

Extraction and Application of Natural Mordant (Almond Leaves) in Dyeing of Cotton Fabric with Turmeric Dye

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Abstract: The main aims of this study are to study the effect of natural mordant on dyeing properties of cotton fabric dyed with turmeric powder and to reduce the environmental problems and human health related to the use of metallic mordants. In this study, tannin is extracted from almond leaves and it is applied as mordant. Phytochemical examination is carried out before and after extraction of tannin. Different mordanting methods are carried out in the dyeing of cotton fabric to study the effect of natural mordant (tannin) on the dyeing properties of cotton fabric. The range of colour value, colour difference and colour strength on dyed cotton fabrics with and without natural mordant are determined by Spectrophotometre. The washing and light fastness of dyed cotton fabrics are also examined.

Key Words: Almond leaves, Phytochemical test, Tannin, Turmeric, Cotton fabric, Fastness properties

1. INTRODUCTION:

Colours and dyes are played an important role in the life of humankind since the ancient times. Dyes are classified into two main groups such as synthetic dye and natural dye. Synthetic dyes are based on petroleum compounds, whereas natural dyes are obtained from plant, animal, and mineral matters. People always prefer the natural dyes because of their soothing and non-toxic nature [1].

Many synthetic dyes, particularly azo dyes and Benzedrine derivatives, release harmful amines, allergens, carcinogens, and other poisonous compounds that may cause cancer, allergy, and are detrimental to human health and environment. The by-products formed have to be discharged in the rivers, ponds or in the atmosphere. Thus, the effluents from the industries are one of the major causes of environmental pollution. These drawbacks of synthetic dyes have prompted environmentalists to look for eco-friendly products [2].

Natural colourants are unsophisticated and harmonised with nature. They are obtained from renewable sources. They are not hazardous to health, and can have a curative effect. Furthermore, the use of natural dyes does not pose any problems with regard to disposal of the product [3].

Natural dyes are mostly eco-friendly, biodegradable, non-toxic as compared to synthetic dyes. However, the natural dyes having limited substantivity for the fibre, require the use of mordant which enhances the fixation of the natural colourant on the fibre [4]. Mordants not only give the dye an affinity, but in many cases, they produce the different colours and improve the fastness of a dye [1].

Tannin is one of the types of natural mordant in the dyeing of textile fibres and it can be obtained from any parts of plant in surrounding. Vegetable tannins are bitter and astringent substances in plants, often occurring in the bark and other parts (especially leaves, fruits, and galls) [3].

This research focused on the extraction of natural mordant (tannin) from almond leaves and analysis of the effect of natural mordant on dyeing properties of cotton fabric with turmeric dye powder.

2. EXPERIMENTAL PROCEDURE:

2.1 Preparation of Raw Materials

Turmeric rhizomes are used in the preparation of natural dye solution. In order to get powder sample of Turmeric rhizomes, they are ground by means of grinder and filtered with a sieve of 100 meshes. In the preparation of natural mordant, the almond leaves are thoroughly cleaned with water to remove the impurities, cut into small pieces and dried at room temperature for three days. After drying process, the dried crumbled leaves are made into fine powder by grinding. Fig. 2.1 shows the preparation of dried almond leaf powder from almond leaves.

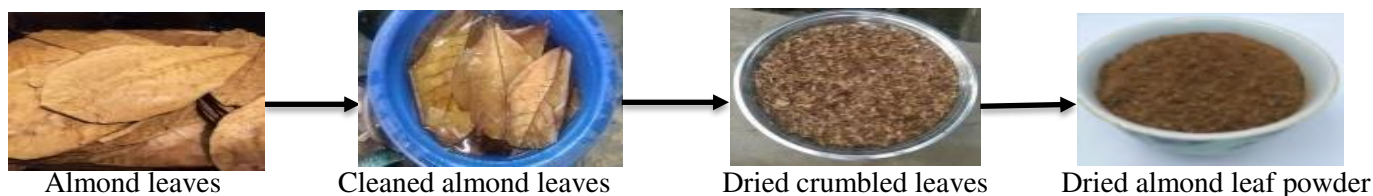


Fig.2.1 Preparation of Dried Almond Leaf Powder

2.2 Preliminary Phytochemical Examination on the Raw Almond Leaves

Before applying the almond leaves as natural mordant, the phytochemical tests are carried out to determine the types of chemical compounds consisting in the almond leaves. The results are shown in Table 2.1.

Table 2.1. Results of Preliminary Phytochemical Examination on the Almond Leaves

Sr. No.	Type of Compound	Results
1	Alkaloid	-
2	Carbohydrate	+
3	Glycoside	+
4	Phenol	+
5	Tannin	+
6	α -amino acid	+
7	Flavonoid	+
8	Steroid	+
9	Terpenoid	+
10	Reducing sugar	+
11	Starch	-
12	Saponin	+
13	Cyanogenic glycoside	-

(+) presence (-) absence

2.3 Extraction of Tannin from Almond Leaves

Soxhlet extraction method is used to extract tannin from almond leaves. Ethanol, petroleum ether and chloroform are applied in this extraction method to get the tannin powder.

