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Chemical Composition of *Curcuma Longa* Leaves and Rhizome Oil from the Plains of Northern India

Awasthi PK[1], Dixit SC

Department of Chemistry, D.B.S. College, Kanpur-208006, [1]NIMS University, Jaipur, India

Address for correspondence: *Mr. Satish. C. Dixit; E- mail: scdixit17@rediffmail.com*

ABSTRACT

Hydro distillation of rhizomes and leaves of *Curcuma longa* resulted in the isolation of 0.36% and 0.53% of oils (w/v) respectively on a fresh weight basis. GC and GC-MS analysis resulted in the identification of 73 constituents in rhizomes comprising 95.2% of the oil, of which the major ones were ar-turmerone (31.7%), α-turmerone (12.9%), β-turmerone (12.0%) and (Z) β-ocimene (5.5%). In the oils, 75 constituents comprising 77.5% of the oils were identified, the major ones were α-phellantrene (9.1%), terpinolene (8.8%), 1,8-cinceole (7.3%), undecanol (7.1) and p-cymene (5.5%).

Key words: Curcuma longa; Zingiberaceae, rhizomes, leaves, essential oil composition, GC-MS

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INTRODUCTION

Curcuma longa L syn *C. domestica* (Zingiberaceae), commonly known as turmeric, is a genus of 70 species of rhizomateous herbs. It is distributed in India, Thailand, Archipelago and Northern Australia. The tuber roots of a few species of the genus curcuma are economic sources of pharmaceutical and perfumery compounds.[1-9] *C. longa*, a perennial herb, is cultivated extensively throughout the warmer parts of the world. It is grown on a large scale in India and China. In India it is cultivated in almost all states, particularly in Tamilnadu, Maharashtra and Bengal.[10] The commercial products of *C. longa* are turmeric powder, extracts and oleoresins. India is one of the largest producers of turmeric and its oleoresin.[10-13] In the Indian system of medicine, turmeric is used to some extent as a digestive aid and in the treatment of fever, infections, dysentery, arthritis, jaundice and other fever problems. Traditional Chinese physicians used turmeric to treat liver and gall bladder problems, stop bleeding and treat chest congestion and menstrual discomforts. The oil of turmeric in small doses acts as a carminative stomachic appetizer and tonic. In large doses, however, it appears to act as an anti oxidant.[14] The essential oil of *C. longa* possess anticancer,[15] anti-inflammatory,[16] antibacterial, antifungal, hepatoprotective,[17] antitumor, hypolipidemic and antithrombic activities.

MATERIALS AND METHODS

Plant material

Fresh rhizomes and leaves were purchased from Chandra Shekhar Azad University of Agriculture and Technology, Kanpur (India), in the month of June, 2005.

Isolation of essential oils

Fresh rhizomes (305g) and leaves (320g) were hydro distilled in a Clevenger-type apparatus for four hours; each afforded 0.36% and 0.53% of oils respectively on

fresh weight basis. The oils thus obtained were dried over anhydrous sodium sulphate and stored in a sealed glass vial at low temperature prior to analysis.

Gas chromatography (GC)

The oils were analyzed on a Hewlett-Packard 5980. A gas chromatograph equipped with a fused silica capillary column (50 X 0.25mm) coated with methyl silicon (thickness 0.17mm) with FID detector. GC conditions were: nitrogen as carrier gas (1ml/min), split ratio 1:80, injection temperature 250°C, FID temp. 300°C and programmed from 80°C to 200°C at a rate of 2°C/min. The retention indices were calculated for all volatile constituents using a homologous series of *n*-alkanes.

GC/MS analysis

GC/MS data were obtained on a Perkin Elmer Turbo Mass spectrometer instrument using a PE-WAX column (60m X 0.32mm, film thickness 0.25µm). Temperature programmed: five minutes at 70°C, then rising at 2°C/min to 120°C and then 3°C/min from 120-240°C. Carrier gas was helium.

Identification of compounds

Compounds were identified by comparing the retention indices of the peaks with literature values[18-23] computer matching against the NBS and Wiley libraries spectra.

