Structures of New Seven-Membered Ring Vibsane-Type Diterpenes Isolated from Leaves of *Viburnum awabuki*

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Five new vibsane-type diterpenes, vibsanin G, vibsanin H, vibsanin K, 18-*O*-methylvibsanin K and 15,18-di-*O*-methylvibsanin H were isolated from the leaves of *Viburnum awabuki* (Caplifoliaceae). Their structures were elucidated by analyses of spectroscopic data involving comparison of their ^{13}C-NMR data with those of the previously known vibsanin C, and the structure of vibsanins H and K were confirmed by X-ray crystallographic analysis and chemical transformation, respectively. All five new compounds differ from the seven-membered ring vibsane-type diterpene, vibsanin C, only in the C-12—C-17 side chain.

Key words *Viburnum awabuki*; Caplifoliaceae; vibsane-type diterpene; seven-membered ring; hydroperoxy group; cytotoxicity

Vibsane-type diterpenes[1] are very rare diterpenoids whose occurrence is limited to the *Viburnum* plant (Caplifoliaceae).[2] Carbon skeletons of vibsane-type diterpenes can be classified into three subtypes, consisting of eleven-membered ring, seven-membered ring and rearranged types, and are represented by vibsanin B (**7**), vibsanin C (**6**)[3] and neovibsanin A (**8**),[4] respectively. We hava already accomplished the thermal and photochemical conversions of **7** to **6**[1,4] and **8**, respectively, and thereby not only established their absolute configurations, which had been equivocal for seventy years, but also proposed a plausible biosynthesis for the three subtypes of vibsane-type diterpenes. These chemical correlations between vibsanin B (**7**) and vibsanin C (**6**) suggested the possible presence of additional new diterpenes as natural products. Since vibsane-type diterpenes exhibit intriguing biological activities such as piscicidal activity (vibsanin A), plant growth inhibitory[3] and cytotoxic activities (vibsanins B and C), it is of interest to evaluate the biological activity of newly isolated vibsane-type diterpenes. These earlier results prompted us to continue to study the chemical constituents of the leaves of *Viburnum awabuki*. As a result, five new diterpenes **1**, **2**, **3**, **4** and **5**, named vibsanin G, vibsanin H, vibsanin K, 18-*O*-methylvibsanin K and 15,18-di-*O*-methylvibsanin H were isolated from the methanol extract. In this paper, we report the structure elucidation of these five new seven-membered ring vibsane-type diterpenes.

The molecular formula of vibsanin G (**1**) was established as $C_{25}H_{36}O_6$ by HR-FAB-MS (*m/z* 455.2425 $[M+Na]^+$). Its IR spectrum showed absorptions attributable to hydroxy groups (3437 cm^{-1}) and two carbonyl groups (1728, 1649 cm^{-1}). ^{1}H- and ^{13}C-NMR data (Table 1) of **1** showed the presence of five tertiary methyl groups [δ_H 0.89, 1.69, 1.95, 2.16, 2.21 (each s)], an oxymethylene [δ_H 4.20 (d, J=12.0 Hz), 4.29 (d, J=12.0 Hz); δ_C 64.1], an oxymethine [δ_H 3.93 (dd, J=6.3, 6.3 Hz); δ_C 76.0], an exomethylene [δ_H 4.82 (d, J=1.0 Hz), 4.91 (d, J=1.0 Hz); δ_C 112.3, 147.2], two trisubstituted olefins [δ_H 5.67, δ_C 114.5, 160.5; δ_H 6.59, δ_C 139.2, 142.3] and a disubstituted olefin [δ_H 5.17 (dd, J=12.2, 12.2 Hz), 6.99 (d, J=12.2 Hz); δ_C 112.7, 137.4]. These spectral features indicated that **1** was a typical seven-membered ring vibsane-type diterpene. In fact, the ^{1}H- and ^{13}C-NMR signals of **1** were found to be very similar to those of vibsanin C (**6**), which was previously isolated as the first example of a seven-membered ring vibsane-type diterpene from the title plant, except for the region containing the C-12—C-17 side chain. Double quantum filtered-correlated spectroscopy (DQF-COSY) and heteronuclear multiple quantum coherence (HMQC) studies of **1** made up two spin networks associated with C-12—C-14 containing a hydroxymethine

