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Original Article

Optimization of Thickening Agent Based on Tamarind Seed Gum for Printing of Cotton and Its Impact on Physical Parameters

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Abstract

In the present study, the researcher has tried to optimize the concentration of the tamarind seed gum or tamarind kernel powder (TKP) as it possess a relatively simple method of producing bright shades, possessing excellent washing and light fastness properties for the block printing process. The main aim of the study was to diversify and revive our rich cultural heritage with use of natural biodegradable materials developed from tamarind kernel powder. The present study was under taken keeping in view the objective to optimize the concentration of natural thickening agent for block printing and to test physical properties of block printed sample. Optimization of the selected thickening agent (Tamarind Kernel Powder) was done at different concentrations. The selected concentration was also analyzed for physical characteristics and fastness on fabric. Physical characteristics and fastness improved in all aspects in compression to the unprinted fabric. Eight per cent concentration of thickening agent was optimized for printing.

Keywords: Block printing, Tamarind Kernel Powder, Natural thickening agent, Colour fastness

The thickener is the crucial component of print paste. The purpose of the thickener is twofold. First, the thickener gives the print paste the proper viscosity or flow characteristics, so the colour can be applied uniformly and evenly. Second, it holds the colour in place so that one colour paste can be applied adjacent to another without the colour bleeding onto other. With dyes, the thickener also holds the colour in place after drying until the printed fabric goes through the fixation process where the dye is released from the thickener and is diffused into the fibre. Thickeners used with dyes are then washed off the fabric before any chemical or mechanical finishing is performed. However, the thickener applied with a pigment system will remain with the print, as no after washing is required. There is a wide range of thickener materials available including alginates, natural vegetable gums, synthetic polymers, or even foams. These materials show sensitivity to factors such as temperature, pH, and salt content The types of thickening agent are quite diverse. The synthetic thickening agents used is generally extremely high-molecular weight polymers capable of developing a very high viscosity at a relatively low concentration. However, the paste or thickening agents are difficult to dispose off as it creates sedimentation in the water during its waste disposal. An increasing awareness about the realization that the intermediates and chemical used in synthetic dyes being toxic and hazardous to human health as well as to the environment, has led to the revival of interest in the non-toxic ecofriendly materials. In the present study, the researcher has tried to optimize the concentration of the tamarind seed gum or tamarind kernel powder (TKP) for the block printing. Tamarind seed gum or tamarind kernel powder (TKP) is derived from the seed of *Tamarind indica*. It belongs to the dicotyledonous subfamily *Caesalpinioideae* (Legiminosae). Tamarind seed gum, a crude extract of tamarind seeds, is rich in polysaccharide, which contain glucose, xylose and galactose units, in a molecular ratio of 3:2:1. It is insoluble in organic solvents and dispersible in hot water to form a highly viscous gel such as mucilaginous solutions with a broad pH tolerance and adhesively. (Baveja et al, 1988)

Moreover it has the potential for commercial applications in the textile printing as a thickening agent. Thus, as an alternative to synthetic thickening agent, natural biodegradable materials developed from tamarind kernel powder can be used for printing. With the advantages of it being environmental friendly and also having a lower cost of production keeping this in mind the researcher has postulated the use of TKP as a natural thickening agent and in the present study has tried to optimise its concentration of thickening agent. The major objectives of this study are to optimize the concentration of natural thickening agent

Table 1: Visual evaluation of printed sample at different concentration of Thickening agent N=5

S.No	Thickening agent %	Uniformity of colour	Sharpness of line	Whiteness of ground	Overall appearance	Total Score	Percentage
1.	2 %	14	14	13	13	54	43.2
2.	4 %	15	15	16	16	62	49.6
3.	6 %	20	20	21	21	82	65.6
4.	8 %	23	22	24	24	93	74.4
5.	10 %	22	23	22	22	89	71.2
6.	12 %	21	20	21	21	83	66.4
7.	14 %	21	19	19	19	78	62.5
8.	16 %	18	16	18	18	70	56.0
9.	18 %	17	13	17	17	64	51.2
10.	20 %	16	13	15	15	59	47.2

for block printing and to test physical properties of block printed sample.

