

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

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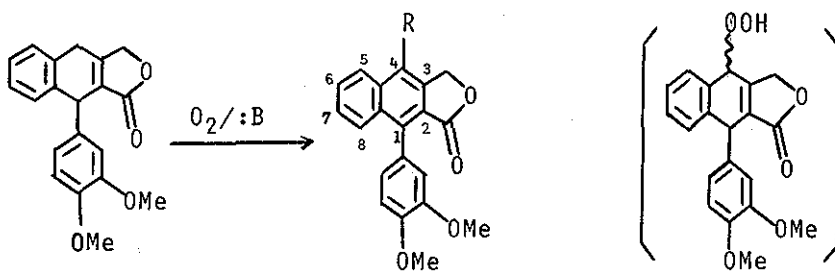
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A biogenetic-type transformation of the β -apolignan (I) into naphthalide lignans (II and III) by a base-catalyzed oxygenation is described.

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 fact⁴ 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 sample² 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.); ¹H-NMR(\underline{d}_6 -DMSO) δ 3.70(3H, s, OMe), 3.84(3H, s, OMe), 5.39(2H, s, -CH₂OCO-), 6.6–7.8(6H, m, Ar-H), 8.34(1H, broad d, \underline{J} =8 Hz, C₅-H); MS $\underline{m/e}$ 336(M⁺, 100%); UV $\lambda_{\text{max}}^{\text{EtOH}}$ nm(log ϵ) 244.5(4.38), 285 sh(3.65), 315.5(3.66), 359.5(3.73). Anal. Calcd. for C₂₀H₁₆O₅: 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 CHCl₃-EtOH, mp 225–226°), IR(KBr) cm^{-1} 1768(C=O), 1618, 1599, 1586 (arom.); ¹H-NMR(CDCl₃) δ 3.86(3H, s, OMe), 3.98(3H, s, OMe), 4.16(3H, s, OMe), 5.56(2H, s, -CH₂OCO-), 6.8–7.9(6H, m, Ar-H), 8.30(1H, broad d, \underline{J} =8 Hz, C₅-H); MS $\underline{m/e}$ 350(M⁺, 100%); UV $\lambda_{\text{max}}^{\text{EtOH}}$ 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

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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.

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