[Chem. Pharm. Bull. 30(9)3207—3211(1982)]

The Constituents of *Schizandra chinensis* Baill. XII.[1] Isolation and Structure of a New Lignan, Gomisin R, the Absolute Structure of Wuweizisu C and Isolation of Schisantherin D

Yukinobu Ikeya, Heihachiro Taguchi* and Itiro Yosioka

Tsumura Laboratory, 1-9-9 Izumi-Honcho, Komae-shi, Tokyo, 201, Japan

(Received March 11, 1982)

A new dibenzocyclooctadiene lignan, gomisin R(**4**), was isolated from the fruits of *Schizandra chinensis* Baill. (Schizandraceae) together with wuweizisu C(**1**)[2] and schisantherin D(**12**).[3] The absolute structure of **1**, the relative structure of which has been elucidated by Liu *et al.*, was defined by chemical correlation with dimethylgomisin J(**2**). The absolute structure of **4** was determined by spectral studies and chemical correlation with **1**.

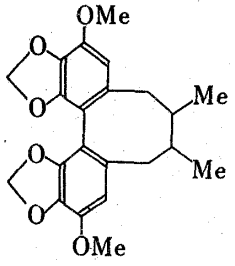
Keywords——*Schizandra chinensis* Baill.; Schizandraceae; dibenzocyclooctadiene; lignan; gomisin R; wuweizisu C; schisantherin D; ^{13}C-NMR

In the preceding paper, we reported the structure elucidations of dibenzocyclooctadiene lignans possessing a $C_{(6)}$-acyloxy group, angeloylgomisin O, and angeloyl- and benzoylisogomisin O, isolated from *Schizandra chinensis* Baill. (Schizandraceae).[1] This paper deals with the structure of a new, similar lignan named gomisin R(**4**) which has a $C_{(6)}$-hydroxy group, the absolute structure of wuweizisu C(**1**) and the isolation of schisantherin D(**12**).

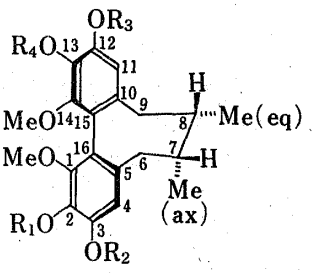
Wuweizisu C was initially isolated from *S. chinensis* and was assigned the structure **1'** by Chen *et al.*[2] After that, its structure was revised to **1** by Liu *et al.*[3] on the basis of consideration of solvent shift and nuclear Overhauser effects (NOE) in the proton nuclear magnetic resonance (^{1}H-NMR) spectrum, and this was confirmed by synthetic studies by Xie *et al.*[4] and by Schneiders *et al.*[5] except for the biphenyl configuration. Schisantherin D was isolated from *S. sphenanthera* by Liu *et al.*,[3] but there is no report of its isolation from *S. chinensis*.

Compound **1** was obtained as colorless prisms (from MeOH), $C_{22}H_{24}O_6$, mp 121—123°C, $[\alpha]_D^{22}$ −58.8° ($CHCl_3$). The ^{1}H-NMR spectrum of **1** shows the presence of two methylenedioxy moieties and two methoxyls on the aromatic rings, and two secondary methyls and two benzylic methylenes on the cyclooctadiene ring. On the basis of the above physical constants and spectral data [^{1}H-NMR, ultraviolet (UV) and infrared (IR) spectra], **1** is assumed to be wuweizisu C.[2]

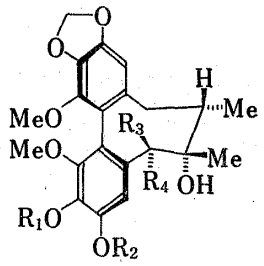
A comparison of the carbon (^{13}C)-NMR spectrum of **1** (Table I) with that of dimethylgomisin J(**2**)[6,7] shows that **1** has the same skeleton and the same conformational structure as **2**, except for the functional groups on the aromatic rings. The appearance of the two downfield methoxy signals at δ 59.6 suggests that two methoxyls are located at the C-1 and C-14 positions and therefore two methylenedioxy moieties must be at the C-(2 and 3) and C-(12 and 13) positions. Two doublet aromatic carbon signals at δ 106.1 and 103.1 can be assigned to C-4 and C-11, respectively, which show upfield shifts of *ca.* 4 ppm (C-4, $\Delta\delta$ −4.2 ppm; C-11, $\Delta\delta$ −3.9 ppm), compared with those of **2**. These results also indicate that the methylenedioxy moieties are located at the C-(2 and 3) and C-(12 and 13) positions.[7] The above results indicate that the stereostructure of wuweizisu C can be represented by **1** with the exception of the biphenyl configuration. Treatment of **1** with $Pb(OAc)_4$ in dry benzene gave a phenolic compound (**3**)[8] Methylation of **3** furnished a tetramethyl ether (**2**), $C_{24}H_{32}O_6$, mp 115—117° C, $[\alpha]_D^{23}$ −88.2° ($CHCl_3$), which was identified as dimethylgomisin J, possessing an *S*-biphenyl configuration, by direct comparison (IR, ^{1}H-NMR, mixed mp and $[\alpha]_D$). The absolute structure of wuweizisu C was thus elucidated as **1**.



