Tannins of Cornaceous Plants. I. Cornusiins A, B and C, Dimeric Monomeric and Trimeric Hydrolyzable Tannins from *Cornus officinalis*, and Orientation of Valoneoyl Group in Related Tannins

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Cornusiin A (1), cornusiin B (2) and cornusiin C (3), new dimeric, monomeric and trimeric hydrolyzable tannins, were isolated from the fruits of *Cornus officinalis* (Cornaceae). Their structures, including the orientation of the valoneoyl group in 1 and 3, were established on the basis of chemical and spectroscopic data. 2,3-Di-*O*-galloyl-D-glucose (7), 1,2,3-tri-*O*-galloyl-β-D-glucose, 1,2,6-tri-*O*-galloyl-β-D-glucose, 1,2,3,6-tetra-*O*-galloyl-β-D-glucose, gemin D (5), isoterchebin, tellimagrandin I (6) and tellimagrandin II were also isolated from the fruits. The orientation of the valoneoyl group in camptothin A (14) and that in camptothin B (15), which had been isolated from *Camptotheca acuminata* (Nyssaceae), were also determined based on that in 1.

Keywords tannin; hydrolyzable tannin; cornusiin A; cornusiin B; cornusiin C; oenothein C; camptothin A; camptothin B; *Cornus officinalis*; *Camptotheca acuminata*

Fruits of *Cornus officinalis* SIEB. *et* ZUCC. have been used as a traditional medicine in Japan and China, and represent one of the eight component drugs in Hachimi-gan, which is one of the most popular Kampo medicines in Japan. Our investigation on the constituents of the fruits revealed the presence of various hydrolyzable tannins including several oligomeric hydrolyzable tannins. This paper deals with the isolation and structure determination of these tannins, including cornusiin A (**1**), cornusiin B (**2**), which are dimeric and monomeric ellagitannins, respectively, and cornusiin C (**3**), a trimeric ellagitannin, and also several other hydrolyzable tannins.[1]

As the orientation of the valoneoyl group in each tannin molecule, which had been difficult to determine, was determined by precise investigation using nuclear magnetic resonance (NMR) spectroscopy for isorugosin B (**4**) and related tannins,[2] we also determined the orientation of the valoneoyl group in **1**, **3** and several other hydrolyzable tannins on the basis of chemical correlation with **4**.

Results and Discussion

Tannins in the fruits of *Cornus officinalis* were isolated as follows. A concentrated filtrate from an aqueous acetone homogenate of fresh fruits was extracted with diethyl ether, and then with ethyl acetate. The ethyl acetate extract was subjected to column chromatography over Sephadex LH-20, to give 1,2,3-tri-*O*-galloyl-β-D-glucose,[3,4] 1,2,6-tri-*O*-galloyl-β-D-glucose,[3,5] gemin D (**5**),[6] 1,2,3,6-tetra-*O*-galloyl-β-D-glucose,[5] isoterchebin,[7] tellimagrandin I (**6**),[7-9] tellimagrandin II[7-9] and a new dimeric hydrolyzable tannin named cornusiin A (**1**). After the extraction with ethyl acetate, the aqueous mother liquor was passed through a column of Celite 545, and adsorbed compounds were eluted with water, and then with acetone. The acetone eluate was subjected to droplet countercurrent chromatography (DCCC), and further purified on a column of

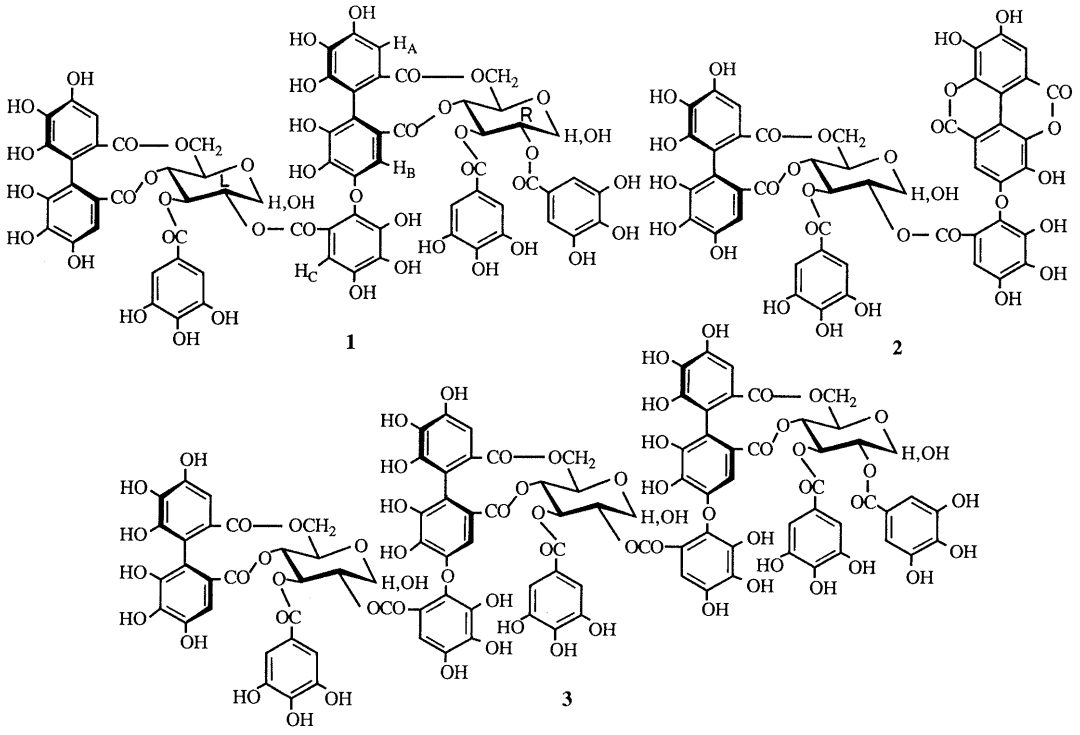


Chart 1

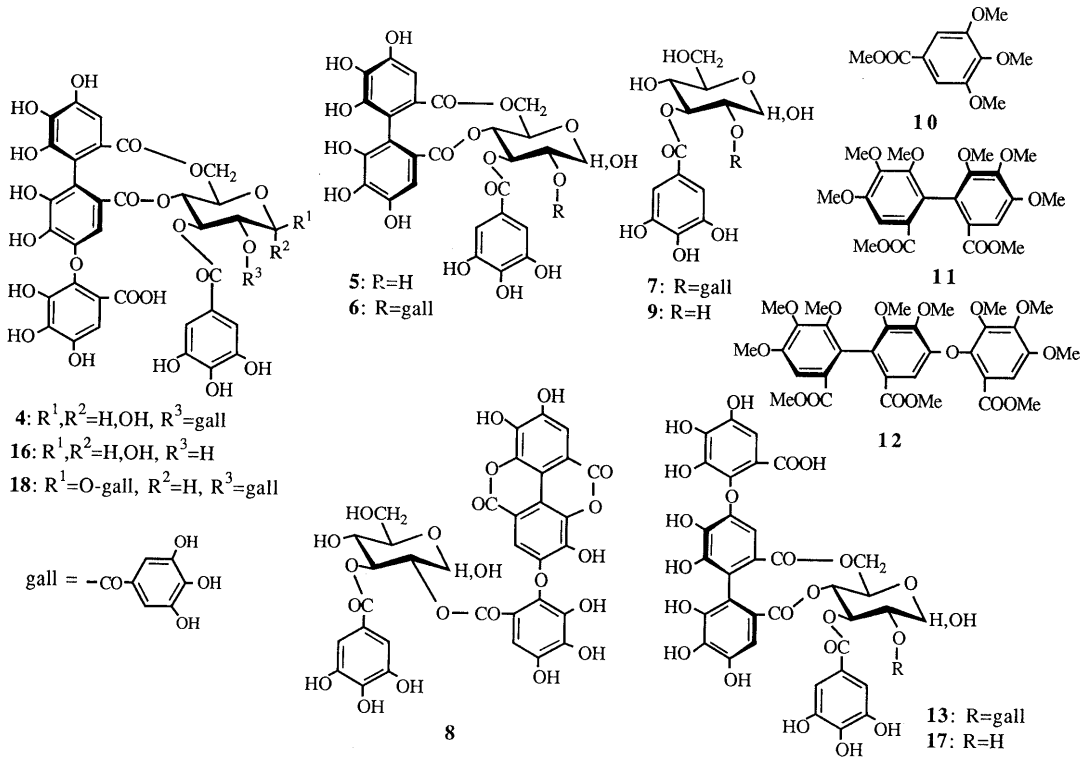


Chart 2

Sephadex LH-20 to afford two other new tannins named cornusiin B (**2**) and cornusiin C (**3**), and also **1**, **5** and 2,3-di-*O*-galloyl-D-glucose (**7**).[10,11]

