does not aborb significantly at 1150 cm^{-1}, but the 'aged' resin shows a three-band absorption (1250, 1205, 1150 cm^{-1}), typical of saturated aliphatic esters [7]. It also shows a sharp absorption band of high intensity at 1270 cm^{-1}, as does fresh resin, due to C–OH stretching of free carboxyl groups [6, 7].

Our results indicate that polymerization (formation of ester bonds) has started in our 'aged' *P. halepensis* resin, but it is still at its beginning (presence of free acid bonds). The formation of terminal olefinic double bonds has already taken place.

EXPERIMENTAL

Pinus halepensis resin was 'aged' for one year, under water, as in ref. [1], after separation of the volatile fraction by steam distillation. Spectra were recorded using an Infrared Spectrophotometer (FTIR) Bruker IFS 113 v. Samples were examined in KBr pellets.

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ESSENTIAL OIL COMPOSITION OF JUVENILE LEAVES FROM COPPICED *EUCALYPTUS NITENS*

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Key Word Index—*Eucalyptus nitens*; Myrtaceae; shining gum; juvenile foliage; essential oil; capillary column GC-MS.

Abstract—The essential oil of *Eucalyptus nitens* juvenile foliage harvested from coppiced trees contained α-pinene, limonene, 1,8-cineol, *cis*-ocimene and α-terpineol as principal components. Minor constituents were monoterpene alcohols, ketones, and aldehydes and 3-methylbutanal. Esters not previously identified in *E. nitens* leaf oil were ethyl 3-methylbutanoate, 3-methylbutyl-3-methylbutanoate, 3-methylbutyl hexanoate and hexyl 3-methylbutanoate.

INTRODUCTION

The possibility of *Eucalyptus* oil production [1] has been investigated in New Zealand forestry practice using a southern New South Wales provenance of *E. nitens* Maiden. This species has been reported to contain nearly 50% 1,8-cineol in the oil from the adult tree foliage [2]. However, when coppiced, *E. nitens* produces juvenile foliage having anatomy typical of that of seedlings, not of the adult tree. Only one investigation of the composition of the oil of a *Eucalyptus* seedling foliage has been described, that of *E. delegatensis* [3]. Recently, the essential oil composition of *E. delegatensis* foliage has been re-examined [4], and comparisons drawn between steam distillation and solvent extraction methods for essential oil isolation, particularly the formation of hydrocarbon artefacts arising from dehydration of labile alcohols with steam.

This report describes the content and composition of the oil from leaves from coppiced *E. nitens*.

RESULTS AND DISCUSSION

Using simple hydrodistillation, *E. nitens* juvenile foliage gave a very pale yellow oil, in 1% yield, or *ca* 4.3 kg oil ha^{-1} of coppiced *E. nitens* stand. The yield of oil from juvenile foliage was less than half that reported (2.5%) from *E. nitens* adult tree foliage [2], a situation similar to that of *E. delegatensis* juvenile and mature tree foliage [3].

The composition of the oil is summarized in Table 1. α-Pinene and 1,8-cineol were the main components, and constituted almost 75% of the oil. Minor components were limonene, *cis*-ocimene, *p*-cymene and α-terpineol, which totalled 16%. Other compounds, not previously recognized in *E. nitens* leaf oil were 3-methylbutanal (a component of *E. delegatensis* juvenile leaf oil [3]), and the esters ethyl 3-methylbutanoate, 3-methylbutyl-3-methylbutanoate, 3-methylbutyl hexanoate and hexyl 3-methylbutanoate, identified by their mass spectra. The majority of the very minor constituents were monoterpenoid alcohols, aldehydes and ketones. These were identified by comparison of their mass spectra with those published [5, 6], or by comparison with authentic compounds where these were available. Fourteen minor compounds were detected but they could not be identified from their mass spectra. Sesquiterpenes and 4-phenylbutan-2-one, present in both mature and juvenile leaf oils of *E. delegatensis* [3, 4], appeared to be absent in *E. nitens* oil. Overall, the composition of *E. nitens* juvenile and adult tree foliage oil is very similar, which would allow the oils to be blended and rectified in order to raise the 1,8-cineol content [1].

