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Fastness Properties of Colorant Extracted from Tamarind Fruits Pods to Dye Cotton and Silk Fabrics

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Abstract
This study investigates the extraction of colour from tamarind fruits pods to dye cotton and silk fabrics using the mordanting treatment with these mordants of CUSO4, FERROUS (II) & (III) SULPHATE AND ALUM. Aqueous and solvent extraction method was adopted for this experiment. The colour obtained was different shades ranging from soft, light brown and brown, depending on the mordant used. However, the change in colour can be improved using other mordant from the ones used in this study, fastness properties test was carried out and proved good result. Therefore, the findings will benefit local dyers, farmers, textiles industries; organisations, institutions that deal with dyes/colour, research institutes and can be good for future research on other natural fabrics.
Keywords: Aqueous and solvent Extraction method, Colour/dye, Tamarind Fruit pods, Cotton and Silk Fabrics, Dyed, Fastness test.

1. Introduction:

The use of natural colors for dyeing fabrics has been in practice since ancient times, where most of the dye color are obtained from the plants parts (leaves, flowers, stem, roots, fruits and pods (Adeel et al, 2009; Katz, 2004). The advent of synthetic dyes during 1856-1900 jeopardized the market of natural colorants, as synthetic dyes were cheaper and gave excellent fastness and reproducible color shades (Samanta & Konar, 2012).

The growing awareness of environmental problems coupled with the toxicity associated with synthetic dyes, brings back the promising prospects of nature to the cheaper extraction technology of colorants from natural, renewable resources plants parts (Kulkarni, 2011).

It is on this footstep of global concern over the use of an eco-friendly and biodegradability of natural materials that this research work bends on one of the famous plant known as Tamarind Plant (tamarindusindica) as a Source of Natural Dyes.

The tamarind plant(tamarindusindica), is also a legume family, which according to the (Mortan, 1987) is a long-lived medium growth plant, of average height between 12-18 metres (40-60 feet).It grows well in full sun, clay, loamy, sandy, and acidic types of soil.

The tree leaves are evergreen, bright green in colour, elliptical in shape, with an alternate arrangement. It is a pinnate compound type, and has a drop branches from a single central trunk, produces flowers with red and yellow elongated flowers of about 2.5cm wide, which later turn into fruits of about 12-15cm in length. The fruit has a hard brown shell when fully ripped; the seeds content varies in numbers from one country to another enclosed in a paste which are brown in colour.

This description was further stressed by Morton (1987) who stated that the tamarind fruit is flattish, beans like, irregularly curve and bulged pods are grown in abundance along new branches and usually vary from 2-7centimetres in length. The pods, at tender stage looks green, highly acidic flesh and soft, whitish, but as it is ripped, the pods turn brown or greyish-brown, with a juicy, acidulous pulp turns brown or reddish brown containing the seeds in it. Thereafter, the skin becomes brittle, easily-cracked shell and the pulp dehydrates naturally to a sticky paste enclosed by a few coarse strands of fibre extending length wise from the stalk.

Morton, further explained that a matured tamarind tree may annually produce 150-225 kilogram of fruits and is use as food, especially drinks, confectionary, medicine and animals feeds. The pods are mostly discarded, thereby contributing to environmental pollution. When soaked in water, it turns brownish in colour; this

motivated the researcher to explore this colour for application on natural fabrics.

The most concern of this study is the fruit pods to extract colour for textiles use, especially the natural fabrics of cotton and silk. The colour to be extracted are brown and grey-brown and the good fastness properties of the colour on these fabrics can confirm if the plant is capable of providing the expected dye on natural fabrics.

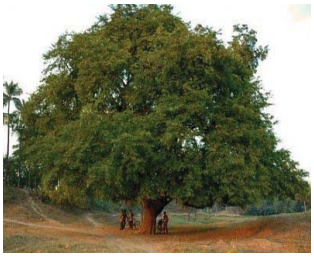

Figure 1, Tamarind tree and fruits

Figure 2, Dried and grinded tamarind pods

2. Materials and Methods

2.1 Materials

- Source: The tamarind fruits were obtained from the Penglachepa market, Khota Bharu, Malaysia.
- Subsrate: Plain weave cotton and silk fabrics were obtained from the store, Faculty of Creative Technology and Heritage, University Malaysia Kelantan, for the dyeing.
- Chemicals: Laboratory grade chemicals,95% acidified methanol & ethanol, copper sulphate, ferrous (II) & (III) sulphates, were obtained from store, Faculty of Agro Based Industry, Jeli Campus, University Malaysia Kelantan.

