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Printing of cotton and silk fabric with marigold flower dye and guar gum

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Abstract
"Go Green is the talk of the day". With the green movement in full swing, implementing eco friendly practices can not only help the environment, but also attract new customers. Because clothing is in constant contact with our skin, the chemical used in dyeing and printing are absorbed into our skin through the pores and these create various skin problems. Natural dyes which are more aesthetic and safer for dyers as well as wearers are the solutions to the problems. Keeping in view the importance of eco-textiles and their increasing demand in national and international market the block and screen printing on cotton and silk fabric using Marigold flower dye with Guar Gum natural thickening agents were carried out. Aluminium potassium sulphate and ferrous sulphate mordants were used during the preparation of printing paste for the colour variation. Visual evaluation of the printed samples on the basis of prints and evaluation of colourfastness properties were also carried out. Very good to excellent block and screen prints were obtained with guar gum as thickening agent. Colour fastness results related to sunlight, washing, crocking, pressing and perspiration showed very good results.

Keywords: Natural dyes, natural thickening agents

Introduction
Clothing has been one of the most important necessities of man. It is human nature to adore himself with beautiful things, the art of textile ornamentation has been one of the ways to accomplish this task which has been in practice from the pre-historic era.

Primitive man went on to beautify his surroundings to satisfy the burning hunger for introducing grace and elegance into ordinary object of everyday life through colour and form. He was not contented to just live comfortably; he also wished to live graciously. Thus, beauty wedded to utility and art was born. The need for decoration shows the innate desire of all human being to rise above the ordinary and give vent to creativity. Man's urge to decorate his immediate surrounding has remained constant and has enchanted him through ages. In every civilization from remote ages to the present day, the art of dyeing and printing has played an important part in adding beauty to the world and makes an important contribution to fabric decoration. Dyeing and printing are the name given to the processes by which a comparatively permanent colour is imparted to certain bodies of which the most important are the textile fiber.

Textile material is dyed and printed for value addition, aesthetic look and fulfill the desire of the customers. The three basic necessity of life i.e., food, clothing and shelter and universally recognized of these, clothing leads to beauty and enhance the appearance of an individual. History testifies that man has throughout been inventing and creating for his aesthetic fulfillment.

India has a rich biodiversity and there is no doubt that the plant kingdom is a treasure house of diverse natural products. One such product from nature is the dye. Natural dyes have been a part of human life since time immemorial and were the only colourant in the world. But with the discovery of synthetic dyes, use of natural dyes has almost diminished. During last two decades, natural dyes have witnessed a process of revival. With the increasing awareness of consumers for eco textiles and need to preserve environment has lead to the revival of old practice of colouration with natural dyestuff. Due to the carcinogenic nature of some synthetic dyes and their intermediates natural dyes are being looked at as an "eco solution" to the ill effects of synthetic dyes.

Printing with natural dyes contributes to the added value of textiles and also responses to the increasing demand of compatibility with the environment. Printed textiles are fabrics on which a pattern is produced subsequent to the weaving of cloth by the application of dyestuff or pigment to the surface of the fabric so as to obtain various designs. A printed fabric can be produced by a wide variety of methods like stencil printing, block printing, screen printing, roller printing, resist printing, etc. textile printing has evolved itself over the course of last century in a very systematic and scientific way. Among all the printing techniques, screen printing and block printing are the most important industrially and commercially. Thickeners used in textile printing are high molecular weight compounds giving viscous paste in water. These impact stickiness and plasticity to the printing paste so that it can be applied to fabric surface without spreading and capable of maintaining the design outlines even under high pressure.

Natural thickening agents produced from vegetable raw materials. For textile printing, the thickeners used must be soluble in water. Guar gum, Gum Arabic, Gum tragancanth, Cereals, Gum Karaya, Locust bean gum, Alginates are natural thickening agents. The main function of thickener is to hold the dye particles in the desired place on the fabric until the transfer of dye into the fabric and its fixation are complete.

The objectives of present study are:

Aims and objectives

- Selection of raw material for the extraction of natural dye.
- Preparation of the printing paste with Guar gum.
- Printing of cotton and silk fabric using Block and Screen.
- Evaluation of the printed fabric.