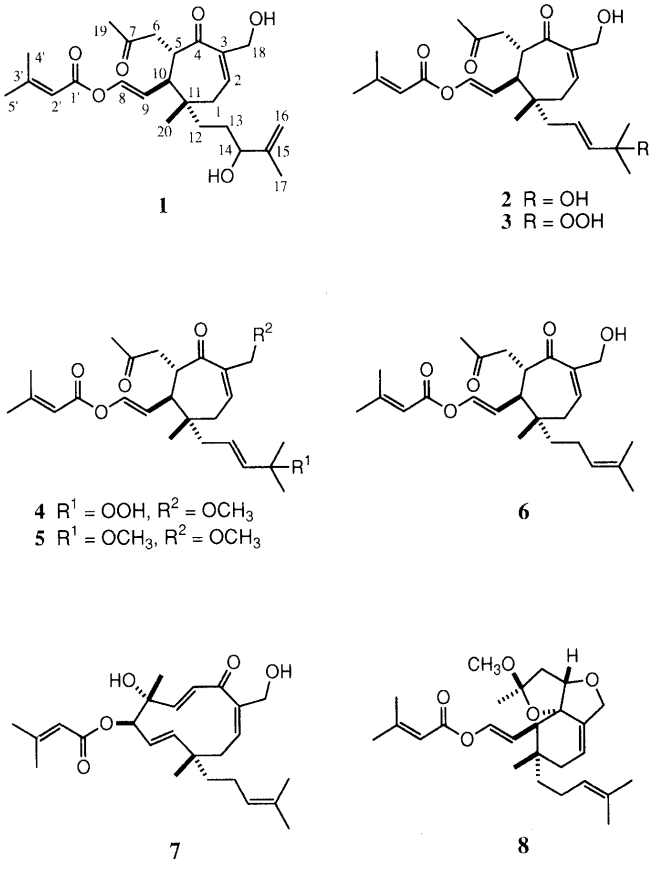

Chart 1. Vibsane-Type Diterpenes from Leaves of *Viburnum awabuki*

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and C-15—C-17 containing the exomethylene as shown in Fig. 1. In heteronuclear multiple bond correlation (HMBC) studies (Fig. 1), the H-14 methine signal (δ_H 3.93) was correlated to C-16 (δ_C 112.3) in the exomethylene, and also the CH_3-17 methyl signal (δ_H 1.69) was correlated to C-14 (δ_C 76.0), as shown in Fig. 1. Thus, two partial fragments could be connected between the C-14 and the C-15 positions to give the partial unit corresponding to the side chain (C-12—C-17). Further observation of a cross peak between the CH_3-20 methyl signal (δ_H 0.89) and C-12 (δ_C 36.0) indicated that the side chain is linked to the C-11 position of the 7-membered ring. The above HMBC correlations resulted in the proposal of the planar structure **1** for vibsanin G. The relative stereochemistry for **1** was assigned as the same as that of vibsanin C (**6**) on the basis of the presence of cross-peaks between the CH_3-20 methyl signal and the H-5, H-9 signals (δ_H 3.02, 5.17) by two dimensional (2D) -nuclear Overhauser enhancement and exchange spectroscopy (NOESY) (Fig. 2). However, the stereochemistry at C-14 has not been clarified. Additionally, the CD spectrum of compound **1** displayed the same positive Cotton effect as that of **6** [**1**: $\Delta\varepsilon$ (260 nm) +3.7; **6**: $\Delta\varepsilon$ (267 nm) +3.4].[1] Therefore, vibsanin G (**1**) had 5*S*, 10*R* and 11*S* configurations.

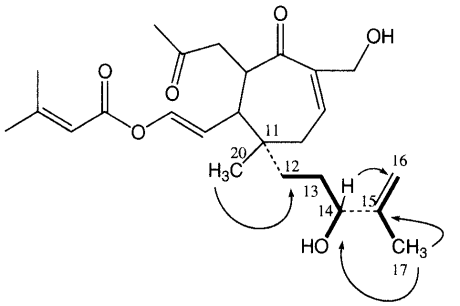


Fig. 1. Dotted Lines Indicate the Connectivities of Partial Structures for the C-12—C-17 Side Chain Inferred from DQF-COSY and HMQC

Arrows denote the correlation beteeen protons (tail) and carbons (head) in the HMBC.

