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Important factors determination on turmeric properties through curcumin reaction with boric acid and oxalic acid

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Abstract: Turmeric (*Curcuma longa* L.) is extensively used as a spice, food preservative and coloring material. It has been used in traditional medicine for various diseases. Curcumin, the main yellow bioactive component of turmeric has been shown to have a wide spectrum of biological actions. Heretofore, it has been reported that natural colored extracts percent is dependent on the temperature, time and container type. In this paper, the curcumin in turmeric was reacted with boric acid and oxalic acid at acetic acid solvent. The main visible transition of product (RC) is obtained in 530 nm. The curcumin percent is calculated from the intensity of the absorption.

Keywords: Turmeric, Currcuma longa L., Curcumin, Turmeric quality, Turmeric properties.

Introduction

Curcuma longa L. (turmeric), a perennial herb and member of the zingiberaceae (ginger) family, grows to a height of three to five feet and is cultivated extensively in Asia, China, India and other countries with a tropical climate [1]. It has oblong, pointed leaves and funnel-shaped yellow flowers. The rhizome, the portion of the plant used medicinally, is usually boiled, cleaned, and dried, yielding a yellow powder [2]. Dried *Curcuma longa* is the source of the spice turmeric, the ingredient that gives curry powder its characteristic yellow color [3]. Turmeric is one such botanical supplement whose use against arthritis, supported almost exclusively by its traditional, centuries-old use as an anti-inflammatory agent in Ayurvedic medicine, has been heavily promoted [4]. Turmeric is widely consumed in the countries of its origin for a variety of uses, including as a dietary spice, a dietary pigment, and an Indian folk medicine for the treatment of various illnesses [5]. It is used in the textile and pharmaceutical industries and in Hindu religious ceremonies in one form or another [6]. Current traditional Indian medicine uses it for biliary disorders, anorexia, cough, diabetic wounds, hepatic disorders, rheumatism, and sinusitis [7-12]. For the last few decades, extensive work has been done to establish the biological activities and pharmacological actions of turmeric's extracts [13]. Curcumin, the main yellow bioactive component of turmeric has been shown to have a wide spectrum of biological actions [14]. These include its antioxidant, anti-inflammatory, anti-carcinogenic, anti-coagulant, anti-mutagenic, anti-diabetic, anti-fertility, anti-bacterial, anti-fungal, anti-viral, anti-protozoal, anti-venom, anti-fibrotic, antiulcer, hypocholesteremic and hypotensive activities [15-19].

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Results and discussion

Determination of important factors in the quality of natural compounds is very interesting in food chemistry. In this work, we were investigated the influence of three factors: time, temperature and container type on the turmeric qualities. To this end, first we synthesized rubrocurcumin by reaction of curcumin with oxalic acid dehydrate and boric acid. UV-Vis spectrum of rubrocurcumin is recorded. The main visible absorbance is obtained in 530 nm. This reaction was carried out on eight samples of turmeric (Table **1**). After measuring the absorbance of the solutions, the curcumin percent is calculated as follows:

$$\text{Curcumin\%} = \frac{E*C}{m}$$

E: Absorption of the sample solution
C: 0.426
m: Turmeric powder weight based on grams

According to the data in the table, we find that turmeric loses its properties (curcumin) under high tempratures and time. To second point, turmeric shouldn't be stored in plastic container.

Table 1: Curcumin percent in turmeric samples.

Samples	Absorbance (λ_{max}=530 nm)	Curcumin (%)
Turmeric powder available in supermarkets	0.137	0.5836
Fresh turmeric rhizome	0.232	0.9888
Turmeric powder is kept in a glass jar for 5 months	0.225	0.9585
Turmeric powder is kept in a plastic jar for 5 months	0.219	0.9329
Turmeric powder is heated under the temperature of 60 ° C for 10 days	0.217	0.9244
Turmeric powder is heated under the temperature of 70 ° C for 10 days	0.211	0.8989
Turmeric powder is heated under the temperature of 80 ° C for 10 days	0.197	0.8392
Turmeric powder is heated under the temperature of 90 ° C for 10 days	0.163	0.6944

