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Fabric Thickness and Quality Characteristics of Screen-Printed Polyester Fabric using Disperse Dye and Gum Acacia

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ABSTRACT

Textile printing, sometimes referred to as "textile makeup," is a versatile and important technique for adding colour and design to textile fibres. The dyes and other auxiliaries are glued with a natural or synthetic thickening agent to confine the colouring materials to the design area on textile material.Plant-based products are preferred over synthetic ones since they are irritant-free. Natural materials are frequently regenerative, non-polluting sources for a sustainable supply.The present study investigated the effect of fabric thickness on the printing quality of polyester fabrics with different constructional parameters.The polyester fabric of different thicknesseswas procured and printing on them was done using gum acacia along with disperse dyes. Printing was done using fine and bold print. After printing samples were assessed by a panel of judges to assess printing qualities.Based on the qualitative and quantitative analysis, it was found that samples of polyester fabric which had less thickness had better printing quality compared to the polyester fabric having more thickness.

KEYWORDS: Printing;Natural gums;Thickness of fabric;Printing qualities;Disperse dye.

1. INTRODUCTION

The art of textile printing is probably as old as civilisation itself, beginnings of the art of stamping or printing on fabric may be traced to the earliest times. The Far East is said to be the region where the art first emerged since there, in ancient times, people were known to have used wood blocks for manual printing. As early as 500 B.C., they were known to have printed fabric (***Solangi et al.,2012***).

However, the fundamental goal of textile printing is to create pleasing patterns with well-defined borders using a creative arrangement of motifs (designs) in one or more colours.In other words, the different patterns are created by applying dyes and pigments locally or randomly.Printing is referred to as localised

dyeing.Printing and dyeing both use the same force that acts between the fibre and the dye (***Milies., 1994***).

Textile printing sometimes referred to as "textile makeup," is a versatile and important technique for adding colour and design to textile fibres. It is the most useful and significant.Analytically speaking, it combines a design concept, one or more colourants, and a textile substrate (often a cloth) while utilising a method for applying the colourants fairly precisely. Generally, printing is a form of dying where certain sections of the cloth are coloured rather than the complete thing. More so than with plain coloured materials, the multicoloured patterns that develop offer beautiful and creative aspects (***Ebrahim et al.,2021***).

The colouring is produced by adding dyes or pigments to the printing paste. The dyes and other auxiliaries are glued with a natural or synthetic thickening agent to confine the colouring materials to the design area on textile material (***Milies., 1994***),Because of their biocompatibility and low toxicity, plant-based thickeners are appealing substitutes for synthetic thickeners. Plant products are favoured over synthetic ones because they are more readily accessible, less expensive, and naturally non-irritating (***Solangi et al.,2012***). Additionally, natural materials are often renewable, non-polluting sources for a sustainable supply. Some drawbacks of synthetic thickeners include their high cost, toxicity and environmental damage.They come from non-renewable sources and might have negative side effects. Concern about the environment has sparked a growing interest inrecent years. Researchers nowadays are seeking environmentally suitable substitutes.

Natural gums have the potential to be employed as a textile thickening agent because of their biocompatibility, low toxicity, environmental friendliness, and low cost when compared to manufactured alternatives.

The researchers have done studies on printing various textile substrates like cotton (***Babel et al.,2015***), polyester ***(Klahal et al.,2012)***, etc., using tamarind kernel powder, and aloe vera gel as a thickening agent. But as per the knowledge of the author,no study was done previously on the effect of fabric thickness on the printing quality of polyester fabrics with natural gum. This present study aimed to assess screen printing quality characteristics on fabrics with different thicknesses.

2. MATERIALS AND METHODS

Two 100% polyester fabrics having different thicknesses were procured from the market. Fabrics hada plain weave and other characteristics are given in Table 1.Other materials used for printing involved Disperse dye (dispersal blue) which was procured from Shri Ji Dyes and Chemicals (India) and natural gum (Gum Acacia) was procured from P J Enterprises, Mumbai was used as thickener.