2.2 Methods

The methods used for extraction were aqueous and solvent.

2.2.1. Preparation of raw material

The sample was collected, then opened the fruits to obtained the pods, which was sundried, and ground into powder with the help of grinder (Win & Swe, 2008).

2.2.2. Extraction and purification of the crude dyestuff

200gm of the sample was weight and taken into three different conical flasks of 2000ml each, and was soaked in (distilled water & the solvent) of 1.8litres overnight. In this process, the whole sample was filtered, solvent were recovered using the soxhlet apparatus at 70°C for hours, to obtain the colour extract (Win & swe; Goodarzian & Ekrami, 2010).

2.2.3 Scouring of the fabrics

The fabrics measuring 50×50 cm, were washed in 0.5gm/l solution of sodium carbonate and rinsed in running water (distilled), then dried at room temperature

2.2.4. Dyeing and Mordanting

Acurrately weighed cotton and silk fabrics were treated with different metal salts of (mordants used Alum, copper sulphate, ferrous(II) & (III) sulphates). The three processes of mordanting were used- pre-mordanting, simultaneous mordanting and post-mordanting using 400mls of dye extract and 100mls of the each mordant at 100°C for 10 minutes . After dyeing, the dyed materials were washed with cold water and dried at room temperature (Pruthi et al, 2007; Jothi, 2008; Suitcharit et al, 2010)

2.2.5 Fastness tests

Colour fastness to washing of the dyed fabrics samples was determined as per MS ISO: 764-1987 methods using washing fastness machine (Linitest). The wash fastness rating was assessed using grey scale as per ISO-105-A02 (loss of colour shade/depth) and ISO-105-A03 (extent of staining), (Samanta &Agarwal, 2009).

The colour fastness fabric samples sizes used for washing fastness was 4×2 centimetres and sandwich stitched between a white wool and cotton fabrics also of the same sizes with the sample sized, 8 fabrics samples were soaked inside washing pots containing 100mls of washing detergent, and were inserted inside the pots holes, the

machine was operated and run for 30 minutes.

The washed samples were removed, rinsed under running distilled water and squeezed to remove excess water on it and shade dried. After, the samples were unstitched and then pressed heat at appropriate temperature, then ready for grading.

The colour fastness to light was determined as per MS ISO: 2450-1987method. The light fastness was tested by exposing the sample to Ultraviolet light (UVL) in a Xenotest220 machine, for 24 hours, the samples size used for the tests is 2×1cm, and were stapled to a prepared card plate, where cotton and silk fabrics according to the dye extract used were on each card plates and were assemble into the light fastness machine plates (metallic).

About 20 samples were assembled at a time into the machine and were run for 8 hours; the machine runs automatically in case of electricity problem and when electricity was switch off. The samples were removed after the period and ready for grading. The fading of each sample was observed against the fading of blue wool standard (1-7), (Adeel et al, 2009).

Colour fastness to rubbing (dry and wet) was assessed as per MS ISO: 766-1987 method using a manually operated crock meter and grey scale as per ISO: 105-A03 (extent of staining).The prepared cotton and silk samples measuring 8×4 centimetres were attached on a piece of white wool fabrics 2×2 centimetres and labelled on each wet/dry, then ready for the test (Mishra & Patni, 2011).

The prepared white woollen fabric were tied to the stroking tip and the fabrics under test were inserted in the prepared box (metallic) and set the machine to zero (0), then run the machine. After 20 strokes the machine was stop, the fabrics sample and the prepared white wool that was rubbed on the samples were removed. Distilled water was used for the wet test on the rubbed surfaced of the white wool prepared, at the end of all the crocking and rubbing the samples were taken for grading.

The colour fastness to perspiration was assessed according to IS-971-1987 method. The specimen was stitched at two sides to a piece of white wool fabric measuring 4×2 centimetres and was soaked in the test solution of (acidic & alkaline) separately with a liquor ratio of 1:50 for 30 minutes at room temperature. The samples were then placed in between two glass plates of perspiration, under load of 4.5kilogrammes (10 lbs).

The apparatus was then kept in the oven for 4 hours at 37±2°. At the end of this period, the specimen was removed, un-stitched at one end, hung for drying in oven at a temperature not exceeding 60°c for one hour.

The beauty of colour in any fabric is of no value to the consumer, unless the dye may be considered fast under the conditions in which the fabric will be used. Colour must meet tests such as washing, ironing, steaming, perspiration, strong light, rubbing and the effects of acid/ alkaline, (Bernard, 1983).

