682. *Triterpene Resinols and Related Acids. Part XIX. Isolation of a Triterpene Diol from* Canarium Schweinfurthii *Resin.*

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An analytical study of the resin from *Canarium Schweinfurthii* shows that the principal component of the steam-volatile oil is (+)-limonene, and that the acidic fraction consists mainly of a mixture of elemadienolic and elemadienonic acids. The neutral fraction contains α- and β-amyrins together with a triterpene diol, $C_{30}H_{50}O_2$ or $C_{30}H_{48}O_2$, which differs from previously described triterpenoid diols. In particular it is different from elemadienediol obtained by reduction of methyl acetylelemadienolate with lithium aluminium hydride and also from *epi*elemadienediol obtained by similar reduction of methyl elemadienonate.

The resin obtained from trunk incisions of the tree *Canarium Schweinfurthii* has previously been reported to contain an oil rich in phellandrene (*Bull. Imp. Inst.*, 1908, **6**, 254) and a non-volatile component similar in crystalline form to the mixture of α- and β-amyrins from *Manila elemi* (Bandke, *Apoth. Ztg.*, 1909, **24**, 210). A sample of the resin was obtained for us by Sir John Simonsen of the Colonial Products Research Council to whom we express our thanks; the present paper records the results of an examination of this sample. Steam-distillation of the resin gave a volatile oil from which (+)-limonene was readily isolated and characterised. The phellandrenes were not present in the volatile oil in any considerable quantity since none of the fractions exhibited selective absorption of appreciable intensity in the ultra-violet. However, treatment of the lower-boiling fractions of the essential oil with maleic anhydride gave in minute yield an adduct, the properties of which coincide with those described for the adduct from (−)-α- and (−)-β-phellandrenes (Goodway and West, *J.*, 1938, 2028).

The material not volatile in steam was separated into acidic and neutral fractions. Acetylation of the acidic fraction gave a crystalline acetate-acid which after repeated crystallisations attained the m. p. 212—216°; methylation of the acetate-acid gave a methyl ester $C_{33}H_{52}O_4$, the physical constants of which, m. p. 112—114°, $[\alpha]_D^{20}$ −41°, showed it to be methyl acetylelemadienolate (m. p. 113·5—114°, $[\alpha]_D$ −43°). Because of the difficulty encountered in the purification of this acid and its derivatives we suspected the presence of elemadienonic acid in the resin. This was confirmed by treatment of the crude resin acid fraction with Girard reagent P, a keto-acid fraction, identified as elemadienonic acid, and a non-ketonic fraction, which readily gave elemadienolic acid, being isolated.

