

# Extraction and Application of Natural Dye on Tanned Leather and Eco-friendly Approach

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**Abstract** - This work aims the extraction of a concentrated dye from turmeric spice (*Curcuma longa*) and its application for tanned leather dyeing and as a potential replacement for the environmentally harmful heavy metal salts in enhancing the natural dye uptake and the fastness properties. It is well known there are some limitations with the use of natural dyes, the use of the dyes is increase due to the eco-friendly approach of the dyeing. The extraction process of natural dyes and methods of application of the dyes on different materials are very important factor and the dye can extract from their bark, stem, leaf and root, so pre and post mordant adding technics were studied. In This work, extraction, purification and optimization of natural dyestuff from a plant *Curcuma Longa* by using different mordants and other factors and then dyeing of tanned leather in exhaust dyeing method. The main coloring component of turmeric or curcumin, which produces yellowish color on the materials after dyeing. The purified curcumin produces various shades on leather with different dyeing parameters and use of mordants. The extraction of dye was carried out at different concentration, extraction time and extraction temperature through aqueous extraction mechanism. It was found that the highest number of absorbance was obtained at 6.0 pH, for 0.5 hours of dyeing time and with 35 g/l of concentration. The results of this investigation clearly suggest that tumeric is an ecofriendly dyeing for fashionable leather products.

**Key Words:** Tumeric, Natural dye, Mordant, aqueous extraction method.

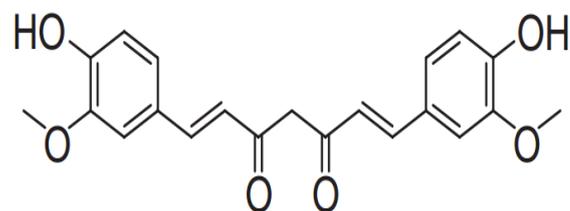
## 1. INTRODUCTION

Dyeing is the art of imparting colorants and hues to fibres, yarns, fabric and other materials by using either natural or synthetic sources. Colouring matter can be obtained from both natural and synthetic sources. Synthetic dyes impart vibrant colour and are widely used but it causes carcinogenic effect on human skin.

Nowadays, natural dyes play an important role in the textile industry because the needs of replacement synthetic dyes which have a lot of conflict with the environmental issues. This means that the development of natural dyes will give benefits to all sides because users friendly for dyeing industry. The study seeks to extraction and application of some natural plants from which dyes can be extracted in aqueous extraction method. The scope is to optimize the extraction of each colour natural dyes from the natural

sources. The optimum parameters for extraction of natural dye are pH, temperature and time.

Natural turmeric dye or curcumin (C<sub>19</sub>H<sub>15</sub>O<sub>6</sub>- yellow) has no side effect on skin and it has no harmful effect on environment also, but Some of the constraints are colour yield, complexity of dyeing process, limited shades, blending problems, fastness related problems and lack of standardize profiles for the extraction process. In this research, an attempt is carried out to dye the tanned leather fabric using cheap and eco-friendly turmeric dye powder. turmeric powder is chosen as a raw material to extract the natural dye for dyeing the tanned leather by using four different dyeing methods. Many natural dyes are nontoxic and inhibit the growth of microorganisms. They have been investigated as functional antimicrobial dyes [67-71]. Curcumin (1,7-bis(4-hydroxy-3-methoxyphenyl)-1,6-heptadiene-3,5-dione) is an active ingredient in turmeric (*Curcuma longa*).



**Fig -1:** Chemical structure of Curcumin

The extraction of dye was carried at different concentration, extraction time and extraction temperature through solvent extraction mechanism. Textile materials (natural and synthetic) were colored for value addition, look and desire of the customers. Anciently, this purpose of coloring the textile material was initiated using natural source of dye. After the synthesis of Mauveine by William Henry Perkin and its subsequent commercialization, the use of natural dyes receded and the position continued to be much the same until in the recent past when growing environmental protection regulations came into existence. For ready availability of pure synthetic dyes of different types/classes and its cost advantages, most of textile dyers/manufacturers shifted towards the use of synthetic colorants. However almost all the synthetic colorants are synthesized from petrochemical sources through hazardous chemical processes which poses a threat towards its eco-friendliness. Increasing environment awareness has made people realize the importance of living with a clean atmosphere.

