REVISED STRUCTURE OF SANGGENON B[1]

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Abstract——— The structure of sanggenon B which had been isolated from the extract of the Chinese crude drug "Sang-Bai-Pi" (Japanese name "Sōhakuhi"), the root bark of Morus sp. (Moraceae), was reversed from the structure (**1'**) to (**1**) on the basis of spectral data.

In the previous paper,[2] we reported the structure (**1'**) for sanggenon B, which had been isolated from the benzene extract of the Chinese crude drug "Sang-Bai-Pi" (Japanese name "Sōhakuhi"), the root bark of Morus sp. (Moraceae), on the basis of spectral and chemical data. Sanggenon B (**1**) is regarded biogenetically as a variation of a Diels-Alder type adduct of a chalcone derivative and a dehydroprenylflavanone derivative. Recently, we reported the structure (**2**) for mulberrofuran H which had been isolated from the root bark of cultivated mulberry tree (a cultivated variety of Morus lhou Koidz.).[3] Mulberrofuran H is regarded biogenetically as a derivative induced from the Diels-Alder type adducts, such as chalcomoracin (**3**),[4] mulberrofurans C (**4**),[5] and J (**5**),[6] through a mechanism described in Chart 1.[3] The biogenetic pathway of mulberrofuran H (**2**) being considered, sanggenon B also seems to be a derivative induced from the Diels-Alder type adducts, sanggenons C (**6**)[7] and D (**7**)[8] through the similar mechanism. This consideration prompted us to reinvestigate the structure of sanggenon B. In this paper, we propose the revised formula (**1**) for the structure of sanggenon B from the following evidence. Comparison of the ^{1}H nmr spectra of **1**, **1a**, and **1b** indicates that the acetylation of the hydroxyl group at the C-7 position caused down field shift (-0.19 ppm) of

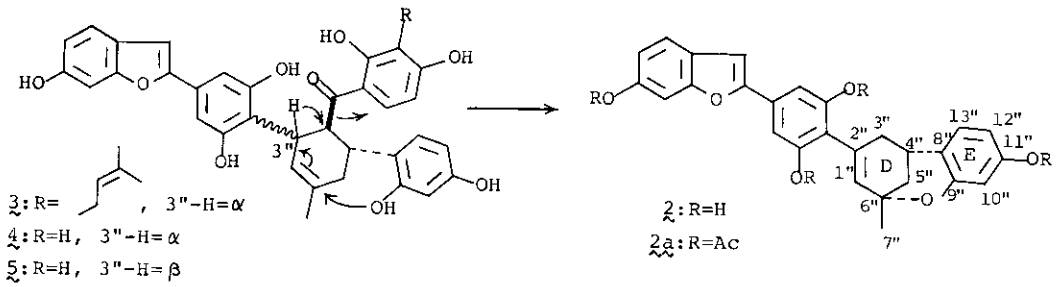
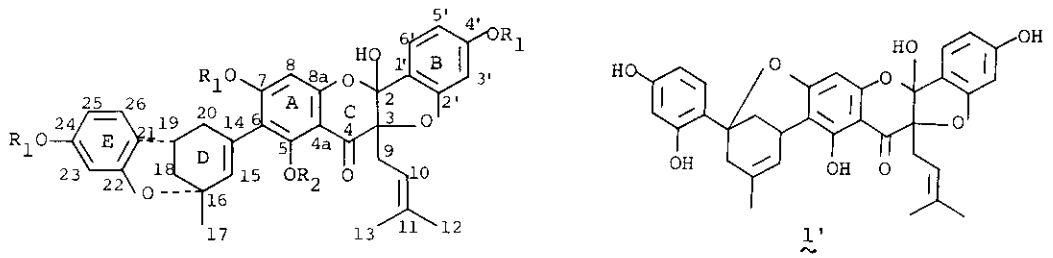
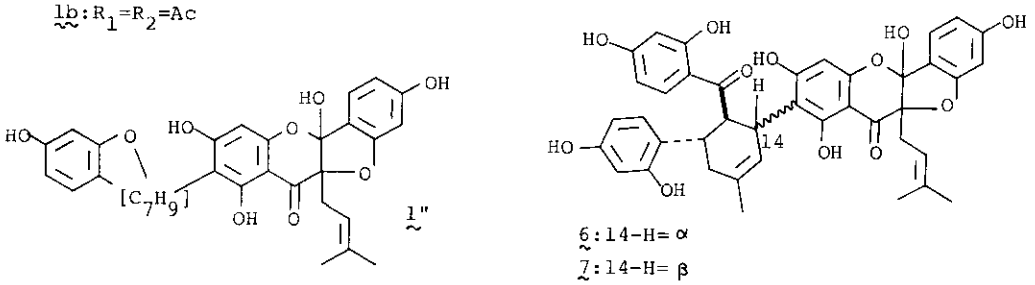