From the neutral non-volatile fraction of the resin we have isolated α- and β-amyrins, and a triterpene diol, $C_{30}H_{50}O_2$ or $C_{30}H_{48}O_2$, m. p. 293—295°, $[\alpha]_D$ +53°. The diol does not react with hydroxylamine, and although it reacts with acetic anhydride and benzoyl chloride the products are resinous. In this respect it resembles hederadiol (Ruzicka and Marxer, *Helv. Chim. Acta*, 1940, **23**, 144) and *epi*elemadienediol (Ruzicka and Häusermann, *Helv. Chim. Acta*, 1942, **25**, 439) both of which give oily acetates. Hydrolysis of the resinous esters from the new diol regenerated the diol. The presence of two hydroxyl groups in the diol was established by active-hydrogen determination, and the presence of two ethylenic linkages was shown by reaction with perbenzoic acid. The two double bonds are not conjugated since the diol does not exhibit selective absorption in the ultra-violet region. Since the analytical values obtained do not permit a decision between the molecular formulæ $C_{30}H_{48}O_2$ and $C_{30}H_{50}O_2$ for the diol, it is not possible to decide whether the diol is pentacyclic or tetracyclic. In the latter event, a relationship to elemadienolic acid is a strong possibility, and a comparison of the diol with elemadienediol was undertaken. Two elemadienediols have been described; the first of these was obtained by Ruzicka, Hosking, and Wick (*Helv. Chim. Acta*, 1931, **14**, 811) by reduction of the methyl ester of "elemi-acid" using Bouveault–Blanc conditions. The acid employed, m. p. 215—216°, $[\alpha]_D$ −20·5°, and the methyl ester (m. p. approx. 80°) were mixtures, and the diol obtained was amorphous. The second, *epi*elemadienediol, was obtained in extremely small yield by similar reduction of methyl elemadienonate (Ruzicka and Häusermann, *loc. cit.*). The low yields of diol obtained by the Bouveault–Blanc method led us to examine the reduction of methyl elemadienolate and methyl elemadienonate with lithium aluminium hydride. From methyl elemadienonate we obtained *epi*elemadienediol in excellent yield. In this diol the secondary hydroxyl group has the opposite configuration from that in elemadienolic acid (Ruzicka, Rey, Spillmann, and Baumgartner, *Helv. Chim. Acta*, 1943, **26**, 1638). *epi*Elemadienediol, m. p. 177—179°, $[\alpha]_D$ −6°, differs from the diol obtained from *Canarium Schweinfurthii*. Similar reduction of methyl acetylelemadienolate gave a new diol, elemadienediol, which differs from *epi*elemadienediol in the orientation of the secondary hydroxyl group. Elemadienediol, m. p. 169—170°, $[\alpha]_D$ −28°, is different from the diol from *Canarium Schweinfurthii* although it resembles the latter and also *epi*elemadienediol in giving an oily acetate.

EXPERIMENTAL.

M. p.s are uncorrected; specific rotations of solids were measured in chloroform in a 10-cm. tube.

(+)-*Limonene.*—The resin (500 g.) from *Canarium Schweinfurthii* was steam-distilled until the distillate was free from oil. The oil (70 g.) was separated, dried (Na_2SO_4), and distilled under reduced pressure to give fractions (*a*) b. p. 57—62°/16 mm. (13 g.), (*b*) b. p. 62—64°/16 mm. (40 g.), and (*c*) b. p. 64—69°/16 mm. (4 g.). Fraction (*b*) was redistilled thrice to give (+)-limonene as a colourless oil, b. p. 62—62·5°/15 mm.; it gives a bright yellow colour with tetranitromethane in chloroform and has $[\alpha]_D^{20}$ +111·4°, η_D^{20} 1·4757, d^{20} 0·846 (Found: C, 88·2; H, 11·6. Calc. for $C_{10}H_{16}$: C, 88·2; H, 11·8%). A chloroform solution of the oil absorbed the equivalent of 2 oxygen atoms when kept at 0° with a 5% solution of perbenzoic acid in chloroform for 120 hours, and no subsequent absorption occurred after a further 48 hours at the same temperature. (+)-Limonene was further characterised by the preparation of its tetrabromide (Baeyer and Villiger, *Ber.*, 1894, **27**, 448), which separates from nitromethane as plates, m. p. 104—106°, $[\alpha]_D$ +72° (*c*, 0·7) (Found: C, 26·1; H, 3·4; Br, 69·8. Calc. for $C_{10}H_{16}Br_4$: C, 26·3; H, 3·5; Br, 70·2%).

Neither fraction (*a*) nor fraction (*c*) exhibited selective absorption in the ultra-violet region. Treatment of fraction (*a*) with maleic anhydride in refluxing ether gave in extremely small yield (47 mg. from 10 g.) an adduct crystallising from methanol in needles, m. p. 125—127° (Found: C, 71·4; H, 7·8. $C_{14}H_{18}O_3$ requires C, 71·9; H, 7·7%).

α- *and* β-*Amyrin Esters.*—The non-volatile fraction obtained after removal of the essential oil was extracted with ether, and the extract filtered from vegetable debris (*ca.* 25%). The ethereal solution was washed thrice with 18% potassium hydroxide solution (extract *A*), then with water, dried (Na_2SO_4), and evaporated to give a neutral fraction (250 g.).

