Chapter-5

_Cymbopogon nardus_
CYMBOPOGON NARDUS LINN. (NON RENDLE)

(POACEAE)

Syn. Andropogon nardus Linn.

Introduction

Cymbopogon is a genus of about 120 species of grasses, distributed in the Old World tropics. Most of them are aromatic and some yield essential oils of commercial importance. The identification and classification of the species are difficult, not only because they hybridize freely and produce numerous transition forms, but also because they often do not flower at all. (Handa and Kaul, 1996)

The composition of the essential oils is not necessarily characteristic of the species. Morphologically indistinguishable grasses yield oils differing widely in chemical composition and properties as in the case of Motia and Sofia varieties of C. martini. On the other hand, distinct species yield oils of almost identical chemical composition as in the case of lemon grass oils from C. citratus and C. flexuosus.

Vernacular Names

<table>
<thead>
<tr>
<th>Language</th>
<th>Vernacular Name</th>
</tr>
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<tr>
<td>Hindi</td>
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<td>Usadhana</td>
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<td>Punjabi</td>
<td>Khavai</td>
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<td>Burma</td>
<td>Singoumia</td>
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(Anonymous, 1950)
Distribution

It is distributed throughout the hotter parts of India, Burma, Malay Peninsula, Sri Lanka, tropical Asia, Africa and Australia. The plant has been cultivated in Java since 1890. In 1912 the plant was introduced into Formosa.

Commercially important essential oils derived from these grasses are: Indian lemon grass oil obtained from *C. flexuosus*, west Indian lemon grass oil obtained from the Motia variety of *C. martini*, and citronella oil obtained mostly from the Lena Batu variety of *C. nardus*. The oil obtained from *C. coloratus* is included among the lemon grass oil. Ginger grass oil derived from the Sofia variety of *C. martini* is inferior to palmarosa oil and is of minor commercial importance (Anonymous, 1950).

Morphology

It is a grass; 1.5-2.1 m high, copiously branched above and forming a large decompound nodding panicle. Culms up to 10 mm in diameter at the base, solid, pale polished, with black finely pubescent or glabrescent nodes; leaves narrow with conspicuous white midrib, lower about 15 mm wide, upper cauline rarely over 9 mm wide, narrowed to the base, apex filiform, glaucous beneath, glabrous except sometimes at top of sheath, with scabrous margins; ligule scarious, 2-2.5 mm long, glabrous or ciliate. Panicle ultimate branches strict with 2-3 peduncles and spathules from each spathe; spathules 10 mm to about 2.5 mm, peduncles of spatheoles filiform 13-18 mm very shortly exerted from the spathe; spikes soon strongly reflexed on their common 10 mm, long peduncle, base swollen ciliate, spikes soon strongly reflexed on their common 10 mm, long peduncle, base swollen ciliate, spikes 10-13 mm long unequally pedicelled, joints and pedicles rather slender 2-2.25 mm not elavate (tip only dilated and toothed), villous, sessile spikelet, not tightly squeezed between joint and pedicel not covered by their hairs, 4-5 mm long, glume 1 oblong-lanceolate, flat or slightly concave below, hyaline and nerveless or with 2 green nerves between the keels which are not or very narrowly winged above the middle, scabrous and slightly excurrent, proper margins inflexed throughout (Kirtikar and Basu, 1994).
Chemical Constituents

The average yield of essential oil from *C. nardus* is 0.22-0.44% on air-dry grass. The main constituents of oil are geraniol and citronellal, the percentage of these vary from place to place, e.g., Ceylon (Sri Lanka) variety contains total geraniol 55-65% and aldehyde as citronellal 7-15%, Java variety yields 80-92% of total geraniol and 34-46% of aldehyde as citronellal, Formosa variety yields 84.2% of total geraniol and 45.1% aldehyde as citronellal. Guatemala variety yields 85-97% of total geraniol and 28-45% of aldehyde as citronellal and Honduras variety furnishes 85-91% of total geraniol and 30-45% of aldehyde as citronellal. Java citronella oil is far superior to the Ceylon oil due to high percentage of geraniol and citronellal (Thibaud, 1954).

The volatile constituents 1-α-thujene, 1-α-pinene, 1-camphene 1-limonene, 1-borneol and 1-α-terpineol (Chakravarti and Bhatacharya, 1953; 1954), γ-cadinene and elemicin (Ghatgey et al., 1956) are reported in Malabar lemon grass.

