PART III

CHEMICAL EXAMINATION OF THE ESSENTIAL OIL OF

SPHARENTHUS INDICUS
CHEMICAL EXAMINATION OF THE ESSENTIAL

OIL OF SPHERENTHUS INDICUS.

Spharenthus indicus (Hindi - gorakhdunl, Telugu - bodasoram, Tamil - kottakaranlai) a branched herb, 30 cm high of the natural order compositae is found throughout India in marshy places and in rice fields. The herb has a bitter sharp flavour with a bad taste and is used in indigestion, bronchitis, diseases of the spleen, and asthma. The roots and the seeds are considered as anthelminitic. The roots are powdered and given as tonic. The juice of the fresh leaves is mixed with a little milk and sugar and drunk as a cure for cough.

Much work has not been attempted on this plant. Its essential oil has been studied to some extent by Baslas\(^1\). The reason for not attempting to work on this plant may be the poor yield of the essential oil.

An attempt to study the essential oil of this plant was made in 1938 at the Indian Institute of Science, Bangalore but no substantial results were achieved.

Since, Baslas had reported in his work, two unknown compounds, whose structures could not be elucidated due to the non-availability of the fraction the present author chose the plant for chemical examination.

The essential oil obtained (0.02%) by the steam and water distillation of the shade dried leaves collected from Tambaram near Madras (India) as a cherry coloured viscous liquid, having a

\(\text{Oil}\)

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sweet small gave the following constants:

\[
\begin{align*}
D_{30} & \quad 0.9935 \\
\eta_{30} & \quad 1.5055 \\
[\alpha]_{D}^{30} & \quad \pm 0 \text{ (optically inactive)}
\end{align*}
\]

Acid value \quad 5.789
Saponification value \quad 75.84

Many of the observations made by Baslas have been found to be missing in the essential oil distilled by the present author.

The investigations of Baslas are compared with those of the present author in Table A and B below:

**Table A**

<table>
<thead>
<tr>
<th></th>
<th>Essential oil distilled by Baslas (loc. cit)</th>
<th>Essential oil distilled by the present author</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>0.01%</td>
<td>0.02%</td>
</tr>
<tr>
<td>Density</td>
<td>0.9267 at 20°</td>
<td>0.9935 at 29°</td>
</tr>
<tr>
<td>Refractive index</td>
<td>1.5112 at 20°</td>
<td>1.5055 at 30°</td>
</tr>
<tr>
<td>Optical rotation$</td>
<td>3° 30'</td>
<td>optically inactive</td>
</tr>
<tr>
<td>Acid value</td>
<td>2.623</td>
<td>5.789</td>
</tr>
<tr>
<td>Ester value</td>
<td>42.62</td>
<td>75.84</td>
</tr>
</tbody>
</table>
### Table B

<table>
<thead>
<tr>
<th>Constituents of the essential oil of Baslas (loc.cit.)</th>
<th>Constituents of the essential oil of the author</th>
</tr>
</thead>
<tbody>
<tr>
<td>ocimene</td>
<td>ocimene</td>
</tr>
<tr>
<td>α-terpinene</td>
<td>α-terpinene</td>
</tr>
<tr>
<td>cadinene</td>
<td>phellandrene</td>
</tr>
<tr>
<td>methyl chavicol</td>
<td>β-caryophyllene</td>
</tr>
<tr>
<td>p-methoxy cinnamaldehyde</td>
<td>p-methoxy cinnamaldehyde</td>
</tr>
<tr>
<td>citral</td>
<td>citral</td>
</tr>
<tr>
<td>geranyl acetate</td>
<td>geranyl acetate</td>
</tr>
<tr>
<td>geraniol</td>
<td>geraniol</td>
</tr>
<tr>
<td>α-ionone</td>
<td>α-ionone</td>
</tr>
<tr>
<td>spheranthene (unknown)</td>
<td>unknown hydrocarbon</td>
</tr>
<tr>
<td>spheranthol (unknown)</td>
<td></td>
</tr>
</tbody>
</table>

A perusal of the above tables shows the differences in the two oils which probably are due to the different climatic and soil conditions under which the plants have been grown.

Methyl chavicol which has been reported as the major component of the essential oil worked up by Baslas has been found to be absent in the present oil. So is the case with geraniol.

