ALKALOIDS OF *Rhinopetalum bucharicum*.

THE STRUCTURE OF RHINOLININE

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The combined alkaloids of the epigeal part of *Rhinopetalum bucharicum* have yielded solanidine, rhinoline, imperialine, a base with mp 272-274°C, and the new alkaloid rhinolinine with mp 301-302°C (methanol), $[\alpha]_D$ − 36.5° (c 1.7, ethanol), $C_{40}H_{67}NO_{12}$. On the basis of a study of IR and NMR spectra, and also passage to the known alkaloids rhinoline and rhinolidine, the structure of rhinolidine 3-O-[O-β-D-glucopyranosyl-(1→4)-β-D-glucopyranoside] has been established for rhinolinine.

Solanidine, rhinoline, and a base with mp 301-302°C [1], and also imperaline [2, 3], and an alkaloid with mp 272-274°C have previously been isolated from the epigeal part of *Rhinopetalum bucharicum* Regel.

The base with mp 301-302°C, $[\alpha]_D$ − 36.5°, $C_{40}H_{67}NO_{12}$, has proved to be new, and we have called it rhinolinine. Rhinolinine is a tertiary base, and its IR spectrum has absorption bands at (cm^{-1}) 3400 (OH), 2963-2855, 1460, 1447 (—CH_3; —CH_2—), 2795 (N—CH_3), and 1110-1020 (broad absorption band characteristic for glycoalkaloids) [4, 5]. The PMR spectrum shows singlets at (ppm) 0.90 (3 H, 18-CH_3), 0.98 (3 H, 19-CH_3), 2.20 (N—CH_3), and a doublet at 1.03 (3 H, 21-CH_3), and the multiplet of a vinyl proton at 5.30 (1 H).

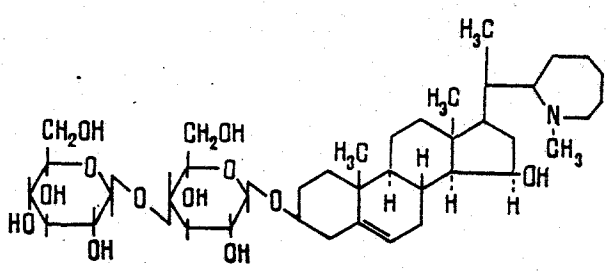
The hydrolysis of rhinolinine with hydrochloric acid gave an aglycone with mp 199-201°C, composition $C_{28}H_{47}NO_2$, identical with rhinolidine [1]. Two molecules of D-glucose were detected in the sugar moiety (GLC and paper chromatography).

Thus, rhinolinine is a glycoalkaloid derived from rhinolidine. The carbohydrate moiety may be present at C_3 or C_{15}.

Acetylrhinolinine was obtained, and in its NMR spectrum the signal of the 18-CH_3 group had shifted by 9 Hz upfield as compared with the same group of rhinolinine. Consequently, the hydroxy group in rhinolinine at C_{15} is free.

The partial hydrolysis of rhinolinine gave rhinoline and rhinolidine [1].

When rhinolinine was subjected to Hakomori methylation [6] followed by hydrolysis of the products obtained, substances were isolated that were identical with the products from a hydrolysate of a permethylate of cellobiose — 2,3,4,6-tetra-O-methyl-D-glucose and 2,3,6-tri-O-methyl-D-glucose (1:1). Consequently, in the rhinoline molecule the glucose forming the carbohydrate chain is attached at C_3. The configurations of the glycosidic centers were determined by means of Klyne's rule [7].



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On the basis of the facts given above, rhinolinine has the structure of rhinolidine 3-O-[O-β-D-glucopyranosyl-(1→4)-β-D-glucopyranoside].

EXPERIMENTAL

Thin-layer chromatography (TLC) was performed in a fixed layer of KSK silica gel (100 mμ). The following solvent systems were used: 1) chloroform–methanol (10:0.5); 2) chloroform–methanol (10:1.5); 3: chloroform–methanol (10:2); 4) benzene–acetate (3:1); and 5) chloroform–methanol (10:3). The revealing agent was Dragendorff's solution. Carbohydrates were detected on a paper chromatogram (Whatman type FN 17)* in the butan-1-ol–pyridine–water (6:4:3) system. The time of chromatography was 15 h and the revealing agent was aniline phthalate.

Gas–liquid chromatography (GLC) was performed on a "Tsvet-4" chromatograph. Carbohydrates were determined in the form of the trimethylsilyl ethers of methyl glycosides [8, 9] using a column (3 m×3 mm) filled with 5% of SE-30 silicone phase on Chromaton N-AW. The temperature of the thermostat was 190°C, and the carrier gas was He at the rate of 48 ml/min. The methyl glycosides of the methylated carbohydrates were obtained by boiling the ethers in 5% methanolic HCl and were chromatographed on a column (1 m×3 mm) containing 20% of butane-1,4-diol succinate on Celite (phase 1) or 10% of polyphenol ether on Chromaton N-AW (phase 2). The temperature of the thermostat was 180°C, and the carrier gas was He [10].

The IR spectra were obtained on a UR-20 spectrometer in KBr, and the NMR spectra on a JNM-4H-100 instrument [in $CDCl_3$–CD_3OD (1:1) with HMDS as internal standard (δ scale)].

