Tetrahedron Letters No. 9, pp 799 - 802.
© Pergamon Press Ltd. 1979. Printed in Great Britain.

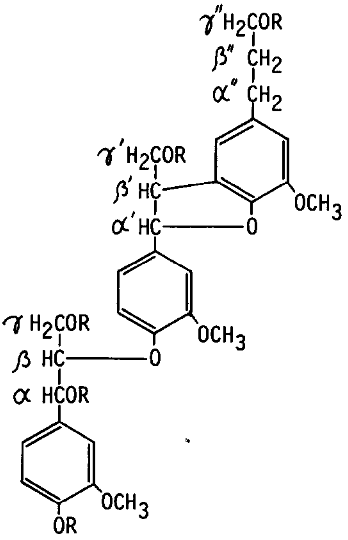
0040-4039/79/0222-0799\$02.00/0

# STRUCTURES OF NEW LIGNANS FROM *LARIX LEPTOLEPIS* GORD.

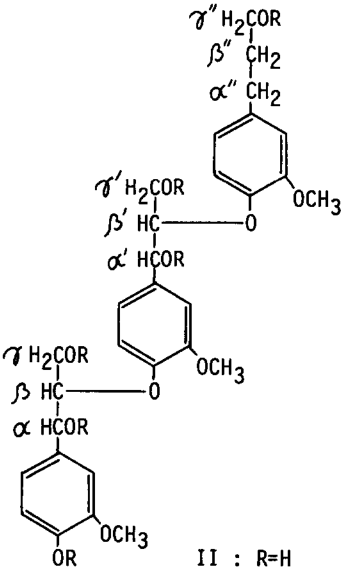
Keiji Miki, Takashi Sasaya, and Akira Sakakibara
Department of Forest Products, Faculty of Agriculture
Hokkaido University, Sapporo 060, Japan

Two lignans constructed from tri-phenylpropanes, leptolepisol A and B, both of which have $\omega$-hydroxypropane as a side chain were isolated from inner bark of *Larix leptolepis* Gord. Leptolepisol A is optically active ($[\alpha]_D^{27}$-3.1, c=0.97 in methanol), and shows following spectral properites: UV$\lambda_{max}^{EtOH}$ (nm) 281($\varepsilon$6676); IR$\nu_{max}^{KBr}$ ($cm^{-1}$) 3400, 1605, 1510, 1380, 1270, 1140, 1025; MS m/e 538, 360, 342, 330, 327, 180, 137; $^1$H-NMR (100 MHz) $\delta_{TMS}^{(CD_3)_2CO+D_2O}$ (ppm) 1.94 (2H, m, $H\beta''$), 2.64 (2H, t, J=8.0Hz, $H\alpha''$), 3.58 (2H, t, J=6.5Hz, $H\gamma''$), 3.82 (6H, s, $OCH_3$), 3.86 (3H, s, $OCH_3$), 3.2-4.0 (5H, m, $H\gamma$, $H\beta'$, $H\gamma'$), 4.42 (1H, m, $H\beta$), 4.92 (1H, d, J=6.0Hz, $H\alpha$), 5.58 (1H, d, J=6.0Hz, $H\alpha'$), 6.6-7.2 (8H, m, Ar-H). The results are similar to those of monomethyl ether of 2,3-dihydro-7-hydroxy-2-(4-hydroxy-3-methoxyphenyl)-3-hydroxymethyl-5-benzofuranpropanol (III) which was isolated by Popoff and Theander[1)] from pine tree as glycoside, and later by us from inner bark of *Larix leptolepis*, too.[2)] In general, a compound having benzyl hydroxyl group like I shows no parent peak but a peak of dehydrated one ($M^+-H_2O$).[3)] The peak at m/e 360 corresponds to dihydrodehydrodiconiferyl alcohol, and that at m/e 180 shows the existence of coniferyl alcohol fragment.

