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Color fastness evaluation of different fabrics dyed with similar dyes (Cotton and silk fabrics with tamarind color)

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This Report Presented in Partial Fulfillment of the Requirements for the Degree of Bachelor of Science in Textile Engineering.

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DECLARATION

We hereby declare that, this project has been done by us under the supervision of **Md. Kamrul Islam, Lecturer, Department of Textile Engineering, Daffodil International University.** We also declare that neither this project nor any part of this project has been submitted elsewhere for awarding degree or diploma.

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DEDICATION

We dedicate this project to Almighty our creator, our strong pillar, our source of inspiration, wisdom, knowledge and understanding. He has been the source of our strength throughout this program and on His wings only have we soared. We also dedicate this work to our honorable Acting Head of department **Mr. Md. Mominur Rahman** who has managed all the important task and remain good parenting with all of the departmental students. We are very much grateful to our supervisor **Md. Kamrul Islam** who have maintain very strong cooperation with us and always giving instruction during our internship period and help us a lot for preparing this thesis report.

ABSTRACT

The main point of our project is to observe the process of dyeing different fabrics with a natural dye and various wet testing like wash, Rubbing, Water, Perspiration, & Light fastness etc.

We have noticed a significant effect on dyed fabric for the variation of color or shade depth by change the amount of salt and soda.

With a view to obtaining best quality of dyed cotton fabric with best quality of tamarind dye, we have undertaken this project to find out the actual nature of the tamarind dye on cotton and silk fabric.

Contents

1. Introduction

Since ancient times, the use of natural colors for dyeing fabrics has been in practice, where much of the dye color is derived from the parts of plants (leaves, flowers, stem, roots, fruits and pods. During 1856-1900, the introduction of synthetic dyes jeopardized the demand for natural dyes, as synthetic dyes were cheaper and provided excellent stability and reproducible color shades. Increasing understanding of environmental concerns coupled with the toxicity associated with synthetic dyes brings back the promising outlook of nature to cheaper extraction technologies for dyes from natural, renewable resource plant parts. This research work bends on one of the popular plants known as Tamarind Plant (tamarindusindica) as a Source of Natural Dyes on this phase of global concern regarding the use of eco-friendly and biodegradability of natural materials. The tamarind plant (tamarindusindica) is also a genus of legumes, which is a medium-growing, long-lived plant with an average height of 12-18 meters (40-60 feet). It grows well in soil types of full sun, clay, loamy, sandy, and acidic. The leaves of the tree are evergreen, colored bright green, elliptical in form, with an alternate arrangement. It is a pinnate compound type and produces flowers with red and yellow elongated flowers of about 2.5cm wide, which later develop into fruits of about 12-15cm in length, with drop branches from a single central trunk. When completely ripped, the fruit has a hard brown shell; the quality of the seeds varies in numbers enclosed in a paste of brown color from one country to another. Morton (1987) who reported that the tamarind fruit is smooth, beans like, irregularly curved and bulged pods are cultivated in abundance along new branches and typically range from 2-7 centimeters in length. The pods look green, highly acidic and smooth, whitish flesh at the tender stage, but when ripped, the pods turn brown or greyish-brown, with a juicy, acidic pulp turning brown or reddish brown containing the seeds in it. The skin then becomes brittle, easily broken shell, and the pulp naturally dehydrates to a sticky paste enclosed by a few coarse fiber strands extending from the stalk wise length. Morton further explained that 150-225 kilograms of fruit can be produced annually by a matured tamarind tree and is used as food, particularly drinks, confectionery, medicine and feed for animals. The pods are often discarded and therefore lead to contamination of the ecosystem. It becomes brownish in color when immersed in water; this inspired the investigator to investigate this color for use on natural fabrics. The fruit pods to extract color for the use of textiles, particularly the natural fabrics of cotton and silk, are the main concern of this study. The color to be extracted is brown and

grey-brown, and if the plant is capable of producing the expected dye on natural fabrics, the good firmness properties of the color on these fabrics can be confirmed.