Cornusiin B (**2**), $[\alpha]_D$ +63° (MeOH), was isolated as a light brown amorphous powder. The proton nuclear magnetic resonance (^{1}H-NMR) spectrum (500 MHz, in acetone-d_6) of **2** indicates that this tannin forms an anomeric mixture, and has a lactonized valoneoyl group [δ 7.61, 7.61 (each s, 1H in total), 7.16 (s, 1H), 7.05, 7.02 (each s, 1H in total)], a galloyl group [δ 6.85, 6.73 (each s, 2H in total)] and a hexahydroxydiphenoyl (HHDP) group [δ 6.59, 6.58 (each s, 1H in total), 6.46, 6.43 (each s, 1H in total)] and a glucopyranose core of $^4C_1$ conformation (see Experimental). The lactonization of the valoneoyl group in **2** was also shown by the absorption maxima at 350 (log ε 4.01) and 363 nm (4.05) in the ultraviolet (UV) spectrum[12] of **2** (in MeOH), and by the chemical shifts of the ester carbonyl (lactone carbonyl) carbon signals [δ 159.8, 159.9 (1C in total), 160.3, 160.5 (1C in total)] at high field relative to the other ester carbonyl carbon signals (δ 164.5—168.3), in the carbon-13 NMR (^{13}C-NMR) spectrum (125.7 MHz, in acetone-d_6 + D_2O) of **2** (see Experimental).

The positive Cotton effect in the short wavelength region ($[\theta]_{221}$ +8.8 × 10^4) in the circular dichroism (CD) spectrum[13] of **2** (in MeOH) indicates that the absolute configuration of the HHDP group is *S*. The chemical shifts of the H-4 proton [δ 5.01 (α-anomer), 4.97 (β-anomer)] and the two H-6 protons [δ 5.21, 3.66 (α-anomer), 5.22, 3.71 (β-anomer)] of the glucose cores of both anomers in the ^{1}H-NMR spectrum indicate that the (*S*)-HHDP group is at O-4—O-6 of the glucose core.[14] The upfield shift of the signal of H-1 of the β-anomer (δ 4.70) of **2**, relative to that of the corresponding proton (δ 5.13)[15] in tellimagrandin I (**6**), is regarded as due to the anisotropic effect of the lactonized valoneoyl group as shown in Chart 3, and therefore, the

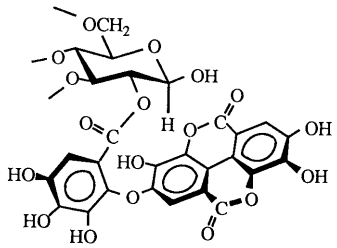


Chart 3. Partial Structure of the β-Anomer of Cornusiin B (**2**), which Induces an Anisotropic Effect on the Anomeric Proton

lactonized valoneoyl group is assigned to be at O-2 on the glucose core. Then, the remaining galloyl group should be at O-3, and thus the structure **2** is assigned for cornusiin B. This structure was also substantiated by the partial degradation of **2** in diluted sulfuric acid, to give a compound named oenothein C (**8**), which was also isolated from the leaves of *Oenothera erythrosepala*,[16] and 3-*O*-galloyl-D-glucose (**9**).[17] Treatment of **2** in hot water gave **5**, which also substantiates the locations of the acyl groups in **2**.

Oenothein C (**8**), $[\alpha]_D$ +72° (MeOH), thus produced from **2**, forms an off-white amophous powder. The ^{1}H-NMR spectrum (500 MHz, in acetone-d_6 + D_2O) of **8** indicates that this tannin forms an anomeric mixture, and has a lactonized valoneoyl group [δ 7.57 (s, 1H), 7.12, 7.10 (each s, 1H in total), 7.00, 6.95 (each s, 1H in total)], a galloyl group [δ 6.95, 6.83 (each s, 2H in total)] and a glucopyranose core of $^4C_1$ conformation. The ^{13}C-NMR spectrum of this tannin also indicates the presence of these acyl groups and the glucose core (see Experimental). The chemical shifts of H-2 [δ 4.85 (α-anomer), 4.96 (β-anomer)] and H-3 [δ 5.61 (α-anomer), 5.06 (β-anomer)] of the glucose core in the ^{1}H-NMR spectrum of **8** show that the two acyl groups should be at O-2 and O-3 of the glucose core. The

upfield shift of H-1 of the glucose core of the β-anomer (δ 4.68) of **8**, relative to the chemical shift of the corresponding proton (δ 5.42) of 2,3-di-*O*-galloyl-D-glucose (**7**), is also attributable to the anisotropic effect of the lactonized valoneoyl group. Therefore, the lactonized valoneoyl group should be located at O-2, and the remaining galloyl group should be at O-3 on the glucose core. The structure **8** thus assigned was also substantiated by the treatment of **8** in diluted sulfuric acid, which afforded **9**. Therefore, the structure **8** should be assigned to oenothein C, which also substantiates the location of acyl groups on the glucose core in cornusiin B as in structure **2**.

Cornusiin A (**1**), $[\alpha]_D$ +78° (MeOH), was obtained as an off-white amorphous powder. The positive-ion fast-atom bombardment mass spectrum (FAB-MS) of **1** showed the $(M+Na)^+$ ion at *m/z* 1593, which is consistent with the molecular formula $C_{68}H_{50}O_{44}$. Although this tannin showed a complicated ^{1}H-NMR spectrum (400 MHz, in acetone-d_6) due to the anomerization of two glucose cores, it showed the signals of eleven aromatic protons [δ 7.09, 7.08, 7.05, 7.04, 7.04, 7.04 (each s, 3H in total, H_C of valoneoyl group and two protons of a galloyl group), 7.01, 6.98, 6.97 (each s, 2H in total, protons of a galloyl group), 6.90, 6.87, 6.85, 6.81 (each s, 2H in total, protons of a galloyl group), 6.70, 6.89, 6.67, 6.65, 6.64, 6.63 (each s, 2H in total, a proton of an HHDP group and H_A of valoneoyl group), 6.49, 6.48, 6.46 (each s, 1H in total, a proton of an HHDP group), 6.21, 6.18, 6.17, 6.16 (each s, 1H in total, H_B of valoneoly group)], together with the protons of two glucose cores (δ 5.83—3.73). The presence of glucose cores in this tannin was confirmed by acid hydrolysis of cornusiin A, followed by gas liquid chromatography (GLC) of the trimethylsilylated hydrolyzates. Methanolysis after methylation of **1** afforded methyl tri-*O*-methylgallate (**10**), dimethyl (*S*)-hexamethoxydiphenate (**11**) and trimethyl (*S*)-octa-*O*-methylvaloneate (**12**) in a molar ratio of 3 : 1 : 1. These results indicate that cornusiin A consists of three galloyl groups, an (*S*)-HHDP group, an (*S*)-valoneoyl group and two glucose cores. The CD spectrum of **1**, which shows a large positive Cotton effect in the short-wavelength region[13,18] ($[\theta]_{220}+3.3\times10^5$), also indicates that both the HHDP group and the valoneoyl group have the *S*-configuration.

The locations of acyl groups on the two glucose cores in cornusiin A were elucidated based on the following data. The absence of the signals of anomeric protons in the region lower than 5.6 ppm in the ^{1}H-NMR spectrum of **1** indicates that two anomeric centers on the two glucose cores in this tannin are unacylated. Partial degradation of cornusiin A afforded **2**, **5**, **7**, **8** and isorugosin B (**4**),[2] which could be produced from cornusiin A as illustrated in Chart 4. Therefore, the structure **1**, including the orientation of the valoneoyl group, which is the same as that in **4**, is assigned for cornusiin A. The chemical shifts of the glucose carbon signals in the ^{13}C-NMR spectrum of **1** are also consistent with the locations of the acyl groups on the glucose cores as in the structure **1**.[15]