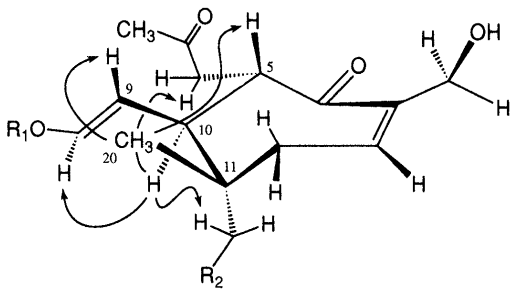


Fig. 2. Relative Stereochemistry of **1** Based on NOEs Indicated by Arrows

The molecular formula of vibsanin H (**2**) was determined to be $C_{25}H_{36}O_6$ on the basis of HR-FAB-MS (*m/z* 455.2398 $[M+Na]^+$) and the ^{13}C-NMR data summarized in Table 1. The presence of hydroxy groups and carbonyl groups were again indicated by the IR spectrum (3437, 1710, 1647 cm^{-1}). The ^{1}H- and ^{13}C-NMR of vibsanin H (**2**) were very similar to those of vibsanins C (**6**) and G (**1**), except for the C-12—C-17 side chain. These spectral data suggested that the structure of **2** is closely related to those of **1** and **6**. Extensive analysis of 2D-NMR indicated the presence of a 3-hydroxy-3-methylbutenyl group as a C-13—C-17 side chain, which was different from those of **1** and **6**. Finally, the structure of **2** was established by X-ray crystallographic analysis, as depicted in the ORTEP drawing in Fig. 4. The CD spectrum [$\Delta\varepsilon$ (263 nm) +3.1] showed a positive Cotton effect and thereby the absolute configuration of **2** was determined to be the same as **1** and **6**.

The ^{1}H- and ^{13}C-NMR data (Tables 1, 2) of vibsanin K (**3**) were also very similar to those of **2**. IR and UV of **3** indicated the presence of the same functional groups as those present in **2**. Moreover, 2D-NMR experiments afforded spin systems associated with all of the partial

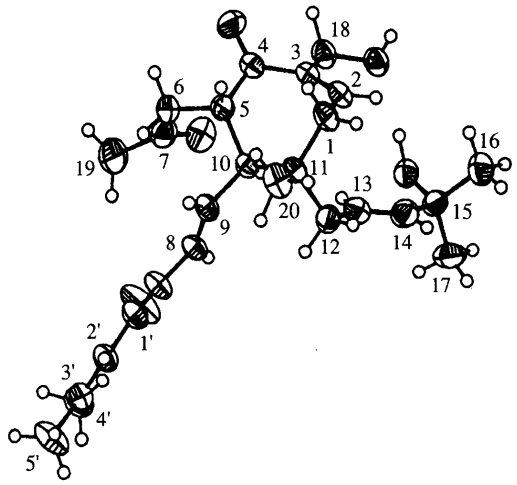
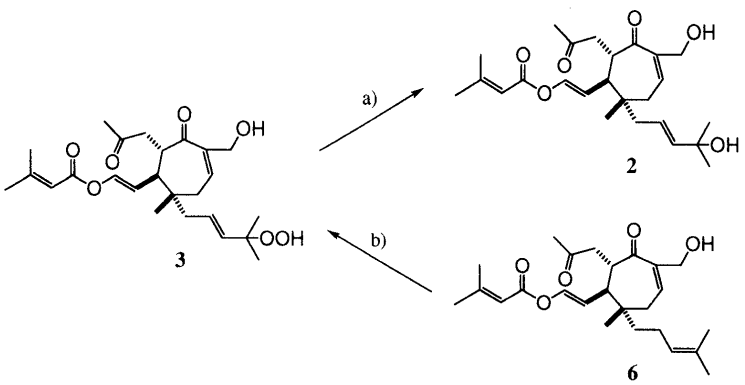


Fig. 3. ORTEP Drawing of **2**



Reaction conditions : a) Ph_3P, benzene; b) O_2, rose bengal, benzene, hv

Fig. 4. Chemical Transformation of **3** and **6**

Table 1. ^{1}H-NMR Data (δ/ppm) of **1**, **2**, **3**, **4** and **5**[a]