One hundred grams of almond leaf powder are treated with 750 ml of 95% ethanol at 100°C for 8 hours. The ethanol extract is then distilled to remove the ethanol by using rotary evaporator at 55°C. The concentrated solution is defatted three times with 100 ml of petroleum ether to remove fats and waxes by using separatory funnel. Then, the petroleum ether layer is discarded because tannin is insoluble in petroleum ether. The remained extract is partitioned against 100 ml of chloroform by using separatory funnel and this process is also repeated three times. The chloroform extract is then decanted because tannin is insoluble in chloroform and then the aqueous extract is concentrated at 55°C by using rotary evaporator. By this way, the dried residues are obtained.

The obtained dried residues are treated again with ethanol and charcoal at 60°C for 30 minutes and then the solution is cooled and filtrated through the filter paper. The filtrate solution is concentrated to form thick extract by using rotary evaporator at 55°C. The concentrated solution is evaporated again in water bath at 50°C to obtain the dried extract. Finally, four grams of dried particles containing tannin is obtained to use as natural mordant. The extracted tannin from the almond leaves is the hydrolysable tannin because it gives blue colour with ferric chloride.

2.4 Phytochemical Examination on the Extracted Tannin

After extracting the tannin from almond leaves, the phytochemical tests are carried out again in order to know whether unnecessary compounds are removed or not. The phytochemical test results on the almond leaf extract are shown in Table 2.2.

Table 2.2. Results of Phytochemical Examination of Mordant

Sr. No.	Type of Compound	EtOH Extract	Partition Against Petroleum Ether	Partition Against Chloroform
1	Alkaloid	-	-	-
2	Carbohydrate	+	+	+
3	Glycoside	+	+	+
4	Phenol	+	+	+
5	Tannin	+	+	+
6	α -amino acid	-	-	-
7	Flavonoid	+	+	+
8	Steroid	+	-	-

9	Terpenoid	+	+	-
10	Reducing sugar	+	+	+
11	Starch	-	-	-
12	Saponin	+	-	-
13	Cyanogenic glycoside	-	-	-

(+) presence (-) absence

2.5 Dyeing of the Cotton Fabric with and without Mordant

In this research, the extracted tannin from almond leaves is used as natural mordant. The various concentrations of tannin mordant (3%, 5% and 7%) are used depending on the weight of the fabric to evaluate the effect of tannin amount in the dyeing of cotton fabric with turmeric dye. The cotton fabric is dyed with turmeric powder using different mordanting methods. In this case, pre-mordanting, simultaneous-mordanting, and post-mordanting methods are used in order to evaluate the effect of methods on the properties of the colour value, colour difference and colour strength. The material to liquor ratio of 1:15 is used for all methods of dyeing. Mordanting and dyeing operations are carried out at a temperature of 80°C for 45 minutes. The designation of the dyed cotton fabrics is shown in Table 2.3.

Table 2.3. Designation of the Dyed Cotton Fabric

Sample Code	Tannin Conc.	Dye Conc.	Methods
C ₁₀	0%	3%	Dyeing without mordant
C ₂₃	3%	3%	Pre-mordanting method
C ₂₅	5%		
C ₂₇	7%		
C ₃₃	3%	3%	Simultaneous mordanting method
C ₃₅	5%		
C ₃₇	7%		
C ₄₃	3%	3%	Post-mordanting method
C ₄₅	5%		
C ₄₇	7%		

3. RESULTS AND DISCUSSIONS:

3.1 Effect of Tannin (from Almond Leaves) and Mordanting Method on Colour Value, Colour Difference and Colour Strength of Dyed Cotton Fabrics

In order to evaluate colour value, colour difference and colour strength of dyed cotton samples, it is examined with Spectrophotometre under illuminant D 65. The results are shown in Table 3.1.