The signals of the HHDP protons (*i.e.*, the protons of the

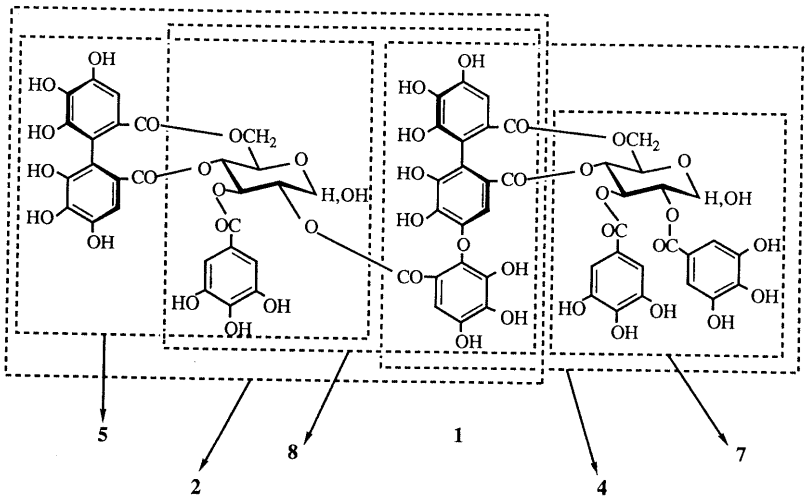
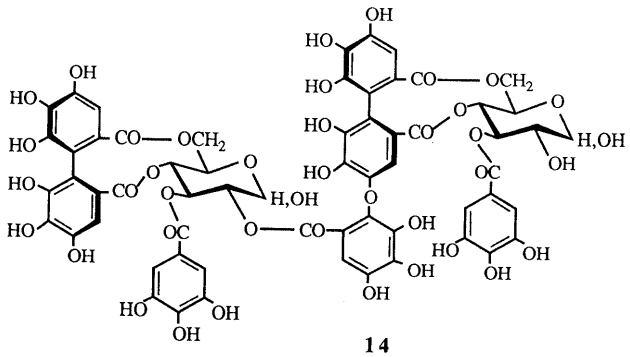


Chart 4



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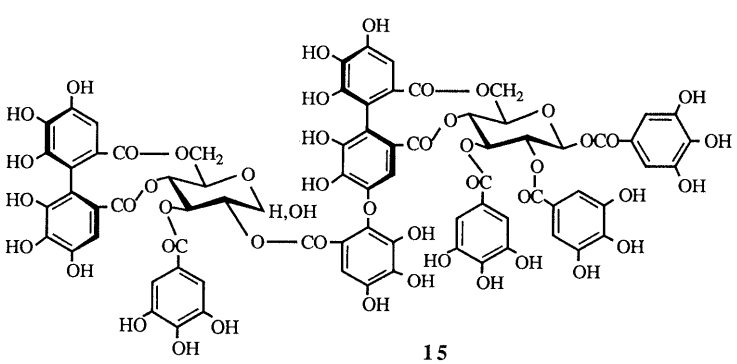

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Chart 5

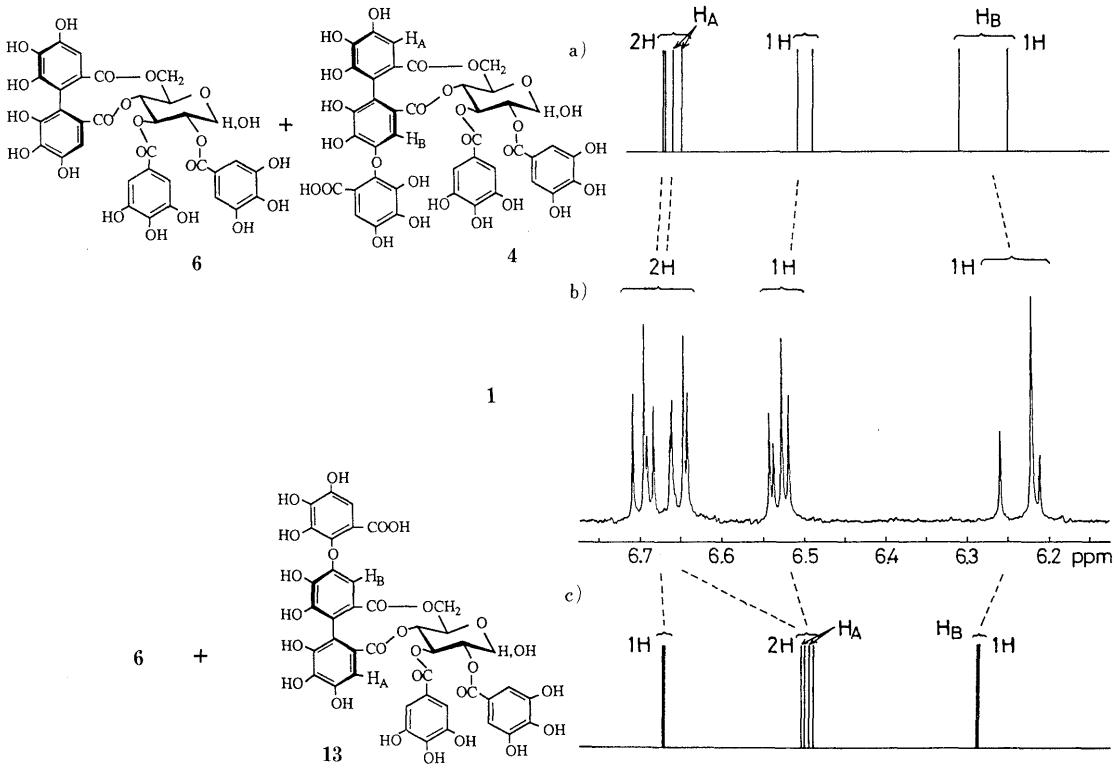

Fig. 1. Comparison of the Chemical Shifts of the HHDP Protons in the ^{1}H-NMR Spectra (in Acetone-d_6+D_2O) of a) Tellimagrandin I (**6**) Plus Isorugosin B (**4**), b) Cornusiin A (**1**), and c) **6** Plus Rugosin B (**13**)

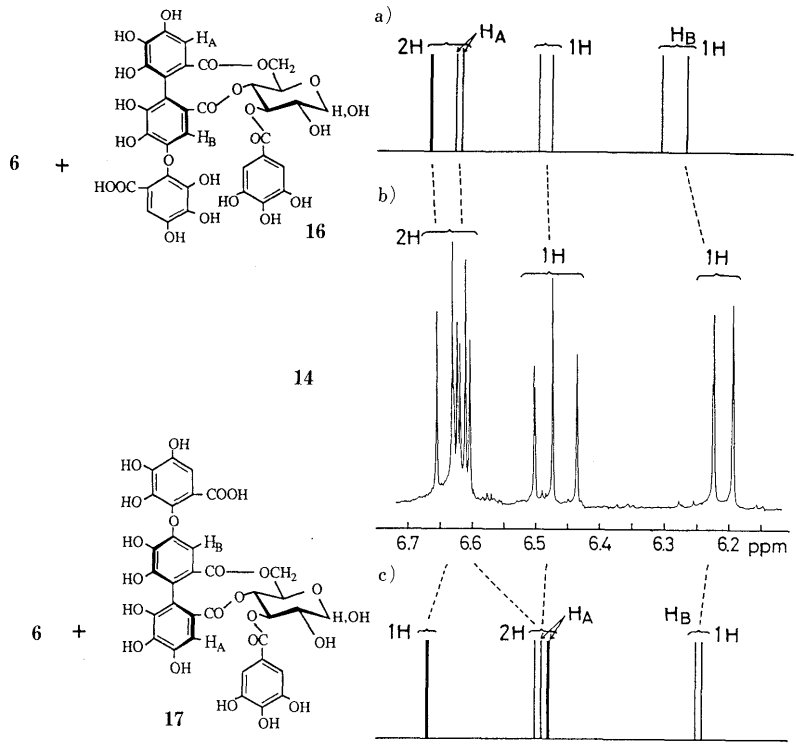

Fig. 2. Comparison of the Chemical Shifts of the HHDP Protons in the ^{1}H-NMR Spectra (in Acetone-d_6+D_2O) of a) Tellimagrandin I (**6**) Plus Isocoriariin F (**16**), b) Camptothin A (**14**), and c) **6** Plus Coriariin F (**17**)

HHDP group and the HHDP part of the valoneoyl group) in the ^{1}H-NMR spectrum of **1** are almost superimposable on the merged signals of the HHDP protons of **6** and **4** (Fig. 1), and are not superimposable on those of **6** and rugosin B (**13**),[3] which is an isomer of **4** concerning the orientation of the valoneoyl group in the molecule. Therefore, the chemical shifts of the HHDP protons (protons in the region of δ 6.8—6.1) can be used for the assignments of the orientation of the valoneoyl group in the oligomeric hydrolyzable tannins such as camptothins A (**14**) and B (**15**), which were

isolated from *Camptotheca acuminata*.[19]

The signal pattern of the HHDP protons in the ^{1}H-NMR spectrum of camptothin A (**14**), a dimeric tannin in which the orientation of the valoneoyl group has not yet been determined, was found to be analogous to that of the combined signals of the HHDP protons of **6** and isocoriariin F (**16**), which has been newly produced by the treatment of **4** with tannase[20] and is an isomer of coriariin F (**17**)[14] concerning the orientation of the valoneoyl group (Fig. 2). Thus, the orientation of the valoneoyl group in camptothin A should be as shown in structure **14**, which has been substantiated by partial hydrolysis of **1** with tannase to afford camptothin A.[19] Thus, the orientation of the valoneoyl group in camptothin A is the same as that in **1**, and is the same as that in **4** (and in **16**).

