Studies on the Constituents of *Viburnum* Species. XIX.¹⁾ Six New Triterpenoids from *Viburnum dilatatum* THUNB.

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Received December 7, 1998; accepted January 26, 1999

Six new triterpenoids, viburnudienone B₁ methyl ester (1), viburnudienone B₂ methyl ester (2), viburnudienone H₁ (3), viburnudienone H₂ (4), viburnenone B₁ methyl ester (5) and viburnenone B₂ methyl ester (6), were isolated from the leaves of *Viburnum dilatatum* (Caprifoliaceae). Their structures were established by extensive spectroscopic studies.

Key words *Viburnum dilatatum*; Caprifoliaceae; triterpene; dammarane; viburnudienone; viburnenone

We have recently reported the isolation of eleven, new class, modified dammarane-type triterpenoids, viburnols A—K, from the CHCl₃ extract of the leaves of *Viburnum dilatatum*.^{1,2)} In the present study, six new dammarane-type triterpenoids, viburnudienone B₁ methyl ester (1), viburnudienone B₂ methyl ester (2), viburnudienone H₁ (3), viburnudienone H₂ (4), viburnenone B₁ methyl ester (5) and viburnenone B₂ methyl ester (6), were isolated. This paper deals with the structural elucidation of these compounds.

Results and Discussion

Viburnudienone B₁ methyl ester (1) was obtained as an amorphous powder, $[\alpha]_D^{25} +26.4^\circ$. The molecular formula was determined to be C₃₁H₄₆O₅ by high-resolution (HR)-MS. The ¹H- and ¹³C-NMR spectra of 1 were very similar to those of viburnol B methyl ester,²⁾ except for the signals due to the side chain part (C₂₀—C₂₇). As regarding the side chain part, the spectral data revealed the presence of a dienone [269 nm; 1668, 1621 cm⁻¹; δ_H 6.05 (1H, m, H-24), 6.01 (1H, br s, H-22), δ_C 191.4 (s, C-23), 158.5 (s, C-20), 154.7 (s, C-25), 126.3 (d, C-22), 126.0 (d, C-24)] and three olefinic methyl

groups [δ_H 2.17 (3H, d, $J=1.2$ Hz, H-27), 2.10 (1H, d, $J=1.0$ Hz, H-21), 1.89 (1H, d, $J=1.2$ Hz, H-26)].

Viburnudienone B₂ methyl ester (2) was also obtained as an amorphous powder, $[\alpha]_D^{25} +17.6^\circ$. The molecular formula was determined to be C₃₁H₄₆O₅ by HR-MS. The ¹H- and ¹³C-NMR spectra of 2 were very similar to those of 1, except for the side chain moiety. These spectral data indicated that 1 and 2 were dammarane-type triterpenoids having a 20,24-diene-23-one type side chain, respectively, and differed only at the stereochemistry of the double bond at C-20. The stereochemistry of the C-20, 22 double bond in 1 and 2 was determined to be *E* and *Z* configurations by the nuclear Overhauser effect (NOE) difference spectra (NOE: 1; H-22/H-17, 2; H-22/CH₃-21), respectively. On the basis of the above evidence, 1 and 2 are clearly established as depicted in the formulas.

Viburnudienones H₁ (3) and H₂ (4) were isolated as an amorphous powder, $[\alpha]_D^{25} +50.0^\circ$ and $+44.4^\circ$, respectively. The ¹H- and ¹³C-NMR spectra of 3 and 4 were very similar to those of viburnol H,¹⁾ except for the signals due to the side chain. As regarding the side chain moieties of 3 and 4, the

Chart 1

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Table 1. ^{13}C -NMR Spectral Data (67.8 MHz, CDCl_3)

