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# Essential Oil Constituents of The Rhizomes of Two Types of *Curcuma longa* of Bangladesh

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## Abstract

Essential oil from the rhizomes of two types of *Curcuma longa*, yellow and red originated in Bangladesh was analyzed by GC-MS. 54 compounds have been identified from the yellow type of which the major compounds are ar-tumerone (27.78%), tumerone (17.16%), culone (13.82%), 2-carene (4.78%), zingiberene (4.37%) and β-sesquiphellandrene (5.57%). The red type contained 39 compounds with carvacrol (21.14%), citral (13.91%), methyleugenol (7.31%), geraniol (6.99%), menthol (5.11%) and caryophyllene oxide (4.14%) as major constituents.

**Key words:** *Curcuma longa*, GC-MS, Ar-tumerone, Carvacrol, Tumerone, Citral.

## Introduction

*Curcuma longa* L (Zingiberaceae) is a rhizomatous perennial herb, commonly known as turmeric, traditionally been used as a source of coloring matter for foods, cosmetics and textiles and as a medicinal ingredient of formulations of the Indian system of medicine for several common ailments like jaundice and other liver ailments, ulcers, parasitic infections, various skin diseases, sprains, inflammation of the joints, cold and flu symptoms. (Anon. 1950). It is also used for preserving food as antimicrobial (Jayaprakasha *et al.*, 2005). The main activities have been found to be anti-inflammatory, hepatoprotective, antimicrobial, wound healing, anticancer, antitumor, a blood purifier, stomachic, antiseptic and anti-viral. Discovery of antiviral properties in curcumin, particularly against HIV, is quite interesting (Anon., 1950; Yusuf *et al.* 1994; Srimal, 1997; Ghani, 2003). It is also useful as hypotensive, hepatoprotective etc (Shaha, 1997). The most important of these compounds and the most intensively studied by far is curcumin, which has also been shown to possess the remarkable activities of preventing or treating alzheimer disease, immunomodulation, and correcting cystic

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fibrosis defects, among others (Balasubramanium, 2006); Ringman *et al*., 2005; Egan *et al,* 2004). The rhizome oil of *C. longa* from northern plains of India was reported to contain 59.7% of ar-turmerone (Nigam and Ahmed, 1990) while the rhizome oil of another Indian chemotype was characterized by ar-turmerone (41.4%), turmerone (29.5%) and turmerol (20%) (Zwaving and Bos, 1992). Other turmeric oils from India contained zingiberene (25.0%) and ar-turmerone (25.0%) (Mitra, 1975). The oils of *C. longa* from northeastern region of India-Bhutan (Sharma *et al*., 1997) contains *ar*-turmerol (16.7-25.7%), a-turmerone (30.1-32%) and ß-turmerone (14.7-18.4%) as major constituents. Singh *et al.* (2003) reported as major constituents ar-turmerone (51.7%), *ar*-turmerol (11.9%), ß-bisabolene (10.7%) and zingiberene (10.2%). Moreover, from the plains of northern India (Garg *et al*, 1999), various accessions of *C. longa* were analyzed for their curcumene and major oil contents. The major chemical constituents of volatile oil were identified *ar*-turmerone, zingiberene, turmerone and curlone (Jayaprakash *et al*., 2005). Martins *et al*. (2001) reported lower contents of *ar*-tumerone (4-12.8%). A new curcuminoid, cyclocurcumin is reported as nematocide from Japan (Kiuchi *et al*., 1993). Riaz *et al.* (2000) reported from Pakistan ar-tumerone (31.1 and 41.2%), tumerone (9.0 and 11.1%), ß-bisabolene (6.5 and 7.6%), ß-curcumene (5.6 and 6.6%), γ-caryophyllene (6.9 and 7.3%) and isoterpinolene (6.4 and 5.7%) as major constituents from two different places. Raina *et al*. (2000), reported the presence of 1,8-cineole (11.2%), γ-turmerone (11.1%), α-caryophyllene (9.8%), ar-turmerone (7.3%) and ß-sesquiphellandrene (7.1%) from India. Though lot of work has been done on the chemical composition and other activities of the oil elsewhere, no work has been done in Bangladesh on the constituents of turmeric oil except Chowdhury *et al*. (2005) on the oil from dry leaves. On the other hand, the red type of rhizome oils was not analyzed yet in the world. So as a part of our screening programme on aromatic plants of Bangladesh, we have investigated these oils.

