Chemical Composition of Leaf and Rhizome Oil of an Elite Genotype Curcuma longa L. from South Eastern Ghats of Orissa

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ABSTRACT
The present study reports the extraction of essential oil from leaf and rhizome of a commercially important cultivar of Curcuma longa L. (cv. Suroma) of south eastern ghat of Orissa using hydro-distillation and identification of its constituents through gas chromatography and mass spectrometry (GC-MS). The essential oil from fresh rhizomes showed ar-tumerone (49.76%) as a principal constituent. However, essential oil from leaf showed alpha-phellandrene (57.8%) as a major constituent.

Key words: Curcuma longa L., hydro-distillation, gas chromatography, mass spectrometry, ar-tumerone, alpha-phellandrene

INTRODUCTION

Turmeric (Curcuma longa L) belongs to the Zingiberaceae family grown in warm rainy regions of the world such as India, China, Indonesia, Jamaica and Peru[1]. It is widely used as a dietary spice, a dietary pigment and an Indian folk medicine for the treatment of various illnesses such as cough, wounds, rheumatism, sinusitis, digestive disorders etc.[2-5] The aroma of turmeric is due to its volatile oil which is an aromatic stimulant and carminative[6]. The essential oil of leaf and rhizome of Curcuma longa shows a wide range of biological activities in terms of antibacterial, antifungal, anticancer, insect repellent and anti snake venom activity[7-10]. Tumerone the major component of the rhizome oil is reported as insect repellent by[11] and also reported to have anti cancerous activity by[12].

India is the world’s largest producer and exporter of turmeric (90% of the world’s total production) and Orissa is 2nd largest producer of turmeric among all the states in India. Among all the high yielding varieties of turmeric from Orissa, suroma has high yield and curcumin content. This variety is mainly cultivated in the south east region of koraput district of Orissa and exported generally on the basis of high yield and high curcumin content. Though the composition of volatile oil of leaf and rhizome of turmeric from various geographical regions has been reported by several authors[13-16] yet, to the best of our knowledge no information is available on the constituents of essential oil of leaf and rhizome oil of suroma variety of Orissa. So it is desirable to find out the chemical constituents of both leaf and rhizome oil of cultivar suroma, which would likely influence the quality and usefulness of this variety. In this study, for the first time we assessed the quantitative and qualitative characteristics of the leaf and rhizome oil of the elite cultivar (suroma) through GC-MS analysis.

MATERIALS AND METHODS

Plant material

The rhizome of Curcuma longa (cv. suroma) were collected from the High Altitude Research Station Pottangi and grown in medicinal plant garden of Centre of Biotechnology, Bhubaneswar, Orissa (India). Fresh leaves and rhizomes were collected, washed under running tap water and were used immediately to extract the essential oils.

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ABSTRACT

The essential oil was extracted by hydro-distillation using cleveger’s apparatus (Boroglass) following the method of[17]. The fresh plant material leaves (100 g) and rhizomes (100 g) were chopped into small pieces and placed in a round-bottom flask separately suspended in distilled water. The apparatus was set at 40-45°C (3 hr) for leaf oil collection and at 50-60°C (8 hr) for rhizome oil collection by steam distillation. The essential oil layer above the water layer was separated and collected in a sterile eppendroff tube. Each essential oil extraction was running in triplicate.

Oil yields

The total amount of oil in each sample was calculated by following method. Yield percentages were recorded as dry weight basis in case of rhizome oil

\[
\text{Rhizome oil % yield (v/w) (dry weight) =} \frac{\text{volume of essential oils (ml)}}{\text{Weight of raw materials (g)}} \times 100\% \\
\text{Leaf oil % yield (v/w) (Fresh weight) =} \frac{\text{volume of essential oils (ml)}}{\text{Weight of raw materials (g)}} \times 100\% 
\]

GC-MS analysis

The component identification was achieved by the GC-MS analysis using HP 6890 series GC (Hewlett-Packard, USA) coupled with mass selective detector (MSD), H P 5973 series (Hewlett-Packard, USA). Helium was used as carrier gas and the sample was injected in splitless mode in a column HP 5 Phenyl methyl siloxane [25 µm (film thickness) x 320 µm (internal diameter) x 30 m (length of column)]. Mass spectra were acquired over a 40-400 atomic mass unit range. Temperature Programming: Initial temperature - 60°C, Ramp rate - 3°C/min, Final temperature – 243 °C. Run time – 61 min. The percentage compositions of the oil were computed from the GC peak areas without using any correction factors.

Identification of the components

Identification of the chemical constituents was based on comparisons of their retention indexes (RI) and mass spectra with the data given in the literature, National Institute of Standards and Technology (NIST), Wiley and our own created libraries[19, 13, 26-30].
RESULTS AND DISCUSSION

The yield of essential oil of leaf after hydro-distillation was 0.5% from fresh leaves, while rhizome yield was 1.2% from dried rhizomes. GC-MS analysis of essential oil of leaf revealed presence of 12 identified components accounting for 91.88% of total peak area in suroma plant of *C. longa*.

Major compounds in leaf oil were alpha-phellandrene (57.8%, mass spectra and structure showed in figure 1) followed by d-Terpinene (13.23%), tumerone (7.18%, mass spectra and structure showed in figure 2), 3-carene (3.69%), 1s-alpha-pinene (2.79%), curlone (2.54% mass spectra and structure showed in figure 3) beta-pinene (1.40%), a-terpineol (1.18%), alpha-nerolidol (0.59%), curcumene (0.58%), caryophyllene (0.56%, mass spectra and structure showed in figure 4, mass spectra and structure showed in figure 4) and alpha-farnesene (0.23%, mass spectra and structure showed in figure 5) Table-1. Alpha-phellandrene has also been reported as the major constituent of leaf oil of turmeric by different authors [18, 13, 20].