The orientation of the valoneoyl group in camptothin B is assigned as in structure **15**, based on the comparison of the chemical shifts of the HHDP protons in the ^{1}H-NMR spectrum of camptothin B with those of **6** and isorugosin A (**18**),[2] and has been confirmed by partial degradation of camptothin B with tannase, which afforded **1**.[19]

Cornusiin C (**3**), $[\alpha]_D$ +23° (MeOH), was isolated as an off-white amorphous powder. The molecular weight of this tannin was analyzed by high-performance gel permeation chromatography (HP-GPC) of **3**, and also of the acetate of **3** on a Shimadzu HSG-15 column, which indicated that cornusiin C has a molecular weight corresponding to that of a trimer of **6**. Although the ^{1}H-NMR spectrum (400 MHz, in acetone-d_6 + D_2O) of **3** was complicated due to the anomerization of the glucose cores, it showed sixteen aromatic protons assignable to four galloyl groups, two valoneoyl groups and an HHDP group [δ 7.13—6.98 (6H in total, two H_C protons in two valoneoyl groups and four protons of two galloyl groups), 6.94—6.82 (4H in total, protons of two galloyl groups), 6.69—6.64 (3H in total, a proton of an HHDP group and two H_A protons in two valoneoyl groups), 6.54—6.51 (1H in total, a proton of an HHDP group), 6.28—6.11 (2H in total, two H_B protons in two valoneoyl groups)] and protons of three glucose cores (δ 5.8—3.7). Methanolysis after methylation of **3** afforded **10**, **11** and **12** in a molar ratio of 4 : 1 : 2. The positive Cotton effect in the short-wavelength region ($[\theta]_{221}$ +4.5 × 10^5) in the CD spectrum of **3** indicates that all of the two valoneoyl groups and the HHDP group have *S*-configuration.[13,18] Therefore, cornusiin C consists of four galloyl groups, an (*S*)-HHDP group, two (*S*)-valoneoyl groups and three glucose cores.

The glucose carbon signals in the ^{13}C-NMR spectrum of **3**, which are almost superimposable on the glucose carbon signals of **6** (Fig. 3), indicate[15] that the four galloyl groups and the two galloyl parts in the two valoneoyl groups should be at O-2 and O-3 on the three glucose cores, and the HHDP group and the two HHDP parts in the

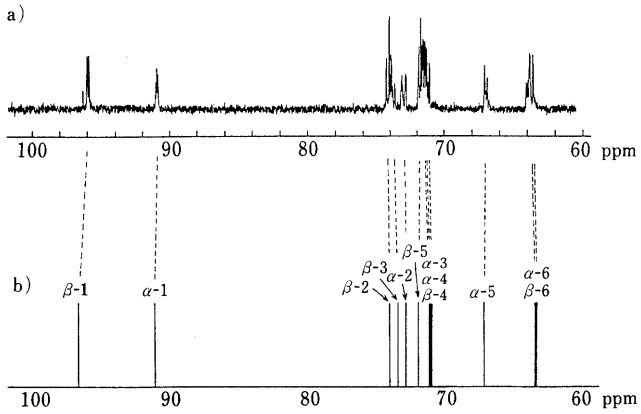

Fig. 3. Comparison of the Chemical Shifts of the Glucose Carbons in the ^{13}C-NMR Spectra of a) Cornusiin C (**3**) (in Acetone-d_6 + D_2O) and b) Tellimagrandin I (**6**) (in Acetone-d_6)

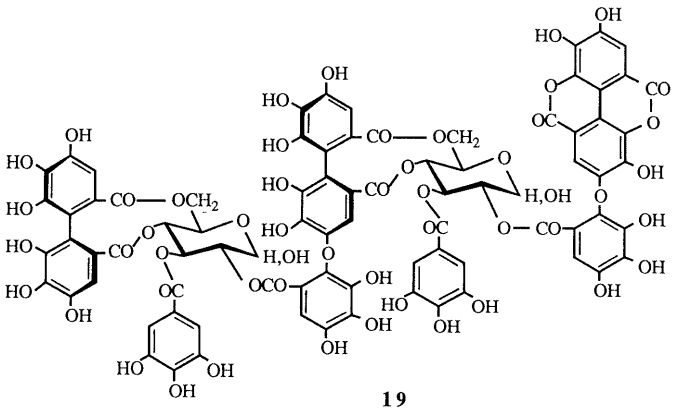

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Chart 6

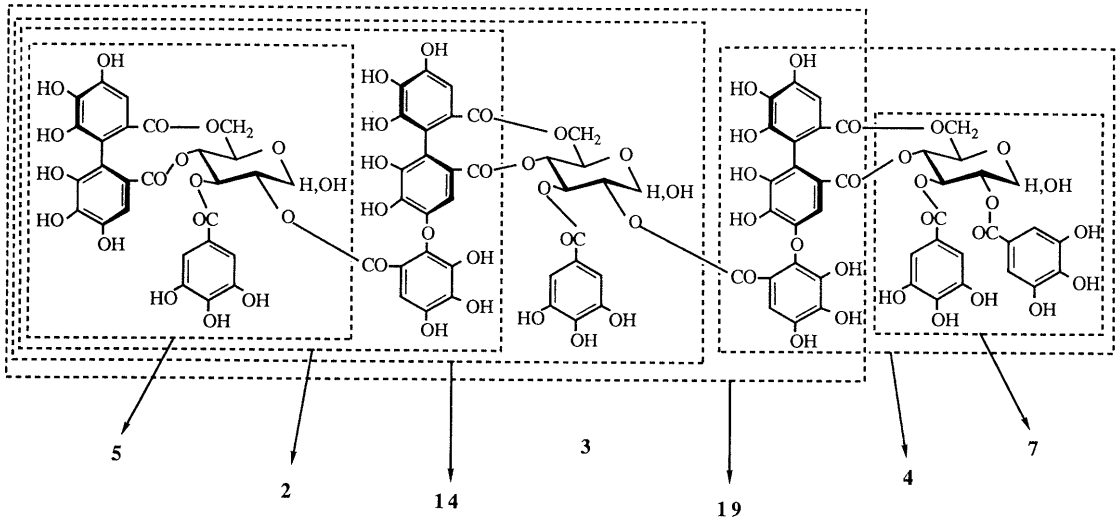

Chart 7

two valoneoyl groups should be at O-4—O-6 on the three glucose cores. Partial degradation of cornusiin C afforded **2**, **4**, **5**, **7**, **14** and a new compound **19** (Chart 7). The structure of **19** was substantiated by partial degradation, which afforded **2** and **8**. These data indicate that the structure of cornusiin C, including the orientation of the two valoneoyl groups, can be formulated as **3**. The chemical shifts of HHDP protons in the ^{1}H-NMR spectrum of cornusiin C, which are similar to those of the combined signals of HHDP protons in **1** and **4**, are also consistent with structure **3**.

The chemical shifts of HHDP protons in the ^{1}H-NMR spectrum of oligomeric hydrolyzable tannins having valoneoyl groups will be useful for the assignment of the orientation of valoneoyl groups in those tannins, unless unusual effects owing to the other groups in each tannin molecule occur.

Among the tannins isolated from *Cornus officinalis*, cornusiin A, a dimeric hydrolyzable tannin, showed a significant inhibitory effect on reverse transcriptase of an RNA (ribonucleic acid) tumor virus, avian myeloblastosis virus[21] and also showed marked host-mediated antitumor activity.[22] Further investigation on the related oligomeric hydrolyzable tannins in this plant is in progress.

