PHENOLS OF Ferula prangifolia

Kh. M. Kamilov and G. K. Nikonov

UDC 547.913.5 : 668.5; 547.587.52

As reported previously [1-4], esters of aromatic hydroxy acids and terpenoid alcohols are found in plants of the genus Ferula. Also found in the form of esters are some coumarins (mogoltin [5-7]) and sesquiterpene lactones (badkhysin [8], oopodin and dehydrooopodin [13]), and there is also a considerable group of terpenoid alcohols present in the free state (ugamdiol, chimgandiol, ovindiol, angrendiol, and others [9, 10]) and numerous sesquiterpene hydroxy lactones. It is logical to assume that the latter may be present in the plants in the form of unknown and more complex compounds the search for and study of which are of undoubted interest.

We have investigated the roots of Ferula prangifolia (Boiss) Korov collected on the slopes of Mt. Bol'shoi Chimgan in the flowering period. According to the literature [11], the resin of the roots of this species contains diols of the azulene series [12].

By thin-layer chromatography we established the presence in the roots of two substances with R_f 0.15 and 0.25 [hexane–benzene–methanol (5 : 4 : 1)] giving no reactions with diazotized sulfanilamide but revealed by a solution of vanillin in concentrated sulfuric acid.

By column chromatography on silica gel we isolated two substances which proved to be esters, $C_{17}H_{22}O_3$ with mp 158-159°C, $[\alpha]_D^{20}$ −60.2° (c 1.0; ethanol) R_f 0.25 (I) and $C_{19}H_{24}O_4$ with mp 80-81°C, $[\alpha]_D^{20}$ + 82.5° (c 1.0; ethanol) R_f 0.15 (II).

The UV spectrum of the first compound had a maximum [λ_{max} 260 nm (log ε 3.80)] showing the presence of a benzene ring, and its IR spectrum had bands at 3400 cm^{-1} (phenolic hydroxyl), 1690, 1230, 1320, and 1115 cm^{-1} (ester of an unsaturated acid), 1170 and 1370 cm^{-1} (gem-dimethyl group), 1610, 1600, and 1520 cm^{-1} (aromatic nucleus), and 825 cm^{-1} (1,4-disubstituted benzene ring). Its NMR spectrum showed the signals of three methyl groups located on quaternary carbon atoms – singlets at 0.84 ppm (6H) and at 0.91 ppm (3H) (in a previous paper [1], the latter signal was erroneously described as a doublet). In addition to this, there were the signals of a methine proton at 4.9 ppm, J = 12 Hz, present in the geminal position to an ester group and the signals of axial and equatorial protons – a multiplet in the 1.2-2.6-ppm region (7H).

The saponification of (I) with caustic alkali gave an aromatic hydroxy acid with mp 205-205.5°C and a sesquiterpene alcohol with mp 194-195°C which were identified on the basis of mixed melting points and IR spectra as, respectively, p-hydroxybenzoic acid and *l*-borneol. Thus, the structure of (I) corresponded to that of chimgin, an ester isolated previously from the roots of Ferula tschimganica Lipsky [1].

The results of a comparison of their IR spectra and of a mixed melting point of (I) and chimgin showed that they are identical. At the same time, (I) differs from chimgin in its optical activity [for (I) $[\alpha]_D^{20}$ −60.2°C; for chimgin + 4.9°C] and it is therefore its *l* isomer.

The second substance, which we have called ferungin has a UV spectrum identical with that of chimgin (λ_{max} 260 nm, log ε 3.85) and similar bands in the IR spectrum – 1690, 1615, 1590, 1520, and 825 cm^{-1} (Fig. 1) – corresponding to p-hydroxybenzoic acid. In addition, it has a maximum at 3500 cm^{-1} showing the presence of a free hydroxy group. The NMR spectrum of (II) showed the following signals: two doublets at 7.67 and 6.77 ppm, J = 9.5 Hz (2H each) (ortho protons of an aromatic nucleus), a multiplet in the 5.4-ppm

Institute of the Chemistry of Plant Substances, Academy of Sciences of the Uzbek SSR. Translated from Khimiya Prirodnykh Soedinenii, No. 6, pp. 718-721, November-December, 1972. Original article submitted March 28, 1972.