The present investigations having been made by the separation of constituents using chromatography instead of fractionation as utilized by Baslas, seem to be more reliable and on a more firm
foundation. Thus constituents like α-phellandrene, β-caryophyllene, and eugenol have been found to be present in the essential oil investigated.

Studies on the structure of a new sesquiterpenic hydrocarbon (also isolated and reported earlier by Baslas) have revealed it to be a precursor of azulene. The present author could, however, not detect the presence of the sesquiterpenic alcohol as mentioned by Baslas. The details of the investigations are given in the experimental portion.

**EXPERIMENTAL**

Steam and water distillation of the shade dried leaves of Sphagnetic indicus in a galvanised still gave a cherry coloured viscous oil in an yield of 0.02% with a faint odour reminding that of clove oil. The oil had the following physical and chemical properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>0.02%</td>
</tr>
<tr>
<td>Density at 30°</td>
<td>0.9935</td>
</tr>
<tr>
<td>Refractive Index at 30°</td>
<td>1.5055</td>
</tr>
<tr>
<td>Optical rotation</td>
<td>optically inactive</td>
</tr>
<tr>
<td>Acid value</td>
<td>5.789</td>
</tr>
<tr>
<td>Ester value</td>
<td>75.84</td>
</tr>
</tbody>
</table>

Chromatography of the oil: Chromatography of the oil (20 gm) dissolved in light petroleum (60-80) over a column (4 x 200 cm) of silica gel and kieselguhr (800 g, 4:1) and elution with light
petroleum, followed by benzene and ethyl acetate gave the following fractions (Table I):

<table>
<thead>
<tr>
<th>Fraction No.</th>
<th>Wt. of fraction in g.</th>
<th>Eluant</th>
<th>Volume in litres</th>
<th>No. of spots</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7.79</td>
<td>Light petroleum (60-80)</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>2</td>
<td>9.64</td>
<td>Benzene</td>
<td>3.2</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>1.47</td>
<td>Ethyl acetate</td>
<td>1.5</td>
<td>1</td>
</tr>
</tbody>
</table>

All the above fractions were rechromatographed over alumina grade I, and successive elution with light petroleum, benzene, and ethyl acetate.

7.79 g of the first fraction (table I) was dissolved in light petroleum (60-80, 10% ml) and chromatographed (table II) over a column of alumina grade II (780 g, ratio 1 : 100) and similar fractions were combined and identified together.
Table II

wt. of the oil taken 7.79 g.
wtk of the adsorbent 780 g.

