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STRUCTURES OF LAPPAOL F AND H, DILIGNANS FROM ARCTIUM LAPPA L

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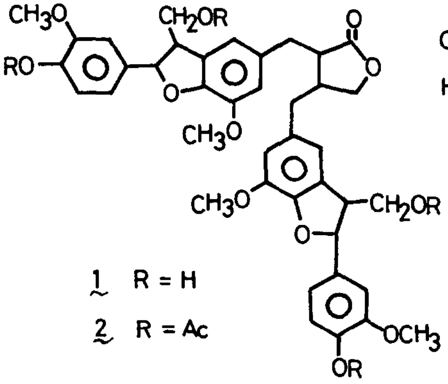
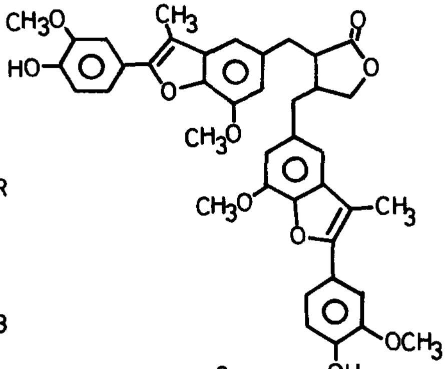
In the previous papers[1,2], we reported the isolation and structural elucidation of lappaol A, B, C, D and E from seeds of Arctium lappa L. In further scrutiny of the lignan components of the same source, we have obtained two new lignans, lappaol F(1) and H(4).[3] Since structurally, these lignans were constructed from four units of coniferyl alcohol, general term "dilignan" should be proposed for them.



1 R = H

2 R = Ac



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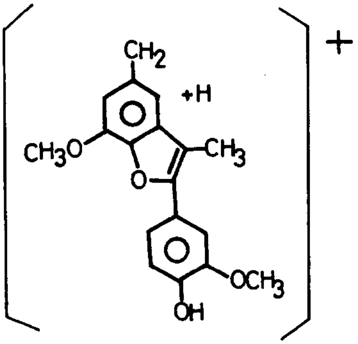
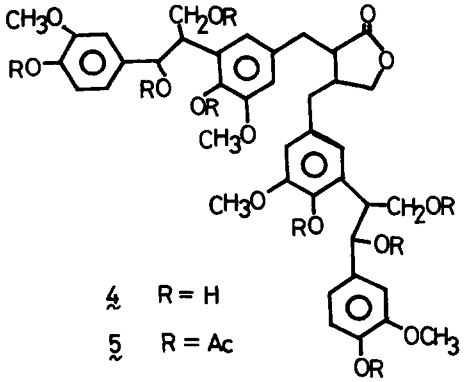
Lappaol F, amorphous powder, m/e 714 (M^+ corresponding to molecular formula $C_{40}H_{42}O_{12}$) is optically active compound, $[\alpha]_D^{20}$ + 13.5 (C=1.33, CH_3OH), and showed following spectral data; UV$\lambda_{max}^{CH_3OH}$ 282 nm(ε 10714); IRν_{max}^{KBr} 3450, 1760, 1600, 850 cm^{-1}; NMR(90MHz) $\delta_{TMS}^{CDCl_3}$ 2.62 (4H, m, Ar-CH$_2$), 2.96 (2H, m, -CH-CH-), 3.62 (6H, m, -C$\underline{H}$-C$\underline{H}_2$OH X 2), 3.87 (3H, s, -OCH$_3$), 3.90 (9H, s, -OCH$_3$), 4.22 (2H, m, -CH$_2$OCO-), 5.54 (2H, d, J=7Hz, -CH-O), 6.50~7.08 (10H, m, Ar-H). The presence of four aromatic rings in 1 was deduced from the absorption intensity (ε 10714), which is as about twice as that of arctigenin (ε 5200). A strong peak at 1760 cm^{-1} in the IR spectrum indicates the presence of a γ-lactone in 1. The NMR spectrum is very similar to that of lappaol A, but slightly different with the signals at δ 5.54 (one more proton) and at δ 6.50~7.08 (two more protons). The mass spectrum showed a characteristic fragment ion (A) at m/e 298, which arises from dihydrobenzofuran moiety. Acetylation of lappaol F afforded a tetraacetate 2, m/e 840 (M$^+$ -COCH$_2$, corresponding to molecular formula $C_{48}H_{50}O_{16}$), whose NMR spectrum exhibited signals at δ 2.01 (6H, s, CH$_2$OCOC$\underline{H}_3$) and 2.29 (6H, s, ArOCOC$\underline{H}_3$). The data mentioned above indicate the presence of two dihydrofuran moieties which would be derived from oxidative coupling of matairesinol and coniferyl alcohol.[4)] Presence of dihydrofuran moiety was further confirmed by the fact that treatment of lappaol F with HCl in dioxane-water (9:1) under refluxing conditions afforded, via dehydration and isomerization, a benzofuran derivative 3, m/e 678 (M$^+$ corresponding to molecular formula $C_{40}H_{38}O_{10}$); IRν_{max}^{KBr} 3500, 1760, 1600 cm^{-1}. In the NMR spectrum, signals due to two aromatic methyl groups were observed at δ 2.30 (3H, s) and 2.34 (3H, s). All of these data coupled with biogenetic cosideration[4)] suggest the structure 1 for lappaol F.