Chart 1





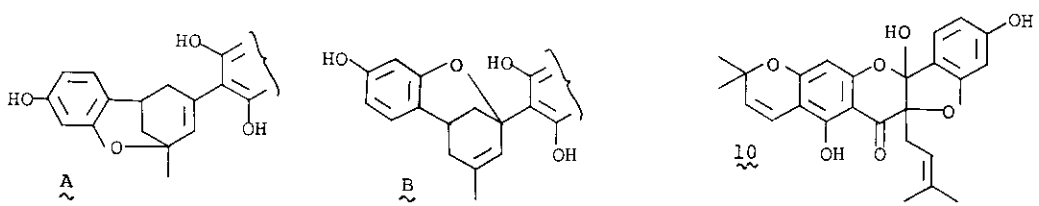


Fig. 1

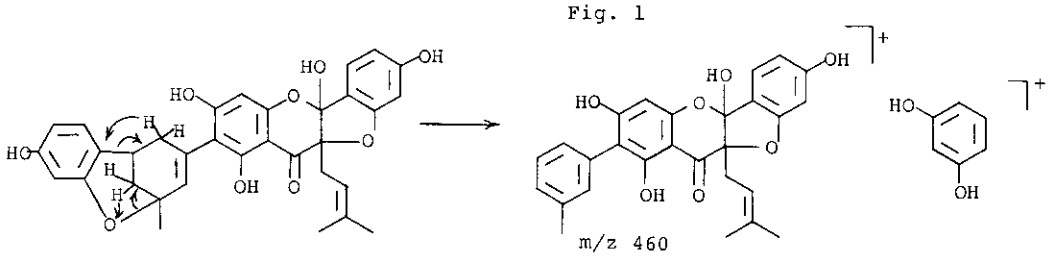
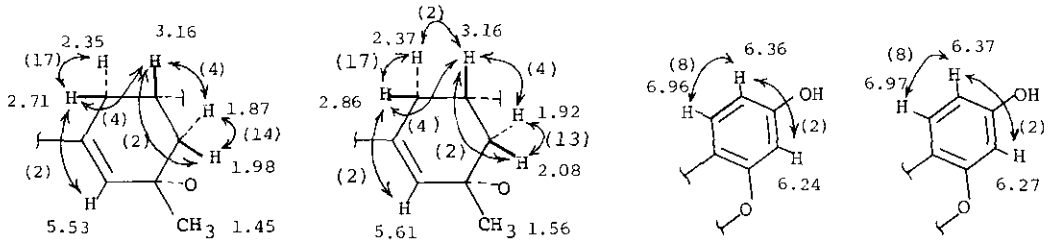
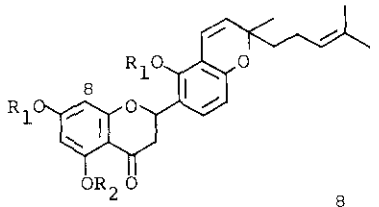


Chart 2

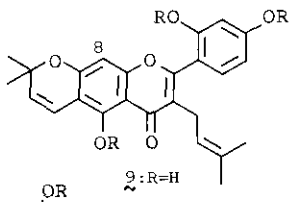


1 2 1 2

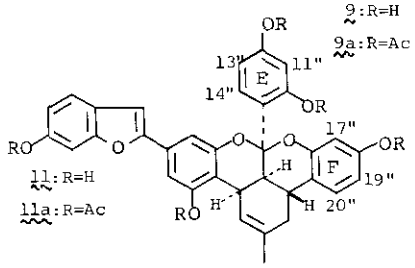
Fig. 2 ( ): J in Hz



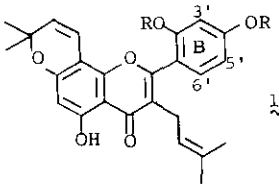
8:R_1=R_2=H
8a:R_1=Ac, R_2=H
8b:R_1=R_2=Ac



9:R=H
9a:R=Ac



11:R=H
11a:R=Ac



12:R=H
12a:R=Ac

Table 1 Chemical shifts (ppm) of C-8-H

1	5.88	1	5.88	8	6.00	8	6.00
1a	6.07	1b	6.57	8a	6.25	8b	6.70
Δ	-0.19		-0.69	Δ	-0.25		-0.70

9	6.24
9a	6.63
Δ	-0.39

solv.: acetone-d_6

Table 2 Chemical shifts (ppm)