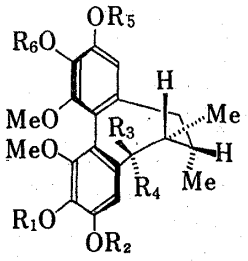
1′



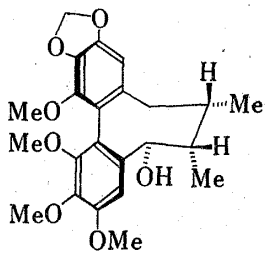
1: $R_1+R_2=R_3+R_4=CH_2$
2: $R_1=R_2=R_3=R_4=Me$
3: $R_1=R_2=R_3=R_4=H$
8: $R_1=R_2=Me$, $R_3+R_4=CH_2$



10: $R_1=R_2=Me$, $R_3+R_4=O$
11: $R_1+R_2=CH_2$, $R_3+R_4=O$
12: $R_1+R_2=CH_2$, $R_3=OCOC_6H_5$, $R_4=H$
13: $R_1+R_2=CH_2$, $R_3=OH$, $R_4=H$
14: $R_1=R_2=Me$, $R_3=OH$, $R_4=H$



4: $R_1+R_2=R_5+R_6=CH_2$, $R_3=OH$, $R_4=H$
5: $R_1+R_2=R_5+R_6=CH_2$, $R_3+R_4=O$
6: $R_1=R_2=Me$, $R_3=OH$, $R_4=H$, $R_5+R_6=CH_2$
9: $R_1=R_2=Me$, $R_3+R_4=O$, $R_5+R_6=CH_2$



7

Chart 1

TABLE I. ^{13}C-NMR Spectral Data for **1**, **2**, **4**, **6**, **7**, **13**, and **14** [δ in $CDCl_3$, 20 MHz, at 25°C]

Carbon	1	2	4	6	7	13	14
1	141.3[a]	151.3[a]	141.6	151.9	151.2	140.8[a]	151.9
2	134.8[b]	140.0[b]	136.4	141.7[a]	140.8[a]	136.3[b]	141.5[a]
3	147.7[c]	151.3	148.2	152.1	152.3	140.8[c]	152.1
4	106.1	110.3	105.6	110.2	106.4	106.0	110.3
5	132.6	133.5	136.0[a]	137.0[b]	136.5[b]	132.6[d]	133.6[b]
6	38.9	39.1	81.1	81.4	73.4	85.8	86.0
7	33.7	33.7	40.1	40.1	42.6	73.6	73.6
8	40.8	40.7	37.1	37.2	39.3	41.6	41.6
9	35.4	35·5	37.9	38.1	34.7	36.3	36.3
10	138.2	138.8	135.7[a]	135.5[b]	137.9[b]	135.6[d]	135.0[b]
11	103.1	107.0	102.7	102.5	102.8	103.4	103.2
12	148.7[c]	152.7	149.3	149.2	149.2	149.8[c]	149.8
13	134.4[b]	139.6[b]	134.5	134.6	134.6	134.9[b]	135.5
14	141.1[a]	151.5[a]	141.6	141.5[a]	140.9[a]	141.5[a]	140.7[a]
15	121.1[d]	122.2	120.4[b]	120.7	119.6	119.5	119.6
16	122.3[d]	123.3	121.5[b]	122.2	121.3	120.3	121.1
17	21.7	21.8	16.5[c]	16.6[c]	22.0	18.8	18.8
18	12.7	12.7	17.5[c]	17.5[c]	7.8	28.6	28.5
OCH_3 C-1, 14	59.6(×2)	60.4(×2)	59.6, 59.5	60.3, 59.5	60.6, 59.6	59.6, 59.7	60.7, 59.8
OCH_3 C-2, 13	—	60.8(×2)	— —	60.8 —	61.0 —	— —	60.8 —
OCH_3 C-3, 12	—	55.7(×2)	— —	56.0 —	56.0 —	— —	56.0
OCH_2O	100.7(×2)	—	100.8, 101.2	100.7	100.8	101.1, 101.3	101.0

a—*c*) Assignments within any column may be reversed.