Table 1. Physical parameters of selected polyester fabrics

Fabric	Weight (gsm)	Thickness (mm)	Fabric count	
			Ends/cm	Picks/cm
Fabric 1	120	0.18	56	34
Fabric 2	150	0.20	72	54

Steps involved in printing are as follows

1. **Scouring of polyester:** Polyester fabrics were scoured for one hour at 50-55°C with 1 ml/L Lissapol N and 0.2 g/Lsodium Carbonate (Na_2CO_3).
2. **Preparation of thickener paste:** A paste of natural gum named Gum Acacia was prepared by soaking overnight in distilled water and then thoroughly mixing.Gum Acacia natural thickener was prepared by soaking gums overnight in 100 ml of water follows by slow stirring for around 30 min, later, the thickener prepared was stirred for 30 min again, using a high-speed stirrer for achieving a uniform composition.
3. **Printing recipe and screen printing:** The recipeused for printing (by Shenai,1985) is given in Table2.

Table 2. Recipe for the printing of polyester with carrier

Disperse dye	0.75 g
Water	1.5mL
Carrier	0.25 mL
Glycerin	0.5 mL
Resist salt L	0.25 g
Thickener	X
Total	50

Polyester fabrics were flat screen-printed manually using a printing paste prepared as per the recipe mentioned above. The present study used two types of designs viz., bold and fine prints. The printed samples were dried at

room temperature for about 15 min. The fixation was carried out by steamingthe samples at 120^{0}C for 10 min.Printing samples will be rinsed with cold water for 20 minutes and then hot water at 80^{0}C for 20 min, followed by a soaping agent with an anionic detergent (2g/l), then rinse well and air-dried at room temperature. Plate No. 1shows printed fabrics.

Plate no.1. Samples printed (Fabric with less thickness and more thickness) with gum acacia as a thickener with Disperse dye

Name of Sample	Fine print	Bold Print
Fabric 1 Gum Acacia		
Fabric 2 Gum Acacia		

4. Assessment of Printed samples (Visual Assessment)

Printed samples were visually evaluated by 50-panel members for different parameters namely Uniformity of print, Sharpness in Outlines and Overall Appearance on a five-point rating scale. A five-point rating scale is given in Table 3. These experts were comprised of faculty members, Senior Research Fellows along with M.Sc. and Ph.D. students of the Departments of Clothing and Textiles department.

Table 3: Five point rating scale used for the evaluation

Sl. No.	Rating	Level of Scale
1	5	Excellent
2	4	Very Good
3	3	Good
4	2	Fair
5	1	Poor

3. RESULT AND DISCUSSION

Results of the visual evaluation of the printed sample using gum acacia are presented in Tables4.

Table 4: WMS for Visual evaluation of screen-printed samples using Gum Acacia for different parameters

Parameters	WMS (Fabric 1)		WMS (Fabric 2)	
	Fine Print	Bold Print	Fine Print	Bold Print
Uniformity of print	3.24	3.5	2.9	3.02
Sharpness in Outlines	3.46	3.48	3.44	3.52
Overall Appearance	3.34	3.62	3.22	3.34
Average	3.34	3.53	3.18	3.29

Table4shows WMS scored by fabric printed with gum acacia. It is clear from the table that fabric 1 secured the highest WMS for uniformity of print, sharpness in outlines and overall appearance for bold

print i.e., 3.5, 3.48 and 3.62 respectively among all the samples printed with gum acacia. It is also clear from the table that fabric1 secured maximum WMS compared to fabric 2 irrespective of fine or bold print.

