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NOVEL EPOXIDES FROM THAMNOSMA MONTANA TORR. AND FREM.

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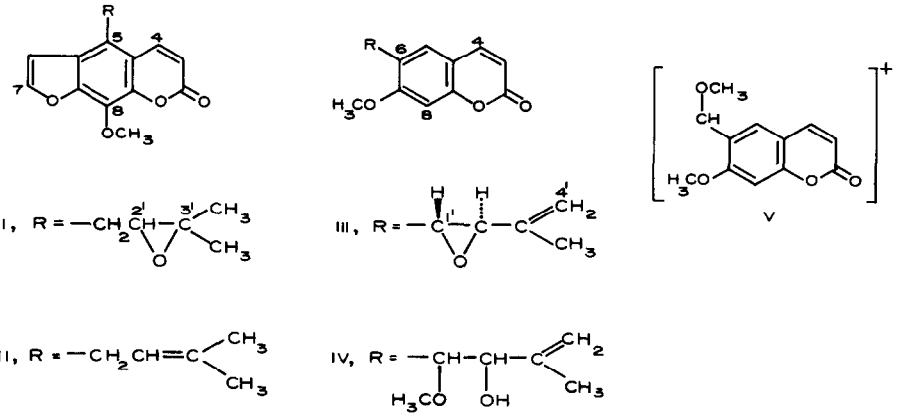
The turpentine broom, Thamnosma montana Torr. and Frem. is an interesting plant in that it provides a rich source of monomeric coumarins (1,2) and, more recently, we have encountered a novel dimeric system, thamnosin (3), not previously found in nature (4). In the course of preliminary investigations concerning the biosynthesis of these plant products, we have isolated several novel epoxy coumarins which we believe may play a significant role in the biosynthesis of this large family. We present the data which allows the structural assignments, I and III, to these substances.

The epoxide, I, m.p. 103-104°, $C_{17}H_{16}O_5$ (5), was found exclusively in the aerial portion of the plant and obtained from the acetone extract by alumina chromatography. Its UV spectrum (λ_{max}^{MeOH} 221, 244 (sh), 251, 266 and 305 mμ) was superimposable on that of alloimperatorin methyl ether (2) (II). A particularly informative NMR spectrum (6) showed the following signals: 1.92 (d, J = 10 hz, H-4); 2.33 (d, J = 2 Hz, H-7); 3.11 (d, J = 2 Hz, H-6); 3.65 (d, J = 10 Hz, H-3); 5.78 (s, OCH_3); 6.5-7.2 (ABC multiplet, J_{AB} = 14.5 Hz, J_{AC} = 3 Hz, J_{BC} = 7.5 Hz, 1'-H and 2'-H); 8.51 and 8.70 (s, CH_3). The identity of I was established when alloimperatorin methyl ether (II) on reaction with m-chloroperbenzoic acid (2) provided an epoxide identical in all respects with the natural product.

The epoxide, III, m.p. 101-104°, $C_{15}H_{14}O_4$, which we have called thamnosmin, was isolated from both the aerial and root portions of the plant. The presence of the 7-alkoxy coumarin chromophore was indicated by the UV spectrum (λ_{max}^{MeOH} 227.5, 253 (sh), 297 and 327 mμ) which was essentially identical with that of suberosin (7-methoxy-6-isopent-2'-enylcoumarin) (7). The NMR spectrum confirmed the 6-substituted-7-methoxycoumarin system with the characteristic coumarin doublets (3.79, J = 9.4 Hz, H-3 and 2.42, J = 9.4 Hz, H-4), the aromatic protons (2.77,



broadened singlet, H-5 and 3.25, sharp singlet, H-8), and a three-proton singlet at 6.13 (OCH_3). The remaining signals in the NMR spectrum were assigned to the protons in the side chain at the 6-position. We should emphasize that extensive spin decoupling experiments were done to establish the correctness of these assignments. Only a brief discussion of the most salient features will be presented here. Thus, the allylic methyl group at C-3' was observed as a doublet of doublets (dd) at 8.25 (J = 1.5 Hz and 0.9 Hz), the allylic epoxide proton (H-2') at 6.80 (J = 2.0 Hz), while the benzylic epoxide proton (H-1') was at 5.93 (dd, J = 2.0 Hz and 0.65 Hz). Finally, two multiplets in the olefinic region (4.97 and 4.85) could be readily attributed to the protons on C-4'. The coupling of 2.0 Hz between the two epoxide protons (confirmed by double irradiation) is indicative of a trans orientation for these protons (8), while the further coupling of H-1' is due to long range coupling with H-5, a fact also confirmed by double irradiation.

The mass spectrum of thamnosmin was also very instructive and a few comments are appropriate. Apart from the molecular ion peak at m/e 258, the base peak at m/e 229 ($C_{14}H_{13}O_3$) represents loss of CHO, a result in good accord with expectation for epoxides (9). Other peaks at m/e 214 (229-CH_3), 189, 159 and 131 are very characteristic for prenylated 7-methoxycoumarin systems (4,10,11).

Acidic hydrolysis of thamnosmin provided a crystalline product, IV, m.p. 121.5-124°, $C_{16}H_{18}O_5$, which by virtue of the data obtained quickly established that the expected epoxide opening had occurred. Thus, the UV and IR spectra of the hydrolysis product revealed no change in the 6-alkyl-7-methoxycoumarin chromophore. All of the signals attributed to the coumarin system in the NMR spectrum of thamnosmin remained essentially unaltered in the hydrolysis product. However, new signals attributed to methoxyl (s, 6.73), hydroxyl (d, 7.16, J = 3.2 Hz,

disappears in D_2O), a proton adjacent to hydroxyl (broad, doublet, 5.96, J = 6.5 Hz, sharpens to clean doublet in D_2O) and a proton adjacent to methoxyl (m, 5.35, J = 6.5 and 0.6 Hz) demand the functionality of the side chain as depicted in IV. Finally, the mass spectrum of the hydrolysis product completely confirmed the previous assignments. While the characteristic coumarin peaks at m/e 189, 159 and 131 were still retained, the base peak was now present at m/e 219. This is exactly what one expects in the fragmentation of IV since fission of the C-1'-C-2' bond provides the important ion, V. These results completely establish the structure, IV, for the hydrolysis product and in turn, III, for the novel epoxide, thamnosmin.

Thamnosmin contains a particularly interesting side chain since its occurrence in nature is almost without precedent (12). In addition, it represents a very attractive biosynthetic relative in the monomeric series to the previously isolated dimeric coumarin, themnosin (3). Experiments to evaluate these interrelationships are now underway.

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