Lappaol H (4), amorphous powder, m/e 714 (M$^+$ -2H$_2$O corresponding to molecular formula $C_{40}H_{46}O_{14}$), $[\alpha]_D^{20}$ -46.6 (C=1.33, CH$_3$OH) showed following spectral properties; UV $\lambda_{max}^{CH_3OH}$ 282 (ε 10285); IR ν_{max}^{KBr} 3450, 1760, 1600, 860, 810 cm^{-1}; NMR $\delta_{TMS}^{C_3D_6O}$ 3.38 (4H, m, Ar-CH_2-), 2.71 (2H, m, -CH-CH-), 3.55 (6H, m, $-C\underline{H}-C\underline{H}_2OH$ X 2), 3.75 (3H, s, $-OCH_3$), 3.78 (3H, s, OCH_3), 3.81 (3H, s, OCH_3), 3.96 (2H, m, $-CH_2OCO-$), 5.25 (1H, d, J=6Hz, -CHO-), 5.28 (1H, d, J=5Hz, -CH-O-), 6.52~6.92 (10H, m, Ar-H). The absorption intensity in the UV spectrum and number of aromatic protons in the NMR spectrum indicate that lappaol H (4) has four aromatic rings and also belong to dilignan class. The mass spectrum pattern of 4 is almost identical with that of lappaol F (1). Acetylation of 4 afforded an octaacetate, 5, IR ν_{max}^{KBr} 1760, 1740, 1600 cm^{-1}. The NMR spectrum of 5 exhibited signals ascribable to alcoholic acetates at δ 1.84, 1.86 (each 3H, s), 1.97 (6H, s) and to phenolic acetates at δ 2.30 (6H, s), 2.34, 2.37 (each 3H, s), and the signals (δ 5.25, 5.28) due to α protons to hydroxy group in 4 shifted lower field (δ 6.03, 6.07, each 1H, d, J=7Hz) in the octaacetate 5.



A



4 R = H

5 R = Ac

Definitive evidence for the structure 4 was obtained by the fact that treatment of 4 with methanolic hydrochloric acid (3%) afforded, accompanied with ring closure, lappaol F $[\alpha]_D^{20}$ + 9.5 (C=2, MeOH), whose spectroscopic data are identical with natural lappaol F (1).

Further investigation on the stereochemistry of the new dilignans are in progress.

References and notes

1) A. Ichihara, K. Oda, Y. Numata and S. Sakamura, Tetrahedron Lett., 3961 (1976); S. Yamanouchi, M. Takido, U. Sankawa and S. Shibata, Yakugaku Zasshi, **96**, 1942 (1976)

2) A. Ichihara, Y. Numata, S. Kanai and S. Sakamura, Agric. Biol. Chem., **41**, 1813 (1977)

3) The structures of lappaol G, I and J will be reported elsewhere.

4) J. M. Harkin, in "Oxidative Coupling of Phenols", ed. by W. I. Taylor and A. R. Battersby, Marcel Dekker, New York, N.Y., 1967, P.243.

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