<table>
<thead>
<tr>
<th>Fraction No.</th>
<th>Wt. in gms.</th>
<th>Eluant</th>
<th>$n_D$</th>
<th>No. of TLC Spots</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.2834</td>
<td>Light petroleum</td>
<td>1.4853</td>
<td>one spot</td>
</tr>
<tr>
<td>2</td>
<td>0.2134</td>
<td>&quot;</td>
<td>1.4853</td>
<td>&quot;</td>
</tr>
<tr>
<td>3</td>
<td>0.1733</td>
<td>&quot;</td>
<td>1.4853</td>
<td>&quot;</td>
</tr>
<tr>
<td>4</td>
<td>0.9075</td>
<td>&quot;</td>
<td>1.4929</td>
<td>two spots</td>
</tr>
<tr>
<td>5</td>
<td>0.8148</td>
<td>&quot;</td>
<td>1.4933</td>
<td>&quot;</td>
</tr>
<tr>
<td>6</td>
<td>0.1685</td>
<td>&quot;</td>
<td>1.4938</td>
<td>&quot;</td>
</tr>
<tr>
<td>7</td>
<td>0.9793</td>
<td>&quot;</td>
<td>1.5107</td>
<td>one spot</td>
</tr>
<tr>
<td>8</td>
<td>0.6353</td>
<td>&quot;</td>
<td>1.5108</td>
<td>&quot;</td>
</tr>
<tr>
<td>9</td>
<td>0.4150</td>
<td>&quot;</td>
<td>1.5110</td>
<td>&quot;</td>
</tr>
<tr>
<td>10</td>
<td>0.9625</td>
<td>&quot;</td>
<td>1.5110</td>
<td>&quot;</td>
</tr>
<tr>
<td>11</td>
<td>0.0447</td>
<td>&quot;</td>
<td>1.5110</td>
<td>&quot;</td>
</tr>
<tr>
<td>12</td>
<td>0.0220</td>
<td>&quot;</td>
<td>1.5110</td>
<td>&quot;</td>
</tr>
<tr>
<td>13</td>
<td>0.1122</td>
<td>Light petroleum + CCl₄</td>
<td>1.4775</td>
<td>mixture</td>
</tr>
<tr>
<td>14</td>
<td>0.0296</td>
<td>&quot;</td>
<td>1.4752</td>
<td>&quot;</td>
</tr>
<tr>
<td>15</td>
<td>0.2012</td>
<td>CCl₄</td>
<td>1.4742</td>
<td>one spot</td>
</tr>
<tr>
<td>16</td>
<td>0.1212</td>
<td>&quot;</td>
<td>1.4743</td>
<td>&quot;</td>
</tr>
<tr>
<td>17</td>
<td>0.1060</td>
<td>&quot;</td>
<td>1.4745</td>
<td>&quot;</td>
</tr>
<tr>
<td>18</td>
<td>0.2933</td>
<td>&quot;</td>
<td>1.4996</td>
<td>&quot;</td>
</tr>
<tr>
<td>19</td>
<td>0.9946</td>
<td>&quot;</td>
<td>1.5010</td>
<td>&quot;</td>
</tr>
<tr>
<td>20</td>
<td>0.0692</td>
<td>&quot;</td>
<td>1.5010</td>
<td>&quot;</td>
</tr>
<tr>
<td>21</td>
<td>0.0672</td>
<td>&quot;</td>
<td>1.5010</td>
<td>&quot;</td>
</tr>
<tr>
<td>22</td>
<td>0.0583</td>
<td>&quot;</td>
<td>1.5010</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
Fractions (i) to (iii) Table II.

These were found to be identical (TLC), and tested along with the similar fractions obtained from the rechromatography of the combined fractions (iv to vi, as they gave a positive ferrox test showing the presence of hydrocarbons) on a column of silica gel impregnated with silver nitrate (15%).

Preparation of silver nitrate impregnated silica gel

An aqueous solution of silver nitrate (15 g of silver nitrate in 16 ml of water) was diluted with 240 ml of alcohol and to this was added silicagel (100 g.) and the mixture shaken for 8 hr. in dark coloured bottles. Removal of the aqueous alcohol under reduced pressure and drying in a vacuum desiccator gave the silica gel impregnated with silver nitrate which was stored in dark coloured bottles covered with black paper as a protection against light.

1.85 g of the fractions (4 -6, table II) was dissolved in light petroleum (60-80°) and chromatographed (table III) over silver nitrate impregnated silica gel column (100 g., ratio 1:50) and eluted with light petroleum.

Table III

<table>
<thead>
<tr>
<th>Fraction No.</th>
<th>Wt. in gms.</th>
<th>Eluant</th>
<th>n\textsubscript{D}</th>
<th>No. of TLC spots</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.5376</td>
<td>Light petroleum</td>
<td>1.4851</td>
<td>one</td>
</tr>
<tr>
<td>2</td>
<td>0.0127</td>
<td>&quot;</td>
<td>1.4854</td>
<td>&quot;</td>
</tr>
<tr>
<td>3</td>
<td>0.0372</td>
<td>&quot;</td>
<td>1.4740</td>
<td>&quot;</td>
</tr>
<tr>
<td>4</td>
<td>0.9732</td>
<td>&quot;</td>
<td>1.4737</td>
<td>&quot;</td>
</tr>
<tr>
<td>5</td>
<td>0.2832</td>
<td>&quot;</td>
<td>1.4735</td>
<td>&quot;</td>
</tr>
</tbody>
</table>
Fractions (i) to (iii) Table II, and fractions (i) and (ii) Table III (Ocimene).

These were found to be identical, and hence mixed together. The combined fractions had the following constants:

\[ D^{25}_{25} \quad 0.7852 \]
\[ 25 \quad 1.4551 \]

The fraction gave a positive ferrox test showing it to be a hydrocarbon.

(Found: C, 87.78; H, 11.72. Calc. for C_{10}H_{16}; C, 88.23; H, 11.77%; m.wt. 137.2; C_{10}H_{16} requires m.wt. 136).

