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Amaranthus paniculates (Rajgeera) starch as a thickener in the printing of textiles

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Maize starch is generally used in printing of Indigosol (solubilised Vat) and Vat dyes on cotton. Suitability of Amaranth starch to substitute conventional thickeners in printing of these dyes has been investigated. It was observed that Amaranth starch, which showed promising performance in printing of Indigosol and Vat dyes could be used in place of maize starch. Since this crop is underutilised, and also available at a cheaper rate, one could use the same for making thickeners for textile printing to substitute maize starch. Copyright © 1996 Elsevier Science Ltd

INTRODUCTION

Thickening agents form an essential part of any printing process. Thickeners used in textile printing are generally high molecular weight polymers. These act as vehicles for carrying dyestuffs, chemicals and other printing assistants to the textile material during the process of printing (Narkar & Narkar, 1973). Thickeners impart adhesivity and plasticity to the printing paste which can be applied on to the fabric without spreading and holding the dye molecule at the desired place until the transfer of dye into the fabric and its fixation are complete.

The quality of the print depends largely on the chemical and physical properties of the thickeners used. To a certain extent the depth, brightness of colour and especially sharpness and smoothness of the print depend on nature of the thickeners.

Most of the natural polymers (Thomas, 1981) used as thickening agents in printing are polysaccharides. The essential requirements of thickener are desirable physical and chemical properties such as viscosity, flow property, ability to wet and adhere to the surface of printing machine. It should give a good colour yield, must be economical and abundantly available. The thickener paste must not have any affinity for or reactivity with the dye and should not withhold the diffusion of the dye into the fabric. It should also be easily washable once the printing is over.

Grain Amaranths have been identified as promising food and feed source (Singhal & Kulkarni, 1988). It has about 12–18% lysine rich protein, and 5–8% fat that contains a relatively high level of squalene (Myers & Fox, 1994). The main constituent is however, 48–62% starch (Uriyapongson & Rayas-Duarte, 1994), concentrated in the perisperm (Zhao & Whistler, 1994a) and which has been projected to have many food and non-food applications (Breene, 1991; Zhao & Whistler, 1994b).

The present work deals in considering the application of *Amaranthus paniculates* locally known as rajgeera as a thickener for printing of Vat and Indigasol dyes. Amaranth has been identified as a waxy starch. Since, waxy starches are less prone to retrogradation, this application was studied.

MATERIALS AND METHODS

Scoured and bleached cambric fabric was used in the study. The following dyes were used:

Indigosol dyes

—Arlindone Brilliant Pink IR (C.I. Solubilised Vat Red 1);
—Arlindone Scarlet IB (C.I. Solubilised Vat Red 6).

Vat dyes

—Navinon Golden Orange RRT (C.I. Vat Orange 2);
—Navinon Red 6B (C.I. Vat Red 13).

Amaranth seeds were obtained from the local market and flour and starch were extracted it by one alkali steeping method. This starch was used as thickener in

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comparison with maize starch. Taking into consideration the required level of viscosity of printing paste the solid content was optimised as 8% and was used in printing with Vat and Indigosol dyes.

(1) Printing with Indigosol dyes: the formulation used was as follows: Dye — 1.0 part, glycerine — 2.0 parts, urea — 2.5 parts, soda ash — 0.2 parts, hot water — 2.0 ml, sodium nitrite — 2.0 parts, thickening agent — 80.3 g to make a total of 100 g. Fabric was printed with the above formulation and developed in a bath containing 20 ml/l H_2SO_4. The samples were then soaped with neutral soap (Auxipon NP) and dried.

(2) Printing with Vat dyes: this was done by the pre-reduction method. Vat dye — 4.0 parts, Glycerine + urea — 5.0 parts, Solution salt B — 3.0 parts, K_2CO_3 — 8 — 12.0 parts, $Na_2S_2O_4$ — 55.0 parts were mixed, warmed to 60°C and kept aside for 30 min. The mixture was then cooled and Rangalite C — 16.0 parts was added to make a total of 100 parts. The fabric samples were then printed, dried, steamed and oxidised in a mixture of 2 g/l $K_2Cr_2O_7$ + 5 g/l acetic acid. This was followed by soaping in neutral soap (Auxipon NP) and dried. Amaranth and maize starch pastes were blended in different proportions of 80:20, 50:50, 20:80 and used in printing with Vat dyes.

(3) Evaluation of prints: the prints were evaluated for colour values, stiffness, colour fastness i.e. fastness to rubbing and washing. Colour fastness was evaluated by the reflectance method. Absorbence of printed fabric was measured on 'Pye-Unicam SP-B-400 UV/VIS Spectrophotometer'.

K/S values were calculated using the Kubelka Munk equation

K = Absorption coefficient

S = Scattering coefficient

$$K/S = \frac{(1-R)^2}{2R}$$

where R = reflectance at complete opacity.

Stiffness of the prints was evaluated using 'Shirley's Stiffness Tester'. Colour fastness to rubbing was measured using a 'Crock meter'. Colour fastness to washing was carried out using ISO III test methods.

RESULTS AND DISCUSSION

Amaranth and maize starch were used as thickeners for printing of Indigosols in 0.5% and 1% shade. A performance analysis of the prints is summarised in Table 1. The results indicate a decrease in depth of the print when maize starch, the conventional thickener was substituted by amaranth starch. The decrease in K/S value was of the order of 15–25% and it varied with the type of the dye. The bending length of the printed sample using amaranth starch was lower than that of the samples using maize starch. Higher percentage shade gave higher bending length of the print and thus more stiffness.