Exhaustive methylation of leptolepisol A with dimethyl sulfoxide/ NaH and $CH_3I$ (procedure of Hakomori) gave pentamethyl ether Ia which shows a parent peak at m/e 626.3101 (Calcd. for $C_{35}H_{46}O_{10}$: 626.3091). Other abundant ions are at m/e 356(IV), 238(V), 207(VI), 181, and 151. Acetylation of A with acetic anhydride-pyridine gave pentaacetate Ib, $M^+$ m/e 766. $^1$H-NMR of Ib reveals the presence of four alcoholic acetoxyls (2.02, 2.05, 2.07 ppm) and one phenolic acetoxyl (2.30 ppm). The NMR signal at 4.62 ppm ($H\beta$) was proved to couple with signals at 4.26 ($H_\gamma$) and 6.02 ($H_\alpha$) ppm which caused to shift into down field by acetylation, with double decoupling experiment. These signals were characterised for guaiacylglycerol-$\beta$-aryl ether structure in lignin chemistry.[4)]



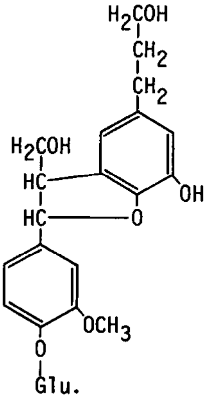
I : R=H, Ia : R=$CH_3$, Ib : R=Ac



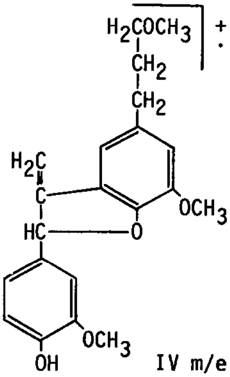
II : R=H

IIa: R=$CH_3$

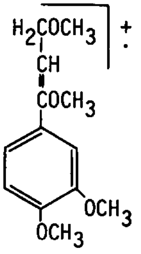
IIb: R=Ac



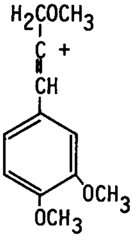
III



IV m/e 356 (1.1%)



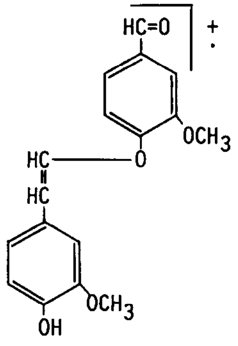
V m/e 238 (1.6%)



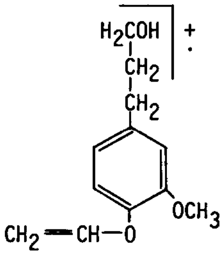
VI m/e 207 (2.2%)

$^{13}$C-NMR spectrum of letolepisol A shows eleven aliphatic carbon peaks and eighteen aromatic carbon signals. The former signals are assigned as follows: $\delta^{CD_3OD}_{TMS}$ (ppm) 32.9 ($C_{\beta''}$), 35.8 ($C_{\alpha''}$), 55.6 ($C_{\beta'}$), 56.4, 56.6, 56.8 (each $OCH_3$), 62.3 ($C_\gamma$, $C_{\gamma''}$), 65.1 ($C_{\gamma'}$), 74.2 ($C_\alpha$), 86.3 ($C_\beta$), 88.6 ($C_{\alpha'}$). These data suggest structure I for leptolepisol A.

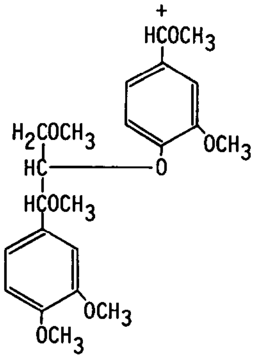
Leptolepisol B is an amorphous and optically active compound ($[\alpha]_D^{27}$ -1.6, c=0.64 in methanol), and shows following spectral properties: UV $\lambda_{max}^{EtOH}$ (nm) 280 ($\varepsilon$ 6056); IR $\nu_{max}^{KBr}$ (cm$^{-1}$) 3400, 1605, 1510, 1265, 1025; $^1$H-NMR $\delta_{TMS}^{(CD_3)_2CO+D_2O}$ (ppm) 1.80 (2H, m, Hβ″), 2.62 (2H, t, J=8.0Hz, Hα″), 3.58 (2H, t, J=6.5Hz, Hγ″), 3.5-4.0 (4H, m, Hγ, Hγ′), 3.82 (6H, s, $OCH_3$), 3.87 (3H, s, $OCH_3$), 4.36 (2H, m, Hβ, Hβ′), 4.96 (2H, m, Hα, Hα′), 6.7-7.2 (9H, m, Ar-H). Abundant mass fragment ions are m/e 300(VII), 208(VIII), 182, and 137. $^{13}$C-NMR spectrum of leptolepisol B shows various aliphatic carbon peaks and complex aromatic carbon signals. The formers may be assigned as follows: 32.7 (Cβ″), 35.5 (Cα″), 56.5 ($OCH_3$), 61.8 and 62.2 (Cγ, Cγ′, Cγ″), 73.9 (Cα, Cα′), 86.3 (Cβ), 87.1 (Cβ′).