Gomisin R (**4**) was obtained as an amorphous powder, $C_{22}H_{24}O_7$, $[\alpha]_D^{24}$ −21.1° ($CHCl_3$). The UV, IR, ^{1}H-NMR and circular dichroism (CD) spectral data indicate that **4** is a dibenzocyclooctadiene lignan possessing an *S*-biphenyl configuration.[9]

The ^{1}H-NMR spectrum of **4** reveals the presence of two secondary methyls (δ 0.88, 6H, d, J=6.5 Hz) on the cyclootadiene ring, and two methylenedioxy moieties and two methoxyls on two aromatic rings. The doublet signal at δ 4.27 (1H, J=8 Hz) is assigned to a benzylic methine carrying a hydroxy group. On oxidation with CrO_3 in pyridine, **4** afforded a carbonyl compound (**5**), $C_{22}H_{22}O_7$, mp 175—177.5°C, $[\alpha]_D^{23}$ +40.5° ($CHCl_3$).[9] On comparison of the ^{13}C-NMR spectrum of **4** with those of gomisin O (**6**) and epigomisin O (**7**), which possess a boat conformation and a twist-boat-chair conformation of the cyclooctadiene ring,[7,9] respectively, the spectrum of **4** was seen to be very similar to that of **6**. The C-6 shift (δ 81.1) and two methyl shifts (δ 16.5 and 17.5) of **4** are essentially the same as those of **6** (C-6: δ 81.4; CH_3: δ 16.6 and 17.5), but they are quite different from those of **7** (C-6: 73.4; CH_3: 7.8 and 22.0).

The above observations indicate that **4** possesses a boat conformation of the cyclooctadiene ring and $C_{(6\beta)}$-hydroxy group. On the other hand, **4** exhibits two downfield methoxy signals at δ 59.5 and 59.6, indicating the presence of methoxyls at C-1 and C-14. The structure of gomisin R was thus assumed to be **4**. All the carbon assignments of **4** listed in Table I are consistent with the proposed structure. Finally, the structure of **4** was confirmed by chemical correlation with **1**.

In the previous papers, we reported that gomisin N (**8**) was oxidized with $KMnO_4$ in a mixture of 2% NaOH and pyridine to give compounds **9** and **10**.[9,10] The same treatment of **1** gave a carbonyl compound (**5**) and a ketoalcohol (**11**), $C_{22}H_{22}O_8$, mp 237—242°C. The former was identical with **5**, derived from **4** (IR, mixed mp, ^{1}H-NMR and $[\alpha]_D$). The absolute structure of gomisin R was thus elucidated as **4**.

Compound **12** was obtained as colorless prisms (from MeOH), $C_{29}H_{28}O_9 \cdot 1/2CH_3OH$, mp 120—125°C, $[\alpha]_D^{24}$ −159°.[11] The ^{1}H- and ^{13}C-NMR and mass spectral analysis of **12** suggested that **12** is schisantherin D. The structure of **12** was confirmed as described below. Hydrolysis of **12** with 3% ethanolic potassium hydroxide afforded benzoic acid and a diol (**13**) as a white amorphous powder, $C_{22}H_{24}O_8$, $[\alpha]_D^{24}$ −41.4° ($CHCl_3$), the struture of which was assumed to be **13** on the basis of a comparison of the ^{13}C-NMR spectrum with that of deangeloylgomisin B (**14**).[7,12] Reduction of **11** with $NaBH_4$ in MeOH gave a diol, which was identified as **13** on the basis of IR, ^{1}H-NMR, mass spectra and $[\alpha]_D$ comparisons. Previously, we reported that the reduction of **10** in the same manner gave only **14** possessing a $C_{(6\beta)}$-hydroxy group.[9] Thus, **12** was confirmed to be schisantherin D.

