

Application of Mixture of Selected Natural Dyes on Mercerized Cotton Material Using Processed Mordants

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The globalization of markets and increasing demand for products has created a deep interest in the use of raw materials from natural resources. The natural dyes, especially vegetable colourants have aroused considerable interest in dyeing of textiles due to their eco-friendly nature and harmful effect of synthetic dyes. The major advantages of natural dyes are that they are biodegradable, non-carcinogenic, non-mutagenic and colours soothing to human eyes. Dyeing with natural dyes can be a way of value addition to the textile products say Gill and Singh (2003).

Owing to the eco-friendly, eco-conservation, eco-protection and concern over the depleting eco-system and also the global consciousness about the use of eco-friendly dyes due to the hazardous and carcinogenic effect among synthetic dyes, natural dyes are preferred over synthetic dyes (Rani and Singh, 2003).

The main problem with natural dyeing are the dye uptake is not good and variety and intensity of the colours are not adequate Deo and Paul (2003) revealed that majority of the natural dyes need a mordant in the form of a metallic salt to create affinity between the fibre and the pigment. While the natural dyes are themselves harmless, the metallic mordants are not generally eco-friendly. In order to develop a totally eco-friendly natural dyeing process, it is necessary to replace the metallic mordants with more eco-friendly processed mordants. The idea of using processed mordants is to reduce the usage of chemicals and to find out the effect of dye uptake, colourfastness and related parameters as well as reconstruction and revival of traditional dyeing techniques.

- To extract and explore the strength of selected natural dyes.
- Study the behaviour and intensity of the dye uptake by mercerized cotton material.
- Optimization of various dyeing parameters.
- To study the effect of mixture proportion of natural dyes using processed mordants.
- Evaluation of the dyed samples objectively and subjectively.

Methodology

A. Selection of the Fabric: Hundred per cent cotton grey 30's count, plain weave material was used for the study.

PRETREATMENT OF THE FABRIC: The aim of the pretreatment is to improve the quality by removing impurities and foreign matters thoroughly and uniformly from the fabric and make the fabric suitable for follow up processing (Prabu and Bharathimohan, 2003). Hence the selected cotton grey material was scoured, bleached and mercerized.

PREPARATION OF FABRIC FOR DYEING: Cotton has no affinity for most of the dyes from natural sources Sharadadevi et al (2001) suggest that cotton fabrics need to be coated with tannin. Myrobalan has ample natural tannin which is most important ingredient in dyeing with natural dyes. Alikhan et al (2005) state that Myrobalan treated fabrics have more affinity to natural dyes. Hence the mercerized cotton material was pretreated with Myrobalan solution.

PILOT STUDY: A pilot study was carried out in order to select dye sources, mordants, mordanting techniques and dyeing procedure.

SELECTION OF DYE SOURCES: Based on availability, easy application and appealing colours about six natural dyes such as annatto seed, amaranth seed, neem leaf, babool bark, turmeric tuber and madder root were selected for the pilot study.

SELECTION OF MORDANTS AND MORDANTING TECHNIQUE: Shivakumar et al (2003) report that natural dyes may require some mordanting agents in order to produce affinity between the fibre and the dye. Considering the drawbacks of metallic mordants there is an imperative need to explore processed mordants to minimize the use of metallic mordants. The metallic mordants such as alum, copper sulphate and ferrous sulphate were modified into processed form of alum, copper sulphate, ferrous sulphate and were used for the study.

A. ALUM $Al_2(SO_4)_3$: One hundred grams of alum was boiled in a flat thava until the content changed to liquid state, then removed from the fire and dried overnight so as to get a powdered form of the product.

B. COPPER SULPHATE ($CuSO_4$): Few drops of ghee was smeared all over the deep frying pan. One hundred grams of Copper Sulphate was spread and roasted until it turned to a white powdered form.

C. FERROUS SULPHATE ($FeSO_4$): One hundred grams of ferrous sulphate was soaked in 25 ml of cows urine (komeyam) in a glass beaker and left for 24 hours, the urine gets evaporated and the dried form of the product was obtained.

MORDANTING TECHNIQUE : In the pre mordanting technique mordanting is the first step after which dyeing is done, while in simultaneous technique mordanting and dyeing are done simultaneously and in post mordanting technique, dyeing is the first step following which mordanting is done. The investigator selected all the three techniques for the pilot study.