C	1	2	3	4	5	6
1	48.2	48.2	55.9	55.9	48.2	48.1
2	169.7	169.8	212.1	212.2	169.6	169.7
3	179.0	178.9	82.4	82.4	179.0	179.0
4	45.4	45.4	45.3	45.3	45.4	45.4
5	55.3	55.2	55.4	55.4	55.3	55.2
6	19.9	19.9	18.3	18.3	19.9	19.9
7	35.2	35.2	35.7	35.8	35.2	35.2
8	39.7	39.7	41.4	41.3	39.7	39.7
9	47.6	47.5	55.1	55.3	47.6	47.5
10	38.2	38.2	44.9	44.9	38.2	38.2
11	77.2	77.3	70.4	70.6	76.8	77.1
12	32.5	32.5	37.2	37.2	32.5	32.6
13	43.8	44.0	43.6	43.9	43.9	44.1
14	49.3	49.3	49.5	49.6	49.4	49.4
15	31.4	31.4	31.5	31.7	31.4	31.4
16	27.7	27.0	27.9	27.2	27.7	27.1
17	50.5	40.5	51.2	41.1	50.6	40.9
18	15.4	15.4	16.4	16.4	15.4	15.5
19	17.9	17.8	17.7	17.7	17.9	17.9
20	158.5	157.7	158.4	158.6	161.4	161.0
21	16.5	20.2	16.5	20.2	16.9	20.4
22	126.3	128.8	126.3	128.6	124.3	126.9
23	191.4	191.0	191.4	191.2	202.2	202.0
24	126.0	126.6	125.7	126.4	54.2	54.2
25	154.7	154.5	154.5	154.2	70.0	69.9
26	27.8	27.7	27.8	27.7	29.5	29.5
27	20.6	20.6	20.6	20.6	29.4	29.4
28	22.7 ^{a)}	22.7 ^{b)}	29.5	29.5	22.7 ^{c)}	22.7 ^{d)}
29	27.9 ^{a)}	27.9 ^{b)}	16.6	16.6	27.9 ^{c)}	28.0 ^{d)}
30	15.8	16.1	15.9	16.2	15.8	16.0
COOCH ₃	52.0	52.0	—	—	52.0	52.0

a—d) Signals may be interchanged in each column.

spectral data were almost the same as those of **1** and **2**, respectively. The gross structures of **3** and **4** were proved by heteronuclear multiple bond correlation (HMBC) and nuclear Overhauser enhancement and exchange spectroscopy (NOESY) spectra. Thus, viburnudienones **H₁** (**3**) and **H₂** (**4**) are clearly established as depicted in the formulas.

Viburnenones **B₁** methyl ester (**5**) and **B₂** methyl ester (**6**) were isolated as an amorphous powder, $[\alpha]_D^{25} +26.0^\circ$ and $+12.5^\circ$, respectively. Both of their molecular formulas were determined to be $\text{C}_{31}\text{H}_{48}\text{O}_6$ by HR-MS. The ^1H - and ^{13}C -NMR spectra of **5** and **6** lacked the signals due to a trisubstituted double bond at C-24, 25. Instead, they showed the characteristic signals of a hydroxy-bearing quaternary carbon [**5**: δ_{H} 4.17 (1H, s, HO-25), δ_{C} 70.0 (s, C-25), **6**: δ_{H} 4.14 (1H, s, HO-25), δ_{C} 69.9 (s, C-25)] and a methylene group linked to a carbonyl group [**5**: δ_{H} 2.60 (2H, s, H-24), δ_{C} 54.2 (t, C-24), **6**: δ_{H} 2.57 (2H, s, H-24), δ_{C} 54.2 (t, C-24)], respectively. These findings suggested that **5** and **6** possessed a 25-hydroxy-20-en-23-one type side chain, respectively. The stereochemistry of the C-20, 22 double bond in **5** and **6** was determined to be *E* and *Z* configurations by comparison of ^1H - and ^{13}C -NMR spectra with **1** and **2**, respectively. Thus, the structures of **5** and **6** were established to be as depicted in the formulas.

Experimental

^1H - and ^{13}C -NMR spectra were recorded with a JEOL JNM-EX 270 spectrometer (270 and 67.8 MHz, respectively, TMS as int. standard). UV spectra were recorded with a Beckman DU-64 spectrophotometer. IR spectra were recorded with a Perkin-Elmer FT-IR 1725X infrared spectrophotometer.