Preparation of bromo derivative

0.5 g of the fraction was at first reduced to dihydromyrcene by refluxing with sodium and alcohol for 3 hr. A pale yellow liquid was got. After removal of alcohol, 5 ml of ether was added to it and after cooling the mixture in ice, an ice cold solution of bromine in ether slowly added. A white crystalline solid precipitated out, which on recrystallisation from alcohol gave a m.p. and mixed m.p. 86\(^\circ\). It was thus identified to be ocimene.

The fraction was further confirmed by Co TLC with an authentic specimen of ocimene.

I.R. of ocimene

Finally it was confirmed by comparison of its I. R. data with an authentic specimen (figs. i and ii).

Fractions (iii to v) Table III (\(\alpha\)-phellandrene)

The combined fraction was purified by rechromatography over a column of alumina grade I and elution with petroleum ether.
Removal of the solvent gave a liquid, b.p. 173°; \(D_{25}^2\) 0.8411; \(n_D^{25}\) 1.4731.

**Preparation of nitrosite**

0.5 g. of the fraction was dissolved in 1.5 ml of light petroleum. Sodium nitrite solution (50%) was slowly added gently shaking it after each addition. About 1 ml of glacial acetic acid was gradually added to the mixture which was then kept aside for an hour. A crystalline solid separated which on recrystallisation from chloroform gave a m.p. and mixed m.p. of 118° showing the presence of \(\alpha\)-phellandrene.

**Preparation of maleic anhydride adduct**

0.5 g. of the fraction was refluxed with 0.25 g. of maleic anhydride in 5 ml of benzene for 1 hr. The excess of benzene was distilled off. Light petroleum (40-60) was added to precipitate the maleic anhydride adduct. The adduct on recrystallisation gave a m.p. and mixed m.p. 122° confirming the presence of \(\alpha\)-phellandrene.

The fraction was further confirmed by Co.TLC with an authentic specimen of \(\alpha\)-phellandrene.

**Fractions (vii) to (xii) Table II (cadinene)**

These being identical were mixed together and purified by chromatography over a column of alumina grade I and elution with light petroleum.

Removal of the solvent gave TLC pure fraction, b.p. 258°, \(D_{25}^2\) 0.9061; \(n_D^{25}\) 1.5110.

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Colour reaction of Wallach

4 to 5 drops of the fraction was dissolved in glacial acetic acid (1 ml) to which a few drops (4) of concentrated sulphuric acid were added and the mixture shaken well. The solution at first turned green, changed to blue on keeping, and finally turned red on warming, showing the presence of cadinene.

Formation of a nitrochloride

1 g. of the fraction was dissolved in 1 ml of glacial acetic acid and to it was added 1 ml of ethyl nitrite and cooled well. To this mixture 1 ml of concentrated hydrochloric acid was added dropwise, when a crystalline solid separated out which on recrystallisation with acetone gave m.p. and mixed m.p. 96°C.

Formation of dichloride

4 to 5 ml of ether was added to the fraction (1 g) and cooled in ice. Dry hydrogen chloride gas was bubbled through it for half an hour and the mixture allowed to stand overnight. Crystals of dihydrochloride separated out which on recrystallisation from ether gave a m.p. and mixed m.p. 117.5°C.

I.R. spectrum.

The I.R. spectrum finally confirmed the fraction to be cadinene (fig. 3)

Fractions (xv) to (xvii) Table II (α-terpinene)

It had the following constants:

\[
\begin{align*}
D^25 \quad & 0.8416 \\
{n_D}^25 \quad & 1.4745
\end{align*}
\]


Formation of a nitrosite

The fraction formed a nitrosite (p. 67) which on crystallisation gave m.p. and mixed m.p. 153°.

Co TLC with the authentic specimen

The fraction was further confirmed by Co TLC with an authentic specimen of α-terpinene.

Fractions (xviii) to (xiv) Table II (β-caryophyllene)

The combined fraction gave boiling point 258°; D₂⁵ = 0.9184; nD₂⁵ = 1.5010.

The fraction had a peculiar smell resembling that of the oil of cloves. The fraction, however, did not respond to the tests for eugenol.

Formation of nitrosochloride

The fraction formed a nitrosochloride which on recrystallisation gave a m.p. and mixed m.p. 158° showing to be β-caryophyllene.

