - IS 971-1956

Subjective evaluation

Printed samples were visually evaluated for its depth of the color, evenness of the color, sharpness of print and overall appearance through 5 point quantum scale (Very good - 5, Good - 4, Fairly good - 3, Poor - 2 and Very poor - 1). All the scores were analyzed through Weighted Mean Score (WMS).

Results and Discussion

While printing few things were observed and recorded. Though the cotton fabric possess good dye penetration, it was observed that 2.5 % cassia tora gum and 3 % mango kernel gum concentrations are more suitable for block printing, whereas for screen printing 5% gum concentration for both cassia tora and mango kernel sources was good. Fixation of dye with cassia tora gum is good, as is alkaline in nature. Cassia tora gum is reacting well with mordant.

With FeSO₄ mordant, Eclipta dye projected gray to black shades depend on the usage of it. Where, SnCl₂ mordant has showed light ocher shades, as shown in figure 4.

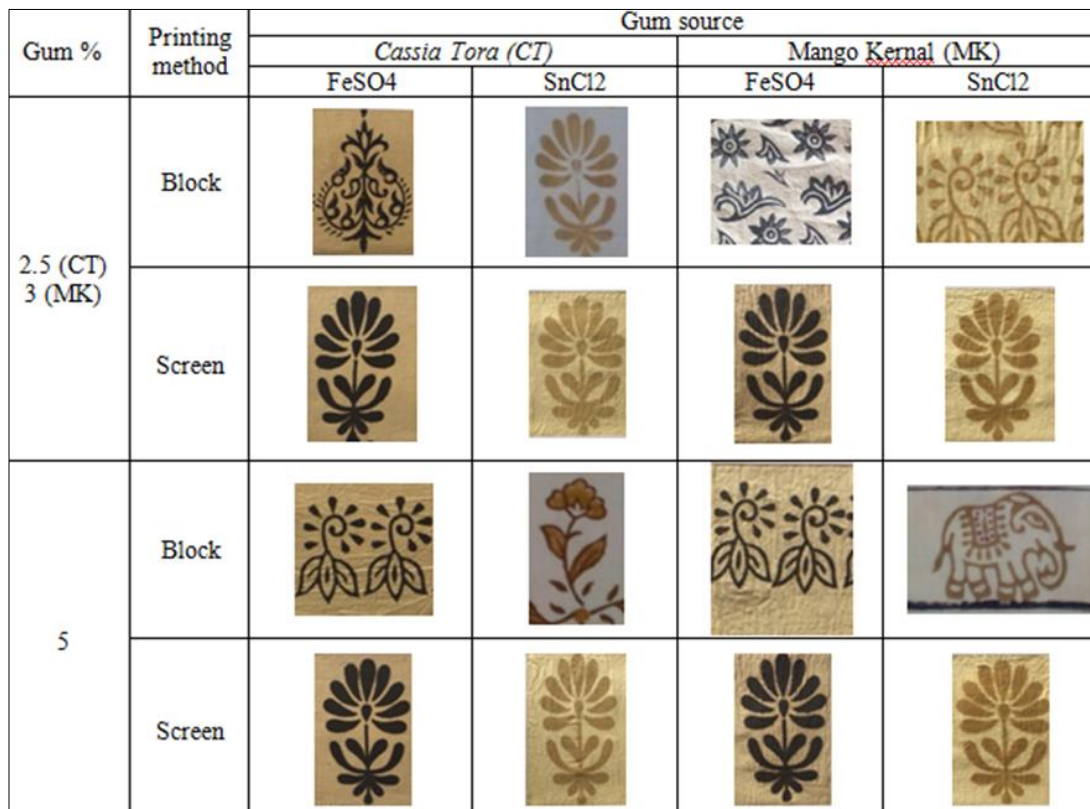


Fig 4: Samples dyed with *Eclipta Prostrata* using *Cassia Tora* and *Mango Kernal* gum

