

818. *Some Terpenic Constituents of Bursera graveolens*
(H. B. K.) *Tr. et Pl. var. villosula Cuatr.**

By K. J. CROWLEY.

A 2,3-seco-triterpene (III) and a new stereoisomer of the oxidation product (I) of menthofuran have been isolated from the heartwood of this species, as well as an oil containing (+)-limonene, (+)- α -terpineol, and (\pm)-carvone.

THE oils of several species of *Bursera* (family Burceraceae) have been examined,¹ being of interest owing to the commercial importance of oil of linaloe, which is derived mainly from *B. delpechiana*. Epilupeol and α -amyrin have recently² been found in the latex of four *Bursera* species. *B. graveolens* (H. B. K.) *Tr. et Pl. var. villosula* Cuatr., the chemical examination of which has not been recorded, grows on the Guajira peninsula, near the Venezuelan-Colombian border. The name "Malua" is applied to this and several related species by the Indians of the region, who inhale the vapours of the burning wood as a sedative and an analgesic. The present work describes the main constituents of the volatile oil, and reports a brief examination of the non-volatile materials.

A high proportion (47.6%) of the wood dissolved in boiling ethanol. The extract contained a volatile oil (4.5% based on the wood), compounds soluble in water (2-3%),

* Preliminary communication, Crowley, *Proc. Chem. Soc.*, 1962, 27.

¹ Guenther, "The Essential Oils," Van Nostrand, New York, 1950, Vol. IV, p. 331; Gildemeister and Hoffmann, "Die Ätherischen Öle," Akademie-Verlag, Berlin, 1959, Vol. V, p. 659.

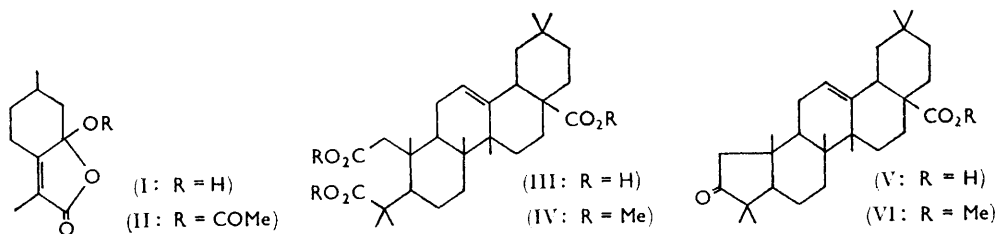
² Tursch and Tursch, *Bull. Soc. chim. belges*, 1961, **70**, 585.

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in aqueous hydrogen carbonate (1.8%), carbonate (2.4%), and hydroxide (0.4%), and a large (30%) neutral fraction. The oil was also obtained in 4.5% yield on steam-distillation of the wood shavings, of which a further 12.4% was soluble in boiling light petroleum.

The steam-volatile oil contains (+)-limonene (57%), (+)- α -terpineol (18%), and (\pm)-carvone (5%), as well as about thirty minor components; one of these, an ester, was hydrolysed to an unidentified acid, $C_{10}H_{16}O_3$, m. p. 151°.

The water-soluble fraction yielded a lactone, $[\alpha]_D^{21} +60.7^\circ$, which proved to be a new stereoisomer of the oxidation product ³ (I) of menthofuran, identified by its physical and spectral properties, and by preparation of the known dehydro-lactone. The lactone (I) readily yielded the acetyl derivative (II), which gave the parent compound on alkaline hydrolysis. This new stereoisomer very probably arises by oxidation of menthofuran, so that the occurrence in nature of the (–)-isomer of menthofuran is to be expected. Attempts were made to detect menthofuran in *B. graveolens* by extraction of the oil under nitrogen, but the colour test ⁴ for this compound was negative, and gas chromatography showed the presence of only trace quantities of a substance with a retention time similar to that of authentic menthofuran.