Experimental

All melting points were determined on a Yanagimoto micromelting point apparatus (a hot-stage type) and are uncorrected. The UV, IR, ^{1}H-NMR and ^{13}C-NMR spectra were recorded with the same machines as those described in the preceding paper.[1] The specific rotations and CD spectra were also measured with the same machines. Mass spectra (MS) were measured with a Hitachi RMU-7L double focusing mass spectrometer. Preparative layer chromatography (PLC) was carried out on plates (20×20 cm, 0.75 mm thick) coated with Kieselgel PF_{254} (Merck). For silica gel column chromatography, Kieselgel 60 (Merck) was used.

Isolation of Compounds——In the previous paper,[9] it was reported that the petroleum ether and methanolic extracts of the fruits of *Schizandra chinensis* (4.671 kg) afforded twelve fractions (fr. 1—12) on silica gel column chromatography with hexane, acetone–benzene and acetone solvent systems.

Isolation of Wuweizisu C(**1**): A part (42 g) of fr. 3 (114 g) was chromatographed on silica gel (700 g), with an EtOAc–hexane solvent system. The fractions eluted with 8% EtOAc–hexane were combined and concentrated to give a residue (2.48 g). Crystallization of this residue from MeOH gave **1** [1.233 g, Calcd yield 0.072%].

Isolation of Gomisin R(**4**) and Schisantherin D(**12**): Fr. 6 (10.97 g) was chromatographed on silica gel (240 g) with an EtOAc–hexane solvent system. The fractions eluted with 18% and 20% EtOAc–hexane were combined and concentrated to give a residue (1.10 g), which was rechromatographed on silica gel (30 g) with an ether–benzene solvent system. The fractions eluted with 2% ether–benzene were combined and

concentrated to give a residue (385 mg), which was purified by PLC with hexane–acetone (7: 3) as an eluent. The zone with *Rf* 0.52 was extracted with $CHCl_3$–MeOH (4: 1) and the extract was concentrated to give **12** (60 mg, yield 0.0013%). The zone with *Rf* 0.62 was extracted with $CHCl_3$–MeOH (4: 1). The extract was concentrated and purified by repeated PLC [1st PLC: benzene–ether (2: 1), *Rf* 0.67, and 2nd PLC: $CHCl_3$–EtOH (20: 1), *Rf* 0.86] to give **4** (47 mg, yield 0.001%).

Wuweizisu C(1)——Compound **1** was obtained as colorless prisms (from MeOH), mp 121—123°C, $[\alpha]_D^{22}$ −58.8° (c=1.02, $CHCl_3$). IR ν_{max}^{KBr} cm^{-1}: 1610 (aromatic), 949, 939 (OCH_2O). ^{1}H-NMR (δ in $CDCl_3$). 0.73 (3H, d, J=7 Hz; H-18), 0.95 (3H, d, J=7 Hz, H-17), 1.83 (2H, m, H-7 and H-8), 2.07 (center, 2H m, H-9), 2.50 (center, 2H, m, H-6), 3.83 (6H, s, 2×OCH_3), 5.93 (4H, s, 2×–OCH_2O–), 6.48 (2H, s, H-4 and H-11). *Anal.* Calcd for $C_{22}H_{24}O_6$: C, 68.72; H, 6.30. Found: C, 68.68; H, 6.28.

Gomisin R(4)——Compound **4** was obtained as a white amorphous powder, $[\alpha]_D^{24}$ −21.1° (c=1.94, $CHCl_3$). UV λ_{max}^{EtOH} (log ε): 220 (4.67), 254 (sh 3.98), 282 (3.30), 288—293 (sh 3.28). IR ν_{max}^{KBr} cm^{-1}: 3540, 3425 (OH), 1615 (aromatic). CD (c=0.0209, MeOH) $[\theta]^{23}$ (nm): +52000 (230), −62000 (255), −10000 (sh 281). ^{1}H-NMR (δ in $CDCl_3$): 0.88 (6H, d, J=6.5 Hz, H-17 and H-18), 1.72 (2H, m, H-7 and H-8), 1.90—2.60 (2H, m, H-9), 3.79 (3H, s, OCH_3), 3.91 (3H, s, OCH_3), 4.27 (1H, d, J=8 Hz, H-6α), 5.92, 5.95 (each 2H, s, 2×–OCH_2O–), 6.40 (1H, s, H-11), 6.47 (1H, s, H-4). MS m/z(%): 400 (M^+, 100), 382 (M^+-H_2O, 43), 344 (93). High resolution MS, Calcd for $C_{22}H_{24}O_7$(M^+): 400.1521. Found: 400.1494.