2. Objectives

- ❖ Extraction of tamarind dye from fruit pods.
- ❖ Method of natural dyeing.
- ❖ Effect on amount of salt and soda in a shade.
- ❖ Effect on different fastness properties, on cotton fabric.
- ❖ Effect on different fastness properties, on silk fabric.
- ❖ To know the result of it.

3. Definition of Dyeing

Dyeing is the method by which textile items such as fibers, yarns, and fabrics add color. The dyeing typically takes place in a special solution containing colorants and specific chemical materials. Dye molecules have an uncut chemical bond with fiber molecules after coloring. Two main variables in dyeing are the regulation of temperature and time. Two kinds of dye, natural and man-made, are mainly available.

Historically, the primary source of pigment has usually been nature, with the colors being derived from animals or plants. However, humans have developed artificial dyes since the mid-18th century to achieve a wider variety of colors and to make the dyes more durable to resist washing and general use. For various types of fiber and at different stages of the

textile production process, different groups of dyes are used, from loose fibers to yarn and fabric to finished clothing.

Acrylic fibers are dyed with simple dyes, while acid dyes are dyed with nylon and protein fibers such as wool and silk, and polyester yarn is dyed with dispersed dyes. A variety of dye types, including vat dyes, and modern synthetic reactive and direct dyes, are used to dye cotton.

4. Materials and Methods

4.1 Materials

Source: The tamarind fruits were obtained from the market.

Substrate: Plain weave cotton and silk fabrics were obtained from the store, for the dyeing.

Chemicals: Laboratory grade chemicals, 95% acidified methanol & ethanol, copper sulphate, ferrous (II) & (III) sulphates, were obtained from store.

4.2 Methods

The methods used for extraction were aqueous and solvent.

4.2.1. Preparation of raw material

The sample was collected and then, with the aid of a grinder, the fruit was opened to extract the pods, which were sundried and ground into powder.

4.2.2. Extraction and purification of the crude dyestuff

The sample weighed 200 gm and was taken into three separate conical flasks of 2000 ml each and soaked overnight in 1.8 liters (distilled water & solvent). In this process, the entire sample was filtered and solvent was recovered for hours at 70 degC to obtain the color extract.

4.2.3 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.

4.2.4. Dyeing and Mordanting

Various metal salts (mordants used Alum, copper sulphate, ferrous(II) & (III) sulphates) were handled with precisely measured cotton and silk fabrics. Using 400mls of dye extract and 100mls of each mordant at 100 degC for 10 minutes, the three mordant processes were used-pre-mordanting, simultaneous mordanting and post-mordanting. After dyeing, the dyed materials were washed with cold water and dried at room temperature.

4.2.5 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 color shade/depth) and ISO-105-A03 (extent of staining).

The sample sizes of the color fastness fabric used for washing quickness were 4 to 2 centimeters and stitched sandwich. Eight fabric samples were soaked inside washing pots containing 100mls of washing detergent, and were placed inside the pots holes, the machine was controlled and run for 30 minutes between a white wool and cotton fabrics both of the same sizes with the sample size.

The washed samples were removed, rinsed and squeezed under running distilled water to extract excess water and dried with shade. The samples were then unstitched and heat pressed at a suitable temperature, then ready to be graded.

The color 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).

Approximately 20 samples were mounted into the machine at a time and ran for 8 hours; the machine runs automatically in the event of an electricity problem and when the electricity is switched off. Following the time, the samples were extracted and ready for

grading. The fading of each specimen against the fading of the regular blue wool was noted (1-7).

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 centimeters were attached on a piece of white wool fabrics 2×2 centimeters and labelled on each wet/dry, then ready for the test.

The prepared white woolen 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. The machine was stopped after 20 strokes, the cloth sample was removed, and the prepared white wool rubbed on the samples was removed. For the wet test, distilled water was used on the rubbed surface of the prepared white wool, and the samples were taken for grading at the end of both the crocking and rubbing.