Formation of nitrosite

The fraction also formed a nitrosite which gave a m.p. and mixed m.p. 114°.

Characterisation with TLC

The fraction (15%) gave an identical Rf value and blue spot on a silver nitrate impregnated silica gel TLC plate, as was obtained with an authentic specimen of β-caryophyllene.

Rechromatography of the benzene fraction (fraction ii, table I)

9.64 g. of the fraction was dissolved in light petroleum (10 ml., 60-80°) and rechromatographed (table IV) over alumina grade II (1000 gm., ratio 1 : 100). The identical fractions (TLC) were mixed and identified together.

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alcoholic KOH for an hour. The hydrolysed ester on being worked in the usual way gave tests for the presence of geraniol (alcohol) and acetate (acid). The fraction was further confirmed to be geranyl acetate by Co TLC with an authentic specimen.

Fractions (vii to xiii) Table IV (p-methoxy cinnamaldehyde)

These are found to be identical. Removal of the solvent from the mixed fraction gave a white crystalline solid with m.p. and mixed m.p. 55° and thus identified to be p-methoxy cinnamaldehyde.

Formation of an oxime

0.5 g. of the solid compound obtained above was dissolved in alcohol (1 ml.) to which hydroxyl amine hydrochloride (0.5 g.) sodium acetate (1 g.) and water (2 ml.) were added. The solution on being refluxed and cooled gave a crystalline solid which when recrystallised with alcohol gave a m.p. and mixed m.p. 152°.

Formation of semicarbazide

A dilute solution of the fraction (0.5 g. dissolved in 3 ml of alcohol) was taken to which semicarbazide hydrochloride (1 g.) sodium acetate (1 g.) and water (2 ml.) were added. The mixture on being refluxed and cooled gave a crystalline solid which on recrystallisation from alcohol gave a m.p. and mixed m.p. 219°.

Fractions (xvi) to (xxi) Table IV (citral)

The combined fraction was purified by chromatography over alumina grade I and elution with benzene. The purified fraction gave the following constants:

\[ D_{25}^{25} = 0.8871 \]
\[ n_D^{25} = 1.4865 \]

The fraction had a characteristic lemon like odour.

10. Ibid.
Colour reaction for citral

A dilute solution of the fraction was prepared in methanol. To this one drop of 1% alcoholic methylene blue (freshly prepared), 10 ml of sodium hydroxide (0.1 N) were added. A blue solution was formed which later turned pink showing the presence of citral.

Characterisation on a TLC plate

Procedure

The above fraction was confirmed by Co TLC with an authentic specimen of citral. Both produced a yellow spot with identical Rf values (characteristic of citral). On spraying the TLC plate with 2:4 dinitro phenylhydrazine reagent (0.4% 2:4 D.N.P. in 2 N HCl).

Preparation of semicarbazone

A dilute solution of the fraction (0.5 g., in 3 ml of glacial acetic acid) was taken to which a solution of semicarbazide (0.5 g in 2 ml water) and sodium acetate (2 g) were added. On refluxing and cooling, a white crystalline product separated out, which on recrystallisation from alcohol gave m.p. and mixed m.p. 166°.

I.R. Spectrum: The fraction was finally confirmed by its I.R. spectrum (Fig. iv)

Fractions (xxii) to (xxv) table IV (unknown hydrocarbon)

The fraction gave a positive p ferrox test, showing it to be a hydrocarbon and gave the following constants:

\[
\begin{align*}
p_{25} & = 0.9075 \\
\ \quad n_D & = 1.4996
\end{align*}
\]

(Found: C, 88.88; H, 11.79. Calc. for C_{15}H_{24};
C, 88.24; H, 11.76%; m. wt. 201. C_{15}H_{24} requires
m. wt. 204)

It was thus confirmed to be a sesquiterpenic hydrocarbon.

Attempts were made to prepare hydrochloride, bromide,
and nitrosochloride derivatives of the sesquiterpene. But no solid
derivative was got. With bromine in chloroform, however, there was
a peculiar change in the colour.

**Colour reaction**

The sesquiterpene with bromine in chloroform decolourised
bromine solution giving a colourless solution at first, which
later changed to green, blue and finally violet. This showed that
the sesquiterpene may be a precursor of azulenes.

