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A novel bridged stilbenoid trimer and four highly condensed stilbenoid oligomers in *Vatica rassak*

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Abstract—Vaticanol G (**1**) and vaticaside D (**2**) isolated from stem bark of *Vatica rassak* (Dipterocarpaceae) were the first instance of stilbenoid trimers with an unusual tribenzobicyclo[3.3.2]decatriene system. Vaticanols D (**3**) and H (**4**)–J (**6**) were elucidated to be a stilbenoid hexamer or heptamer containing a structurally identical trimeric unit. Their structures and the relative configurations were established on the basis of 2D NMR spectroscopy. The hexamers (**3**, **4** and **5**) and the heptemer (**6**) showed cytotoxicity against KB cells. © 2001 Elsevier Science Ltd. All rights reserved.

1. Introduction

A number of stilbenoid (C_6–C_2–C_6) oligomers have been recently isolated from the plants belonging to Dipterocarpaceae[1–20] and the oligomers in this family have a variety of frameworks resulting from different oxidative condensation of nucleus in dihydrofuran ring, benzocyclopentane ring, dibenzo[2.1]heptadiene system, and dibenzobicyclo[3.2.1]-octadiene system. A number of biological activities of stilbenoid derivatives such as cancer chemopreventive activity,[21] antifungal activity,[22] anti-inflammatory activity,[23] cytotoxicity against human tumor cell lines,[3] inhibitory activity of histamine release[24] and gastric ATPase[25] have also been revealed by degrees. Stilbenoid oligomers are, therefore, regarded as one of important candidates for drug development. To reveal a structural variety of stilbenoid oligomers and to estimate their biological activity is a substantial clue to clarify their potency in nature. In continuation of our phytochemical studies of Dipterocarpaceous plants, the structures of stilbenoid oligomers in *Hopea*,[26,27] *Vatica*,[28–30] and *Shorea*[31–33] were elucidated and the distinctive cytotoxicity observed in some stilbenoids was discussed.[34]

In the preceding papers, the structures of new stilbenoid oligomers (vaticanols A–F) and *O*-glycosyl stilbenoid oligomers (vaticasides A–C) composed of several resveratrol (3,5,4′-trihydroxystilbene) units in stem bark of *Vatica rassak* were discussed.[28,30] Further investigation of an acetone extract of the stem bark resulted in isolation of six new stilbenoid oligomers named vaticanols G (**1**), D (**3**),[29] (Fig. 1) H (**4**)–J (**6**) and vaticaside D (**2**). Among the isolates **1** and **2** have a novel bridged framework in the molecule as a tribenzobicyclo[3.3.2]decatriene system. Compounds **3**–**6** are new types of resveratrol oligomers that are hexamers (**3**–**5**) and a heptamer (**6**). This paper deals with their structure elucidation involving the relative configuration and their cytotoxicity against KB cells.

2. Results and discussion

Vaticanol G (**1**), $[\alpha]_D^{25}=+151°$ (MeOH) obtained as a yellow amorphous powder showed a positive reaction to the Gibbs test. An absorption band (282 nm) in the UV spectrum showed the presence of aromatic rings. The molecular formula was established to be $C_{42}H_{32}O_9$ by means of the high resolution FAB-MS ($[M-H]^-$ ion at *m/z* 679.1972) and the ^{13}C NMR spectrum which showed 42 carbon signals. By usual methylation or acetylation, **1** afforded a nonamethyl ether (**1a**) or a nona-acetate (**1b**), respectively, suggesting that **1** has nine phenolic hydroxyl groups. The ^1H-, ^{13}C NMR (Table 1) and ^1H–^1H COSY spectral data (measured at room temperature (rt)) indicated the presence of five aromatic rings and eight phenolic

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Keywords: natural product; resveratrol; hexamer; heptamer; Dipterocarpaceae; cytotoxicity.