The color 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 centimeters 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.).

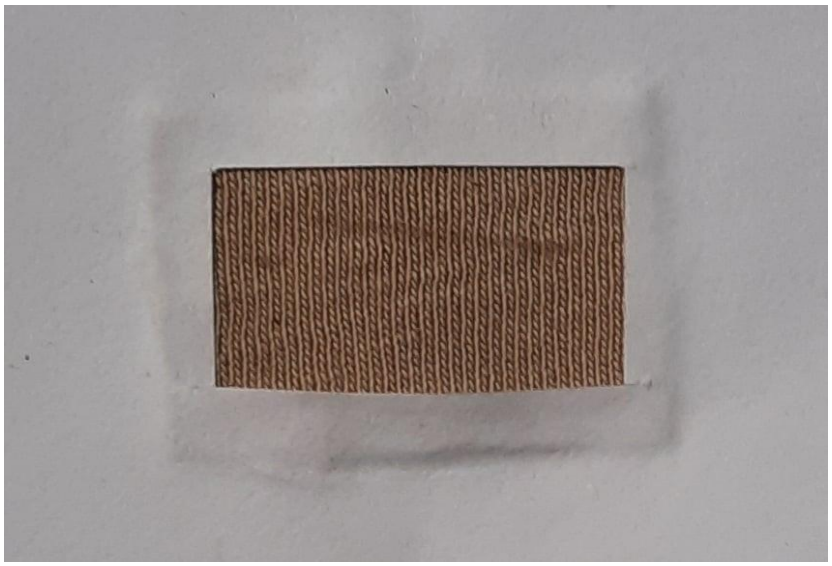
At 37±20, the apparatus was then kept in the oven for 4 hours. The specimen was removed at the end of this time, un-stitched at one end, hanging for drying in the oven for one hour at a temperature not exceeding 60 deg C.

Unless the dye can be considered rapidly under the circumstances under which the fabric will be used, the beauty of color in any fabric is of little benefit to the user. Color must follow tests such as washing, ironing, steaming, perspiration, bright light, rubbing and the effects of acid/ alkaline.

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

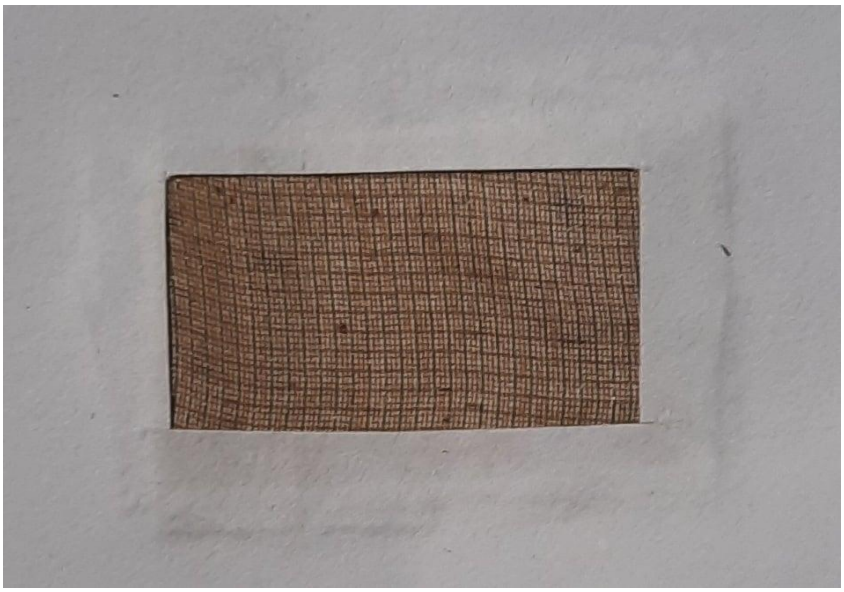
5. Results and Discussion

5.1 Achieved shade in cotton fabric.



Color may different for image quality.

