THE STRUCTURE OF SESELIRIN: A NEW CHROMONE FROM THE ROOTS OF SESELI SESSILIFLORUM

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From the roots of Seseli sessiliflorum Schrenk (family Umbelliferae) collected by M. G. Pimenov in the summer of 1969 in the region of the Turaigyr range (Kazakhstan) we have isolated a new chromone with the composition $C_{19}H_{20}O_6S$, mp 194–195° C (from methanol), $[\alpha]_D^{21}$ −165.4° (c 0.41, chloroform), mol wt 376 (mass spectrometry), and we have called it "seselirin" (I).

The UV spectrum of I (λ_{max} 224, 258, and 294 mμ, log ε 4.20, 4.38, and 4.39) and in particular its high absorption coefficient at 258 mμ are typical for chromones [1-3]. The fact that seselirin is a chromone is also shown by its IR spectrum (Fig. 1): 1650, 1625, and 1585 cm^{-1} (—C=C— and C=O bonds of a chromone nucleus) [4]. A strong absorption band at 1700 cm^{-1} indicates the presence of the carbonyl group of an α,β-unsaturated ester. The latter hypothesis is confirmed by the capacity of seselirin for undergoing acid and alkaline hydrolyses, giving a product II, $C_{15}H_{16}O_5$, with mp 198–200° C, $[\alpha]_D^{19}$ −15.8° (c 0.63, chloroform).

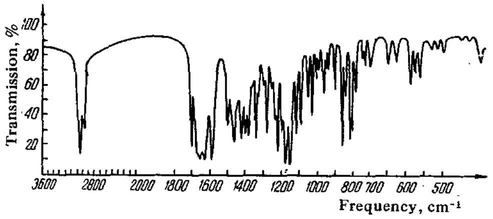


Fig. 1. IR spectrum of seselirin (mull in paraffin oil).

The UV spectrum of II (λ_{max} 252, 256, and 296 mμ, log ε 4.31, 4.32, and 4.02) indicates that the substance contains a chromone nucleus. The IR spectrum of II has a new band at 3525 cm^{-1}. Consequently, its molecule contains a free hydroxyl group of an alcoholic nature. The results of elementary analysis show the presence in II of a second hydroxyl group which, judging from the positive reaction of the compound with ferric chloride, has a phenolic nature.

The number and nature of the hydroxyl groups in II are confirmed by the formation of a diacetate, $C_{19}H_{20}O_7$, with mp 184–186° C, whose IR spectrum lacks the absorption band of an OH group, and whose NMR spectrum has three-proton singlets at 2.07 and 2.43 ppm, characteristic for aliphatic and aromatic acetoxy groups.

The diffuse absorption band in the 2500–2750 cm^{-1} region in the IR spectrum of the product from the saponification of seselirin shows the formation of an intramolecular hydrogen bond. The presence of a phenolic hydroxyl group in the molecule is shown by a bathochromic shift of the long-wave maximum (by 63 mμ) in the UV spectrum (in the presence of caustic alkali) and also by the band at 1765 cm^{-1} in the IR spectrum, which is characteristic for a conjugated carbonyl, and the presence of an intramolecular hydrogen bond is shown by a one-proton singlet at 12.95 ppm in the NMR spectrum (Fig. 2). The formation of a chelate bond in the structure under discussion is possible if the OH group is present in position 3 or 5.

A somewhat broadened singlet (1H) at 5.95 ppm relates to H_3 of the chromone nucleus, interacting with the protons of the methyl group at C_2 (the signal of the latter is found at 2.35 ppm, J = 1 Hz). Therefore, the hydroxy group is located at position 5.

The singlets at 1.42 and 1.38 ppm (3H each), a two-proton multiplet with a center at 2.91 ppm, and a one-proton multiplet at 3.85 ppm are due to the methyl, methylene, and methine protons of a dihydropyran ring attached to a benzene nucleus in position 5', 6' and having a hydroxyl group in position 3' [5]. The signal of an isolated proton of a benzene nucleus is located at 6.28 ppm.

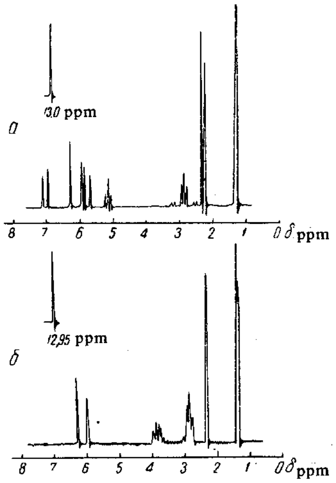
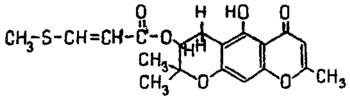
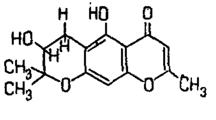


Fig. 2. NMR spectrum of a) seselirin and b) the product of its hydrolysis in deuterochloroform.

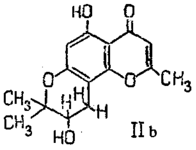
Thus, substance II has the structure IIa or IIb.



