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THICKENING AGENT BASED ON TAMARIND SEED GUM FOR DISPERSE PRINTING OF POLYESTER

Kittiya Klahal[1,a],Janya Pikul[2,a],Wancheng Sittikijyothin[3,a*] and Rattanaphol Mongkholrattanasit[4,b]

[a]Department of Chemical Engineering, Faculty of Engineering, Burapha University, 169 Tambon Saensook, Amphur Muang, Chonburi, 20131, Thailand
[b]Department of Textile Chemistry Technology, Faculty of Industrial Textiles and Fashion Design, Rajamangala University of Technology Phra Nakhon, 517, Nakhonsawan Road, Kwang Suan Chitladda,Dusit District, Bangkok, 10300, Thailand
kwang_son55@hotmail.com[1], pew_93@hotmail.com[2], wancheng@buu.ac.th[3],rattanaphol.m@rmutp.ac.th[4]

Abstract

The technical feasibility of using tamarind kernel powder from different areas in Thailand (Uthaithani, Ang Thong, and Nakhon Sawan) as a thickening agent for printing polyester with disperse dye in comparison to the commercial tamarind kernel powder from India aspresently used in textile printing was examined. All tamarind kernel powder samples presented high polysaccharide and protein contents. The obtained result indicated that the properties as colour values, colour strength (K/S), overall fastness properties, handling, and sharpness of printed polyester fabric were good to very good levels. Only slight differences were observed between two places of tamarind kernel powder (Thailand and India) utilized for thickening agent.

Keywords:Tamarind seed gum; Thickening; Printing; Textile; Polyester fabric; Disperse dye

*Corresponding author: Tel. +66 38 102222 Ext. 3352; Fax: +66 38 745900 Ext. 3350.
E-mail address: wancheng@buu.ac.th (Wancheng Sittikijyothin)

1. Introduction

Tamarind seed gum or tamarind kernel powder (TKP) is derived from the seeds of *Tamarindus indica* Linn. [1]. It belongs to the dicotyledonous subfamily Caesalpinioideae (Leguminosae) [2]. It grows in more than 50 countries of the world. The major areas of production are in Asian countries like India, Bangladesh, Sri Lanka, Thailand, and Indonesia, and in the African and the American continents [2]. The tamarind tree is a long-lived, large evergreen or semi-green tree, grows wild, though cultivated to a limited extent. A mature tree may attain a maximum height of 30 m [3]. The tamarind tree has the ability to grow in poor soils because of their nitrogen fixing capability and withstanding long periods of drought makes them ideal low input, high yielding trees [4].

Tamarind seed gum, a crude extract of tamarind seeds, is rich in polysaccharide (~65-72%) [5], which contains glucose, xylose and galactose units (Figure 1), in a molecular ratio of ~3:2:1 [6-8]. Its structure is based on a β (1→4)-D-glucan backbone, substituted at position 6 of the glucopyranosyl units mainly by single α-D-xylopyranosyl residues as well as by disaccharide side chains composed of β -D-galactopyranosyl-(1→2)- α -D-xylopyranosyl residues [7]. In addition, tamarind seed gum is a high molecular weight polysaccharide (720-880 kDa) [6, 8-9], which forms viscous solutions when dissolved in water as many polysaccharide gums extracted from plant materials. Presently, it has potential for commercial applications for examples in the pharmaceutical industry for controlling drug release [10] and in the textile printing as a thickening agent [11-13]. Particularly in the food industry in Japan, refined tamarind seed gum as permitted food additive has been used for modifying texture as a thickening, stabilizing and gelling agents [14].