Therefore, under this study only washing, light, rubbing, and perspiration test were conducted; the tested samples were graded for change in colour and staining using grey scales (Raja, 2010). All the tested specimens were graded and results were arranged in the Tables 1-3 below, according to the medium combination.

3. Results and Discussion

3.1. Treatment methods results on the fruits pods extracted in aqueous combination

The evaluation of colour fastness to washing, light, rubbing and perspiration test on dyed cotton and silk fabrics samples extracted from tamarind fruits pods treated with Alum (aluminium potassium sulphate), Copper (II) Sulphate, Iron (II) &Iron (III) Sulphates in aqueous medium combination is presented below in table 1.

The mordants play a very important role in imparting colour to the fabrics. The mordants used inthe combination gave varying shades resulting to inconsistency of colour value results (Kamel etal, 2009).

All the treated samples subjected to washing fastness shows fairly good (3-4) for the plant and no colour change, with negligible staining, the variation in the colour values was as a result of the itself decomposes, thus converting to colourless or to a different colour compound(Jothi,2008). The exposure to light showed excellent to good (7-6, 6-5 &5-4) for all the treaded samples, except on simultaneous mordant with alum for both cotton, where its shows fair (2-3), the variation of colour value can be related to lack of good complexes formation with the metal (mordant), which can protects the chromatophore from photolytic degradation(Pathade et al,2011). Rubbing fastness test samples shows excellent to good (5,& 4-5) on all the treated samples, except for post-mordant cotton wet (3-4) shows fair to good on the extract, but no colour change and negligible staining(4-5), it can be observed that there were instability of the colour value, which can be due good complexing of the fibre by the mordant, which result to the effect of solubilising the dye making it colour loss (Pattenden,1989).

Perspiration fastness test shows excellent to good (4-5), fairly good (3-4) for alkaline of the fruits pods extracts, except in simultaneous mordant with iron (II) sulphate on silk, post-mordant with copper (II) sulphate on cotton shows loss of shade (2 & 2-3) respectively. Mordants are metals salts which produce affinity between the fabric and the dye (Vankar et al, 2009), but no colour change and negligible colour staining on almost all the treated samples in acidic and alkaline media in this aqueous medium combination.

Table 1: Fastness grades of tamarind fruits pods on cotton and silk fabrics at dyeing time of 10minutes at 100°C temperature in aqueous medium combination.

Mordanting Method	Type of Mordant Used	Tamarind Pod A																			
		Cotton										Silk									
		Light Grades	Washing		Rubbing			Perspiration				Light Grades	Washing		Rubbing			Perspiration			
			Grades		Grades			Grades					Grades		Grades			Grades			
					Dry	Wet		Acidic		Alkaline					Dry	Wet		Acidic		Alkaline	
			CC	CS	CS	CS	CS	CC	CS	CC	CS		CC	CS	CC	CS	CC	CC	CS	CC	CS
Pre-Mordanting	A	7	3-4	4-5	4		4	3	5	4	5	7	3	5	4		4	4	5	3-4	5
	B	7	4	4	4		4	3-4	5	3	5	6	3	4-5	4		4	3-4	5	4	5
	C	6	4	4	4-5		4	4	5	4	5	6	3-4	4-5	4		4	4	5	4	5
	D	6	4	4	4		4	4	5	3-4	5	5-6	3	5	4		4-5	3-4	5	3	5
Simultaneous Mordanting	A	2-3	4	4-5	4		4	3-4	5	4	5	3	3-4	5	4		4	3	5	3-4	4-5
	B	5-6	4	5	4		4	3-4	5	3	5	6	3-4	5	4		4	4-5	5	4	5
	C	5-6	3	5	4		4	3	5	4	5	5-6	3	5	4		4	2	5	3	5
	D	7	4	4-5	4		3-4	4	5	3-4	5	5	3	5	4		4	3	5	3-4	5
Post-Mordanting	A	7	3-4	4	4		4	4-5	5	4-5	5	7	3	5	4		4	4	5	4	5
	B	6	4	5	5		4-5	2	5	3-4	5	6	3	5	4-5		4-5	3-4	5	4	5
	C	5-6	3-4	5	4-5		3-4	3	5	4-5	5	5-6	3	5	4		4	4	5	3	5
	D	7	3-4	4-5	4		3-4	4	5	4	5	5-6	3	5	4		3-4	2-3	5	3	5
Without Mordanting		5-6	4	4-5	4		4	4	5	4-5	5	5-6	4	5	4		4-5	3	5	3	5

Key: A- Aluminium Potassium Sulphate
B- Copper (II) Sulphate
C- Iron (II) Sulphate
D- Iron (III) Sulphate

CC- Colour Change
CS- Colour Staining

3.2 Treatment methods results of the fruit pods extracted in methanol medium combination:

The evaluation of colour fastness to washing, light, rubbing and perspiration fastness test on tamarind fruits pods extracted dyed cotton and silk fabrics samples treated with Alum, Copper(II) sulphate, Iron (II) & Iron(III) sulphates in methanol medium combination is presented in table 2.