Schisantherin D(12)——Compound **12** was obtained as colorless prisms (from MeOH), mp 120—125°C, $[\alpha]_D^{24}$ −159° (c=1.38, $CHCl_3$).[11] UV λ_{max}^{EtOH} nm (log ε): 226 (4.76), 259 (sh, 4.01), 281 (3.99). IR ν_{max}^{KBr} cm^{-1}: 3380 (OH), 1721 (C=O), 1618 (aromatic). ^{1}H-NMR (δ in $CDCl_3$): 1.17 (3H, d, J=7 Hz, H-17), 1.35 (3H, s, H-18), 2.00 (1H, m, H-8), 2.15 (1H, dd, J=14/2 Hz, H-9β), 2.48 (1H, dd, J=14/8 Hz, H-9α), 3.50, 3.80 (each 3H, s, 2×OCH_3), 5.72 (1H, s, H-6α), 5.58, 5.73 (each 1H, d, J=1.5 Hz, –OCH_2O–), 5.97 (2H, s, –OCH_2O–), 6.57 (1H, s, H-11), 6.75 (1H, s, H-4), 7.43 (5H, m, C_6H_5CO–), 3.45 (1.5H, s, 1/2C$\underline{H}_3$OH). MS m/z (%): 520 (M^+, 57), 398 ($M^+-C_6H_5COOH$, 53), 326 (100), 105 (C_6H_5CO, 87), 77 (C_6H_5, 34). *Anal.* Calcd for $C_{29}H_{28}O_9$–1/2CH_3OH: C, 66.06; H, 5.65. Found: C, 65.92; H, 5.91.

Treatment of 1 with $Pb(OAc)_4$ in Dry Benzene, giving 3——A solution of **1** (150 mg) and $Pb(OAc)_4$ (600 mg) in dry benzene (6 ml)[8] was stirred at 60°C for 10 h then diluted with ether (80 ml). The total mixture was washed with H_2O, dried over Na_2SO_4 and concentrated. The residue was dissolved in 80% AcOH (2 ml), stirred at room temperature for 2 h and concentrated under reduced pressure. The residue was purified by PLC [hexane–acetone (3: 2)] to give **3** (45 mg, yield 32%) as a pale brown amorphous powder. IR ν_{max}^{KBr} cm^{-1}: 3370 (OH), 1600 (aromatic). ^{1}H-NMR (δ in $CDCl_3$): 0.70 (3H, d, J=6.5 Hz, –CH–C$\underline{H}_3$), 0.95 (3H, d, J=6 Hz, –CH–C$\underline{H}_3$), 1.82 (2H, m, 2×–C$\underline{H}$), 2.08 (center, 2H, m, ArC$\underline{H}_2$–), 2.48 (center, 2H, m, ArC$\underline{H}_2$–), 3.22 (6H, s, 2×OCH_3), 5.75 (4H, br s, OH, D_2O exchangeable), 6.65 (2H, s, 2×arom.–H).

Methylation of 3——$(CH_3)_2SO_4$ (0.3 ml) and K_2CO_3 (300 mg) were added to a solution of **3** (45 mg) in dry acetone (3 ml). The reaction mixture was stirred at 45°C for 4 h, then diluted with H_2O (20 ml) and extracted with ether (15 ml×3). The ethereal extract was washed with H_2O, dried over Na_2SO_4, and concentrated. The residue was purified by PLC [benzene–ether (5: 1)] to give a dimethyl ether (40 mg) as colorless prisms (from ether–hexane), mp 115—117°C, $[\alpha]_D^{23}$ −88.2° (c=1.36, $CHCl_3$). IR ν_{max}^{KBr} cm^{-1}: 1591, 1576 (aromatic). *Anal.* Calcd for $C_{24}H_{32}O_6$: C, 69.21; H, 7.74. Found: C, 69.28; H, 7.94. This compound was identified as dimethylgomisin J(2)[6] by direct comparison with an authentic sample (IR, ^{1}H-NMR, $[\alpha]_D$ and mixed mp).

