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New Constituents of the Aril of *Myristica fragrans*[1)]

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The following constituents were isolated for the first time from the aril of *Myristica fragrans* HOUTT.: 3-(3,4,5-trimethoxyphenyl)-2-(*E*)-propen-1-ol (**1**), 3-(3-methoxy-4,5-methylenedioxyphenyl)-2-(*E*)-propen-1-ol (**2**), 2,3-dihydro-7-methoxy-2-(3,4-dimethoxyphenyl)-3-methyl-5-(1-(*E*)-propenyl)benzofuran (**3**), fragransol-C (**4**), fragransol-D (**5**), 2,3-dimethyl-1,4-bis-(3,4-methylenedioxyphenyl)butan-1-ol (**6**), myristicanol-A (**7**) and myristicanol-B (**8**). Compounds **4**, **5**, **7** and **8** are new neolignans which may be formed by coupling of cinnamyl alcohol and propenylbenzene units.

Keywords——fragransol-C; fragransol-D; lignan; mace; *Myristica fragrans*; myristicanol-A; myristicanol-B; neolignan

Mace (the aril of *Myristica fragrans* HOUTT.) is a commonly used spice, and has also been used as remedy for strengthening the stomach and expelling "wind-evil" in Chinese medicine and as an alleged abortient and narcotic in folk medicine. In the preceding papers,[2,3)] we reported antibacterial action of a methanolic extract of mace and its major phenolic constituents, dehydrodiisoeugenol and 5′-methoxydehydrodiisoeugenol, against *Streptococcus mutans* which causes dental caries in humans and animals. Furthermore, we have isolated various lignans and neolignans from the phenolic fraction.[3-6)] In the present paper, we report the isolation and identification of new constituents from the neutral fraction of mace.

Results and Discussion

A neutral fraction of the methanolic extract of mace was subjected to alumina column chromatography according to the procedure reported by Isogai *et al.*,[7,8)] followed by repeated silica gel column chromatography and preparative thin layer chromatography (TLC). These procedures led to the isolation of new lignan and neolignan compounds (**3**—**8**) along with known arylpropanoids (**1**, **2**, myristicin and elemicin), acyclic bis-arylpropanoids and dihydrobenzofurans.[7-9)] The structures of **1**—**8** were established by spectroscopic methods as follows.

Compound **1** was obtained as an oil with the molecular formula $C_{12}H_{16}O_4$ and its structure was determined to be 3-(3,4,5-trimethoxyphenyl)-2-(*E*)-propen-1-ol by spectroscopic and chemical methods (see Experimental). This compound has previously been isolated from the seeds of *Uvariodendron connivens* (BENTH.) R. E. FRIES[10)] but this is the first isolation from mace.

Compound **2** was obtained as colorless needles, mp 72—73 °C, with the molecular formula $C_{11}H_{12}O_4$. The proton nuclear magnetic resonance (^{1}H-NMR) spectrum showed the presence of methoxyl, methylenedioxyl and HO–CH_2–CH=CH– groups, revealing that the structure of **2** is 3-(3-methoxy-4,5-methylenedioxyphenyl)-2-(*E*)-propen-1-ol. The ^{1}H-NMR

and carbon-13 nuclear magnetic resonance (^{13}C-NMR) spectral data were in agreement with those reported.[11,12] This compound (anthriscinol) has been isolated from the roots of *Anthriscus sylvestris* HOFFM[11] but not from mace.

Compound **3** was obtained as colorless prisms, mp 111—112 °C. The ^{1}H-NMR spectrum was quite similar in overall appearance to that of dehydrodiisoeugenol except an additional methoxyl signal. On the basis of spectroscopic comparisons with an authentic methyl ether of dehydrodiisoeugenol (*dl*-form), **3** was identified as *trans*-2,3-dihydro-7-methoxy-2-(3,4-dimethoxyphenyl)-3-methyl-5-(1-(*E*)-propenyl)benzofuran. From a comparison of the specific rotation ($[\alpha]_D$ −3.6° in **3**) with those of analogous 2,3-dihydro-3-methyl-2-phenylbenzofurans,[13-17] **3** seems to be a racemic mixture of (2*R*,3*R*)- and (2*S*,3*S*)-forms. The presence of this compound in nutmeg and mace had been suggested by Harvey[18] based on combined gas chromatography and mass spectrometry (MS) but it has not yet been fully characterized.

