

SHORT COMMUNICATION
TERPENOIDS AND RELATED COMPOUNDS—VII*
TRITERPENOIDS OF *PHYLLANTHUS ACIDUS* SKEELS

P. SENGUPTA and J. MUKHOPADHYAY

Organic Chemistry Laboratory, University of Kalyani, Nadia, W. Bengal, India.

(Received 4 August 1965)

Abstract—From the bark of *Phyllanthus acidus* Skeels the pentacyclic triterpenoids, phyllanthol and olean-12en-3 β -ol (β -amyrin) have been isolated. The biosynthetic path of phyllanthol has been outlined.

THE BIOSYNTHESIS of various types of tetracyclic and pentacyclic triterpenoids from all-*trans*-squalene by synchronous cyclization initiated by the attack of the formal cation OH⁺ followed by skeletal rearrangement and methyl and hydride shifts is well understood.¹ The cation (I) is suggested² to produce pentacyclic triterpenoids of (a) oleanane and friedo-oleanane³ or (b) ursane and modified ursane skeletons. The occurrence of various types of triterpenoids of the above skeletons in different plants suggests a highly selective control of the degree to which rearrangement can be effected by different enzyme systems in particular plants or plant families.

A number of triterpenoids of the former class have been isolated from natural sources. These are germanicol,⁴ olean-13(18)en-3 β -ol,⁵ olean-12en-3 β -ol⁶ (β -amyrin), D-friedo-olean-14en-3 β -ol⁷ (taraxerol), D:C-friedo-olean-7en-3 β -ol⁸ (multiflorenol), D:B-friedo-olean-5en-3-one⁹ (glutenone), D:B-friedo-olean-5en-3 β -ol¹ (glut-5en-3 β -ol) and freidelin.¹⁰ Arundoin was believed to be a member of this class with a 9(11)-ethylenic linkage.¹¹ However, more recently it has been demonstrated¹² that the suggested structure¹¹ of arundoin was incorrect and that it belonged to a different class of pentacyclic triterpenoids.

Only five members of the latter class, viz. taraxasterol,¹³ ψ -taraxasterol,¹³ urs-12en-3 β -ol¹⁴ (α -amyrin), bauerenol^{8, 15} and phyllanthol¹⁶ have so far been isolated from nature. Of these phyllanthol (VII, R=H), the only member of this class containing a cyclopropane ring, has been isolated from only one source, i.e. *Phyllanthus engleri* Pax.¹⁶ It may be expected that

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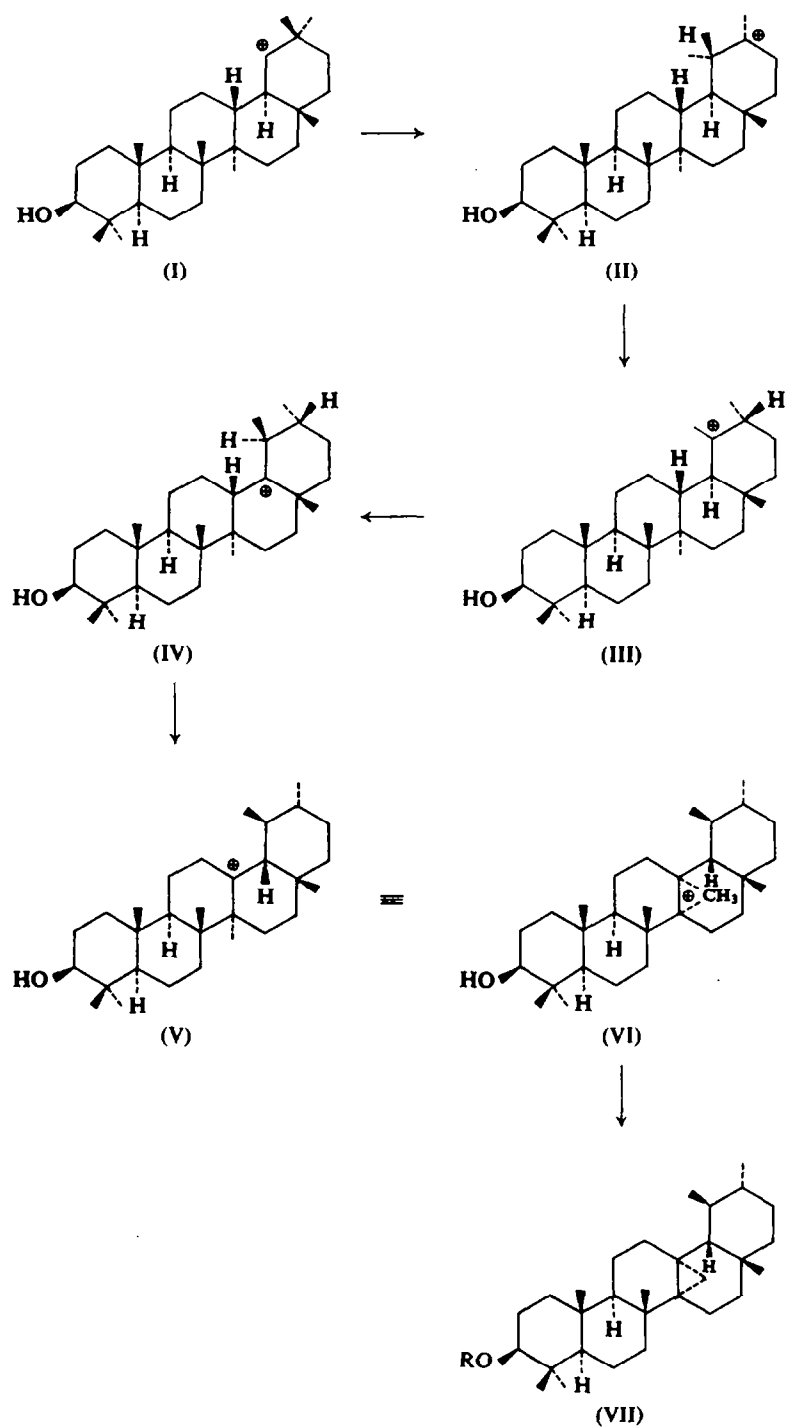