More of the sesquiterpene hydrocarbon was isolated by
fractionating the original oil (40 g) under reduced pressure (10 mm),
when the fraction b.p. 126-129° was found identical with the above
fraction. It was purified by chromatography over a column of
alumina and elution with light petroleum. Removal of the solvent
gave a liquid, b.p. 127-129°/10 mm; \( \varepsilon_{25}^{25} \) 0.9079; \( n_25^\circ \) 1.4984.

**Dehydrogenation with selenium**

2 g of the fraction was refluxed with 5 g of selenium
for 10 hr. at a temperature 300-310° and later distilled off
under reduced pressure when a blue distillate was got. The
distillate was dissolved in light petroleum (10 ml) and shaken
with syrupy phosphoric acid (3 ml; d. 1.75) till the solvent layer
became practically colourless. Addition of water (ice-cold) and
extraction with ether, gave a blue coloured strongly smelling liquid suspected to be an azulene.

**Preparation of picrate of the azulene**

The azulene was dissolved in a small quantity of alcohol and to this added an alcoholic solution of picric acid (0.5 g). The picrate formed, on recrystallisation with ethyl acetate gave a m.p. and mixed m.p. 122° showing it to be S-guaiazulene.

**Fraction (xxvi) to (xxxiv) Table IV (α-ionone)**

The mixed fraction, purified by chromatography over a column of alumina grade I and elution with chloroform gave after removal of the solvent a fraction $D^2_{25}$ 0.9287; $n^2_D$ 1.4990. It had a peculiar odour of the lily of the valley.

**Preparation of 2:4-dinitrophenyl hydrazone**

0.5 g of the fraction was dissolved in 95% alcohol (10 ml). Freshly prepared 2:4 D.N.P. solution in alcohol was added to it and the resulting mixture allowed to stand at room temperature. After 5 to 10 min., crystals of 2:4-dinitrophenylhydrazone appeared. Recrystallisation with alcohol gave a product with m.p. and mixed m.p. 142°. It was then identified to be α-ionone.

**I.R. studies**

The infra-red spectrum (fig. 7) of the fraction was found superimposable on that of an authentic specimen of α-ionone and hence confirms its identity.

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Preparation of tetrabromo derivative

The fraction gave a tetrabromo derivative with bromine in ether, which on recrystallisation gave m.p. and mixed m.p. 117°.

Formation of phenyl urethane

The fraction also formed a phenyl urethane with phenyl isocyanate which on recrystallisation from light petroleum (60-80) gave a product with m.p. and mixed m.p. 97°.

The fraction was finally confirmed by Co TLC with an authentic specimen of eugenol.

SUMMARY AND CONCLUSION

1. The essential oil of spharenthus indicus has been obtained as a cherry coloured viscous liquid from the leaves and soft stems in a yield of 0.02% by steam and water distillation.
2. The oil has a characteristic sweet rose-like odour, together with a faint note of clove oil.
3. A new sesquiterpenic hydrocarbon, precursor of S-guaiazulene has been isolated from the oil.
4. In addition to the previously recorded constituents of the oil, the presence of α-phellandrene, β-caryophyllene and eugenol has been detected.
5. The essential oil has been found to have the following

percentage composition which is different from that reported earlier by Basias.

<table>
<thead>
<tr>
<th>Compounds</th>
<th>percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>cadinene</td>
<td>15.29</td>
</tr>
<tr>
<td>(\alpha)-ionone</td>
<td>12.55</td>
</tr>
<tr>
<td>(\beta)-caryophyllene</td>
<td>7.42</td>
</tr>
<tr>
<td>(p)-methoxy cinnamaldehyde</td>
<td>7.40</td>
</tr>
<tr>
<td>eugenol</td>
<td>6.95</td>
</tr>
<tr>
<td>(\alpha)-phellandrene</td>
<td>6.99</td>
</tr>
<tr>
<td>ocimene</td>
<td>6.10</td>
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<td>citral</td>
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<td>2.24</td>
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<tr>
<td>hydrocarbon</td>
<td>5.30</td>
</tr>
</tbody>
</table>

6. Quite a few medicinal properties have been ascribed to the leaves of the plant, which are likely to be more prominent in the essential oil and hence its utility.

* * * * *