Compound **4** was isolated as an oil and its molecular formula was determined to be $C_{21}H_{24}O_5$ by high-resolution MS. The ^{1}H-NMR spectrum showed the presence of a *sec*-methyl (δ 1.39), a methine (δ 3.48, m), a methine substituted by oxygen (δ 5.14, d) and five aromatic protons, which are ABX-type protons (3H, δ *ca.* 6.9—7.0) and two broad singlet protons (δ 6.83 and 6.86), indicative of 2-aryl-2,3-dihydro-3-methylbenzofuran neolignans. However, **4** showed no signals due to the presence of a CH_3–CH=CH– group, which is commonly present in a series of compounds of this type from mace and nutmeg[7-9] but there were characteristic signals of a HO–CH_2–CH=CH– group; the two protons of the double bond formed an AB system, of which the A proton (δ 6.25) was further split by the adjacent HO–CH_2– protons (δ 4.31) giving rise to a pair of triplets (J = 15.9 and 5.9 Hz), while the B proton (δ 6.57) appeared as a doublet (J = 15.9 Hz). Most of the ^{13}C-chemical shifts for **4** except the side chain closely resembled those of **3**. Since Bowden *et al.*[13] have reported that the 3-Me and 2-H signals of the *cis* isomer appear at δ 0.7—0.8 and 5.7—5.8, respectively, but those of the *trans* isomer appear at δ 1.3—1.4 and 5.1, respectively, owing to the shielding effect of the phenyl group in 2,3-dihydrobenzofurans, the two substituents must be oriented with a *trans* relationship in **4** on the basis of the chemical shifts of 3-Me (δ 1.39) and 2-H (δ 5.14). Furthermore, the absolute configuration was determined as 2*S* and 3*S* on the basis of the specific rotation, $[\alpha]_D$ −44.0.[13-17] These findings led us to conclude the structure of **4** to be (2*S*,3*S*)-2,3-dihydro-5-(3-hydroxy-1-(*E*)-propenyl)-7-methoxy-2-(3,4-dimethoxyphenyl)-3-methylbenzofuran, which was isolated for the first time from a natural source and named fragransol-C.

Compound **5** was isolated as an oil, with the molecular formula $C_{21}H_{22}O_6$. The ^{1}H-NMR spectrum was quite similar to that of **4** but differ in signals ascribed to a 3-methoxy-4,5-methylenedioxyphenyl group in place of the 3,4-dimethoxyphenyl group present in **4**. The diagnostic chemical shifts of 3-Me (δ 1.40) and 2-H (δ 5.14) were indicative of 2,3-*trans* stereochemistry for **5**.[12] It was of interest that **5** was dextrorotatory, $[\alpha]_D$ +47.6°, in contrast with **4** being levorotatory, $[\alpha]_D$ −44.0°, indicating 2*R*,3*R*-absolute configuration of **5**.[13-17] The structure was thus concluded to be (2*R*,3*R*)-2,3-dihydro-5-(3-hydroxy-1-(*E*)-propenyl)-7-methoxy-2-(3-methoxy-4,5-methylenedioxyphenyl)-3-methylbenzofuran, a new natural product, which was named fragransol-D.

Compound **6** was obtained as an oil with the molecular formula $C_{20}H_{22}O_5$. The ^{1}H-NMR showed the presence of two *sec*-methyls (δ 0.76 and 1.00), a benzylic methylene (δ 2.36 and 2.45), two methines (δ 1.56, 1.74), a benzylic methine substituted by oxygen (δ 4.39) and two 3,4-methylenedioxyphenyl groups. The double resonance experiments showed that on irradiation at δ 1.56 (3-H), the two double doublets at δ 2.36 and 2.45 (4-H_a and 4-H_b), and the doublet at δ 0.76 (3-Me) became two doublets and a singlet, respectively, and on irradiation at δ 1.74 (2-H), the doublets at δ 4.39 (1-H) and 1.00 (2-Me) each became a singlet

each. Consequently, the structure was concluded to be 2,3-dimethyl-1,4-bis-(3,4-methylenedioxyphenyl)butan-1-ol. For determining the configurations at C-2 and C-3, **6** was converted to an aryl-tetralin type compound (**6a**) by treatment with *p*-toluenesulfonic acid.[19] In the nuclear Overhauser effect (NOE) experiments on this compound, irradiation at δ 0.86 (2-Me) and 1.05 (3-Me) resulted in appreciable increases of the 1-H/3-H/2′,6′-H and 2-H/4α-H/4β-H signals, respectively. Furthermore, irradiation at δ 1.62 (3-H) resulted in increases of

