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Extraction of Natural Dye from Chili (*Capsicum Annum*) for Textile Coloration

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Abstract

The synthetic dyes which are of wide commercial importance cause severe atmospheric and environmental pollution. The present investigation was carried out to extract natural dye from green chili (*Capsicum annum*).The main coloring component in chili is oleoresin. The dye was extracted using solvent extraction method. A mordant is a substance used to set dyes on fabrics by forming a coordination complex with the dye which then attaches to the fabric. Two mordants – copper sulphate and ferrous sulphate were used in ratios 1:1, 1:3, 3:1.100% scoured cotton cloth was used for dyeing by three different techniques-pre mordanting, simultaneous mordanting and post mordanting. Fastness is the ability of a dye to remain permanent and not run or fade. Color fastness studies on the dyed cloth were undertaken. The mordants helped in fixing the dye to the fabric as well as improve the fastness properties of the dyed cloth. Different shades of yellow were obtained from the dye extracted from chili skin. These different shades are obtained from a single dye using the two mordants in different ratios. Good light fastness, good rub fastness and moderate wash fastness was observed in fabrics dyed with the dye extracted from Green chili.

Keywords: **Natural dye, *Capsicum annum*, Mordants, Fastness**

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 (Siva, 2007). Synthetic dyes are produced from cheap petroleum sources and show superior fastness properties (Aminoddin and Haji, 2010). 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 (Samanta and Agarwal, 2009). 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 (Patel, 2011). Consumption of natural dyes is 1% of synthetic dyes consumption (Sachan and Kapoor, 2007).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 (Aminoddin and Haji, 2010). 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 (Onal, 1996; Pruthi *et al*, 2007; Saha and Dutta; Siva, 2007; Adeel *et al*, 2009).

Textile effluents are characterized by strong color and high concentration of organic and inorganic compounds caused by residual dyes that were not fixed to the fibers during the dyeing process (Adeel *et al*, 2009). Majority of natural dyes need a chemical in the form of metal salts to create an affinity to the fibers and pigment. These chemicals are called mordants. The natural dyes which require mordant are called as adjective dyes. Common mordants used are alum, chrome, stannous chloride, copper sulphate, ferrous sulphate etc. (Siva, 2007; Mahangade et al, 2009; Samanta and Agarwal, 2009). Color fastness is the resistance of a material to change any of its color characteristics or extent of transfer of its colorants to adjacent white materials in touch (Samanta and Agarwal, 2009). Generally light fastness, wash fastness and rub fastness are considered for textile fibers.

For a substance to act as dye, it must 1) have a suitable color 2) be capable to be fixed to the fabric. 3) should not be fugitive after fixing on fabric to be dyed (Saha and Dutta). Pigment molecules containing aromatic ring structure coupled with a side chain are usually required for resonance, and thus, to impart color (Mishra and Patni, 2011). Various colors are obtained from plant dyes (Cage). Cotton textile industry used these cheap natural dyes since the medieval period (Naqvi, 1980). *Capsicum annum* Linn. is from Solanaceae family. The main coloring component is oleoresin. It is a mixture of esters of capsanthin, capsorubin, zeaxanthin, cryptoxanthin and other carotenoids. Capsanthin is the major color component in green chili (Patel, 2011) Chili has good heat stability. It is abundantly found in many countries of the world. The present investigation aimed at extraction of dye from the chili skin for its application on cotton cloth.

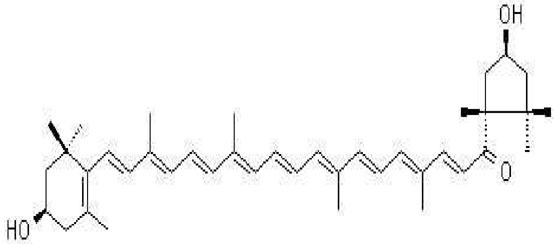

Fig 1: Structure of capsanthin

2. Materials and Methods

2.1 Materials

1. Source

Green chili was collected from Market Yard, Pune.

2. Substrate

100% cotton cloth was purchased from Prakash Departmental Stores, Pune

3. Chemicals

Laboratory grade chemicals- 95% ethanol, copper sulphate and ferrous sulphate were supplied by Anand Agencies, Pune.

