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Hand Screen Printing Of Polyester Fabric With Gum Talha And Disperse Dye

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Abstract:
Printing of textiles is one of the most used methods for surface enrichment. It is a procedure that combines the notion of design, one or more colorings, and employing a method to correctly apply colourants onto the fabric, according to an analytical look. Several new synthetic fibres were innovated during the industrial revolution which can only be coloured during the polymerization process. These need a lot of chemicals for printing and the waste is dumped into the environment which affects the quality of life. In order to reduce the load on the environment in this study printing recipe was prepared to utilise gum talha as a natural thickener instead of using chemicals. Natural gums have the potential to be employed as a textile thickening agent due to their biocompatibility, low toxicity, environmental friendliness and affordability when compared to synthetic alternatives. The main objective of the present study was to print fabric with different recipes and to select the best printing recipe using gum talha and disperse dye for printing. In the present study, a total of six printing recipes were prepared using gum talha separately, and then each printing paste of the recipe was printed using hand screen printing. The printed samples were evaluated by a panel of judges for printing characteristic/quality, K/S value, BOD and COD values of effluent collected during the experiment were tested. Based on the results of statistical analysis, colour strength value and effluent characteristic, one recipe without carrier using Gum talha and disperse dye was considered as safest as it scored the highest ranking/values among the different parameters tested.

Keywords: *Polyester; Printing; Natural gums; Thickness of fabric; Disperse dye.*

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I. Introduction

Textile printing is a centuries-old craft that has been used continuously for many years. The craft of textile printing is used to create eye-catching, vibrant graphics with clearly defined borders that are artfully grouped into motifs or symbols. Printing can bring any textile material to maturity by conferring flexibility to it for fashion design. One of the oldest and most flexible printing methods is screen printing, which involves applying ink or dye to the substrate through a mesh screen. Using the screen-printing process, a substantial amount of printing material can be added to the substrate, increasing print thickness. To add colour to the printing paste, dyes or pigments are utilised. A successful print requires the employment of precise colours, clearly defined edges, an even distribution of print paste, a steady hand, and effective dye application **(Mongkholrattanasit *et al.*, 2021)**. The type of thickening agent employed and the flow of the resulting print paste affect all the aforementioned variables. But we need a lot of chemicals for printing, and the waste we dump into the environment is affecting the quality of life we lead. In order to reduce the load on the environment in this study printing recipe was created utilising gum talha as a natural thickener instead of using chemicals. Natural gums have the potential to be employed as a textile thickening agent due to their biocompatibility, low toxicity, environmental friendliness and affordability when compared to manufactured alternatives **(Chaudhary and Singh, 2018)**.

Gum talha is a dried exudate of the Plant Acacia. Commonly and commercially used varieties are Gum Acacia Seyal (commonly known as talah) and Acacia Senegal (hashab). Gum talha is a natural exudate obtained from both the stem and branches of A. seyal, the species is reported to produce significant amounts of gum that has many traditional and industrial uses **(Mohammed, 2011).** It is one of several plant exudate gums that are less expensive than gum arabic and are therefore frequently employed in less expensive applications or in times of scarcity of gum arabic.

Gum Talha is an orange to light-white solid that fractures like glass. Gum Talha is primarily made up of high molecular weight polysaccharides, such as galactoxyloglucan, which is rich in the polysaccharide xyloglucan. It also contains glucose, xylose, and their calcium, magnesium, and potassium salts, which when hydrolysed yield arabinose, galactose, rhamnose, and glucuronic acid. Being natural gum, it offers the benefits of being biodegradable, having natural thickening characteristics and being eco-friendly with cheap production costs **(Younis*et al.*, 2022*).***

The researchers have done studies on printing various textile substrates like cotton (**Babel *et al.*, 2015**), polyester **(Klahal *et al.*, 2014*)***, etc., using tamarind kernel powder and aloe vera gel as a thickening agent. Review on printing of polyester with gum talha was not available, so the present study was done using gum talha as a natural thickening agent. Objectives of the study were:

1. To print polyester fabric with different recipe using gum talha as a natural thickener
2. To assess the properties of printed polyester fabric
3. To select best printing recipe using gum talha and disperse dye for printing

II. Materials And Methods

A 100% polyester fabric was 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 gum (Gum Talha) was procured from P J Enterprises, Mumbai.

Table 1. Physical parameters of selected polyester fabrics

Fabric	**Weight(gsm)**	**Thickness(mm)**	**Fabric count**	
			Ends/cm	**Picks/cm**
Polyester	120	0.18	56	34

Steps involved in printing are as follows

1. Scouring of polyester: Polyester fabric was 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 natural thickener named Gum talha was prepared by soaking overnight in distilled water and then thoroughly mixing. 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, usinga high-speed stirrer for achieving a uniform composition.
3. Printing recipe and screen printing: Different recipes used for printing (by Shenai, 1985 and Awoke *et al*., 2013) are given in Tables 2 to 4.

