ECO-FRIENDLY PRINTING OF COTTON FABRIC USING NATURAL DYE FROM *ACACIA CATECHU* WILLD.

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Abstract: Cotton fabric samples were printed with *acacia catechu wild* using reactive-printing technique has been investigated. The effect of different factors, i.e. quantities of urea, thickening agent and Sodium bicarbonate has been studied. The printed goods were evaluated by measuring the *K/S* values and the overall fastness properties. The results show that the colour strength (*K/S)* value of recipe 3 was the best printed result, and the next good result was obtained in the order of recipe 2 and recipe 1. The colour fastness results were ranging between fair and good level.

Keywords: *Acacia catechu* willd., Thickening, Printing, Textile, Cotton, Natural dyes

1. Introduction

Natural dyes, dyestuff and dyeing are as old as textiles themselves. Man has always been interested in colours; the art of dyeing has a long past and many of the dyes go back into prehistory. It was practised during the Bronze Age in Europe [1]. Natural dyeing has been used by humans for purposes varying from coloration of food, cosmetics, and textiles to impart other functions to them [2]. Nowadays, a revival interest in the use of natural dyes in textile coloration has been growing. This is a result of the stringent environmental standards imposed by many countries in response to the toxic and allergic reactions associated with synthetic dyes [3]. Natural dyes have a wide range of shades that can be obtained from various parts of plants, including roots, bark, leaves, flowers and fruits [4]. Dyeing with natural dyes, however, normally requires the use of mordants, which are metallic salts of aluminum, iron, chromium, copper, among others, for ensuring a reasonable fastness of the colour to sunlight and washing [5]. The metal ions of these mordants can act as electron acceptors for electron donors to form coordination bonds with the dye molecules, making them insoluble in water. The use of natural dyes cuts down significantly on the amount of toxic effluent resulting from synthetic dye processes. Natural dyes have also been used for printing [6 - 8].

Acacia catechu Willd. (Family: *Fabaceae* and subfamily: *Mimosoideae*) is a moderately sized deciduous tree with rough, dark grayish brown bark. It is a native of Central and East Africa, Southern Asia, Bhutan, Thailand, China, India, Myanma, Nepal and Pakistan [9]. It grows up to 13 meters in height. The leaves are pinnate with a pair of recurved prickles at the base of the rachis. Flowers are pale yellow arranged in cylindrical spikes. Pods are glabrous oblong. The sapwood is sharply distinct from heartwood, light yellowish-white or yellow. Heartwood is deep red or reddish brown, darkening on exposure. The different parts of the tree have a variety of medicinal uses. In ayurveda, the bark and heartwood are used to treat various conditions like thinning of blood, tooth related troubles, skin disorders, chronic fever, worm infestation, throat problems, obesity, hepatomegaly and spleenomegaly, tastelessness, hemorrhages, blood disorder and urine related disorders [10]. The plant is used for fodder, fuel and katha paste [9]. Cutch is a very easy dye to work with. It shows excellent fastness on cotton

and silks. It produces brown tones. The dyeing process is a chemical property of a brown tannin called catechu tannic acid. The main colourant in catechu is catechin which is not soluble in cold water [9]. When pure, it forms minute, colourless crystals which are acted on by alkalies, causing them to absorb oxygen, giving a yellow, then red, and finally a black colour [9].

The aim of this present work is to investigate the suitability of using gum of *acacia catechu* as a natural dye in printing cotton fabric using the reactive printing technique. The colour strength (*K/S*) and overall fastness of the prints were also studied.

2. Experimental

2.1 Materials

2.1.1 *Acacia Catechu* Willd. gum

Acacia Catechu Willd. gum used in this experiment were collected in Kamphaeng Phet province in Thailand.

2.1.2 Fabric

A commercial produced plain-weave cotton fabric was washed with 2 g/L soaping agent at 60 °C for 30 min. Then it was thoroughly rinsed and air dried at room temperature.

2.1.3 Thickening agent

The thickening agent used was sodium alginate (supplied by Boonthawee Chemical Co, Thailand)

2.1.4 Chemical

- Aluminium potassium sulfate dodecahydrate and anti-reduction were supplied by Fluka Co, Thailand.
- Sodim bicarbonate and Urea (supplied by Boonthawee Chemical Co, Thailand)
- Soaping agent (supplied by Hanson Chemical Co, Thailand).

2.2 Method

2.2.1 *Acacia Catechu* Willd. gum powder

The *Acacia Catechu* Willd. gum was crushed by manual crushing and separated. Then, they were ground by mesh sieve.