i. Selection and preparation of raw material. On the basis of the preliminary survey of Mewar region of Rajasthan tamarind seed was selected for the printing paste owing to its easy availability and low cost of production. The tamarind seed pods were purchased from local market of Udaipur. The collected tamarind seeds were roasted in a hot oven at 70°- 80°C for 30 minutes and the seed coat was manually removed from the seeds. Then, milling was done followed by sieving in order to obtain the fine tamarind kernel power.

ii. Optimization of thickening agent concentration. Various concentrations of thickening agent *i.e.* 2, 4, 6, 8, 10, 12, 14, 16, 18, 20 g per 100ml of distilled water were mixed followed by heating in the oven for 1 min for proper mixing of the tamarind kernel powder in the water. This was allowed to stand for few hours to attain full swelling of gum particle and was finally filtered.

Preparation of the printing paste

After preparation of the thickening paste of different concentration, the fabric was printed with the following recipe given by Kale (1997):

30 parts procion
30 parts urea
230 parts water
650 parts thickening agent
60 parts sodium bicarbonate

iii. Assessment of the printed sample (Visual evaluation) The block printed samples with different concentration of thickening agent were visually evaluated by panel of experts from Textiles and Apparel Designing department. The printed samples were displayed before the judges. The evaluation was done on the basis of the 5 point rating scale. The attributes for evaluation were uniformity of colour, sharpness of line and whiteness of ground. Total scores for each attribute was calculated and best 5 samples were selected. The 5 selected concentration samples were again tested for different physical characteristics (thickness, tensile strength, crease recovery, stiffness) and fastness properties (washing, perspiration, fading) in order to select the best sample for the final printing.

iv. Testing of the physical properties of the selected samples:

a) Fabric thickness: The method described in ISI (IS: 7702 - 1975) was used to measure the thickness of the samples

b) Tensile strength test: Tensile strength of the unprinted and printed fabric with different concentration of selected thickening agents was measured by tensile strength testing machine Ravelled strip test method as described in ISI (IS:1969-1968) was used to measure the breaking strength of the samples.

c) Crease recovery: Determination of wrinkle recovery or crease resistance of the fabric, which enables the fabric to resist wrinkling or mussing, was done by measuring the 'crease recovery angle'. Crease recovery angle was measured as per ISI (IS: 4681-1968) on 'crease recovery tester'.

d) Fabric stiffness test: To determine the stiffness of the fabric *i.e.* resistance of fabric to bending, cantilever test as described in ISI (IS: 6490-1971) was used.

v. Testing for colour fastness properties: The printed samples was evaluated for colour fastness to washing, sunlight, and perspiration by following standard procure laid down by bureau of Indian standardsNo.IS:3361-1976, 686-1957, IS: 971-1956 respectively.

Results of Experimental Work

Optimization of the concentration of thickening agent by visual evaluation: Block printed sample using different concentration of thickening agent (2g, 4g, 6g, 8g, 10g, 12g, 14g, 16g, 18g, 20g) were visually evaluated by a panel of experts for various attributes viz. sharpness of outline, whiteness of ground, uniformity of colour and overall appearance. Table 1 shows that on the basis of uniformity of colour block printed samples with 8 per cent was given the highest preference with a total marks of 23 out of 25 followed by 10 per cent concentration with a total marks of 22 out of 25.The next preferred concentrations on the basis of uniformity of colour were 12 and 14 per cent with a total marks of 21followed by 6 per cent concentration with 20 marks. It is clearly visible from the table that the printed sample were not uniform in the lower and higher concentration hence least preferred by the judges.

In terms of sharpness of line, 10 per cent concentration was highly preferred by the judges with a total score of 23 out of 25 followed by 8 per cent concentration with 22 marks whereas samples with 6 and 12 percent concentration were next preferred with 20 marks. Thickening agent with higher concentration (16-20%) and lower concentration (2-4%) showed poor results in terms of sharpness of line.

