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EFFECT OF FABRIC THICKNESS ON PRINTING QUALITY OF POLYESTER FABRIC PRINTED USING NATURAL GUM AND DISPERSE DYE

Vinita Singh [1*] and Sakshi [2]

[1] Ph.D. Scholar and [2] Associate Professor

Department of Clothing and Textiles, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar Uttarakhand-263145, India

[*] Corresponding author:

vinitasingh2547@gmail.com

AUTHOR- VINITA SINGH, Research Scholar, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand

vinitasingh2545@gmail.com

Contact no. - 9711760294

SECOND AUTHOR- SAKSHI, Associate Professor, College of Home Science, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand

sakshi_ct@rediffmail.com

Contact no. - 9457011191

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 thicknesses was procured and printing on them was done using natural gums 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: Polyester; Printing; Natural gums; Thickness of fabric; Disperse dye.

INTRODUCTION

The art of textile printing is probably as old as civilisation itself, the beginnings of the art of stamping or printing on fabric may be traced to the earliest times. The Far East is said to be where art first emerged since 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 [6].

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

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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 [3].

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 [2].

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 [3], 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 [6]. 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 in recent 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.

Printability is a combination of thickness-related factors that contribute to achieving the desired print quality level and relates to the fabric's ability to absorb dye or pigment. An important property of dye on fabric is its setting behaviour. The spread and placement of the dye on the fabric surface is affected by the surface structure of the fabric. The researchers have done studies on printing various textile substrates like cotton [1] polyester [4] 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 gums. This present study aimed to assess the quality characteristic of screen printing on fabrics having different thicknesses.

MATERIALS AND METHODS

Two 100% polyester fabrics having different thicknesses were procured from the market. Fabrics had a 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 gums (Guar gum, Gum tragacanth, Gum Arabic, Gum Talha and Sodium alginate gum) were procured from P J Enterprises, Mumbai were used as thickeners.

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/L sodium Carbonate (Na_2CO_3).
2. **Preparation of thickener paste:** A paste of each natural thickener named Guar gum, Gum tragacanth, Gum arabic, Gum talha and Sodium alginate gum were prepared by soaking overnight in distilled water and then thoroughly mixing. Different 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 recipe used for printing [5] is given in Table 2.

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 (Different natural gums)	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 steaming the samples at 120^0C for 10 min. Printing samples will be rinsed with the cold water for 20 minutes and then hot water at 80^0C 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. 1 and 2 show printed fabrics.

Plate no.1. Samples printed (Fabric with less thickness) with different natural thickeners with Disperse dye

Name of Sample	Fine print	Bold Print
Fabric 1 Gum Talha		

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Fabric 1 Gum Acacia		
Fabric 1 Gum Tragacanth		
Fabric 1 Sodium Alginate		
Fabric 1 Guar Gum		

Plate no.2. Samples printed (Fabric with more thickness) with different natural thickeners with Disperse dye

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

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Fabric 2 Gum Tragacanth		
Fabric 2 Sodium Alginate		
Fabric 2 Guar Gum		

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. 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

III. RESULT AND DISCUSSION

Results of the visual evaluation of the printed sample using different gums in presented in Tables 4 to 8.

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

Parameters	WMS (Fabric 1)		WMS (Fabric 2)	
	Fine Print	Bold Print	Fine Print	Bold Print
Uniformity of print	4.02	4.06	3.54	3.86
Sharpness in Outlines	4.02	4.04	3.76	3.8
Overall Appearance	4.18	4.24	3.86	3.92
Average	4.07	4.10	3.72	3.86

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Table 4 shows WMS scored by fabric printed with gum Talha. 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., 4.06, 4.04 and 4.24 respectively among all the samples printed with Talha gum. It is also clear from the table that fabric 1 secured maximum WMS compared to fabric 2 irrespective of fine or bold print.

Table 5: 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

Table 5 shows 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.

Table 6: WMS for Visual evaluation of screen-printed samples using Gum Tragacanth for different parameters

Parameters	WMS (Fabric 1)		WMS (Fabric 2)	
	Fine Print	Bold Print	Fine Print	Bold Print
Uniformity of print	2.86	2.94	2.62	2.78
Sharpness in Outlines	3.04	3.05	2.8	2.92
Overall Appearance	2.98	3.1	2.78	2.82
Average	2.96	3.03	2.73	2.84

Table 6 shows WMS scored by fabric printed with gum tragacanth. 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., 2.94, 3.05 and 3.1 respectively among all the samples printed with gum tragacanth. It is also clear from the table that fabric 1 secured maximum WMS compared to fabric 2 irrespective of fine or bold print.

