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Effect of printing on physical properties of muga silk fabric with reactive and acid dyes

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Abstract
The pride of India, muga silk is known for its natural shimmering golden colour. The most expensive of silks, muga is intrinsically woven into the cultural traditions of the people of Assam. In recent times, fashion designers have found exciting prospects in using muga silk for developing new products and designs. This can be further enhanced by printing the muga silk fabric with novel and striking shades using synthetic dyes. The printed muga silk fabric will increase the scope of muga silk in local market as well as in global market for apparel, household and decorative handicraft items. The present research work was undertaken to explore an innovative idea of printing muga silk with reactive and acid dyes. The research work included the printing of muga silk fabric with reactive and acid dye and to see the effect of printing on the physical properties of the fabric.

Keywords: Physical, muga silk fabric, Acid dyes

1. Introduction

"In textiles, the fabric provides the body, dyeing provides the soul and printing provides the life."

Printing is one of the traditional fabric decoration techniques. It is a creative art nurtured and patronized through centuries. The main objective of textile printing is the production of attractive designs with well defined boundaries made by the artistic arrangement of a motif or motifs in one or more colours. Printing brings any textile material into full bloom by conferring flexibility to it for fashion designs. Printed silks of India have always been valued worldwide for their rich colours and fine designs. The Indian silk displays the wealth of the textile art in India owing to production of all four variety of silk here. India is the only country, which produces the golden colour muga silk. On muga silk, the traditional colours like red, green and black can provide a dramatic effect against the golden background. Colours look exceptionally bright when applied on silk. The colouring of silk products requires culmination of art and science of textile colouration. The exclusive fashion goods, according to global demands and standards, are thus possible only on joining the hands of designers and colourist. Synthetic dyes are synthesized from chemicals in quantities as per requirement of textile industry. They are available in wide range of colours and can be applied easily. Silk is proteinous in nature, so it is mostly dyed with acid and reactive dyes to have bright shades and ease in application. Reactive dyes have gained importance by virtue of brilliancy of colours, good all-round fastness properties and comparatively low cost. The most important characteristic of reactive dyes is the formation of covalent bonds with the substrate on which they are applied due to which it becomes permanent in fabrics as compared to other dye types. Silk occupies second position among textile fibres to be dyed invariably with acid dyes because it gives very bright shades and good fastness against light. Acid dyes are soluble in water and being salts of a strong acid; they give neutral solutions and act as strong electrolytes in aqueous solution. Therefore, present study was planned to print muga silk fabric with acid and reactive dyes and to see the effect of printing on its physical properties.

Methodology

The methods and materials used in the present study were as follows:

Fabric used

Plain weave fabric with count of 90 x 110 and weight 64 g/ sq meter was used as substrate for printing. The samples measuring 10 inch x 10 inch of muga silk fabric were taken for the printing purpose.

Dyes Used

One reactive dye (Procian brilliant red H-8B) and one acid dye (Acid red-RS) were used for printing process.

Thickeners used

The gums or thickeners used in textile printing are high molecular weight compounds giving viscous paste in water. Two gums namely, mixture of guar gum and sodium alginate (50:50) and guar gum were used for reactive and acid dye, respectively. These gums were selected on the basis of their fastness properties they attribute to printed fabric.

Equipment used

The equipment used in the study is given in Table 1

Table 1: List of equipment used in the study

Equipment	Purpose	Test method used
KMI Electronic tensile strength tester	Fabric strength test	(IS: 1969- 1968)
Martindale Abrasion Tester	Abrasion resistance test	-
Crease recovery Tester	Crease recovery Test	(IS: 4681-1968)
Fabric thickness Gauge	Fabric thickness	(IS: 7702 – 1975)
Eureka stiffness tester	Fabric stiffness test	(IS: 6490 – 1971)
Nikon microscope E-400	Microscopic structure of muga silk fibre	-

Pre – Testing

The physical properties of the muga silk fabric were tested before its preparation for printing i.e., scouring and actual printing. The properties assessed were fabric weight, fabric thickness, fabric stiffness, tensile strength, crease recovery, pilling resistance and abrasion resistance.

Preparation of the fabric

The muga silk fabric was scoured with detergent solution prepared @ 0.5 ml of mild detergent (Ezee) per 100 ml of water and maintaining material to liquor ratio as 1:30. Fabric was soaked into the detergent solution for 45 minutes at room temperature (30˚C) with occasional gentle stirring to make the fabric soft and absorbent.