In terms of whiteness of ground again the top two concentrations were 8 and 10 per cent with a total score of

Table 2: Effect of thickening agent on physical characteristics of the printed fabric

Fabric	Concentration of thickening agent (%)	Thickness (mm)	Tensile strength (kg)		Crease recovery (º)		Stiffness (cm)	
			Warp	Weft	Warp	Weft	Warp	Weft
Unprinted		0.21	14.7	15	75	80	2.2	1.8
Printed	6 %	0.22	15.1	14.6	79	83	2.3	1.7
	8 %	0.22	16.3	15.2	80	85	2.4	1.9
	10 %	0.22	16.7	15.6	83	87	2.5	2.0
	12 %	0.23	16.9	15.7	86	89	2.5	2.2
	14 %	0.23	17.0	15.9	88	90	2.6	2.2

Table 3: Fastness properties of the selected concentrations of thickening agent

Paste No.	Thick-ening agent %	Washing fastness		Perspiration fastness				Sunlight fastness
		Staining	change	Staining		change		
				Alkali	Acid	Alkali	Acid	
1.	**6 %**	3	3	5	3	5	3	7
2.	**8 %**	5	5	5	4	5	5	8
3.	**10 %**	4	4	5	4	5	4	8
4.	**12 %**	3	4	4	3	5	4	7
5.	**16 %**	3	3	4	3	5	4	7

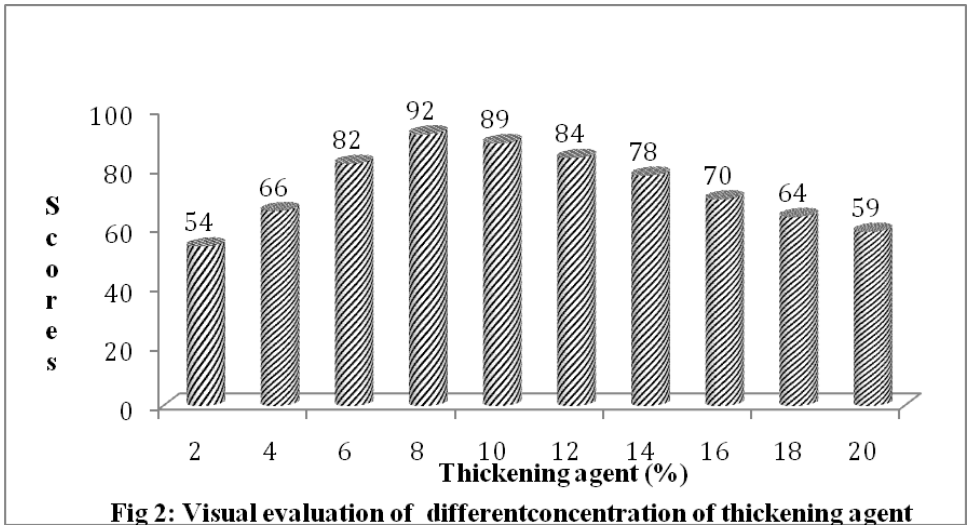

Fig 2: Visual evaluation of differentconcentration of thickening agent

24 and 22 marks respectively, followed by 6 and 12 per cent of concentration with a total of 21 marks out of 25. The next preferred concentration was 14 percent with 19 marks. The lower concentration (2-4%) and the higher concentration (18-20%) did not show satisfactory results.

In terms of overall appearance printed sample with 8 per cent with total marks of 24 out of 25 was highly preferred followed by 10 per cent concentration with 22 marks. The next preferred printed samples in this direction were 6 and 12 per cent concentration with a total of 21 marks followed by 14 and 16 percent concentration with a total of 19 and 18 marks out of 25 respectively. Following the same trend the lower (2 % and 4%) and higher concentration (18% and 20%) were least preferred by judges.

Considering the results of all the attributes of visual evaluation the top five highest scored concentrations (6, 8, 10, 12 and 14%) of the thickening agent and was selected.

The selected five concentrations were further evaluated on the basis of physical characteristics and colour fastness properties for the selection of the best concentration.

Physical parameters of the block printed fabric.

Fabric thickness: It is evident from the table that thickness of the fabric slightly increases when compare to the unprinted fabric. The unprinted cotton fabric have a thickness of 0.21mm whereas the fabric printed with 6,8 and 10 percent thickening agent showed a slight increase in the thickness 0.22 mm thickness. While for 12 and 14% the thickness was found to be 0.23 mm.