The neutral fraction (50 g.) was acetylated with acetic anhydride and pyridine. The product was dissolved in the minimum quantity of boiling acetone, from which a mixture of α- and β-amyrin acetates separated. Two further crops were obtained by concentration of the mother-liquors (total yield, 32 g.). The mixture of acetates was hydrolysed by boiling 5% ethanolic potassium hydroxide for 24 hours. The mixed alcohols were isolated by means of ether and benzoylated by heating them on the water-bath with pyridine and benzoyl chloride for 7 hours. The mixed benzoates were isolated in the usual manner and crystallised from acetone–ethanol from which the product (26 g.) separated as stout prisms, m. p. 178—187°.

The mixture of benzoates was separated by washing with ether until the melting point of the residue was greater than 210°. The insoluble residue, m. p. 210°, was recrystallised from benzene–acetone, to yield β-amyrin benzoate (2·8 g.) as plates, m. p. 230—232° undepressed when mixed with a specimen obtained from *Manila elemi*. Hydrolysis of the benzoate followed by direct acetylation of the product with acetic anhydride and pyridine gave β-amyrin acetate as needles (from acetone), m. p. 232—234°, $[\alpha]_D$ +82° (*c*, 0·73), undepressed in melting point when mixed with a specimen obtained from *Manila elemi* (Found: C, 82·0; H, 10·9. Calc. for $C_{32}H_{52}O_2$: C, 82·0; H, 11·2%).

The combined ethereal solutions obtained after the removal of the fraction, m. p. 210°, were evaporated and the residue crystallised from benzene–ethanol, to give α-amyrin benzoate (17·5 g.) as stout prisms,

m. p. 193—195° undepressed when mixed with a specimen obtained from *Manila elemi.* Hydrolysis of the benzoate followed by acetylation of the alcohol with acetic anhydride and pyridine, gave α-amyrin acetate as plates (from acetone), m. p. 219—221°, $[\alpha]_D$ +79° (*c*, 0·46 in benzene) (Found : C, 82·3; H, 11·4. Calc. for $C_{32}H_{52}O_2$: C, 82·0; H, 11·2%).

Diol, $C_{30}H_{48-50}O_2$.—The acetone mother-liquor from the mixed amyrin acetates was evaporated to dryness, and the residual dark resin hydrolysed by refluxing 5% ethanolic potassium hydroxide (200 c.c.) for 3 hours. The product was isolated by means of ether and dried at 100° *in vacuo.* A solution of the resin (18 g.) in light petroleum (b. p. 60—80°)-benzene (1 : 3; 920 c.c.) was filtered through a column of activated alumina (60 × 6 cm.), and the column developed by washing to give the following fractions :

Fraction	Solvent		c.c.	Eluate	
1	Light petroleum–benzene	(1 : 3)	920	0·8 g.	(oil)
2	,, ,,	(1 : 2)	600	0·6	(oil)
3	,, ,,	(1 : 1)	500	0·7	(oil)
4—6	Benzene		1500	0·7	(oil)
7	Benzene–ether	(4 : 1)	500	0·6	(resin)
8—9	Ether		1000	4·0	(resin)
10—11	,,		1000	3·8	(resin)
12—14	,,		1500	1·6	(resin)
15—17	Ether–ethanol	(4 : 1)	1500	0·9	(tar)
18	Ethanol		500	0·2	(oil)

Fractions 1—7 and 12—18 could not be crystallised. Fractions 8 and 9 were extracted with successive small amounts of cold ethyl acetate. The insoluble powder (50 mg.) crystallised from nitromethane as plates, m. p. 293—295° (decomp.; evacuated tube). Fractions 10 and 11 were dissolved in ethyl acetate. After 3 days the micro-crystalline powder was collected and crystallised from nitromethane to give the *diol* (400 mg.) as plates, m. p. 292—295° (decomp.; evacuated tube), undepressed when mixed with the sample obtained from fractions 8 and 9, and having $[\alpha]_D$ +54°, +52° (*c*, 0·44, 0·64 respectively) (Found : C, 81·3, 81·7; H, 11·4, 11·3; N, 0%; active H, 1·85. $C_{30}H_{50}O_2$ requires C, 81·4; H, 11·4. $C_{30}H_{48}O_2$ requires C, 81·8; H, 11·0%). A chloroform solution of the diol absorbed the equivalent of 2 oxygen atoms when treated at 0° with a 5% solution of perbenzoic acid in chloroform for 120 hours; no subsequent absorption of oxygen occurred after a further 24 hours at 0°.