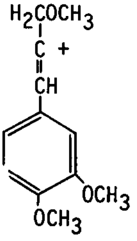
VII m/e 300 (14.3%)



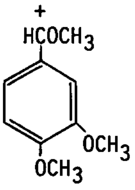
VIII m/e 208 (94.7%)



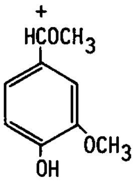
IX m/e 405 (31.9%)



X m/e 207 (19.0%)



XI m/e 181 (100%)



XII m/e 167 (95.8%)

These data suggest the presence of guaiacylglycerol units in B. Exhaustive methylation of B according to Hakomori's procedure gave hexamethyl ether IIa, M$^+$ m/e 658.3411 (Calcd. for $C_{36}H_{50}O_{11}$: 658.3353), 405(IX), 207(X), 181(XI), 167(XII), 151. The hexaacetate of B(IIb)(M$^+$, m/e 826) shows the signals due to five alcoholic acetoxyls and one phenolic acetoxyl in the NMR spectrum. The signals of aliphatic parts are assigned as follows: 3.4-4.4 (4H, m, $H_\gamma$, $H_{\gamma'}$), 4.60 (2H, m, $H_\beta$, $H_{\beta'}$), 6.04 (2H, m, $H_\alpha$, $H_{\alpha'}$). These complicated signals suggest that leptolepisol B may be a mixture of diastereomers.

Recently, some lignans constructed from tri-phenylpropanes (so called sesquilignans) have been isolated from seeds of *Arctium lappa* L. by Ichihara et al.[5,7] and also by Yamanouchi et al.[6] It is very interesting, however, that leptolepisol A and B involve β-5 and β-0-4 linkages which are characteristic in lignin molecule. In the works of biosynthesis of lignin, Freudenberg et al.[8] isolated two trimers (trilignols) with similar structures as those of leptolepisol A and B from the enzymatic dehydrogenation products of coniferyl alcohol. Only difference is that these dehydrogenation products have α-β-unsaturated side chains. However, it is very likely that ω-hydroxypropyl side chain may also exist in lignin molecule, as Aoyama and Sakakibara[9] have shown in the dioxane-water hydrolysis product from protolignin. It should be noted that the same linkage patterns exist both in lignans and lignin, but the formers are in most cases optically active, while the latter is inactive.

## References

1) T. Popoff and O. Theander, Acta Chem. Scand., B31, 4, 329 (1977)
2) K. Miki and T. Sasaya, Mokuzai Gakkaishi, in press.
3) S. Omori and A. Sakakibara, ibid., 21, 170 (1975)
4) C. D. Ludwig, B. J. Nist and J. L. McCarthy, J. Am. Chem. Soc., 86, 1186 (1964)
5) A. Ichihara, K. Oda, Y. Numata and S. Sakamura, Tetrahedron Lett., 3961 (1976)
6) S. Yamanouchi, M. Takido, U. Sankawa and Shibata, Yakugaku Zasshi, 96, 1942 (1976)
7) A. Ichihara, Y. Numata, S. Kanai and S. Sakamura, Agric. Biol. Chem., 41, 1813 (1977)
8) K. Freudenberg and H. Tausend, Chem. Ber., 96, 2081 (1963)
9) M. Aoyama and A. Sakakibara, Mokuzai Gakkaishi, 24, 422 (1978)

(Received in Japan 26 October 1978)