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Extraction of natural dyes from *Curcuma longa, Trigonella foenum graecum* and *Nerium oleander*, plants and their application in antimicrobial fabric

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ABSTRACT

The present study has been focused on the extraction of natural dyes from *Curcuma longa, Trigonella foenum graecum* and *Nerium oleander* and investigation of their phytochemical and pharmacological characteristics. Dyes were prepared using aqueous, acidic, alcoholic and alkaline extraction techniques. UV spectral studies of the dyes showed a variation in absorption maxima and their color varied with respect to the pH and the solvent used during extraction. The dyes prepared from turmeric using aqueous extraction technique and from fenugreek using alkaline extraction showed good antibacterial activity. The aqueous and alcoholic extraction of *Nerium oleander* was able to inhibit the growth of many fungal strains including *Tricoderma* spp., *Tricophyton rubrum, Candida albicans, Aspergillus niger, Cladosporium* spp. etc. The antimicrobial property of the dyes was used in developing antimicrobial fabric.

1. Introduction

The art of making natural dyes is one of the oldest techniques known to man and dates back to the dawn of civilization. In India, it has been traditionally used for coloring of fabrics and other materials. India's expertise in natural dyes dates back to ancient times. The discovery of synthetic dyes in the West in the nineteenth century dealt a massive blow to Indian textile industry (Ali and El-Mohamedy, 2011). Some of the chemical dyes in use have been found hazardous to human life causing skin and lung diseases (Ayoola et al., 2008; Edeoga et al., 2005; Karc et al., 2009). Therefore, intense research in the recent past has focused on the search for dyes from plants, animals, insects and minerals (Zibbu and Batra, 2010; Giri Dev et al., 2009; Ibrahim et al., 1997; Junior and Zanil, 2000; Kumar et al., 2009). India, due to its rich biodiversity and varied climatic zones, is a source of a wide range of natural dyes. Although natural dyes have merits – obtained from renewable resources, non-hazardous, eco-friendly (Mariselvam et al., 2012a,b,b; Hashem et al., 2009; Shahid et al., 2012; Khan et al., 2011; Yusuf et al., 2012; Moiz et al., 2010; Lawhavinit et al., 2010), etc. Their availability is not widespread because of very few organized manufactures, non-standardization of raw material and manufacturing process, and complexity of process involved in application of natural dyes (Prusty et al., 2010; Singh et al., 2005; Ramya et al., 2011; Singh and Jain, 2012).

In our present study, natural dyes were extracted from rhizomes of *Curcuma longa* L. (Zingiberaceae), seeds of *Trigonella foenum graecum* (Fabaceae) and flowers of *Nerium oleander* (Apocyanaceae) to find out their suitability in replacing synthetic dyes (Fig. 1). Phytochemical screening, UV spectral studies and antimicrobial studies were carried out on these dyes. The antimicrobial fabrics were developed based on their antimicrobial properties.

2. Material and method

2.1. Extraction of dyes

The extraction methods of vegetable dyes basically depend on the medium in which the dye is extracted; hence, four methods were used in the extraction of natural dyes (Santhi et al., 2011; Khan et al., 2012).

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Fig. 1. Sources for natural dyes extracted in this study.

Fig. 2. Image of extracted dyes from various sources (1-aquous, 2-alkaline, 3-alcoholic and 4-acidic).

2.1.1. Aqueous method

In the present study – 10 gm of the leaves of plant was taken and boiled with 100 ml of soft water at 100 °C. Then the boiled solution was cooled and filtered. The pH of the solution was recorded.

2.1.2. Alkaline method

One percent alkaline solution with addition of 1 g of sodium hydroxide in 100 ml of water was prepared. The dye materials were boiled in the medium at 100 °C. Filter the pH of the solution was recorded after filtration.

2.1.3. Acidic method

One percent acidic solution by adding of 1 ml of HCL in 100 ml of soft water was prepared. The dye materials were added to it and boiled at 100 °C. The pH of the solution was recorded.

2.1.4. Alcoholic method

Add 50 ml of alcohol to 50 ml of water. The dye materials were added and boiled at 100 °C, filter the dye solution and the pH of the solution was recorded.

2.2. UV–visible spectral analysis

UV absorption spectra of the extracted were recorded on double deam spectrophotometer 2203. The resolution of the spectrum is 1 nm and the observed absorption wavelength range was 200–1000 nm.

2.3. Phytochemical studies

The dyes were tested for phytochemicals, such as carbohydrates, protein, amino acid, alkaloid, flavonoids, tannins, saponin, terpenoids, phlobatinins, aromatic acids, phenolic compounds, xathoprotein, reducing sugar and triterpenoids.

2.4. Antimicrobial activity

2.4.1. Microorganisms

Salmonella paratyphi, *Vibrio harveyi*, *Vibrio mimicus*, *Vibrio alginolyticus*, *Staphylococcus lutea*, *Tricoderma* spp., *Tricophyton rubrum*, *Candida albicans*, *Aspergillus niger*, and *Cladosporium* spp. were used.

The antimicrobial activities of different natural dyes were tested against five bacterial strains and five fungal clinical isolates using

Table 1
Phytochemical screening of turmeric dyes.

S.no	Test for	Aqueous method	Alkaline method	Acidic method	Alcoholic method
1	Carbohydrate	–	–	–	+
2	Protein	–	+	+	+
3	Amino acid	+	+	–	–
4	Alkaloids	+	+	+	–
5	Flavonoids	–	+	–	+
6	Terpenoids	–	+	–	+
7	Tannins	+	+	–	–
8	Saponin	+	+	–	+
9	Plobatinins	–	+	–	–
10	Aromatic acids	–	–	+	–
11	Phenolic compounds	–	–	–	–
12	Xanthoproteins	–	–	–	–
13	Reducing sugar	–	–	–	–
14	Triterpenoids	–	–	–	–

+: Present.
–: Absent.