Proton	**1**[b]	**2**[c]	**3**[b]	**4**[d]	**5**[d]
1	2.26 (dd, 15.8, 8.8)	1.78 (dd, 15.1, 9.3)	2.28 (dd, 14.0, 9.0)	1.83 (dd, 15.9, 8.7)	1.94 (m)
	2.37 (dd, 15.8, 4.9)	2.03 (dd, 15.1, 4.6)	2.40 (dd, 16.2, 4.5)	2.03 (m)	2.01 (m)
2	6.59 (dd, 8.8, 4.9)	6.33 (dd, 9.3, 4.6)	6.59 (dd, 9.0, 4.6)	6.46 (m)	6.51 (m)
5	3.02 (ddd, 12.2, 7.3, 3.4)	2.94 (ddd, 11.7, 6.4, 6.1)	3.01 (m)	3.05 (ddd, 9.9, 7.4, 4.9)	3.04 (ddd, 9.9, 6.5, 5.4)
6	2.64 (dd, 16.8, 3.4)	2.49 (dd, 17.6, 6.4)	2.64 (dd, 17.6, 6.4)	2.38 (dd, 17.9, 4.9)	2.47 (dd, 17.8, 5.4)
	2.98 (dd, 16.8, 7.3)	2.78 (dd, 17.6, 6.1)	2.94 (dd, 17.6, 7.1)	2.87 (dd, 17.9, 7.4)	2.84 (17.8, 6.5)
8	6.99 (d, 12.2)	7.23 (d, 12.2)	7.01 (d, 12.2)	7.25 (d, 12.4)	7.22 (d, 12.4)
9	5.17 (dd, 12.2, 12.2)	5.20 (dd, 12.2, 11.7)	5.17 (dd, 12.2, 12.2)	5.16 (dd, 12.4, 11.4)	5.20 (dd, 12.4, 11.5)
10	2.12 (dd, 12.2, 12.2)	2.46 (dd, 11.7, 11.7)	2.26 (dd, 12.2, 12.2)	2.27 (dd, 11.4, 9.9)	2.28 (dd, 11.5, 9.9)
12	1.13 (m)	1.66 (dd, 12.0, 6.1)	2.05 (dd, 13.6, 7.8)	2.00 (dd, 14.0, 9.3)	1.94 (dd, 13.7, 6.6)
	1.40 (m)	2.02 (dd, 12.0, 6.8)	1.93 (dd, 13.6, 5.4)	1.71 (dd, 14.0, 5.8)	1.80 (dd, 13.7, 7.7)
13	1.37 (m)	5.56 (m)	5.56 (d, 15.8)	5.45 (ddd, 15.4, 9.3, 5.8)	5.39 (ddd, 15.7, 7.7, 6.6)
	1.42 (m)				
14	3.93 (dd, 6.3, 6.3)	5.57 (br s)	5.61 (d, 15.8)	5.63 (d, 15.4)	5.46 (d, 15.7)
16	4.82 (d, 1.0)	1.24 (3H, s)	1.29 (3H, s)	1.29 (3H, s)	1.24 (3H, s)
	4.91 (d, 1.0)				
17	1.69 (3H, s)	1.23 (3H, s)	1.34 (3H, s)	1.33 (3H, s)	1.24 (3H, s)
18	4.20 (d, 12.0)	4.18 (d, 13.4)	4.14 (d, 12.7)	4.00 (d, 12.9)	4.20 (d, 13.5)
	4.29 (d, 12.0)	4.55 (d, 13.4)	4.35 (d, 12.7)	4.33 (d, 12.9)	4.29 (d, 12.9)
19	2.16 (3H, s)	1.83 (3H, s)	2.16 (3H, s)	1.81 (3H, s)	1.83 (3H, s)
20	0.89 (3H, s)	0.73 (3H, s)	0.95 (3H, s)	0.74 (3H, s)	0.72 (3H, s)
2′	5.67 (br s)	5.65 (br s)	5.69 (br s)	5.64 (qq, 1.4, 1.4)	5.65 (qq, 1.4, 1.1)
4′	2.21 (3H, s)	2.02 (3H, s)	2.21 (3H, s)	2.01 (3H, d, 1.4)	2.01 (3H, d, 1.1)
5′	1.95 (3H, s)	1.37 (3H, s)	1.94 (3H, s)	1.35 (3H, d, 1.4)	1.36 (3H, d, 1.4)
15-OOH				8.38 (s)	
15-OCH_3				3.11 (3H, s)	3.10 (3H, s)
18-OCH_3					3.14 (3H, s)

a) Figures in parentheses denote *J* values (Hz). *b*) 400 MHz in $CDCl_3$. *c*) 400 MHz in C_6D_6. *d*) 600 MHz in C_6D_6.

