ANALYSIS OF THE VOLATILE CHEMICAL CONSTITUENTS OF TUMERIC (*CURCUMA LONGA* LINN: ZINGIBERACEAE)

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ABSTRACT

The volatile oil constituents of tumeric were extracted through exhaustive hydro-distillation and the individual chemical components identified using a gas chromatograph coupled with a mass spectrometer (GC/MS). Eleven components were identified, representing 87.2 % of the total oil composition with the tumerones comprising 80 % of the oil. It was found that ar-tumerone (33.6 %); â-tumerone (30.0 %) and á-tumerone (16.4 %) were the main constituents in the volatile oil extracts of tumeric while the other terpenes made up the balance.

Keywords: *Curcuma longa*; Zingiberaceae; tumeric; spice; essential oil; tumerone; curcumin.

INTRODUCTION

Tumeric (*Curcuma longa* Linn.; Zingiberaceae) is a perennial herb that grows up to a height of about 1 meter with comparably shorter stems and large oblong leaves. It bears short-branched rhizomes that are brownish-yellow in color and possess a distinct aromatic note. It is native to southern India but is now grown in most tropical and subtropical climatic zones of the world, and its distribution has been observed throughout Asia, Africa and South America. It has been the subject of extensive studies due to its medicinal and economic importance.

The rhizomes of tumeric have had a long tradition of use as food flavour, additive, preservative and colouring agent as well as in the Chinese and the Ayurvedic systems of medicine (Araujo and Leon 2001). Such preference for medicinal and condimental uses has been attributed to the presence of certain chemical constituents in the rhizome extracts. The main component of commercial interest in tumeric is curcumin and it's other derivatives. Curcumin is the principal chemical compound responsible for the yellow colour of tumeric and is also the active ingredient in the commercially available curry powder. It has been reported to show anti-inflammatory (Such 2002; Brag *et al.* 2003; Chainani 2003; Huang *et al.* 1992), anti-oxidant (Sacchetti *et al.* 2005; Unnikrishnan and Rao 1995; Reddy and Lokesh 1992; Sreejayan Rao 1994), anti-protozoan (Araujo *et al.* 1998, 1999), anti-bacterial (Chopra *et al.* 1941; Bhavani Shankar and Murthy 1979), anti-HIV (Mazumber *et al.* 1995; Eigner and Scholz 1999), anti-tumor (Kuttan *et al.* 1985; Kuttan *et al.* 1987; Huang *et al.* 1988, 1991; Narayan 2004; Lai and Roy 2004; Ji *et al.* 2004; Duvoix *et al.* 2005; Aratanechemuge *et al.* 2005; Hanif *et al.* 1997; Aggarwal *et al.* 2003) and hosts of other potent biological activities. The other curcumin derivatives ar-tumerone is anti-venom (Ferreira *et al.* 1992), demethoxycurcumin and bisdemethoxycurcumin have anti-oxidant properties (Unnikrishnan and Rao 1995) and sodium curcuminate is anti-inflammatory (Ghatak and Basu 1972).

The volatile constituents from the rhizomes of tumeric have been reported from different regions of the world to contain different chemical constituents as the main components. Such reports indicate the main constituents of the tumeric rhizomes to be á-curcumene and á-zingiberene (Hu *et al.* 1998), 1,8-cineole (Raina *et al.*, 2002) and the á- and â-tumerones (McCarron *et al.* 1995; Bansal *et al.*, 2002; Raina *et al.* 2002; Leela *et al.* 2002). The leaf essential oils of tumeric have also been extensively studied and reported to be composed of ñ-cymene (Garg *et al.* 2002), terpinolene (Oguntimein *et al.* 1990; Raina *et al.* 2002), myrcene (Bansal *et al.* 2002) and á-phellandrene (Leela *et al.* 2002; Behura *et al.* 2002) as the main constituents.

In an ongoing study to establish the volatile chemical constituents from the spice products of Papua New Guinea (PNG) (Rali *et al.* 2003; Wossa *et al.* 2005),

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we report herein the chemical constituents in the rhizome oil of tumeric obtained from the East New Britain Province.

MATERIALS AND METHODS

Representative tumeric rhizomes were obtained from Rabaul in the East New Britain Province of PNG. The essential oils from these samples were extracted by exhaustive hydro-distillation at the University of PNG laboratory using a modified all-glass standard distillation apparatus, and the pure oils obtained were dried over anhydrous magnesium sulphate. The oil was analyzed using a gas chromatograph coupled to a mass spectrometer (GC/MS) and the individual components identified.

The analyses of the oil constituents were as previously described (Wossa *et al.* 2005). The individual oil constituents were identified by their respective retention indices and confirmed by comparison to the mass spectral data of the authentic reference compounds or with the library of the published data (Adams 1995).

RESULTS AND DISCUSSIONS

The volatile oil from the fresh rhizomes of *Curcuma longa* afforded colorless oil in 0.61 % yield. The major constituents of the volatile oil were predominantly sesquiterpenes as outlined in Table 1, with ar-tumerone (33.6 %), â-tumerone (30.0 %) and á-tumerone (16.4 %) as the major constituent of the tumeric oil while other components made up the balance.

These results compliment the work previously reported (McCarron *et al.* 1995; Bansal *et al.* 2002; Leela *et al.* 2002; Raina *et al.* 2002) where tumerones are the main constituents. It further indicates that the tumerone contents from the tumeric obtained from Rabaul are higher (80.0 %) than that reported in literature from other regions of the world.

We also note, however, that some of the volatile components of *C. longa* reported in literature as major constituents but found to be in lesser amounts in our study include á-phellandrene, 1,8-cineole, ar-curcumene, á-zingiberene and â-sesquiphellandrene. Such variability in the composition of the essential oil constituents of tumeric further confirm an earlier postulation that the chemical compositions differ within species from different geographical localities due to the climatic and geographical conditions as well as the soil types and the age at harvest (Miyazaki and Taki 1955). An important factor that may also contribute to such variation in the chemical composition is the type of cultivars used and its unique genotypes that are further influenced by the local environmental conditions in which the cultivars are grown.

Our results indicate that the cultivars used in Rabaul produce high tumerone yields in the volatile oil and are therefore of commercial significance. Such high yields suggest the potential for large-scale cultivation and commercialization of this particular cultivar of tumeric as an agricultural commodity. Further, downstream processing of the rhizomes of tumeric to obtain these chemicals of importance through appropriate technology will increase market value, hence high economic returns. In realizing these prospects, it is worthy that further research are undertaken towards value added production of commodities.

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Table 1. Chemical composition in the volatile oil distillates of *Curcuma longa* L.

Chemical constituents	Retention indices	% Composition
á-phellandrene	1027	0.7
1,8-cineole	1058	1.7
ar-curcumene	1507	1.2
á-zingiberene	1519	1.2
â-sesquiphellandrene	1555	1.4
2-methyl-6-ñ-tolyl-2-hepten-4-ol	1659	1.0
â-tumerone	1703	30.0
ar-tumerone	1708	33.6
á-tumerone	1747	16.4

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