Experimental

Optical rotations were measured on a JASCO DIP-4 polarimeter. UV and infrared (IR) spectra were recorded on a Hitachi 200-10 spectrophotometer and a JASCO A-102 spectrometer, respectively. ^{1}H- and ^{13}C-NMR spectra were recorded on a Varian VXR-500 instrument (500 MHz for ^{1}H-NMR and 125.7 MHz for ^{13}C-NMR) in the SC-NMR Laboratory of Okayama University. A JEOL JMN-GX400 spectrometer (400 MHz), a Varian XL-200 instrument (200 MHz) and a Hitachi R-22FTS spectrometer (90 MHz) were also used for measurements of the ^{1}H-NMR spectra. Chemical shifts were given in δ values (ppm) from tetramethylsilane. The carbon numbers used in this experimental section are those of the formulae in Chart 8. FAB-MS were recorded on a JEOL GMS-HX100 spectrometer and on a JEOL JMS D-300 spectrometer, and electron impact (EI) MS on a Shimadzu LKB-9000 instrument. CD spectra were recorded on a JASCO J-500 machine equipped with a DP-501 data processor. Normal-phase HPLC was performed on a Superspher Si60 column (4 mm × 125 mm) (unless otherwise mentioned) with a solvent system (N1) which consists of hexane–MeOH–tetrahydrofuran–formic acid (55 : 33 : 11 : 1) containing oxalic acid (450 mg/l), or a solvent system (N2) consisting of hexane–ethyl acetate (2 : 1), at a flow rate of 1.5 ml/min. Reversed-phase HPLC was conducted on a LiChrospher RP-18 column (4 mm × 250 mm) in an oven at 40 °C, with a solvent system (R1) consisting of 0.01 M H_3PO_4–0.01 M KH_2PO_4–EtOH (10 : 10 : 1), at a flow rate of 1.2 ml/min. A YMC A312 (ODS) column (6 mm × 150 mm) with another solvent system (R2) (0.1 M KH_2PO_4–0.1 M H_3PO_4–CH_3CN, 9 : 9 : 2) was also used for reversed-phase HPLC. Detection for the HPLC analyses was effected with a Shimadzu SPD-6A UV spectrophotometric detector at 280 nm. GLC was performed on a Hitachi 163 gas chromatograph equipped with a glass column (3 mm × 2 m) packed with 2.5% OV-17 on Chromosorb W. The injection temperature and column temperature were set at 230 °C and 170°C, respectively.

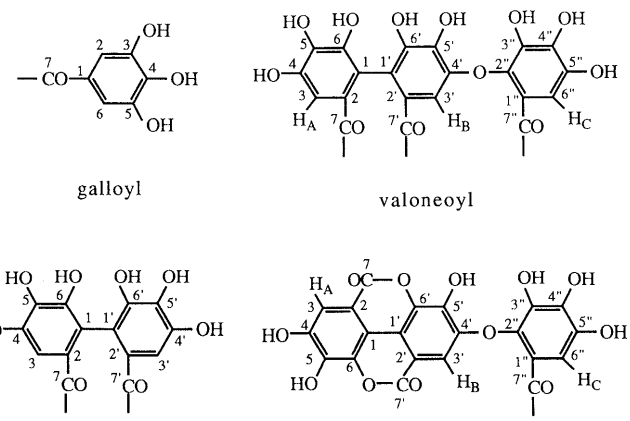

Chart 8

Isolation of Tannins from Fruits of *Cornus officinalis* Ripe fruits (500 g) of *Cornus officinalis* were homogenized in 70% acetone (1.4 l) immediately after collection from the trees. The homogenate was filtered, and the filtrate was concentrated to 200 ml *in vacuo*. The resulting aqueous solution was extracted with diethyl ether (300 ml × 3) and then with ethyl acetate (300 ml × 10). The ethyl acetate extract (9.4 g) was subjected to column chromatography over Sephadex LH-20 (2.2 × 70 cm) with increasing concentrations of MeOH in EtOH (0%→20%→50%→75%), to afford 1,2,3-tri-*O*-galloyl-*β*-D-glucose (13 mg), 1,2,6-tri-*O*-galloyl-*β*-D-glucose (67 mg), gemin D (**5**) (24 mg), 1,2,3,6-tetra-*O*-galloyl-*β*-D-glucose (82 mg), isoterchebin (182 mg), tellimagrandin I (**6**) (278 mg) and tellimagrandin II (232 mg). Crude cornusiin A (**1**) obtained from the eluate with 75% MeOH in EtOH was further purified over Sephadex LH-20 which 75% MeOH in EtOH, to give purified **1** (32 mg). The aqueous mother liquor from the extraction with ethyl acetate was adsorbed on Celite 545, and elution was performed with H_2O, and then with acetone. A portion (8.5 g) of the acetone eluate (32 g) was subjected to DCCC (3.2 mm × 120 cm × 100 glass tubes) by the ascending method using *n*-BuOH–*n*-PrOH–H_2O (4 : 1 : 5), and the eluate was collected in 10 g-fractions. Combined fractions 45—75 (287 mg) were further purified by column chromatography on Sephadex LH-20 with EtOH as the eluant, to give cornusiin B (**2**) (29 mg). Combined fractions 91—150 (868 mg) from DCCC were chromatographed over Sephadex LH-20 with EtOH, and then with EtOH–acetone–H_2O (13 : 1 : 6) as eluants. 2,3-Di-*O*-galloyl-D-glucose (**7**) (5 mg) was obtained from the EtOH eluate, and **1** from the EtOH–acetone–H_2O eluate. Combined fractions 151—187 (1.36 g) of DCCC were further purified on a column of Sephadex LH-20 with EtOH, and then with EtOH–acetone–H_2O (6 : 1 : 3) as eluants. The EtOH eluate afforded **5** (16 mg), and the EtOH–acetone–H_2O eluate afforded cornusiin C (**3**) (104 mg).

Cornusiin A (1) This compound was isolated as an off-white amorphous powder. $[\alpha]_D$ +78° (c = 1, MeOH). *Anal.* Calcd for $C_{68}H_{50}O_{44}\cdot 11H_2O$: C, 46.16; H, 4.10. Found: C, 46.21; H, 3.97. FAB-MS *m/z*: 1593 $(M+Na)^+$. UV λ_{max}^{MeOH} nm (log ε): 218 (5.14), 271 (4.81). IR ν_{max}^{KBr} cm^{-1}: 1730 (ester carbonyl), 1615. CD (MeOH): $[\theta]_{220}$ $+3.3\times10^5$, $[\theta]_{238}$ $+1.4\times10^5$, $[\theta]_{260}$ -1.3×10^5, $[\theta]_{285}$ $+1.3\times10^5$. ^{1}H-NMR (in acetone-d_6): see text. ^{1}H-NMR (400 MHz, in acetone-d_6 + D_2O) δ: 7.14, 7.12, 7.07, 7.06, 7.06, 7.04, 7.03, 7.00 [each s, 5H in total, H_C of valoneoyl (val) and 2 × galloyl], 6.95, 6.92, 6.90, 6.84 (each s, 2H in total, galloyl), 6.71, 6.70, 6.69, 6.69, 6.67, 6.66, 6.65, 6.65 (each s, 2H in total, HHDP and val H_A), 6.55, 6.54, 6.53, 6.52 (each s, 1H in total, HHDP), 6.26, 6.22, 6.21 (each s, 1H in total, val H_B), 5.84 [t, J = 10 Hz, glu (glucose) H-3$_L$ (H-3 of glucose core L, the left glucose core shown in formula **1** in Chart 1) of α_L-β_R form (α-form of glucose core L and β-form of glucose core R)], 5.83 (t, J = 10 Hz, glu H-3$_L$ of α_L-α_R form), 5.72 (t, J = 10 Hz, glu H-3$_R$ of β_L-β_R form), 5.70 (t, J = 10 Hz, glu H-3$_R$ of α_L-α_R form), 5.55 (d, J = 4 Hz, glu H-1$_R$ of β_L-α_R form), 5.52 (d, J = 4 Hz, glu H-1$_R$ of α_L-α_R form), 5.5—5.0 (complicated peaks), 4.81, 4.74, 4.43, 4.3—4.2 (each br dd, J = 6, 10 Hz, glu H-5$_L$ and H-5$_R$ of the four forms), 4.53 (d, J = 8 Hz, glu H-1$_L$ of α_L-β_R form), 4.50 (d, J = 8 Hz, glu H-1$_L$ of β_L-β_R form), 4.0—3.8 (each d, J = 13 Hz, glu H-6$_L$ and H-6$_R$ of the four forms). ^{13}C-NMR (125.7 MHz, in acetone-d_6 + D_2O) δ: 63.4, 63.5, 63.7, 63.8, 63.8 [glu C-6, α and β (α- and β-anomers)], 66.9, 67.0, 67.1 (glu C-5, α), 71.0, 71.2, 71.3, 71.4, 71.5, 71.5, 71.6, 7.17, 71.9 (glu C-3, α; C-4, α; C-4, β; C-5, β), 72.8, 72.8, 73.4 (glu C-2, α), 73.5, 73.6, 73.9, 73.9 (glu C-3, β), 74.0, 74.0, 74.4, 74.5 (glu C-2, β), 90.9, 91.2, 91.3 (glu C-1, α), 96.3, 96.3, 96.6, 96.7 (glu C-1, β), 105.1, 105.1, 105.6, 105.8 (val C-3′), 107.7, 107.9, 107.9, 108.1, 108.2, 108.2, 108.3 (HHDP C-3 and C-3′; val C-3), 110.2, 110.2, 110.3, 110.3, 110.6 (galloyl C-2 and C-6; val C-6′′), 114.0, 114.7, 115.5, 115.6, 115.6, 115.7, 115.8, 115.9, 116.3, 116.4, 116.8, 117.2, 117.3 (HHDP C-1 and C-1′; val C-1, C-1′ and C-1′′), 120.5, 120.7, 120.8, 120.9, 121.1, 121.1 (galloyl C-1), 125.7, 125.8, 125.9, 125.9, 126.1, 126.1, 126.4, 126.6, 126.6 (HHDP C-2 and C-2′; val C-2 and C-2′), 136.1, 136.4, 136.5, 136.6, 136.8, 136.8, 137.5, 137.5 (HHDP C-5 and C-5′; val C-2′′, C-5 and C-5′), 138.8, 138.9, 138.9, 139.0, 139.1, 139.1, 139.2 (galloyl C-4), 139.9, 140.0, 140.3, 140.4, 140.5, 140.5 (val C-3′′ and C-4′′), 143.1, 143.1, 143.3, 143.4 (val C-5′′), 144.4, 144.4, 144.5, 144.5, 144.6, 144.7, 144.8, 144.8, 145.1, 145.1, 145.1, 145.2, 145.3, 145.4, 145.5, 145.6, 145.6, 145.7, 145.8, 145.9, 145.9, 145.9 (galloyl C-3 and C-5; HHDP C-4, C-4′, C-6 and C-6′; val C-4, C-6 and C-6′), 146.6, 147.6, 147.6 (val C-4′), 164.8, 165.5, 165.6, 165.8, 166.0, 166.1, 166.2, 166.3, 166.5, 166.5, 166.8, 167.5, 167.5, 167.5,