Table 2. ^{13}C-NMR Data (δ/ppm) of **1**,[a] **2**,[a] **3**,[b] **4**,[c] **5**,[c] and **6**[c]

C	**1**	**2**	**3**	**4**	**5**	**6**
1	35.9	37.5	37.1	37.1	36.5	35.9
2	139.2	139.9	139.5	138.1	136.3	137.7
3	142.3	140.4	141.1	139.1	140.1	142.9
4	205.5	204.2	205.2	202.6	202.9	205.1
5	48.3	47.2	47.8	48.2	47.8	48.4
6	44.1	43.5	43.9	43.8	43.8	44.2
7	207.8	207.9	207.8	206.2	206.0	206.4
8	137.4	137.7	137.8	138.0	137.9	136.8
9	112.7	112.0	112.1	113.1	112.9	113.4
10	46.6	42.4	44.1	45.0	44.8	46.3
11	39.8	41.7	41.1	41.0	40.9	40.1
12	36.0	42.9	43.5	43.9	43.2	40.0
13	29.5	123.3	126.4	126.0	125.8	23.3
14	76.0	141.5	138.1	139.1	139.9	124.9
15	147.2	70.6	81.9	81.4	74.7	131.2
16	112.3	30.1	24.8	25.2	26.0	17.6
17	17.6	30.2	23.4	24.2	26.2	25.7
18	64.1	63.2	63.9	71.5	71.4	63.7
19	30.1	29.7	30.1	29.7	29.7	29.5
20	24.3	24.4	24.8	25.0	23.7	24.0
1′	163.1	163.1	163.2	163.3	163.1	163.1
2′	114.5	114.5	114.5	114.9	114.9	114.9
3′	160.5	160.5	160.7	160.4	160.2	160.0
4′	20.6	20.6	20.6	20.3	20.3	20.2
5′	27.7	27.7	27.7	27.0	27.0	27.0
15-OCH_3					58.3	
18-OCH_3				58.5	50.2	

a) 100 MHz in $CDCl_3$. *b*) 150 MHz in $CDCl_3$. *c*) 150 MHz in C_6D_6.

structures presented in **2**. Detailed analysis of HMBC of **3** resulted in the same planar structure as **2**. However, the molecular formula of $C_{25}H_{36}O_7$ (*m/z* 471.2388 $[M+Na]^+$) for **3** suggested the presence of one more oxygen

Table 3. Positional Parameters and Equivalent Isotropic Thermal Parameters for Non-Hydrogen Atoms of **2** with Estimated Standard Deviations in Parentheses