The most interesting constituent found in the heartwood was 2,3-seco-oleana-12-ene-2,3,28-trioic acid (III), which was isolated in 0.15% yield. This compound and its derivatives (IV), (V), and (VI) had constants in agreement with those reported by Ruzicka.⁵ It has been prepared from oleanolic acid,^{5,6} but has not previously been found in a plant. No other 2,3-seco-triterpene has been reported as occurring in Nature, although the intermediacy of a compound of this type has been postulated ⁷ in a proposed biogenesis of the A-nor-triterpene, ceanothic acid.

EXPERIMENTAL

Analyses by gas chromatography (g.l.c.) were performed on a Perkin-Elmer 154-D instrument, employing, in most cases, polyethylene glycol adipate ⁸ as the stationary phase, at 120, 160, and 200°. Helium was used as the carrier gas. Only old samples of oily heartwood were used, as young wood contained little extractable material. Light petroleum refers to the fraction of b. p. 40–60°.

Extraction.—Shavings of the heartwood (5 kg.) were extracted for 4 days with continuously recirculated boiling ethanol. The solvent was removed by distillation, the final fraction (2 l.) being diluted with water and twice extracted with ether to yield an oil (45 g.). After addition of water (5 l.) the residual ethanol extract was steam-distilled in a closed system for 6 days. The pale yellow oil (total yield, 261 ml., 223 g., 4.46%) had n_D^{22} 1.4781, $[\alpha]_D^{22} +84.5^\circ$.

Examination of the Volatile Oil.—Fractionation through a 40-cm. Vigreux column at reduced pressure separated the oil into 15 fractions, g.l.c. of which indicated, by summation, the presence of limonene (57%), six other monoterpene hydrocarbons (7%), α -terpineol (18%), carvone (5%), two other oxygenated monoterpenes (4%), and at least 25 other compounds in

³ Woodward and Eastman, *J. Amer. Chem. Soc.*, 1950, **72**, 399.

⁴ Ref. 3, footnote 3.

⁵ Ruzicka and van der Sluys-Veer, *Helv. Chim. Acta*, 1938, **21**, 1371.

⁶ Kitasato, *Acta Phytchim. Tokyo*, 1938, **10**, 239.

⁷ Guise, Ritchie, and Taylor, *Austral. J. Chem.*, 1962, **15**, 314.

⁸ von Rudloff, *Canad. J. Chem.*, 1960, **38**, 631.

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the range 2.0—0.1% each. (+)-Limonene, which was not separated from authentic limonene on g.l.c. of the mixture through three types of column, was identified by its optical rotation ($[\alpha]_D^{19} + 127^\circ$), by the preparation of the tetrabromide, m. p. 103—104°, and by its infrared spectrum. The fraction of b. p. 128—131°/40 mm. was treated with Girard's T-reagent. α -Terpineol was separated from the other non-ketonic components by elution with ether from a column of neutral alumina. The product (88% pure) had $[\alpha]_D^{21} + 80^\circ$, was not separated from authentic material on g.l.c. through three types of column, and gave an infrared spectrum virtually identical with that of α -terpineol. Chromatography of the ketonic fraction on neutral alumina yielded (\pm)-carvone of 96% purity. This had $[\alpha]_D^{21} + 1.3^\circ$, yielded an oxime, m. p. 94°, and a semicarbazone, m. p. 155°, and gave the infrared spectrum of carvone.

The fractions boiling between 100 and 140°/2 mm. were combined, and the main component (2.0% of the oil) was eluted with light petroleum from a column of neutral alumina. After being refluxed for 6 hr. with 10% ethanolic potassium hydroxide, the product, in ether, was washed with aqueous sodium hydrogen carbonate, and gave a solid (1.0 g.), m. p. 151° (from ethyl acetate). This substance was optically inactive, and showed only end-absorption ($\log \epsilon$ 2.3 at 205 μ) in the ultraviolet (Found: C, 65.45; H, 8.6. Calc. for $C_{10}H_{16}O_3$: C, 65.2; H, 8.75%), ν_{\max} (in KCl; Perkin-Elmer model 237 spectrophotometer) 3356, 1730 (CO_2H), 1385 and 1370 (Pr^i), 1323, 1253, 1180, 1078, 934, 828, and 732 cm^{-1} .

