Structure of Oregonin, a Natural Diarylheptanoid Xyloside

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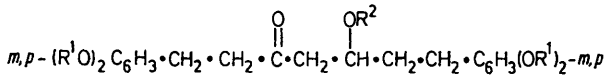
Summary Oregonin, 1,7-bis-(3,4-dihydroxyphenyl)heptan-3-one-5-xylopyranoside represents a new type of glycoside related to the diarylheptanoid series of compounds.

RED alder (*Alnus rubra* Bong., previously *A. oregona* Nutt.) (Betulaceae) is known for a red-orange staining which occurs on freshly cut wood and bark. Investigations of precursors to this staining phenomenon revealed the presence of a novel diarylheptanoid xyloside (I), which we name oregonin. The structure (I) is assigned on the basis of the n.m.r. ($CDCl_3$), i.r. ($CHCl_3$), u.v., and mass spectrometric data of its derivatives (II)—(V) and on the synthesis of (IV) and (V).

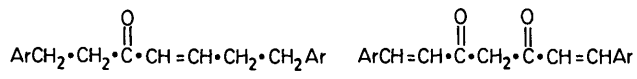
Methylation (diazomethane) of an enriched fraction obtained from the bark extract gave a crystalline tetramethyl ether (II), m.p. 53—56°, ν_{max} 1713 (saturated C=O) and 3440 (OH) cm^{-1}, following t.l.c. separation. Field desorption mass spectrometry (F.D.–M.S.) shows the parent ion of (II) to be M^+ 534. Electron impact mass spectrometry (E.I.–M.S.) failed to produce a peak above an intense *m/e* 384 which corresponds to (V). Presumably in E.I.–M.S. the acetal linkage in (II) cleaves to give (IV) which dehydrates to (V). In support of this concept F.D.–M.S. pyrolysis[1] of (II) produces peaks at *m/e* 402 and 384 corresponding to (IV) and (V). The u.v. spectrum of (II) shows λ_{max} (EtOH) 229, 280, and λ_{min} (EtOH) 251 nm for a 3,4-dimethoxyphenylpropane chromophore.[2]

Tetramethyloregonin (II) on acetylation gives (III), M^+ 660·278 ($C_{34}H_{44}O_{13}$). The n.m.r. spectrum of (III) shows signals for the xylopyranoside triacetate unit[3] as follows: 2- and 4-H (τ 4·92—5·22, m) shifted from *ca.* τ 6·75 (m) in the spectrum of (II), 3-H (τ 4·82, t), shifted from τ 6·56 (t); 2 × 5-H (τ 5·90, q, and 6·64, q), 9 OAc protons [τ 7·97 (3H, s) and 7·98 (6H, s)], and an anomeric proton (τ 5·46, d, J 7 Hz indicative of a β-anomer). The spectrum also shows signals for the aglycone portion of (III) as follows: τ

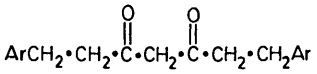
3·12—3·36 (6H, m, ArH), 5·84 (1H, m, $CH_2CHOR^2CH_2$), 6·14 and 6·16 (12H, 2 × s, OMe), 7·02—7·56 (8H, m, benzylic and α-keto-CH_2), and 8·17 (2H, m, $CHOR^2CH_2CH_2$).



(I) R^1 = H, R^2 = xylose
(II) R^1 = Me, R^2 = xylose
(III) R^1 = Me, R^2 = xylose triacetate
(IV) R^1 = Me, R^2 = H



(V) (VI)



(VII)

Ar = *m,p*-$(MeO)_2C_6H_3$

Hydrolysis of (II) (2% H_2SO_4) yielded xylose (identified by paper chromatography[4]), the aglycone (IV) [M^+ 402, saturated C=O 1710 cm^{-1}, OH 3540 cm^{-1}, τ 6·94 (removed by D_2O, OH), and 5·94 (m, C*H*OH)], in small amounts, and the dehydrated aglycone (V) [M^+ 384, αβ-unsaturated ketone ν_{max} 1672 (C=O) and 1628 cm^{-1} (C=C)] as the major product. A doublet (*J* 16 Hz) at τ 3·91 in the n.m.r. spectrum of (V) shows the double bond to be *trans* disubstituted. Integration of the aromatic signals (τ 3·01—3·38, m) now shows seven protons including the β-hydrogen of the conjugated ketone system. The aliphatic proton resonances of (IV) are similar to those for the cyclized C_9–C_1–C_9 ketone alnusone.[5]

The structures (IV) and (V) were confirmed by synthesis. Condensation of veratryl aldehyde and acetylacetone by the method used by Pabon[6] for curcumin gave (VI), M^+ 396, m.p. 130—131°. Hydrogenation (Pd–C) of (VI) gave (VII) M^+ 400, m.p. 68—69°. Reduction of (VII) ($NaBH_4$–MeOH) gave (IV) (M^+ 402, m.p. 99—100°) (separated by t.l.c.) and the corresponding diol. Dehydration of (IV) (2% H_2SO_4) gave (V), M^+ 384, m.p. 64—65°. Synthetic (IV) and (V) both gave identical mass, n.m.r., u.v., and i.r. spectra, and R_f values to those derived from natural oregonin.

The *meta,meta*-bridged biphenyl C_9–C_1–C_9 compounds such as myricanone[7] and alnusone[5] may be formed from diarylheptanoids such as oregonin *via* oxidative coupling catalysed by peroxidase. Work in our laboratory also indicates that oregonin is involved in the formation of red-orange chromophores, perhaps by peroxidase catalysis. In addition oregonin is biogenetically interesting since no other diarylheptanoid glycosides have yet been reported. The biosynthesis of diarylheptanoids is not fully understood in view of Roughley and Whiting's work on curcumin.[8]

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[1] J. J. Karchesy, M. L. Laver, D. F. Barofsky, and E. Barofsky, Abstracts, 167th National Meeting of the American Chemical Society, Los Angeles, California, March–April, 1974, CELL, Paper No. 45.
[2] O. Goldschmid, in 'Lignins, Occurrence, Formation, Structure, and Reactions,' eds. K. V. Sarkanen and C. H. Ludwig, Wiley-Interscience, New York, 1971, p. 256.
[3] P. L. Durette and D. Horton, *J. Org. Chem.*, 1971, **36**, 2658.
[4] L. Hough and J. K. N. Jones, in 'Methods in Carbohydrate Chemistry,' vol. 1, eds. R. L. Whistler and M. L. Wolfrom, Academic Press, New York, 1962, p. 21.
[5] M. Nomura, T. Tokoroyama, and T. Kubota, *J.C.S. Chem. Comm.*, 1974, 65.
[6] H. J. J. Pabon, *Rec. Trav. chim.*, 1964, **83**, 379.
[7] M. J. Begley, R. V. M. Campbell, L. Crombie, B. Tuck, and D. A. Whiting, *J. Chem. Soc.*, (*C*), 1971, 3634.
[8] P. J. Roughley and D. A. Whiting, *Tetrahedron Letters*, 1971, 3741.