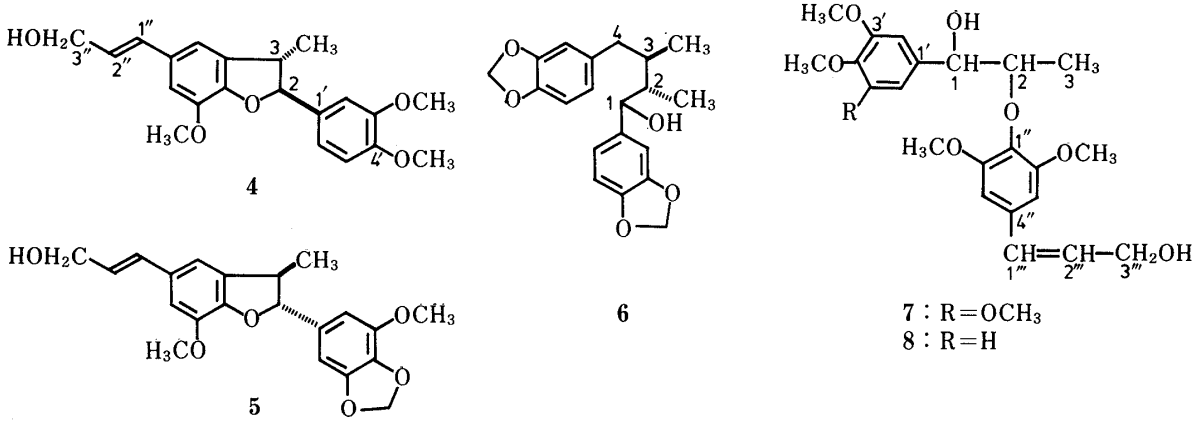

Fig. 1. Structures of New Lignans and Neolignans Isolated from Mace

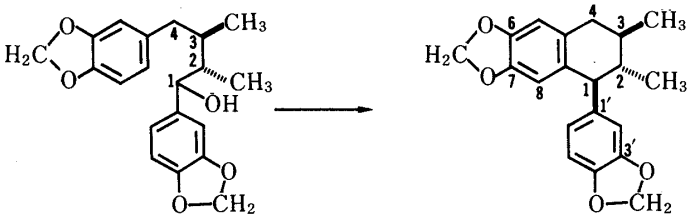

Fig. 2. Acid-Catalyzed Cyclization of **6** to **6a**

TABLE I. ^{13}C-NMR Spectral Data for Neolignans (**3**, **4**, **5**, **7** and **8**) in $CDCl_3$

Carbon	3	4	5	Carbon	7	8
C-2	93.5	93.6	93.5	C-1′	132.8	132.8
C-3	45.5	45.4	45.6	C-2′	103.6[d]	109.5
C-3a	133.2	133.4	133.2	C-3′	153.0	148.9
C-4	109.7	110.1	110.2	C-4′	153.0	148.0
C-5	132.1[a]	130.8	134.8	C-5′	153.0	110.9
C-6	113.3	114.1	114.2	C-6′	103.6[d]	118.1
C-7	144.1	144.1	144.2	C-1	82.5	82.6
C-7a	146.4	147.3	147.2	C-2	73.2	72.9
3-$\underline{C}H_3$	17.6	17.6	17.9	C-3	12.7	12.7
C-1′	132.7[a]	132.5	135.2	C-1″	135.5	134.9
C-2′	109.6[b]	109.6	100.5[c]	C-2″	153.6	153.7
C-3′	149.2	149.2	148.9	C-3″	103.2[d]	103.7
C-4′	149.2	149.2	130.8	C-4″	134.7	132.6
C-5′	110.9	110.9	143.6	C-5″	103.2[d]	103.7
C-6′	119.1[b]	119.1	106.3[c]	C-6″	153.6	153.7
C-1″	130.9	131.4	131.4	C-1‴	130.7	130.8
C-2″	123.3	126.2	126.2	C-2‴	128.5	128.4
C-3″	18.1	63.7	63.7	C-3‴	63.3	63.4
–O–$\underline{C}H_3$	55.9 (3)	55.8 (3)	56.0 (1)		56.1 (4)	55.8 (2)
			56.7 (1)		60.7 (1)	56.1 (2)
–O–$\underline{C}H_2$–O–			101.4			