5.2 Achieved shade in silk fabric.



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5.3. Treatment results on methods

the fruits pods extracted in aqueous combination.

Samples taken from tamarind fruit pods treated with alum (aluminum potassium sulphate), copper (II) sulphate, iron (II) & iron (III) sulphate in an aqueous medium combination are provided below in Table 1 for the assessment of color fastness for washing, illumination, rubbing and perspiration tests on dyed cotton and silk fabrics.

The mordants play a very important role in imparting color to the fabrics. The mordants used in the combination gave varying shades resulting to inconsistency of color value results.

All treated samples subjected to washing fastness show reasonably good (3-4) for the plant and no change in color, with negligible staining, due to the decomposition of the color values, the difference in the color values was transformed to colorless or to another color compound. 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 color value can be related to lack of good complexes formation with the metal (mordant), which can protects the chromatophore from photolytic degradation. 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 color change and negligible staining(4-5), it can be observed that there were instability of the color value, which can be due good complexing of the fiber by the mordant, which result to the effect of solubilizing the dye making it color loss.

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, but no color change and negligible color 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 100^0C temperature in aqueous medium combination.

Key: A- Aluminium Potassium Sulphate CC- Colour Change

B- Copper (II) Sulphate CS- Colour Staining

C- Iron (II) Sulphate

D- Iron (III) Sulphate

Mordanting method	Type of Mordant used	Tamarind Pod A																			
		Cotton										Silk									
		Light Grades	Washing		Rubbing			Perspiration				Light Grade	Washing		Rubbing			Perspiration			
			Grades		Grades			Grades					Grades		Grades			Grades			
					Dry	Wet		Acidic		Alkaline					Dry	Wet		Acidic		Alkali	
			cc	cs	cs	cs		cc	cs	cc	cs		cc	cs	cc	cs	cc	cc	cs	cc	
Pre-Mordanting	A B C D	7 7 6 6	3-4 4 4 4	4-5 4 4 4	4 4 4-5 4		4 4 4 4	3 3-4 4 4	5 5 5 5	4 3 4 3-4	5 5 5 5	7 6 6 5-6	3 3 3-4 3	5 4-5 4-5 5	4 4 4 4		4 4 4 4-5	4 3-4 4 3-4	5 5 5 5	3-4 4 4 3	
Simultaneous Mordanting	A B C D	2-3 5-6 5-6 7	4 4 3 4	4-5 5 5 4-5	4 4 4 4		4 4 4 3-4	3-4 3-4 3 4	5 5 5 5	4 3 4 3-4	5 5 5 5	3 6 5-6 5	3-4 3-4 3 3	5 5 5 5	4 4 4 4		4 4 4 4	3 4-5 2 3	5 5 5 5	3-4 4 3 3-4	
Post-Mordanting	A B C D	7 6 5-6 7	3-4 4 3-4 3-4	4 5 5 4-5	4 5 4-5 4		4 4-5 3-4 3-4	4-5 2 3 4	5 5 5 5	4-5 3-4 4-5 4	5 5 5 5	7 6 5-6 5-6	3 3 3 3	5 5 5 5	4 4-5 4 4		4 4-5 4 3-4	4 3-4 4 2-3	5 5 5 5	4 4 3 3	
Without Mordanting		5-6	4	4-5	4		4	4	5	4-5	5	5-6	4	5	4		4-5	3	5	3	

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

The evaluation of color 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.

Both treated samples subjected to washed fastness test on the treated samples on tamarind colored extracts showed reasonably good (4, & 3-4), no color shift with negligible color staining on cotton and silk samples, the changes in the result value could be correlated with the separation of the color dye from the substrate due to the wear of the dye-fiber bond between the natural dye and the fiber. Both treated samples of colored extracts showed excellent to strong (7, 6-5 &5) and fair color change (3) in pre-mordant and simultaneous mordant in alum on both cotton and silk for the light exposure to the fastness test, this color change was due to the lack of complex mordant formation between the fiber and the color, it could have protected the chromatophore from photolytic degradation.