I



IIa



IIb

Structure IIa corresponds to the natural dihydropyranochromone hamaudol [6]. A comparison of the physical constants of the saponification product of seselirin (mp 198–200° C, $[\alpha]^{19}_{D}$ −15.8° (c 0.63, chloroform) and of hamaudol (mp 197–197.5° C, $[\alpha]^{32}_{D}$ −18°), their diacetates (mp of the diacetate of II is 184–186° C, of the diacetate of hamaudol 185–185.5° C), and also their NMR spectra lead to the conclusion that these substances are identical.

In the seselirin molecule, only the secondary hydroxyl is esterified. The presence of a phenolic hydroxyl is shown by the positive reaction with ferric chloride, by the presence of a singlet (1H) at 13.0 ppm in the NMR spectrum, and by the absence of the band of a free hydroxyl group in the IR spectrum. In the NMR spectrum of seselirin, the shift of the signal of the methine proton of the dihydropyran ring downfield by 1.33 ppm due to the acylation of the secondary hydroxyl group in II is in agreement with the proposed structure.

Thus, the acyl residue C_4H_5OS is located in position 3' of the dihydropyran ring.

A comparison of the NMR spectra of seselirin and hamaudol shows that the one-proton doublet at 5.78 and 7.05 ppm (J = 10.0 Hz) and the three-proton singlet at 2.4 ppm are due to the acid residue. The singlet at 2.4 ppm belongs to a $-S-CH_3$ group, the quadruplet at 5.78 and 7.05 ppm is caused by the protons of a $-CH=CH$ group. Therefore, the acid residue must have the structure $CH_3-S-CH=CH-COOH$. This is confirmed by the low value of the C=O frequency in the IR spectrum of seselirin and by a certain downfield shift of the $-S-CH_3$ signal in its NMR spectrum. Consequently, the structure 2',2'-dimethyl-3'-(3-methylthioacryloyloxy)-3',4'-dihydropyrano-5',6':6,7-(5-hydroxy-2-methyl) chromone (I) may be proposed for seselirin.

EXPERIMENTAL

The UV spectra were taken on an SF-4A spectrophotometer (ethanol and a 0.03 N ethanolic solution of KOH), the IR spectra on a UR-10 spectrophotometer (mulls in paraffin oil), and the NMR spectra on a T-60 (60 MHz) instrument in $CDCl_3$ (o is tetramethylsilane). The mass spectrometric determination of the molecular weight was carried out by P. I. Zakharov and the microanalyses were performed by E. A. Nikonova. The elementary analyses of all the compounds corresponded to the calculated figures.

Isolation of seselirin. The air-dried and comminuted roots of Seseli sessiliflorum (1.2 kg) were extracted with methanol (3 × 5 *l*). The combined extracts (10.8 *l*) were evaporated to a volume of 220 ml, diluted with a double volume of water, and treated with ether (10 × 250 ml). The ethereal extracts were washed with 5% sodium carbonate solution (5 × 100 ml) and water (3 × 100 ml) and dried over Na_2SO_4, and the solvent was evaporated off in vacuo. The residue (67.0 g) was transferred to a column of KSK silica gel (7.5 cm in diameter and 34 cm high). Elution was carried out with a mixture of petroleum ether and ethyl acetate with a gradually increasing concentration of the latter, and 500-ml fractions were collected. Fractions 19–23 [eluent: petroleum ether–ethyl acetate (85 : 13)] yielded 1.3 g of a crystalline substance with mp 194–195° C, $[\alpha]^{21}_{D}$ −165.4° (c 0.41, chloroform). Found, %: C 60.5; H 5.35; S 81.8. Mol wt 376 (mass spectrometry). Calculated for $C_{19}H_{20}O_6S$, %: C 60.62; H 5.35; S 8.49. Mol wt 376.41.

Saponification of seselirin. A mixture of 0.5 g of seselirin and 30 ml of 0.25 N methanolic KOH was heated in the water bath for 1 hr. Then the reaction mixture was diluted with a double volume of water and acidified with 10% H_2SO_4 solution, and the methanol was distilled off in vacuo. The crystalline residue (0.3 g) was filtered off and recrystallized from methanol. It had the composition $C_{15}H_{16}O_5$, mp 198–200° C, mol wt 276 (mass spectrometry).

Acid hydrolysis of seselirin. A mixture of 0.3 g of seselirin and 30 ml of a 0.1 N solution of HCl in methanol was heated for 12 hr. The crystals (0.19 g) that deposited when a double volume of water was added had mp 198–200° C after recrystallization from methanol.

Acetylation of the hydrolysis product of seselirin. A mixture of 0.1 g of the substance, 1.0 ml of acetic anhydride, and 0.1 g of sodium acetate was heated in a water btah for 2 hr. The precipitate after the addition of 50 ml of water was recrystallized from an ethyl acetate–petroleum ether mixture (1: 3). It had the composition $C_{19}H_{20}O_7$, mp 184–186° C.

CONCLUSIONS

From the roots of *Seseli sessiliflorum* Schrenk a new chromone has been isolated for which the structure of 2',2'-dimethyl-3'-(3-methylthioacryloyloxy)-3',4'-dihydropyrano-5',6': 6,7-(5-hydroxy-2-methyl) chromone has been proposed. It is the first representative of this group of natural compounds containing sulfur.

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