Colorfastness properties

Table 1: Color fastness properties of *Eclipta Prostrata* dye printed (block and screen) cotton samples with 2.5 percent gum acacia and *Cassia Tora* gum

Gum and Mordant conc. (%)	Printing type	Colour fastness grades												
		Sun Light	Washing			Rubbing				Perspiration				
			CS			Dry		Wet		Acidic		Alkaline		
			CC	S	C	CC	CS	CC	CS	CC	CS	CC	CS	
GA – WOM (control)	Block	4	3	3	3	3	3	2	2	2	2	2	2	2
	Screen	4	3	3	3	3	3	2	2	2	2	2	2	2
GA - 3% FeSO ₄	Block	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5
	Screen	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5
GA - 3% SnCl ₂	Block	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	4/5	5	5	4/5
	Screen	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	4/5	5	5	4/5
CT – WOM	Block	4	3/4	3/4	3/4	3	3	3	3	3	3	3	3	3
	Screen	4	3/4	3/4	3/4	3	3	3	3	3	3	3	3	3
CT - 3%FeSO ₄	Block	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5
	Screen	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5
CT - 3% SnCl ₂	Block	7	5	5	5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
	Screen	7	5	5	5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5

Note: GA- Gum Acacia, WOM- without mordant, CT – *Cassia Tora* gum

All the treated samples have showed good color fastness to sunlight, wash, crock and perspiration. On the other hand, the samples printed with without mordant did not demonstrated good color fastness properties. That is that, there is moderate fastness to light with appreciable level of color fading on the samples were observed. Moreover, other fastnesses have shown fair to good fastness property.

When mordant treated printed samples were tested against color fastness analysis, they posses very good fastness to sunlight with very slight fading, where other fastness parameters are between very good to excellent with no or minimum change in the color.

Thickening agent plays crucial role in dye fixing to the selected substrate. From the above table, it is clearly evident that, *Cassia tora*, a natural gum source has good potential to anti-smudging. While printing, it was observed that, *cassia tora* gum is giving accurate design outline, which is on par with the commercially available Acacia gum. This might be due to the alkaline based gum. The color fastness of the printed samples with 2.5 % *Cassia tora* gum – a thickening agent is good, however, spreading is observed for the screen printed samples. It was observed that, 2.5 % and 5 % gum consistencies are good for block and screen methods respectively.

Two per cent Mango kernel gum did not projected good finish work. while printing. So, 3 per cent of gum was used to carry out the

Table 2: Color fastness properties of *Eclipta Prostrata* dye printed (block and screen) cotton samples with 3% gum acacia and mango kernel gum

Gum and Mordant conc. (%)	Printing	Colour fastness grades													
		Sun Light	Washing			Rubbing			Perspiration						
			CS			Dry		Wet		Acidic		Alkaline			
			CC	S	C	CC	CS	CC	CS	CC	CS		CC	CS	
									S	C	CC	S	C		
GA – WOM (control)	Block	4	3	3	3	2/5	2/5	2	2	2	2	2	2	2	2
	Screen	4	3	3	3	2/5	2/5	2	2	2	2	2	2	2	2
GA - 3% FeSO ₄	Block	6	4	4	4	4	4	4	4	4	4	4	4	4	4
	Screen	6	4	4	4	4	4	4	4	4	4	4	4	4	4
GA - 3% SnCl ₂	Block	6	4	4	4	4	4	4	4	4	4	4	4	4	4
	Screen	6	4	4	4	4	4	4	4	4	4	4	4	4	4
MK – WOM	Block	5	3	3	3	3	3	3	3	3	3	3	3	3	3
	Screen	5	3	3	3	3	3	3	3	3	3	3	3	3	3
MK - 3% FeSO ₄	Block	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5	4/5
	Screen	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5	4/5
MK - 3%SnCl ₂	Block	7	5	5	5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
	Screen	7	5	5	5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5

Note: GA- Gum Acacia, WOM- without mordant, MK – Mango Kernel gum

Having good color fastness property, but when compared to Cassia tora gum, mango kernel gum has slight smudging quality while printing. After a pilot study, found good results

with 3% mango kernel gum in the printing paste. All the colorfastness results with 3 % Mango Kernel gum are on-par with the 2% Cassia tora gum printed samples.