a—*d*) Assignments may be interchanged.

the 1-H/4α-H signals. These results indicated that the phenyl and the two methyl substituents are in a *trans–trans* relationship to one another. In addition, a negative circular dichroic band at 299 nm ([θ] = −8150) led us to conclude that **6a** is a (1*S*,2*S*,3*R*)-aryl-tetralin derivative.[20,21] Consequently, **6** must have the same relative configurations at C-2 and C-3 as those of the acid-cyclization product (**6a**). Recently, isolation of two 2,3-dimethyl-1,4-diarylbutane-type lignans was reported from the same plant source, *Myristica fragrans*,[22] but the two methyl groups were in *cis* orientation in contrast with the *trans* orientation in **6**.

Compound **7** was obtained as an oil with the molecular formula $C_{22}H_{48}O_7$. The ^{1}H-NMR spectrum showed signals of a *sec*-methyl, a benzylic methine substituted by oxygen (δ 4.80, br d, 1-H) and a methine substituted by oxygen (δ 4.33—4.39, 2-H), characteristic of acyclic bis-arylpropanoids. In addition, the signals for five methoxyl, four aromatic (δ 6.54 and 6.68, each 2H, each singlet) and HO–CH_2–CH=CH– protons indicated the presence of 3,4,5-trimethoxyphenyl and 4-(3-hydroxy-1-(*E*)-propenyl)-2,6-dimethoxyphenoxyl groups, the latter of which was also confirmed by the observation of the mass fragment ion at *m/z* 209. The small $J_{1,2}$ value and ^{13}C-chemical shift of C-3 revealed that **7** belonged to an *erythro* series.[4] Consequently, the structure was concluded to be *erythro*-2-[4-(3-hydroxy-1-(*E*)-propenyl)-2,6-dimethoxyphenoxy]-1-(3,4,5-trimethoxyphenyl)propan-1-ol, a new natural product, named myristicanol-A. This compound was identical with that prepared from *erythro*-2-(4-allyl-2,6-dimethoxyphenyl)-1-(3,4,5-trimethoxyphenyl)propan-1-ol by SeO_2 oxidation.

Compound **8** was obtained as an oil with the molecular formula $C_{22}H_{28}O_9$, the molecular ion being 14 mass units lower than that of **8** in the MS. The ^{1}H-NMR spectrum was quite similar except for methoxy and aromatic proton signals. The presence of 4-(3-hydroxy-1-(*E*)-propenyl)-2,6-dimethoxyphenoxyl and 3,4-dimethoxyphenyl groups was shown by the ^{1}H-NMR spectrum. The small $J_{1,2}$ value (*ca.* 1—2 Hz) and ^{13}C-chemical shift of C-3 indicated it to be an *erythro* form.[4] The structure was thus concluded to be *erythro*-2-[4-(3-hydroxy-1-(*E*)-propenyl)-2,6-dimethoxyphenyl]-1-(3,4-dimethoxyphenoxy)propan-1-ol, a new natural product, named myristicanol-B.

In conclusion, cyclic and acyclic bis-phenylpropanoids (**3**, **4**, **5** and **6**, **7**, **8**, respectively) were isolated as new natural products along with known cinnamyl alcohol derivatives (**1**, **2**). Neolignans with an allyl alcoholic side chain were isolated for the first time from mace and might be formed by direct coupling of the cinnamyl alcohols (**1**, **2**) and propenylphenols (myristicin, elemicin, *etc.*) on the basis of evidence that both monomeric units were present in the mace in significant amounts.