Isolation of 2,4,5,6,7,7a-Hexahydro-7a-hydroxy-3,6-dimethylbenzofuran-2-one (I).—The residue from the steam-distillation was dissolved in chloroform (2 l.) and washed with water (3×2 l.). On concentration of the combined aqueous washings, the lactone (I) crystallised as needles (5.4 g.), m. p. 191° (from methanol), $[\alpha]_D^{21} + 60.7^\circ$, λ_{\max} (MeOH) 217 μ ($\log \epsilon$ 4.06), λ_{\max} (0.05N-methanolic NaOH) 264 μ ($\log \epsilon$ 3.61) {lit.,³ m. p. 188°, $[\alpha]_D^{30} - 61.6^\circ$, λ_{\max} (alcoholic NaOH) 265 μ ($\log \epsilon$ 3.72)} (Found: C, 65.9; H, 7.5. Calc. for $C_{10}H_{14}O_3$: C, 65.9; H, 7.75%). The identity of the product was shown by conversion into the anhydro-compound, m. p. 30—32° (lit.,³ 30—32°), and confirmed by comparison of its infrared spectrum with that⁹ of an authentic specimen.

Acetylation of the Hydroxy-lactone (I).—The hydroxy-lactone (0.31 g.), acetic anhydride (5 g.), and pyridine (5 g.) were heated for 2 hr. on a steam-bath. The product, in ether, was washed with dilute hydrochloric acid. The resulting gum crystallised from light petroleum as plates (0.24 g.) of the *acetyl derivative* (II), m. p. 77.5°, $[\alpha]_D^{22} - 27^\circ$ ($c = 2.0$ in EtOH), λ_{\max} (MeOH) 221 μ ($\log \epsilon$ 4.04) (Found: C, 64.5; H, 7.15. $C_{12}H_{16}O_4$ requires C, 64.3; H, 7.2%). When treated for 2 min. with refluxing 1% aqueous sodium hydroxide and acidified, the derivative yielded the original hydroxy-lactone (m. p. and mixed m. p.).

Extraction of the Triterpene Acid (III).—The above chloroform solution of the non-volatile extract was washed with 2.5% aqueous sodium hydroxide (2 l.) and water. The combined aqueous washings were acidified and extracted with chloroform, which was re-extracted with aqueous sodium hydrogen carbonate. When the resulting mixture (90 g.) of acids was dissolved in ethanol, diluted with water, and kept at 0°, the triterpene acid (III) (7.4 g.) precipitated. The acid had m. p. 294—296° (from aqueous dioxan), $[\alpha]_D^{22} + 65^\circ$ (c 1.0 in pyridine) (Found: C, 70.5; H, 9.4%; Equiv., 187. Calc. for $C_{30}H_{46}O_6, \frac{1}{2}C_2H_5OH$: C, 70.85; H, 9.4%; Equiv., 175) [Kitasato⁶ also isolated the acid (III) as the hemi-alcoholate]. By the reported procedures⁵ the acid yielded the triester (IV), m. p. 169—170°, $[\alpha]_D^{24} + 56^\circ$ (c 1.2 in $CHCl_3$) (Found: C, 72.59; H, 9.75%; M (Rast), 548. Calc. for $C_{33}H_{52}O_6$: C, 72.75; H, 9.6; M , 544), the keto-acid (V), m. p. 321°, the keto-ester (VI), m. p. 185—186°, $[\alpha]_D^{20} + 169^\circ$ (c 1.2 in $CHCl_3$), λ_{\max} (EtOH) 283 μ , (ϵ 307), end-absorption at 205 μ (ϵ 4000) (Found: C, 79.25; H, 10.0. Calc. for $C_{32}H_{50}O_3$: C, 79.6; H, 10.45%). The oxime, m. p. 204—206°, of the keto-ester (VI), and the bromo-lactone, m. p. 237—239°, of the keto-acid (V) were also obtained.

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⁹ Wither, Ph.D. Thesis, Stanford University, 1956.