TRITERPENE ACIDS FROM THE ROOTS OF MERISTOTROPIS TRIPHYLLA FISCH. ET MEY.

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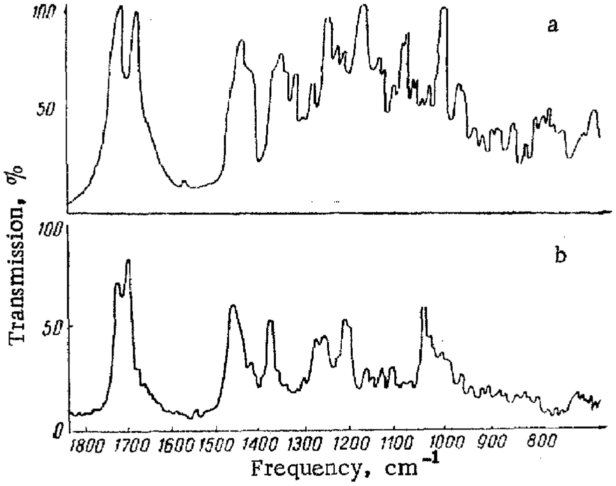
Khimiya Prirodnykh Soedinenii, Vol. 1, No. 5, pp. 311-315, 1965

On the acid hydrolysis of an aqueous extract of the roots of Meristotropis triphylla Fisch. et Mey. syn. Glycyrrhiza triphylla Fisch. et Mey. N. P. Kir'yalov and T. N. Naugol'naya [1] obtained a new unsaturated hydroxyketotriterpene acid of composition $C_{32}H_{48}O_4$ with mp 355-356.5° $[\alpha]_D$ −67.2°(c 10; pyridine), which was given the name of meristotropic acid.

While confirming the presence of meristotropic acid in a sample of the roots of Meristotropis triphylla that we have investigated, we were able to isolate by chromatography on alumina neutral products of the hydrolysis of some individual substances, among which were two, probably triterpene, acids in the form of methyl esters (see Experimental). One of these esters had the composition $C_{33}H_{50}O_4$ and, on saponification, gave an acid $C_{32}H_{48}O_4$, identical in composition with meristotropic acid but differing in its properties. Like meristotropic acid, it had one carboxyl group (shown by the preparation of methyl and ethyl esters), one hydroxyl group (shown by the isolation of monoacetates of the methyl and ethyl esters of the acid), and one isolated keto group (shown by the IR spectrum; Figure, a, band at 1687 cm^{-1}). The UV spectrum has a maximum at λ 282 mμ (log ε 3.52), which characterizes the acid as a homoannular diene. The analysis of the IR and UV spectra of the derivatives confirms both its composition $C_{32}H_{48}O_4$ and the conclusion that it is an hydroxyketotriterpene compound having a conjugated system of double bonds in one ring. The name isomeristotropic acid is proposed for this acid.

The other methyl ester had the composition $C_{31}H_{48}O_5$. Saponification of the ester gave an acid with the composition $C_{30}H_{46}O_5$. The composition of this acid is similar to that of echinatic acid [1], but its properties and those of its derivatives are different.



IR spectra of (a) isomeristotropic acid and (b) triphyllic acid.

The acid isolated was found to contain one carboxyl group (shown by the preparation of methyl and ethyl esters, and also by the presence of a band at 1729 cm^{-1} in the IR spectrum, Figure, b); of the three remaining oxygen atoms in the molecule of the acid, two belong to hydroxyl groups (diacetates of the methyl and ethyl esters are formed), and one is included in an isolated keto group (band at 1708 cm^{-1}), which is also confirmed by the UV spectrum: λ 282 mμ (log ε 1.57), the maximum at 282 mμ being characteristic of all the derivatives investigated.

Thus, this acid is a dihydroxyketotriterpene acid, and it has been isolated from the roots of Meristotropis triphylla for the first time. At the present state of the investigation, we propose to call it triphyllic acid.

Experimental

The extraction of the roots, the treatment of the extract, and its hydrolysis in methanol acidified with 5-7% sulfuric acid were carried out as described previously [1].

The neutral part of the hydrolyzate could not be separated by repeated recrystallization from solvents.

