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Research Paper

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Extraction, Characterization and Application of Dye from *Curcuma longa*

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***Abstract*—**The colourant in turmeric rhizome (*Curcuma longa*) was extracted using the solvent extraction method and characterized using UV/Visible spectroscopy to determine its absorbance against wavelength. The UV/Visible analysis confirmed that the colourant absorbs strongly in the yellow region of the visible range of the electromagnetic spectrum. Physico-chemical properties such as melting point and its solubility in different solvents were determined. The dye extract was also tested on cotton and wool fabrics using three salts, such as aluminium chloride, sodium chloride and ammonium chloride, as mordants. The result revealed that *Curcuma longa* is most suitable for dyeing wool fabric. When aluminum chloride was used as mordant for dye fixation the hue produced was more deep than the other two mordants tested. The colourant was also applied to personal care product such as body cream and the result obtained showed that the concentration of the colourant employed determines the strength of the hue in the product.

***Keywords*—**Turmeric, *Curcuma longa*, Colourant, Mordants, and Dye extract.

I. INTRODUCTION

Ever since pre-historic time, man has been fascinated to colour objects used daily by employing inorganic salts or natural pigments of vegetable, animal and mineral origins. These colouring substances, known as dyes, are the chemical compounds used for colouring fabrics, leather, plastic, paper, food items, cosmetics, etc., and to produce inks and artistic colours [1]. Dyes are of two types, i.e. synthetic and natural. Synthetic dyes are based on petroleum compound, whereas natural dyes are obtained from plant, animal, and mineral matters. Natural dyes are derived from natural resources such as plant, minerals and animals. It can be obtained from the roots, bark, leaves, flowers, and fruit of plants [2, 3].

Natural dyes, being plant metabolites, are present only in small amounts in dye-bearing materials along with large quantities of other non-dye materials. Due to their comparatively large quantities, synthetic dyes succeeded in pushing out of commercial use after the 19th century [4]. However, the production of synthetic dyes involves many violent reactions, which are conducted at high temperature and pressure using primary chemicals isolated from petroleum. During the manufacturing process, many carcinogenic chemicals are also required. 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. Natural dyes on the other hand are not toxic and do not have negative impact on the environment, which has been an increasing interest in researching them and their potential applications in textile industries and other consumer products [5].

Natural dye content of plants origin may vary according to the age, part of the plant, and agro-climatic conditions, and it is important to know the dye content in order to get reproducible shades [6]. Thus, determination of dye content as well as characterization of dye material is important in the case of natural dyes. Different techniques including High Performance Liquid Chromatography (HPLC), Thin-layer Chromatography (TLC), Infra-red spectroscopy (IR), High-Performance Thin-layer Chromatography (HPTLC), UV-Visible spectroscopy (UV-Vis), and Mass Spectroscopy (MS) have been employed for this purpose [7, 8].

Here, we reported the extraction, characterization and potential applications of a colourant from Tumeric plant. Turmeric is a member of the *Curcuma* botanical group, which is part of the ginger family of herbs, the Zingiberaceae [9]. Its botanical name is *Curcuma longa*. It is widely grown both as a kitchen spice and for its medicinal uses. The extraction of the dye was carried out with ethanol using the Soxhlet apparatus; physico-chemical properties were determined and characterization was done using UV-Visible spectroscopy. Aluminium Chloride, Sodium Chloride and Ammonium Chloride were used as mordants on pure cotton (100%) and wool fabric to get the most suitable

fabric/mordant combination for the dye. Its potential use in body cream was also tested and reported.

II. EXPERIMENTAL PROCEDURE

Materials

Curcuma longa, n-hexane, ethanol, methanol, acetone, chloroform, diethyl ether, ethyl acetate, petroleum spirit, water, Soxhlet apparatus, 250 ml round bottom flask, melting point apparatus, capillary tube, test tube, and thermometer.

Sample collection and preparation

The rhizome of the *Curcuma longa* samples were collected from Epe, Lagos state, Nigeria. The samples were peeled, cut into smaller sizes, dried in sunlight for a number of days till all the moisture was removed by evaporation, and this was later ground to powdered form.