4. Equipments used in the present study

- Weighing balance (Citizen)
- Water bath (Neolab WB344)
- Soxhlet apparatus
- Hot air oven (Thermo lab)
- Colorimeter (Erma Japan CXL)
- UV Trans illuminator (Bioera)

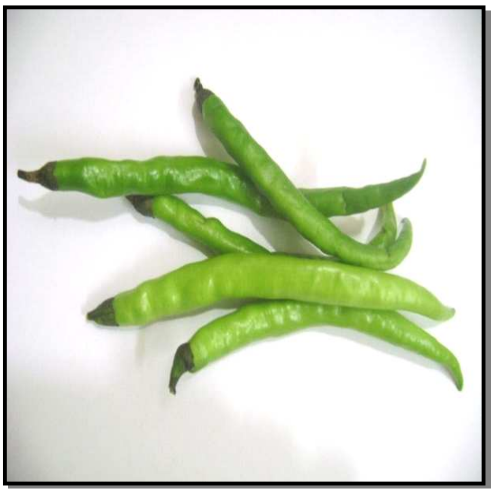

Fig. 2: Green Chili

2.2 Methods

Solvent extraction was used for extracting the dye.

2.2.1 Preparation of Raw Material

The samples were collected and washed thoroughly with water to remove any impurities. After drying at room temperature, the samples were ground into powder with the help of grinder (Win and Swe, 2008).

2.2.2 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 was heated in a water bath at 60°C for 60mins.The solution was then filtered to obtain crude dyestuff (Win and Swe, 2008; Goodarzian and Ekrami, 2010).

2.2.3 Purification of Crude Dyestuff
The crude dyestuff is distilled to get 1/3rd of the solution using the Soxhlet apparatus at 70°C for 3hrs. n this process ethanol is recovered and the concentrated dye is obtained. The solution is kept overnight at room temperature for precipitation. The precipitation in ethanol water is obtained by decanting the solution. The obtained particles are dried in the oven overnight at 60°C (Win and Swe, 2008; Goodarzian and Ekrami, 2010). Water was added in the soxhlet apparatus. By addition of water, the boiling points of the compounds are lowered, allowing them to evaporate at lower temperatures (Chowdhari *et al*, 2004)

2.2.4 Scouring of Cotton Cloth
Scouring of cotton cloth was 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 was thoroughly washed with tap water and dried at room temperature. The scoured material was soaked in clean water for 30 mins prior to dyeing or mordanting. (Salam and Salam, 2005; Pruthi *et al*, 2007; Jothi, 2008; Vankar *et al*, 2009; Aminoddin and Haji, 2010)

2.2.5 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 (Pruthi *et al*, 2007; Jothi, 2008; Suitcharit *et al*, 2010)

Table 1: Conditions for Dyeing and Mordanting

Dye	Mordant	M:L	Temp.	Time
4% owf	2% owf	1:40	80°C	60 mins

2.2.6 Fastness tests
The dyed material was tested for light fastness, wash fastness and rub fastness. The color fastness is usually rated either by loss of depth of color in original sample or is expressed by staining scale (Samanta and Agarwal, 2009). Light fastness was analyzed by exposing the dyed materials to direct sunlight for 24hrs. The dyed clothes were kept under UV transilluminator for 10mins. The wash fastness was carried out by washing the dyed fiber with non-ionic soap (1g/lit). The rub fastness of the dyed fiber was carried out by rubbing the fiber and checking for fading of color (Adeel *et al*, 2009; Raja, 2010; Mishra and Patni, 2011).

3. Results and Discussion
Different shades of yellow were obtained from the dye extracted from chili skin. These different shades are obtained from a single dye using the two mordants in different ratios. Similarly, red and blue pigments were obtained from crude indigo extract of *Indigofera tinctoria* (Chanayatht *et al., year*) and yellow color was obtained from turmeric dye (Sachan and Kapoor, 2007). Mordants play very important role in imparting color to the fabric. The mordants used in combination in different ratios gave varying shades.

Better color strength results are dependent on the metal salt used (Kamel *etal*, 2009). Strong co-ordination tendency of Fe enhances the interaction between the fiber and the dye, resulting in high dye uptake (Jothi, 2008). Ferrous sulphate and Copper sulphate have the ability of forming co-ordination complexes (Co-ordination numbers are 6 and 4 respectively). Functional groups such as amino and carboxylic acid on the fiber can occupy the unoccupied sites on interaction with the fiber. Thus, a ternary complex is formed by the metal salt on which one site is with the fiber and the other site is with the dye (Mongkholrattanasit *et al*) Use of copper sulphate and ferrous sulphate gives high resistance to fading, whereas stannous chloride or alum do not (Samanta and Agarwal, 2009).