EXTRACTION OF THE DYE SOLUTION: The dye from natural sources can be extracted in alkaline, acidic and aqueous medium. As aqueous medium does not involve the use of harmful chemicals to extract the dye, the investigator selected aqueous medium for the study.

SELECTED DYES, MORDANTS AND MORDANTING TECHNIQUE: The dyed samples produced from the pilot study were visually evaluated by a panel of judges. Based on their recommendation three dyes, three processed mordants and post mordanting technique were selected for the study.

OPTIMIZATION OF DYEING PARAMETERS: A series of experiments were carried out to determine optimum values of five dyeing parameters namely dye concentration, dye extraction time, dyeing time, mordant concentration and mordanting time.

Table I - Optimized Proportions Selected for the Study

Dyeing Variables	Trial Proportions	Selected Proportions
Dye concentration	1,2,3,4,g/100 ml	2g/100ml
Dye extraction time	1 hr, 24hrs, 48hrs, 72hrs	48hrs
Dyeing time	15,30,45,60 min	45min
Mordant concentration: Alum	1%, 2%, 3%, 4%	2.0%
Copper sulphate and Ferrous sulphate	0.50%, 1.0%, 1.5%, 2.0%	1.0%
Mordanting time	15,30,45,60	45min

The constant parameters used in all the experiments were

Material liquor ratio	-	1:40
Dye soaking time	-	48 hrs.
Dye extraction temperature	-	at boil
Dyeing temperature	-	at boil
Mordant soaking time	-	1 hour
Mordant temperature	-	at boil
pH for dyeing	-	7
Dye extraction medium	-	aqueous

ACTUAL DYEING: Fifteen meters of mercerized cotton material was used for the study. One meter was kept aside as original. The remaining 14 meters of material were used for dyeing with selected natural dyes using processed mordants following post mordanting technique. The dyeing was carried out following optimized parameters selected for the study. The dyed samples were evaluated subjectively and objectively.

FINDINGS: The findings of the study are discussed under the following headings.

- A. Visual inspection
- B. Laboratory test

A. VISUAL INSPECTION: The dyed and washed samples were displayed before a panel of judges comprising of 25 textile experts. A rating scale was prepared and given to the judges to evaluate the samples for their evenness in dyeing, brilliancy of colour, texture, luster and general appearance.

Table 2- Evaluation of the Dyed Samples by a Panel of Judges
(In Percentage)

S.No	Nomenclature of the samples	Evenness in dyeing		Brilliancy of colour			Texture			Lustre			General appearance			Mean
		Even	Uneven	Very bright	Bright	Dull	Smooth	Medium	Rough	High	Medium	Low	Good	Fair	Poor	
1	AB 1:3 AP	70	30	20	80	-	25	75	-	30	70	-	80	20	-	75
2	AB 1:3 CP	80	20	20	60	20	20	80	-	40	60	-	75	25	-	71
3	AB 1:3 FP	75	25	25	75	-	30	70	-	40	60	-	80	20	-	72
4	AB 1:1 AP	100	-	20	80	-	25	75	-	45	55	-	100	-	-	82
5	AB 1:1 CP	100	-	30	70	-	40	60	-	40	60	-	100	-	-	78
6	AB 1:1 FP	100	-	15	85	-	25	75	-	50	50	-	100	-	-	82
7	AB 3:1 AP	100	-	15	85	-	30	70	-	15	85	-	100	-	-	88
8	AB 3:1 CP	100	-	15	95	-	20	80	-	45	55	-	100	-	-	86
9	AB 3:1 FP	100	-	10	90	-	25	75	-	25	75	-	100	-	-	88
10	AM 1:3 AP	100	-	-	85	15	30	70	-	30	70	-	80	20	-	81
11	AM 1:3 CP	100	-	5	95	-	40	60	-	30	70	-	90	10	-	83
12	AM 1:3 FP	100	-	-	80	20	25	75	-	20	80	-	75	25	-	82
13	AM 1:1 AP	100	-	5	95	-	30	70	-	25	75	-	100	-	-	88
14	AM 1:1 CP	100	-	15	85	-	20	80	-	40	60	-	100	-	-	85
15	AM 1:1 FP	100	-	10	90	-	35	65	-	20	80	-	100	-	-	87
16	AM 3:1 AP	100	-	5	90	-	40	60	-	15	85	-	95	5	-	86
17	AM 3:1 CP	100	-	10	90	-	45	55	-	20	80	-	100	-	-	85
18	AM 3:1 FP	100	-	15	85	-	30	70	-	30	70	-	100	-	-	85

A – Annatto B – Babool M – Madder A – Alum C – Copper Sulphate F – Ferrous Sulphate
P – Post Mordanting Technique

With reference to evenness in dyeing, brilliancy of colour, texture, luster, and general appearance of the dyed samples annatto with babool in 3:1 proportion, annatto with madder in 1:1 and also 3:1 proportion recorded more than 85 per cent acceptance irrespective of mordants used. Among the samples dyed in different dye proportion AB 3:1 ratio scored the maximum percentage irrespective of mordants used.