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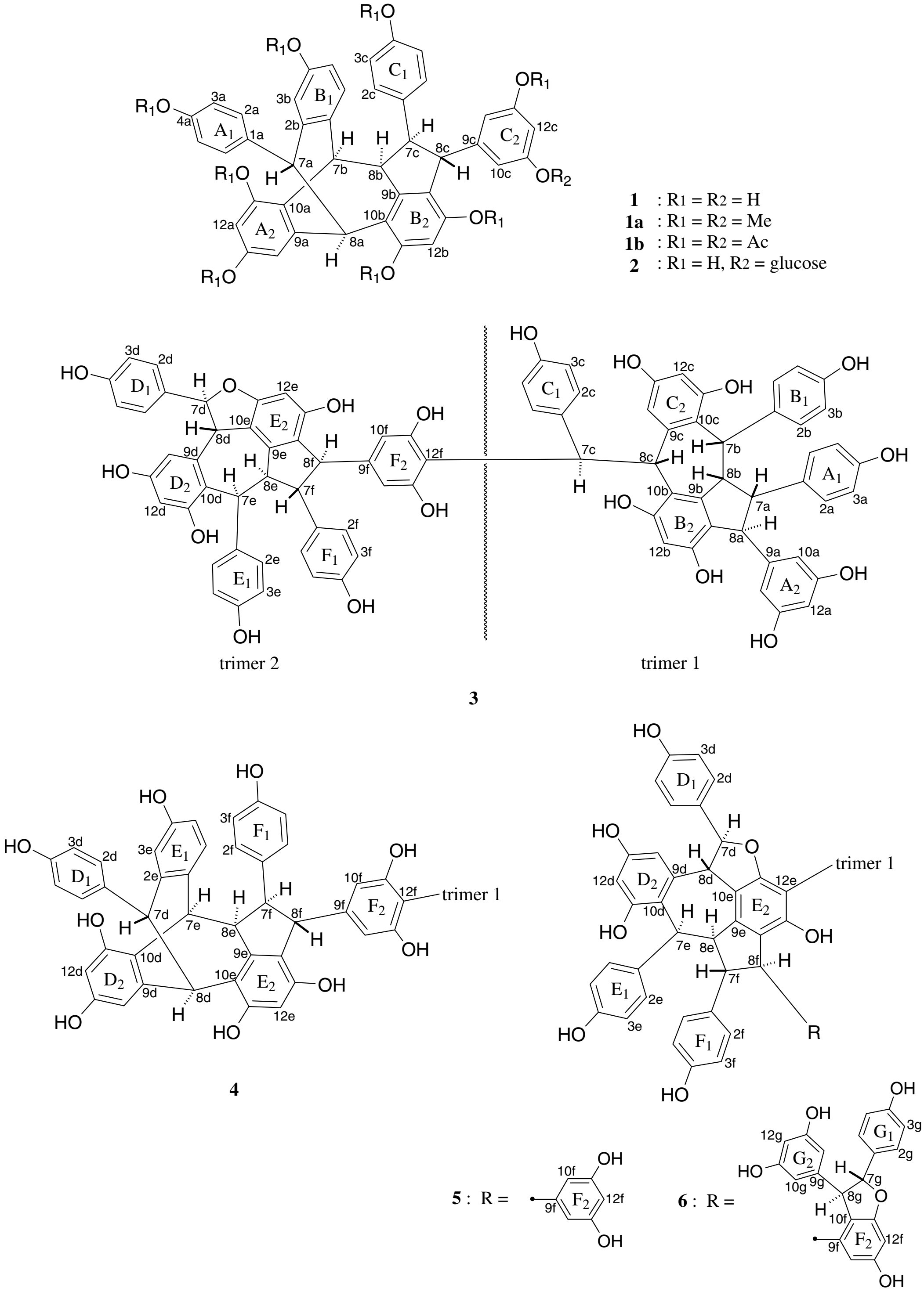