167.6, 167.6, 168.1, 168.1, 168.5, 168.6, 168.6 (galloyl C-7; HHDP C-7 and C-7′; val C-7, C-7′ and C-7″).

Cornusiin B (2) This compound was isolated as a light brown amorphous powder. $[\alpha]_D$ +63° (c=0.5, MeOH). *Anal.* Calcd for $C_{48}H_{30}O_{30}\cdot 8H_2O$: C, 46.84; H, 3.77. Found: C, 47.24; H, 4.19. UV λ_{max}^{MeOH} nm (log ε): 219 (4.88), 260 (4.85), 350 (4.01), 363 (4.05). IR ν_{max}^{KBr} cm^{-1}: 1720—1700 (ester carbonyl), 1605. CD (MeOH): $[\theta]_{221}$ +8.8×10^4, $[\theta]_{239}$ +7.2×10^4, $[\theta]_{261}$ −5.2×10^4, $[\theta]_{283}$ +4.8×10^4. ^{1}H-NMR (500 MHz, in acetone-d_6) δ: 7.61 [s, H_A of lactonized valoneoyl (LV)], 7.16 (s, LV H_C), 7.05 (s, LV H_B), 6.85 (s, galloyl), 6.59, 6.46 (each s, HHDP), 5.76 (t, J=10 Hz, glu H-3), 5.32 (d, J=3.5 Hz, glu H-1), 5.21 (dd, J=6.5, 12.5 Hz, glu H-6), 5.05 (dd, J=3.5, 10 Hz, glu H-2), 5.01 (t, J=10 Hz, glu H-4), 4.56 (ddd, J=1, 6.5, 10 Hz, glu H-5), 3.66 (dd, J=1, 12.5 Hz, glu H-6) (α-anomer); 7.61 (s, H_A of LV), 7.16 (s, LV H_C), 7.02 (s, LV H_B), 6.73 (s, galloyl), 6.58, 6.43 (each s, HHDP), 5.38 (t, J=10 Hz, glu H-3), 5.22 (dd, J=6.5, 13 Hz, H-6), 5.15 (dd, J=8, 10 Hz, H-2), 4.97 (t, J=10 Hz, H-4), 4.70 (br d, J=8 Hz, glu H-1), 4.06 (ddd, J=0.5, 6.5, 10 Hz, H-5), 3.71 (dd, J=0.5, 13 Hz, H-6) (β-anomer). ^{13}C-NMR (125.7 MHz, in acetone-d_6 +D_2O) δ: 63.4 (C-6) 66.9 (C-5), 71.1 (C-4), 71.5 (C-3), 72.9 (C-2), 90.8 (C-1) (α-glu); 63.4 (C-6), 71.1 (C-4), 71.9 (C-5) 73.9 (C-3), 74.0 (C-2), 96.4 (C-1) (β-glu); 107.8, 107.9, 107.9 (HHDP C-3 and C-3′), 109.2, 109.3 (LV C-3′), 108.7, 109.0, 109.9, 109.9, 110.0, 110.2 (galloyl C-2 and C-6; LV C-2, C-2′ and C-6″), 111.4 (LV C-3), 113.3, 113.4 (LV C-1), 113.9, 114.4 (LV C-1″), 115.4, 115.4 (LV C-1′), 115.7 (HHDP C-1 and C-1′), 120.2, 120.3 (galloyl C-1), 125.8, 125.8, 126.3, 126.4 (HHDP C-2 and C-2′), 136.2, 136.2, 136.3, 136.4, 136.6 (LV C-2″; HHDP C-5 and C-5′), 137.5, 137.6, 137.6, 137.6 (LV C-6 and C-6′), 138.9, 139.0 (galloyl C-4), 140.1, 140.1, 140.2 (LV C-3″ and C-5), 140.5, 140.7, 140.8, 141.4 (LV C-4″ and C-5′), 143.7, 143.8 (LV C-5″), 144.3, 144.3 (HHDP C-6 and C-6′), 145.1, 145.1, 145.1 (HHDP C-4 and C-4′), 145.5 , 145.6 (galloyl C-3 and C-5), 149.1, 149.1 (LV C-4), 149.8, 149.8 (LV C-4′), 159.8, 159.9 (LV C-7′), 160.3, 160.5 (LV C-7), 164.5, 164.5 (LV C-7″), 166.5, 166.9 (galloyl C-7), 167.6, 167.7, 168.2, 168.3 (HHDP C-7 and C-7′).

Cornusiin C (3) This compound was isolated as an off-white amorphous powder. $[\alpha]_D$ +23° (c=1, MeOH). *Anal.* Calcd for $C_{102}H_{74}O_{66}\cdot 12H_2O$: C, 47.64; H, 3.84. Found: C, 47.73; H, 3.94. UV λ_{max}^{MeOH} (log ε): 219 (5.30), 272 (5.00). IR ν_{max}^{KBr} cm^{-1}: 1730 (ester carbonyl), 1615. CD (MeOH): $[\theta]_{221}$ +4.5×10^5, $[\theta]_{238}$ +1.4×10^5, $[\theta]_{259}$ −2.1×10^5, $[\theta]_{285}$ +1.5×10^5. ^{1}H-NMR (400 MHz, in acetone-d_6 +D_2O): δ: 7.13, 7.12, 7.11, 7.11, 7.10, 7.10, 7.08, 7.07, 7.06, 7.05, 7.05, 7.05, 7.05, 7.04, 7.04, 7.03, 7.03, 7.03, 7.02, 7.02, 7.00, 6.98 (each s, 6H in total, val H_C×2 and galloyl×2), 6.94, 6.94, 6.93, 6.92, 6.92, 6.91, 6.91, 6.88, 6.87, 6.85, 6.84, 6.84, 6.82 (each s, 4H in total, galloyl×2), 6.69, 6.68, 6.67, 6.67, 6.66, 6.66, 6.64, 6.64 (each s, 3H in total, val H_A×2 and HHDP), 6.54, 6.53, 6.53, 6.52, 6.52, 6.51 (each s, 1H in total, HHDP), 6.28, 6.27, 6.25, 6.23, 6.23, 6.22, 6.18, 6.18, 6.14, 6.13, 6.12, 6.11 (each s, 2H in total, val H_B×2), 5.82—5.66 (each t, J=10 Hz, glu H-3, α), 5.52 (d, J=4 Hz, glu H-1, α), 5.5—4.9 (complicated peaks), 4.73, 4.72, 4.51, 4.49 (each d, J=8 Hz, glu H-1, β), 4.8—4.1 (glu H-5, α and β), 3.95—3.76 (each d, J=13 Hz, glu H-6, α and β). ^{13}C-NMR (125.7 MHz, in acetone-d_6 +D_2O) δ: 63.5—64.0 (glu C-6, α and β), 66.8—67.0 (glu C-5, α), 71.0—71.8 (glu C-3, α; C-4, α; C-4, β; C-5, β), 72.8—73.1 (glu C-2, α), 73.6—74.3 (glu C-3, β; C-2, β), 90.9—91.1, (glu C-1, α), 96.0—96.5 (glu C-1, β), 104.6—105.7 (val C-3′), 107.7—108.1 (HHDP C-3 and C-3′; val C-3), 109.9—110.7 (galloyl C-2 and C-6; val C-6″), 113.5—117.5 (HHDP C-1 and C-1′; val C-1, C-1′ and C-1″), 120.3—120.8 (galloyl C-1), 125.5—126.4 (HHDP C-2 and C-2′; val C-2 and C-2′), 136.0—137.8 (HHDP C-5 and C-5′; val C-2″, C-5 and C-5′), 138.9—139.2 (galloyl C-4), 140.1—140.4 (val C-3″ and C-4″), 143.0-143.3 (val C-5″), 144.3—145.9 (galloyl C-3 and C-5; HHDP C-4, C-4′, C-6 and C-6′; val C-4, C-6 and C-6′), 146.5, 146.5, 147.5, 147.5 (val C-4′), 164.6—168.7 (galloyl C-7; HHDP C-7 and C-7′; val C-7, C-7′ and C-7″).