Experimental

Apparatus——All melting points were determined on a Yanagimoto micro-melting point apparatus and are uncorrected. Infrared (IR) spectra were taken on a Hitachi 260-10 infrared spectrometer. ^{1}H- and ^{13}C-NMR spectra were measured with JEOL GX-270, GX-400 (^{1}H, 270 and 400 MHz) and JEOL FX 90Q (^{1}H, 89.55 and ^{13}C, 22.5 MHz) spectrometers with tetramethylsilane as an internal standard. MS were measured with a JMS-DX 300 mass spectrometer (JEOL) at an ionization voltage of 70 eV. Optical rotations were measured with a JASCO DIP-4 automatic polarimeter at 25 °C. Circular dichroic (CD) spectra were recorded on a JASCO J-500 spectropolarimeter equipped with a JASCO DP-500 data processor.

Isolation——A neutral fraction (9.3 g) of mace obtained as reported in the previous paper[3] was successively chromatographed on alumina (solvents, benzene with increasing amounts of AcOEt) and silica gel, followed by preparative TLC on silica gel as usual. These procedures led to the isolation of new constituents including arylpropenols (**1**, 740 mg; **2**, 3.6 mg), neolignans (**3**, 18 mg; **4**, 45 mg; **5**, 5.3 mg; **7**, 7.9 mg; **8**, 7.5 mg) and a lignan (**6**, 5.6 mg) together with reported compounds such as myristicin, elemicin, *trans*-2,3-dihydro-7-methoxy-2-(3,4-methylenedioxyphenyl)-3-methyl-5-(1-(*E*)-propenyl)benzofuran (17 mg), *trans*-2,3-dihydro-7-methoxy-2-(3-methoxy-4,5-methylene-dioxyphenyl)-5-(1-(*E*)-propenyl)benzofuran (1.85 g), *erythro*-2-(4-allyl-2,6-dimethoxyphenoxy)-1-(3,4-dimethoxyphenyl)propan-1-ol (132 mg), *erythro*-2-(4-allyl-2,6-dimethoxyphenoxy)-1-(3,4,5-trimethoxyphenyl)propan-1-ol (108 mg) and fragransol-A (9 mg).[3,6-9]

3-(3,4,5-Trimethoxyphenyl)-2-(*E*)-propen-1-ol (1)——Colorless oil (lit.[10] mp 110 °C). High-resolution MS: Found, *m/z* 224.1052, Calcd for $C_{12}H_{16}O_4$, *m/z* 224.1049 (M^+). ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 3.84 (6H, s, 3′,5′-OMe), 3.87 (3H, s, 4′-OMe), 4.32 (2H, d, J=5.0 Hz, $-C\underline{H}_2OH$), 6.26 (1H, dt, J=15.8, 5.0 Hz, $=C\underline{H}-CH_2OH$), 6.57 (1H, d, J=15.8 Hz, $-C\underline{H}=CH-CH_2OH$), 6.62 (2H, s, 2′,6′-H).

3-(3-Methoxy-4,5-methylenedioxyphenyl)-2-(*E*)-propen-1-ol (2)——Colorless needles. mp 72—73 °C (hexane–EtOAc), lit.[12] (mp 83—84 °C). High-resolution MS: Found, *m/z* 208.0764, Calcd for $C_{11}H_{12}O_4$, *m/z* 208.0736 (M^+). ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 3.91 (3H, s, 3′-OMe), 4.30 (2H, d, J=5.6 Hz, $-C\underline{H}_2OH$), 5.97 (2H, s, $-O-C\underline{H}_2-O-$), 6.22 (1H, dt, J=15.9, 5.6 Hz, $=C\underline{H}-CH_2OH$), 6.51 (1H, d, J=15.9 Hz, $-C\underline{H}=CH-CH_2OH$), 6.54, 6.62 (each 1H, each d, J=1.5 Hz, 2′,6′-H).