Oxidation of 4 with CrO_3 in Pyridine——CrO_3 (50 mg) was added to a solution of **4** (25 mg) in pyridine (0.5 ml). The reaction mixture was stirred at room temperature for 3 h, then diluted with H_2O (20 ml) and extracted with ether (15 ml×3). The combined ethereal extract was washed with 1 N HCl, then with H_2O, dried over Na_2SO_4 and concentrated. The residue was purified by PLC [hexane–acetone (4: 1)] to give **5** (17.8 mg) as colorless prisms (from ether–hexane), mp 175—177.5°C, $[\alpha]_D^{23}$ +40.5° (c=0.593, $CHCl_3$). UV λ_{max}^{EtOH} nm (log ε): 237 (4.40), 252 (sh 4.11), 290 (3.87). IR ν_{max}^{KBr} cm^{-1}: 1650 (C=O), 1602 (aromatic). ^{1}H-NMR (δ in $CDCl_3$): 0.78 (3H, d, J=6.5 Hz, H-17), 1.00 (3H, d, J=7 Hz, H-18), 1.77 (1H, m, H-8), 2.53 (1H, m, H-7), 1.92—2.47 (2H, m, H-9), 3.77, 3.87 (each 3H, s, 2×OCH_3), 5.98, 6.03 (each 2H, s, 2×–OCH_2O–), 6.45 (1H, s, H-11), 7.38 (1H, s, H-4). *Anal.* Calcd for $C_{22}H_{22}O_7$: C, 66.32; H, 5.57. Found: C, 66.29; H, 5.69.

Oxidation of 1 with $KMnO_4$——A solution of **1** (720 mg) and $KMnO_4$ (1440 mg) in a mixture of pyridine (14 ml) and 2% NaOH (28 ml) was stirred at 50°C for 2 h, then diluted with H_2O (40 ml). The solution was treated with $NaHSO_3$ until no color could be detected in the solution, then it was extracted with ether (40 ml×2). The combined ethereal extract was washed with 1 N HCl, then with H_2O, dried over Na_2SO_4 and concentrated. The residue was purified by PLC [hexane–acetone (4: 1)] to give unchanged **1** (184 mg), **5** (42 mg, yield 5.6%) and **11** (9 mg, yield 1.1%). **5**: colorless prisms (from ether–hexane), mp 175—177.5°C, $[\alpha]_D^{23}$ +36.0° (c=0.600, $CHCl_3$). *Anal.* Calcd for $C_{22}H_{22}O_7$: C, 66.32; H, 5.57. Found: C, 66.22; H, 5.67. This compound was identified as **5** derived from **4** by direct comparison (IR, ^{1}H-NMR, $[\alpha]_D$ and mixed mp). **11**: colorless prisms (from MeOH), mp 237—242°C, $[\alpha]_D^{23}$ −67.2° (c=0.580, $CHCl_3$). UV λ_{max}^{EtOH} nm (log ε): 220 (4.57), 251 (sh 4.17), 284—285 (sh 3.66). IR ν_{max}^{KBr} cm^{-1}: 3420 (OH), 1690 (C=O), 1620, 1605 (aromatic). ^{1}H-NMR (δ in $CDCl_3$): 1.09 (3H, d, J=7 Hz, H-17), 1.37 (3H, s, H-18), 1.61 (1H, m, H-8), 2.21 (1H, dd, J=13.5/2 Hz, H-9β), 2.56 (1H, dd, J=13.5/9.5 Hz, H-9α), 3.81, 3.93 (each 3H, s, 2×OCH_3), 5.93, 6.03 (each

2H, s, 2×–OCH_2O–), 6.39 (1H, s, H-11), 6.61 (1H, s, H-4). *Anal.* Calcd for $C_{22}H_{22}O_8$: C, 63.76; H, 5.35. Found: C, 63.53; H, 5.49.

