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Studies of Lignoids in *Lauraceae*. III.[1] A New Lignan from the Heart Wood of *Cinnamomum Camphora* Sieb.

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Synopsis. From the heart wood of *Cinnamomum Camphora* Sieb., a new lignan, (−)-*trans*-2-(3,4-dimethoxybenzyl)-3-(3,4,5-trimethoxybenzyl)butyrolactone [I] and 3-hydroxy-5,7-dimethoxy-3′,4′-methylenedioxyflavan [IV], were isolated, and their structures were determined.

In a previous report,[2] we described the isolation and structural determination of several lignans from the leaves of four kinds of *Cinnamomum Camphora*, the camphor tree.[3] We will report here a new lignan, (−)-*trans*-2-(3,4-dimethoxybenzyl)-3-(3,4,5-trimethoxybenzyl)-butyrolactone [I] and 3-hydroxy-5,7-dimethoxy-3′,4′-methylenedioxyflavan [IV], isolated from the heart wood of the "sesquiterpene tree,"[3] a kind of camphor tree which contains nerolidol as a major component of the leaf oil, along with dimethylmatairesinol [II] and kusunokinin [III].[2]

Results

(−)-trans-*2-(3,4-Dimethoxybenzyl)-3-(3,4,5-trimethoxybenzyl)butyrolactone [I].* This compound is a γ-lactone (ν_{max}^{KBr} 1760 cm^{-1}). The NMR spectrum of aliphatic protons indicates that this compound has a *trans*-substituted γ-lactone ring, as in the case of dimethylmatairesinol;[2] δ (ppm) 2.55 (4H, m), 2.90 (2H, m), and 3.8—4.25 (2H, m). Five methoxyl groups are also detectable.

In the region of aromatic protons, the signal at δ 6.18 ppm (2H, s) indicates two protons of a symmetric trimethoxybenzyl group, *i.e.*, either the 3,4,5-trimethoxybenzyl or the 2,4,6-trimethoxybenzyl group. Of them, the latter can be excluded because the chemical shifts of benzyl CH_2 are almost identical with those of dimethylmatairesinol; *i.e.*, benzyl CH_2 is not flanked by two methoxyl groups.

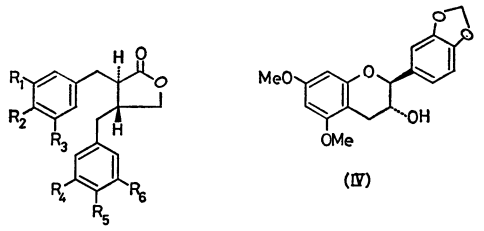
The signals at δ 6.61 (1H, d, J=8 Hz), 6.68 (1H, br s), and 6.75 ppm (1H, d, J=8 Hz) show three protons of a dimethoxybenzyl group which has two protons located at positions ortho to each other-, *i.e.*, the 3,4-, 2,4- or 2,5-dimethoxybenzyl group. It may be supposed that the 3,4-dimethoxybenzyl group is the most probable from the fact that the signals of the three protons appear in a narrow range and that the two coupled protons are not so equivalent. This supposition is confirmed by the co-occurence of this compound with dimethylmatairesinol [II] and kusunokinin [III].

From these results, this compound is determined to be either *trans*-2-(3,4-dimethoxybenzyl)-3-(3,4,5-trimethoxybenzyl)butyrolactone [I] or *trans*-2-(3,4,5-trimethoxybenzyl)-3-(3,4-dimethoxybenzyl)butyrolactone [Ia].

The MS spectrum shows an ion of *m/e* 208. The fragmentation (Scheme 1) is considered to proceed in the same manner as in the case of kusunokinin,[2] and the formation of this ion can be explained on the basis of [I, but not on that of Ia.]

The CD curve of this compound shows a negative Cotton effect at 235 and 270 nm, as in the case of thujaplicatin methyl ether and related compounds.[4] Therefore, the absolute configuration may be concluded to be 2R, 3R.

(−)-trans-*3-Hydroxy-5,7-dimethoxy-3′,4′-methylenedioxyflavan (IV).* The IR spectrum shows an OH group (3300 cm^{-1}). The NMR spectrum shows a methylenedioxy group, two methoxy groups, and five aromatic protons. The B ring is a 1,3,4-trisubstituted one, because its protons appear as a singlet at δ 7.14 ppm, and there are two doublets (J=8 Hz), at δ 6.91 and 7.06 ppm, all benig finely splitted. The A ring is a 1,2,3,5-tetrasubstituted one, because two protons appear as two doublets (J=3 Hz) at δ 6.19 and 6.27 ppm, as in the case of tetramethylcatechin.[5] H-2 and H-3 are supposed to be located *trans* to each other, because H-2 appears as a doublet (J=2 Hz) at δ 4.99 ppm (equatorial-equatorial coupling). This supposition is confirmed by the very small signal of M$^+$−18 in the