For all treated samples, the fastness test on methanol medium combination showed that the treated samples were reasonably strong (3-4), with the exception of pre-mordant acid on silk showed fair (2-3) and post-mordant alkaline on cotton and silk acid showed fair grading as well as fair grading (2-3), but no color change and staining in both acidic and alkaline media, the color loss and variation, can be related to the inability of the mordant to have good between the fabrics and the dye.

Table 2: Fastness grades of tamarind fruits pods extract on cotton and silk fabrics at dyeing time of 10minutes at100^{0}C temperature in methanol medium combination.

Mordanting method	Type of Mordant used	Tamarind Pod B																		
		Cotton										Silk								
		Light Grades	Washing		Rubbing			Perspiration				Light Grade	Washing		Rubbing			Perspiration		
			Grades		Grades			Grades					Grades		Grades			Grades		
					Dry	Wet		Acidic		Alkaline					Dry	Wet		Acidic		Alka
			cc	cs	cs	cs		cc	cs	cc	cs		cc	cs	cc	cs	cc	cc	cs	cc
Pre-Mordanting	A B C D	3 5-6 3 5	4 3 3 3-4	5 5 4-5 4-5	5 4 4 4		4 3-4 4 4-5	3 4 3 3-4	4-5 4-5 5 5	3 4 3 3	4-5 4-5 5 5	3 5-6 3 5-6	4 3-4 3-4 3-4	5 5 4 5	4 3-4 4 3-4		4 4 4 4	3-4 3 2-3 3	4-5 5 5 5	4 4 3 4
Simultaneous Mordanting	A B C D	3-4 7 7 7	3 4 4 3-4	4 5 5 5	5 5 5 3-4		4-5 4-5 4 4	4-5 3 3-4 3	5 5 5 5	4 3-4 3-4 4	4-5 5 5 5	3 5-6 7 5-6	3-4 3 4 3	5 4 5 4-5	4-5 3-4 4 5		4 4-5 4 4	4-5 3 2-3 3	5 5 5 5	5 4 3 3-4
Post-Mordanting	A B C D	6 7 5-6 6	3 3-4 4 3	4 4-5 4-5 4-5	4-5 4-5 4 4		4-5 5 5 4-5	3 3 3 3	5 5 5 5	2-3 3-4 4 3-4	5 5 5 5	6 7 5-6 5	3 4 4 3-4	4-5 5 5 4-5	4-5 4 4 4-5		4-5 4 5 4	4 2-3 2-3 3	5 5 5 5	3 2-3 3 3-4
Without Mordanting		3	3-4	4-5	5		4-5	3-4	5	3	5	3	4	4-5	5		5	3	5	3

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

Samples treated with Alum, Copper (II) Sulphate, Iron (II) & Iron (III) Sulphates in ethanol medium combination are presented in Table 3 to determine the color fastness of the washing, light, rubbing and fastness test on tamarind fruits extracted from ethanol medium combination tinted on cotton and silk fabrics. For cotton and silk from the

extracts, all treated samples subjected to the washing fastness test show reasonably good (3-4) with negligible color change and staining, this inconsistency in color value grades was due to the inability of the metal salts above to form complexes of coordination between the fabrics and the dye. Excellent to excellent (7-5) and moderately good are the handled samples subjected to light exposure (3-4). The color transition to dry and wet rubbing test for all the treated samples was excellent to decent (4-5), with negligible color staining, the most notable downside was the color variation, which was because of poor coordination tendency of the metal salts to enhances interaction between the fiber and the dye, resulting to low dye absorption.