2,3-Di-*O*-galloyl-D-glucose (7) This compound was isolated as a light brown amorphous powder. $[\alpha]_D$ +87° (c=1, MeOH). *Anal.* Calcd for $C_{20}H_{20}O_{14}\cdot 2H_2O$: C, 46.16; H, 4.64. Found: C, 46.33; H; 4.38. UV λ_{max}^{MeOH} (log ε): 217 (4.65), 276 (4.29). IR ν_{max}^{KBr} cm^{-1}: 1710 (ester carbonyl), 1625. CD (MeOH): $[\theta]_{216}$ +3.9×10^4, $[\theta]_{263}$ −2.0×10^4, $[\theta]_{288}$ +3.0×10^4. ^{1}H-NMR (200 MHz, in acetone-d_6) δ: 7.11, 7.09, 7.06, 7.05 (each s, 4H in total, 2×galloyl), 5.80 (dd, J=8, 9 Hz, glu H-3, α), 5.48 (d, J=3 Hz, glu H-1, α), 5.42 (t, J=8 Hz, glu H-3, β), 5.09 (dd, J=7,8 Hz, glu H-2, β), 4.99 (d, J=7 Hz, glu H-1, α), 4.95 (dd, J=3,9 Hz, glu H-2, α), 4.10—3.50 (glu H-4, H-5 and H-6, α and β).

1,2,3-Tri-*O*-galloyl-β-D-glucose This compound was isolated as an off-white amorphous powder. $[\alpha]_D$ +43° (c=1, MeOH). *Anal.* Calcd for $C_{27}H_{24}O_{18}\cdot 3H_2O$: C, 46.96; H, 4.38. Found: C, 46.74; H; 4.07. UV λ_{max}^{MeOH} (log ε): 218 (4.80), 279 (4.44). IR ν_{max}^{KBr} cm^{-1}: 1720 (ester carbonyl), 1620. CD (MeOH): $[\theta]_{257}$ −0.1×10^4, $[\theta]_{280}$ +1.1×10^4. ^{1}H-NMR (90 MHz, in acetone-d_6) δ: 7.10, 7.07, 6.99 (2H each, s, 3×galloyl), 6.09 (d, J=8 Hz, glu H-1), 5.60 (t, J=9.5 Hz, glu H-3), 5.40 (dd, J=8, 9.5 Hz, glu H-2), 4.1—3.5 (glu H-4, H-5 and H-6).

Partial Degradation of Cornusiin B (2) 1) A suspension of cornusiin B (**2**) (10 mg) in 1 N H_2SO_4 (2 ml) was heated in a sealed tube in a boiling-water bath for 2 h. The reaction mixture was subjected to chromatography using a SEP-PAK C_{18} cartridge with H_2O and then MeOH as eluants. The MeOH eluate was evaporated, and the residue was suspended in 30% EtOH. After removal of the insoluble material (ellagic acid, 2 mg) by centrifugation, the supernatant was chromatographed over Toyopearl HW-40 (superfine grade) with 30% EtOH as an eluant, to afford oenothein C (**8**) (3 mg). The H_2O eluate from the SEP-PAK cartridge was neutralized with 0.5 N KOH, and evaporated to give a syrupy residue. HPLC analysis (normal phase; solvent system N1) showed the presence of 3-*O*-galloyl-D-glucose (**9**) [t_R (retention time): 3.0 min] in the residue.

2) An aqueous suspension (0.3 ml) of **2** (1 mg) in a sealed tube was heated in a boiling-water bath for 19 h. HPLC analyses [normal phase, solvent system N1; reversed-phase (LiChrospher RP-18 column), solvent system R1] of the reaction mixture showed the presence of gemin D (**5**) [(N1) t_R 4.3 min and 4.6 min (anomer mixture)[23]; (R1) t_R 2.9 min and 4.0 min].

Oenothein C (8) This compound was obtained as an off-white amorphous powder. $[\alpha]_D$ +72° (c=0.5, MeOH). *Anal.* Calcd for $C_{34}H_{24}O_{22}\cdot 5H_2O$: C, 46.69; H, 3.92. Found: C, 46.71; H, 3.85. UV λ_{max}^{MeOH} (log ε): 216 (4.78), 259 (4.80), 350 (4.02), 363 (4.08). IR ν_{max}^{KBr} cm^{-1}: 1730—1710 (ester carbonyl), 1615. ^{1}H-NMR (500 MHz, in acetone-d_6 +D_2O) δ: 7.57 (s, LV H_A), 7.12 (s, LV H_C), 7.00 (s, LV H_B), 6.95 (s, galloyl), 5.61 (t, J=10 Hz, glu H-3), 5.25 (d, J=3.5 Hz, glu H-1), 4.85 (dd, J=3.5, 10 Hz, glu H-2), 3.91 (ddd, J=2.5, 5, 10 Hz, glu H-5), 3.75 (dd, J=2.5, 12 Hz, glu H-6), 3.73 (t, J=10 Hz, glu H-4), 3.69 (dd, J=5, 12 Hz, glu H-6 (α-anomer); 7.57 (s, LV H_A), 7.10 (s, LV H_C), 6.95 (s, LV H_B), 6.83 (s, galloyl), 5.06 (t, J=9.5 Hz, glu H-3), 4.96 (dd, J=8, 9.5 Hz, glu H-2), 4.68 (d, J=8 Hz, glu H-1), 3.78 (dd, J=2, 12 Hz, glu H-6), 3.63 (dd, J=5, 12 Hz, glu H-6), 3.63 (t, J=9 Hz, glu H-4), 3.40 (ddd, J=2, 5, 9 Hz, glu H-5) (β-anomer). ^{13}C-NMR (in acetone-d_6 +D_2O): δ 61.6 (C-6) 69.2 (C-4), 72.3 (C-5), 72.9 (C-2), 73.9 (C-3) 90.3 (C-1) (α-glu); 61.6 (C-6), 69.3 (C-4), 73.9 (C-2), 76.7 (C-3), 77.1 (C-5), 95.3 (C-1) (β-glu); 108.5, 108.8, 109.5, 109.5. (LV C-2 and C-2′), 109.0, 109.1 (LV C-3′), 109.7, 109.8 (galloyl C-2 and C-6), 109.9, 110.0 (LV C-6″), 111.4 (LV C-3), 113.1, 113.2 (LV C-1), 113.6, 114.1 (LV C-1″), 115.1, 115.2 (LV C-1′), 120.4, 120.7 (galloyl C-1), 136.0, 136.5 (LV C-2″), 137.2, 137.3, 137.3 (LV C-6 and C-6′), 138.8, 138.9 (galloyl C-4), 139.9, 139.9 (LV C-3″), 140.1 (LV C-5), 140.5, 140.7 (LV C-4″), 140.5, 141.1 (LV C-5′), 143.5, 143.6 (LV C-5″), 145.5, 145.6 (galloyl C-3 and C-5), 149.0, 149.0 (LV C-4), 149.7 (LV C-4′), 160.1, 160.2 (LV C-7′), 160.4, 160.5 (LV C-7), 164.5, 164.7 (LV C-7″), 167.0, 167.5 (galloyl C-7).

Partial Degradation of Oenothein C (8) A suspension of oenothein C (**8**) (11 mg) in 1 N H_2SO_4 (2.5 ml) was heated in a sealed tube in a boiling-water bath for 10 h. After adjustment of the pH to 4 with 0.5 N KOH, the mixture was chromatographed over MCI-gel CHP-20P (1.1×19.5 cm) with H_2O as an eluant, to give 3-*O*-galloyl-D-glucose (**9**) (2 mg), ^{1}H-NMR (200 MHz, in acetone-d_6 +D_2O) δ: 7.20 (s, galloyl), 5.41 (t, J=9 Hz, glu H-3, β), 5.28 (d, J=3 Hz, glu H-1, α), 5.17 (t, J=9 Hz, glu H-3, α), 4.74 (d, J=8 Hz, glu H-1, α), 4.00—3.44 (glu H-2, H-4, H-5 and H-6, α and β).