All the treated samples subjected to washed fastness test on the treated samples on tamarind dyed extracts showed fairly good (4, & 3-4), no colour change with negligible colour staining on cotton and silk samples, the changes of the results value can be related to the detachment of the colour dye from the substrate due to wear dye-fibre bond between the natural dye and the fibre (Mahala, 2001). For the light exposure to fastness test, all the treated samples dyed extracts showed excellent to good (7, 6-5 &5) and fair in colour change (3) in pre-mordant and simultaneous mordant in alum on both cotton and silk, this colour change was due to lack of complexes formation by the mordant between the fibre and the dye, it could have protected the chromatophore from photolytic degradation (Goodarzian & Ekrami, 2010).

Rubbing fastness test showed excellent to good (5, & 4-5) and fairly good (3-4), for all the treated samples, perspiration fastness test on methanol medium combination showed that the treated samples have fairly good (3-4), except for pre-mordant acidic on silk showed fair (2-3) and post- mordant alkaline on cotton and silk acidic shows also fair grading (2-3), but no colour change and staining in both acidic and alkaline media, the colour loss and variation, can be related to the inability of the mordant to have good between the fabrics and the dye (Samanta & Agarwal, 2009).

Table 2: Fastness grades of tamarind fruits pods extract on cotton and silk fabrics at dyeing time of 10minutes at100°C temperature in methanol medium combination

Mordanting Method	Type of Mordant Used	Tamarind Pod B																			
		Cotton										Silk									
		Light Grades	Washing		Rubbing			Perspiration				Light Grades	Washing		Rubbing			Perspiration			
			Grades		Grades			Grades					Grades		Grades			Grades			
					Dry	Wet		Acidic		Alkaline					Dry	Wet		Acidic		Alkaline	
			CC	CS	CC	CS	CC	CC	CS	CC	CS		CC	CS	CC	CS	CC	CC	CS	CC	CS
Pre-Mordanting	A	3	4	5	5		4	3	4-5	3	4-5	3	4	5	4		4	3-4	4-	4	4-5
	B	5-6	3	5	4		3-4	4	4-5	4	4-5	5-6	3-4	5	3-4		4	3	5	4	5
	C	3	3	4-5	4		4	3	5	3	5	3	3-4	4	4		4	2-3	5	3	5
	D	5-5	3-4	4-5	4		4-5	3-4	5	3	5	5-6	3-4	5	3-4		4	3	5	4	5
																			5		
Simultaneous Mordanting	A	3-4	3	4	5		4-5	4-5	5	4	4-5	3	3-4	5	4-5		4	4-5	5	5	5
	B	7	4	5	5		4-5	3	5	3-4	5	5-6	3	4	3-4		4-5	3	5	4	5
	C	7	4	5	5		4	3-4	5	3-4	5	7	4	5	4		4	2-3	5	3	5
	D	7	3-4	5	3-4		4	3	5	4	5	5-6	3	4-5	5		4	3	5	3-4	5
Post-Mordanting	A	6	3	4	4-5		4-5	3	5	2-3	5	6	3	4-5	4-5		4-5	4	5	3	5
	B	7	3-4	4-5	4-5		5	3	5	3-4	5	7	4	5	4		4	2-3	5	2-3	5
	C	5-6	4	4-5	4		5	3	5	4	5	5-6	4	4-5	4		5	2-3	5	3	5
	D	6	3	4-5	4		4-5	3	5	3-4	5	5	3-4	5	4-5		4	3	5	3-4	5
Without Mordanting		3	3-4	4-5	5		4-5	3-4	5	3	5	3	4	4-5	5		5	3	5	3	5

3.3 treatment methods of the fruits pods extracted in ethanol medium combination:

The evaluation of colour fastness to washing, light, rubbing and perspiration fastness test on tamarind fruits extracted from ethanol medium combination dyed on cotton and silk fabrics samples treated with Alum, Copper (II) Sulphate, Iron(II) & Iron (III) Sulphates in ethanol medium combination is presented in table 3. All treated samples subjected to washing fastness test shows fairly good (3-4) for cotton and silk from the extracts, with negligible colour change and staining, this inconsistency in colour value grades was as a result of inability of the metal salts above to formed coordination complexes between the fabrics and the dye (Padma, 2000). The treated samples subjected to light exposure shows excellent to good (7-5) and fairly good (3-4). The colour change to dry and wet rubbing test for all the treated samples was excellent to good (4-5), with negligible colour staining, the most noticeable disadvantage was the colour variation, which was because of poor coordination tendency of the metal salts to enhances interaction between the fibre and the dye, resulting to low dye absorption(Mahala, 2001).