RESULTS AND DISCUSSION

The oils were obtained by conventional hydro distillation of the rhizomes and leaves of *C. longa* in a Clevenger type apparatus. Each gave oil in 0.36% and 0.53% yield respectively on fresh weight basis. GC and GC-MS analysis resulted in the identification of total 73 and 75 constituents, respectively from the rhizomes and leaves oil.

The relative concentrations of the volatile components identified are presented in Table 1, according to their elution order on a BP-1 column. The major components of the rhizome oil were ar-turmerone (31.7%), α-turmerone (12.9%), β-turmerone (12.0%) and (Z)-β-ocimene (5.5%). On the other hand the major constituents in the leaf oil were α-phellandrene (9.1%), terpinolene (8.8%), 1, 8-cineole (7.3%) and undecanol (7.1%) and p-cymene (5.5%). On comparing the similarity between the chemical composition of rhizomes and oil, it was observed that out of 73 and 75 constituents identified in the rhizomes and oils respectively, 51 were common in both the oils.

Apart from the above similarity, following differences were also recorded: ar-turmerone (31.7% and 1.2%), α-turmerone (12.9% and 0.5%), and β-turmerone (12.0% and 0.1%), which were major constituents in the rhizomes oil were observed as minor or trace constituents in the leaves oil. Similarly, the other constituents such as α-cadinene (1.2% and 0.7%), β-curcumene (1.3 and 0.5%), humulene epoxide (1.9% and 0.7% were two to three times higher, while τ-cadinol (2.4% and 0.4%) was 6 times higher in rhizome oil. Similarly δ-elemene (1.0% and t), E(α)-atlantone (1.5% and 0.1%) and virdifloral (1.7% and t) were 10 to 17 times higher in rhizome oil.

On the other hand α-phelladrene (9.1% and 0.1%), terpinolene (8.8% and 0.1%), undecanal (7.1% and 0.2%), p-cymene (5.5%and 0.1%), which were present as major components in the leaves essential oil were observed as trace constituents in the rhizome oil, except 1,8-cineole (7.3% and 2.6%), which was three times higher in the leaves oil. Similarly, myrcene (1.6% and 0.2%), iso-bornyl acetate (1.8% and 0.2%) and geranyl butyrate (1.1% and t) were eight to 11 times higher in the oil while carvone (0.9% and 0.5%), tetradecane (1.8% and 0.6%) and ar-curcumene (1.0% and 0.2%) were two to five times higher in the oil than those of rhizomes oil.

Apart from the above differences, Z-(β)-ocimene (5.5%), elimicin(2.0%), caryophyllene oxide (2.1%) were only present in the rhizomes oil, while sabinyl acetate (3.5%), methyl eugenol (3.0%), cinnamaldehyde (1.9%), neral (1.8%), cis-sabinol (1.5%), α-terpineol (1.4%) and β-elimine (1.2%) were only present in the oil.

On comparing our results with the Bhutanese rhizomes oil[24] (eight month old), it was observed that out of 73 and 21 constituents, 13 constituents were common in both types of oil. Zingiberene (1.3% and 1.5%) was the only constituent with similar composition in both types. Although ar-turmerone (31.7% and 25.7%), α-termerone (12.9% and 32.0%), and β-turmerone (12.0% and 18.4%) were major constituents in both the oils, but their percentage did vary to certain extent. ar-turmerone (31.7% and 25.7%) was 1.5 times higher in Indian (our) oil. On the other hand ar-turmerone (0.1% and 1.3%) and p-cymene (0.1% and 0.6%) were six to 13 times higher, while α-termerone (12.9% and 32.0%), β-turmerone (12.0% and 18.4%) , β-bisabolene (0.2% and 0.5%), 1-bisabolene (0.2% and 0.9%) and α-phellandrene (0.2% and 1.1%) were 1.5 to five times higher in the rhizome oil from Bhutan.