1 : $R_1 = R_2 = H$
1a : $R_1 = R_2 = Me$
1b : $R_1 = R_2 = Ac$
2 : $R_1 = H$, $R_2 =$ glucose

3

4

5 : R =

6 : R =

Figure 1.

hydroxyl groups which form a 4-hydroxyphenyl group (ring A_1), a 4-hydroxy-1,2-disubstituted benzene ring (ring B_1), a 3,5-dihydroxy-1,2-tetrasubstituted benzene ring (ring A_2), a 3,5-dihydroxy-1,2,6-pentasubstituted benzene ring (ring B_2) and a 3,5-dihydroxy benzene ring (ring C_2). The spectrum also exhibited a mutually coupled aliphatic protons (H-7a and H-8a) and a sequence of four aliphatic protons in this order (H-7b/H-8b/H-7c/H-8c) as drawn in bold line in Fig. 2. Considering the molecular formula, the remaining unit in the molecule is corresponding to C_6H_5O. In the ^1H NMR spectrum, the other signals of four broad singlets [δ_H 5.92 (H-2c), 5.98 (H-3c), 6.68 (H-5c) and 7.12 (H-6c)] (Fig. 3a) and a hydroxyl group were assignable to a benzene ring (ring C_1). In the ^{13}C NMR spectral data (Table 1), all carbon signals attributed to six methine carbons and 36 aromatic carbons were assigned by the ^{13}C–^1H COSY and COLOC spectrum (data not shown). The four carbons bearing an aromatic proton on ring C_1 were observed as a broadened signal at δ_C 127.5 (C-2c), 114.3 (C-3c), 116.2 (C-5c) and 130.7 (C-6c). The behavior of chemical shift values

Table 1. ^{1}H- and ^{13}C NMR Spectral data of **1** and **1a**

No.	**1**			**1a**[a]	
	rt[a]		$-20^{\circ b}$	rt	
	δH	δC	δH	δH	δC
1a		140.0			140.4
2a,6a	6.42 (br s)	130.3	6.45 (br s)	6.44 (br d)	130.0
3a,5a	6.45 (br d)	114.8	6.45 (br s)	6.53 (br d)	113.5
4a (OH)	7.93 (br s)	155.6	8.31 (br s)		159.2
7a	4.55 (d, 3.4)	57.2	4.52 (d, 3.7)	4.58 (d, 3.4)	57.0
8a	4.63 (d, 3.4)	50.3	4.59 (d, 3.7)	4.75 (d, 3.4)	50.5
9a		142.0			141.3[c]
10a		126.2			128.1
11a (OH)	8.08 (br s)	153.3	8.02 (br s)		156.1
12a	6.20 (d, 2.4)	101.8	6.18 (d, 2.2)	6.30 (d, 2.4)	97.8
13a (OH)	7.68 (br s)	155.9	7.47 (br s)		159.1
14a	5.67 (d, 2.4)	111.5	5.64 (d, 2.2)	5.70 (d, 2.4)	109.5
1b		129.3			129.8
2b		141.8			141.4[c]
3b	6.08 (d, 2.4)	119.5	6.04 (d, 2.4)	6.14 (d, 2.4)	118.7
4b (OH)	7.49 (br s)	154.9	7.84 (br s)		154.9
5b	5.76 (dd, 8.3, 2.4)	112.9	5.73 (dd, 8.5, 2.4)	5.76 (dd, 8.8, 2.4)	111.0
6b	6.02 (d, 8.3)	135.1	5.97 (d, 8.5)	6.08 (d, 8.8)	135.0
7b	4.89 (d, 2.0)	42.8	4.86 (d, 2.4)	4.96 (d, 2.9)	42.5
8b	3.86 (dd, 7.0, 2.0)	53.9	3.80 (dd, 6.5, 2.4)	3.87 (dd, 9.3, 2.9)	53.4
9b		147.1			146.4
10b		117.7			119.3
11b (OH)	8.54 (br s)	155.1	8.92 (br s)		158.1
12b	6.47 (s)	102.1	6.46 (s)	6.71 (s)	95.0
13b (OH)	7.67 (br s)	153.1	8.04 (br s)		156.1
14b		122.0			124.1
1c		137.2			137.7
2c	5.92 (br s)	127.5	5.90 (dd, 8.3, 2.0)	5.80 (br d)	127.1
3c	5.98 (br s)	114.3	5.95 (dd, 8.3, 2.4)	5.94 (br d)	113.1
4c (OH)	7.94 (br s)	156.5	8.30 (br s)		158.4
5c	6.68 (br s)	116.2	6.67 (dd, 8.3, 2.4)	6.78 (br d)	114.7
6c	7.12 (br s)	130.7	7.14 (dd, 8.3, 2.0)	7.27 (br d)	130.8
7c	3.52 (d, 7.0)	63.0	3.47 (d, 6.5)	3.62 (d, 9.3)	62.6
8c	4.11 (s)	57.1	4.06 (s)	4.18 (s)	57.1
9c		147.7			147.0
10c,14c	5.97 (d, 2.4)	106.5	5.91 (d, 2.0)	6.13 (d, 2.2)	106.5
11c,13c (OH)	8.04 (br s)	159.1	8.37 (br s)		161.8
12c	6.12 (t, 2.4)	101.1	6.08 (t, 2.0)	6.28 (t, 2.2)	97.6
OMe				3.70 (4a-OMe)	55.3[d]
				3.74b (11a-OMe)	56.1
				3.45 (13a-OMe)	55.3[d]
				3.47 (4b-OMe)	54.9
				4.14 (11b-OMe)	56.7
				3.72b (13b-OMe)	55.6
				3.63 (4c-OMe)	55.3[d]
				3.65 (11c, 13c-OMe)	55.2