## Materials and Methods

The essential oil from fresh rhizomes collected from the experimental field of BCSIR Laboratories, Chittagong during December 2006 by hydrodistillation method for 4 hrs. The rhizomes were macerated before distillation.

### GC-MS analysis

The essential oils from rhizomes of *C. longa* were analyzed by GC-MS electron impact ionization (EI) method on GC-17A gas chromatograph (Shimadzu) coupled to a GC-MS QP 5050A Mass Spectrometer (Shimadzu); fused silica capillary column (30m x 2.5μm; 0.25 mm film thickness), coated with DB-1 (J and W); column temperature 100$^{o}$C (2 min) to 250$^{o}$C at the rate of

3oC/min; carrier gas, helium at constant pressure of 90Kpa. Acquisition parameters full scan; scan range 40-350 amu. The compounds were identified by comparing with the NIST library data.

**Results and Discussion**

Essential oil from the rhizomes of two types of *Curcuma longa*, yellow and red from Bangladesh were analyzed by GC-MS. The oil yield were 1.1% and 0.8% respectively. 54 compounds have been identified from the yellow type (Table I) of which the major are ar-tumerone (27.78%), tumerone (17.16%), culone (13.82%), 2-carene (4.78%), zingiberene (4.37%) and β-sesquiphellandrene (5.57%). The red type contains 39 compounds (Table II) with carvacrol (21.14%), citral (13.91%), methyleugenol (7.31%), geraniol (6.99%), menthol (5.11%) and caryophyllene oxide (4.14%). Other notable compounds in the yellow type are caryophyllene (0.98%), *ar*- curcumene (3.29%), 1,6,10-dodecatriene, 7,11-dimethyl-3-methylene (1.18%),benzene, 1-(3-cyclopentylpropyl)

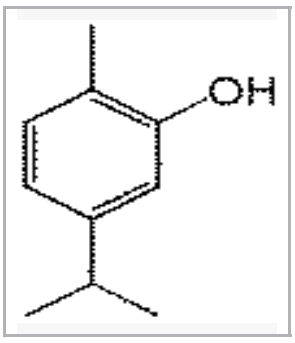


**Fig. 1. Chemical structure of carvacrol**

-2,4-dimethy (1.19%), bicyclo[7.2.0] undecane, 10,10-dimethyl-2,6-bis(methylene) (1.44%), ß-bisabolene (2.91), a-bisabolol (2.04%) and in the red type are citronellol (1.89%), piperitone (2.27%), 2,6-octadiene-1,8-diol, 2,6-dimethyl (1.05%), neryl acetate (1.53%), geranic acid (2.24%), geranyl acetate (1.82%), 2,6-octadiene,4,5-dimethyl (1.18%), 1,6,10,14-Hexadecatetraen-3-ol, 3,7,11,15-tetramethyl (1.76%), a-farnesene (1.00%), (E,E,E)-3,7,11,15-tetramethyl-hexadeca-1,3,6,10,14-pentaene (1.65%), 6,11-Dimethyl-2,6,10-dodecatrien-1-ol (1.16%), 2,6,11,15-Tetramethyl-hexadeca-2,6,8,10,14-pentaene (2.91%), 2,2,4-Trimethyl-3-(3,8,12,16-tetramethyl-heptadeca-3,7,11,15-tetraenyl)-cyclohexanol (1.17%), nerolidyl propionate (1.07%), neric acid (2.29%), 3,7-nonadien-2-ol,4,8-dimethyl (2.39%). Turmeric is the most popular and effective traditional medicinal plant useful in many ailments Shaha (1997). Most of the therapeutic properties are attributed due to the curcuminoids present in the rhizomes. The major curuminoids, ar-tumerone, tumerone and culone content found in the present oil resembles that of oils of C. longa from Indonesia (Zwaving and Bos, 1992), Pakistan (Riaz *et al.,* 2000) and Bhutan (Sharma *et al.,* 1997). Bangladesh produces C. longa throughout the country. It is necessary to analyze samples from various places for selecting a variety containing higher contents of curcuminoids. Considering the potential bioactive