Conclusion

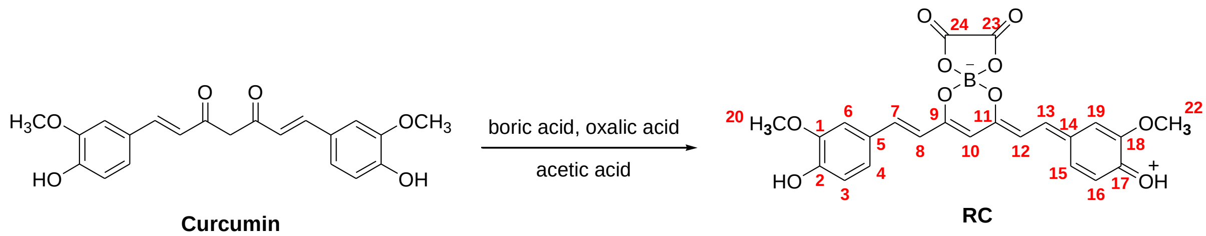
The rubrocurcumin compound was prepared in one step by reaction of curcumin with oxalic acid dehydrate and boric acid with good yield. The product is soluble in $CHCl_3$. In UV/Vis spectrophotometry study have shown the conjugation causes absorption signatures shift to longer wavelengths. This study showed that time, temperature and container type are important factors for turmeric properties.

Experimental

All solvents and compounds were purchased from Merck Company. The solvents were distilled before use and stored over a drying agent. IR spectra were recorded with a Shimadzu FTIR-408 spectrophotometer as KBr pells. ^{1}H NMR and ^{13}C NMR spectra were recorded on a Brucker 400 AC spectrometer in $CDCl_3$ as a solvent at room temperature. The λmax and colour intensities were determined on a Philips PU 8620 UV spectrophotometer using a 1-cm quartz cell. TLC was performed by the use of Merck's silica gel.

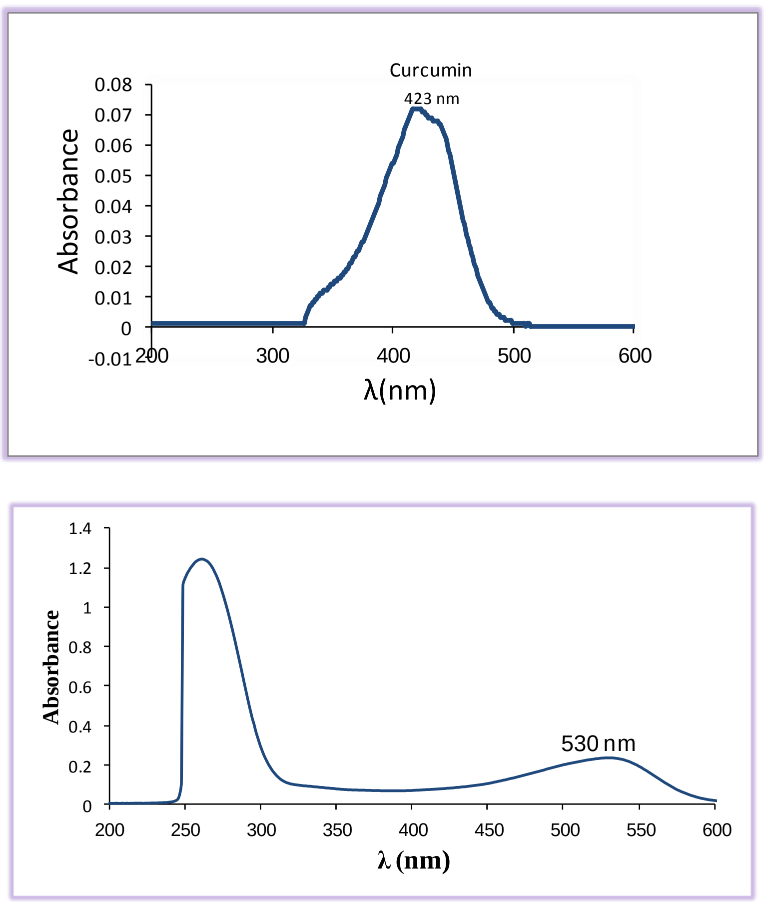
Reaction of curcumin with boric acid and oxalic acid: Rubrocurcumin:

For preparing of rubrocurcumin, oxalic acid dehydrate (1 g), boric acid (0.25 g) and curcumin (1 g) in acetic acid (100 mL) were added together in a flask (Scheme **1**). The mixture was stirred at 90 degree centigrade for 2 h. After this time, the flask was cooled rapidly to room temperature. Then, the solution was filtered, concentrated and diluted with 40 mL distilled water. 20 g sodium sulfate was added to the solution, and, after 10 min, the mixture was filtered and extracted with dichloromethane (3 x 50 mL). The combined extracts were dried (Na_2SO_4) and concentrated, and the residue was chromatographed over silica gel by CH_2Cl_2: methanol in a ratio of 19:1 to good yield (Figure **1**). IR (neat, cm^{-1}): 3443 (O-H), 2987 (CH_{sp2}), 2856 (CH_{sp3}), 1738 (stretching C=O), 1634 (stretching C=C), 1373 (bending C-H), 1258 (bending C=O), 1122 (stretching C-O), 763 and 746 (stretching B-O), 704 and 605 (bending O-B-O). ^{1}H NMR (FT-400 MHz, $CDCl_3$): δ; 3.50 (s, $3H_{22}$), 3.73 (s, $3H_{20}$), 5.06 (s, OH), 5.2 ($1H_{16}$), 5.4 ($1H_{19}$), 6.46 ($1H_{13}$), 6.51 ($1H_{10}$, $1H_{12}$, $1H_{15}$), 6.57 ($1H_3$), 6.66 ($1H_4$, $1H_6$, $1H_7$), 6.85 ($1H_8$). ^{13}C NMR (FT-100 MHz, $CDCl_3$): δ; 53.4 (C_{22}), 56.2 (C_{20}), 87.2 (C_{20}), 89.3 (C_{19}), 91.7 (C_{10}), 111.8 (C_6), 115.4 (C_{16}), 116.8 (C_3), 119.6 (C_8), 120.1 (C_4), 122.3 (C_{13}), 128.8 (C_5), 131.2 (C_7), 131.9 (C_{14}), 133.5 (C_{15}), 144.9 (C_2), 146 (C_{18}), 151.3 (C_1), 161 ($C_{23,24}$), 166.4 (C_{17}), 182.6 ($C_{9,11}$). UV-Vis (nm): 268 and 530 (π to π^* transition) (Scheme **2**).



Scheme 1.:Synthesis of rubrocurcumin (RC) from curcumin.

Figure 1: The rubrocurcumin solution.



Scheme 2: UV-Vis analysis of curcumin and rubrocurcumin.

Determination of curcumin in turmeric through its reaction with boric acid and oxalic acid:

Turmeric (0.1 g) and acetic acid (60 mL) were added together in a two-necked flask. The mixture was stirred at 90 degree centigrade for 1 h. Then, oxalic acid dehydrate (2 g) and boric acid (2 g) were added to the flask. The mixture was stirred at 90 degree centigrade for 30 minutes. After this time, the flask was cooled rapidly to room temperature. Then, 40 mL acetic acid was added to the mixture. After mixing the contents of the flask, 5 mL of the solution from the upper part of it was transferred into a 50-mL flask. Then, the contents of the flask were diluted to 50 mL with acetic acid.

UV-Vis spectrum of solution is recorded (Scheme **2**). The main visible transition is obtained in 530 nm. We saw conjugation causes absorption signatures shift to longer wavelengths because the π to π^* transitions are more intense than other transitions. The curcumin amount was calculated from the sample solution absorption.

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