Degradation of Cornusiin A (1) A suspension of cornusiin A (**1**) (2 mg) in 1 N H_2SO_4 (0.1 ml) was heated in a sealed tube in a boiling-water bath for 4 h. The reaction mixture was neutralized with 1 N KOH, and then the solvent was distilled off. The presence of glucose in the residue was shown by GLC analysis after trimethylsilylation.

Methanolysis after Methylation of Cornusiin A (1) Ethereal diazomethane (5 ml) was added to an EtOH solution (5 ml) of **1** (31 mg), and the mixture was left to stand for 1 h at room temperature. After evaporation of the solvent, 0.5% NaOMe in MeOH (2 ml) was added to the residue, and the mixture was left to stand overnight. Then, the reaction mixture was neutralized with acetic acid, and the solvent was evaporated off. The residue thus obtained was separated by preparative thin layer chromatograhy (0.5 mm thick) over Kieselgel PF_{254} using hexane–chloroform–acetone (6:3:1) as a developer, to give **10** (8 mg), **11** {$[\alpha]_D$ −35° (c=1, EtOH)} (5 mg) and **12** {$[\alpha]_D$ −17° (c=1, acetone)} (6 mg).

Quantitative Analysis of the Constituent Phenolic Acids in Cornusiin A (1) and in Cornusiin C (3) Ethereal diazomethane (0.5 ml) was added to a solution of **1** (2 mg) in EtOH (0.5 ml), and the mixture was left to stand for 30 min. After removal of the solvent with an N_2 stream, the residue was treated with 0.2% NaOMe in MeOH (2 ml) overnight. Then the reaction mixture was neutralized with acetic acid, and the solvent was distilled off.

HPLC analysis (normal phase, solvent system N2) of the residue showed the presence of **10** (t_R 1.9 min), **11** (t_R 5.3 min) and **12** (t_R 13.2 min) in a molar ratio of 3 : 1 : 1. Cornusiin C (**3**) was treated in an analogous way, and HPLC analysis of the methanolyzates showed the presence of **10**, **11** and **12** in a molar ratio of 4 : 1 : 2.

Partial Degradation of Cornusiin A (1) An aqueous solution (24 ml) of cornusiin A (**1**) (50 mg) in a sealed tube was heated in a boiling-water bath for 8 h. The reaction mixture was loaded on a column of MCI-gel CHP-20P (1.1 × 8 cm), and elution was performed with H_2O, 20% MeOH, 40% MeOH and MeOH, successively. The 20% MeOH eluate (9 mg) was further purified on a column of Toyopearl HW-40 (superfine grade) with 20% EtOH as a developer, to afford **5** (1 mg) and **7** (3 mg). The 40% MeOH eluate (28 mg) from the column of MCI-gel was purified on a column of Toyopearl HW-40 (superfine grade) with 40% EtOH as a developer, to give **2** (8 mg) and **8** (2 mg).

HP-GPC of Tannins and Their Acetates HP-GPC was performed on a Shimadzu HSG-15 (7.9 mm × 50 cm) column in an oven at 40°C, with tetrahydrofuran as a developer. Plots of retention volumes versus logarithms of molecular weights for tannins, **1**, **3**, **6**, form a linear relationship expressed by the following equation:

$$\log MW = -0.48 \times RV + 8.77$$

in which MW means molecular weight, and RV means retention volume (ml). The correlation for their acetates can be expressed as follows:

$$\log MW = -0.43 \times RV + 8.33$$

Partial Degradation of Cornusiin C (3) An aqueous solution (20 ml) of cornusiin C (**3**) (79 mg) in a sealed tube was heated in a boiling-water bath for 2 h. After removal of the solvent, the residue was chromatographed over Toyopearl HW-40 (superfine grade) (1.1 × 16 cm) with increasing amounts of EtOH in water (20%→40%→60%). Gallic acid (4 mg) and **7** (1 mg) were isolated from the 20% EtOH eluate. The 40% EtOH eluate afforded **5** (1 mg), **4** (2 mg) and a mixture of **2** and **14**. Further separation of the mixture was performed on a SEP-PAK C_{18} cartridge with increasing amounts of MeOH in water (20%→30%→40%), to afford 1 mg of **14** (from the 20% MeOH eluate) and 2 mg of **2** (from the 30% MeOH eluate and the 40% MeOH eluate). The 60% EtOH eluate from the column of Toyopeal HW-40 afforded compound **19** (8 mg).

Compound 19 This compound was obtained as an off-white amorphous powder. $[\alpha]_D$ +22° (c=0.3, MeOH). *Anal.* Calcd for $C_{82}H_{54}O_{52} \cdot 16H_2O$: C, 45.61; H, 4.01. Found: C, 45.55; H, 3.69. UV λ_{max}^{MeOH} nm (log ε): 217 (5.13), 260 (4.96), 346 (4.06), 361 (sh, 4.03). IR ν_{max}^{KBr} cm^{-1}: 1730 (ester carbonyl), 1615. FAB-MS m/z: 1871 $(M+H)^+$, 1893 $(M+Na)^+$. ^{1}H-NMR (500 MHz, in acetone-d_6 + D_2O) δ: 7.53, 7.53, 7.50, 7.49 (each s, 1H in total, LV H_A), 7.22, 7.21, 7.12, 7.10 (each s, 1H in total, LV H_C), 7.06, 7.04, 7.04, 7.02, 7.01, 7.00, 6.99, 6.99, 6.98, 6.95, 6.94 (each s, 4H in total, LV H_B, val H_C and galloyl), 6.76, 6.76, 6.71, 6.69 (each s, 2H in total, galloyl), 6.62, 6.62, 6.61, 6.60, 6.60, 6.59, 6.58 (each s, 2H in total, val H_A and HHDP), 6.51, 6.49, 6.48 (each s, 1H in total, HHDP), 6.24, 6.19, 6.17, 6.11 (each s, 1H in total, val H_B), 5.81, 5.80, 5.60, 5.58 (each t, J=10 Hz, glu H-3, α), 5.52—5.45 (complicated peaks), 5.38 (d, J=4 Hz, H-1, α), 5.33—4.82 (complicated peaks), 4.70—4.00 (glu H-5, α and β), 4.60, 4.53, 4.50 (each d, J=8 Hz, glu H-1, β), 3.79—3.71 (each d, J=13 Hz, glu H-6, α and β).

Partial Degradation of 19 An aqueous suspension (0.1 ml) of **19** in a sealed tube was heated in a water-bath at 60 °C for 41 h. HPLC analyses [normal-phase HPLC using a Nomura Develosil 60-5 column (4 mm × 150 mm) with solvent system N1, and reversed-phase HPLC using a YMC A312 (ODS) column with solvent system R2] showed the presence of **2** and **8** in the reaction mixture.

Production of Isocoriariin F (16) from Isorugosin B (4) A tannase solution (0.5 ml) was added to an aqueous solution (1.8 ml) of **4** (16 mg), and the mixture was kept at 37 °C overnight. The reaction mixture was partitioned between diethyl ether and water, and the aqueous layer was chromatographed over Sephadex LH-20 (1.1 × 19 cm) with 90% EtOH as a developer, to afford isocoriariin F (**16**) (4 mg).

Isocoriariin F (16) This compound was obtained as a light brown amorphous powder. $[\alpha]_D$ +13° (c=0.5, MeOH). UV λ_{max}^{MeOH} nm (log ε): 215 (4.71), 264 (4.32). CD (MeOH): $[\theta]_{224}$ $+6.93 \times 10^4$, $[\theta]_{239}$ $+2.08 \times 10^4$, $[\theta]_{260}$ -3.88×10^4, $[\theta]_{289}$ $+0.97 \times 10^4$. ^{1}H-NMR (400 MHz, in acetone-d_6 + D_2O) δ: 7.23 (s, val H_C), 7.00 (s, galloyl), 6.62 (s, val H_A), 6.31 (s, val H_B), 5.31 (t, J=10 Hz, glu H-3), 5.23 (d, J=4 Hz, gluH-1), 5.16 (dd, J=7, 13 Hz, glu H-6), 4.85 (t, J=10 Hz, glu H-4), 4.47 (ddd, J=1,7,10 Hz, glu H-5), 3.78 (dd, J=4, 10 Hz, glu H-2), 3.70 (dd, J=1, 13 Hz, glu H-6) (α-anomer); 7.25 (s, val H_C), 7.00 (s, galloyl), 6.63 (s, val H_A), 6.27 (s, val H_B), 5.18 (dd, J=7, 13 Hz, glu H-6), 5.11 (dd, J=9, 10 Hz, glu H-3), 4.88 (t, J=10 Hz, glu H-4), 4.70 (d, J=8 Hz, glu H-1), 4.02 (ddd, J=1, 7, 10 Hz, glu H-5), 3.77 (dd, J=1, 13 Hz, glu H-6), 3.55 (dd, J=8, 9 Hz, glu H-2) (β-anomer).

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