Atom	*x*	*y*	*z*	B_{eq}
C-1	−0.2804 (4)	0.108 (1)	−0.5348 (4)	3.4 (2)
C-2	−0.4684 (7)	−0.090 (2)	−0.3860 (1)	7.0 (3)
C-3	−0.3422 (4)	−0.083 (1)	−0.6871 (4)	3.8 (2)
C-4	−0.3670 (4)	−0.066 (1)	−0.8034 (5)	3.5 (2)
C-5	−0.3880 (4)	−0.224 (1)	−0.8707 (5)	3.7 (2)
C-6	−0.1736 (4)	0.633 (1)	−0.4333 (6)	4.4 (2)
C-7	−0.3078 (4)	0.350 (1)	−0.2830 (5)	3.2 (2)
C-8	−0.0321 (4)	0.163 (2)	−0.3246 (5)	4.2 (2)
C-9	0.1434 (5)	−0.156 (2)	−0.2628 (6)	5.4 (2)
C-10	−0.3907 (5)	−0.444 (1)	−0.8405 (6)	4.6 (2)
C-11	−0.2796 (4)	0.278 (1)	−0.4784 (4)	3.2 (2)
C-12	−0.3946 (4)	0.017 (1)	−0.3183 (6)	4.3 (2)
C-13	−0.3992 (4)	0.249 (1)	−0.3146 (5)	3.8 (2)
C-14	−0.2365 (3)	0.295 (1)	−0.3630 (4)	2.8 (2)
C-15	0.0494 (4)	0.158 (2)	−0.2846 (5)	4.6 (2)
C-16	0.0918 (4)	0.004 (1)	−0.2039 (5)	3.8 (2)
C-17	0.1506 (4)	0.121 (2)	−0.1180 (6)	5.0 (2)
C-18	−0.2829 (4)	0.294 (1)	−0.1624 (4)	3.3 (2)
C-19	−0.0735 (4)	0.327 (1)	−0.4012 (5)	3.9 (2)
C-20	−0.4120 (6)	−0.180 (2)	−0.9906 (6)	5.8 (2)
C-1′	−0.1542 (4)	0.446 (1)	−0.3593 (4)	3.2 (2)
C-2′	−0.1874 (4)	0.257 (1)	−0.1212 (4)	3.1 (2)
C-3′	−0.1738 (4)	0.095 (1)	−0.0339 (5)	4.0 (2)
C-4′	−0.1208 (4)	0.370 (1)	−0.1538 (4)	3.4 (2)
C-5′	−0.1312 (4)	0.531 (1)	−0.2425 (5)	3.6 (2)
O-4	−0.0820 (2)	0.072 (1)	0.0055 (3)	4.0 (1)
O-7	−0.3407 (4)	−0.235 (1)	−0.6300 (4)	6.5 (2)
O-8	−0.3184 (3)	0.104 (1)	−0.6442 (3)	3.8 (1)
O-15	−0.3404 (2)	0.287 (1)	−0.0980 (3)	5.2 (1)
O-18	0.0261 (2)	−0.112 (1)	−0.1482 (3)	3.8 (1)
O-1′	−0.3345 (3)	−0.078 (1)	−0.2687 (4)	5.0 (1)

atom than **2**. This data implied the presence of a hydroperoxy group in **3**, which was further supported by a positive KI–starch test.[5] The hydroperoxy group could be verified as being located on the C-15 position in the following way. Firstly, C-15 quaternary carbon signal appeared at abnormally low-field at δ_C 81.9 (**2**; δ_C 70.6).[6] Secondly, treatment of **3** with triphenylphosphine in benzene afforded **2**, whereas a photosensitized oxidation of vibsanin C (**6**) gave rise to **3**.[7] These chemical transformations confimed that the hydroperoxy group in **3** was located at the C-15 position. The structure of vibsanin K (**3**) was thus established to be 15-hydroperoxy vibsanin H.

Compound **4** had the molecular formula $C_{26}H_{38}O_7$ (*m/z* 485.2516 $[M+Na]^+$) and its spectral data indicated again the presence of a hydroperoxy group (δ_H 8.38, δ_C 81.4). The NMR data (Tables 1, 2) of **4** were very similar to those of **3**, except for the presence of a methoxy group (δ_H 3.11; δ_C 58.5). These spectral data disclosed that the hydroxyl group at the C-18 position in vibsanin K (**3**) was replaced by a methoxy group in **4**. In fact, the C-18 (δ_C 71.5) methylene carbon signal showed a distinct cross peak to a singlet signal due to the methoxy group in the HMBC. Thus, the methoxy group must be located on the C-18 position. The stereochemistry of **4**, including the absolute configuration was established to be the same as **3** on the basis of 2D-NOESY and CD spectra [ε (274 nm) +1.4]. Accordingly, the structure of **4** was determined as 18-*O*-methylvibsanin K.

Compound **5** had the molecular formula $C_{27}H_{40}O_6$ and its IR spectrum showed no absorption attributable to hydroxy groups. The NMR of **5** indicated the presence of two methoxy groups (δ_H 3.10, δ_C 58.3; δ_H 3.14, δ_C 50.2), in addition to the remaining signals assignable to vibsanin H (**2**). This suggests that **5** is a 15,18-di-*O*-methyl derivative of **2**. Two methoxy proton signals showed HMBC correlations to oxygen-bearing C-15 (δ_C 74.7) and C-18 (δ_C 71.4), respectively. Consequently, the planar structure **5** was constructed. The relative configuration of **5** was elucidated on the basis of 2D-NOESY and the absolute configuration of **5** was assigned as the same as that of vibsanin H (**2**) by the same positive Cotton effect observed at 275 nm.

