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Research article

Extraction and evaluation of dyeing quality of natural curcumin

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Key words: Curcumin dye, Mordants, Extraction, Fabric.

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Abstract

Due to the eco-friendly approach of the natural dyes its use increasing day by day though there are some limitations with the use of the dyes. By improvement in extraction process of natural dyes and technique of dyeing it can be replace the synthetic dyes, which are problematic for environment and human health. This work deals with the extraction and purification of natural dyestuff from a plant Curcuma Longla L. and dyeing of cotton fabric by exhaust dyeing method. The main coloring component of turmeric is curcumin, which produces yellow color in the textile material. The purified curcumin produces various shades on cotton fabric with different dyeing parameters and use of mordants. The maximum K/S value was found with 10 % concentration of dye in pH 7, with 80^{0}C temperature of dyeing bath and the time taken was 45 minutes.

Introduction

Natural Dyes have been used extensively since long periods. It was practiced during the Bronze Age in Europe. The earliest written record of the use of natural dyes was found in China dated 2600 BC. Synthetic dyes are produced from cheap petroleum sources and show superior fastness properties. The synthetic dyes are widely available at an economical price and produce a wide variety of colors. These dyes, however, produce skin allergies, toxic wastes and other harms to human body. Germany was the first to take initiative to put ban on numerous specific azo-dyes for their manufacturing and applications. Netherlands, India and some other countries also followed the ban [1]. Consumption of natural dyes is 1% of synthetic dyes consumption. The Indian textile industry contributes about 14 per cent to industrial production, 4 per cent to the country's gross domestic product (GDP) and 17 per cent to the country's export earnings, according to the Annual Report 2009-10 of the Ministry of Textiles. The natural dyes are clinically safer than their synthetic analogues in handling and use because of non-carcinogenic and biodegradable nature [2]. Natural dyes have better biodegradability and generally have higher compatibility with the environment. They are non-toxic, non-allergic to skin, non-carcinogenic, easily available and renewable. Some natural dyes obtained from plants are Heena Saffron, Black walnut, Cutch, Indigo, Logwood, Maddar Turmeric Weld Wood, Bastard teak, (Palash) Kamala, Mayrabolan, Pomegranate etc.

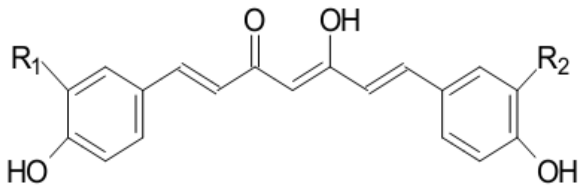

Figure 1. Structure of Curcumin

Experimental

Material and Methodology

Sample collection and Preparation of Raw Material

Curcuma Longa Linn (Haldi) root & tuber, was used for dyes preparation, which was collected from the rural area of Bilaspur C.G. The sample was washed thoroughly with water to remove impurities. After drying at room temperature, the samples were ground into powder with the help of grinder.

Extraction of Crude Dyestuff

100 g of sample was weighed and taken in a round bottom flask and 500ml of solvent (ethanol water) was added to it. The flask heated in a water bath at 60°C for 60 mins. The solution then, filtered to obtain crude dyestuff [3].

Purification of Crude Dyestuff

The crude dyestuff was distilled to get 1/3rd of the solution using the Soxhlet apparatus at 70°C for 3hrs. & through this process ethanol was recovered and the concentrated dye is obtained. The solution is kept overnight at room temperature for precipitation. The precipitation in ethanol water was obtained by decanting the solution. The obtained particles were dried in the oven overnight at 60°C. Water was added in the soxhlet apparatus. By addition of water, the boiling points of the compounds was lowered, allowing them to evaporate at lower temperature.[4]

Scouring of Cotton Cloth

Scouring of cotton cloth has done by washing it in a solution containing 0.5g/lit Sodium carbonate and 2g/lit non-ionic detergent (Tween 80) at 50°C for 25 mins, keeping the material to liquor ratio at 1:40. The scoured cotton will be thoroughly washed with tap water and dried at room temperature. The scoured material will be soaked in clean water for 30 mins prior to dyeing or mordanting. [5, 6]

Dyeing and Mordanting

Accurately weighed cotton cloth was treated with different metal salts (mordants used cupric sulphate and ferrous sulphate).Three processes of mordanting were used – pre mordanting, simultaneous mordanting and post mordanting. After dyeing, the dyed material was washed with cold water and dried at room temperature.[7]

Optimization of dyeing conditions for cotton fabrics

Cotton fabrics are dyed with the curcumin dye at aliquor ratio of 1:40. For optimizing the dyeing conditions, at first, experiments are carried out to optimize the dyeing pH. Dyeing processes were carried out with 2% concentration of purified dye at pH 3 to 9. To get the effect of dyeing temperature and dyeing time on the color strength, another set of experiment is carried out in optimized dyeing pH at 60, 70, 80, 90 and 100°C for different time periods i.e. 30, 45, 60 and 90 minutes. Another set of experiment is also carried out at different dye concentration such as; 2%,4%, 6%, and 8% in optimum dyeing conditions. Based on the K/S values of the dyed samples, optimum dyeing pH, temperature and time are selected and taken for further study.[8, 9]

Evaluation of color strength

Estimation of color strength of the dyed fabrics are carried out by determining the K/S values using a computer color matching system (CS-5, Applied color system, USA). The reflectance value (R) in the visible wavelength region is measured by means of the systronic double beam spectrophotometer. The value of reflectance (R) of the dyed fabric is measured at the wavelength of 425 nm and also the K/S value of the sample is found directly from the instrument. Every dyed sample is measured in the same way and the K/S values are obtained directly from the instrument [9], which followed the Kubelka Munk theory as in following equation,