In Java Citronella oil, the following volatile constituents are reported (i) alcohols, e.g., isobutyl alcohol, isoamyl alcohol, 2-hexenol, n-hexanol, citronellol, geraniol, (ii) aldehydes, e.g., isovaleraldehyde, furfural, benzaldehyde, citronellal, citral, vanillin, (iii) ketones, e.g., methyl heptenone, d-l-methyl-3-cyclohexanone, (iv) esters, e.g., geranyl butyrate, citronellyl citronellate, (v) phenols and phenolic ethers, e.g., eugenol, (γ-cadinol, (vi) terpenes e.g., 1-limonene, dipentene, (vii) oxides, e.g., dicitronelloxide (viii) sesquiterpene alcohols, e.g., elemol, β-or γ-cadinol, cymbopogol (Thibaud, 1954).

Malabar lemon grass oil appears to be very much similar to the oil from Inchi grass. Borneol, 1-camphene, 1-limonene, 1-terpineol and sesquiterpenes including a tertiary alcohol are reported in Inchi grass oil (Chakravarti et al., 1954).

The Ceylon variety when propagated in Jammu (300 m) yielded the volatile constituents 1-camphene, d-citronellal, geraniol, geranyl butyrate and d-cadinene (Paul et al., 1960). *C. nardus* cultivated at Lucknow, gave 46.4% total alcohol (as geraniol), 39.95% geraniol and 8 total aldehydes (as citronellal) (Virmani and Datta, 1965).
This species when collected from other place gave total alcohols (as geraniol) 38.7%. Primary alcohol (as geraniol) 5.8% and aldehydes (as citronellal) 9.9%; free acids, isocapric, isovaleric, butyric, propionic acids; aldehydes which were identified as d-citronellal, citral, isovaleraldehyde and pelargonaldehyde; n-heptyl alcohol, geraniol and citronellol in free state; esters, acetates, propionates, butyrates and isovalerates of geraniol and citronellol were also reported (Gulati and Sadgopal, 1972).

β-pinene (15%), limonene (28%), methyl heptenone (3%), α-phellendrene (16.25%), citronellal (5.5%), camphene (0.25%), linalool (8%), citronellol (6%), geranyl acetate (7%), nerol (3%) and geraniol (8%) were reported in C. nardus var Stracheyi. (Mathela and Sinha, 1978). Citronellal (32.0%), citronellol (14.4%) and geraniol (20.1%) were obtained from Cymbopogon species of Bangladesh (Manzoor-i-Khuda et al., 1984).

**Medicinal Uses**

The infusion of the leaves is used as a stomachic and carminative. The oil possesses stimulant, carminative, antispasmodic and diaphoretic properties. It is credited as rubefacient and widely in perfumery, for scenting soaps, varnishes, insecticides, spraying liquids, disinfectants and shoe polishes. In Cambodia, the flowers are considered as bechic and diaphoretic, whereas roots are reputed as a diuretic, sudorific, anti-periodic (Kirtikar and Basu, 1994).

*C. nardus* var. *Stracheyi* contains high content of the essential oil for which it possesses antibacterial and antifungal properties (Mathela et al., 1978).

The volatile oils of *C. nardus* and *C. citratus* have good activity against all the gram-positive bacteria and fungi. It has been seen that the oils were not very effective against the gram-negative bacteria. The antibacterial activities of these two volatile oils were same except on *S. aureus* (*C. citratus* having more activity). *C. citratus* has been shown to possess good activity against all the fungi except *C. lunata* (Kokate and Verma, 1971).
Discussion

GLC and GC-MS analysis of citronella oil resulted in identification of 28 components comprising of 99.7% of total volatiles. The identified components, their retention indices and percentage are summarized in Table 5.1. The components are arranged in the order of elution on Ulbon HR-1 fused silica column. Eight peak indices of each component along with structural and molecular formulae are given in Table 5.2.

The oil was found to be a complex mixture of several components, mainly monoterpenes and sesquiterpenes. Quantitatively the oil was characterized by higher percentage of sesquiterpenes (80.3%) than the monoterpenes (14.2%).

Sesquiterpene fraction consisted of seven hydrocarbons (73.8%) and eight oxygenated sesquiterpenes (6.5%). Valencene (about 37%) was found to be the predominant component followed by α-t-bergamotene (19.4%), γ- and δ-cadinene (9.3%) trans-β-caryophyllene (5.8%), t-nerolidol (3.4%) and β-selinene (2.1%).