Methodology

Selection and extraction of dye from selected raw material: Dye from many natural sources were extracted i.e., Ashoka leaves, madder, hibiscus flowers, onion peel, pomegranate rind and marigold flower. Dyes extracted from other sources are suitable for dyeing and printing with light shades whereas a dark colour was required for the printing. Madder roots was very expensive as it also gives darker shades i.e. Marigold flower was selected for the printing process due to availability in plenty. They are collected from the temples and marriage halls. The collected material was dried, soaked overnight in water. Dye was extracted following the standardized parameter. Dye material concentration – 6g/100ml of water boiled for 45 minutes and the solution was stirred frequently. After removal from beaker solution was strained through muslin cloth. The extracted solution was heated in order to make it concentrated to 7.5ml suitable for making printed paste.

Preparation of fabric: Cotton and Silk fabrics were soaked overnight in detergent and mild detergent respectively. Then they were washed thoroughly with water and dried in shade.

Selection of suitable mordants and mordanting techniques of fabric: Pre-mordanting and Simultaneous mordanting techniques were selected for the study. A 5% Solution of Aluminium Potassium Sulphate was prepared. The mordanting was carried out keeping the material to liquor ratio of 1:30 at room temperature. After mordanting the fabric was squeezed and air dried.

For simultaneous mordanting Ferrous Sulphate and Aluminium potassium sulphate was added into the printing paste itself respectively taking 5% solution. Pre- mordanting of fabric was done with Aluminium potassium sulphate on the other hand simultaneous mordanting was carried out with both Aluminium potassium sulphate and ferrous sulphate on Cotton and Silk.

Preparation of printing paste: Thickening agents were added gradually to the dye concentrate to make the consistency of printing paste suitable for printing with Block and Screen. To obtain the suitable paste, the thickening agent was added into the concentrated dye extract.

To attain the suitable paste, the thickening agent was poured into the dye slowly and mixed well. It was stirred vigorously to produce a uniform printing paste.

Printing of fabric Samples: Block and Screen printing was done on both Silk and Cotton fabric with Marigold dye and Guar gum as thickening agent.

Testing of the physical properties of the printed samples

- **Fabric thickness**: ISI (IS: 7702 - 1975)
- **Crease recovery**: ISI (IS: 4681 - 1968)
- **Bending Length test**: ISI (IS: 6490 - 1971)

Evaluation of colourfastness of printed samples-

Colourfastness to sunlight: It was tested as per the test method IS: 686-1985.

Colourfastness to washing: The samples were evaluated for washing fastness, washing was done as per IS: 3361-1979 method and evaluation was done with the help of grey scale.

Colourfastness to Crocking: The fastness against crocking was carried out according to IS: 766 – 1988 method.

Colourfastness to pressing

Preparation of test specimen: This is of great importance especially for the material meant for apparel purpose. For wet and dry pressing specimen of same size 2" x4" was cut from the printed fabric. They then sandwiched to white cotton fabric and stitched from 2 sides.

Procedure: For Dry pressing, a hot iron was placed on each of the composite specimen for 20seconds. Later the white piece was checked for staining and printed sample for colour change using grey scale.

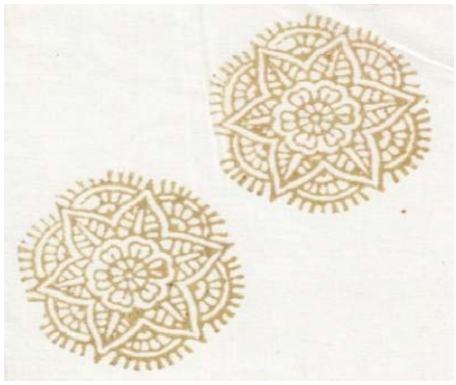
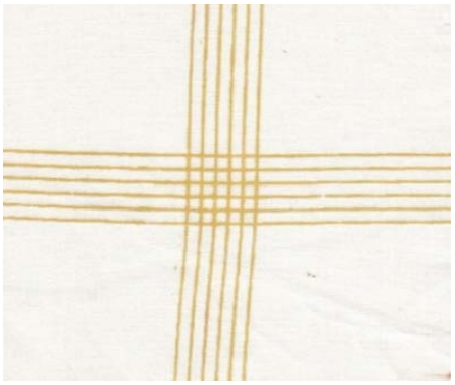
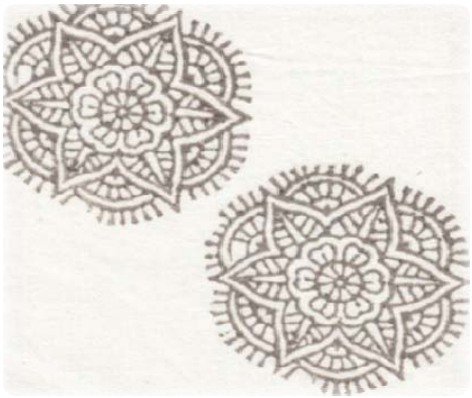
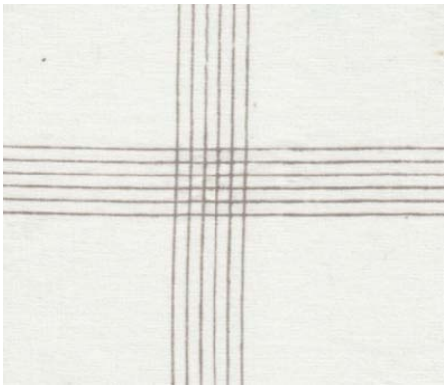
For wet pressing the sample of same size were put in the beaker and rinsed properly, then a hot iron was placed on the specimen. Five readings were taken from each sample.