Fig 1: Mean of visual evaluation done for printed fabric

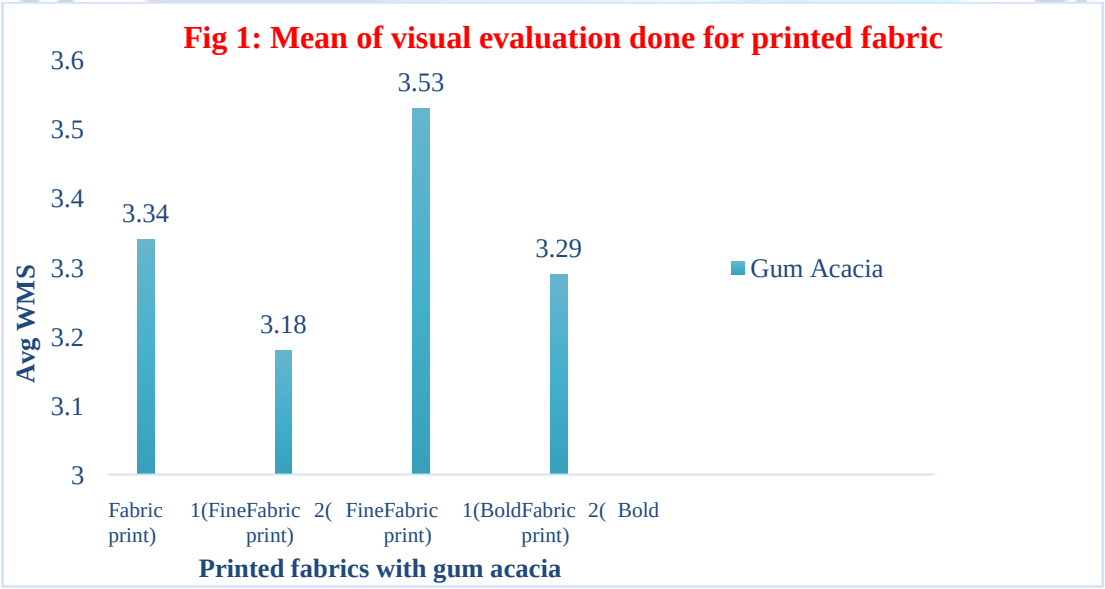

Figure 1 depicts the analysis of data related to the mean of visual evaluation done for printed fabrics, it is evident from the figure that maximum preference was given to Gum Acacia for Fabric 1 under bold print followed by Fabric 2 under bold printon the basis of various printing characteristics such as uniformity of print, sharpness in outlines and overall appearance for finebold printby the experts.

BOD AND COD

The central pollution control board (CPCB) has given standards for the discharge of wastewater from different industries. Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) were assessed for the release of printing effluent into the river by comparing with standards given by CPCB, these parameters were assessed to check the eco-friendliness of the printing process. The wastewater samples collected at different steps of the printing process were coded and are given below:

Stage 1 WOF- wastewater collected after initial washing of polyester fabric

Stage 2 PW-wastewater collected after the printing of samples (from washing of paste containers, screen and squeegee)

Stage 3AW-wastewater collected after treatment of printed samples following steaming

Table 5. BOD and COD of wastewater generated during the Printing Process of Fabric 1

S.NO.	Sources of Wastewater		Parameters	
			BOD (mg/l)	COD (mg/l)
	*Permissible limit (Discharge in inland water)		30	250
1.	Stage 1 Pre-treatment	WOF	20.2	94
2.	Stage 2 Printing Waste	Gum Acacia PW	36.6	222.2
3.	Stage 3 Washing Waste	Gum AcaciaAW	29.9	204

*Standard for discharge of Treated Textile effluent in inland water as per Environment (Protection) Fifth Amendment Rules, 2016, Ministry of Environment, Forest and Climate Change, India.

Table 6. BOD and COD of wastewater generated during the Printing Process of Fabric 2

S.No.	Sources of Wastewater		Parameters	
			BOD (mg/l)	COD (mg/l)
	*Permissible limit (Discharge in inland water)		30	250
1.	Stage 1 Pre-treatment	WOF	24.3	130
2.	Stage 2 Printing Waste	Gum Acacia PW	41	227
3.	Stage 3 Washing Waste	Gum Acacia AW	32	209

*Standard for discharge of Treated Textile effluent in inland water as per Environment (Protection) Fifth Amendment Rules, 2016, Ministry of Environment, Forest and Climate Change, India.

Tables 5 and 6depict the analysis of data related to the BOD and COD values of effluent collected after pre-treatments, printing waste and washing waste. It is clear from both the tables that BOD and COD values of pre-treatments were less compared to printing waste. They were under the permissible limit as prescribed by Environment (Protection) Fifth Amendment Rules, 2016. It is also seen from the tables that Gum acacia printed wastes BOD and COD values were within the permissible limit. It is also obvious from (Table 4) regarding visual evaluation, that Gum acacia for fabric 1 has secured the highest WMS with respect to printing characteristics.

4. CONCLUSION

It can be concluded from the results that fabric1(having less thickness) printed with natural thickenerGum Acacia secured maximum WMS compared to Fabric 2(having more thickness) irrespective of the fine or bold print due to less thickness of fabric 1, the dye molecules easily penetrate within the fabric gives best results in all the parameters and also printing from natural thickeners are eco-friendly and effluent released from these are in permissible limit creating less pollution and Gum Acacia was recommended as effluent quality well within the permissible limit.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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