Vibsanins B (**7**) and C (**6**) exhibited moderate cytotoxic activities on KB cells (IC_{50} 3.5 and 11 μM), whereas vibsanin K (**3**) having a hydroperoxy function, did not show any activity, hence the hydroperoxy residue did not contribute to enhancement of cytotoxic activity, contrary to general anticipation.[8]

Experimental

Optical rotations were measured on a Jasco DIP-1000. UV spectra were recorded on a Hitachi 340 spectrophotometer. IR spectra were measured on a Jasco FT-IR 5300. ^{1}H- and ^{13}C-NMR spectra were obtained at 400 or 600 MHz (^{1}H-NMR) and 100.16 or 150 MHz (^{13}C-NMR) using a JEOL GX-400 or a Varian Unity 600 instrument. Chemical shift values are expressed in d (ppm) downfield from tetramethylsilane as internal standard. Mass spectra were recorded on a JEOL AX-500 instrument. Silica gel (Merck, 70—230 mesh and Wakogel C-300) and octadecylsilica gel (Cosmosil ^{75}C18-OPN) were used for column chromatography. Precoated Silica gel 60 F_{254} and RP-8 F_{254} plates were used for analytical thin-layer chromatography, and spots were visualized by UV (254 nm) light and 2% $CeSO_4$ in H_2SO_4 after heating.

Extraction and Purification Leaves of *V. awabuki* were collected in Tokushima, Japan, and a voucher specimen has been deposited in the herbarium of our Institute. The dried and powdered leaves (1.5 kg) were immersed in MeOH at room temperature for 1 month. The MeOH extract was evaporated *in vacuo* to give a gummy extract (500 g). The extract (95 g) mixed with silica gel (Merck, 70—230 mesh, 100 g) in MeOH was evaporated under reduced pressure. The obtained solids were pulverized, packed into a glass column, which had been packed with silica gel (Merck, 70—230 mesh, 600 g), and eluted in order with hexane (2 l), hexane–EtOAc (7:3, 2 l), hexane–EtOAc (1:1, 2 l), EtOAc (2 l), EtOAc–MeOH (8:2, 2 l), and MeOH (4 l) to give 6 fractions (1—6). Fraction 4 (13 g) was purified by repeated silica gel column chromatography (C-300, 1. $CHCl_3$: MeOH = 30 : 1; 2. hexane : EtOAc = 7 : 3) to give fractions 12—15. Fraction 15 (300 mg) was subjected to reversed-phase chromatography using Cosmosil ^{75}C18-OPN and eluted with MeOH–H_2O (7:3) to give fraction 16—18. Fraction 17 (123 mg) was purified by HPLC [Cosmosil ^{5}C18-AR, i.d. 10 × 280 mm; MeOH–H_2O (1:1; 2 ml/min)] to afford vibsanin G (**1**) (15.6 mg) and vibsanin H (**2**) (8.4 mg). Fraction 11 (473 mg) was rechromatographed on silica gel (C-300, 50 g) with hexane–EtOAc (1:2) to give fractions 19—22. Fraction 19 (224 mg) was purified by HPLC [Cosmosil ^{5}C18-AR, i.d. 10 × 280 mm; MeOH–CH_3CN–H_2O (1:2:1; 2 ml/min)] to give vibsanin K (**3**) (13.4 mg). Fraction 12 (128.0 mg) was fractionated by silica gel chromatography [1. C-300, hexane–EtOAc (1:1); 2. Cosmosil ^{75}C18-OPN, MeOH–H_2O–CH_3CN (1:1:1)] to afford 18-*O*-methylvibsanin K (**4**) (6.2 mg) and 15,18-di-*O*-methylvibsanin H (**5**) (4.1 mg).

Vibsanin G (**1**): Oil, $[\alpha]_D^{21}$ +61.5° (*c* = 0.41, $CHCl_3$); CD ε (260 nm) +3.7; FAB-MS *m/z* (rel. int. %): 455 $[M+Na]^+$, 83 (100); HR-FAB-MS: Found 455.2425, Calcd 455.2410 for $C_{25}H_{36}O_6Na$; UV λ_{max} (EtOH) nm (ε): 244 (14200); IR (film) cm^{-1}: 3437 (OH), 1728, 1649 (C=O), 1446, 1379 (C=C); ^{1}H and ^{13}C-NMR: Tables 1 and 2.