Colourfastness to artificial perspiration: It was tested as per the test method IS: 971 – 1983.

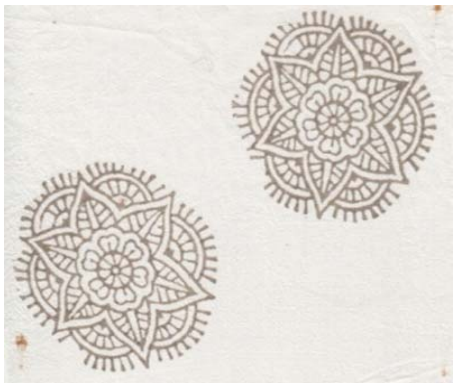
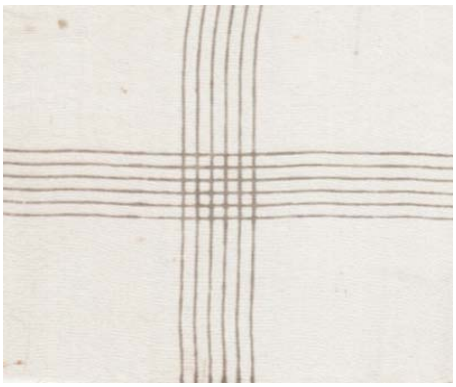
Table 1: Grades of colour change and staining

Grade	Color change	Staining	Colourfastness
5	No change in colour	No Stain	Excellent
4- 4/5	Slight Change	Slight Stain	Good
3- 3/4	Noticeable Change	Noticeable Stain	Moderate
2- 2/3	Considerable Change	Considerable Stain	Poor
1	Maximum change in Colour	Heavily Stain	Very Poor

Cotton Samples Printed With Guar Gum

Mordant	Block Printed	Screen Printed
Aluminium Potassium Sulphate		
Ferrous Sulphate		

Silk Samples Printed With Guar Gum

Mordant	Block Printed	Screen Printed
Aluminium Potassium Sulphate		
Ferrous Sulphate		

Results and Discussion

Optimized concentration of Thickening agent

The following quantity of the thickening agents was found to be optimum for preparing printing paste.

Table 2: Optimized concentration of Thickening agent

Thickening agents	Concentration in dye solution
Guar Gum	8 gm/100 ml

Results of Visual Evaluation Test

Table 3: Visual evaluation of cotton printed samples N = 30

Thickening Agents	Mordants	Printing Techniques	Sharpness of lines (%)					Uniformity of prints (%)					Clearity of background (%)				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Guar Gum	Alum	Screen	0.0	16.7	10.0	10.0	63.3	0.0	0.0	30.0	33.3	36.7	0.0	0.0	43.3	3.3	53.3
		Block	3.3	0.0	26.7	43.3	26.7	0.0	13.3	20.0	40.0	26.7	0.0	16.7	13.3	33.3	36.7
	Ferrous	Screen	0.0	3.3	13.3	23.3	60.0	3.3	3.3	20.0	26.7	46.7	0.0	0.0	20.0	36.7	43.3
		Block	0.0	0.0	16.7	30.0	53.3	0.0	0.0	30.0	20.0	50.0	0.0	0.0	23.3	30.0	46.7

It is clear from the table that the print qualities like sharpness of lines, uniformity of prints and clearity of background are best in the sample printed with Guar gum irrespective of mordants, mordanting techniques and printing techniques.