2.2.2 Printing pastes

The printing pastes for *acacia catechu* printing of cotton were prepared as follows:

Table 1 The recipe of printing paste

Printing paste	Recipe 1	Recipe 2	Recipe 3
Acacia catechu powder (g)	30	30	30
Aluminium potassium sulfate dodecahydrate (g)	30	30	30
Urea (g)	200	100	100
Thickening agent (g)	550	650	640
Anti-reduction (g)	10	10	10
Sodium bicarbonate (g)	10	10	20
Warm water (g)	170	170	170
Total weight of the paste (g)	1,000	1,000	1,000

2.2.3 Printing Procedure

Printing was carried out using the flat screen technique. Printed samples were then dried at 100 °C for 3 min and fixed by superheated steam at 100 °C for 10 min. Printed samples were rinsed with cold water for 20 min. and then hot water at 80 °C for 20 min, followed by soaping agent with an anionic detergent (2 g/L) at 100 °C for 10 min, then rinsed well and air-dried at room temperature.

2.2.4 Evaluation of colour strength and fastness properties

The colour strength (*K/S*) and *CIELAB* of the dyed samples were evaluated using a spectrophotometer (Hunter Lab: ColorQuest XE). All measured sample showed the maximum absorption wavelength (λmax) value at 400 nm. The *K/S* is a function of colour depth and is calculated by the Kubelka-Munk equation, $K/S = (1-R)^2/2R$, where *R* is the reflectance, *K* is the sorption coefficient, and *S* is the scattering coefficient. The colour fastness to light, washing and rubbing of the printed samples was determined according to Thai Industrial Standard (TIS) 121:2518 No.2, No. 3 and No. 5, respectively.

3. Results and discussion

3.2 Effect of printing on colour value

A study on *Acacia Catechu* Willd. printing with sodium alginate as thickener was carried out. The colour value results obtained is presented in Table 2. It can be observed that the colour strength (*K/S)* value of recipe 3 was the best printed result, and the next good result was obtained in the order of recipe 2 and recipe 1. Cotton fabric printed *Acacia Catechu* Willd. showed very good handling and sharpness, as shown in Figure 1.

Table 2 Colour value of printed cotton fabric using *Acacia Catechu* Willd

Recipe	K/S	L*	a*	b*	Handling	Sharpness
1	3.46	54.55	13.44	22.47	Very good	Very good
2	5.96	50.55	16.06	26.08	Very good	Very good
3	6.90	49.95	16.59	27.53	Very good	Very good

3.2 Effect of printing on fastness properties

The fastness rating of cotton fabrics printed with *Acacia Catechu* Willd are presented in Table 3 to Table 5. Table 3 indicates that the ligth fastness ratings of the cotton fabrics printed with *Acacia Catechu* Willd were fair (3-4). The colour change in washing fastness ratings of the cotton fabrics printed with *Acacia Catechu* Willd. were fair to very good (3 -4). However, colour staining was good to very good (4-5), as shown in Table 4. The colour fastness to rubbing is shown to be in the range of 4 to 4-5 (good to very good), except the wet rubbing, whose rating was only 3-4 (fair to good), as seen in Table 5.

Recipe 1 Recipe 2 Recipe 3

Figure 1: Comparison of printed cotton fabric using different recipe

Table 3 Colour fastness to light (Thai Industrial Standard (TIS) 121:2518 No.2)

Fastness	Recipe		
	1	2	3
Colour change	3-4	4	4

Table 4 Colour fastness to washing at 40ºC (Thai Industrial Standard (TIS) 121:2518 No.3)

Fastness	Recipe		
	1	2	3
Colour change	3-4	3-4	3-4
Colour staining			
-Acetate	4-5	4-5	4-5
-Cotton	4-5	4-5	4-5

Table 5 Colour fastness to rubbing (Thai Industrial Standard (TIS) 121:2518 No.5)

Recipe	Colour staining			
	Warp direction		Weft direction	
	Dry	Wet	Dry	Wet
1	4	3-4	4	3-4
2	4-5	3-4	4-5	3-4
3	4-5	3-4	4-5	3-4

4. Conclusion

The possibility of using *Acacia Catechu* Willd. in the fine powder form in printing cotton fabric using reactive printing technique has been studied. The investigation shows that the recipe 3 is the most suitable recipe, which gave the highest *K/S* value. The fastness properties were fair to good. *Acacia Catechu* Willd could be used as natural dye for textile printing on cotton fabric.

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