***trans*-2,3-Dihydro-7-methoxy-2-(3,4-dimethoxyphenyl)-3-methyl-5-(1-(*E*)-propenyl)benzofuran (3)**——Colorless prisms (hexane), mp 111—112 °C. $[\alpha]_D$ −3.6° (c=0.112, $CHCl_3$). MS *m/z*: 340 (M^+), $C_{21}H_{24}O_4$. IR ν_{max}^{KBr} cm^{-1}: 1598, (conjugated C=C). ^{1}H-NMR (90 MHz, $CDCl_3$) δ: 1.38 (3H, d, J=6.8 Hz, 3-Me), 1.87 (3H, d, J=5.3 Hz, $-CH=CH-C\underline{H}_3$), 3.51 (1H, m, 3-H), 3.87 (6H, s, 2×OMe), 3.89 (3H, s, OMe), 5.11 (1H, d, J=9.2 Hz, 2-H), 5.8—6.2 (1H, m, $-CH=C\underline{H}-CH_3$), 6.2—6.5 (1H, m, $-C\underline{H}=CH-CH_3$), 6.78 (1H, s, 4-H), 6.87 (1H, s, 6-H), 6.8—7.0 (3H, ABX, 2′,5′,6′-H).

(2*S*,3*S*)-2,3-Dihydro-5-(3-hydroxy-1-(*E*)-propenyl)-7-methoxy-2-(3,4-dimethoxyphenyl)-3-methylbenzofuran (Fragransol-C, 4)——Colorless oil. $[\alpha]_D$ −44.0° (c=0.109, $CHCl_3$). High-resolution MS: Found, *m/z* 356.1647, Calcd for $C_{21}H_{24}O_5$, *m/z* 356.1624 (M^+). IR ν_{max}^{KBr} cm^{-1}: 3440, 1598, 1518, 1495. ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 1.39 (3H, d, J=6.6 Hz, 3-Me), 3.48 (1H, m, 3-H), 3.87 (3H, s, OMe), 3.88 (3H, s, OMe), 3.90 (3H, s, OMe), 4.31 (2H, d, J=5.9 Hz, $-C\underline{H}_2OH$), 5.14 (1H, d, J=9.5 Hz, 2-H), 6.25 (1H, dt, J=15.9, 5.9 Hz, $=C\underline{H}-CH_2OH$), 6.57 (1H, d, J=15.9 Hz, $-C\underline{H}=CH-CH_2OH$), 6.83 (1H, br s, 4-H), 6.86 (1H, br s, 6-H), 6.94—7.00 (3H, ABX, 2′,5′,6′-H).

(2*R*,3*R*)-2,3-Dihydro-5-(3-hydroxy-1-(*E*)-propenyl)-7-methoxy-2-(3-methoxy-4,5-methylenedioxyphenyl)-3-methylbenzofuran (Fragransol-D, 5)——Colorless oil. $[\alpha]_D$ +47.6° (c=0.105, $CHCl_3$). High-resolution MS: Found, *m/z* 370.1399, Calcd for $C_{21}H_{22}O_6$, *m/z* 370.1416 (M^+). IR ν_{max}^{KBr} cm^{-1}: 3400, 1600, 1485, 1445, 1130, 1095. ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 1.40 (3H, d, J=6.6 Hz, 3-Me), 3.43 (1H, dq, 3-H), 3.899, 3.903 (each 3H, OMe), 4.31 (2H, d, J=5.8 Hz, $-C\underline{H}_2OH$), 5.09 (1H, d, J=9.0 Hz, 2-H), 5.97 (2H, s, $-O-C\underline{H}_2-O-$), 6.25 (1H, dt, J=15.9, 5.8 Hz, $=C\underline{H}-CH_2OH$), 6.57 (1H, d, J=15.9 Hz, $-C\underline{H}=CH-CH_2OH$), 6.610, 6.613 (each 1H, each s, 2′-H and 6′-H), 6.82 (1H, br s, 4-H), 6.85 (1H, br s, 6-H).

