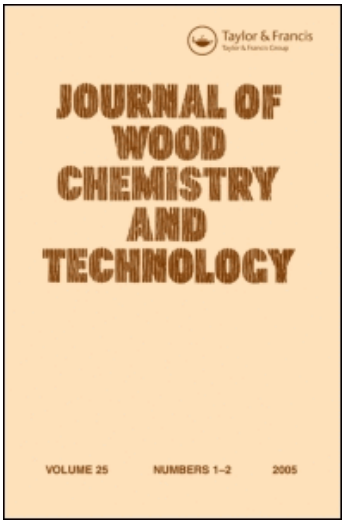


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# ESSENTIAL OILS FROM EXOTIC EUCALYPTUS: LEAF OILS OF *EUCALYPTUS YOUMONII*, *EUCALYPTUS MACRORHYNCHA*, *EUCALYPTUS MACARTHURI*, AND *EUCALYPTUS CINERA* FROM NORTHWEST HIMALAYS (INDIA)

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## ABSTRACT

Analyses of oils obtained by hydrodistillation of foliage of *E. youmonii*, *E. macrorhyncha*, and *E. macarthuri* from India revealed that the three oils are chemically alike, but for the quantitative differences of the main components. The eudesmol ($\alpha$- and $\beta$-) content in *E. macrorhyncha* and *E. macarthuri* is rather similar (15.38% and 18.91% respectively), but much higher in *E. youmonii* (50.04%). The 1,8-cineol content in *E. youmonii* (30.70%) and *E. macrorhyncha* (29.83%) are alike while geranyl acetate (23.84%) content in *E. macarthuri* is highest amongst the three. *E. cinerea* oil contains cineol (64.65%), $\alpha$-terpineol (11.56%) and limonene (12.51%) as the major components. On the whole *E. macrorhyncha*, *E. macarthuri* and *E. cinerea* oils are rich in monoterpenoids (71.16%, 71.90% and 94.55%) whereas that of *E. youmonii* is rich in sesquiterpenoids (53.37%).

## INTRODUCTION

The 700 species rich genus *Eucalyptus*, a native of Australia[1], is truly an industrial tree known for its multipurpose uses for timber, paper, rayon grade pulp, and essential oils, etc. Introduced in India[2,3] in the year 1843, it has suc cessfully adapted to various soil and climatic areas, thus establishing a "second home". On a rough estimate, about 12.5 lakh acres of land is under *Eucalyptus* plantation in India, but *E. globulus* (cineol) and *E. citriodora* (citronellal) are the only ones used for commercial oil production. A large quantity of foliage biomass, particularly available from *Eucalyptus* fellings[4] is the potential source of essential oils. It could yield more than 2500 tons/year of additional oil in con-

trast to 900 tons/year of world *Eucalyptus* oil production from about 20 *Eucalyptus* species.

Leaves of *E. youmonii* and *E. macrorhyncha* are a commercial source of rutin besides essential oils. *E. macarthuri* and *E. cinerea* also do well in Northwest Himalayas. The biomass from these *Eucalyptus* species in the present investigation has been evaluated for the production of essential oils.

## EXPERIMENTAL

Fresh leaves were collected (Palampur, Himachal Pradesh) from each species and hydrodistilled in the laboratory. The moisture contents of the leaves were determined by drying the leaves at 80°C for 4 hrs. in an electric oven. For hydrodistillation, fresh foliage (500 g) was immersed in water (3.0 liter) distilled for 3 hrs. in a Clevenger apparatus at atmospheric pressure. The oil samples were dried over anhydrous sodium sulphate and preserved at -10°C until analyzed. The physicochemical characteristics of the oil samples were determined by standard methods[5] and summarized in Table 1.



**TABLE 1**

Physico-chemical Specifications of Eucalyptus Essential Oils

| | *youmonii* | *macrorhyncha* | *macarthuri* | *cinerea* |
|---|---|---|---|---|
| Oil % (mfb) | 1.6 | 1.0 | 1.5 | 3.5 |
| $d_{25}^{25}$ | 0.9606 | 0.9336 | 0.9371 | 0.9185 |
| $n_D^{25}$ | 1.4785 | 1.4680 | 1.4660 | 1.4614 |
| $(\alpha)_D^{25}$ | +6.62° | -14.55° | +5.74° | +3.2° |
| Acid value | 1.49 | 1.42 | 3.0 | 1.5 |
| Ester value | 16.79 | 23.84 | 88.37 | 14.45 |
| Alcohol value | 148.38 | 128.04 | 213.30 | 45.67 |
| Carbonyl value | 3.80 | 7.69 | 6.64 | 5.7 |

mfb = moisture free basis.

Thin layer chromatographic (TLC) analyses of the oils and the fractions was done on silica gel G plates using benzene and benzene/ethyl acetate (95:5) as eluents and 2% vanillin sulphuric acid as the detection reagent.

Gas chromatograhic (GC) analyses were conducted on a stainless steel column (6 ft x 0.25 in) packed with 10% Reoplex-400 on Chromosorb-W was used with a nitrogen flow rate of 45 ml/min. The oven temperature was maintained at 90°C for the first six minutes and then heated at a rate of 6°C/min to 180°C. The compounds were identified by comparison with relative retention time of known terpenoids run under identical conditions.