**Table 1. Constituents of rhizome essential oil of *C. longa* (Yellow variety).**

| Sl.No. | Compounds | Relative (%) |
|---|---|---|
| 1 | α-Pinene | 0.16 |
| 2 | Camphene | 0.14 |
| 3 | ß-Pinene | 0.56 |
| 4 | α -Phellandrene | 0.52 |
| 5 | 3-Carene | 0.14 |
| 6 | α-Terpinene | 0.35 |
| 7 | m-Cymene | 0.21 |
| 8 | Limonene | 0.17 |
| 9 | Eucalyptol | 0.61 |
| 10 | 1,3,6-Octatriene, 3,7-dimethyl-, (E)- | 0.09 |
| 11 | 2-Carene | 4.78 |
| 12 | ß, ß.-Dimethylstyrene | 0.17 |
| 13 | Camphor | 0.46 |
| 14 | Borneol | 0.20 |
| 15 | Menthol | 0.09 |
| 16 | p-Cymen-8-ol | 0.09 |
| 17 | α-Bergamotene | 0.63 |
| 18 | α -Santalene | 0.77 |
| 19 | Caryophyllene | 0.98 |
| 20 | Decahydroquinoline 243a | 0.13 |
| 21 | ß-Santalene | 0.23 |
| 22 | α-Caryophyllene | 0.95 |
| 23 | α-Himachalene | 0.30 |
| 24 | Ar-Curcumene | 3.29 |
| 25 | 1,6,10-Dodecatriene, 7,11-dimethyl-3-methylene-, (E)- | 1.18 |
| 26 | Zingiberene | 4.37 |
| 27 | cis-α -Bisabolene | 0.20 |
| 28 | Benzene, 1-methyl-4-(1-methylpropyl)- | 0.11 |
| 29 | ß-Bisabolene | 2.91 |
| 30 | Teresantalol | 0.49 |
| 31 | ß-Sesquiphellandrene | 5.57 |
| 32 | 2,3,5-Trimethylfuran | 0.17 |

**Table I : To be contd.**

| | | |
|---|---|---|
| 33 | Elixene | 0.08 |
| 34 | α-Bisabolol | 2.04 |
| 35 | 2-Oxabicyclo[9.1.0]dodeca-3,7-diene, 1,5,5,8-tetramethyl-, | 0.18 |
| 36 | γ-Elemene | 0.08 |
| 37 | (1,2,3-Trimethyl-cyclopent-2-enyl)-methanol | 0.19 |
| 38 | Tumerone | 17.16 |
| 39 | Dicumyl peroxide | 0.63 |
| 40 | Caryophyllene oxide | 0.14 |
| 41 | Benzene, 1-(3-cyclopentylpropyl)-2,4-dimethy | 1.19 |
| 42 | α-Santalol | 0.64 |
| 43 | Benzene, 1,4-dimethyl-2-(2-methylpropyl)- | 0.45 |
| 44 | Naphthalene,1,2,3,4,4a,5,6,8a-octahydro-4a, 8-dimethyl-2-(1-methylethylidene)- | 0.08 |
| 45 | Di-epi-.a-cedrene | 0.52 |
| 46 | Bicyclo[7.2.0]undecane, 10,10-dimethyl-2,6-bis(methylene) | 1.44 |
| 47 | 1,1'-Bicyclohexyl, 4-(methoxymethyl)-4'-propyl- | 0.09 |
| 48 | Acoradiene | 0.42 |
| 49 | Ar-tumerone | 27.78 |
| 50 | 4,7-Methanobenzofuran, 2,2'-oxybis[octahydro-7,8,8-trimethyl | 0.67 |
| 51 | Curlone | 13.82 |
| 52 | Aristolene | 0.23 |
| 53 | 2,5-Octadiene, 3,4,5,6-tetramethyl- | 0.77 |
| 54 | γ-Gurjunenepoxide-(1) | 0.17 |

properties (Shaha, 1997; Funk *et al.,* 2006) isolation of curcuminoids for commercial uses is suggested. On comparing our results of the rhizome oil with those reported earlier from different places in the world (Jayaprakasha *et al.,* 2006; Nigam and Ahmad, 1990; Zwaving and Bos, 1992; Mitra, 1975; Sharma *et al,*1997; Singh *et al.*, 2003; Garg *et al.*, 1999; Martins *et al.*, 2001; Riaz *et al.*, 2000; Raina *et al.*, 2000) showed similar results with respect to the content of the major constituents such as ar-turmerone and turmerone. But have significant variations in the contents of ar-tumerone (27.78%), tumerone (17.16%), culone (13.82%), 2-carene (4.78%), zingiberene (4.37%), β-sesquiphellandrene (5.57%), caryophyllene (0.98%) and ar-curcumene (3.29%). But it is very interesting to note that comparison of our results reported