Table 4: Visual evaluation of silk printed samples N = 30

Thickening Agents	Mordants	Printing Techniques	Sharpness of lines (%)					Uniformity of prints (%)					Clearity of background (%)				
			1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Guar Gum	Alum	Screen	0.0	10.0	6.7	53.3	30.0	3.3	6.7	26.7	10.0	53.3	0.0	3.3	16.7	30.0	50.0
		Block	3.3	0.0	13.3	63.3	20.0	3.3	0.0	20.0	26.7	50.0	0.0	0.0	26.7	33.3	40.0
	Ferrous	Screen	0.0	6.7	16.7	33.3	43.3	0.0	3.3	6.7	26.7	63.3	0.0	20.0	13.3	10.0	56.7
		Block	0.0	6.7	6.7	23.3	63.3	0.0	6.7	23.3	6.7	63.3	0.0	0.0	26.7	33.3	40.0

It is clear from the above table that the print qualities like sharpness of lines, uniformity of prints and clearity of background are best in the sample printed with Guar gum irrespective of mordants, mordanting techniques and printing techniques.

Results of Colourfastness tests

The results of colourfastness tests of printed fabric to sunlight, washing, pressing, crocking and perspiration are presented in the following tables:

Colourfastness to sunlight

Table 5: Colourfastness of samples printed with Marigold flower dye and Guar gum to Sunlight

Days	Color-change							
	Samples simultaneously mordanted with ferrous sulphate				Samples pre-mordanted with aluminium potassium sulphate			
	Block		Screen		Block		Screen	
	Silk	Cotton	Silk	Cotton	Silk	Cotton	Silk	Cotton
1.	5	5	5	5	5	5	5	5
2.	5	5	5	5	5	5	5	5
3.	5	5	5	5	5	5	5	5
4.	5	5	5	5	5	5	5	5
5.	5	5	5	5	5	5	5	5
6.	5	4/5	5	4/5	5	4/5	5	4/5
7.	4/5	4/5	4/5	4/5	5	4/5	5	4/5

The results highlighted that the excellent colourfastness to sunlight of the samples printed with marigold flower dye and guar gum. A slight change in colour was noticed after 6-7 days exposure to sunlight on both silk and cotton samples printed with screen and block. There was no change in colour in the silk samples premordanted with aluminium potassium sulphate and printed with screen and block.

Colourfastness to Washing

Table 6: Colourfastness of silk fabric printed with Marigold flower dye and Guar Gum to washing

Sr. No.	Samples simultaneously mordanted with ferrous sulphate				Samples pre-mordanted with aluminium potassium sulphate			
	Block		Screen		Block		Screen	
	CC	S	CC	S	CC	S	CC	S
1.	5	5	5	5	5	5	5	5
2.	5	5	5	5	5	5	5	5
3.	5	5	5	5	5	5	5	5
4.	5	5	5	5	5	5	5	5
5.	5	5	5	5	5	5	5	5

CC- Color-change, S- Staining

The result revealed that the excellent colourfastness to washing of the silk fabric printed with marigold flower dye and guar gum. There was no colour change and staining on all the printed samples irrespective of different parameters of printing.

Table 7: Colourfastness of cotton fabric printed with Marigold flower dye and Guar Gum to washing

Sr. No.	Samples simultaneously mordanted with ferrous sulphate				Samples pre-mordanted with aluminium potassium sulphate			
	Block		Screen		Block		Screen	
	CC	S	CC	S	CC	S	CC	S
1.	5	5	5	5	5	5	5	5
2.	5	5	5	5	5	5	5	5
3.	5	5	5	5	5	5	5	5
4.	5	5	5	5	5	5	5	5
5.	5	5	5	5	5	5	5	5

CC- Color-change, S- Staining

The above table shows excellent colourfastness to washing of the cotton fabric printed with marigold flower dye and guar gum. No change in colour and no staining was noticed in both the samples simultaneously mordanted with ferrous sulphate and pre-mordanted with aluminium potassium sulphate.
Colourfastness to Crocking

Table 8: Colourfastness of silk fabric printed with Marigold flower dye and Guar gum to crocking

Sr.no	Samples simultaneously mordanted with ferrous sulphate								Samples pre-mordanted with aluminium potassium sulphate							
	Block printed samples				Screen printed samples				Block printed samples				Screen printed samples			
	Dry crocking		Wet crocking		Dry crocking		Wet crocking		Dry crocking		Wet crocking		Dry crocking		Wet crocking	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	4/5	5
2.	5	5	5	4/5	5	5	5	4/5	5	4/5	4/5	5	5	5	5	5
3.	5	5	4/5	5	5	5	4/5	5	5	5	5	4/5	5	5	5	5
4.	5	5	5	4/5	5	5	5	5	5	5	5	5	5	5	5	5
5.	5	5	4/5	5	5	4/5	4/5	4/5	5	4/5	4/5	5	5	5	4/5	5

CC- Color-change, S- Staining

The above table shows very good to excellent colourfastness to crocking of the silk samples printed with marigold flower dye and guar gum. No change in colour and staining was noticed in dry crocking of both the samples simultaneously mordanted with ferrous sulphate and pre-mordanted with aluminium potassium sulphate of screen and block. Slight change in colour and slight staining was found in adjacent fabric in wet crocking.