Vibsanin H (**2**): Needles, mp 120—122 °C (*n*-hexane–EtOH); $[\alpha]_D^{21}$ +77.2° (*c* = 0.98, $CHCl_3$); CD ε (263 nm) +3.1; FAB-MS *m/z* (rel int. %): 455 $[M+Na]^+$, 83 (100): HR-FAB-MS: Found 455.2398, Calcd 455.2410 for $C_{25}H_{36}O_6Na$; UV λ_{max} (EtOH) nm (ε): 245 (16000); IR (film) cm^{-1}: 3437 (OH), 1710, 1647 (C=O), 1448, 1379 (C=C); ^{1}H- and ^{13}C-NMR: Tables 1 and 2.

X-Ray Crystallographic Analysis of Vibsanin H (2) Crystal data: monoclinic, space group $P2_1$, *a* = 15.001 (3), *b* = 6.501 (2), *c* = 12.258 (4) Å, β = 94.69, *D*calc = 1.30 g/cm^3, radiation = Cu*K*α (λ = 1.54178), final *R* = 0.044; Data Collection: MXC (MAC Science); Cell refinement: MXC (MAC Science); Data reduction: CRYSTAN; Program(s) used to solve structure: CRYSTAN SHELXS-86[9]; Program(s) used refine structure: CRYSTAN; Molecular graphics: CRYSTAN; Software used to prepare material for publication: CRYSTAN.

Vibsanin K (**3**): Oil, $[\alpha]_D^{21}$ +81.1° (*c* = 0.62, $CHCl_3$); FAB-MS *m/z* (rel. int.%): 471 $[M+Na]^+$, 83 (100): HR-FAB-MS: Found 471.2388, Calcd 471.2359 for $C_{25}H_{36}O_7Na$; UV λ_{max} (EtOH) nm (ε): 244 (10900); IR (film) cm^{-1}: 3429 (OH), 1714, 1647 (C=O), 1446 (C=C); ^{1}H- and ^{13}C-NMR: Tables 1 and 2.

Reduction of Vibsanin K (3) To a solution of **3** (10 mg) in benzene (1.0 ml) was added triphenylphosphine (10 mg) at room temperature and the mixture was stirred for 1 h. The reaction mixture was evaporated *in vacuo* to give a residue, that was then chromatographed on silica gel (hexane–EtOAc, 3:1) to yield a product (3.8 mg) that was identical in all respects with **2**.

Photosensitized Oxidation of Vibsanin C (6) To a solution of **6** (10 mg) in benzene (1.0 ml) was added rose bengal (5 mg) under an oxygen atmosphere and the mixture was irradiated by high pressure Hg lamp for 15 min. The reaction mixture was evaporated *in vacuo* to give a residue, that was then chromatographed on silica gel (hexane–EtOAc, 4:1) to yield a product (1.1 mg) that was identical in all respects with **3**.

18-*O*-Methylvibsanin K (**4**): Oil, $[\alpha]_D^{21}$ +93.5° (*c* = 0.19, $CHCl_3$); CD ε (274 nm) +1.4; FAB-MS *m/z* (rel. int. %): 485 $[M+Na]^+$, 137 (100); HR-FAB-MS : Found 485.2481, Calcd 485.2516 for $C_{26}H_{38}O_7Na$; UV λ_{max} (EtOH) nm (ε): 231 (14200); IR (film) cm^{-1}: 3387 (OOH), 1726, 1644 (C=O), 1444, 1379 (C=C); ^{1}H- and ^{13}C-NMR: Tables 1 and 2.

15,18-Di-*O*-methylvibsanin H (**5**): Oil, $[\alpha]_D^{21}$ +91.2° (*c* = 0.35, $CHCl_3$); CD ε (275 nm) +1.4; FAB-MS *m/z* (rel. int. %): 483 $[M+Na]^+$, 136 (100); HR-FAB-MS : Found 483.2694, Calcd 483.2723 for $C_{27}H_{40}O_6Na$; UV λ_{max} (EtOH) nm (ε): 234 (12100); IR (film) cm^{-1}: 1730, 1647 (C=O), 1447, 1379 (C=C); ^{1}H- and ^{13}C-NMR: Tables 1 and 2.

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