

resolution when mixtures of old and reconstituted resin have been used.

EXPERIMENTAL

Apparatus. A Beckman amino acid analyser, Model 120C, equipped with a short (0.9 cm i.d. \times 23.0 cm) glass column, packed with Beckman PA 35 resin to a height of 15 cm was used. Mixed resins containing various amounts of Beckman AA15, PA 28 and PA 35 may also be used without affecting column performance. Expanded scale electronics (4–5 mV) allowed detection of as little as 0.1 nmol.

Reagents. Ninhydrin and methyl cellosolve were obtained from Pierce Chemical Co. (Rockford, IL). Standard amino acid mixture was from Sigma Chemical Co. (St. Louis, MO). Glucosamine was from ICN Nutritional Biochemicals (Montreal, Quebec). Galactosamine HCl was from B.D.H. (Vancouver, B.C.). All other reagents were of A.C.S. analytical grade. The pH 5.25 buffer, ninhydrin reagent and NaOH regenerating solution were made according to manufacturers' specifications.

Procedure. Standards (0.05–0.2 ml), int. standard (0.2 ml) or samples (not more than 0.8 ml) for analysis were applied manually in pH 2.2, 0.2 M citrate buffer. The elution system (70 ml/hr) was operated routinely at 90 kg/cm² and the ninhydrin

(35 ml/hr) at 1.13 kg/cm² as described in the manufacturers' instructions [7]. If eluting pressures exceeded 18.67 kg/cm² the resin bed was stirred in 0.2 N NaOH to a depth of ca 8 cm and repacked under elution pump pressure.

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TERPENES FROM THE ESSENTIAL OIL OF *CYMBOPOGON DISTANS*

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Key Word Index—*Cymbopogon distans*; Gramineae; essential oil; monoterpenes; sesquiterpenoids.

Abstract—A GC/MS study of the hydrocarbon fraction and the fraction containing oxygenated compounds showed the presence of 12 monoterpene hydrocarbons (28.4%), 13 sesquiterpene hydrocarbons (32.8%), 3 sesquiterpene alcohols (27.2%), 2 esters (7.2%) and 3 carbonyl compounds (4.4%) in the essential oil of *Cymbopogon distans*. Of these, 27 compounds have been identified.

INTRODUCTION

Members of the genus *Cymbopogon* are known for the presence of economically important compounds like citral, citronellal, citronellol, geraniol, geranyl acetate and eugenol. *Cymbopogon distans*, a wild species growing around Nainital ascending to 1500 m [1], also produces large amounts of essential oil. Geraniol, (+)-limonene, (+)-menthol, (–)-carvomenthone, methyl eugenol and *n*-caproic acid were reported as the main constituents of this oil [2]. We have now investigated the oil of

Cymbopogon distans but could not confirm the presence of any of these compounds except limonene. This communication reports the identification of 27 compounds in the oil of *C. distans*.

RESULTS AND DISCUSSION

Physico-chemical properties of the isolated oil were: specific gravity 0.801, acid value 1.15, ester value 19.6, ester value after acetylation 80.95 and carbonyl value 5.1. The oil yield from fresh plant material was 0.6%.

Table 1. Compounds identified in the hydrocarbon fraction of *Cymbopogon distans*

GC peak	Compound	% in oil
1	α -Pinene	3.5
2	Camphene	0.9
3	β -Pinene	2.4
4	Sabinene	0.7
5	α -Phellandrene	2.3
6	Myrcene	0.8
7	α -Terpinene	1.5
8	Limonene	5.8
9	β -Phellandrene	3.1
10	γ -Terpinene	1.3
11	<i>p</i> -Cymene	5.1
12	Terpinolene	1.0
13	<i>trans</i> - α -Bergamotene	0.7
14	Caryophyllene	4.7
15	β -Farnesene	2.0
16	α -Humulene	3.5
17	Sesquiterpene C ₁₅ H ₂₄	0.8
18	γ -Amorphene	0.7
19	β -Bisabolene	5.4
20	α -Murolene	2.3
21	β -Selinene	2.9
22	Sesquiterpene C ₁₅ H ₂₄	2.3
23	δ -Cadinene	2.4
24	γ -Cadinene	3.6
25	Sesquiterpene C ₁₅ H ₂₄	1.5

The results of GC/MS analysis of the hydrocarbon and oxygenated fractions are given in Tables 1 and 2, respectively. The oxygenated fraction still contained traces of hydrocarbons. Twelve monoterpene and 13 sesquiterpene hydrocarbons accounted for 28.4 and 32.8% of the oil, respectively. The fraction containing oxygenated compounds constituted 38.8% of the oil; sesquiterpene alcohols proved to be its principal constituents (27.2% of the oil) followed by esters (7.2%) and carbonyl compounds (4.4%).

The 2,4-DNP and semicarbazones of carbonyl compounds prepared from the *C. distans* oil proved to be different (TLC; mp) from the carbonyl compounds reported from other species of *Cymbopogon*. Thus, *Cymbopogon distans* produces an essential oil which differs markedly from other known *Cymbopogon* oils.

EXPERIMENTAL

Plant material. *Cymbopogon distans* was collected from Hanumangarhi (Nainital) in October when it was in flowering condition and the whole plant (stem, leaf and flower) was used for extraction of essential oil. The identity of the plant was confirmed by Dr. P. S. Green, Kew Gardens, England; voucher No. H257/79.

The essential oil (30 ml) was extrd by steam distillation of the

Table 2. Compounds identified in the fraction containing oxygenated compounds

GC peak	Compound	% in oil
1	Octanal	0.7
2	Bornyl acetate	4.8
3	Carbonyl compound, MW 196	2.3
4	Neryl propionate	2.4
5	Farnesol	5.1
6	Carbonyl compound, MW 190	1.4
7	α -Bisabolol	3.0
8	Sesquiterpene alcohol C ₁₅ H ₂₆ O	19.1

fresh plant material (stems, leaves and flowers) of *C. distans* (5 kg), sepd from water with pentane, dried over dry Na₂SO₄ and the solvent distilled off. The physico-chemical properties were determined [3]. The oil (10 ml) was fractionated by CC on Si gel [4]. The hydrocarbon fraction (6 ml) and the fraction containing oxygenated compounds (4 ml) were analysed by GC/MS. A 40-m glass capillary column packed with Carbowax 20M was used in the GC/MS. The ionization energy was 70 eV. Column temp. was programmed 80–100° at 1°/min, 100–200° at 2°/min and finally 200–210° at 3°/min. GC were obtained with increasing resolution, e.g. 0–72 min, 0–12 min, 28–34 min, 24–42 min and 40–50 min, and the mass spectra corresponding to GC peaks were obtained. The computer, simultaneously, searched the NBS library of the compounds and the degree of match was recorded as fit and reverse fit data. The percentage of each constituent was also recorded. The mass spectra were also compared with those available in the literature [5–10].

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