The wash and rub fastness (both dry and wet) grades of the prints with both the thickeners were almost identical and of the order 4–5 to 5, i.e. 'very good' to

Table 1. Performance properties of rajgeera starch and maize starch

Sample No.	% Shade	K/S	% Decrease in K/S	Fastness				Bending length (cm)
				Wash		Rub		
				Change in shade	Staining on white cloth	Dry	Wet	
Dye: Arlindone Pink IR								
1	0.5	1.50	14.28	4–5	5	5	5	2.15
2	—	(1.75)	—	(4–5)[a]	(5)	(5)	(5)	(2.40)
3	1.0	1.62	16.92	4–5	5	5	5	2.25
4	—	(1.95)	—	(4–5)	(5)	(5)	(5)	(2.50)
Dye: Arlindone Scarlet IB								
5	0.5	1.70	22.37	4–5	5	5	5	2.45
6	—	(2.19)	—	(4–5)	(5)	(5)	(5)	(3.18)
7	1.0	2.10	26.31	4–5	5	5	5	2.58
8	—	(2.85)	—	(4–5)	(5)	(5)	(5)	(3.83)
Dye: Arlindone Brown BR								
9	1.0	2.12	24.28	4–5	5	5	5	2.13
10	—	(2.80)	—	(4–5)	(5)	(5)	(5)	(2.85)
							Control:	2.05

( )[a] = Values for Maize starch.

'excellent'. The softness of the print obtained using amaranth starch as, thickener was, however, better than that of the maize starch based print. The only drawback with amaranth starch was the lowering in the colour value or depth of the print.

In the next set of experiments, two Vat dyes, namely Navinon Golden Orange RRT and Navinon Red 6B, were used for printing using 2 and 4% shade. Results with respect to this set of experiments are given in Table 2. In this case too there was a slight decrease in K/S value of the print when maize starch was substituted by amaranth starch as a thickener in printing. The decrease in K/S was confined to about 7–8% in 2% shade and it was < 1% in the case of 4% shade. In other words, although the absolute values of K/S varied with respect to the dye, the percentage decrease in K/S value was more or less in the same order and as the shade percentage was increased such a lowering in depth of print was found to marginalised. With respect to the bending length of the printed samples, amaranth starch showed a distinct edge over maize starch and prints obtained with the former were softer than the ones obtained with the latter.

Hence it could be summarised that substitution of maize starch with amaranth starch is possible in Indigosol and Vat dye printing on cotton. At a higher percentage shade, the depth of the print and all other properties were almost identical. In fact, in stiffness characteristics, amaranth starch was better and its marginal adverse effect on colour value could be compensated.

In the next set of experiments blending of maize and amaranth starch pastes was done in varying proportions and Vat dyes were printed on the

Table 2. Performance properties of rajgeera starch and maize starch

Sample No.	% Shade	K/S	% Decrease	Fastness				Bending length (cm)
				Wash		Rub		
				Change in shade	Staining on white cloth	Dry	Wet	
Dye: Navinon Gold Orange RRT								
11	2.0	2.65	7.01	4–5	5	5	5	2.15
12	—	(2.85)	—	(4–5)	(5)	(5)	(5)	(2.42)
13	4.0	5.42	0.55	4–5	5	5	5	2.27
14	—	(5.45)	—	(4–5)	(5)	(5)	(5)	(2.72)
Dye: Navinon Red 6B								
15	2.0	1.36	8.11	4–5	5	5	5	2.15
16	—	(1.48)	-	(4–5)	(5)	(5)	(5)	(2.42)
17	4.0	3.56	0.22	4–5	5	5	2.57	2.57
18	—	(4.58)	—	(4–5)	(5)	(5)	(5)	(2.85)
							Control:	2.05

( ) = Corresponding value for Maize starch.

Table 3. Performance properties of blends of maize and rajgeera starch pastes

Sample No.	Blend composition	K/S	% Decrease in K/S	Fastness				Bending length (cm)
				Wash		Rub		
	Maize: Rajgeera			Change in shade	Staining on white cloth	Dry	Wet	
Dye: Navinon Gold Orange RRT, 2% shade								
12	100:00	2.85	—	4–5	5	5	5	2.42
19	80:20	2.71	4.91	4–5	5	5	5	2.25
20	50:50	2.68	5.96	4–5	5	5	5	2.18
21	20:80	2.66	6.66	4–5	5	5	5	2.18
11	0:100	2.65	7.01	4–5	5	5	5	2.15
Dye: Navinon Red 6B								
16	100:00	1.48	—	4–5	5	5	5	2.42
22	80:20	1.46	1.35	4–5	5	5	5	2.40
23	50:50	1.43	3.34	4–5	5	5	5	2.33
24	20:80	1.40	5.41	4–5	5	5	5	2.23
15	0:100	1.36	8.11	4–5	5	5	5	2.15

cotton fabric. Performance analysis is summarised in Table 3. As can be seen, the percentage decrease in one K/S value gradually increased with increase in substitution of Maize starch paste by amaranth starch paste. The same was true for Navinon Red 6B. Bending length of the prints was found to decrease as the amaranth content in the blend paste increased. Since its magnitude is limited, one could safely use pure amaranth starch; if at all this colour depth loss is to be further controlled 50:50 combination of the blend pastes could be used. The fastness properties, washing as well as rubbing seemed to be excellent which are characteristics of Vat dyes.

It has also been observed that at higher percentage of shade the influence of the nature of starch on K/S is totally diminished, and blending of pastes becomes unnecessary.

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