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Xanthoarnol: A New Dihydrofuranocoumarin

In the course of our studies on the alkaloids of Rutaceous plants,[1] we have isolated a new nonphenolic dihydrofuranocoumarin as a minor component (0.00052%) of the roots (heartwood) of *Xanthoxylum arnottianum* Maxim.[2] We wish to designate this compound as xanthoarnol, and report here its structural elucidation.

Xanthoarnol (**1**) is a neutral compound isolated as colourless fine needles, mp 208—209°, $[\alpha]_D^{24}$ ±0° (c=1.36, MeOH). It shows the following spectral properties: IR ν_{max}^{Nujol} cm^{-1}: 3430, 3325 (OH), 1708 (C=O), 1630, 1577 (C=C); UV λ_{max}^{EtOH} mμ (log ε): 222.5 (4.15), 249 (3.58), 260 (3.52), 331 (4.27); NMR ($CDCl_3$+CD_3OD) δ: 1.28 (3H, singlet, C-CH_3), 1.32 (3H, singlet, C-CH_3), 4.37 (1H, doublet, J=4.4 Hz, $C_6H_5CH(OR)C\underline{H}(OR)$-), 5.33 (1H, doublet, J=4.4 Hz, $C_6H_5C\underline{H}(OR)CH(OR)$-), 6.19 (1H, doublet, J=9.0 Hz, C_3-H), 6.74 (1H, singlet, aromatic (C_8) H), 7.49 (1H, singlet, aromatic (C_5) H), 7.72 (1H, doublet, J=9.0 Hz, C_4-H). Mass Spectrum m/e: 262 (M^+; 16.5%), 229 (M^+-33; 68.1%), 187 (M^+-75; 100%). These spectral data indicate that **1** is a derivative of 6,7-disubstituted coumarin, having the partial structure (**3**). The fact that the ultraviolet spectrum of xanthoarnol (**1**) is almost superimposable on

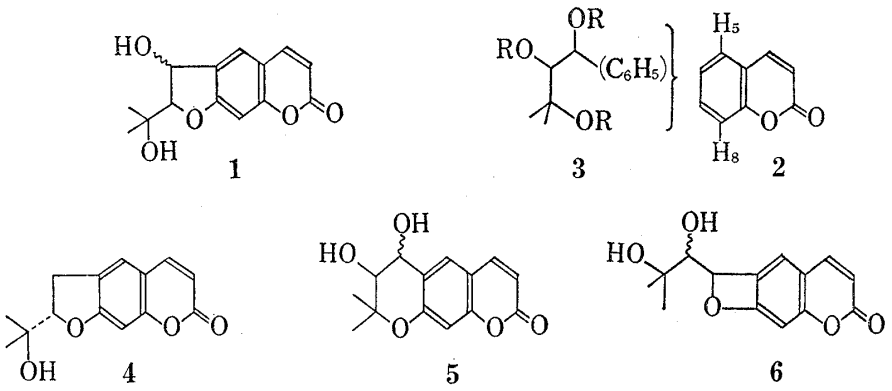

Chart 1

that of marmesin (**4**) indicates the presence of an oxygen atom at the C_7 position of the coumarin nucleus. These observations restrict the structural possibilities of xanthoarnol to the six structures, *cis* or *trans* isomers of the three structures shown by formulae (**1**), (**5**), and (**6**).

Because of the extremely small quantity of the natural product available to us, it was impossible to establish the structure by chemical transformation of the compound. We therefore attempted to compare the natural product with authentic samples.

Treatment of xanthyletin (**7**) with osmium tetroxide gave racemic *cis*-isokhellactone[3] (**5**) as colourless needles, mp 246—248°, IR ν_{max}^{Nujol} cm^{-1}: 3440, 3420 (OH), 1700 (C=O), 1630, 1560 (C=C). NMR ($CDCl_3$+CD_3OD) δ: 1.33 (3H, singlet, C-CH_3), 1.52 (3H, singlet, C-CH_3),

1) Preceeding paper; Part XIX: H. Ishii, H. Ohida and J. Haginiwa, *Yakugaku Zasshi*, **92**, 118 (1972); H. Ishii and K. Hosoya, *Chem. Pharm. Bull.* (Tokyo), **20**, 860 (1972).
2) Isolation work will be reported in a full paper (H. Ishii, K. Hosoya, T. Ishikawa and J. Haginiwa, *Yakugaku Zasshi*, in preparation). The plants were collected in the Bonin Islands and are called "Iwa-Zansho" in Japanese.
3) Sokolova, *et al.*[4] claimed that they have prepared the compound depicted by formula (**5**), and named it isokhellactone. However, we wonder why their hydrolysis of a diester of an originally optically active compound having two asymmetric centers yielded an optically inactive product. We will discuss on this in our full paper.
4) A.I. Sokolova and G.K. Nikonov, *Khim. Prir. Soedi.*, **6**, 14 (1970) [*Chem. Abstr.*, **73**, 35157r (1970)].