	C-23-H	C-25-H		C-10"-H	C-12"-H
1	6.24	6.36	2	6.27	6.37
1b	6.49	6.61	2a*	6.57	6.64
Δ	-0.25	-0.25	Δ	-0.30	-0.27

	C-17"-H	C-19"-H
11	6.38	6.51
11a	6.62	6.78
Δ	-0.24	-0.27

solv.:acetone-d_6
* :$CDCl_3$

Table 3 Chemical shifts (ppm)

	C-11"-H	C-13"-H		C-3'-H	C-5'-H
11	6.42	6.23	12	6.55	6.59
11a	7.04	6.92	12a*	7.11	7.12
Δ	-0.62	-0.69	Δ	-0.56	-0.53

solv.: acetone-d_6 *: $CDCl_3$

Table 4 ^{13}C nmr chemical shifts (ppm)

	1		1		1		2
C-2	101.2	C-5'	108.6	C-14	132.0	C-2"	135.6
C-3	90.8	C-6'	124.2	C-15	131.3	C-1"	132.4
C-4	186.6	C-9	31.2	C-16	70.6	C-6"	71.8
C-4a	98.7	C-10	117.2	C-17	27.0	C-7"	27.5
C-5	160.7	C-11	135.3	C-18	33.9	C-5"	34.6
C-6	109.7	C-12	25.1	C-19	30.9	C-4"	31.8
C-7	164.3	C-13	17.4	C-20	38.5	C-3"	39.8
C-8	94.2			C-21	117.9	C-8"	119.0
C-8a	160.7			C-22	154.0	C-9"	155.2
C-1'	119.8			C-23	102.5	C-10"	103.9
C-2'	159.6	solv.: acetone-d_6		C-24	156.0	C-11"	157.8
C-3'	98.3			C-25	107.0	C-12"	108.8
C-4'	159.7			C-26	129.1	C-13"	130.6

the proton at the C-8 position and that the acetylation of the hydroxyl groups at the C-7 and C-5 positions caused the larger down field shift (-0.69 ppm) of the proton (Table 1). Similar shifts were observed in the case of the proton at the C-8 position of sanggenon N (**8**) and its acetates (**8a, 8b**) (Table 1).[9] On the other hand, the acetylation of the C-5 hydroxyl group of cudraflavone B (**9**) caused a down field shift (-0.39 ppm) (Table 1).[10] These results suggest that sanggenon B has hydroxyl groups at the C-5 and C-7 positions so that the formula (**1'**) for sanggenon B should be revised.

In the previous paper,[2] it was clarified that sanggenon B has the same flavanone skeletal structure as sanggenon A (**10**)[11] and that the C-6 side chain consists of a methylcyclohexene ring and a 2,4-dioxygenated phenyl moiety. To confirm the structure of the C-6 side chain, a comparative examination of the ^{1}H nmr spectra of **1** and **1b** was carried out and it was found that acetylation of the C-24 hydroxyl group caused down field shifts (-0.25 ppm) of the protons at C-23 and 25 positioins in the E ring. Similar shifts were observed in the cases of the relevant E ring protons of **2** and its acetate (**2a**),[3] and the F ring protons of mulbarrofuran G (**11**) and its acetate (**11a**) (Table 2).[12] On the other hand, the acetylation of the 10" and 12" hydroxyl groups of **11** caused larger down field shifts (-0.62～-0.69 ppm) of the protons at C-11" and 13" positions in the E ring.[12] Similar result was also reported in the case of the relevant B ring protons of morusin (**12**) and its acetate (**12a**) (Table 3).[13] These results suggest that the 2,4-dioxygenated phenyl moiety (E ring) in the C-6 side chain of **1** has a hydroxyl group and the other oxygen atom forms an ether linkage. From the above results, the partial structure (**1"**) was proposed. The presence of a tetrasubstituted methylcyclohexene ring (C_7H_9 moiety) was suggested by the following examination of the ^{1}H nmr spectra of **1**. The spectrum was analysed with the aid of sequential decoupling experiments, and the deduced two possible partial structures (**A** and **B**) are shown in Fig. 1. In the ^{1}H nmr spectrum of **1**, the chemical shift values and the coupling constants of the protons of the C_7H_9 moiety as well as the E ring were similar to those of the relevant protons of **2** (Fig. 2).[3]