On comparing our oil results with those of the Bhutanese oils, it was observed that out of 75 and 49 constituents

Table 1: Comparison of Constituents of *Curcuma longa* Rhizomes and Leaves from India and Bhutan*

RI	Component	Rhizomes Oil		Leaves Oil	
		India	Bhutanese*	India	Bhutanese*
701	n-Heptane	t	-	-	-
746	Toluene	-	t	-	t
760	Isobutyl acetate	t	-	0.2	-
800	n-Octane	t	-	T	-
811	3-Buten-2-ol	-	-	T	-
850	cis-3-Hexenol	-		T	
900	n-Nonene	0.3	-	T	-
921	α-Thujene	-	-	-	0.1
931	α-Pinene	-	0.1	0.1	2.6
941	Camphene	0.4	-	0.8	t
965	Sabinene	t	-	0.1	0.4
975	β-Pinene	-	-	0.2	7.2
982	Myrcene	0.2	t	1.6	1.8
1000	α-Phellandrene	0.1	1.1	9.1	18.2
1003	δ-3-Carene	-	-	-	0.9
1008	α-Terpinene	-	-	-	0.4
1014	p-Cymene	0.1	0.6	5.5	13.3
1019	Limonene	-	0.1	-	3.3
1020	1,8-Cineole	2.6	0.9	7.3	14.6
1032	(Z)-β-Ocimene	5.5	-	-	0.1
1041	(E)-β-Ocimene	t	-	-	0.3
1057	γ-Terpinene	0.1	t	-	1.0
1071	Dehydro-p-cymene	-	-	-	0.1
1081	Terpinolene	0.1	-	8.8	11.6
1087	Linalool	0.6	-	-	1.2
1092	2-Nonanol	-	-	T	-
1099	α-Fenchol	0.1	-	0.2	-
1117	trans-p-Menth-2-en-1-ol	0.1	-	0.1	-
1125	p-Methyl acetophenone	0.1	-	0.1	-
1133	Camphor	0.1	-	-	t
1149	Borneol	0.2	-	0.5	0.3
1154	p-Cymen-8-ol	-	-	-	2.4
1164	Terpinen-4-ol	0.3	-	-	0.8
1173	Myrtenal	0.3	-	-	0.1
1174	α-Terpineol	-	t	1.4	0.9
1182	Myrtenol	0.6	-	-	t
1186	cis-Sabinol	-	-	1.5	1.0
1192	2-Decanol	0.6	-	-	-
1198	cis-Carvotanacetol	0.2	-	0.5	t
1206	cis-Carveol	0.2	-	0.2	-
1211	Carvone	0.5	-	0.9	-
1222	Neral	-	-	1.8	-
1223	Piperetone	-	-	-	t
1226	Cinnamaldehyde	-	-	1.9	0.4
1232	Perilla ketone	-	-	0.5	-
1240	Geraniol	0.2	-	-	-
1248	Linalyl acetate	0.7	-	-	-
1255	Geranial	-	-	0.5	-
1260	Safrol	-	-	0.3	-
1267	Iso-Bornyl acetate	0.2	-	1.8	-
1272	Undecane	0.1	-	0.1	-
1278	Geranyl formate	0.2	-	0.1	-
1281	Thymol	-	-	0.7	0.2
1286	Carvacrol	t	-	0.6	0.1
1292	Sabinyl acetate	-	-	3.5	-

Table 1: Contd.....