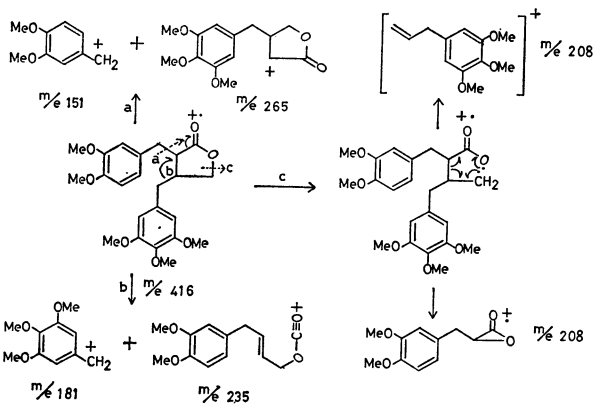
(IV)

(I) R_1, R_2, R_4, R_5, R_6 : OMe , R_3:H

(Ia) R_1, R_2, R_3, R_5, R_6 : OMe , R_4:H

(II) R_1, R_2, R_4, R_5 : OMe , R_3, R_6:H

(III) R_1 R_2 : OCH_2O , R_4, R_5 : OMe , R_3, R_6:H



Scheme 1.

MS spectrum (resistant to dehydration[6]). Therefore, this compound is identified as *trans*-3-hydroxy-5,7-dimethoxy-3′,4′-methylenedioxyflavan [IV].

Experimental

Instruments. The CD curve, and the IR, NMR, UV, and MS spectra were obtained by using ORD UV-5 (JASCO), IR-400 (Shimadzu), JNM-4H-100 (JEOL), ESP-3T (Hitachi), and JMS-OlSG-2 (JEOL) apparatuses respectively. $[\alpha]_D$ was measured by the use of a Yanako OR-50 (Yanagimoto) apparatus, and elemental analyses were carried out with a CHN Corder MT-2 (Yanagimoto).

Isolation. Shaves of the heart wood (10 kg) of the tree (10 years old) were extracted with hexane; the hexane solution was then concentrated in *vacuo* and steam-distilled to remove any volatile components. The residue (70 g) was dissolved in hexane and chromatographed on a silica gel column (solvent: hexane: ethyl acetate=100: 0—0: 100) into 22 fractions.

The 19 th fraction (3.7 g) was rechromatographed on a silica gel column (solvent: benzene: ethyl acetate=75: 25) into 18 fractions. From the second fraction, [III] was isolated by TLC.

The 20 th fraction of the first chromatography (4.8 g) was rechromatographed on a silica gel column (solvent: benzene: ethyl acetate=100: 0—0: 100) into 8 fractions. A crystalline material (mp 106—107 °C) was obtained from the second fraction by TLC; this substance shows one spot on TLC with benzene–ethyl acetate (60: 40), but with hexane–chloroform–methanol (6: 3: 1) it shows two spots, which were separated by TLC. The less polar compounds was identified by means of its spectral data as [II].

The more polar compound [I]: a minor component, mp 120—121.5 °C, λ_{max}^{EtOH} 229 nm ($\varepsilon=1.4\times10^4$), 280 nm ($\varepsilon=3.2\times10^3$), $[\alpha]_D$ −17.8° ($c=0.51$ in $CHCl_3$). Found: C, 66.4%; H, 6.2%. Calcd for $C_{23}H_{28}O_7$: C, 66.3%; H, 6.7%. IR cm^{-1} (KBr): 1760, 1590, 1510. NMR (δ ppm in $CDCl_3$): 2.55 (4H, m), 2.90 (2H, m), 3.28 (s), 3.32 (s) (15H), 3.8—4.25 (2H, m), 6.18 (2H, s), 6.61 (1H, d, $J=8$Hz), 6.68 (1H, br s), 6.75 (1H, d, $J=8$ Hz). MS: *m/e* 416 (M^+), 386 (M^+-30), 265, 235, 209, 208, 181, 151 (base peak).

The 17 th fraction of the first chromatography (3.0 g) was rechromatographed into 8 fractions in the same manner as in the case of the 19 th fraction. From the 3 rd fraction, a crystalline substance [IV] was isolated by TLC: a minor component, mp 164—165 °C, $[\alpha]_D$ −39.3° ($c=0.84$ in $CHCl_3$), λ_{max}^{EtOH} 286 nm ($\varepsilon=3.4\times10^3$). Found: C, 65.8%; H, 5.2%. Calcd for $C_{18}H_{18}O_6$: C, 65.5%, H, 5.5%. IR cm^{-1} (KBr) 3300, 1610, 1490. NMR (δ in $CDCl_3$): 1.82 (1H, d, $J=6$ Hz, **OH**), 2.95 (2H, m, H_2-4), 3.83 (6H, s, 2× CH_3O), 4.28 (1H, m, H-3), 4.99 (1H, d, $J=2$ Hz, H-2), 6.03 (2H, s, OCH_2O), 6.19 (1H, d, $J=3$ Hz, H-8 or H-6), 6.27 (1H, d, $J=3$ Hz, H-6 or H-8), 6.91 (1H, d, $J=8$ Hz, H-5′ or H-6′), 7.05 (1H, d, $J=8$ Hz, H-6′ or H-5′), and 7.14 ppm (1H, s, H-2′).

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