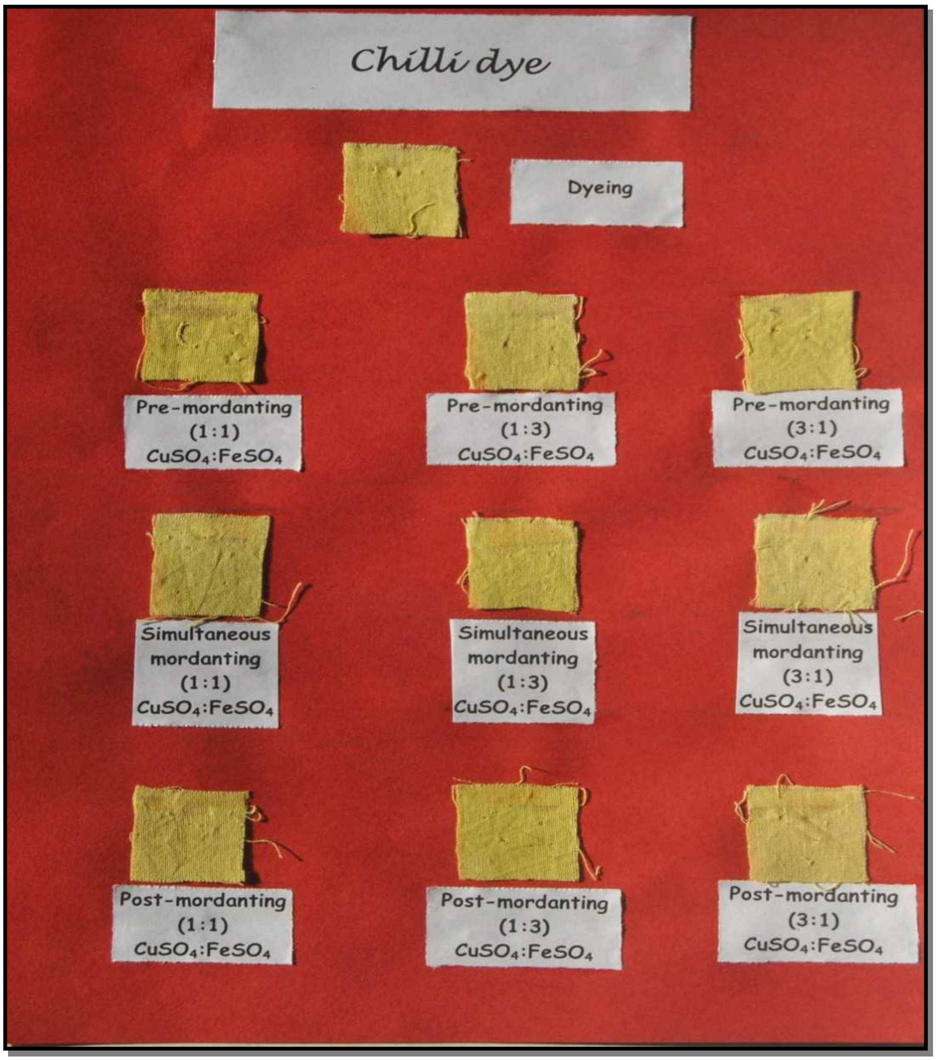

Fig. 3: Application of Dye on Cotton Cloth

The mordanted cotton cloth was immediately used for dyeing because some mordants are light sensitive. The chromatophore of the dye makes it resistant to photochemical attack, but the auxochrome may alter the fastness (Jothi, 2008). Good light fastness was observed in fabrics dyed with the dye extracted from Green chili. This is due to the formation of complex with the metal which protects the chromatophore from photolytic degradation. Wash fastness of the dye is influenced by the rate of diffusion of the dye and state of the dye inside the fiber (Jothi, 2008). The fiber dyed with green chili dye showed good wash fastness.

Good rub fastness was exhibited by the fibers dyed using the dye extracted from the green chilli. Complexing the fiber with mordant has the effect of insolubilizing the dye, making it color fast. Mordants give different shades to the fabric. Similarly, wide range of soft and light colors was obtained on silk using the dye extracted from flower of *Spathadia campanulata* (Kumaresan *et al.,*2011). Mordants are used to increase the dye uptake and to improve the color fastness behaviour of the natural dye (Samanta and Agarwal, 2009). The present investigation revealed that the use of combination of mordants in varying ratios gives different shades. Good light fastness and rub fastness are observed in the clothes dyed by the chili dye. Moderate wash fastness meaning slight fading was observed when the dyed clothes were washed.

4. Conclusion

The study carried out is significant because organic dyeing helps to preserve the traditional art of dyeing and also provides employment and yields economical and ecological benefits. The process of extraction and dyeing is environmental friendly and causes minimum environmental or atmospheric pollution. Use of other mordants may also be considered for improving the fastness of dyed cloth further research will help to explore the important properties of dye extracted from chili skin. A systematic approach for extracting, characterizing and improving the properties of dye is very important to minimize the cost investment, for yield maximization and dye purity.

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