MS were recorded with a JEOL JMS-DX 303 mass spectrometer. Column chromatography was carried out on Kieselgel 60 (Merck; 230—400 mesh), Cosmosil 75C₁₈-OPN (Nacalai Tesque). Preparative HPLC was carried out on Tosoh HPLC system using Cosmosil 5C₁₈-AR (Nacalai Tesque, 10 mm i.d.×25 cm) and TSK gel OH-120 (Tosoh Co., 7.8 mm i.d.×30 cm) columns with UV detector.

Extraction and Isolation Fresh leaves of *V. dilatatum* (4.4 kg) were extracted with MeOH. The MeOH extract was concentrated under reduced pressure and the residue was suspended in a small excess of water. This suspension was successively extracted with CHCl_3 , Et_2O , AcOEt and *n*-BuOH. The CHCl_3 soluble fraction was concentrated under reduced pressure to produce a residue (92.5 g). This residue was chromatographed on a silica gel column using *n*-hexane– Me_2CO (4:1) and eluate was separated into four fractions (frs. 1—4). Fraction 3 was rechromatographed on a 75C₁₈ open column using MeOH– H_2O (3:1) and the eluate was separated into six fractions (frs. 3-1—3-6). Fraction 3-2 was subjected to prep. HPLC [5C₁₈-AR column; MeOH– H_2O (5:1), flow rate: 1.5 ml/min, detection: 270 nm] to give compounds **1** (5.0 mg), **2** (5.0 mg), **3** (1.2 mg) and **4** (1.0 mg). Fraction 3-3 was subjected to prep. HPLC [OH-120 column; *n*-hexane–acetone (5:1), *n*-hexane–AcOEt (3:1), flow rate: 0.75, 1.5 ml/min, detection: 240 nm] to give compounds **5** (2.0 mg) and **6** (0.6 mg).

Viburnudienone B₁ Methyl Ester (1) An amorphous powder, $[\alpha]_D^{25} +26.4^\circ$ ($c=0.5$, CHCl_3). EI-MS m/z : 498 $[\text{M}]^+$. HR-MS m/z : 498.3363 (M^+ , Calcd for $\text{C}_{31}\text{H}_{46}\text{O}_5$; 498.3345). UV $\lambda_{\text{max}}^{\text{MeOH}}$ nm (log ϵ): 269.0 (4.21). IR ν (CHCl_3) cm^{-1} : 2954, 2880, 1719, 1668, 1621. ^1H -NMR (270 MHz, CDCl_3) δ : 6.05 (1H, m, 24-H), 6.01 (1H, brs, 22-H), 4.37 (1H, ddd, $J=11.9$, 11.4, 5.0 Hz, 11-H), 3.70 (3H, s, COOCH₃), 2.50 (1H, d, $J=16.7$ Hz, 1-H _{β}), 2.38 (1H, m, 17-H), 2.28 (1H, d, $J=16.7$ Hz, 1-H _{α}), 2.17 (3H, d, $J=1.2$ Hz, 27-CH₃), 2.10 (3H, d, $J=1.0$ Hz, 21-CH₃), 1.89 (3H, d, $J=1.2$ Hz, 26-CH₃), 1.78 (1H, d, $J=11.9$ Hz, 9-H), 1.24, 1.22 (3H each, s, 28, 29-CH₃), 1.19 (3H, s, 19-CH₃), 1.04 (3H, s, 18-CH₃), 0.97 (3H, s, 30-CH₃). ^{13}C -NMR (67.8 MHz, CDCl_3): Table 1.