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

Where, K refers to the constant of color, S is the constant of material and R is the degree of reflection. The value of K/S is directly proportional to the concentration of dye in the dyed fabric

Measurement of exhaustion of dyes by UV/VIS spectroscopy

Degree of exhaustion is the amount of dyestuff, which is diffused in the fiber from the dye bath at the time of dyeing. UV/Vis spectrophotometer is used to measure the exhaustion and fixation of the dyestuff. By measuring the concentration of dye bath before and after the dyeing process, the percentage of exhaustion can be estimated [10] with the equation, considering the color of metal salts.

$$E\% = \frac{C_1 - C_2}{C_1} x10$$

Where, C1 and C2 are the concentrations of the dye bath before and after dyeing process respectively. The concentrations of the dye solution before and after dyeing were measured using UV/VIS spectrometer at the wavelength of 425. Before measuring the absorbency, the wavelength of maximum absorbency is determined for the dye by using the calibration standard solutions.

Result and Discussion

The highest degree of exhaustion of cotton fabrics, dyed with different methods, are determined by UV-Visible spectroscopy and the results are shown in table 1. The degree of exhaustion of premordanted cotton fabric with cupric sulphate was found greater than other. It was found that value of K/s increases with concentration of dye (figure 1). Figure 2 shows that K/S value is maximum in 80^0C temperature. The color strength was found maximum in 7 pH (figure 3). The best results with respect to time for dyeing cotton fabrics are obtained at 50 minutes.

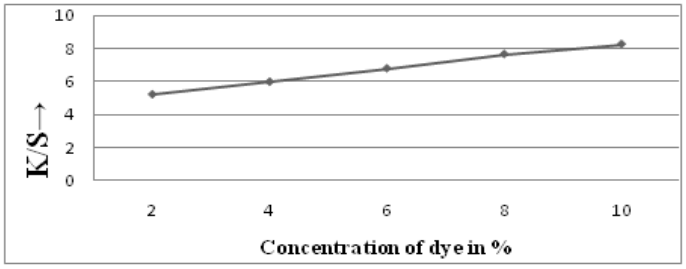

Figure 1. Effect of concentration of dye on color strength of cotton fabrics dyed with curcumin

Table 1. Dye exhaustion % of curcumin by cotton fabrics

S/N	Fabric dyed with curcumin	Dye exhaustion (%)
1	Cotton without mordant	45
2	Cotton post-mordanted with ferrous sulphate)	50
3	Cotton post-mordanted with cupric sulphate	58
4	Cotton simultaneous-mordanted with ferrous sulphate)	63
5	Cotton simultaneous -mordanted with cupric sulphate	68
6	Cotton pre-mordanted with ferrous sulphate)	75
7	Cotton pre-mordanted with cupric sulphate	78

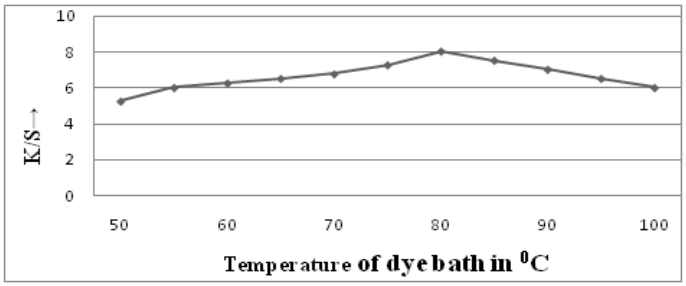

Figure 2. Effect of temperature on color strength of cotton fabrics dyed with curcumin

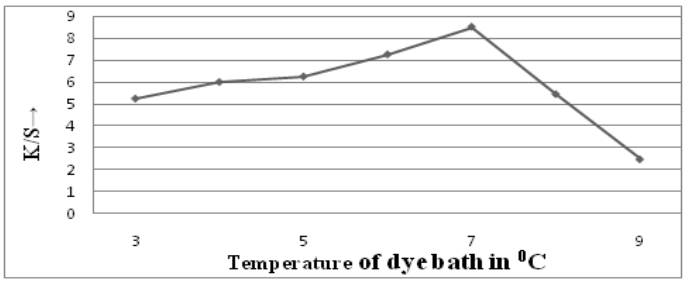

Figure 3. Effect of pH on color strength of cotton fabrics dyed with curcumin

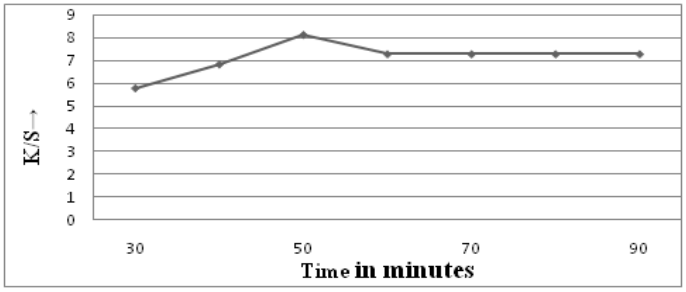

Figure 4. Effect of dyeing time on color strength of cotton fabrics dyed with curcumin

Conclusion

By changing the dyeing procedure and mordant a variety of colors also can be produced. Clothes dyed with natural dyes are eco friendly, harmless and also have the potential to be sold at a higher price. So extraction & purification of natural dyes and their application can be a great significance in the future of the commercial and domestic dyeing industries.

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