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Table 7: WMS for Visual evaluation of screen-printed samples using Sodium Alginate for different parameters

Parameters	WMS (Fabric 1)		WMS (Fabric 2)	
	Fine Print	**Bold Print**	**Fine Print**	**Bold Print**
Uniformity of print	3.89	4.16	3.48	3.56
Sharpness in Outlines	3.68	3.92	3.54	3.76
Overall Appearance	3.78	4.1	3.8	3.96
Average	3.78	4.06	3.60	3.76

Table 7 shows WMS scored by fabric printed with sodium alginate. 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., 4.16, 3.92 and 4.1 respectively among all the samples printed with sodium alginate. It is also clear from the table that fabric 1 secured maximum WMS compared to fabric 2 irrespective of fine or bold print.

Table 8: WMS for Visual evaluation of screen-printed samples using Guar Gum for different parameters

Parameters	WMS (Fabric 1)		WMS (Fabric 2)	
	Fine Print	**Bold Print**	**Fine Print**	**Bold Print**
Uniformity of print	2.69	2.9	2.52	2.59
Sharpness in Outlines	2.48	2.72	2.2	2.46
Overall Appearance	2.62	2.82	2.38	2.66
Average	2.59	2.81	2.36	2.57

Table 8 shows WMS scored by fabric printed with guar gum. 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., 2.9, 2.72 and 2.82 respectively among all the samples printed with guar gum. 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

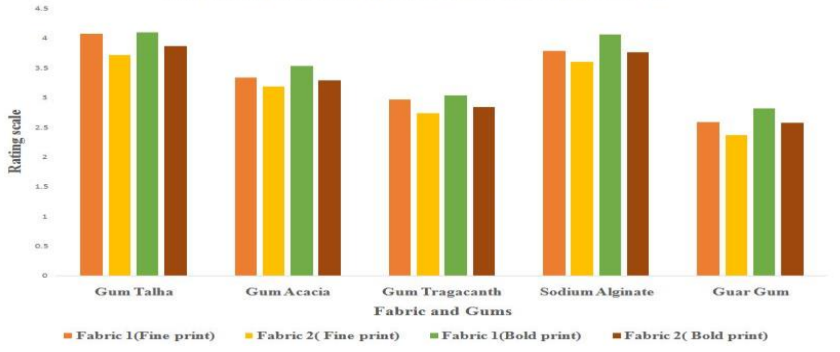

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Figure 1 depicts the analysis of data related to the mean of visual evaluation done for printed fabrics, it is evident from the figure that maximum preference was given to Gum 1(Gum Talha) followed by Gum 4 (sodium alginate) on the basis of various printing characteristics such as uniformity of print, sharpness in outlines and overall appearance for fine bold print by 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 the washing of paste containers, screen and squeegee)

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

Table 9. 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 1 PW	28.2	206.6
		Gum 2 PW	36.6	222.2
		Gum 3 PW	35.2	214.8
		Gum 4 PW	37.4	224.6
		Gum 5 PW	31.2	226.1
		Gum 1 AW	21.5	182.1

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3.	**Stage 3 Washing Waste**	Gum 2AW	29.9	204
		Gum 3AW	30.28	202.5
		Gum 4AW	32.1	213.7
		Gum 5AW	24.2	215.4

*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 10. 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 1 PW	31.1	210
		Gum 2 PW	41	227
		Gum 3 PW	39	220
		Gum 4 PW	40.2	228
		Gum 5 PW	35	230
3.	**Stage 3 Washing Waste**	Gum 1AW	25	186
		Gum 2AW	32	209
		Gum 3AW	34	208
		Gum 4AW	36.6	217
		Gum 5AW	28.9	220

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*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 9 and 10 depict 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 1 (Gum Talha) printed wastes BOD and COD values were within the permissible limit. It is also obvious from tables 4 to 8 regarding visual evaluation, that Gum 1(Gum Talha) has secured the highest WMS w.r.t printing characteristics.

CONCLUSION

It can be concluded from the results that fabric 1(having less thickness) printed with natural thickener 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 1 was recommended as effluent quality well within the permissible limit.

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