RI	Component	Rhizomes Oil		Leaves Oil	
		India	Bhutanese*	India	Bhutanese*
1302	Undecanol	0.2	-	7.1	-
1313	Linalyl propionate	-	-	0.3	-
1322	cis-Carvyl acetate	-	-	0.5	-
1331	δ-Elemene	1.0	-	t	-
1349	Thymol acetate	0.2	-	0.1	-
1353	Capric acid	-	-	0.4	-
1362	Geranyl acetate	0.9	-	1.0	-
1372	Methyl eugenol	-	-	3.0	-
1373	5-Hydroxy-p-menth-6-en-2-one	-	-	-	0.6
1380	β-Patchouline	0.2	-	0.5	-
1383	6-Hydroxy-p-menth-1-en-3one	-	-	-	0.6
1384	β-Elemene	-	-	1.2	-
1400	Tetradecane	0.6	-	1.8	-
1408	Caryophyllene	t	-	0.6	0.5
1430	γ-Elemene	-	-	0.5	-
1440	α-Cadinene	1.2	-	0.7	-
1444	α-Humulene	-	-	-	0.2
1450	α-Guainene	0.1	-	-	-
1451	(E)-β-Farnesene	-	t	0.1	0.2
1456	α-Patchoulene	0.1	-	-	-
1458	Germacrene-D	t	-	0.1	-
1469	α-Curcumene	-	1.4	-	0.2
1472	ar-Curcumene	0.2	-	1.0	-
1479	Zingiberene	1.3	1.5	1.0	0.5
1498	α-Selinene	-	-	0.1	-
1499	β-Bisabolene	0.2	0.5	-	0.2
1510	β-Curcumene	1.3	-	0.5	-
1515	β-Sesquiphellandrene	-	1.9	0.1	0.4
1526	Elimicin	2.0	-	-	0.1
1534	Geranyl butyrate	t	-	1.1	-
1543	cis-Sesquisabinene hydrate	t	-	-	-
1547	Germacrene-B	t	-	-	-
1552	(E)-Nerolidol	0.4	-	-	0.3
1561	ar-Turmerol	0.1	1.3	0.6	-
1567	Caryophyllene oxide	2.1	-	-	0.4
1578	cis-β-Elemene	0.1	-	-	-
1592	Virdifloral	1.7	-	t	-
1599	trans-Sesquisabinene hydrate	0.7	-	0.1	-
1611	Humuline epoxide II	1.9	-	0.7	-
1618	10-epi-γ-Eudesmol	0.1	-	0.1	-
1628	T-Cadinol	2.4	-	0.4	-
1639	β-Eudesmol	0.5	-	-	-
1651	ar-Turmerone	31.7	25.7	0.5	0.1
1656	α-Turmerone	12.9	32.0	0.5	0.3
1675	α-Bisabolol	0.2	-	t	-
1681	Germacrone	0.9	-	t	0.2
1692	β-Turmerone	12.0	18.4	0.1	t
1694	Curcuphenol	-	0.1	-	-
1696	Curdione	0.2	-	0.3	0.5
1716	1-Bisabolene	0.2	0.9	0.1	-
1723	Geranyl hexanoate	0.2	-	0.1	-
1750	(E)-α-Atlantone	1.5	1.1	0.1	-
1756	Furanodienone	0.8	-	0.2	-
1801	n-Heptyl salicylate	0.4	-	0.1	-
2057	Cinnamyl cinnamate	-	-	0.3	-

t = traces = (<0.1%), *as reported in previous literature[24]

identified in our oil and that of Bhutanese leaves, 26 constituents were common in both the oils. α-phellandrene, (9.1% and 18.2%), p-cymene (5.5% and 13.3%), 1,8-cineole (7.3% and 14.6%), terpinolene (8.8% and 11.6%) were the major constituents in both the oil, but their percentage did vary to a certain extent. It is interesting to note that caryophyllene (0.6% and 0.5%) was the only constituent which had similar composition.

On the other, hand perilla ketone (1.9% and 0.4%), carvacrol (0.6% and 0.1%), ar-turmerone (0.5% and 0.1%), β-elemene (1.2% and 0.2%), and camphene (0.8% and t) were five to eight times higher, while α-terpineol (1.4% and 0.9%), cis-sabinol (1.5% and 1.0%), α-turmerone (0.5% and 0.3%), zingiberene (1.0% and 0.5%) and thymol (0.7% and 0.2%) were 1.5 to 3.5 times higher in our oil than that of the Bhutanese oil. Curdione(0.3% and 0.5%), germacrone (t and 0.2%), β-sesquiphellandrene (0.1% and 0.4%), and sabinene (0.1% and 0.4%) were two to four times higher while α-pinene (0.1% and 2.6%) and β-pinene (0.2% and 7.2%) were 26 to 36 times higher in Bhutanese oil than in our oil.

It would be worth mentioning here that undecanol (7.1%), a major constituent in our leaf oil, was absent in the Bhutanese leaf oil.

The above variations in the percentage composition of Curcuma rhizome and leaf oils from Kanpur, India with those of Bhutanese oils may be due to the variation in the their ago climatic and geographical regions.

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