Printing

The samples were printed with reactive and acid dye using standard recipe of printing with each dye as given in Table 2 and 3, respectively.

The printing pastes of both dyes were prepared separately using their respective gums. The fabric samples were printed using screen printing technique. The printed samples of both the dyes were steamed in a laboratory steamer at 100˚C for 15 minutes in the case of reactive dye and for 30 minutes in the ase of acid dye. The steamed samples were rinsed thoroughly in running cold water and then in warm water to remove the superficial dye and gum from fabric surface, if any.

Table 2: Printing recipe for Reactive dye

Dye	0.36 g
Gum (mixture of guar gum and sodium alginate)	10 g
Sodium bicarbonate	0.36 g
Urea	1.2 g

Table 3: Printing recipe for Acid dye

Dye	0.3 g
Gum (guar gum)	10 g
Tartaric acid	0.4 g
Glycerine	0.28 g

Testing of physical properties

The physical properties of control, washed and printed muga silk fabrics were compared to study the effect of printing on physical properties of muga silk fabric. The control sample in the study was muga silk fabric sample as purchased from the market. The fabric was washed to remove finishing agents to prepare it for printing and was called washed sample.

Results and Discussion

Microscopic structure

The surface characteristics of control, washed and printed muga silk fibres were investigated through microscopic study at magnification 40 x. The longitudinal view of control muga fibre showed characteristic longitudinal striations and irregular width (*Fig 1*). The striated appearance of wild silk is evident because structurally the fibre is composed of minute filaments called fibrils or micelles. A smooth and lustrous surface was observed in the case of washed fibres (*Fig 2*). There were remarkable changes in the surface characteristics of the fibres after printing it with reactive dye and acid dye (*Fig 3 and 4* respectively). This may be due to the reason that washing, printing and steaming processes removed the gum sericin from the surface of the fibres and thus imparted smoothness to fabric surface. Longitudinals view showed that printed silk fibres appeared as a smooth, lustrous, translucent filament and showed very slight variations in diameter along its length.

Fig 1: Longitudinal view of control muga silk fibre

Fig 2: Longitudinal view of washed muga silk fibre

Fig 3: Longitudinal view of muga silk fibre printed with reactive dye

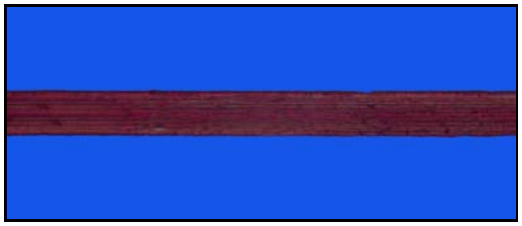

Fig 4: Longitudinal view of muga silk fibre printed with acid dye

Fabric thickness

Table 4: Thickness of muga silk fabric before and after printing

Sl. No.	Sample	Thickness (mm)	Per cent increase
1.	Control	0.12	-
2.	Washed	0.13	08.3
3.	Printed with reactive dye	0.13	08.3
4.	Printed with acid dye	0.13	08.3

Table 4 shows that thickness of muga silk fabric increased after washing. There was 8.3 per cent increase in thickness of muga silk fabric after washing. This may be due to swelling of the fibres after scouring. But there was no change in thickness of fabric sample after printing when compared to washed fabric sample. This can be due to the fact that after printing, steaming and washing, dye is absorbed in the fabric and thickener layer is washed off thus imposing no extra thickness to the fabric as suggested by Shenai (1976) [11].

Fabric weight

The weight of the control muga silk fabric sample was 0.040 (g/inch^2) which decreased after washing and on printing. After washing, there were 12.5 per cent loss in the fabric weight. The weight of fabric sample decreased further on printing. After printing with reactive dye there was 17.5 per cent loss and in the case of samples printed with acid dye there was 15 per cent loss in fabric weight. This weight loss on washing may be due to the removal of the finishing agents from the control fabric that may include sizing agents, gum sericin and superficial impurities (*Table 5).*

Table 5: Weight of muga silk fabric before and after printing

Sl. No.	Sample	Fabric weight (g/inch^2)	Per cent loss
1.	Control	0.040	-
2.	Washed	0.035	12.5
3.	Printed with reactive dye	0.033	17.5
4.	Printed with acid dye	0.034	15