Measured in CD_3COCD_3. All protons were assigned by the aid of ^{1}H–^{1}H and ^{1}H–^{1}H long range COSY, ^{13}C–^{1}H COSY, COLOC spectrum and NOESY experiments.

[a] 400 MHz (^{1}H NMR) and 100 MHz (^{13}C NMR).

[b] 500 MHz (^{1}H NMR).

[c] Interchangeable.

[d] Overlapping.

closely resembled those of 4-hydroxyphenyl groups as found in ring A_1 (δ_C 130.3 and 114.8). These results indicated that ring C_1 formed a 4-hydroxyphenyl group and the steric hindrance in the molecule caused disturbance of the free rotation of the ring, which implied that the two pairs of identical atoms [H(C)-2c and H(C)-6c; H(C)-3c and H(C)-5c] were located in different environment. Huang et al. reported similar behaviors of a 4-hydroxyphenyl group in the ^{1}H NMR spectra of three stilbenoid oligomers (amurensins (D–F)).[35] In the ^{1}H NMR spectrum of amurensin D, one of the 4-hydroxyphenyl groups was observed as four doublet of doublets at −40°C. In the ^{1}H NMR spectral measurement of **1** at different temperatures, the signals (H-2c, 3c, 5c and 6c) gradually became split into doublet of doublets according to lower temperature (Fig. 3, **a**(rt)–**e**(−20°C)). The pattern of signals at −20°C [δ_H 5.90, 7.14 (dd, J=8.3, 2.0 Hz, H-2c and H-6c) and δ_H 5.95, 6.67 (dd, J=8.3, 2.4 Hz, H-3c and 5c)] (Table 1) was similar to that of the 4-hydroxyphenyl group in amurensin D at −40°C. The similarity was observed in a stilbenoid dimer of isoampelopsin F, one of a 4-hydroxyphenyl groups of which appeared as four doublet of doublets in the ^{1}H NMR spectrum at rt.[36] Thus ring C_1 in **1** was characterized to be a 4-hydroxyphenyl group.