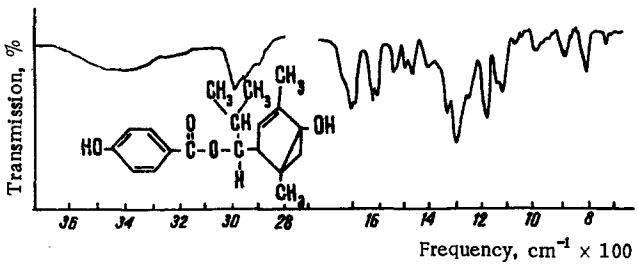

Fig. 1. IR spectrum of ferungin (in KBr).

region (olefinic proton), a triplet at 5.1 ppm, J_1 = 9 Hz with traces of secondary splitting having J_2 = 2 Hz (methine proton in the geminal position to an acyl residue), a three-proton singlet at 1.75 ppm (methyl group of a double bond), three-proton doublets at 0.95 and 0.85 ppm (methyl groups on a secondary carbon atom), and a singlet at 1.1 ppm (3H) (methyl group on a tertiary carbon atom).

The saponification of ferungin gave an alcohol with the composition $C_{12}H_{20}O_2$, mp 84-85°C, and an acid $C_7H_6O_3$ with mp 212-213°C. The alcohol was identified by its IR spectrum and a mixed melting point with an authentic sample as ferutinol [2] and the acid as p-hydroxybenzoic.

Thus, ferungin is a new, previously unknown, ester of ferutinol and p-hydroxybenzoic acid.

EXPERIMENTAL

The NMR spectrum was taken on a JNM-4H-100/100 MHz spectrometer (CCl_4, the chemical shifts are given in the δ scale from the signal of HMDS taken as 0), the IR spectrum on a UR-20 instrument (KBr), and the mass spectrum on an MKh-1303 instrument.

Isolation of *l*-Chimgan. The comminuted roots of Ferula pragifolia (7 kg) were extracted with methanol (24, 20, and 30 liters). The extracts were combined, evaporated in vacuum to small volumes (2.5 liters), mixed with water (1 : 2), and treated with ether (10 × 300 ml). The ethereal solution was dried with sodium sulfate and evaporated to an oily residue (620 g).

The extract (25 g) was transferred to a column filled with silica gel (1 : 20) and elution was performed first with petroleum ether, 0.5-liter fractions being collected (fractions I-X) and then with petroleum ether–ethyl acetate (99 : 1). Fractions X-XV were combined, evaporated in vacuum to dryness, and dissolved in benzene (2 ml), and petroleum ether was added (18 ml). About 4 g (1.4%) of a colorless crystalline substance with mp 158-159°C precipitated.

Hydrolysis of *l*-Chimgan. A. Isolation of *l*-Borneol. A mixture of 1.0 g of the substance and 50 ml of 10% aqueous caustic soda was heated in the water bath for 30 min, and was then cooled and extracted with ether (3 × 300 ml). The ethereal solution was evaporated and the residue was sublimed in vacuum. This gave small colorless crystals with mp 194-195°C.

B. Isolation of p-Hydroxybenzoic Acid. The alkaline solution after the removal of the borneol was acidified with 10% sulfuric acid and extracted with ether. The ethereal extract was evaporated and the residue was recrystallized from water. This gave 0.2 g of colorless acicular crystals with mp 205-205.5°C.

Isolation of Ferungin. When the chromatographic column was eluted with a mixture of petroleum ether and 5% of ethyl acetate and 0.5-liter fractions were collected, fractions XV-XX yielded a crystalline substance with mp 80-81°C (from H_2O).

The hydrolysis of the ferungin and the isolation of the hydroxy acid and ferutinol were performed by the method described above. The hydroxy acid obtained had mp 212-213°C (from H_2O), and the ferutinol mp 84-85°C (from H_2O).

SUMMARY

From the roots of Ferula prangifolia (Boiss) Korov. two phenolic components have been isolated that are esters of p-hydroxybenzoic acid and sesquiterpene alcohols. On the basis of their physicochemical constants and hydrolysis products it has been shown that one of them is *l*-chimgin (borneol p-hydroxybenzoate) and the second, which has been called ferungin, is ferutinol p-hydroxybenzoate.