$^{1}$H-NMR (60 MHz and 90 MHz) and $^{13}$C-NMR (22.49 MHz) spectra were recorded on Varin T-60A and Jeol FX-90 QFT models using deuterated chloroform ($CDCl_3$) as solvent and tetramethyl silane (TMS) as the internal standard.



For column chromatography, 10 ml of each oil was eluted on a silica gel column (500 g) with hexane, benzene, chloroform, and ethyl acetate. Fractions were monitored by TLC and subjected to GC, $^{1}$H-NMR, and $^{13}$C-NMR analyses. Authentic samples were plotted on chromatoplates where the colors of the spot and the $R_f$ values were used for identification of the candidate compounds. Terpene hydrocarbons were confined to the hexane fraction while esters and 1,8-cineol were eluted by benzene; chloroform and ethyl acetate fractions contained the polar oxygenated compounds. The compounds in various fractions were confirmed by $^{13}$C-NMR without isolating the individual compounds as the $^{13}$C-NMR signals were widely separated.[6,7] The identity of the individual components was derived from the chemical shift values duly supported in many cases by $^{1}$H-NMR and GC enrichment.

## RESULTS AND DISCUSSION

The essential oils of Australian grown *E. youmonii*[8] and *E. macrorhyncha*[9] have been analyzed, but the essential oils of those species introduced in India have not been analyzed. It was anticipated that the geographical and physical factors would exert considerable influence on the biosynthetic pathways in the plants.

In terms of their composition, the oils from the two species are similar, but the percentages of the components vary to a great extent (Table 2). The oil of *E. macrorhyncha* is rich in monoterpenes (74.76%) containing cineol (29.83%) as the major component whereas *E. youmonii* is high in sesquiterpenes (53.37%), where $\alpha$- and $\beta$-eudesmol alone constitute 50.04% of the oil. The oil of *E. macrorhyncha* also contains an appreciable quantity of piperitone (12.70%), gera-

**TABLE 2**

Composition of Eucalyptus Leaf Oils

| Chemical Compounds | E. youmonii | E. macrorhyncha | E. macarthuri | E. cinerea |
|---|---|---|---|---|
| Monoterpenoids | 40.74 | 71.15 | 71.90 | 96.75 |
| α-pinene | - | - | - | traces |
| β-pinene | - | - | - | traces |
| limonene | 1.56 | 6.29 | 4.36 | 12.51 |
| unidentified | 0.74 | 1.29 | 1.03 | - |
| p-cymene | 2.30 | 5.43 | 2.08 | 0.85 |
| ν-terpinene | - | - | - | 0.40 |
| 1,8-cineol | 30.70 | 29.83 | 20.18 | 64.65 |
| linalool | 0.68 | 1.87 | 3.0 | - |
| camphor | 1.40 | 0.29 | - | - |
| terpinen-4-ol | - | - | - | 2.21 |
| α-terpineol | 2.50 | 3.69 | 0.68 | 11.56 |
| citronellol | - | - | - | traces |
| geraniol | - | 4.86 | 15.90 | - |
| piperitone | - | 12.70 | - | - |
| geranyl acetate | 0.51 | 3.18 | 23.84 | - |
| α-terpinyl acetate | 0.35 | 1.72 | 0.83 | 0.85 |
| citronellyl acetate | - | - | - | 1.50 |
| Sesquiterpenoids | 54.87 | 24.58 | 25.12 | 2.20 |
| β-caryophyllene | 1.50 | 3.71 | 4.53 | - |
| β-caryophyllene oxide | 3.33 | 5.49 | 1.68 | - |
| α-eudesmol | 20.86 | 4.36 | 3.58 | - |
| β-eudesmol | 29.18 | 11.02 | 15.33 | - |
| unidentified | 15 compounds | 11 compounds | 7 compounds | 8 compounds |
| sobrerols | - | - | - | present. |

niol (4.86%), and geranyl acetate, absent in the Australian oil. The remaining constituents of the two oils are in agreement with those reported, except for percentage variations.

Relative to oil compositions reported in the literatur[10,11], *E. macarthuri* had a low geranyl acetate content (23.84% as opposed to 65-70% reported in the literature), but higher 1,8-cineol (20.18%) and eudesmol (18.90%) contents (Table 2). The different composition supports the assumed importance of chemical/geographical factors on development of *E. macarthuri.*[12,13] Another interesting observation is the varying ratio of $\alpha$-eudesmol to $\beta$-eudesmol in three of the oils. While in *E. macarthuri* the $\alpha$:$\beta$ ratio is 1:5, in *E. youmonii* it is 1:1.5 and in *E. macrorhyncha* 1:3. These days $\beta$-eudesmol is receiving considerable attention because of its healing action in cases of ulcers and inhibition of aspirin induced ulcer[14,15]. A few of unidentified compounds in three of the oils may be the same since they had identical GC retention times.

*E. cinerea* leaf oil[16-19] contained 1,8-cineol (64.65%), $\alpha$-terpineol (11.56%), and limonene (12.51%) as the major components. Out of 21 constituents only 12 compounds could be identified, but these accounted for 94.55% of the oil (Table 2).

## CONCLUSION

The analyses of the Indian grown *Eucalyptus* species have demonstrated that substantial variation in the essential oil composition of a species can be ex pected with climatic and geographical variation.

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