Government of Germany was the first to take initiative to put up a ban on azo-dyes manufacturing, dyeing, and importing textile and other consumer goods dyed with these dyes. There is considerable rise in the popularity of natural lifestyle based on naturally sustainable goods. The natural dyes for textile coloration have re-flourished due to their recently dis-covered de-odorizing, anti-microbial, UV protective properties in addition to the elegant shades on different types of fabrics. Applications of waste materials as sources of natural dyes can also assist in the preservation of the environment and also decrease the cost of natural dyeing [1].

## 2. MATERIALS AND METHODS

Dyestuffs are coloring materials which can generate enough colorants or it can give pale color and can be obtained from different sources. (natural or synthetic) Almost an organic material will produce a color when boiled in a dyebath, but only specific plants will yield a color that can act as a dye. Natural dyes can be obtained from various sources like leaves, stems, Flower heads, Barks, Roots, Outer skins, and husks.

Tanned leather is used to dye with the extracted dyestuff from turmeric spice (*Curcuma longa*) with varied number of experiments with different parameters.

### 2.1 Collection of sample and development

The roots of turmeric are collected from the, local market in Bahir dar, Ethiopia. The collected turmeric roots are washed with water to remove the dust and impurities at the external part of the root and then it was dried in sunlight. Then, the roots of turmeric are powdered by means of grinder. The powder of turmeric roots is used as dyestuffs in this study.



Fig -2: Typical Turmeric leaves and stems

### 2.2 Dye extraction Method

Fresh rhizomes of turmeric are sliced after washing through hot water to remove external dirt materials. Then sliced and dried in the sunlight for three days and again dried at 100°C for 30 minutes in a hot air to remove excess moisture.

The dye was extracted in aqueous extraction method from the root of Curcumin to get coloring materials or

components through different combinations of parameters like extraction temperature, extraction temperature, pH and time, depend on these parameters (Table 1) can generate for the number of trials.

Table -1: Different combination of parameters

Initial samples	Concentration (g/l)	Time (min)	pH	Temperature (°C)
1	25	30	6	60
2	30	45	8	80
3	35	60	10	100

The chemical structure of curcumin was evaluated using FTIR. FT-IR relies on the fact that the most molecules absorb light in the infrared region of the electromagnetic spectrum.

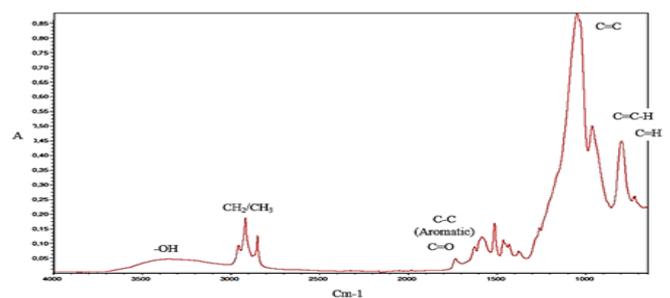


Fig -2: IR curve for the sample measured by FTIR spectrum

### 2.3 Dyeing of tanned fabric using Turmeric

The four methods of dyeing are used to dye the tanned leather with powder of turmeric root. They are: (1) Dyeing without mordanting method, (2) Dyeing by pre-mordanting method, (3) Dyeing by post-mordanting method, and (4) Dyeing by simultaneous-mordanting method.

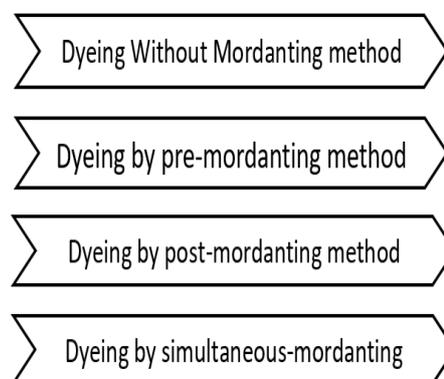


Fig -3: Different mordanting techniques

**Table -2:** Initial dye concentration and dyeing parameters

Test samples	pH	Time (min)	Temperature (°C)	Tumeric powder conc. (g/l)
1	6	30	60	25
2	6	45	80	30
3	6	60	100	35
4	7	30	60	25
5	7	45	80	30
6	7	60	100	35
7	8	30	60	25
8	8	45	80	30
9	8	60	100	35

Based on table 1, nine number of trials or the number of experiments is generated through the help of Taguchi software (Table 2).