On preliminary chromatography of a mixture of the neutral substances of the hydrolyzate (10 g) on alumina (activity grade II) and elution with chloroform, a small amount of a liquid substance was obtained in the first fraction. In the subsequent two or three fractions the methyl ester of meristotropic acid (mp 277-279°), identical with the authentic ester, was found. After the elution of the methyl meristotropate, the following two fractions contained a mixture of substances which could not be separated by crystallization, depositing from solvents in the form of accretions of granules. Using thin-layer chromatography on alumina (inactive) with chloroform – alcohol (20 : 1) solvent, this mixture gave two spots (R_f 0.6 and 0.29). The mixture was separated on a column in the following way: 4 g of the mixture was dissolved in chloroform and was chromatographed on 320 g of alumina (activity grade II; length of column 80 cm, diameter 5.5 cm), being eluted with a mixture of chloroform and alcohol (5 ml of alcohol to 100 ml of chloroform). The fractions (50 ml each) were analyzed separately. The first fractions contained a substance with mp 217-219° and R_f 0.6 (methyl isomeristotropate). The subsequent fractions consisted of the initial mixture, which was rechromatographed. After the elution of a certain amount of the mixture (1.2-1.6 g), the following portions of eluate contained a substance with mp 266.5-268.5°, R_f 0.29 (methyl triphyllate).

Methyl isomeristotropate. On recrystallization from alcohol, it formed plates with mp 217-219°. Yield 0.05% (on the weight of the dry roots). The substance was readily soluble in acetone and chloroform, and less readily in benzene and ether, $[\alpha]_D$ +113° (c 5; chloroform). The IR spectrum had a maximum at λ 282 mμ (log ε 3.79) characteristic of a homoannular diene. IR spectrum: 1730 (ester CO group), 1708 (isolated ketone CO group in a six-membered ring), 1645 cm^{-1} (double bond).

Found, %: C 77.33, 77.76; H 9.95, 9.82. Calculated for $C_{33}H_{50}H_4$, %: C 77.6; H 9.86.

Isomeristotropic acid. A solution of 0.5 g of the methyl ester with mp 217-219° in 20 ml of alcohol containing 0.12 g of KOH was heated for 5-6 hr on a water bath. Then water was added, the mixture was acidified with sulfuric acid, and the precipitate was filtered off and recrystallized from alcohol. Mp 262.5-264.5° (plates). The acid was insoluble in ether, benzene, and chloroform; $[\alpha]_D$ +85° (c 5; dioxane). The UV spectrum had a maximum at λ 282 mμ (log ε 3.51). IR spectrum: 1723 (carboxyl group), 1687 cm^{-1} (ketone CO group).

Found, %: C 77.34, 77.15; H 9.78, 9.83. Calculated for $C_{32}H_{48}O_4$, %: C 77.38; H 9.73.

Ethyl isomeristotropate. A mixture of 0.5 g of isomeristotropic acid and 30 ml of ethanol containing 0.6 ml of sulfuric acid was boiled for 6-7 hr. The mixture was cooled and diluted with water, and the precipitate was filtered off, washed with water, dried, and recrystallized from alcohol. Mp 152-153°, $[\alpha]_D$ +100° (c 2.5; chloroform). The substance was readily soluble in chloroform and acetone. IR spectrum: intense bands at 1732 (ester CO group), 1713 (ketone CO group), and 1647 cm^{-1} (double bond).

Found, %: C 78.16, 78.13; H 10.15, 10.25. Calculated for $C_{34}H_{52}O_4$, %: C 77.81; H 9.98.

Acetate of methyl isomeristotropate. A solution of 0.5 g of the methyl ester in 12 ml of acetic anhydride containing 0.3 g of sodium acetate was heated to its boiling point over a period of 5 hr. The mixture was then diluted with water, heated for 15 minutes, and filtered, and the residue was washed with water. It was recrystallized from alcohol. Mp 271-272.5°, $[\alpha]_D$ +109.6° (c 5; chloroform). The UV spectrum had one maximum at λ 282 mμ (log ε 3.8). IR spectrum: 1725 (common maximum of the ester CO groups) and 1700 cm^{-1} (ketone CO group).

Found, %: C 75.86, 75.96; H 9.48, 9.54. Calculated for $C_{35}H_{52}O_5$, %: C 76.04; H 9.48.

Under similar conditions, 0.2 g of ethyl isomeristotropate gave the corresponding acetate with mp 222.5-224.5° (from alcohol), $[\alpha]_D$ +60° (c 2.5; chloroform). The IR spectrum retained the maximum at λ 282 mμ (log ε 3.58). IR spectrum: 1727 and 1703 cm^{-1}.

Found, %: C 76.34, 76.32; H 9.45, 9.43. Calculated for $C_{36}H_{54}O_5$, %: C 76.28; H 9.60.