For no color shift and negligible color staining in both acidic and alkaline media, the transpiration fastness test shows reasonably good (3-4) excluding pre-mordant in Iron (II) & Iron (III) sulphates showing color loss (2, &2-3), acidic but negligible color staining in both acidic and alkaline media from the fruit pods, During the alkaline test, the loss of color and difference of grade value results may be correlated with the ionization of the natural dye, as most natural dyes have hydroxyl groups that ionize under alkaline conditions, some of the samples were tested under acidic conditions, That would make them fade. It was clearly stated, however, that the results of the graded value might be appropriate and that the dye extract is useful for textile coloring.

Table 3: Fastness grades of tamarind fruits pods on cotton and silk fabrics at dyeing time of 10minutes at 100^{0}C temperature in ethanol medium combination.

Mordanting method	Type of Mordant used	Tamarind Pod B																			
		Cotton										Silk									
		Light Grade	Washing		Rubbing			Perspiration				Light Grade	Washing		Rubbing			Perspiration			
			Grades		Grades			Grades					Grades		Grades			Grades			
					Dry	Wet		Acidic		Alkaline					Dry	Wet		Acidic		Alkalin	
			cc	cs	cs	cs	cs	cc	cs	cc	cs		cc	cs	cc	cs	cc	cc	cs	cc	c
Pre-Mordanting	A B C D	3-4 5 5-6 5-6	3 4-5 3 3	4 5 5 5	4-5 4 5 5		4 4 5 4	3 3-4 2-3 3	4-5 5 5 5	3 4 3 3-4	4-5 5 5 5	3 5 5-6 5-6	4 3 3-4 4	5 5 4-5 4-5	4-5 4 5 4		4-5 4 5 4	4 4 3-4 2-3	5 5 5	4 3-4 4 3	4

Simultaneous Mordanting	A B C D	3 5-6 5 5-6	4 4- 5 3- 4 4	4 5 4 5	5 4 4 4		4 4 3 4	4- 5 3 3 3	5 5 5 5	3 3- 4 3- 4 3- 4	5 5 5 5	3 6 5-6 5-6	3 3 3- 4 4	4- 5 5 4- 5 4- 5	5 4 5 4		5 5 4 4	4 3- 4 3 3	5 5 5 5	4- 5 3 3- 4 4	
Post-Mordanting	A B C D	3 7 6 6	3 4 4 4	4 5 4 4- 5	5 4-5 4-5 4		4 4 4 4	4 3- 4 3 2	5 5 5 5	3- 4 3 3 3- 4	4- 5 4- 5 5 5	3 5-6 5-6 5	3 4 4 3	4- 5 4- 5 4- 5 4	5 4 4-5 4-5		5 4 4 4- 5	3- 4 4- 5 2 2	5 5 5 5	4 4 3- 4 3- 4	
Without Mordanting		3	4	5	4-5		4	3	5	3	5	3	4	5	4-5		4- 5	3- 4	5	4	

6. Conclusion

The use of the mordants gave the fabrics different shades, with a wide range of soft and light colors obtained both on cotton and silk, using the dye extracted from the fruit pods, especially on the medium combination of methanol and ethanol. Samples showed excellent to good, reasonably well, in terms of color fastness measured, Except that, in an aqueous combination, the extract has 4 samples with a grade value lower than (3). There are 6 in the methanol mixture that were lower than the grade value (3). It has 5 samples in the ethanol mix, which was less than grade (3).

Extracts, however, are fine natural dyes, so it is recommended that they be used as dyes for textile industries, institutions dealing with dyes/coloring, organizations, the government.

7. Findings and future work

It was discovered from the investigation that the extract was good for natural dyes, so it can be adopted by dyeing industries as well as local dyers and that the plant is abundant, so our unemployed young people can have something to do, farmers can also extend their cultivation, As a result, market business is developed in that direction, other types of mordants and natural fabrics such as chromium, stannous chloride, potash, lemon juice and wool, jute, etc. can be further investigated.

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