Viburnudienone B₂ Methyl Ester (2) An amorphous powder, $[\alpha]_D^{25} +17.6^\circ$ ($c=0.5$, CHCl_3). EI-MS m/z : 498 $[\text{M}]^+$. HR-MS m/z : 498.3331 (M^+ , Calcd for $\text{C}_{31}\text{H}_{46}\text{O}_5$; 498.3345). UV $\lambda_{\text{max}}^{\text{MeOH}}$ nm (log ϵ): 269.0 (4.07). IR ν (CHCl_3) cm^{-1} : 2954, 2880, 1719, 1668, 1620. ^1H -NMR (270 MHz, CDCl_3) δ : 6.08 (1H, t, $J=1.2$ Hz, 22-H), 6.02 (1H, t, $J=1.2$ Hz, 24-H), 4.33 (1H, ddd, $J=11.8$, 11.4, 5.0 Hz, 11-H), 4.13 (1H, ddd, $J=11.1$, 10.5, 6.3 Hz, 17-H), 3.70 (3H, s, COOCH₃), 2.48 (1H, d, $J=17.0$ Hz, 1-H _{β}), 2.25 (1H, d, $J=17.0$ Hz, 1-H _{α}), 2.14 (3H, d, $J=1.2$ Hz, 27-CH₃), 1.88 (3H, d, $J=1.2$ Hz, 26-CH₃), 1.81 (3H, d, $J=1.2$ Hz, 21-CH₃), 1.77 (1H, d, $J=11.8$ Hz, 9-H), 1.24, 1.22 (3H each, s, 28, 29-CH₃), 1.18 (3H, s, 19-CH₃), 1.03 (3H, s, 18-CH₃), 1.02 (3H, s, 30-CH₃). ^{13}C -NMR (67.8 MHz, CDCl_3): Table 1.

Viburnudienone H₁ (3) An amorphous powder, $[\alpha]_D^{25} +50.0^\circ$ ($c=0.1$, CHCl_3). EI-MS m/z : 470 $[\text{M}]^+$. HR-MS m/z : 470.3437 (M^+ , Calcd for $\text{C}_{30}\text{H}_{46}\text{O}_4$; 470.3396). UV $\lambda_{\text{max}}^{\text{MeOH}}$ nm (log ϵ): 269.0 (4.03). IR ν (CHCl_3) cm^{-1} : 3472, 2956, 1707, 1669, 1620. ^1H -NMR (270 MHz, CDCl_3) δ : 6.06 (1H, t, $J=1.2$ Hz, 24-H), 6.02 (1H, brs, 22-H), 3.99 (1H, m, 11-H), 3.90 (1H, s, 3-H), 3.50 (1H, d, $J=13.0$ Hz, 1-H _{β}), 2.32 (1H, m, 17-H), 2.25 (1H, d, $J=13.0$ Hz, 1-H _{α}), 2.17 (3H, d, $J=1.2$ Hz, 27-CH₃), 2.10 (3H, d, $J=1.2$ Hz, 21-CH₃), 1.89 (3H, d, $J=1.2$ Hz, 26-CH₃), 1.71 (1H, d, $J=10.4$ Hz, 9-H), 1.19 (3H, s, 28-CH₃), 1.00 (9H, s, 18, 19, 30-CH₃), 0.71 (3H, s, 29-CH₃). ^{13}C -NMR (67.8 MHz, CDCl_3): Table 1.

Viburnudienone H₂ (4) An amorphous powder, $[\alpha]_D^{25} +44.4^\circ$ ($c=0.1$, CHCl_3). EI-MS m/z : 470 $[\text{M}]^+$. HR-MS m/z : 470.3359 (M^+ , Calcd for $\text{C}_{30}\text{H}_{46}\text{O}_4$; 470.3396). UV $\lambda_{\text{max}}^{\text{MeOH}}$ nm (log ϵ): 269.0 (3.99). IR ν (CHCl_3) cm^{-1} : 3475, 2955, 1707, 1670, 1620. ^1H -NMR (270 MHz, CDCl_3) δ : 6.06 (1H, t, $J=1.3$ Hz, 22-H), 6.03 (1H, d, $J=1.3$ Hz, 24-H), 4.06 (1H, m, 17-H), 3.98 (1H, m, 11-H), 3.90 (1H, s, 3-H), 3.51 (1H, d, $J=12.9$ Hz, 1-H _{β}), 2.23 (1H, d, $J=12.9$ Hz, 1-H _{α}), 2.14 (3H, d, $J=1.3$ Hz, 27-CH₃), 1.88 (3H, d, $J=1.3$ Hz, 26-CH₃), 1.81 (3H, d, $J=1.3$ Hz, 21-CH₃), 1.70 (1H, d, $J=10.6$ Hz, 9-H), 1.19 (3H, s, 28-CH₃), 1.04, 0.996, 0.989 (9H, s, 18, 19, 30-CH₃), 0.70 (3H, s, 29-CH₃). ^{13}C -NMR (67.8 MHz, CDCl_3): Table 1.

