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UNANISOFLAVAN, A NEW ISOFLAVAN FROM *SOPHORA SECONDIFLORA* DC.

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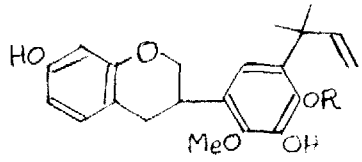
Flavanones and chalcones bearing unusual isoprenoid side chains, and possessing antiulcer properties, have been isolated from several species of *Sophora*[1,2] but so far *S. secondiflora* has been examined only because of the hallucinogenic alkaloids in its seeds.[3] We find that it also contains, besides the known flavonoids liquiritigenin and calycosin, a new member of the relatively uncommon isoflavan series.

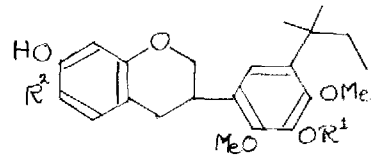
Unanisoflavan (1a), $C_{22}H_{26}O_5$, m.p. 184°, $[\alpha]_D$ ($CHCl_3$) -73.5, λ_{max}(EtOH) 286, 293 sh (log ε 3.7, 3.5), ν_{max} (mull) 3500, 3300, 1600, 1620 cm^{-1}, contains two phenolic OH groups, two OMe groups, and a 1,1-dimethylallyl side chain as shown by the n.m.r. spectrum of the diacetate, m.p. 114°, τ ($CDCl_3$) 8.60(s;2xMe), 7.74, 7.67, 6.26, 6.24 (all s; 4xMe), 5.0-5.16 (mm; 2H) and 3.94 (dd, *J* 17, 10Hz; 1H). Although further resonances at 7.06 (d, *J* 8Hz; $ArCH_2$), *ca.* 6.47 (m; ArCH), 6.01 ('t', *J* 10Hz) and 5.70 (dd, *J* 10, 4Hz) ($ArOCH_2$) were obviously consistent with an isoflavan nucleus[4] they appeared to be capable of other interpretations. Moreover, the mass spectral fragmentation, while entirely consistent with that of known isoflavans,[5] was again ambiguous largely because concurrent fragmentation of the prenyl side chain made it very difficult to identify with certainty the products of retro-Diels Alder fissions. For related reasons the mass spectrum also failed to clarify the distribution

of substituents between rings A and B notwithstanding its use,[6] without discussion, for the very similar isoflavan (1b).

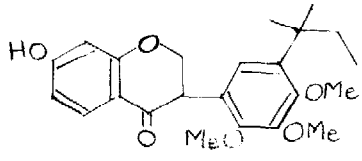
Hydrogenation of unanisoflavan gave the dihydro derivative (2a). Selective methylation ($Me_2SO_4/Me_2CO/KHCO_3$) of this was unexpectedly easy and gave the phenolic ether (2b), m.p. 115°. Oxidation with DDQ (2 mol. equiv. in MeOH) under N_2 by the method of Findlay and Turner[7] then gave as the only product the isoflavanone (3), m.p. 175°, ν_{max} 1685 cm^{-1}, with τ($CDCl_3$) 8.76 (s: 2 x Me), 9.36 (t, J 7 Hz; $CH_2\underline{CH_3}$) and 8.28 (q, J 7Hz; $\underline{CH_2}CH_3$) defining the side chain. Further resonances form an ABX system, τ 5.93 (q, J ~5.5 Hz, X) and 5.49 (dd, J 14, ~5.5 Hz; AB) consistent only with an isoflavanone nucleus, while aromatic resonances at 2.16 (d, J 8.5 Hz; 5-H), 3.53 (dd, J, 8.5, 2 Hz) and 3.66 (d, J, 2 Hz) establish a 4-substituted resorcinol nucleus for ring A.



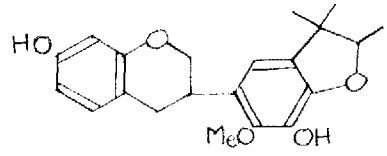
(1) a, R=Me
b, R=H



(2) a; R^1=H; R^2=H
b, R^1=Me; R^2=H
c, R^1=H; R^2=CHO



(3)



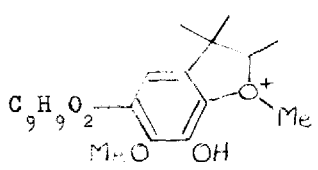
(4)

To confirm that ring A contains OH and not OMe, dihydro-unanisoflavan (2a) was formylated[8] with $CHCl_2OMe/TiCl_4$ in CH_2Cl_2 giving the aldehyde (2c) with characteristic chelation producing i.r. bands at 3200 (br; OH) and 1645 cm^{-1} (CO) and proton resonances at -1.06 (OH) and 0.30 (CHO). Ring B is not attacked showing that the only site available must be highly hindered and is therefore probably adjacent to the C_5 substituent. This arrangement is confirmed by models which show it to be the only one where the two features

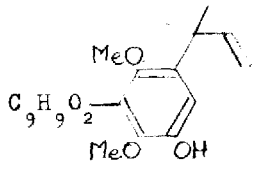
are close enough to explain the upfield shift in the ring B singlet that results when the prenyl group is saturated; e.g. τ 3.22 in unanisoflavan dimethyl ether but 3.50 in (2a).

That in ring B the prenyl group is flanked by OMe but not OH is indicated by the resistance of unanisoflavan to acid-catalysed cyclisation in mild conditions whereas aqueous methanolic HCl at 100° for 4 h results in selective demethylation and ring closure giving the dihydrobenzofuran derivative (4), $C_{21}H_{24}O_5$, M^+, 356.1591, m.p. 235°, with τ ($CDCl_3$/DMSO) 8.94 and 8.74 (each s, 3H; CMe_2), 8.62 (d, J 6.5 Hz; CH_3CH), and ~5.58 (q, J ~6.5 Hz; $MeCH.O$). The selective nature of the demethylation, the absence of rearrangement in the side chain, and the resistance of the dihydrounanisoflavan (2a) to demethylation under much more stringent conditions all point to a mechanism with the oxonium ion (5) as a central feature.

Finally, acetylation of (2a) results in a strong downfield shift in the ring B aromatic singlet (from 3.50 to 3.17) so that this proton is <u>para</u> to the OH group.[9] Structure (1a) emerges. Alternatives such as (6) with 2',6'-substitution can be further excluded on the grounds that flavonoids almost invariably carry OH or an ether group at the 4'-position and that the 2',6'--di-substitution pattern has been found[4] to induce conformational changes in the heterocyclic ring that separate out the benzylic methylene proton resonances in a manner not observed here. Moreover, out of the 13 isoflavans known to us, no less than 8 possess a 2',3',4'-trioxygenated ring B but none a 2',5',6' pattern.



(5)



(6)

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