Perspiration fastness test shows fairly good (3-4) for no colour change and negligible colour staining in both acidic and alkaline media, except pre-mordant in Iron (II) & Iron (III) sulphates which shows loss of colour (2, &2-3), in acidic, but negligible colour staining in both acidic and alkaline media from the fruit pods, the loss of colour and variation of grades value results can be related to the ionization of the natural dye during alkaline test, since the most natural dyes have hydroxyl groups which ionize under alkaline conditions, some of the samples was tested in acidic conditions, that can make them to fade (Jothi, 2008). However, it was clearly noted that the graded value results can be acceptable and the dye extract be useful for textile colouring.

Table 3: Fastness grades of tamarind fruits pods on cotton and silk fabrics at dyeing time of 10minutes at 100°C temperature in ethanol medium combination

Mordanting Method	Type of Mordant Used	Tamarind Pod C																			
		Cotton										Silk									
		Light Grades	Washing		Rubbing			Perspiration				Light Grades	Washing		Rubbing			Perspiration			
			Grades		Grades			Grades					Grades		Grades			Grades			
					Dry	Wet		Acidic		Alkaline					Dry	Wet		Acidic		Alkaline	
			CC	CS	CC	CS	CC	CC	CS	CC	CS		CC	CS	CC	CS	CC	CC	CS	CC	CS
Pre-Mordanting	A	3-4	3	4	4-5		4	3	4-5	3	4-5	3	4	5	4-5		4-5	4	5	4	4-5
	B	5	4-5	5	4		4	3-4	5	4	5	5	3	5	4		4	4	5	3-4	5
	C	5-6	3	5	5		5	2-3	5	3	5	5-6	3-4	4-5	5		5	3-4	5	4	5
	D	5-6	3	5	5		4	3	5	3-4	5	5-6	4	4-5	4		4	2-3	5	3	5
Simultaneous Mordanting	A	3	4	4	5		4	4-5	5	3	5	3	3	4-5	5		5	4	5	4-5	5
	B	5-6	4-5	5	4		4	3	5	3-4	5	6	3	5	4		5	3-4	5	3	5
	C	5	3-4	4	4		3	3	5	3-4	5	5-6	3-4	4-5	5		4	3	5	3-4	5
	D	5-6	4	5	4		4	3	5	3-4	5	5-6	4	4-5	4		4	3	5	4	5
Post-Mordanting	A	3	3	4	5		4	4	5	3-4	4-5	3	3	4-5	5		5	3-4	5	4	5
	B	7	4	5	4-5		4	3-4	5	3	4-5	5-6	4	4-5	4		4	4-5	5	4	5
	C	6	4	4	4-5		4	3	5	3	5	5-6	4	4-5	4-5		4	2	5	3-4	5
	D	6	4	4-5	4		4	2	5	3-4	5	5	3	4	4-5		4-5	2	5	3-4	5
Without Mordanting		3	4	5	4-5		4	3	5	3	5	3	4	5	4-5		4-5	3-4	5	4	5

Conclusion

The used of the mordants gave different shades to the fabrics, there was wide range of soft and light colors obtained both on cotton & silk, by using the dye extracted from the fruits pods especially on methanol & ethanol medium combination. With regards to color fastness tested, samples exhibited excellent to good, fairly well, except that the extract has 4 samples with less than grade value (3) in aqueous combination. In methanol combination, it has 6 that were less than grade value (3). In ethanol combination, it has 5 samples that was less than grade (3).

However, the extracts is a good natural dyes, so recommend to be use as dyes, to textiles industries, institutions that deals with dyes/coloring, organizations, the government.

Findings and future work

From the investigation it was revealed that the extract was good use as natural dyes, so can be accepted by dyeing industries as well as local dyers and that the plant is abundance, therefore, our unemployed youths can have something to do, farmers also can expand their cultivation, consequently market business will be generated in that direction, further investigation can be done with other types of mordants and natural fabrics such as chrome, stannous chloride, potash, lemon juice and wool, jute, etc respectively.

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