FIG. 1

other members of *Phyllanthus* species should contain phyllanthol or related members of the modified ursane skeleton. But an examination¹⁷ of *Phyllanthus emblica* (Syn. *Emblica officinalis*) demonstrated that it contained lupeol only.

In the present communication we report the isolation of phyllanthol (VII, R = H) along with olean-12en-3 β -ol (β -amyrin) from another member of *Phyllanthus* species, viz. *Phyllanthus acidus*, which is a shrub or a small tree, cultivated in gardens in India chiefly for its fruits. The neutral fraction from the benzene extract of the dried and powdered bark was chromatographed over alumina; the crystalline fractions obtained gave, on acetylation, phyllanthyl acetate (VII, R = Ac) and olean-12en-3 β -yl acetate identical with the respective authentic specimens. Phyllanthyl acetate on hydrolysis afforded phyllanthol (VII, R = H), identical with an authentic specimen and on acid-catalysed isomerization¹⁸ yielded urs-12en-3 β -yl acetate (α -amyrin acetate) identical with an authentic specimen.

In line with the suggestions of Ruzicka,² a hypothetical biogenetic route for the formation of phyllanthol (VII, R = H) in nature is shown in Fig. 1. For the sake of convenience, intermediates I–V are shown as classical carbonium ions. The intermediate V is equivalent to the non-classical carbonium ion VI, which can now eliminate a proton to form phyllanthol (VII, R = H).

EXPERIMENTAL

Isolation of Crude Triterpenoid Mixture

Dried and powdered bark of *P. acidus* Skeels (1 kg) were extracted with benzene in a Soxhlet apparatus for 8 hr. The residue (26 g) obtained on the removal of benzene, was taken up in ether and the ether solution was washed with cold 5% aq. NaOH solution and then water and dried (Na₂SO₄). The aqueous alkaline solution did not yield any crystalline material on acidification. The neutral semi-crystalline material (24 g) obtained after the evaporation of ether was chromatographed over activated alumina (400 g). After a forerun of waxy material (7.8 g), a mixture of benzene and ether (4:1) eluted from the column a colourless crystalline material (7.4 g), m.p. 194–220°. The melting point was not improved by crystallization from various solvents.

Phyllanthyl Acetate (VII, R = Ac)

The above crystalline solid (7.4 g) was acetylated in the usual manner with acetic anhydride (75 ml) and pyridine (75 ml). A crude acetate (4.75 g), m.p. 260–262°, crystallized out of the reaction medium. On repeated crystallization from a mixture of chloroform and methanol, the acetate furnished pure phyllanthyl acetate (1.25 g), m.p. 266–268°, [α]_D + 44° (CHCl₃), identical with an authentic specimen. (Found: C, 81.86; H, 11.12. Calc. for C₃₂H₅₂O₂: C, 81.99; H, 11.18%) It gave a single spot in thin-layer chromatography.

Olean-12en-3 β -yl Acetate (β -Amyrin Acetate)

The above acetylation mixture, after separation of phyllanthyl acetate was poured into ice, when a crude crystalline acetate mixture (1.49 g), m.p. 180–200°, was obtained. On repeated crystallization from a mixture of chloroform and methanol and finally from acetone, this crude acetate mixture furnished olean-12en-3 β -yl acetate, m.p. 230–234°, [α]_D + 81° (CHCl₃), identical with an authentic specimen. (Found: C, 82.03; H, 11.02. Calc. for C₃₂H₅₂O₂: C, 81.99; H, 11.18 per cent.) It gave a single spot in thin-layer chromatography.

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Phyllanthol (VII, R = H)

Phyllanthyl acetate (1.25 g) in benzene (36 ml) was refluxed for 5 hr with 24 ml of 10% methanolic KOH solution. After working up as usual, the crude alcohol was chromatographed over activated alumina (100 g). Elution with a mixture of benzene and ether (4:1) furnished a solid, which after crystallization from acetone gave pure phyllanthol, m.p. 228–230°, identical with an authentic specimen.

*Acid-Catalysed Isomerization of Phyllanthyl Acetate to Urs-12en-3 β -yl Acetate*¹⁸

Phyllanthyl acetate (500 mg) was refluxed for 2 hr with conc. HCl (15 ml) and glacial acetic acid (100 ml). The reaction mixture on cooling precipitated a crystalline acetate, which was filtered and crystallized from acetone to furnish urs-12en-3 β -yl acetate, m.p. 224–226°, identical with an authentic specimen.

Acknowledgements—We are highly indebted to Prof. D. H. R. Barton of Imperial College, London, for comparing our phyllanthyl acetate and phyllanthol with his authentic samples. We thank Messrs. East India Pharmaceutical Works Ltd., Calcutta, for the award of a scholarship to one of us (J.M.).