Methyl triphyllate. The substance isolated gave only one spot with R_f 0.29 (inactive alumina, in chloroform). The substance, after recrystallization from alcohol, had the form of regular hexagonal plates, mp 266.5-268.5°. Yield 0.1% (of the weight of the dry roots). It was sparingly soluble in ether and alcohol; $[\alpha]_D$ +14.9° (c 1.2; chloroform). The UV spectrum had a maximum at λ 282 mμ (log ε 1.38) (non-conjugated ketone). IR spectrum: 1725 (ester CO group), 1700 (ketone CO group in a six-membered ring), and 1658 cm^{-1} (double bond).

Found, %: C 74.25, 74.20; H 9.67, 9.74. Calculated for $C_{31}H_{48}O_5$, %: C 74.35; H 9.66.

Triphyllic acid. A solution of 0.2 g of the ester of triphyllic acid in 46 ml of ethanol containing 0.5 g of KOH was heated for 4 hr. The mixture was diluted with water and acidified, and the precipitate was filtered off, washed with water, and recrystallized from alcohol, mp 317-319°, $[\alpha]_D$ +5° (c 5; pyridine). The acid was sparingly soluble in chloroform and dioxane, and readily soluble in pyridine. The UV spectrum had a maximum at λ 282 mμ (log ε 1.57) (CO group of a non-conjugated ketone). IR spectrum: 1729 (carboxyl CO group) and 1708 cm^{-1} (ketone CO in a six-membered ring).

Found, %: C 74.25, 74.02; H 9.57, 9.47. Calculated for $C_{30}H_{46}O_5$, %: C 74.03; H 9.52.

Ethyl triphyllate. A solution of 0.6 g of triphyllic acid in 30 ml of 4% ethylsulfuric acid was heated for 6 hr. The mixture was cooled and diluted with water, and the precipitate was filtered off and washed with water, mp 212-213° (from alcohol), $[\alpha]_D$ +13.35° (c 3.75; chloroform). The UV spectrum had a maximum at λ 282 mμ (log ε 1.33). IR spectrum: 1724 (ester CO group), 1705 (ketone CO), and 1658 cm^{-1} (double bond).

Found, %: C 74.86, 74.83; H 9.76, 9.70. Calculated for $C_{32}H_{50}O_5$, %: C 74.70; H 9.72.

Saponification of ethyl triphyllate (under the conditions used for the methyl ester) gave the initial acid.

Diacetate of methyl triphyllate. A mixture of 0.2 g of the methyl ester, 2 ml of acetic anhydride and 0.1 g of sodium acetate was boiled for 5 hr. The mixture was diluted with water, heated for 15 min, and cooled, and the precipitate was filtered off, washed with water, dried, and recrystallized from alcohol; mp 234-235° (plates), $[\alpha]_D$ +15.5° (c 10; chloroform). The UV spectrum retained the maximum at λ 282 mμ (log ε 1.60). IR spectrum: 1734 (ester CO group), 1710 cm^{-1} (ketone CO group).

Found, %: C 71.17, 72.21; H 8.81, 8.87. Calculated for $C_{35}H_{52}O_7$, %: C 71.91; H 8.97.

On saponification (conditions as for the saponification of the methyl and ethyl esters), the diacetate of methyl triphyllate gave the initial triphyllic acid.

The diacetate of ethyl triphyllate was obtained from 0.3 g of ethyl triphyllate under the same conditions as for the diacetate of the methyl ester; mp 222-224° (from alcohol), $[\alpha]_D$ +18° (c 2.5; chloroform). The UV spectrum had a maximum at λ 282 mμ (log ε 1.49) (non-conjugated ketone). IR spectrum: 1735 (common maximum of the ester CO group) and 1712 cm^{-1} (ketone CO group).

Found, %: C 72.31, 72.29; H 9.17, 9.17. Calculated for $C_{36}H_{54}O_7$, %: C 72.20; H 9.09.

The roots for the investigation were collected in the neighborhood of the town of Ashkhabad. The analyses were carried out by E. A. Sokolova, and the IR spectra were recorded by T. V. Burkeeva on a IKS-14 instrument in liquid paraffin. The investigation is continuing.

Summary

Triterpene substances hzve been found in aqueous extracts of the roots of Meristotropis triphylla Fisch. et Mey. on acid hydrolysis in methanol. Two new triterpene acids, isomeristotropic and triphyllic acids, have been isolated and characterized.

REFERENCE

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5 May 1965

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