Isolation of the Combined Alkaloids. The epigeal part of *Rhinopetalum bucharicum* (460 g) was wetted with 10% ammonia, and the alkaloids were extracted with chloroform in a continuous apparatus until the bases had been extracted completely. The alkaloids were re-extracted with chloroform from a sulfuric acid solution made alkaline with ammonia. This gave 0.92 g of combined bases (0.2% of the weight of the dry plant).

Separation of the Combined Alkaloids. The total alkaloids (0.92 g) were dissolved in chloroform–methanol (10:2) and chromatographed on a column of silica gel with elution by chloroform–methanol (10:2 and 10:4). The eluates were collected in 10-ml fractions, the total number of fractions being 48. The combined fractions 3-6 were rechromatographed on a column of alumina and were eluted with chloroform. The first eluates yielded solanidine [1, 11] with mp 209-211°C (acetone), R_f 0.48 (system 1).

Fractions 7-11 (0.06 g) were rechromatographed on a column of silica gel and were eluated with chloroform–methanol (10:0.5). A base was isolated with mp 265-267°C (ethanol), which was identified as imperialine, R_f 0.05 (system 1).

Fractions 12-20, on treatment with methanol, gave 0.26 g of rhinoline [1] with mp 255-257°C (methanol), $[\alpha]_D$ − 53.2° (c 1.94; ethanol), R_f 0.27 (system 2).

Fractions 30-40 were combined, and on treatment with methanol they yielded rhinolinine with mp 301-302°C (methanol), $[\alpha]_D$ − 36.5° (c 1.7; ethanol), R_f 0.06 (system 2).

The chloroform–methanol (10:4) eluate, after treatment with methanol, gave a base with mp 272-274°C (methanol), R_f 0.05 (system 5).

Hydrolysis of Rhinolinine. Rhinolinine (0.1 g) was hydrolyzed with a 10% solution of hydrochloric acid in the presence of ethanol (1:1), the mixture being heated on the water bath for 3 h. Then the ethanol was evaporated off in vacuum and the residue was made alkaline with ammonia and was extracted with chloroform. The chloroform was distilled off and the residue was treated with acetone. This gave white acicular crystals with mp 199-201°C (acetone), $[\alpha]_D$ − 52.9° (c 1.70; ethanol), $C_{28}H_{47}NO_2$, R_f 0.25 (system 1), M^+ 429, identical with rhinolidine.

In the alkaline solution after the isolation of the rhinolidine, D-glucose was detected by paper chromatography.

Acetylrhinolinine. Rhinolinine (0.12 g) was acetylated with acetic anhydride (2 ml) in pyridine (1.5 ml). This gave amorphous acetylrhinolinine with R_f 0.45 (system 4) the IR spectrum of which lacked the absorption band of an OH group and showed the absorption bands of an ester carbonyl at 1760 and 1238 cm^{-1}.

*As in Russian Original – Publisher.

NMR spectrum (ppm): singlet at 0.81 (3 H, 18-CH_3), 0.93 (3 H, 19-CH_3), 2.14 (N-CH_3), 1.95 (12 H, $OCOCH_3$), 2.01 (6 H, $OCOCH_3$), and 2.03 (6 H, $OCOCH_3$), doublet at 1.05 (3 H, 21-CH_3), and multiplet at 5.26 (C=CH).

Partial Hydrolysis of Rhinolinine. A solution of 30 mg of the base in 1.5% sulfuric acid was boiled for 3 h. The hydrolysate was diluted with water, made alkaline with ammonia, and extracted with chloroform. On TLC (system 3), the chloroform residue showed three spots with R_f 0.16, 0.40, and 0.78 in a ratio of 1:1:1. These R_f values coincided with those for rhinolinine, rhinoline, and rhinolidine. All three substances were obtained by separation on a column of silica gel.

Rhinolinine Permethylate. With shaking (90 min at room temperature), 0.3 g of sodium hydride was added to 100 mg of rhinolinine in 15 ml of dimethyl sulfoxide. Then 20 ml of methyl iodide was added over an hour and stirring was continued for another two hours. The reaction product was left overnight and it was then poured into an aqueous solution of sodium sulfite and was extracted with chloroform. The residue after the evaporation of the chloroform showed two spots with R_f 0.35 (in greater yield) and 0.16 (system 3), the latter coinciding with the R_f value of rhinolinine. To obtain the pure methylated product, the mixture was passed through a column of alumina. On elution with chloroform–methanol (10:0.3), the amorphous rhinolinine permethylate (R_f 0.35) was isolated.

Hydrolysis of Rhinolinine Permethylate. A solution of 20 mg of rhinolinine permethylate in 5 ml of 10% sulfuric acid was boiled for 6 h. Then the acid solution was neutralized with barium carbonate and the precipitate was filtered off. The filtrate was evaporated in vacuum. In TLC on type LS-50 mμ silica gel (Czechoslovakia) in the ethyl ketone–1% NH_4OH (30:4) system with a running time of one hour (l = 10 cm), the residue showed spots with R_f 0.48 and 0.75, identical with those of a hydrolysate of cellobiose permethylate. The revealing agent was aniline phthalate (105-110°C, 10 min).

SUMMARY

1. Solanidine, rhinoline, imperialine, a base with mp 272-274°C, and the new base rhinolinine have been isolated from the combined alkaloids of the epigeal part of *Rhinopetalum bucharicum*.

2. On a basis of the study of the chemical transformations and IR and NMR spectra of rhinolinine, the structure of rhinolidine 3-O-[O-β-D-glucopyranosyl-(1→4)-β-D-glucopyranoside] has been suggested for it.

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