Table 3.1. Test Results of Colour Value, Colour Difference and Colour Strength on Dyed Cotton Fabrics

Sr. No.	Sample Code	CIELAB					ΔE*	K/S
		L*	a*	b*	C*	h*		
1	C ₁₀	91.04	-5.06	33.49	33.87	98.60	0.00	0.89
2	C ₂₃	82.37	-0.22	49.97	49.97	90.24	19.27	1.85
3	C ₃₃	81.57	0.43	50.25	50.26	89.57	20.05	2.23
4	C ₄₃	80.35	0.28	43.37	43.37	89.63	15.51	2.70
5	C ₂₅	83.46	-1.20	49.25	49.27	91.40	17.92	2.22
6	C ₃₅	81.59	0.81	55.61	55.62	89.17	24.77	2.84
7	C ₄₅	77.99	1.54	40.49	40.52	87.82	16.21	3.63
8	C ₂₇	80.41	0.36	51.66	51.66	89.60	21.74	2.31
9	C ₃₇	79.16	1.92	55.44	55.47	88.01	25.92	3.03
10	C ₄₇	75.76	2.32	35.94	36.02	86.31	17.14	4.33

According to the colour coordinates of CIELAB, the dyed cotton sample without mordant (C₁₀) is the least yellow colour. Regarding with the results of b* values, it can be noticed that simultaneous mordanting method gives the highest colour saturation in yellow whereas post-mordanting method gives lowest colour saturation in yellow. In the

comparison on the results of colour difference (ΔE^*) values, it is clearly shown that simultaneous mordanting method gives more colour difference than the other two mordanting methods.

In the results of colour strength value (K/S) for three mordanting methods, post-mordanting method gives more colour strength than the other mordanting methods. It is seen that the concentration of mordant is directly proportional to the colour strength (K/S) for all mordanting methods. Mordanting with tannin clearly gives higher colour strength as compared with the unmordanted sample because tannin has many carboxylic (-COOH) and hydroxyl (-OH) groups which are able to bind with cellulose macromolecules.

3.2 Effect of Natural Mordant on Colour Fastness of Dyed Cotton Fabrics

Dyed cotton samples are examined with Scrub O Meter washing machine using ISO Test 3 method for washing fastness, GOTECH type rubbing fastness tester (GT-7020) for rubbing fastness and M 237 Xenon light fastness tester using AATCC test method for light fastness. The colour fastness properties of unmordanted and mordanted-dyed samples are shown in Table 3.2. It is indicated that mordanting with tannin improves the washing fastness of all dyed samples. By using tannin mordant extracted from almond leaves, there are no stains on the adjacent fabrics in the washing fastness test.

Table 3.2. Colour Fastness Results of Dyed Cotton Fabrics

Sr. No.	Sample Code	Washing Fastness		Rubbing Fastness		Light Fastness
		Change in Shade	Staining on Cotton	Dry	Wet	
1	C ₁₀	1	5	4	3	2
2	C ₂₃	2	5	4	3	3
3	C ₃₃	2	5	4	3	3
4	C ₄₃	2	5	4	3	4
5	C ₂₅	2	5	4	3	3
6	C ₃₅	2	5	4	3	3
7	C ₄₅	2	5	4	3	4
8	C ₂₇	3	5	4	3	4
9	C ₃₇	3	5	4	3	4
10	C ₄₇	3	5	4	3	4-5

In the results of rubbing fastness test, dry rubbing fastness is good for all the samples and wet rubbing fastness is fair. In the results of light fastness, it can be seen that mordanting with tannin improves the light fastness of all dyed samples. This is due to the fact that tannins are complex polyhydric phenols of high molecular weight containing large molecules and giving good affinity for cellulosic fibres resulting in high light and washing fastness. According to the results, the light fastness of post-mordanting method is better than the other two methods. Among all samples, the light fastness of treated fabric with 7% tannin by using post-mordanting method is the best.

4. CONCLUSIONS:

In this study, tannin extracted from the almond leaves is applied in dyeing of cotton fabric with turmeric dye. According to the test result, it is found that the tannin extracted from the almond leaves is the hydrolysable tannin which can be used as natural mordant because of solubility in water otherwise, in dye solution. Tannin mordant enhances the colour quality of cotton fabrics because it can increase in colour strength and fastness grades in terms of washing and light.

Mordanting methods and tannin concentrations influence on the colour development, colour difference and colour strength. Among the three mordanting methods, post-mordanting method gives the highest colour strength whereas pre-mordanting method gives the lowest colour strength. Furthermore, the colour strength value increases with an increase in tannin concentration for all methods.

The best result of colour strength is achieved by post-mordanting method with 7% tannin mordant but more brilliant colour shade is recorded for simultaneous mordanting method with 5% tannin. It can be concluded that post-mordanting method with 7% tannin is suitable to achieve the good colour strength of mordanted-dyed samples. To obtain the yellower and more brilliant colour of cotton, simultaneous mordanting method is suitable.

5. RECOMMENDATIONS:

As for the future work, tannin should be extracted from the other natural sources because of its usefulness and application in textiles. It is necessary to study the effect of tannin mordant on colour value and colour strength on dyed cotton fabrics with various dye concentration, operation time and temperature. The tannin should be applied in

combination with metal mordant to study the influence of combination of tannin and metal mordants. It is also suggested that the effect of tannin mordant on dyeing properties and fastness properties of protein fibres such as wool and silk, and other synthetic fibres should be studied.

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