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Improving the colour fastness of acidic perspiration and alkaline perspiration with eucalyptus bark dye on cotton

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Abstract
This paper reports the improving the colourfastness of the natural dye with dye fixing agents, extraction of the colourants from natural sources; effects of different mordants and mordanting methods; selection of fixing agents; dyeing variables; post-treatment process and analysis of colour improvement parameters with fixing agents for cotton dyed with natural dye; assessed colour improvement with colourfastness test.

Keywords: *Eucalyptus Bark natural dye, fixing agents, colourfastness, eco-friendly mordants, acidic perspiration and alkaline perspiration.*

1. Introduction
One of the limitations of natural dyes in their availability in limited quantities. The consumption of synthetic dye has been estimated to be closed to 1 million tons per year globally. According to German study, about 90,000 tons of natural dyes can be produced a year about 250 -500 million acres of land will be required to produce about 100 million tons of plant material which is needed to produce 1million tons of natural dyes required to replace synthetic dyes. This is about 10-20 per cent of the area cultivated for grain through out the world. It is a long term goal and cannot be easily achieved in immediate future. The present target of the natural dyes is about 10, 000 tons which is equivalent to 1 per cent of the world's synthetic dye consumption. UAS is one of the major importers of natural dyes.
The major advantage of natural dyes is the fact that they are produced renewable sources. Among the few drawbacks of natural dyes low colour fastness property is one. But no specific study was reported on improving the colourfastness [properties of natural dyes with dye fixing agents. Hence, this study was taken.

2. Materials and methods used in this study were given below
In this article we reviewed improving the colourfastness properties of natural dyes with 5 dye fixing agents. Eco-friendly mordants such as alum, stannous chloride and ferrous sulphate. Eucalyptus Bark dye was selected for the study as this source produce fugitive colours on cotton. A pre- treatment with myrobalan was given for better dye uptake. After dyeing the sample were post treated with 5 dye fixing agents such as alum, ammonia, lime juice and calcium chloride for better colourfastness of natural dyes on cotton.
The dye extraction and treating procedures were standardized based on the procedures suggested by AICRP- Home science (1997). The treatments were given to the cotton samples and evaluation of treated samples in terms of colour fastness to sun light, washing, crocking and perspiration before and after treatment was undertaken by following the standard procedures laid down by Bureau of Indian standard Test Series IS 768-1956 for colour change and is 769-1956 for staining using geometric grey scale. The results were analyzed based on the colour fastness of control samples to find out the impact of the treatments.
Alkaline method was suitable for extraction of dye from Eucalyptus Bark. The optimum time for extraction of dye liquor from the Bark 60 minutes. A dye material concentration of 4 percent (2g/g of fabric) was selected. The optimum time for dyeing was 45 minutes for both then dye. Cotton fabric was pre treated with 20 per cent myrobalan concentration. Increase the tannin deposition which intern increased the depth of the shade obtained.

To improve the colour fastness 5 per cent solution of fixing was selected. Based on absorption values, depth of the shade and appearance three concentrations for each mordant was selected. In case of alum 5, 10, and 15 per cent and 1, 2, and 3 per cent concentrations of stannous chloride and ferrous sulphate mordants for cotton were selected for pre mordanting cotton fabric. Evaluation of colourfastness of test fabrics with **t**wo colour fastness tests were carried out on cotton fabric to evaluate the colours obtained from Eucalyptus Bark and also assess improvement in colour of the fabric treated with fixing agents

3. Post-treatment with fixing agents

This is a post-treatment given to dyed fabrics to aid fixing of dye on to the fabric. Five eco-friendly fixing agents such as vinegar, alum, ammonia, lime juice and calcium chloride were selected for the retreatment. These fixing agents were selected, as they are common fixing agents used for dyeing fabrics. As per Dedhia (1998) [5] first 5 per cent solution of each of the fixing agents was prepared. Five per cent of fixing agents produced noticeable changes in the dyed samples. Hence, 5 per cent fixing agent was selected. Later, the dyed fabric was placed in the solution for 30 minutes. Finally the fabric was removed, rinsed in warm soap solution and dried.

The most common serviceable conditions such as the following were selected for evaluation of the colourfastness of fabrics.

4. Evaluation of Colourfastness Tests

Percentage: 3% Mordants: Alum, stannous chloride, ferrous sulphate, Extraction medium: alkaline alkali conc. 1g/100ml. Dye Extraction Time: 60 min, Mordanting time: 30 min, Dyeing time: 45 min.