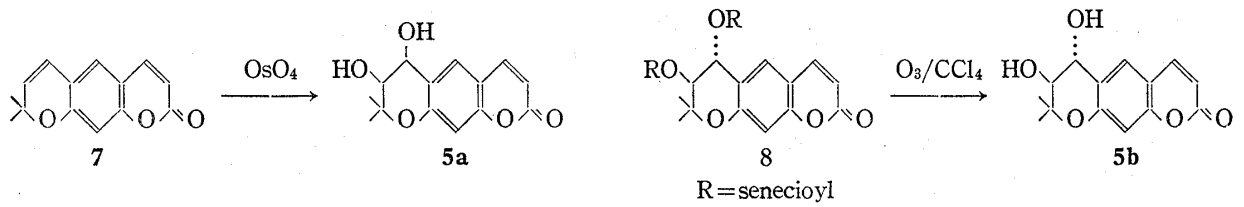

Chart 2

3.74 (1H, doublet, J=4.1 Hz, $C_{3'}$-H), 4.86 (1H, doublet, J=4.1 Hz, $C_{4'}$-H), 6.20 (1H, doublet, J=9.0 Hz, C_3-H), 7.76 (1H, doublet, J=9.0 Hz, C_4-H). Mass Spectrum m/e: 262 (M^+; 27.1%), 191 (M^+-71; 100%).

Recently, Sano, *et al.*[5] skilfully prepared the optically active (+)-*trans*-isokhellactone, mp 229—231°,[6] $[\alpha]_D^{20}$ +133.3° (c=1.63; MeOH), IR ν_{max}^{Nujol} cm^{-1}: 3675, 3580, 3427 (OH), 1733 (C=O); NMR ($CDCl_3$) δ: 1.37 (3H, singlet, C-CH_3), 1.53 (3H, singlet, C-CH_3), 2.71 (2H, br. singlet, 2×OH), 3.65 (1H, doublet, J=9.0 Hz, $C_{3'}$-H), 4.62 (1H, doublet, J=9.0 Hz, $C_{4'}$-H), 6.17 (1H, doublet, J=9.5 Hz, C_3-H), 6.69 (1H, singlet, C_5-H), 7.57 (1H, singlet, C_8-H), 7.58 (1H, doublet, J=9.5 Hz, C_4-H); Mass Spectrum m/e: 262 (M^+; 30.7%), 191 (M^+-71; 100%), by ozonolysis of the natural product decurisidin (**8**). Neither infrared (IR) spectrum in solution of samples of the above epimeric isomer of isokhellactone is identical with that of xanthoarnol (**1**). Moreover, the chemical fact that the periodic acid test[7] with xanthoarnol (**1**) is negative indicates the absence of an α-glycol system in its molecule. This evidence leaves only two possibilities for xanthoarnol, a racemate of the *trans*- or *cis*- compound of structure (**1**). Although all efforts to prepare these epimers from marmesin (**4**) by oxidation with lead teraacetate or by bromination with N-bromosuccinimide failed, xanthoarnol (**1**) can be depicted by the plane structure (**1**). A compound related to this product is the known angular dihydrofurano-coumarin vaginol[8] (**9**), whose configuration has also not yet been established. Fragmentation of xanthoarnol (**1**) and vaginol (**9**) would be expected to produce the corresponding furano-coumarins, psoralen (**10**) and angelicin (**11**), respectively. Therefore, the natural occurrence

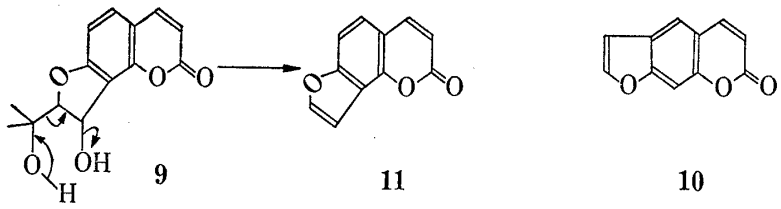

Chart 3

of xanthoarnol (**1**) is of interest as it suggests a biogenetical precursor of psoralen (**10**) which occurs in the same plant.

Chemical experiments on the configuration of xanthoarnol (**1**) are still going on in our laboratory.

5) K. Sano, I. Yosioka and I. Kitagawa, *Chem. Pharm. Bull.* (Tokyo), **21**, 2095 (1973); K. Hata and K. Sano, *Yakugaku Zasshi*, **89**, 549 (1969); K. Sano, I. Yosioka, I. Kitagawa and K. Hata, Abstracts of Papers, the 91st Annual Meeting of Pharmaceutical Society of Japan, Fukuoka, April, 1971, p. 777; K. Sano, I. Yosioka and I. Kitagawa, Abstracts of Papers, the 93rd Annual Meeting of Pharmaceutical Society of Japan, Tokyo, April, 1973, p. 177 (II).

6) The sample which Mr. Sano kindly gave us melts at 153°. This mp differs from that in their report, but as the compound shows resonable spectral data we believe that this discrepancy may be explained by the presence of two crystalline phases, *i.e.* dimorphism; We ourselves occasionally obtained a crystalline form other than that reported.

7) R.L. Shriner, R.C. Fuson and D.Y. Curtin, "Systematic Identification of Organic Compounds," 5th ed., New York·London, 1956, pp. 145—147.

8) K. Rajendran, C.K. Mesta, S.K. Paknikar and S.C. Bhattacharyya, *Indian J. Chem.*, **8**, 200 (1970).

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