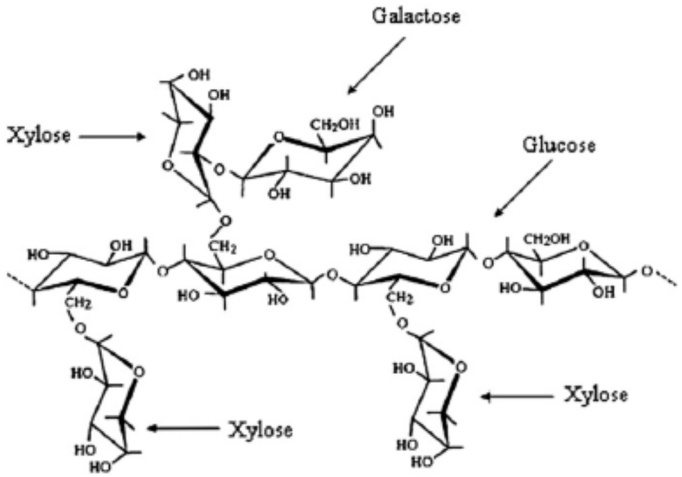

Figure 1*: Schematic illustration of the structure of tamarind seed gum.*

The present work was undertaken with the aim of determining the idea disperse printing on polyester fabric by using tamarind kernel powder as a thickening agent. The tamarind kernel powder from different areas of tamarind seeds in Thailand was investigated in comparison to the commercial tamarind kernel powder from Indiaas presently used as thickening agent in textile printing. The chemical composition of tamarind seed was investigated. The colour strength and fastness properties of printed fabric were evaluated.

2. Materials and Methods

2.1. Materials

Tamarind kernel powder used in this experiment was extracted from tamarind seeds which collected indifferent places (Uthaithani, Ang Thong and Nakhon Sawan provinces). While the commercial tamarind kernel powder as used in India textile was supplied byTNH Import and Export Co, Thailand.A commercial produced plain-weave polyester fabric (weight 94 g/m^2) was scoured (supplied by TNH Import and Export Co, Thailand). The disperse dye used was Disperse Blue 183(n-[2-[(2-bromo-6-cyano-4-nitrophenyl)azo]-5-(diethylamino)phenyl]propanamide).

2.2. Preparation of tamarind kernel powder

The tamarind seeds were dried in a hot oven at 100°C for 30 min and the seed coat was manually removed from the seeds. Then, they were milled and ground through a 355 μm mesh sieve.

2.3.Determination of chemical composition

Moisture and ash contents are determined according to the American Society for Testing and Materials methods (ASTM-D2974-87) and AOAC Official Method 923.03, respectively. Protein contentwas obtained from the total nitrogen content (N x5.7) by theKjeldahl method, as described in the AOAC Official Method ofAnalysis 981.10. Fat content was determined according to the AOACOfficial Method of Analysis 923.06.The main monosaccharide component was analyzed by GC-FID(Agilent Technologies 6890N Network GC system) fitted with flameionization detector, equipped with a 30x0.25 mm DB-225 column [15-17].

2.4.Preparation of thickening agent

The thickening agent was prepared by adding 16 grams of tamarind kernel powder to 200 mL of 8 % (W/W) distilled water in the presence of sodium azide (5 ppm) in order to prevent bacterial degradation. The dispersion mixture was vigorously stirred for 1 hour, at room temperature, followed by heating the dispersion at 80°C in a water bath for 30 min, under continuous stirring.

2.5.Preparation of printing pastes

The printing pastes for disperse printing of polyester were prepared using the following recipe:

Disperse dye	8	g
Thickening agent	800	g
Urea	75	g
Acetic acid	3	g
Water	114	g
Total weight of the paste	1,000	g

2.6.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 180°C for 5 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), then rinsed well and air-dried at room temperature.

2.7. Evaluation of colour strength and fastness properties

The colour strength (*K/S*) and *CIELAB* ofthe dyed samples were evaluated using aspectrophotometer (Hunter Lab: ColorQuest XE). All measured sample showed the maximum absorption wavelength (λmax) value at 400 nm.The *K/S* is a function of colourdepth and is calculated by the Kubelka-Munk equation:

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

where*R* is the reflectance, *K* is the sorption coefficient,and *S* is the scattering coefficient.The colour fastness to washing and rubbing of the dyed samples wasdetermined according to ISO 105-C06A1S:1994 and ISO 105-X12:2001, respectively.