Table 1. Composition of *Eucalyptus nitens* juvenile leaf essential oil

RR_t	Identity	Composition (%)
0.30	3-Methylbutanal	0.7
0.44	α-Pinene	22.4
0.56	Camphene	0.1
0.68	β-Pinene	0.2
0.69	Ethyl 3-methylbutanoate*	0.2
0.92	Myrcene	0.3
0.94	α-Phellandrene	0.1
0.96	α-Terpinene	0.1
1.00	Limonene	4.6
1.15	1,8-Cineol	51.9
1.18	*cis*-Ocimene	5.4
1.23	γ-Terpinene	0.4
1.29	*p*-Cymene	2.6
1.30	Terpinolene	0.3
1.50	3-Methylbutyl 3-methylbutanoate†	1.0
1.73	Dihydrocarvone	0.5
1.89	3-Methylbutyl hexanoate‡	0.2
2.03	Hexyl 3-methylbutanoate§	0.1
2.14	Myrtenol	0.1
2.42	Linalol	0.4
2.48	Fenchol	0.2
2.59	4-Terpineol	0.3
2.73	*trans*-Pinocarveol	0.2
2.88	Borneol	0.1
2.90	α-Terpineol	3.3
3.12	1-*p*-menthan-9-al	0.4
3.33	Geraniol	0.8

*MS m/z 130 $[M]^{+\cdot}$ (3%), 115 $[M-15]^{+}$ (18%), 103 $[M-27]^{+}$ (8%), 88 $[Et{-}O{-}C(OH){=}CH_2]^{+\cdot}$ (100%), 85 $[M-27-18]^{+}$ (77%).

†MS m/z 130 $[M-42]^{+}$ (3%), 129 $[M-43]$ (4%), 115 $[M-42-15]^{+}$ (6%), 103 $[M-69]^{+}$ (19%), 85 $[M-69-18]^{+}$ (66%), 70 $[Me_2CH{-}CH{=}CH_2]^{+}$ (100%).

‡MS m/z 117 $[M-69]$ (18%), 99 $[M-69-18]^{+}$ (55%), 70 $[Me_2CH{-}CH{=}CH_2]^{+\cdot}$ (100%).

§MS m/z 103 $[M-83]^{+}$ (88%), 85 $[M-83-18]$ (100%), 84 $[Me{-}(CH_2)_3{-}CH{=}CH_2]^{+}$ (60%).

EXPERIMENTAL

Plant material. A small area of Compartment 905, Kaingaroa State Forest, New Zealand, was initially established at 1667 stems ha^{-1} with *Eucalyptus nitens*, Nimmitabel provenance (southern New South Wales, Australia). At 5 years, it was clear-felled, and the resulting stumps coppiced to give 1286 live stools ha^{-1}. The coppiced growth was harvested at 2 years of age, and yielded 442 kg ha^{-1} of leaves.

Isolation of leaf oil. Eucalyptus nitens leaves (4.62 kg dry wt) were hydrodistilled at atmospheric pressure until no more oil was seen to be condensing (3 hr). The condensate was partitioned with redistilled Et_2O, dried over $MgSO_4$ and concd to constant weight at 50°.

Analysis. The *E. nitens* leaf oil was analysed by capillary column GLC (25 m × 0.2 mm SP2340) using 50:1 split injection (injector temp. 220°, FID temp. 280°). The column was programmed from 30° to 200° at 4°/min. Peak areas were recorded by reporting integrator. GC-MS analysis used GC conditions identical with above, and used a quadrupole instrument operating at 70 eV, 300 μA electron energy, and an ion-source temp. of 200°. The interface was an open-split type at 220°. Spectra were acquired each 1.1 sec.

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