In the ^{13}C nmr spectrum, the chemical shift values of the carbon atoms of the D and E rings of **1** were similar to those of the relevant carbon atoms of **2** except the carbon atom (C-14) which was affected by the additional substituent effect (Table 4).[3] From these results, the partial structure (**A**) seems to be more favorable than the structure (**B**). Further supporting data for the proposed structure were

obtained by the following long-range selective ^1H decoupling technique: when the signal at δ 1.45 (C-16-CH_3) was weakly irradiated, the signal at δ 70.6 (C-16) increased the area (ca. +23 %). The irradiation of the signal at δ 5.53 (C-15-H) increased the area (ca. +22 %) of the C-16 signal while causing a change in the shape of the signal. The irradiation of the signal at δ 3.16 (C-19-H) also increased the area (ca. +3 %) of the same carbon signal. In the mass spectrum of **1**, the characteristic fragment ion at m/z 460 (M^+- $C_6H_6O_2$) seems to be formed through the similar route as in the case of mulberrofuran H (Chart 2).[3] From these results, we propose the revised formula (**1**) for the structure of sanggenon B.

EXPERIMENTAL

Abbreviations: s=singlet, d=doublet, t=triplet, m=multiplet, br=broad, sh=shoulder, infl.=inflection. The general experimental procedures used are described in the previous paper.[3]

Acetylation of sanggenon B (1) (formation of 1a and 1b)

Sanggenon B (**1**, 35 mg) was acetylated with acetic anhydride (2 ml) and pyridine (0.5 ml) at room temperature for 2 min, and treated as usual. The product was purified by preparative TLC (hexane:ether=2:3, silica gel) to give triacetate (**1a**, 9.5 mg) and tetraacetate (**1b**, 8.2 mg).

Sanggenon B triacetate (1a)

The compound (**1a**) was obtained as an amorphous powder, positive to $FeCl_3$ test: green. uv λ_{max}^{EtOH} nm (log ε): 229 (sh 4.12), 280 (sh 3.79), 283 (3.80), 294 (sh 3.62), 366 (3.10). ir $\nu_{max}^{CHCl_3}$ cm^{-1} : 3590 (sh),3510 (br), 1760, 1640 (sh), 1630, 1615 (sh), 1590, 1580. EI-MS m/z: 696 (M^+). ^1H nmr (90 MHz, acetone-d_6): δ 1.45 (3H, s, C-11-CH_3), 1.50 (3H, s, C-16-CH_3), 1.57 (3H, s, C-11-CH_3), 1.90 (2H, m, C-18-H x2), 2.03, 2.20, 2.23 (each 3H, s, $COCH_3$), 2.22 (1H, d, J=16.5, C-20-H), 2.55 (1H, br d, J=16.5, C-20-H), 2.65-2.85 (1H, m, C-9-H), 3.24 (1H, m, C-19-H), 3.25 (1H, dd, J=9 and 15, C-9-H), 5.12 (1H, m, C-10-H), 5.40 (1H, br s, C-15-H), 6.07 (1H, s, C-8-H), 6.47 (1H, d, J=3, C-23-H), 6.56 (1H, 1H, dd, J=3 and 9, C-25-H), 6.74 (1H, d, J=2, C-3'-H), 6.78 (1H, dd, J=2 and 9, C-5'-H), 7.12 (1H, d, J=9, C-26-H), 7.57 (1H, d, J=9, C-6'-H), 11.53 (1H, s, C-5-OH).

Sanggenon B tetraacetate (1b)

The compound (**1b**) was obtained as an amorphous powder, negative to $FeCl_3$. uv λ_{max}^{EtOH} nm (log ε): 228 (4.16), 275 (3.69), 282 (sh 3.64), 335 (2.90). ir $\nu_{max}^{CHCl_3}$ cm^{-1}: 3490, 1765, 1690,1655 (sh), 1613, 1587. EI-MS m/z: 738 (M^+). ^1H nmr (90 MHz, acetone-d_6): δ 1.46 (3H, s, C-11-CH_3), 1.50 (3H, s, C-16-CH_3), 1.60 (3H, s, C-11-

CH_3), 1.90 (2H, m, C-18-H x2), 2.04, 2.23 (each 6H, s, $COCH_3$ x2), 2.25 (1H, d, J=16.5, C-20-H), 2.59 (1H, br d, J=16.5, C-20-H), 2.80-2.95 (1H, m, C-9-H), 3.26 (1H, dd, J=9 and 15, C-9-H), 3.28 (1H, m, C-19-H), 5.08 (1H, m, C-10-H), 5.36 (1H, br s, C-15-H), 6.49 (1H, d, J=2.5, C-23-H), 6.57 (1H, s, C-8-H), 6.61 (1H, dd, J=2.5 and 9, C-25-H), 6.71 (1H, d, J=2, C-3'-H), 6.79 (1H, dd, J=2 and 9, C-5'-H), 7.18 (1H, d, J=9, C-26-H), 7.58 (1H, d, J=9, C-6'-H).

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