Hydrolysis of 12——A solution of **12** (52 mg) in 3% KOH–EtOH (2 ml) was kept at 75°C for 5 h, then diluted with H_2O (20 ml) and extracted with ether (15 ml×3). The combined ethereal extract was washed with H_2O, dried over Na_2SO_4 and concentrated to give a residue, which was purified by PLC [hexane–EtOAc (1: 1)] to give a diol (**13**, 37 mg) as a white amorphous powder, $[\alpha]_D^{24}$ −41.1° (c=1.29, $CHCl_3$). UV λ_{max}^{EtOH} nm (log ε): 220 (4.58), 257 (sh 3.95), 282 (3.57). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3550, 3525 (OH), 1612 (aromatic). MS, m/z(%): 416 (M^+, 59), 398 (M^+-H_2O, 26), 326 (100). ^{1}H-NMR (δ in $CDCl_3$) 1.10 (3H, d, J=6.8 Hz, H-17), 1.37 (3H, s, H-18), 1.78 (1H, m, H-8), 2.07 (1H, dd, J=13.5/1.5 Hz, H-9β), 2.37 (1H, dd, J=13.5/8 Hz, H-9α), 3.87, 3.90 (each 3H, s, 2×OCH_3), 4.53 (1H, d, J=11 Hz, H-6α, singlet after addition of D_2O), 5.97, 5.98 (each 2H, s, 2×–OCH_2O–), 6.50, 6.55 (each 1H, s, 2×arom.–H). High resolution MS, m/z, Calcd for $C_{22}H_{24}O_8$ (M^+): 416.1471. Observed: 416.1478.

The aqueous solution was acidified with 1 N HCl and extracted with ether. The ethereal extract was washed with H_2O, dried over Na_2SO_4 and concentrated to give colorless prisms (2 mg), mp 122—123°C. This compound was identified as benzoic acid by direct comparison with an authentic sample (IR and mixed mp).

Reduction of 11 with $NaBH_4$——$NaBH_4$ (22 mg) was added to a solution of **11** (11 mg) in MeOH (2 ml). The reaction mixture was allowed to stand at room temperature overnight, then diluted with ether (40 ml). The total mixture was washed with H_2O, dried over Na_2SO_4 and concentrated to dryness. The residue was purified by PLC [benzene–ether (1: 1)] to give a diol (8 mg) as a white amorphous powder, $[\alpha]_D^{23}$ −40.0° (c= 0.400, $CHCl_3$). MS m/z(%) 416 (M^+, 60), 398 (23), 326 (100). This compound was identified as **13** by comparison with an authentic sample (IR, ^{1}H-NMR, MS and $[\alpha]_D$).

References and Notes

1) Part XI: Y. Ikeya, N. Ookawa, H. Taguchi, and I. Yosioka, *Chem. Pharm. Bull.*, **30**, 3202 (1982).
2) Y.-Y. Chen, Z.-B. Shu, and L.-L. Li, *Scientia Sinica*, **19**, 276 (1976).
3) C.-S. Liu, S.-D. Fang, M.-F. Huang, Y.-L. Kao, and J.-S. Hsu, *Scientia Sinica*, **21**, 483 (1978).
4) J. Xie, J. Zhon, G. Zhang, J. Yang, and H. Jin, *Acta Pharm. Sinica*, **16**, 306 (1981).
5) G.E. Schneiders and R. Stevenson, *J. Org. Chem.*, **46**, 2969 (1981).
6) Y. Ikeya, H. Taguchi, I. Yosioka, and H. Kobayashi, *Chem. Pharm. Bull.* **27**, 1583 (1979).
7) Y. Ikeya, H. Taguchi, H. Sasaki, K. Nakajima, and I. Yosioka, *Chem. Pharm. Bull.*, **28**, 2414 (1980).
8) Y. Ikeya, H. Taguchi, and I. Yosioka, *Chem. Pharm. Bull.*, **29**, 2893 (1981).
9) Y. Ikeya, H. Taguchi, I. Yosioka, and H. Kobayashi, *Chem. Pharm. Bull.*, **27**, 2695 (1979).
10) This reaction shows that the benzylic methylene group of the axial methyl side was oxidized to a carbonyl group, and the methine carrying the axial methyl to a carbinol, accompanied by inversion of methyl orientation. The reaction mechanism of the inversion of $C_{(7)}$-methyl orientation may involve initial attack of the reagent at the $C_{(6)}$-position from the less hindered side to yield a carbonyl compound (**9** from **8**), which forms an enolized intermediate in the alkaline medium, and then $C_{(7)}$ is attacked by the reagent from the less hindered side to yield a ketoalcohol (**10** from **4**).
11) Since compound **12**, which was obtained by us, contains 0.5 mol of methanol of crystallization, its physical constants are little different from those of schisantherin D obtained by Liu *et al.* [Ref. 3: mp 108—110°C, $[\alpha]_D^{23}$ −180° ($CHCl_3$)].
12) Y. Ikeya, H. Taguchi, I. Yosioka, and H. Kobayashi, *Chem. Pharm. Bull.*, **27**, 1383 (1979).