2. Laboratory Tests

Mechanical Tests

Fabric weight, thickness, breaking strength and elongation, wettability and absorbency of mercerized original, samples dyed with selected dyes using processed mordants following post mordanting technique values are discussed.

- In view of the fabric weight it was obvious that except AM 1:3 AP and AM 1:1 AP, all other samples revealed an appreciable increase than the original sample and the maximum was observed in the sample AB 3:1 FP by 16 per cent and AB 1:1 CP by 12.6 per cent.
- Not much difference was found with the samples treated with mixed proportion of dyes when compared with the original samples with regard to fabric thickness.
- All the dyed samples showed minimum reduction in their breaking strength along warp direction when compared to the original sample. While AB 1:3 FP, AB 1:1 AP, AB 1:1 CP and AB 3:1 AP showed an appreciable increase. Regarding weft side almost all the samples showed negligible decrease than the original sample.
- Considering the warp side among the dyed samples annatto with babool dye in 1:1 proportion revealed satisfactory performance than the original sample irrespective of mordants used with respective to elongation. Maximum increase in elongation was recorded by AB 3:1 FP Sample. All the dyed samples recorded appreciable increase than the original in the weft side of elongation.

Wetability and Absorbancy Test

- Among the samples dyed in different proportions AB 1:1 FP, AB 3:1 AP and AB 3:1 FP exhibited better performance by showing minimum time towards absorbency with regard to drop test, sinking time and capillary rise test.

Colourfastness Test

The dyed samples were evaluated for their ability to retain their colourfastness property during washing, sundrying, pressing and crocking. The samples were assessed using AATCC rating scale.

Among the samples dyed in different proportions AB 1:3 AP, AB 1:1 AP, AM 1:1 CP and AM 3:1 CP samples recorded a maximum value by 97 per cent, the rest of the samples exhibited values ranging from 80-94 per cent. Thus colour fastness of the natural dyed samples in different proportions showed an excellent rating to washing, pressing, sun drying and crocking in general for all the samples irrespective of dyes and mordants used in different proportions.

Table III - Colourfastness of the Dyed Samples

S.No	Sample	Colour fastness of sunlight	Colour fastness to pressing		Colour fastness to crocking		Colour fastness to washing		Percentage
			Dry Staining	Wet Staining	Dry Staining	Wet Staining	Dry staining	Wet staining	
1	AB 1:3 AP	4	5	5	5	5	5	5	97
2	AB 1:3 CP	5	5	5	4	4	5	5	80
3	AB 1:3 FP	5	5	5	3	3	5	5	89
4	AB 1:1 AP	4	5	5	5	5	5	5	97
5	AB 1:1 CP	5	5	5	4	4	5	5	91
6	AB 1:1 FP	5	5	5	4	3	5	5	91
7	AB 3:1 AP	4	5	5	5	4	5	5	94
8	AB 3:1 CP	5	5	5	4	4	5	5	94
9	AB 3:1 FP	5	5	5	3	3	5	5	89
10	AM 1:3 AP	4	5	5	5	3	5	5	91
11	AM 1:3 CP	5	5	5	4	3	5	5	91
12	AM 1:3 FP	5	5	5	4	3	5	5	91
13	AM 1:1 AP	4	5	5	5	3	5	5	91
14	AM 1:1 CP	5	5	5	5	4	5	5	97
15	AM 1:1 FP	5	5	5	4	4	5	5	94
16	AM 3:1 AP	4	5	5	5	4	5	5	94
17	AM 3:1 CP	5	5	5	5	4	5	5	97
18	AM 3:1 FP	4	5	5	4	3	5	5	89

Conclusion:

It could be inferred from this study that among the selected three natural dyes, three processed mordants, following post mordanting technique, samples dyed with annatto and babool dye in 3:1 proportion mordanted with ferrous sulphate, and also of the same dyes with 1:1 proportion using Copper sulphate and alum as mordants following post mordanting technique excelled by way of scoring maximum values with reference to selected parameters used for the study.

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