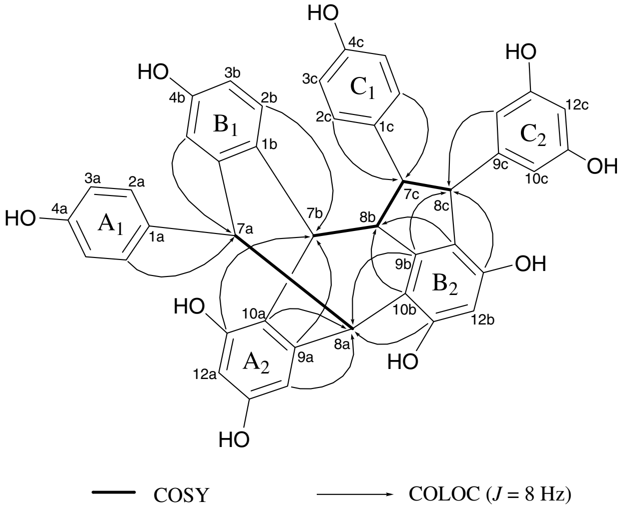

Figure 2. Selected 2D NMR data of **1**.

In the COLOC spectrum (Fig. 2, measured at rt), significant correlations were observed between C-2a(6a)/H-7a, C-10a,C-14a/H-8a, C-6b/H-7b, C-10b,14b/H-8b, C-2c,C-6C/H-7c and C-10c(14c)/H-8c, which indicated that rings A_1, A_2, B_1, B_2, C_1 and C_2 were attached to C-7a, C-8a, C-7b, C-8b, C-7c and C-8c, respectively. Considering the ^3J long-range correlations between C-11a/H-7b, C-3b/H-7a, C-9b,C-11b/H-8a and C-9b,C-13b/H-8c, the aromatic carbons of C-10a, C-6b, C-10b and C-14b were connected with C-7b, C-7a, C-8a and C-8c, respectively. Finally the planar structure of **1** can be drawn as in Fig. 2.

To confirm the relative stereochemistry, NOESY experiment (measured at −20°C) was conducted (Fig. 4). Significant NOEs were observed through this experiment between H-10c(14c)/H-7c, H-10c(14c)/H-8b and H-7b/H-7c, indicating that the relative configuration of methine hydrogens at C-7b, C-8b, C-7c and C-8c were α, α, α and β, respectively. Considering the framework of

