Tetrahedron Letters No.10, pp. 771-774, 1969. Pergamon Press. Printed in Great Britain.

ISOMERISATION OF QUILLAIC ACID AND ECHINOCYSTIC ACID WITH HYDROCHLORIC ACID

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(Received in Japan 4 December 1968; received in UK for publication 22 January 1969)

An acid hydrolysis of the extract of the roots of Saponaria officinalis L.,* which is cultivated in the central district of Japan, afforded, after chromatography on silica gel, two triterpenoid acids, gypsogenic acid (Ia) (2), m.p. >330°, $[\alpha]_D$ +85.6° (MeOH), [Me ester (Ib): m.p. 242-247°, $[\alpha]_D$ +76.8°]** and quillaic acid (IIa) (3), m.p. 258-265° (dec), $[\alpha]_D$ +65.0° (MeOH), [Me ester (IIb): m.p. 200-205° (dec), $[\alpha]_D$ +50.1°].*** Methylation of the non-crystalline fractions followed by chromatography on alumina yielded additional three new compounds, m.p. 250-255°, $[\alpha]_D$ +42.1° (IIIb), m.p. 212-213° (dec), $[\alpha]_D$ -9° (IVb) and m.p. 220-223°, $[\alpha]_D$ -10.0° (Vb). The structures of these compounds were deduced from the analytical results and mass spectra and from the NMR spectra of their acetates and were established by the following chemical correlation. LAH reduction of IIb and IIIb gave an identical tetrol (VIa), m.p. 246-255° (dec), $[\alpha]_D$ +47.6°, which was acetylated to give the amorphous tetraacetate (VIb). Oxidation of VIb with selenium dioxide in acetic acid afforded a $\Delta^{11,13(18)}$-diene, which was identified with saikogenin D tetraacetate (VIIb) (5). On the other hand, LAH reduction of IVb and Vb gave the same tetrol, m.p. 257-263°, which was identical with dihydrosaikogenin D (VIIIa) prepared previously (5) by hydrogenation of VIIa.

In view of the fact that the $\Delta^{13(18)}$-oleanene derivatives (IVb) and (Vb) were isolated together with the corresponding Δ^{12}-oleanenes (IIb) and (IIIb), treatment of quillaic acid (IIa) with HCl in aq EtOH under the same condition as used for hydrolysis of the saponins was examined. The experimental results were as shown

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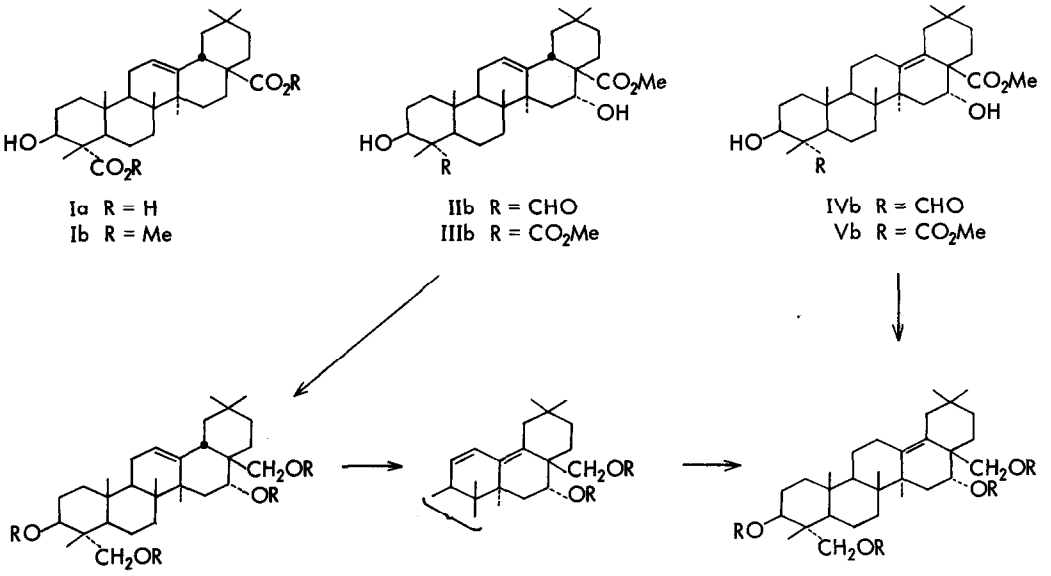
* From Saponaria officinalis L., isolation of gypsogenin has previously been reported (1). The authors are indebted to Prof. S. Miki of Mukogawa Women's University for identification of the plant source.

** Unless otherwise stated, the rotations were measured in $CHCl_3$ solutions.

*** The authors thank Dr. O. Jegar for these authentic samples. The previous paper (4) recorded m.p. 292-294°, $[\alpha]_D$ +56.1° (pyridine) for IIa and m.p. 222-223°, $[\alpha]_D$ +40.1° (pyridine) for IIb.