The turmeric leaf oil composition reported by different authors like [21] showed 53.4% alpha-phellandrene as a major constituent, [22] reported 57% and [23] reported 48 % alpha-phellandrene as a major constituent in the leaf oil of *C. longa*. The present study showed that suroma leaf oil with 57.8% alpha-phellandrene matched to a great extent in the percentage composition of its major constituent alpha-phellandrene in several turmeric types of different origin. A typical gas chromatogram of leaf and rhizome oil of cultivar suroma is shown in fig.1 and fig.2 respectively.

This result of GC-MS evaluation of essential oil of rhizome was compared with previous studies,[23] reported ar-tumerone (8.4%) in rhizome oil of *C. longa*, [24] reported ar -tumerone (18%), [25] reported ar-tumerone (6.4%)[23] reported ar-tumerone (16.7-25.7%) in rhizome oil of *C. longa*. Presence of significantly high percentage (49.76%) of ar-tumerone in the cultivar suroma will increase its demand and use in the national and international market as the high ar-tumerone content would increase the medicinal value of the oil.

### Table 1. Chemical composition of rhizome oil

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Oil constituents</th>
<th>MF</th>
<th>Area (%)</th>
<th>RI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Alpha-phellandrene</td>
<td>C_{10}H_{16}</td>
<td>2.79</td>
<td>969</td>
</tr>
<tr>
<td>2</td>
<td>Eucalyptol</td>
<td>C_{10}H_{16}</td>
<td>1.4</td>
<td>1059</td>
</tr>
<tr>
<td>3</td>
<td>Benzene, 1-(1,5-dimethyl-4-hexenyl)-4-methyl-1</td>
<td>C_{8}H_{16}</td>
<td>3.89</td>
<td>1524</td>
</tr>
<tr>
<td>4</td>
<td>Ar-tumerone</td>
<td>C_{15}H_{24}</td>
<td>49.75</td>
<td>1660</td>
</tr>
<tr>
<td>5</td>
<td>Curlone</td>
<td>C_{15}H_{24}</td>
<td>18.37</td>
<td>1582</td>
</tr>
</tbody>
</table>

MF: Molecular Formula, RI: Retention Index

### Table 2. Chemical composition of leaf oil

<table>
<thead>
<tr>
<th>Sl.No.</th>
<th>Oil constituents</th>
<th>MF</th>
<th>Area (%)</th>
<th>RI</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Is-alpha-pinene</td>
<td>C_{10}H_{18}</td>
<td>2.79</td>
<td>948</td>
</tr>
<tr>
<td>2</td>
<td>Beta-pinene</td>
<td>C_{10}H_{18}</td>
<td>1.4</td>
<td>943</td>
</tr>
<tr>
<td>3</td>
<td>Alpha-phellandrene</td>
<td>C_{13}H_{20}</td>
<td>57.8</td>
<td>969</td>
</tr>
<tr>
<td>4</td>
<td>3-carene</td>
<td>C_{10}H_{16}</td>
<td>3.69</td>
<td>948</td>
</tr>
<tr>
<td>5</td>
<td>(+)-4-Carene</td>
<td>C_{18}H_{28}</td>
<td>13.23</td>
<td>919</td>
</tr>
<tr>
<td>6</td>
<td>?-terpinene</td>
<td>C_{18}H_{32}</td>
<td>1.18</td>
<td>1440</td>
</tr>
<tr>
<td>7</td>
<td>Caryophyllene</td>
<td>C_{15}H_{24}</td>
<td>0.56</td>
<td>1494</td>
</tr>
<tr>
<td>8</td>
<td>1,6,10-Dodecahexatriene, 7,11-dimethyl-3-methylene-(Z)-</td>
<td>C_{22}H_{34}</td>
<td>0.58</td>
<td>1440</td>
</tr>
<tr>
<td>9</td>
<td>Alpha-farnesene</td>
<td>C_{15}H_{24}</td>
<td>0.23</td>
<td>1458</td>
</tr>
<tr>
<td>10</td>
<td>1,3-Cyclohexadiene,6-(1,5-dimethyl-4-hexenyl)-2-methyl-1-[S-(R*,S*)-</td>
<td>C_{22}H_{34}</td>
<td>0.70</td>
<td>1451</td>
</tr>
<tr>
<td>11</td>
<td>Tumerone</td>
<td>C_{18}H_{30}</td>
<td>7.18</td>
<td>1616</td>
</tr>
<tr>
<td>12</td>
<td>Curlone</td>
<td>C_{15}H_{24}</td>
<td>2.54</td>
<td>1582</td>
</tr>
</tbody>
</table>

MF: Molecular Formula, RI: Retention Index

Figure-1: Mass spectrum and structure of alpha-Phellandrene

Figure-2: Mass spectrum and structure of Ar-tumerone
CONCLUSION:

The ever increasing demand of the turmeric because of its wide-ranging use in the food, pharmaceutical and cosmetic industries, needs the chemical characterization of the essential oil of leaf and rhizome oil of turmeric (suroma) cultivar. The present study for the first time clearly established the significance and usefulness of the leaf and rhizome oil of suroma cultivar and at the same time adding value to agricultural products. In this regard, it is advisable to use methods for the assessment of biological activities of the essential oil that not only highlight aromatic or preservative activities but also correlate with functional properties potentially useful for pharmaceuticals, nutritional and cosmetic applications.

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REFERENCES:

12. Yongkyu Lee., Activation of apoptotic protein in U937 cells by a component of turmeric oil, BMB reports. Department of Food and Biotechnology, Dongseo University, Busan, 2008, 613-716.


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