Bending length

Table 6: Bending length of muga silk fabric before and after printing

Sl. No.	Sample	Bending length (cm)		Per cent decrease	
		warp	weft	warp	weft
1.	Control	3.6	4.9	-	-
2.	Washed	2.3	3.6	36.1	26.5
3.	Printed with reactive dye	2.5	4.0	30.5	18.3
4.	Printed with acid dye	2.6	3.9	27.7	20.4

Bending length decreased after washing and printing when compared with control sample. The bending length of the control muga silk fabric was 3.6 cm in warp direction and 4.9 cm in weft direction. After washing per cent loss in bending length was 36.1 per cent and 26.5 per cent warp way and weft way, respectively. After printing with reactive dye, the per cent decrease was 30.5 per cent warp way and 18.3 per cent weft way. In the case of acid dye printed samples, per cent loss in bending length was 27.7 per cent and 20.4 per cent warp and weft way, respectively, when compared to control sample. The decrease in bending length may be due to the reduction in stiffness and removal of impurities and gum sericin from the surface of the fabric. According to Gulrajani and Malik (1993) [6], removal of brittle gum, sericin makes the silk fabric flexible, thus decreasing its bending length. But when printed samples were compared to washed fabric there was slight increase in bending length in both warp and weft directions (Table 6).

Crease recovery

Table 7: Crease recovery of muga silk fabric before and after printing

Sl. No.	Sample	Crease recovery angle (°)		Per cent increase	
		warp	weft	warp	weft
1.	Control	60.4	63.3	-	-
2.	Washed	64.6	66.7	6.6	5.3
3.	Printed with reactive dye	65.7	68.1	8.7	7.5
4.	Printed with acid dye	65.2	67.8	7.9	7.1

It is evident from Table 7 that crease recovery angle was improved after washing and printing of fabric. The crease recovery angle of control muga silk fabric was 60.4^0 and 63.3^0 in warp and weft directions, respectively. In washed fabric sample, the crease recovery increased 6.6 per cent warp way and 5.3 per cent weft way. In reactive dye printed samples there was maximum per cent increase in crease recovery i.e., 8.7 per cent warp way and 7.5 per cent weft way. Crease recovery of samples printed with acid dye was less as compared to samples printed with reactive dye. After printing crease recovery angle increased due to the structure relaxation, during which the most strained segments of the molecules disappear and turn into moderately strained segments (Pavlov and Nedkova 2001) [10].

Tensile strength

Table 8: Tensile strength of muga silk fabric before and after printing

Sl. No.	Sample	Tensile strength (kg/cm)		Per cent decrease	
		warp	weft	warp	weft
1.	Control	4.14	5.88	-	-
2.	Washed	3.87	5.43	6.5	6.2
3.	Printed with reactive dye	3.61	5.24	12.8	10.8
4.	Printed with acid dye	3.52	5.12	14.9	12.9

The tensile strength of control and printed samples was carried out in both warp and weft direction and results are given in Table 8. It is clear from the table that the tensile strength of muga silk fabric sample is more in weft direction as compared to warp direction. This may be due to the reason that at the time of weaving the warp threads are subjected to high tension and have undergone permanent elongation. Thus have less tensile strength in warp way as compared to weft way.

The tensile strength of control muga silk fabric was 4.14 kg/cm warp way and 5.88 kg/cm weft way. After washing there was 6.5 per cent loss in warp direction and 6.2 per cent loss in weft direction. After printing with reactive dye, tensile strength decreased 12.8 per cent in warp and 10.8 per cent in weft direction. The per cent loss in the tensile strength of samples acid dye was more as compared to samples printed with reactive dye.

Abrasion resistance and Pilling

There was no weight loss due to abrasion even after 2500 cycles in the control muga silk fabric as well as in washed and printed samples of reactive and acid dyes. Therefore, it was concluded that the abrasion resistance of muga silk fabric was very good and was not affected even by printing. In case of pilling, it was found that all the samples were pilling resistant. This may be due to the fact that silk fabric used in the study had high tensile strength and was made up of filaments and therefore, there were no protruding fibre ends on the surface of the fabric, thus no pilling was found on muga silk fabric samples.

Conclusion

Effect of printing on physical properties of muga silk fabric was assessed by comparing results of physical testing conducted before and after printing. The fabric weight, tensile strength and bending length decreased slightly after printing but crease recovery of the muga silk fabric improved after printing. Printing had no effect on thickness of the fabric. Thus it could provide a viable option to cottage level industries for their development, value addition and product diversification.

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