**Table II. Constituents of rhizome essential oil of *C. longa* (Red variety)**

| Sl.No. | Compounds | Relative (%) |
|---|---|---|
| 1 | Linalool | 0.64 |
| 2 | Menthol | 5.11 |
| 3 | Citronellol | 1.89 |
| 4 | Geraniol | 6.99 |
| 5 | Piperitone | 2.27 |
| 6 | 6-Nonenal, 3,7-dimethyl- | 0.57 |
| 7 | Carvacrol | 21.14 |
| 8 | 2,6-Octadiene-1,8-diol, 2,6-dimethyl- | 1.05 |
| 9 | Cyclohexyl formate | 0.87 |
| 10 | Neryl acetate | 1.53 |
| 11 | Geranic acid | 2.24 |
| 12 | Geranyl acetate | 1.82 |
| 13 | Methyleugenol | 7.31 |
| 14 | α-Selinene | 0.70 |
| 15 | 2,6-Octadiene, 4,5-dimethyl | 1.18 |
| 16 | Caryophyllene oxide | 4.14 |
| 17 | Juniper camphor | 0.64 |
| 18 | Cyclohexanol, 3,3,5-trimethyl-, acetate, cis- | 0.55 |
| 19 | 1,6,10,14-Hexadecatetraen-3-ol, 3,7,11,15-tetramethyl-, (E,E)- | 1.76 |
| 20 | trans-Nerolidol | 0.59 |
| 21 | 8-Oxabicyclo[3.2.1]oct-6-en-3-one, 2,4-dimethyl- | 0.55 |
| 22 | 3-Bornanone | 0.94 |
| 23 | 2-Cyclohexene-1-carboxaldehyde, 2,6-dimethyl-6-(4-methyl-3-pentenyl)- | 0.65 |
| 24 | Adoxal | 0.72 |
| 25 | α-Farnesene | 1.00 |
| 26 | Bicyclo[3.3.1]nonan-9-one, 2,4-dimethyl-3-nitro- (exo)- | 0.67 |
| 27 | 5,9-Undecadien-2-one, 6,10-dimethyl-, (Z)- | 0.56 |
| 28 | (E,E,E)-3,7,11,15-Tetramethylhexadeca-1,3,6,10,14-pentaene | 1.65 |
| 29 | 6,11-Dimethyl-2,6,10-dodecatrien-1-o | 1.16 |
| 30 | 2,6,11,15-Tetramethyl-hexadeca-2,6,8,10,14-pentaene | 2.91 |
| 31 | Gitoxigenin | 0.82 |
| 32 | 2,2,4-Trimethyl-3-(3,8,12,16-tetramethyl-heptadeca-3,7,11,15-tetraenyl) -cyclohexanol | 1.17 |
| 33 | Nerolidyl propionate | 1.07 |
| 34 | Neric acid | 2.29 |
| 35 | 3,7-Nonadien-2-ol, 4,8-dimethyl- | 2.39 |
| 36 | Pyrazolo[1,5-a]pyridine, 3,3a,4,7-tetrahydro-3,3-dimethyl-, (3aS) | 0.63 |
| 37 | 20-Oxopregn-16-en-12-yl acetate | 0.66 |
| 38 | 2,6,10-Dodecatrien-1-ol, 3,7,11-trimethyl- | 0.93 |
| 39 | Citral | 13.91 |

on the rhizome oil composition from the different places showed different results in the percentage content of some of the major and minor constituents. This confirms that the variations in the cultivar reported is not due to geographic divergence and ecological conditions but that is due to different chemotype than ours. Presence of carvacrol (Fig:1), citral, methyleugenol, geraniol, menthol and caryophyllene oxide are reported for the first time in turmeric oil. Carvacrol is used as a flavor ingredient and also as an antibacterial or antifungal agent based on it biological activity (Knowles *et al.*, 2005). Carvacrol is an essential oil component of oregano, thyme, marjoram, and summer savory (Arrebola *et al.*, 1994; Lagouri *et al.*, 1993) generally recognized as a safe food additive (CFR 172.515) (Leriche and Carpentier, 1995), used as a flavoring agent in several products, such as baked goods, candy, beverages, and chewing gum (Fenaroli, 1995). On the basis of above fact it may be concluded that *C. longa* growing in Bangladesh, may be utilized as a source for the isolation of natural ar-tumerone and carvacrol respectively.

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