Tensile strength: The tensile strength of the unprinted fabric was 14.7 and 15.0 kg in warp and weft directions. Whereas the tensile strength of the printed fabric ranged between 15.1- 17.0 kg in warp direction and in weft direction it ranged between 14.6 – 15.9 kg. Maximum tensile strength was seen at 14 % while minimum was noted at 6% concentration. Thus it is clear from the table that tensile strength increases with the increase in the

concentration of thickening agent.

Crease recovery: Printed fabric showed decline in the crease recovery in both warp and weft direction as compare to the unprinted fabric. Unprinted cotton fabric had crease recovery of 75º in warp direction and 80º in weft direction whereas the printed fabric showed a crease recovery ranging between 79 – 88 º in warp direction. While in weft direction it showed a recovery ranging between 83 – 90 º. Minimum crease recovery was seen at 6 % level while maximum was noted at 14 % for both warp and weft direction. Eight per cent concentration of thickening agent showed a crease recovery of 80º in warp direction and 85º in weft direction.

Stiffness (Bending length): Bending length for unprinted fabric in warp and weft directions was found to be 2.2 cm and 1.8 cm, respectively whereas the application of printing paste showed a slight increase in the bending length for both warp and weft direction which ranged between 2.3 – 2.6cm in warp direction and 1.7 – 2.2 cm in weft direction. The bending length was observed to be 2.3; 2.4cm warp direction at 6, 8 per cent concentration respectively. For 10 and 12 per cent concentration the bending length was found to be 2.5 cm while 2.6 cm at 14 per cent in warp direction. The bending length in weft direction was found to be 1.7, 1.9 and 2.0 cm at 6, 8 and 10 per cent concentration respectively. Whereas 2.2 cm bending length was observed for 12 and 14 per cent concentration of thickening agent.

Colour fastness to washing: The ratings for washing fastness were given on the basis of change in colour as well as staining on adjacent test fabric. It can be noticed that washing fastness of all the samples was good to excellent 3/5 to 5. Printed sample with 8 per cent concentration showed excellent fastness (5) to washing followed by 10 per cent thickening agent with 4/5 washing fastness whereas samples with other concentration shows good fastness (3/5).

Both the test specimens of unprinted cotton fabric remained completely unstained and there was no change (negligible staining) in the printed sample with 8 per cent concentration of thickening agent followed by 10 and 14 per cent concentration which showed slight staining in test specimen, while maximum staining was observed in 6 and 16 per cent concentration.

Fastness to perspiration: It is very important factor for the fabric used in apparels. This test was conducted on both against acid and alkaline artificial solutions of perspiration and it was observed that block printed cotton samples at different concentration showed best results for alkaline perspiration solution. From the rating given in the table 3, it can be observed that staining on the adjacent test specimen showed slight to negligible staining in alkaline solution in which 6-8 per cent solution showed excellent results and slightly stained for 14 and 16 per cent. Change in staining in different concentration of thickening agent in acidic medium was found to be better for 8 and 10 per cent concentration when compared to the rest of the selected concentration of thickening agent. It is evident from the table that no change in the value was in alkali medium for all the selected concentrations. No change in the acid medium was observed at 8 per cent concentration. Slight change was noted in the concentration of 10, 14 and 16 per cent while maximum change was observed at 6 per cent concentration.

Fastness to fading to light: In this study, fading was taken as a criterion for light fastness of the printed samples. Fading of the samples was evaluated by the exposed and unexposed portion of the samples in contrast to the blue wool standards.

The table clearly shows that 8 and 10 per cent concentrations of thickening agent scored maximum score on the grey scale for light fastness followed by the rest of the concentrations.

Hence, 8 per cent concentration of thickening agent was found to be the best to be used during the printing process and was thus selected.

Conclusion: Keeping the above data in mind it may be concluded that considering results of all the aspects visual evaluation like uniformity of outlines, sharpness of line, whiteness of ground and overall appearance and physical testing 8 per cent concentration of thickening agent showed best results in terms of fastness to washing, perspiration and light and also possessed good physical characteristics.

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