Table 1: Acidic Perspiration Fastness Properties of Eucalyptus Bark Dye on Cotton

Mordant	Mordant conc. G/100g of fabric	Control			T1			T2			T3			T4			T5		
		CC	CS		CC	CS		CC	CS		CC	CS		CC	CC		CC	CS	
			C	S		C	S		C	S		C	S		C	S		C	S
Alum	5	3/4	4	3	5	4	4	4	4	4	5	4	4	5	4	4	5	4	4
	10	3/4	3	2/3	5	4	4	4	4	3	5	4	3	5	4	4	5	4	3
	15	3/4	3	2/3	5	4	4	4	4	3	5	4	3	5	4	4	5	4	3
Stannous chloride	1	3	4	4	5	5	4	4	4	4	5	4	3/4	5	4	4	4	4	4
	2	3	4	3	5	5	4	4	4	3	5	4	3/4	5	4	4	5	4	4
	3	3	4	3	5	5	4	4	4	3	5	4	3	5	4	4	5	4	4
Ferrous sulphate	1	4	4	3	5	5	4	4	4	3	5	4	4	5	4	4	4	4	3/4
	2	4	4	3	5	5	4	4	4	3	5	4	4	5	4	4	5	4	3/4
	3	4	4	3	5	5	4	4	4	3	5	4	4	5	4	4	5	4	3/4

Note: vinegar (CH_3COOH), T2-Alum ($AlK(SO_4)_2$, T3-ammonia (NH_3),T4- Lime juice,T5- calcium chloride ($CaCl_2$).

4.1. The acidic perspiration fastness of eucalyptus bark dye on cotton mordanted with eco-friendly mordants and post treated with various fixing and leveling agents is given in table: 1

The fastness grades of control fabric showed fair to good resistance to colour change when exposed to acidic perspiration. Resistance to colour staining varied as per mordant used. Alum mordanted control sample showed very fair resistance to colour change due to acidic perspiration, where as, in stannous chloride fair resistance to colour change was observed. The grey shades of ferrous sulphate mordanted samples showed good resistance to colour change. Alum mordanted samples showed fair to good resistance to staining on cotton composite fabric and poor to fair resistance on silk fabric. Stannous chloride and ferrous sulphate mordanted cottons exhibited good resistance to staining on cotton composite fabric. All mordanted cottons except 1 per cent stannous chloride mordanted samples, showed fair resistance to staining on silk composite fabric. Good resistance was exhibited by cotton mordanted with 1 per cent of stannous chloride.

Post-treatment with vinegar resulted in excellent resistance to colour change in mordanted cottons after exposure to acidic perspiration. Good to excellent resistance to staining was observed due to acidic perspiration. Alum mordanted samples showed good resistance to staining on both cotton and silk composite fabrics. In case of stannous chloride and ferrous sulphate mordanted samples, excellent resistance to staining on cotton and good resistance to staining on silk composite fabric was observed. Post treatment with vinegar seemed to have improved acidic perspiration fastness in all mordanted samples over control. The resistance to staining was also increased in all mordanted samples over control.

Alum post treated cottons exhibited good resistance to colour change due to acidic perspiration irrespective of the mordant used. Good resistance to staining on cotton was also observed in all mordanted samples after exposing to acidic perspiration. Alum, stannous chloride mordanted cottons had registered fair to good resistance to staining on silk composie fabrics. Ferrous sulphate mordanted cottons showed only fair resistance to staining due to acidic perspiration. These treatment imparted slight improvements in acidic perspiration incase of alum and stannous chloride mordanted samples over the control. Slight increase in colour was noted incase of alum and stannous chloride mordanted cottons over control. Ferrous sulphate mordanted cottons did not registered any improvement in fastness to acidic perspiration over control.

Post treatment with ammonia exhibited excellent resistance to colour change with fair to good resistance to staining due to acidic perspiration. After exposure, all mordanted samples exhibited good resistance to staining on cotton composite fabrics. On silk composite fabric, alum mordanted cottons showed fair to good resistance to staining and stannous chloride mordanted samples exhibited fair to very fair resistance. Ferrous sulphate mordanted cottons showed good resistance. Treatment with ammonia had registered improvement in acidic perspiration fastness of mordanted cottons over control. Increase in colour was observed in all mordanted samples. Slight increase in resistance to staining was observed in majority of the post treated samples.

Post treatment with lime juice had registered excellent resistance to colour change with good resistance to staining on both cotton and silk composite fabrics due to acidic perspiration. Improved acidic perspiration fastness was registered in all mordanted samples over control. Increase in depth of the shade was also noticed in all mordanted samples

due to acidic perspiration over control.

Calcium chloride post treated cottons showed good to excellent resistance to colour change after exposure to acidic perspiration. Alum mordanted cottons showed excellent resistance to colour change and good resistance to staining on cottons fair to good resistance to staining on silk. Stannous chloride and ferrous sulphate mordanted cottons showed negligible stains on both the composite fabrics. Calcium chloride had contributed for improved acidic perspiration fastness of mordanted cottons over control. Increasing resistance to colour change and staining was found in majority of the mordanted cottons.

Percentage: 3% Mordants: Alum, stannous chloride, ferrous sulpha, Extraction medium: alkaline alkali conc. 1g/100ml.

Dye Extraction Time: 60 min, Mordanting time: 30 min, Dyeing time: 45 min.