The monoterpene fraction consisted of four hydrocarbons (4.5%) and five oxygenated monoterpenes (9.7%). 1,8-Cineole (6%) was the main monoterpene component followed by myrcene (2.9%), terpinyl acetate (2.9%) and cis-ocimene (0.7%).

The most common major monoterpene components especially citronellal, geraniol, citronellol, terpineol, sabinene hydrate, limonene, geranyl acetate and terpinyl acetate were either absent or in minor amounts in the present analysis. The sesquiterpenic components like t-caryophyllene, t-nerolidol, valencene, selinene and elemol present in similar composition as those reported earlier but in considerably higher amounts. (Thibaud, 1954; Paul et al., 1960; Virmani and Datta, 1965; Mathela and Sniha, 1978).

Four non-terpenic components, amounting to about 5%, consisted mainly of formic acid (3.1%), 2-methyl-1-butamine (0.9%) and bis-1,2-benzene dicarboxylic acid (0.9%).
Table 5.1: Chemical composition of volatile oil of *Cymbopogon nardus*

<table>
<thead>
<tr>
<th>Peak No.</th>
<th>Components</th>
<th>RI</th>
<th>%</th>
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<tbody>
<tr>
<td>1</td>
<td>Formic acid</td>
<td>406</td>
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<tr>
<td>2</td>
<td>α-Thujene</td>
<td>922</td>
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</tr>
<tr>
<td>3</td>
<td>2-Methyl-1-butamine</td>
<td>-</td>
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<tr>
<td>4</td>
<td>Myrcene</td>
<td>977</td>
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<tr>
<td>5</td>
<td>p-Cymene</td>
<td>977</td>
<td>2.9</td>
</tr>
<tr>
<td>6</td>
<td>1,8-Cineole</td>
<td>1016</td>
<td>6.0</td>
</tr>
<tr>
<td>7</td>
<td>cis-Ocimene</td>
<td>1027</td>
<td>0.7</td>
</tr>
<tr>
<td>8</td>
<td>Linalool</td>
<td>1084</td>
<td>0.4</td>
</tr>
<tr>
<td>9</td>
<td>Isomenthol</td>
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<tr>
<td>10</td>
<td>Linalyl acetate</td>
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<td>11</td>
<td>4-Terpinyl acetate</td>
<td>1307</td>
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<td>12</td>
<td>trans-β-Caryophyllene</td>
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<td>Valencene</td>
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<td>γ-Cadinene</td>
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<td>β-Selinene</td>
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<td>δ-Cadinene</td>
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<td>19</td>
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<td>Ledol</td>
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<td>t-Nerolidol isomer</td>
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<tr>
<td>27</td>
<td>Bis-1,2-benzene-dicarboxylic acid</td>
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<tr>
<td>28</td>
<td>Palmitic acid</td>
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<tr>
<td><strong>Total (28)</strong></td>
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<td>99.7</td>
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</table>

Monoterpene Hydrocarbons (4) = 4.5%
Oxygenated Monoterpene (5) = 9.7%
Sesquiterpene Hydrocarbons (7) = 73.8%
Oxygenated Sesquiterpene (8) = 6.5%
Others (4) = 5.2%
Total (28) = 99.7%
Table 5.2: Eight mass peak of volatile oil of *Cymbopogon nardus*

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of Component</th>
<th>Structure</th>
<th>Mass Fragmentation</th>
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<tbody>
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<td>HCOOH</td>
<td>45, 44(37), 46(34), 47(11), 42(10), 38(8), 39(8), 36(5)</td>
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<td>α-Thujene C₁₀H₁₅</td>
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<td>2-Methyl-1-butanamine</td>
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<td>Myrcene C₁₀H₁₆</td>
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<td>p-Cymene C₁₀H₁₆</td>
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<td>1,8-Cineole C₁₀H₁₈O</td>
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<td>4-Terpinalyl acetate</td>
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<td>trans-β-Caryophyllene</td>
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<td>204</td>
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<td>C₁₅H₂₆</td>
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<td>14</td>
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<td>22</td>
<td>Globulol</td>
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<td>C₁₅H₂₅O₂</td>
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<td>Bis-1,2-benzene dicarboxylic acid</td>
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<td>Palmitic acid C₁₆H₃₂O₂</td>
<td>CH₃(CH₂)₁₄COOH</td>
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References