Table 2. Recipe 1 for the printing of polyester with and without carrier

Recipe 1 (without carrier)		Recipe 1 (with carrier)	
Disperse dye	1.25mL	Disperse dye	1.25 gm
TRO	1.25 mL	TRO	1.25 mL
----	---	Carrier, para phenylphenol (Lobachemie)	0.25 mL
Hot water	0.5 mL	Hot water	0.5 mL
Thickener (Different natural gums)	22 g	Thickener (Different natural gums)	21.75 gm
Total	25	**Total**	25

Table 3. Recipe 2 for the printing of polyester with and without carrier

Recipe 2 (without carrier)		Recipe 2 (with carrier)	
Disperse dye	1.25 gm	Disperse dye	1.25 gm
Urea	1 gm	Urea	1 gm
----	---	Carrier, para phenylphenol (Lobachemie)	0.25 mL
Hot water	0.5 mL	Hot water	0.5 mL
Thickener (Different natural gums)	22.25 gm	Thickener (Different natural gums)	22 gm
Total	25	**Total**	25

Table 4. Recipe 3 for the printing of polyester with and without carrier

Recipe 3 (without carrier)		Recipe 3 (with carrier)	
Disperse dye	1.25 gm	Disperse dye	1.25 gm
Acetic acid	0.25 mL	Acetic Acid	0.25 mL
----	---	Carrier, para phenylphenol (Lobachemie)	0.25mL

Hot water	0.5 mL	Hot water	0.5 mL
Thickener (Different natural gums)	23 gm	Thickener (Different natural gums)	22.7 gm
Total	25	**Total**	25

Polyester fabric was flat screen-printed manually using a printing paste prepared as per the different recipes 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° C for 10 min. Printing samples will be rinsed with cold water for 20 minutes and then hot water at 80° 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. 1 shows printed fabrics with and without carrier with gum talha.

Plate no.1. Samples printed (with & without carrier) with gum talha as a thickener withDisperse dye

Name of Sample	**Fine print**	**Bold Print**
Recipe 1 **(Without carrier)**		
Recipe 1 **(With carrier)**		
Recipe 2 **(Without carrier)**		
Recipe 2 **(With carrier)**		
Recipe 3 **(Without carrier)**		
Recipe 3 **(With carrier)**		

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 5. 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 5: 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

Assessment of Physico-Chemical Parameters of Effluent

Central pollution control board (CPCB) has given standards for discharge of wastewater from different industries. BOD, COD etc will be assessed for release of effluent into river by comparing with standards given by CPCB.

III. Result And Discussion

Subjective Evaluation of Screen printed samples: Screen printing was carried out with three different recipes with or without carrier total of six recipes. The mean scores obtainedby printed samples of different recipes with or without carrier with gum talha as a thickener(tables- 6 & 7) showed different rating.

Table 6: WMS for Visual evaluation of screen-printed samples using Gum Talha for different parameters without carrier

	WMS (Recipe 1)		**WMS (Recipe 2)**		**WMS (Recipe 3)**	
Parameters (Without carrier)	**Fine Print**	**BoldPrint**	**Fine Print**	**BoldPrint**	**Fine Print**	**BoldPrint**
Uniformity of print	3.25	3.5	2.8	3.0	3.20	3.03
Sharpness in Outlines	3.47	3.62	3.41	3.48	3.44	3.5
Overall Appearance	3.54	4.1	3.23	3.34	3.30	3.64
Average	**3.42**	**3.74**	**3.14**	**3.27**	**3.31**	**3.39**
Relative Ranking	**II**	**I**	**VI**	**V**	**IV**	**III**

Table 6 shows WMS scored by fabric printed (without carrier) with gum taha using both bold and fine print. It is clear from the table that for both bold and fine prints recipe 1 secured the highest WMS for uniformity of print, sharpness in outlines and overall appearance for bold print relative ranking secured i.e., I, V and III and for fine print secured i.e., II, VI and IV respectively among rest of recipes.

Table 7: WMS for Visual evaluation of screen-printed samples using Gum Talha for different parameters with carrier

	WMS (Recipe 1)		**WMS (Recipe 2)**		**WMS (Recipe 3)**	
Parameters (With carrier)	**Fine Print**	**Bold Print**	**Fine Print**	**BoldPrint**	**Fine Print**	**BoldPrint**
Uniformity of print	3.23	3.2	2.5	2.8	3.17	3.0
Sharpness in Outlines	3.45	3.59	3.39	3.23	3.40	3.2
Overall Appearance	3.51	3.9	3.20	3.1	3.26	3.60
Average	**3.39**	**3.56**	**3.03**	**3.04**	**3.27**	**3.26**

Relative Ranking	**II**	**I**	**VI**	**V**	**IV**	**III**

Table 7 shows WMS scored by fabric printed (with carrier) with gum taha using both bold and fine print. It is clear from the table that for both bold and fine prints recipe 1 secured the highest WMS for uniformity of print, sharpness in outlines and overall appearance for bold print relative ranking secured i.e., I, V and III and for fine print secured i.e., II, VI and IV respectively among rest of recipes.