2,3-Dimethyl-1,4-bis-(3,4-methylenedioxyphenyl)butan-1-ol (6)——An oil. $[\alpha]_D$ −24.7° (c=0.47, $CHCl_3$). High-resolution MS: Found, *m/z* 342.1483, Calcd for $C_{20}H_{22}O_5$, *m/z* 342.1468 (M^+). ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 0.76 (3H, d, J=6.8 Hz, 3-Me), 1.00 (3H, d, J=6.8 Hz, 2-Me), 1.56 (1H, m, 3-H), 1.74 (1H, m, 2-H), 2.36 (1H, dd, J=13.7, 7.3 Hz, 4-H_a), 2.45 (1H, dd, J=13.7, 8.1 Hz, 4-H_b), 4.39 (1H, d, J=8.8 Hz, 1-H), 5.956 (2H, s, $-O-C\underline{H}_2-O-$), 5.961 (2H, s, $-O-C\underline{H}_2-O-$), 6.4—6.8 (6H, m, ArH). ^{13}C-NMR ($CDCl_3$) δ: 77.6 (d, C-1), 42.1 (d, C-2), 35.3 (d, C-3), 41.5 (t, C-4), 137.8 (s, C-1′), 106.8 (d, C-2′), 146.8 (s, C-3′), 147.3 (s, C-4′)*, 107.8 (d, C-5′), 119.9 (d, C-6′), 134.8 (s, C-1″), 107.8 (d, C-2″), 145.4 (s, C-3″), 147.7 (s, C-4″)*, 109.1 (d, C-5″), 121.6 (d, C-6″), 9.5 (q, 2-Me), 14.1 (q, 3-Me), 100.5 (t, $-O-C\underline{H}_2-O-$), 100.8 (t, $-O-C\underline{H}_2-O-$), *, Assignments may be interchanged. CD: $[\theta]_{298}$ = +1560, $[\theta]_{277}$ = +1350, $[\theta]_{249}$ = −1140.

***erythro*-2-[4-(3-Hydroxy-1-(*E*)-propenyl-2,6-dimethoxyphenoxy]-1-(3,4,5-trimethoxyphenyl)propan-1-ol (Myristicanol-A, 7)**——An oil. High-resolution MS: Found, *m/z* 434.1973, Calcd for $C_{23}H_{30}O_8$, *m/z* 434.1941 (M^+); MS: 434 (M^+), 237 ($M-(MeO)_3\cdot C_6H_2\cdot CHOH)^+$, 210 $(HOCH_2CH=CH\cdot C_6H_2\cdot(OMe)_2)^+$. IR ν_{max}^{KBr} cm^{-1}: 3470, 1585, 1504, 1460, 1420, 1230, 1122, 1060, 1005. ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 1.14 (3H, d, J=6.4 Hz, 3×3-H), 3.82 (3H, s, OMe), 3.85 (6H, s, 2×OMe), 3.90 (6H, s, 2×OMe), 4.33—4.39 (1H, m, 2-H), 4.34 (2H, d, J=5.6 Hz, $-C\underline{H}_2OH$), 4.80 (1H, br d, 1-H), 6.33 (1H, dt, J=15.9, 5.6 Hz, $=C\underline{H}-CH_2OH$), 6.54 (2H, s, 2′,6′-H), 6.58 (2H, d, J=15.9 Hz, $-C\underline{H}=CH-CH_2OH$), 6.68 (2H, s, 3″,5″-H).

***erythro*-2-[4-(3-Hydroxy-1-(*E*)-propenyl)-2,6-dimethoxyphenoxy]-1-(3,4-dimethoxyphenyl)propan-1-ol (Myristicanol-B, 8)**——An oil. High-resolution MS: Found, *m/z* 404.1865, Calcd for $C_{22}H_{28}O_7$, *m/z* 404.1835 (M^+). IR ν_{max}^{KBr} cm^{-1}: 3455, 1582, 1520, 1509, 1462, 1020. ^{1}H-NMR (270 MHz, $CDCl_3$) δ: 1.13 (3H, d, J=6.4 Hz, 3×3-H), 3.86 (3H, s, OMe), 3.88 (3H, s, OMe), 3.90 (6H, s, 2×OMe), 4.05 (1H, s, OH), 4.32 (2H, d, J=6.3 Hz, $-C\underline{H}_2OH$), 4.38 (1H, dq, 2-H), 4.81 (1H, br d, 1-H), 6.33 (1H, dt, J=15.9, 5.6 Hz, $=C\underline{H}-CH_2OH$), 6.58 (1H, d, J=15.9 Hz, $-C\underline{H}=CH-CH_2OH$), 6.67 (2H, s, 3″-H and 5″-H), 6.76 (1H, dd, J=1.7, 8.3 Hz, 6′-H), 6.81 (1H, d, J=8.3 Hz, 5′-H), 6.94 (1H, d, J=1.7 Hz, 2′-H).