Ia R = H
Ib R = Me

IIb R = CHO
IIIb R = CO_2Me

IVb R = CHO
Vb R = CO_2Me

VIa R = H
VIb R = Ac

VIIa R = H
VIIb R = Ac

VIIIa R = H
VIIIb R = Ac

in TABLE and it has been proved that the $\Delta^{13(18)}$-isomers (IVb) and (Vb) are artifacts transformed from the respective Δ^{12}-isomers during acid hydrolysis of the saponins. A small amount of the neutral fraction obtained from the 2.5 hr reaction consisted mainly of a product showing UV absorption at λ_{max}^{EtOH} 237, 244 and 253 mμ, characteristic of 28-norolean-12,17-diene (IX) (6). The prolonged reaction yielded an increased amount of neutral fraction, which showed only a weak UV absorption of the diene chromophore and on recrystallisation from aq MeOH afforded a γ-lactone (X), m.p. 318-321°, ν_{max}^{Nujol} 1758 and 1729 cm^{-1}. This compound (X) was obtained also by further treatment of the isolated $\Delta^{13(18)}$-en-28-oic acid (IVa), m.p. 205-211° (dec), $[\alpha]_D$ -9.1°, with HCl in aq EtOH.

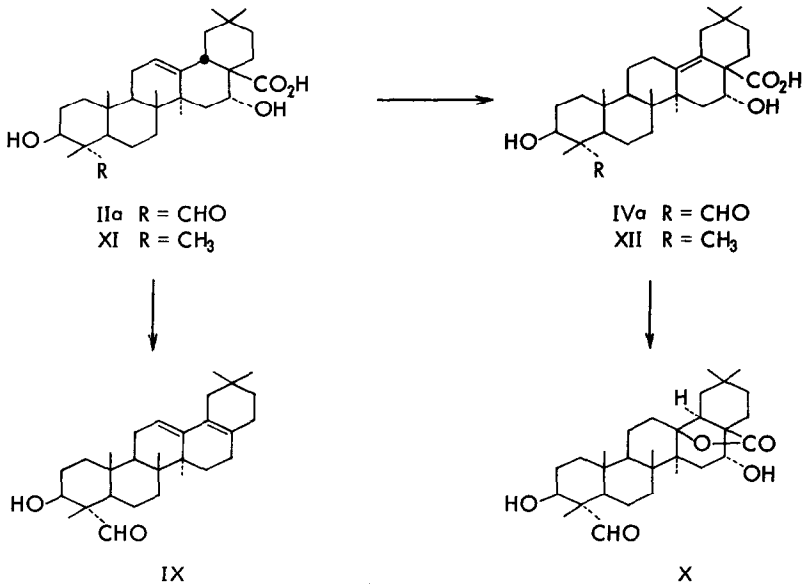
Barua et al. have reported (7) isolation of albigenic acid, 3β,16α-dihydroxyolean-13(18)-en-28-oic acid (XII), together with its Δ^{12}-isomer, echinocystic acid (XI), from acid hydrolysis of the extractive of the beans of Albizzia lebbeck Benth and they mentioned that albigenic acid (XII) is not an acid-induced isomerisation product of echinocystic acid (XI). However, in view of the above-mentioned result, it became doubtful that albigenic acid (XII) is a naturally occurring $\Delta^{13(18)}$-oleanene derivative. Echinocystic acid (XI) (50 mg) was refluxed for 4 hr with HCl in aq EtOH under the same condition as described

TABLE
Product Distribution in Treatment of Quillaic Acid (IIa) with HCl-aq EtOH[a]

Refluxing period	Fractions		Me esters of	
	Neutral	Acidic[b]	IIa	IVa
2.5 hr	5 mg	44 mg	29 mg	8 mg
5	10	39	20	10
20	27	18	2	11

[a] A mixture of quillaic acid (50 mg), conc HCl (4 ml), 95% EtOH (16 ml) and water (4 ml) was refluxed under a N_2 atmosphere.

[b] The acidic fractions were methylated with diazomethane and separated into the methyl esters of IIa and IVa by preparative TLC using silica gel and toluene-AcOEt (2 : 1).



IIa R = CHO
XI R = CH_3

IVa R = CHO
XII R = CH_3

IX X

(7) for isolation of albigenic acid. The reaction mixture was fractionated in the same manner as described above for the reaction of quillaic acid (IIa) and methyl albigenate (11 mg), m.p. 225-230°, $[\alpha]_D$ -12.0° (EtOH) was isolated together with recovered methyl echinocystate (14 mg), m.p. 213-216°, $[\alpha]_D$ +28.8° (MeOH) and a neutral fraction (12 mg).

Although quillaic acid (IIa) and echinocystic acid (XI) were easily isomerised to their $\Delta^{13(18)}$-isomers under the condition of hydrolysis of the saponins, the $\Delta^{13(18)}$-isomer corresponding to gypsogenic acid (Ia)

was not isolated at all in this investigation on Saponaria officinalis L. Gypsogenic acid (Ia) on treatment with HCl in aq EtOH was so stable that it was recovered almost quantitatively, except for only formation of a small amounts of neutral products, even after refluxing for 10 hr. From the above results, one might conclude that easy isomerisation of quillaic acid (IIa) and echinocystic acid (XI) to their $\Delta^{13(18)}$-isomers is ascribed to the presence of the highly hindered, axial 16α-hydroxyl group. Although olean-12-en-28-oic acids having the 16α-hydroxyl group were shown to be unstable to HCl in aq EtOH, those were only a little affected by treatment with refluxing 1 N H_2SO_4 in 70% (w/w) aq EtOH for 5 hr. This condition, however, did not result in the complete hydrolysis of the saponins of Saponaria officinalis L. to the sapogenins.

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