As it is clearly visible from the graph that irrespective of recipe samples printed without carrier have scored higher average compared to samples printed with recipe using carrier. It can be concluded that printing can be done on polyester even without carrier which is environmentally friendly as carrier takes more time to degrade.

Evaluation of colour coordinator of printed sample: The samples printed with different recipes of gum talha as a thickener with or without carrier, steamed with constant time and temperature were evaluated for their colour strength values (K/S value). Thickeners act as a vehicle for the dye and during the fixation, the dye gets transferred into the fabric. K/S value is directly proportional to the amount of the dye present in the material and it can beused to evaluate the efficiency of new thickeners **(Abdou *et al.*, 2012)**.

Table 8: K/S value of polyester samples printed using different recipes with & without the use of carrier

Name of samples	**K/S value**	
	(Without carrier)	**(With carrier)**
Recipe 1	3.30	3.25
Recipe 2	1.35	1.38
Recipe 3	2.74	2.71

The colour values of the printed polyester fabric using different recipes with & without the use of carrier are summarized in table-8. It is clear from the table that recipe 1 secured the highest K/S value among the rest of the recipes. The following section will present the results of the investigation.

Effect of TRO concentration

Due to the disperse dye's insolubility in water, wetting agents like TRO should be used to wet the dye before pasting **(Milies, 1994)**, therefore makes a wonderful base for printing. Samples printed with the recipe consist TRO is shown to be uniform, sharpened and neat and clear. Thus, the dye fixed on the surface of polyester supports increases with rising dye concentration, causing the colour strength to become more apparent in both the parameters carrier and without carrier. But due to the dye hue, and on the basis of visual evaluation we select without a carrier.

Effect of urea concentration

Urea is a vital component in the printing paste of reactive dye as during the steaming process, particularly in the superheated steam immediately following printing, it causes the cotton fibres to swell, allowing the dye to rapidly penetrate the fibres, Therefore, urea acts as a solubilizer and disaggregating agent for reactive dyes, as well as a hydroscopic agent for swelling cotton fibres during the steaming process **(Awoke *et al.*, 2013).** But in the case of polyester printing urea is a humectant also and humectants attract moisture from the air, as a result in optimised recipe paste becomes watery creating printing difficult during the printing process and in the printed samples hallowing and flushing occurred. As a result of the combination effect, hydrolysis may occur andreduce colour strength.

Effect of Acetic acid concentration

Acetic acid is used in polyester printing for maintaining an acidic pH (4.5-5.5) which is sometimes desired in the printing process, but due to the presence of two carbon atoms in one molecule of acetic acid its biodegradability is not ideal **(Kaushik *et al.*, 2007).** Samples printed with an optimised recipe containing acetic acid give the best result in comparison to urea, but printing with acetic acid creates more pollution harmful to the environment. Due to the presence of acid in the print paste, hydrolysis may occur and it also reduces colour strength.

BOD AND COD

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

Table 9. BOD and COD of wastewater generated during the Printing Process of the different recipes without carrier with gum talha as a thickener

S.NO.	Sources of Wastewater		Parameters	
			BOD (mg/l)	COD (mg/l)
	*Permissible limit (Discharge in inlandwater)		30	250
1.	Stage 1 Pre-treatment	WOF	20.1	93
2.	Stage 2 PrintingWaste	Recipe 1	26	198.2
		Recipe 2	28.1	204.2
		Recipe 3	31.2	208.9
3.	Stage 3 WashingWaste	Recipe 1	21.5	182.1
		Recipe 2	26.2	198.9
		Recipe 3	29.8	206.5

*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 thedifferent recipes with carrier with gum talha as a thickener

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	20.1	93
2.	Stage 2 PrintingWaste	Recipe 1	28.2	207
		Recipe 2	29.4	208.2
		Recipe 3	32.2	212.8
3.	Stage 3 WashingWaste	Recipe 1	23.5	185.1
		Recipe 2	27.9	203.8
		Recipe 3	30.28	210

*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 washing waste 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 Recipe 1 (without carrier) printed wastes BOD and COD values were within the permissible limit. It is also obvious from tables 6 to 7 regarding visual evaluation, that Recipe 1(Gum talha) has secured the highest WMS regarding printing characteristics.

IV. CONCLUSION

Gum talha as a new thickening agent for hand screen-printing of polyester fabrics using disperse dye. A total of six printing recipes were prepared using gum talha separately, the results revealed that printing polyester fabric using recipe 1 (without carrier) was recommended as effluent quality well within the permissible limit as well as result of visual evaluation and K/S values were also good. It can be concluded from study that natural gum can be used as substitute for synthetic materials for polyester printing in order to reduce BOD and COD valuesof effluent which is more environmentally friendly.