Table 9: Colourfastness of cotton fabric printed with Marigold flower dye and Guar gum to crocking

Sr.no	Samples simultaneously mordanted with ferrous sulphate								Samples pre-mordanted with aluminium potassium sulphate							
	Block printed samples				Screen printed samples				Block printed samples				Screen printed samples			
	Dry crocking		Wet crocking		Dry crocking		Wet crocking		Dry crocking		Wet crocking		Dry crocking		Wet crocking	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1.	5	5	5	5	5	5	4/5	5	5	5	5	5	5	5	5	5
2.	5	5	5	4/5	4/5	4/5	5	4/5	5	4/5	4/5	5	5	5	5	5
3.	5	5	4/5	5	5	5	5	5	5	5	5	4/5	5	5	5	5
4.	4/5	5	5	4/5	5	5	5	5	5	5	5	5	5	5	5	4/5
5.	5	5	4/5	5	5	4/5	4/5	4/5	5	4/5	4/5	5	5	5	4/5	5

CC- Color-change, S- Staining

Table no. 9 shows very good to excellent colourfastness to crocking of cotton samples printed with marigold flower dye and guar gum. No change in colour and no staining was noticed in dry crocking of both simultaneously mordanted with ferrous sulphate and pre-mordanted with aluminium potassium sulphate of screen and block printed samples whereas slight change in colour and slight staining was found on adjacent fabric in wet crocking.
Colourfastness to pressing

Table 10: Colourfastness of silk fabric printed with Marigold flower dye and Guar gum to pressing

Sr.no	Samples simultaneously mordanted with ferrous sulphate								Samples pre-mordanted with aluminium potassium sulphate							
	Block printed samples				Screen printed samples				Block printed samples				Screen printed samples			
	Dry pressing		Wet pressing		Dry pressing		Wet pressing		Dry pressing		Wet pressing		Dry pressing		Wet pressing	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1.	5	5	5	4/5	5	5	5	5	5	5	4/5	5	5	5	5	4/5
2.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3.	5	4/5	5	5	5	5	4/5	5	5	5	5	4/5	5	4/5	5	5
4.	5	5	5	4/5	5	5	5	5	5	5	5	5	5	5	4/5	5
5.	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5

CC- Color-change, S- Staining

Table no. 10 shows very good to excellent colourfastness to pressing of the silk samples printed with marigold flower dye and guar gum. No change in colour and no staining was noticed with dry pressing whereas no change in colour but slight staining were found on adjacent fabrics with wet pressing on screen and block printed samples.

Table 11: Colourfastness of cotton fabric printed with Marigold flower dye and Guar gum to pressing

Sr.no	Samples simultaneously mordanted with ferrous sulphate								Samples pre-mordanted with aluminium potassium sulphate							
	Block printed samples				Screen printed samples				Block printed samples				Screen printed samples			
	Dry pressing		Wet pressing		Dry pressing		Wet pressing		Dry pressing		Wet pressing		Dry pressing		Wet pressing	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1.	5	5	5	5	5	5	4/5	5	5	5	5	4/5	5	5	4/5	5
2.	4/5	5	4/5	4/5	4/5	4/5	5	4/5	4/5	4/5	4/5	5	5	5	5	5
3.	5	5	4/5	5	5	5	4/5	5	5	5	5	4/5	4/5	5	5	5
4.	4/5	5	4/5	4/5	5	5	5	5	4/5	5	5	4/5	5	5	5	4/5
5.	5	5	4/5	5	5	4/5	4/5	4/5	5	4/5	4/5	5	5	5	4/5	5

CC- Color-change, S- Staining

The above table shows very good to excellent colourfastness to pressing of silk samples printed with marigold flower dye and guar gum. Slight change in colour and slight staining was noticed with dry and wet pressing on all the printed samples irrespective of mordanting and mordanting techniques.

