HETEROCYCLES, Vol. 9, No. 2, 1978

A BASE-CATALYZED OXYGENATION OF THE β-APOLIGNAN: A BIOGENETIC MODEL

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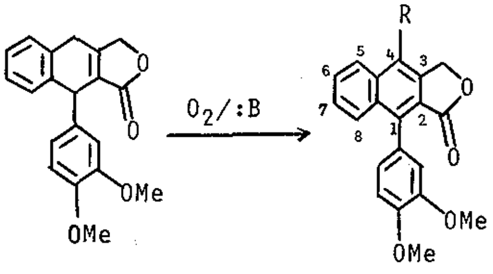
A biogenetic-type transformation of the β-apolignan (I) into naphthalide lignans (II and III) by a base-catalyzed oxygenation is described.

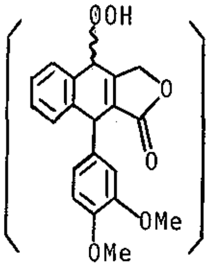
In the previous communication,[1] we suggested that the β-apolignan was a possible precursor of naphthalide lignans on the basis of their co-occurrence in a plant.

We now report the transformation of the β-apolignan (I)[2] into aromatized 2,3-naphthalide and 4-hydroxy-2,3-naphthalide lignans



(I)

(II) R=H
(III) R=OH
(IV) R=OMe



(V)

(II and III) by a base-catalyzed oxygenation.[3] The conversion supports the biogenetic hypothesis, which in turn can explain the fact[4] that the lignans of type II always coexist with those of type III in the same plants. In a typical experiment, oxygen was bubbled through a stirred solution of I (60 mg) and potassium t-butoxide (68 mg) in hexamethylphosphoric triamide (5 ml) at 25° for 1 hr. Usual work-up and subsequent chromatography on silica gel gave II (7% yield), identical with an authentic sample[2] on IR spectral comparison, and III [31% yield; colorless needles from EtOH, mp 263–264°(decomp.)]. The structure of III was assigned on the basis of the spectral and chemical evidences. Compound III: IR(KBr)cm^{-1} 1758(C=O), 1633, 1604, 1596, 1583(arom.); ^{1}H-NMR($\underline{d}_6$-DMSO)δ 3.70(3H, s, OMe), 3.84(3H, s, OMe), 5.39(2H, s, $-CH_2OCO-$), 6.6–7.8(6H, m, Ar-H), 8.34(1H, broad d, $\underline{J}$=8 Hz, C_5-H); MS $\underline{m}/\underline{e}$ 336(M^+, 100%); UV λ_{max}^{EtOH} nm(log ε) 244.5(4.38), 285 sh(3.65), 315.5(3.66), 359.5(3.73). Anal. Calcd. for $C_{20}H_{16}O_5$: C, 71.42; H, 4.80. Found: C, 71.10; H, 4.88. The yields of II and III on the run performed at 0° were a trace and 44%, respectively.

The lactone (III) was methylated with methyl iodide to give, in 76% yield, a methyl ether (IV) (colorless needles from $CHCl_3$–EtOH, mp 225–226°), IR(KBr)cm^{-1} 1768(C=O), 1618, 1599, 1586 (arom.); ^{1}H-NMR($CDCl_3$)δ 3.86(3H, s, OMe), 3.98(3H, s, OMe), 4.16 (3H, s, OMe), 5.56(2H, s, $-CH_2OCO-$), 6.8–7.9(6H, m, Ar-H), 8.30 (1H, broad d, $\underline{J}$=8 Hz, C_5-H); MS $\underline{m}/\underline{e}$ 350(M^+, 100%); UV λ_{max}^{EtOH} nm (log ε) 242.5(4.66), 288.5(3.76), 305.5(3.77), 353(3.78).

Anal. Calcd. for $C_{21}H_{18}O_5$: C, 71.99; H, 5.18. Found: C, 71.82; H, 5.17.

The formation of III [possibly *via* hydroperoxide V] and II from I can be rationalized by 'carbanion-radical-anion chain mechanism' proposed by Russell *et al*..[5]

Application of this process to the synthesis of natural naphthalide lignans is now in progress.

NOTES AND REFERENCES

1. T. Momose, T. Nakamura, and K. Kanai, *Heterocycles*, 1977, **6**, 277.
2. T. Momose, K. Kanai, T. Nakamura, and Y. Kuni, *Chem. and Pharm. Bull. (Japan)*, 1977, **25**, 2755.
3. Ayres and Mundy have reported the base-catalyzed aromatization of α- and β-apolignans and have postulated a disproportionation or some participation of oxygen as a mechanism; D. C. Ayres and J. W. Mundy, *J. Chem. Soc., Chem. Commun*., 1968, 1134.
4. For example, a) co-occurrence of taiwanin C and E in *Taiwania cryptomerioides* or their concurrent formation from a common precursor [Y. -T. Lin, T. -B. Lo, K. -T. Wang, and B. Weinstein, *Tetrahedron Letters*, 1967, 849; Z. Horii, M. Tsujiuchi, K. Kanai, and T. Momose, *Chem. and Pharm. Bull. (Japan)*, 1977, **25**, 1803]; b) co-occurrence of plicatinaphthalene and plicatinaphthol in *Thuja plicata* (H. MacLean and B. F. MacDonald, *Canad. J. Chem*., 1969, **47**, 4495; *Idem*, *ibid*.,

1969, **47**, 457); c) co-occurrence of justicidin B and diphyllin in *Justicia procumbens* var. *leucantha* (M. Okigawa, T. Maeda, and N. Kawano, *Tetrahedron*, 1970, **26**, 4301; K. Ohta and K. Munakata, Abstracts of Papers, 8th Shokubutsu-kagaku Symposium, Tokyo, Jan. 1972, p. 1); d) co-occurrence of chinensin and chinensinaphthol in *Polygala chinensis* (S. Ghosal, R. P. S. Chauhan, and R. S. Srivastava, *Phytochemistry*, 1974, **13**, 2281; *Idem*, *ibid*., 1974, **13**, 1933).

5. G. A. Russell, E. G. Janzen, A. G. Bemis, E. J. Geels, A. J. Moye, S. Mak, and E. T. Strom, "Selective Oxidation Processes," American Chemical Society, Washington, 1965, p. 112.

Received, 21st November, 1977