- i. Dyeing without mordanting method: Mordant is used when there is no affinity between a fiber and a color material. The function of mordant is to make affinity between the material in the dye bath. So, during this method the dyeing process is done without mordants.
- ii. Dyeing by pre-mordanting method: during the dyeing process mordants are added before the dyeing process completed after some minutes and Mordant dyeing was carried out through using of 3% of copper sulphate.
- iii. Dyeing by post-mordanting method: the mordant was added at the end of dyeing process.
- iv. Dyeing by simultaneous-mordanting: the mordant copper sulphate was added at the first stage of dyeing and added also at the end of dyeing simultaneously.

**2.4 Comparison of Rubbing and light fastness**

In determining the light fastness of dyed fabrics, AATCC test method is mainly used to determine light fastness of dyed leather. In determining the rubbing fastness of dyed fabric, both dry rubbing and wet rubbing were studied.

**2.5 Determination of color strength**

Every dyed sample is measured in the same way and the K/S (Kubelka Munk) values are obtained directly from the instrument, which followed the theory as in equation. higher K/S value implies higher the color strength.

$$K/S = (1-R)^2/2R..... (1)$$

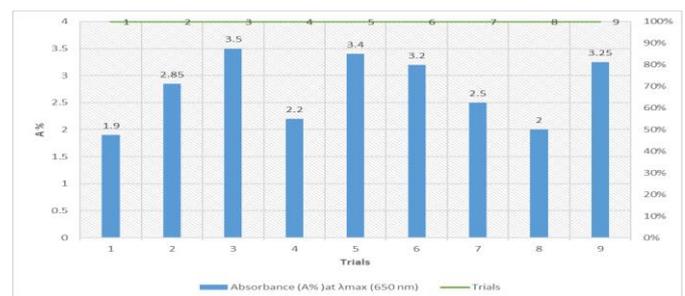
Where k/s color strength value and R is stands for reflectance percentage.

**3. RESULTS AND DISCUSSION**

The tanned leather is used as a material to be dyed in this study due to its eco-friendly nature of tumeric colorants. The turmeric dyestuff is used in this study because not only it is cheap but also it gives a bright yellow color. Copper sulphate can be used for protein and cellulose materials or fabric. It helps as mordant and auxiliary chemicals improves light and washing fastness of natural dyes and keeps colors clear. It is inexpensive and safe to use. So, alum is used as a mordant in this study.

**3.1 Absorbance Result of Extracted Dyestuff**

The readings of absorbance for all samples were measured using UV-VIS Spectrophotometer and recorded.



**Fig -4:** absorbance result of extracted dyestuff

**3.2 Rubbing and light Fastness**

In determining the light fastness of dyed fabrics, AATCC test method is mainly used to determine light fastness of dyed leather. In determining the rubbing fastness of dyed fabric, both dry rubbing and wet rubbing were studied.

**Table -3:** Comparison of Rubbing and light fastness properties test result

Trials	Mordant Timing	Light fastness	Rubbing Fastness		
			Wet	Dry	
1	Copper sulphate (CuSO4)	Without mordant	4	3	4
2		Pre	4	3	4
3		Post	4	3	4
4		Simultaneous	4	3	4
5	Lemon	Pre	3	2	4
6	Waste tea	Pre	4	4	3
7	Vinegar	Pre	4	3	3

### 3.3 Effect of Mordant

Copper sulphate and other mordants are used to select the optimum dyeing parameters and the best dyeing mechanism with its color strength (table 3).

## 4. CONCLUSION

The main coloring component of turmeric, which produces yellowish color on the materials is good for the dyeing of fashionable garments or leather products due to its pale effect. The purified curcumin produces various shades on leather with different dyeing parameters and use of mordants. The extraction of dye was carried out at different concentration, extraction time and extraction temperature through solvent extraction mechanism. It was found that the highest number of absorbance was obtained at 6.0 pH, for 0.5 hours of dyeing time and with 35 g/l of concentration at a temperature of 100°C. The results of this investigation clearly suggest that turmeric is an ecofriendly dyeing for fashionable leather products.

### CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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