Table 2: Alkaline Perspiration Fastness Properties of Eucalyptus Bark Dye on Cotton

Mordant	Mordant conc. G/100g of fabric	Control			T1			T2			T3			T4			T5		
		CC	CS		CC	CS		CC	CS		CC	CS		CC	CC		CC	CS	
			C	S		C	S		C	S		C	S		C	S		C	S
Alum	5	3/4	3	3	5	4	3	4	4	3/4	4	4	3	5	4	4	5	4	4
	10	3/4	3	2/3	5	4	3	4	4	3/4	4	4	3	5	4	4	5	4	3
	15	3	2	2/3	5	4	3	4	4	3	4	4	3	5	4	4	5	4	3
Stannous chloride	1	3	2/3	2/3	5	5	5	4	4	3/4	4	4	3	5	4	3	4	4	4
	2	3	2	2/3	5	4	4	4	4	3/4	4	4	3	5	3	3	5	4	3
	3	3/4	2	2	5	5	5	4	5	3	4	4	3	5	3	3	5	4	3
Ferrous sulphate	1	3	2/3	2/3	5	4	3	4	4	3	4	4	3	4	3	3	4	4	3
	2	3	2/3	2/3	5	4	2/3	4	4	3	4	4	3	4	3	3	4	4	3
	3	3	2/3	2/3	5	4	2/3	4	3	3	4	4	3	4	3	3	4	4	3

Note: Vinegar (CH_3COOH), T2-Alum AlK $(SO_4)_2$, T3-Ammonia (NH_3), T4- Lime juice, T5- Calcium Chloride ($CaCl_2$).

4.2. Alkaline perspiration fastnesses of eucalyptus bark dye on cotton mordanted with eco-friendly mordants and post treated with various fixing and leveling agents is given in table: 2

The alkaline perspiration fastness of eucalyptus bark dye on cotton mordanted with eco-friendly and post treated with various fixing agents is given in the table 2:

The alkaline perspiration fastness grades of eucalyptus bark dye showed fair to very fair resistance to colour change in control sample with all three mordants. Cotton fabric mordanted with alum showed poor to fair resistance, those treated with stannous chloride showed poor to fairly poor resistance and cotton treated with ferrous sulphate showed fairly poor resistance. However, colour staining in silk control sample showed fairly poor to fair resistance when mordanted with alum poor to fairly poor resistance was noticed with stannous chloride mordanted samples and fairly poor resistance was observed when mordanted with ferrous sulphate.

Post treatment with vinegar had contributed for excellent resistance to colour change over control. Cotton fabrics dyed with eucalyptus bark mordanted with alum and ferrous sulphate showed good resistance, samples treated with stannous chloride almost had excellent resistance but for the one treated with 2 per cent which showed good resistance. While colour staining to silk showed fair resistance with alum, fairly poor to fair resistance was observed with ferrous sulphate, whereas, silk behaved similarly that of cotton with stannous chloride mordant.

In case of post treatment with ammonia, colour change with all the three mordants showed good resistance. Colour staining in cotton composite fabric also showed similar fastness, but silk fastness showed fair resistance with all the three mordants. Good resistance to staining was observed on silk, mordanted with 1 per cent stannous chloride. However, improvement in resistance to both colour change and colour staining was observed over control.

Post treatment with lime juice exhibited impact on providing excellent resistance to colour change in case of alum and stannous chloride mordanted cottons, whereas samples mordanted with ferrous sulphate showed good resistance. Colour staining on cotton composite fabric was found to be fair to good. Among the three mordants alum has good resistance while, stannous chloride and ferrous sulphate showed fair resistance similar behavior was noted even in the case of silk composite fabric. Noticeable change was observed in fastness to acidic perspiration.

The colour change with calcium chloride post treatment ranged from good to excellent due to alkaline [perspiration. While, cotton composite fabric showed good resistance to colour staining, fair resistance was observed in silk fabric with all the three mordants. However improvement in fastness was noticed.

5. Conclusion

Dyes from natural sources have ancient history in India and can trace their root to antiquity. Today, the faded antiquity is unveiling due to the concern manifested globally for saving the environment from pollution. Natural dyes are being considered as a more environment friendly substitute for synthetic dyes. But no specific study was reported on improving the colour fastness properties of natural dyes with dye fixing agents. Hence, this study was taken up to improve colour fastness with fixing agents.

Among the mordanted eucalyptus bark dyed post treated cottons, vinegar post treatment had contributed in deepening the dye shades and leveled dyeing incase of alum and ferrous sulphate mordanted samples. It was found un-suitable from stannous chloride mordanted samples. The sunlight fastness was improved in case of all mordanted samples over control. The acidic perspiration fastness of all mordanted cottons showed increased resistance to colour change and staining. Slight increase in resistance to staining was observed in all post treated cottons due to alkaline perspiration. Slight improvement in acidic perspiration incase of alum and stannous chloride mordanted samples was noticed over control. Improved alkaline fastness with improved resistance to staining in all mordanted samples was registered over control.

Fair to good resistance to staining due to acidic perspiration. The alkaline perspiration fastness of all mordanted cottons was slightly improved. Improved acidic perspiration in all

mordanted samples was observed which was graded as excellent fastness. Improved resistance to alkaline perspiration was registered over control in case of alum and stannous chloride mordanted samples increased acidic perspiration fastness was observed over control. The alkaline perspiration fastness was improved in all mordanted samples over control.

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