The Structure of Glaupalol, a Novel Furanocoumarin from *Glaucidium palmatum* Sieb. et Zucc.

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EXTRACTION of the rhizomes of *Glaucidium palmatum* Sieb. et Zucc.† (Ranunculaceae) has yielded a new type of coumarin, glaupalol, $C_{15}H_{16}O_4$ molecular ion at *m/e* 260, m.p. 202—204°, optically inactive (optical rotatory dispersion curve), for which we suggest the structure (I).

Glaupalol (I) showed phenolic properties,[1] and was characterized as its monoacetate (II), m.p. 119—120° and the methyl ether (III), m.p. 76—77°. In agreement with this, the ultraviolet spectrum exhibited absorptions at 213, 296, 310, and 340 mμ (ε 45,600, 15,400, 13,500, and 5750), shifting on basification to 247, 310, and 385 mμ (ε 27,500, 17,000, and 2910), and the infrared spectrum showed bands at 3200 (OH), 1675 (hydrogen-bonded α-pyrone), 1625 (double bond), and 1565 cm.$^{-1}$ (aromatic ring). All sixteen protons were assigned in the n.m.r. spectrum (60 Mc./sec.) of glaupalol. The presence of two tertiary methyls, singlets at τ 8·73 and 8·53 and one methyl side-chain, singlet at τ 7·40, attached to an aromatic ring was readily deduced from the n.m.r. spectrum. One secondary methyl group, doublet at τ 8·52 (J = 6·5 c./sec.), and one proton, quartet at τ 5·33 (J = 6·5 c./sec.), were assigned to be attached to the carbon bearing an ether-type oxygen and a fully substituted carbon atom as shown by demonstrating their coupling by double resonance. Two aromatic protons located in *ortho*-positions appeared as an AB-type quartet (J_{AB} = 9 c./sec.) at τ 3·00 and 2·80 and a hydroxyl proton at τ 2·92 disappeared on treatment with deuterium oxide.

Glaupalol methyl ether (III) gave on alkaline hydrolysis an unsaturated phenolic acid which reverted to the starting material on attempted acetylation with acetic anhydride and was characterized as its methyl ester (IV), m.p. 128—129°, whose ultraviolet spectrum, λ_{max} (EtOH) 263 mμ (ε 11,750), resembled that of *cis*-cinnamic acid. As a phenol (IV), the absorption maxima were shifted to longer wavelengths at 297 and 310 mμ (ε 13,800 and 12,300) in a sodium hydroxide solution indicating that glaupalol has a coumarin skeleton. The position of the free hydroxyl group at C-6 in this coumarin was made probable by the isolation of toluhydroquinone on alkaline fusion of glaupalol (I).

† The plant materials used by the group at the Kyoto University were kindly supplied by Dr. M. Tamura, Osaka University, and Dr. S. Ishizawa, Niigata University.

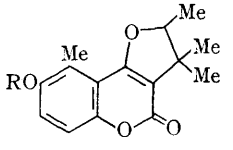
Ozonolysis of *O*-methylglaupalol (III) gave from the ethyl acetate layer the neutral keto-dilactone (V), $C_{16}H_{18}O_6$, m.p. 132—133° and the phenolic acid (VI), $C_9H_{10}O_4$, m.p. 141—142° and from the aqueous layer the keto-lactone (VII), $C_7H_{10}O_2$, as its 2,4-dinitrophenylhydrazone (VIII). Compounds (VI) and (VIII) were also isolated in the usual way after saponification of the keto-dilactone (V) in boiling methanolic hydrochloric acid, confirming that (VI) and (VII) are, in fact, fission products of (V). The phenolic acid (VI) gave, on decarboxylation in boiling quinoline in the presence of copper powder, 5-hydroxy-2-methoxy-toluene (IX).[2] Therefore, considering the coupling constant ($J = 9$ c./sec.) of the two aromatic protons (AB-type quartet at τ 3·18 and 2·88) in the n.m.r. spectrum of the phenolic acid, it must have the structure of 2-hydroxy-5-methoxy-6-methyl-benzoic acid (VI).

The structure of the keto-lactone was elucidated by interpretation of the spectral properties of its 2,4-dinitrophenylhydrazone (VIII) which was isolated in *syn*- and *anti*-forms (VIIIa and VIIIb), m.p. 200—201° and 192—194°.

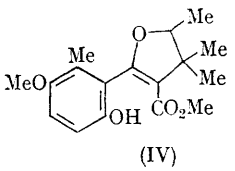
The infrared spectrum of the *syn*-form exhibited absorptions at 3160 (NH) and 1740 cm.$^{-1}$ (hydrogen-bonded γ-lactone) while that of the *anti*-form showed bands at 3250 (NH) and 1770 cm.$^{-1}$ (γ-lactone). The n.m.r. spectrum of the *syn*-form showed two singlets (3H each) at τ 8·72 and 8·59 for tertiary methyls, a doublet (3H, $J = 7$ c./sec.) at τ 8·56 for a secondary methyl attached to the carbon bearing the lactonized hydroxyl group and a quaternary carbon atom, a quartet (1H) at τ 5·42 ($J = 7$ c./sec.) coupled only with this secondary methyl and a singlet at τ −3·90 for a hydrogen-bonded imino-proton. The n.m.r. spectrum of the *anti*-form was quite similar to that of the *syn*-form showing peaks at τ 8·57 (3H, singlet), 8·36 (3H, singlet), 8·55 (3H, doublet, $J = 7$ c./sec.), 5·57 (1H, quartet, $J = 7$ c./sec.) except for the position of the NH proton which appeared in a higher field region at τ −1·75.

The *anti*-form was converted into the *syn*-form on sublimation *in vacuo* at about 190°. Based on these findings the keto-lactone is formulated as (VII) and accordingly the keto-dilactone and glaupalol are represented by the formulae (V) and (I), respectively.

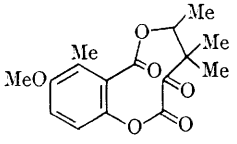
Occurrence of a coumarin derivative from a plant of the Ranunculaceae is interesting from the chemotaxonomical point of view.



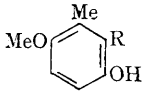
(I) R=H
(II) R=Ac
(III) R=Me



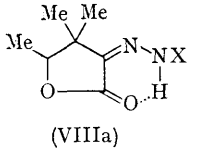
(IV)



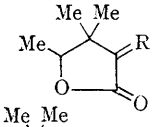
(V)



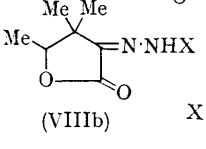
(VI) R=CO_2H
(IX) R=H



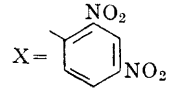
(VIIIa)



(VII) R=O
(VIII) R=N·NHX



(VIIIb)



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[1] S. Soloway and S. H. Wilen, *Analyt. Chem.*, 1952, **24**, 979.
[2] E. Bamberger, *Annalen*, 1912, **390**, 131.