Elemadienonic Acid.—The extract *A* was acidified with 5% hydrochloric acid and extracted with ether. The ethereal solution was dried (Na_2SO_4) and evaporated, to yield a resinous acid mixture (80 g.) which did not crystallise but on acetylation readily yielded a crystalline acetate-acid. A solution of the crude acid (50 g.) in methanol (500 c.c.) was refluxed for 1 hour with Girard reagent P and glacial acetic acid (3 c.c.), and the mixture separated into non-ketonic and ketonic fractions as described by Ruzicka and Häusermann (*loc. cit.*) and Bilham and Kon (*J.*, 1942, 544). The ketonic fraction was thrice crystallised from methanol, to give elemadienonic acid as needles, m. p. 224—225°, $[\alpha]_D^{22}$ +44° (*c*, 1·41) (Found : C, 79·4; H, 10·1. Calc. for $C_{30}H_{46}O_3$: C, 79·2; H, 10·2%). Esterification of the acid with diazomethane gave methyl elemadienonate as needles, m. p. 104—105°, $[\alpha]_D^{20}$ +36° (*c*, 0·76).

Elemadienolic Acid.—The non-ketonic fraction of the acid mixture was directly acetylated with acetic anhydride and pyridine, and the product crystallised five times from methanol to yield acetylelemadienolic acid (20 g.) as stout needles, m. p. 238—240°, $[\alpha]_D$ −40° (*c*, 1·25) (Found : C, 77·4; H, 10·0. Calc. for $C_{32}H_{50}O_4$: C, 77·1; H, 10·1%). Esterification of the acetyl-acid with diazomethane gave methyl acetylelemadienolate as needles (from acetone–methanol), m. p. 113—114°, $[\alpha]_D^{20}$ −43°, −41° (*c*, 0·52, 0·91) (Found : C, 77·5; H, 10·3. Calc. for $C_{33}H_{52}O_4$: C, 77·3; H, 10·2%). Hydrolysis of acetylelemadienolic acid with methanolic potassium hydroxide gave elemadienolic acid which crystallised from methanol as small cubes m. p. 222—224°, $[\alpha]_D^{20}$ −29° (*c*, 0·92) (Found : C, 79·0; H, 10·3. Calc. for $C_{30}H_{48}O_3$: C, 78·9; H, 10·6%).

Elemadienediol.—A solution of methyl acetylelemadienolate (1·7 g.) in dry ether (75 c.c.) was added to a suspension of lithium aluminium hydride (0·5 g.) in ether (100 c.c.). The mixture was refluxed for 3 hours, cooled, and cautiously treated with water. The mixture was acidified with sulphuric acid (2N.), and the ethereal layer washed with water, dried (Na_2SO_4), and evaporated. The residue was crystallised from aqueous ethanol to give *elemadienediol* as stout prismatic needles (1·5 g.), m. p. 169—170°, which gave a yellow colour with tetranitromethane in chloroform and had $[\alpha]_D^{20}$ −28° (*c*, 1·0) (Found : C, 81·1; H, 11·5. $C_{30}H_{50}O_2$ requires C, 81·4; H, 11·4%).

epi*Elemadienediol.*—Reduction of methyl elemadienonate (2 g.) with litihum aluminium hydride (0·6 g.) in ether (175 c.c.) as described for methyl acetylelemadienolate gave a product which after crystallisation from aqueous ethanol yielded *epi*elemadienediol (1·47 g.) as needles, m. p. 177—179°, $[\alpha]_D$ −6·4° (*c*, 1·9) (Found : C, 81·2; H, 11·2%).

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[*Received, September 8th,* 1950].