Colourfastness to artificial perspiration

Table 12: Colourfastness of silk fabric printed with Marigold flower dye and Guar gum to perspiration

Sr.no	Samples simultaneously mordanted with ferrous sulphate								Samples pre-mordanted with aluminium potassium sulphate							
	Block printed samples				Screen printed samples				Block printed samples				Screen printed samples			
	Acidic		Alkaline		Acidic		Alkaline		Acidic		Alkaline		Acidic		Alkaline	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1.	4/5	5	4/5	4/5	4/5	5	4/5	4/5	4/5	5	4/5	4/5	4	4/5	4/5	5
2.	4/5	4/5	4/5	5	4/5	5	4/5	4/5	5	5	4/5	5	4/5	5	4/5	5
3.	4/5	5	4/5	5	4/5	4/5	4/5	5	4/5	5	4/5	5	4/5	5	4/5	5
4.	4/5	5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4	4/5	4/5	4/5
5.	4/5	5	4/5	5	4/5	5	4/5	5	4/5	4/5	4/5	5	4/5	5	4/5	5

CC- Color-change, S- Staining

Table no. 12 shows very good to excellent colourfastness to perspiration of the silk samples printed with marigold flower dye and guar gum. Slight change in colour and slight staining was noticed in acidic as well as alkaline perspiration on screen and block printed samples irrespective to mordanting and mordanting techniques.

Table 13: Colourfastness of cotton fabric printed with Marigold flower dye and Guar gum to perspiration

Sr.no	Samples simultaneously mordanted with ferrous sulphate								Samples pre-mordanted with aluminium potassium sulphate							
	Block printed samples				Screen printed samples				Block printed samples				Screen printed samples			
	Acidic		Alkaline		Acidic		Alkaline		Acidic		Alkaline		Acidic		Alkaline	
	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S	CC	S
1.	4/5	5	4/5	4/5	4/5	4/5	4/5	5	4/5	5	4/5	5	4/5	5	4/5	5
2.	4/5	5	4/5	5	4/5	5	4/5	5	4/5	4/5	4/5	4/5	4/5	4/5	4/5	4/5
3.	4/5	4/5	4/5	5	4/5	4/5	4/5	4/5	4/5	5	4/5	5	4/5	5	4/5	5
4.	4/5	5	4/5	5	4/5	5	4/5	5	4/5	4/5	4/5	5	4/5	4/5	4/5	5
5.	4/5	4/5	4/5	5	4/5	5	4/5	5	4/5	5	4/5	5	4/5	5	4/5	5

CC- Color-change, S- Staining

Table no. 13 shows very good to excellent colourfastness to perspiration of the cotton samples printed with marigold flower dye and guar gum. Slight change in colour and slight staining was noticed in acidic as well as alkaline perspiration on screen and block printed samples of both simultaneously mordanted with ferrous sulphate and pre-mordanted with aluminium potassium sulphate.

Table 14: Physical properties of silk and cotton fabric Screen printed with Marigold dye

Printed Samples with different thickening agents	Average Thickness (mm)	% increase in Thickness	Crease Recovery (º)		Bending length (inch.)			
			Warp	Weft	Warp	% of Bending length	Weft	% of Bending length
Controlled Sample	0.09		120	115	1.5		1.1	
Silk fabric								
GG Screen	0.107	18.88%	105	106	1.7	11.7%	1.5	36.36%
GG Block	0.104	15.55%	102	107	1.8	20%	1.4	27.27%
Cotton fabric								
Controlled Sample	0.301		105	100	2.2		1.8	
GG Screen	0.301	0 %	101	98	2.3	4.54%	1.8	0%
GG Block	0.323	7.30%	100	98	2.3	4.54%	1.9	5.55%

GG- Guar gum

Fabric Thickness: It can be concluded that for Cotton samples printed with Screen and Block shows no increase in thickness with Guar Gum. For Silk samples printed with screen printing it shows little increase in thickness.

Crease Recovery: It can be concluded that Guar Gum shows the minimum crease recovery for both cotton and silk screen and block printed samples.

Bending Length: It can be concluded for cotton and silk samples printed with screen and Block shown little increase in bending length printed with guar gum.

Samples screen and block printed with guar gum on cotton and silk fabric

Screen Printing

Block Printing

Conclusion

From the present study it can be concluded that Guar gum as thickening agent with Marigold flower extracts can be used successfully for the printing of cotton and silk fabric. As the optimized concentration of guar gum as thickening agent is 8 gm/ 100 ml dye solution. The colourfastness and physical properties of the samples with all the parameters were good to excellent.

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