Oil and Colourant Extraction

To obtain the oil-free colour, the oil was first removed by extracting with n-hexane. A 44 g of the sample was taken into a thimble, and 250 ml round bottom flask containing n-hexane was set up in a Soxhlet extractor. Extraction of oil was done for 4 hours under moderate boiling and the flask was cooled. The flask was removed and the solvent contained in it was recovered by distillation. After defatting, the samples were dried to a constant weight and returned to the Soxhlet to extract the colourant with ethanol. The extraction was carried out for 4 hours using ethanol with the same method described for defatting and the extractant was equally recovered by distillation. After extraction, the colourant obtained was concentrated by evaporation in open air and kept until further analysis.

III. PHYSICO-CHEMICAL & UV-VISIBLE STUDIES

Melting Point Determination

The melting point of the dye extract was determined using the capillary tube method [10].

Solubility Test

Solubility test of the colourant was carried out in some selected solvents. The following solvents were used: methanol, ethanol, acetone, petroleum spirit, chloroform, diethyl ether and ethyl acetate. The test was carried out by adding 0.1 g of the colourant to 10 ml of each of the above solvents in test tube at room temperature.

Test of Mordants and Fabric with Dye Extract Using Cotton and Wool

The cotton and wool fabric were dyed using three different salts as mordants. The aim of this was to get the most suitable fabric for the dye extract and the best mordant out of $AlCl_3$, NaCl and NH_4Cl.

Applications of Dye Extract to Personal Care Product such as Cream

The extract was applied to body cream, which successfully incorporated noticeable colour onto the personal care product.

UV-Visible Spectroscopy

The Ultraviolet spectroscopy (UV) was carried out on the dye extract using UV-1800 Shimazdu spectrophotometer.

IV. RESULTS AND DISCUSSION

The results of the physical test carried out on the colourant are summarized in Table 1. The colourant proved to be more soluble in methanol, ethanol and acetone than other solvents tested with it. Thus, ethanol was further used for extracting the colourant.

The percentage yield of the dye was calculated using the weight of defatted sample and weight of sample after extraction.

The UV-Visible absorption spectra of the dye extract of the colourant is shown in Figure 1. Ethanol was used as the blank reference [11]. The extract of *Curcuma longa* absorbs strongly in the yellow region of the visible range of the electromagnetic spectrum. The extract exhibited characteristic yellow hue having absorption maxima at 425 nm. The UV absorption falls within the visible region of the electromagnetic spectrum which indicates the presence of colour imparting chromophore in the dye extract. This also indicates the presence of highly conjugated double bonds in the compound known as curcuminoids which is responsible for the yellow colouration.

Table 1: Physical properties of Curcuma longa

TEST PERFORMED	RESULTS
a) Appearance of crystals	Yellow crystals
b) Yield	8.8%
c) Melting point	152^{o}C
d) Solubility	Methanol, Ethanol, Acetone –Soluble
	Chloroform, Diethyl ether – Partially soluble
	Ethyl acetate, Petroleum spirit, Water – Insoluble
e) Body cream	White to Yellow

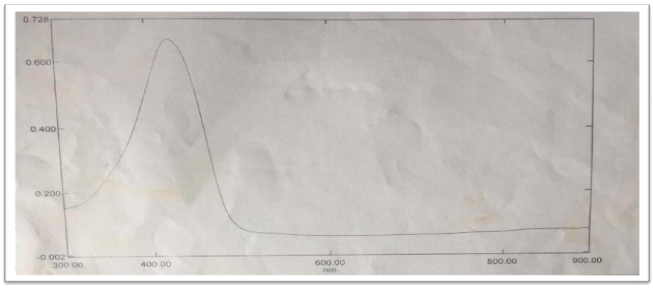


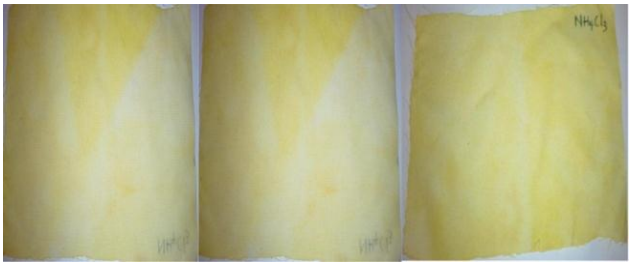
Figure 1: UV-Visible Spectrum of dye extract of Curcuma Longa