3. Results and discussion

3.1. Characterization of tamarind kernel powder

The main characteristics of milled tamarind kernel powder wereanalyzed (Table 1). It can be seen that the tamarind kernel powder wasrich in polysaccharide and protein contentwhich is in good agreement withprevious reports [6, 8].

Table 1:*Chemical compositions of tamarind kernel powder from different places*

	Uthaithani	Ang Thong	Nakhon Sawan	India
Moisture (%)	9.69	9.09	9.63	10.78
Ash (%)	0.05	0.05	0.05	0.39
Protein (%)	13.46	13.95	13.61	12.53
Fat (%)	6.52	7.48	7.71	5.64
[a]Polysaccharide (%)	79.97	78.52	78.63	81.62

All values (%) on a dried weight basis are mean ± standard deviation of three determinations.
[a]Polysaccharide values (%) were calculated by difference.

3.2. Effect of disperse printing on colour value

A study on disperse printing with four different areas of tamarind seed (Uthaithani, Ang Thong, Nakhon Sawan, andIndia) as thickening agent was carried out. The colour value results obtained is presented in Table 2. It can be observed that the K/S value of tamarind kernel powder from India was the best printed result, and the next good result was obtained in the order of Uthaithani, Nakhon Sawan and Ang Thong. Polyester fabric printed with

tamarind kernel powder from India showed very good handling and sharpness. The samples printed with Uthaithani, Ang Thong and Nakhon Sawan tamarind seed produced good handling and sharpness, as shown in Figure 2.From the results, it can be postulated that the depth of the obtained prints governed by the rheological properties, thickening film properties and extent of releasing the dye molecules during the steaming step [13].

***Table 2**: Colour value of printed polyester fabric using different areas of tamarind seeds*

Area	K/S	L*	a*	b*	Handling	Sharpness
Control Fabric	0.01	94.97	-0.49	1.69	-	-
India	5.97	33.52	8.74	-43.11	Very good	Very good
Uthaithani	4.37	37.97	6.00	-43.15	Good	Good
Ang Thong	4.11	38.77	5.57	-42.69	Good	Good
Nakhon Sawan	4.21	38.38	5.60	-42.62	Good	Good

a) India b) Uthaithani c) Ang Thong d) Nakhon Sawan

***Figure 2**: Comparison of printed polyester fabric using different areas of tamarind seed.*

3.3. Effect of printing on fastness properties

The fastness rating of polyester fabrics printed with tamarind kernel powder are presented in Tables 3 and 4. Table 3 indicates that the washing fastness ratings of printed polyester fabrics were very good (4-5). The colour fastness to rubbing is alsoin 4-5 of rating (very good), asseen in Table 4.

Table 3:*Colour fastness to washing at 40ºC (ISO 105-C06 A1S: 1994)*

Fastness	Area of tamarind seed			
	India	Uthaithani	Ang Thong	Nakhon Sawan
Colour change	4-5	4-5	4-5	4-5
Colour staining				
-Acetate	4-5	4-5	4-5	4-5
-Cotton	4-5	4-5	4-5	4-5
-Nylon	4-5	4-5	4-5	4-5
-Polyester	4-5	4-5	4-5	4-5
-Acrylic	4-5	4-5	4-5	4-5
-Wool	4-5	4-5	4-5	4-5

Table 4:*Colour fastness to rubbing (ISO105- X12: 2001)*

Area of tamarind seed	Colour staining			
	Warp direction		Weft direction	
	Dry	Wet	Dry	Wet
India	4-5	4-5	4-5	4-5
Uthaithani	4-5	4-5	4-5	4-5
Ang Thong	4-5	4-5	4-5	4-5
Nakhon Sawan	4-5	4-5	4-5	4-5

4. Conclusions

This research investigated on the application of a thickening agent based on tamarind kernel powder for disperse printing of polyester. From the observations observed in the present study, it may be conclude that:

a. The tamarind kernel powder was rich in polysaccharide and protein.
b. Tamarind kernel powder from India showed higher *K/S* values than that from other areas in Thailand.
c. The fastness properties were very good.
d. Tamarind seed gum could be used as thickening agent for the disperse printing on polyester fabric.

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