Table 3: Color fastness properties of *Eclipta prostrata* dye printed (block and screen) cotton samples with 5 % gum acacia, *Cassia Tora* and mango kernel gums

Gum and Mordant conc. (%)	Printing type	Colour fastness grades													
		Sun Light	Washing			Rubbing			Perspiration						
			CS			Dry		Wet		Acidic		Alkaline			
			CC	S	C	CC	CS	CC	CS	CC	CS		CC	CS	
									S	C	CC	S	C		
GA – WOM (control)	Block	4	3	3	3	3	3	2	2	2	2	2	2	2	2
	Screen	4	3	3	3	3	3	2	2	2	2	2	2	2	2
GA - 3% FeSO ₄	Block	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5	4/5
	Screen	7	5	5	5	4/5	4/5	4/5	4/5	5	5	5	4/5	4/5	4/5
GA - 3% SnCl ₂	Block	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	4/5	5	5	4/5	4/5
	Screen	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	4/5	5	5	4/5	4/5
CT - WOM	Block	5	3/4	3/4	3/4	3	3	3	3	3	3	3	3	3	3
	Screen	5	3/4	3/4	3/4	3	3	3	3	3	3	3	3	3	3
CT - 3% FeSO ₄	Block	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	4/5	4/5	4	5	5
	Screen	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	4/5	4/5	4	5	5
CT - 3%SnCl ₂	Block	7	4/5	4/5	4/5	4/5	4/5	4/5	4/5	5	5	5	5	5	4/5
	Screen	7	5	4/5	4/5	4/5	4/5	4/5	4/5	5	5	5	5	5	4/5
MK – WOM	Block	5	4	4	4	3	3	3	3	3.5	3	3.5	3.5	3.5	3.5
	Screen	5	4	4	4	3	3	3	3	5	4.5	5	5	4.5	4.5
MK - 3%FeSO ₄	Block	7	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	4.5	4.5	4	5	5
	Screen	7	4.5	4.5	4.5	4.5	4.5	4.5	4.5	5	4.5	4.5	4	5	5
MK - 3%SnCl ₂	Block	7	5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	4.5
	Screen	7	5	4.5	4.5	4.5	4.5	4.5	4.5	5	5	5	5	5	4.5

Samples printed with 5 % gums are on par with acacia gum. Samples Printed with natural dye on cotton fabric (*Eclipta Prostrata*) using both the gums along FeSO₄, and SnCl₂ mordant’s have showed similar results for sunlight fastness. 2.5% cassia tora gum with FeSO₄, & SnCl₂ printed samples of *Eclipta* exhibited very good resistance to colour change and colour stain when treated with salt on par with control. Where, FeSO₄ samples have showed good resistance to colour change and colour stain. All the printed samples are on par with the control sample in fastness to rubbing for both wet and dry. Samples showed good fastness to perspiration through acidic means, compared to alkaline. 5% cassia tora

gum with FeSO₄ samples showed color stain in almost all fastness properties compared to control.

Note: when tested on silk fabric, both block and screen printing samples have shown same colorfastness results, but the color depth was very poor compared to cotton material.

Visual evaluation of *Eclipta cassia tora* printed samples

Visual evaluation for all the samples except without mordants have shown good acceptability in terms of Depth of color, Evenness of print and Sharpness of print (shown in Table 4). As samples printed with FeSO₄ & SnCl₂ mordants have given Black & Khaki green colors, they have shown good color dept.