Viburnenone B₁ Methyl Ester (5) An amorphous powder, $[\alpha]_D^{25} +26.1^\circ$ ($c=0.2$, CHCl_3). EI-MS m/z : 516 $[\text{M}]^+$. HR-MS m/z : 516.3448 (M^+ , Calcd for $\text{C}_{31}\text{H}_{48}\text{O}_6$; 516.3450). UV $\lambda_{\text{max}}^{\text{MeOH}}$ nm (log ϵ): 246.0 (4.06). IR ν (CHCl_3) cm^{-1} : 3424, 2963, 1719, 1660, 1602. ^1H -NMR (270 MHz, CDCl_3) δ : 5.99 (1H, s, 22-H), 4.37 (1H, ddd, $J=11.7$, 11.4, 5.0 Hz, 11-H), 4.17 (1H, s, 25-OH), 3.71 (3H, s, COOCH₃), 2.60 (2H, s, 24-H₂), 2.51 (1H, d, $J=17.3$ Hz, 1-H _{β}), 2.38 (1H, m, 17-H), 2.29 (1H, d, $J=17.3$ Hz, 1-H _{α}), 2.10 (3H, s, 21-CH₃), 1.98 (1H, m, 12-H _{β}), 1.78 (1H, d, $J=11.7$ Hz, 9-H), 1.26 (6H, s, 26, 27-CH₃), 1.24, 1.22 (3H each, s, 28, 29-CH₃), 1.20 (3H, s, 19-CH₃), 1.05 (3H, s, 18-CH₃), 0.97 (3H, s, 30-CH₃). ^{13}C -NMR (67.8 MHz, CDCl_3): Table 1.

Viburnenone B₂ Methyl Ester (6) An amorphous powder, $[\alpha]_D^{25} +12.5^\circ$

($c=0.06$, CHCl_3). EI-MS m/z : 516 $[\text{M}]^+$. HR-MS m/z : 516.3486 (M^+ , Calcd for $\text{C}_{31}\text{H}_{48}\text{O}_6$; 516.3450). UV $\lambda_{\text{max}}^{\text{MeOH}}$ nm ($\log \epsilon$): 247.0 (3.96). IR ν (CHCl_3) cm^{-1} : 3441, 2963, 1719, 1658, 1602. ^1H -NMR (270 MHz, CDCl_3) δ : 6.06 (1H, d, $J=1.2$ Hz, 22-H), 4.33 (1H, ddd, $J=11.5$, 11.3, 4.8 Hz, 11-H), 4.14 (1H, s, 25-HO), 4.06 (1H, ddd, $J=11.2$, 10.5, 6.7 Hz, 17-H), 3.70 (3H, s, COOCH_3), 2.57 (2H, s, 24- H_2), 2.49 (1H, d, $J=17.2$ Hz, 1- H_β), 2.26 (1H, d, $J=17.2$ Hz, 1- H_α), 1.83 (3H, d, $J=1.2$ Hz, 21- CH_3), 1.78 (1H, d, $J=11.5$ Hz, 9-H), 1.24 (6H, s, 26, 27- CH_3), 1.23, 1.22 (3H each, s, 28,29- CH_3), 1.18 (3H, s, 19- CH_3), 1.04 (3H, s, 18- CH_3), 1.03 (3H, s, 30- CH_3). ^{13}C -NMR (67.8 MHz, CDCl_3): Table 1.

Acknowledgements We are grateful to Messrs. S. Sato and T. Matsuki of this university for measurement of the mass and NMR spectra.

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