The results of the dyed fabrics are shown in Figure 2 and 3. By applying *Curcuma longa* dye extract on wool and cotton using sodium chloride, aluminium chloride and ammonium chloride as mordants, it was observed that aluminium chloride gives the best hue. Also, from the result, *Curcuma longa* dye extract proved to be more compatible for dyeing of pure wool fabric than cotton fabric using aluminium chloride as mordant. Thus, wool has more affinity than cotton when applying the dye extract.

Figure 4 shows the application of the dye on a cream. Based on its performance as added additive to the personal care product, it was observed that the concentration of the pigment employed determines the strength of the hue in the product to which the pigment is been applied. Since *Curcuma Longa* has its medicinal use to the body, an excess of the pigment in the personal care product has no negative effect on the body [6].

NaCl $AlCl_3$ NH_4Cl

Figure 2: Wool Fabric treated with the different mordant



NaCl $AlCl_3$ NH_4Cl

Figure 3: Cotton Fabric treated with different mordants and dyed

Before application. After application

Figure 4: Effect of dye extract on Body cream

V. CONCLUSION AND FUTURE SCOPE

From this study, we conclude that the UV absorption of the pigment falls within the visible region of the electromagnetic spectrum with absorption maxima at 425nm and the pigment was found acceptable in the dyeing of wool fabric with $AlCl_3$ as mordant. Also, the *Curcuma longa* pigment incorporated as colour additive to personal care product was found satisfactory as it imparted brilliant colouration to it.

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REFERENCES

[1] M.L. Gulrajani, "*Present status of natural dyes"* Book of papers of the convention on natural dyes. Vol. **5**, Issue **3, 1999**.

[2] A. Mukherji, "*Dyeing of Cotton Fabric with Kigelia Pinnata, SpathodeaCompanulata and Carissa Congesta"* Book of Papers of the Convention onNatural Dyes. Vol. **4**, Issue **2, 1999**.

[3] S. Naz and A. Bhatti, "*Dyeing properties of cotton fabric using un-irradiated and gamma irradiated extracts of Eucalyptus camaldulensis bark powder*" Indian Journal of Fibre and Textile Research, Vol. **36**, Issue **2**, pp.**132–146, 2011**

[4] O. Deveoglu, E. Torgan, and R. Karadag, "*High-performance liquid chromatography of some natural dyes: analysis of plant extracts and dyed textile"* Color Technology, Vol. **128** pp.**133–138, 2012**

[5] P.S. Vankar, "*The Chemistry of Natural dyes*" General Resonance, **India** pp. 73-80, 2000

[6] N. Bhattacharyya, "*Natural dyes and their eco-friendly application*" IAFL, **New Delhi**.

[7] O. Deveouglu, "*Natural Dye Researcher*" **Marmara University**, In press, Accessed 16th July 2017.

[8] A. K. Samanta and P. Agarwal, "*Application of natural dyes in textiles*" Indian Journal of Fibre and Textile Research, Vol. **34** Issue **4** pp.**384–399, 2009.**

[9] M. Grieve and C. F. Leyel "*A Modern Herbal: The Medical, Culinary, Cosmetic and Economic Properties, Cultivation and Folklore of Herbs, Grasses, Fungi, Shrubs and Trees with all of their Modern Scientific Uses"* **New York**: Barnesand Noble Publishing,1992.

[10] A. I. Vogel, A. R. Tatchell, B. S. Furnis, A. J. Hannaford and P. W. G. Smith "*Vogel's Textbook of Practical Organic Chemistry (5th ed.)"* **1978**

[11] P. Singh, *"Green Synthesis and Characterization of Silver Nanoparticles by using Aloe Vera plant extract"* International Journal of Scientific Research in Chemical Science, Vol. **6** Issue **3** pp.**1-3, 2019**

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