Table 4: Comparative visual evaluation of cotton (block and screen) printed samples with Eclipta dye using Cassia Tora gum and Mango Kernel gum against commercial gum (gum acacia), N=30

Gum %	Gum and mordant	Type of printing	Depth of color	Evenness of print	Sharpness of print	Overall appearance	Aggregate WMS
2.5%	GA – WOM (control)	Block	2.6	2.7	2.8	2.7	2.7
		Screen	2.8	3.4	3.7	3.4	3.325
	GA - 3%FeSO ₄	Block	4.9	4.9	4.9	4.9	4.9
		Screen	4.9	4.9	4.9	4.9	4.9
	GA - 3%SnCl ₂	Block	4.7	4.9	4.9	4.9	4.85
		Screen	4.7	4.9	4.9	4.9	4.85
	CT - WOM	Block	2.3	2.1	2.5	2.3	2.3
		Screen	3.4	3.4	3.6	3.4	3.45
	CT - 3%FeSO ₄	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
	CT - 3%SnCl ₂	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
3%	GA - WOM	Block	2.6	2.7	2.8	2.7	2.7
		Screen	2.8	3.4	3.7	3.4	3.325
	GA - 3%FeSO ₄	Block	4.9	4.9	4.9	4.9	4.9
		Screen	4.9	4.9	4.9	4.9	4.9
	GA - 3%SnCl ₂	Block	4.7	4.9	4.9	4.9	4.85
		Screen	4.7	4.9	4.9	4.9	4.85
	MK - WOM	Block	2.3	2.1	2.5	2.3	2.3
		Screen	3.4	3.4	3.6	3.4	3.45
	MK - 3% FeSO ₄	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
	MK - 3%SnCl ₂	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
5%	GA - WOM	Block	2.3	2.1	2.5	2.3	2.3
		Screen	2.8	3.0	2.7	3.0	2.899
	GA - 3%FeSO ₄	Block	4.9	4.9	4.9	4.9	4.9
		Screen	4.9	4.9	4.9	4.9	4.9
	GA - 3%SnCl ₂	Block	4.7	4.9	4.9	4.9	4.85
		Screen	4.7	4.9	4.9	4.9	4.85
	CT - WOM	Block	2.5	2.1	2.5	2.3	2.6
		Screen	3.4	3.4	3.6	3.4	3.45
	CT -3%FeSO ₄	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
	CT - 3%SnCl ₂	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
	MK - WOM	Block	2.5	2.1	2.5	2.3	2.6
		Screen	3.4	3.4	3.6	3.4	3.45
	MK - 3%FeSO ₄	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9
	MK - 3%SnCl ₂	Block	4.8	4.8	4.8	4.8	4.8
		Screen	4.9	4.9	4.9	4.9	4.9

Sample without mordant has not shown good ratings, this might be due to the absence of fixing agent, which further leads to improper and uneven shade in color affecting the sample's overall appearance. When critically analyzed, screen printed samples have shown good results than block printed samples with respect to consumer acceptability through visual evaluation.

Implications of the study

Can explore and identify other agro waste sources; can compare, identified sources with commonly available sources; further study can be carried out on application as stiffening/thickening agents on other type of fabric; and can be explore its usage in other textile applications.

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Conclusion

To summarize, While printing it was observed that, using 2.5 percent Cassia Tora gum in printing has gave more clear design when printed with screen printing method, whereas 5 percent was effective for block printing. This variation in consistency is due to the difference in the printing methods (screen and block). 2.5% cassia tora gum is having good penetration on cotton fabric for both block and screen printing; where the same percentage is spreading with block printing. Contrary to this, use 5 percent gum gave accurate design outline for block printing and lack penetration while screen printing. Fixation of dye with *cassia tora* than mango kernel gum is good owing to its good reaction with the mordant. As it is alkaline in nature, it supports good penetration of the dye in the fabric. On the whole, perpetuate of the print without mordant is poor than the samples printed with mordant.

Color fastness properties for block printed samples against light have excellent fastness printed with both the mordants. Where, no color change was observed against wash fastness. Little color change was noticed after dry and wet rubbing. No

change in colour was observed for acidic perspiration but slight to no change in colour was seen against alkaline perspiration. The use of herbal sources will not only sustain the eco-system, but also have beneficial results to the wearer.

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