Conversion of Myristicin to 1——Myristicin (96 mg) dissolved in dioxane (5 ml) and SeO_2 (110 mg) dissolved in water (0.5 ml) were mixed under cooling. The mixture was then heated at 92 °C for 1 h, and filtered after cooling. Water was added and the solution was extracted with $CHCl_3$. The $CHCl_3$ layer was washed sequentially with 10% $NaHCO_3$ and saturated NaCl solutions, and dried. The solvent was evaporated off *in vacuo*. The products were purified by preparative TLC on silica gel with a solvent system of $CHCl_3$–EtOH (19:1) or benzene–AcOEt (7:3) to yield **1** (4.5 mg, 4.7%), 1-(3-methoxy-4,5-methylenedioxyphenyl)-2-propen-1-ol (16.5 mg, 17%) and 3-(3-methoxy-4,5-methylenedioxyphenyl)-2-(*E*)-propenal (2.3 mg, 2.4%).

Conversion of *erythro*-2-(4-Allyl-2,6-dimethoxyphenoxy)-1-(3,4,5-trimethoxyphenyl)propan-1-ol to 7——*erythro*-2-(4-Allyl-2,6-dimethoxyphenoxy)-1-(3,4,5-trimethoxyphenyl)propan-1-ol (80.5 mg) was oxidized with SeO_2 (50 mg)

under similar conditions to those described above. The products were separated by preparative TLC with a solvent system of $CHCl_3$–EtOH (19 : 1) to yield **7** (3.1 mg) and *erythro*-2-[4-(1-hydroxy-2-propenyl)-2,6-dimethoxyphenoxy]-2-(3,4,5-trimethoxyphenyl)propan-1-ol (5.8 mg).

Conversion of 6 to 2,3-Dimethyl-6,7-methylenedioxy-1-(3,4-methylenedioxyphenyl)tetralin (6a)——Compound **6** (5 mg) was dissolved in CH_2Cl_2 (2 ml) and *p*-toluenesulfonic acid (0.5 mg) in CH_2Cl_2 was added. The mixture was kept for 1 h at room temperature, then neutralized with aqueous $NaHCO_3$. The organic layer was filtered and the filtrate was evaporated to dryness *in vacuo*. The residue was dissolved in $CHCl_3$ (3 ml) and chromatographed on preparative thin layer plates of silica gel with $CHCl_3$–EtOH (20 : 1) to afford a mixture of **6** (Rf=0.73, 2.0 mg) and **6a** (Rf=0.91). The latter was further purified by silica gel TLC with $CHCl_3$–EtOH (19 : 1) to yield a pure compound (2.6 mg, 51%), ^{1}H-NMR (400 MHz, $CDCl_3$) δ: 0.86 (3H, d, J=6.4 Hz, 2-Me), 1.05 (3H, d, J=6.4 Hz, 3-Me), 1.48 (1H, m, 2-H), 1.62 (1H, m, 3-H), 2.56 (1H, dd, J=11.9, 16.1 Hz, axial 4β-H), 2.70 (1H, dd, J=4.5, 16.1 Hz, equatorial 4α-H), 3.38 (1H, d, J=10.4 Hz, 1-H), 5.81 (2H, d, J=1.5 Hz, –O–C<u>H</u>$_2$–O–), 5.93 (2H, d, J=1.4 Hz, –O–C<u>H</u>$_2$–O–), 6.16 (1H, s, 8-H), 6.521 (2H, d, J=1.5 Hz, 2′-H), 6.523 (1H, s, 5-H), 6.62 (1H, dd, J=1.5, 7.9 Hz, 6′-H), 6.73 (1H, d, J=7.9 Hz, H-5′). Assignments were done on the basis of spin decoupling and NOE experiments. CD: $[\theta]_{282}=+4050$, $[\theta]_{299}=-8150$ (in $CHCl_3$).

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