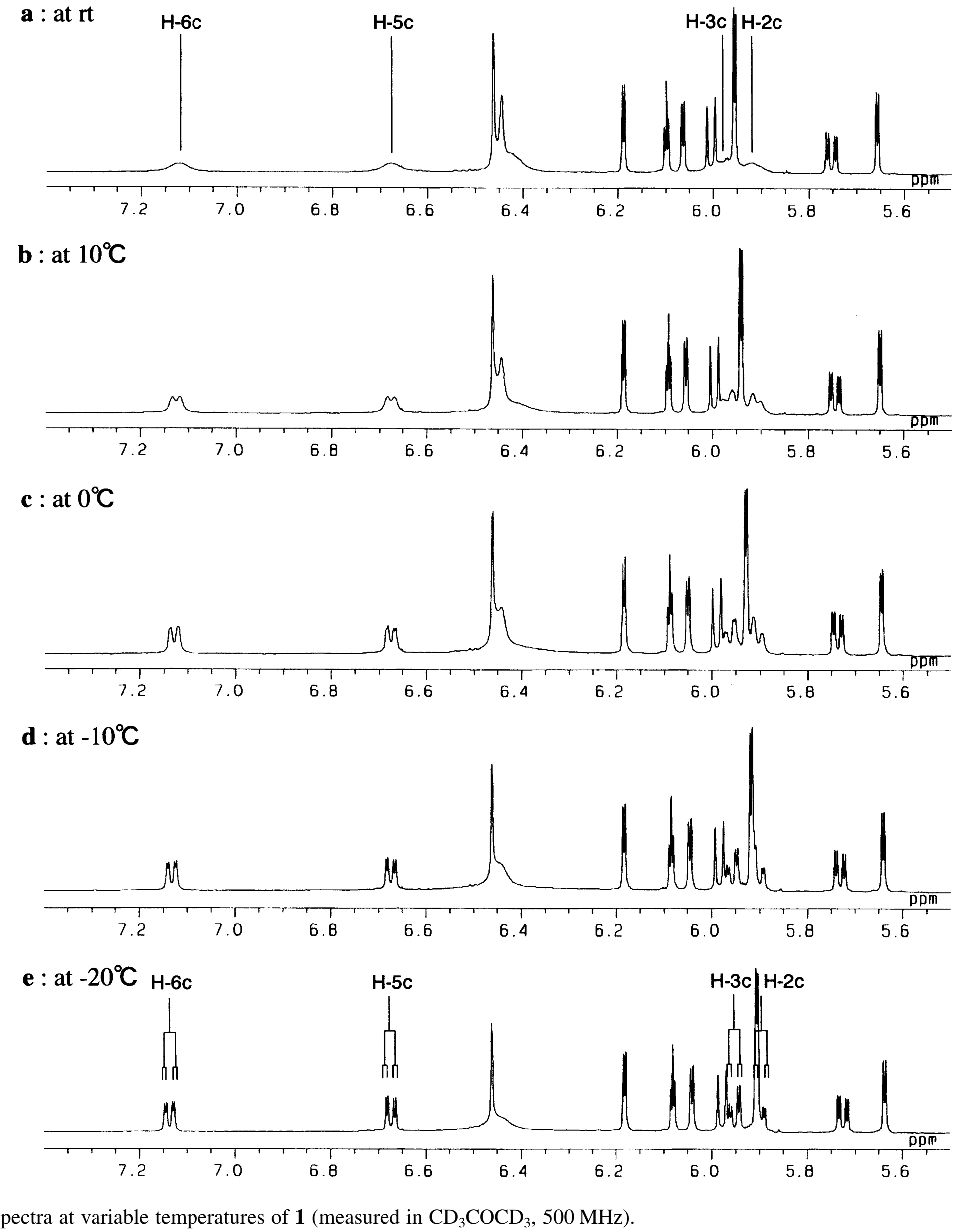

Figure 3. ^1H NMR spectra at variable temperatures of **1** (measured in CD_3COCD_3, 500 MHz).

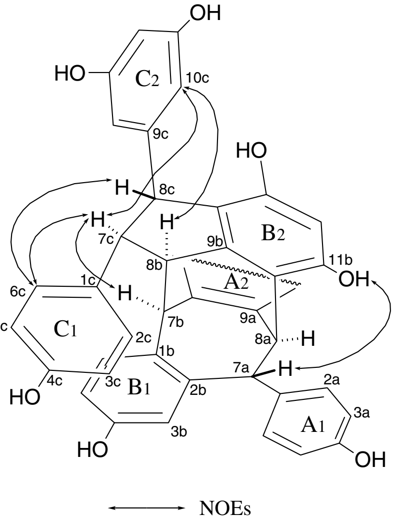

Figure 4. Selected NOEs observed in the NOESY spectrum of **1** (measured at −20°C, 500 MHz).

tribenzobicyclo[3.3.2]decatriene system, H-8a should be located in α configuration. The configuration of H-7a was confirmed to be β by the NOE result (H-7a/OH-11b). This stereostructure of **1** proposes that two linkages (C-7c/C-1c and C-7b/C-1b) are almost parallel and ring C_1 is located above ring B_1. This model intensively indicated that the free rotation of ring C_1 is disturbed by the steric hindrance of ring B_1. In the NOESY experiment (Fig. 4), the signals of the methine hydrogens due to H-7c and H-8c showed distinctive NOE cross peaks with the aromatic proton of H-6c. On the other hand, the aromatic proton (H-2c) which is located above ring B_1 had no cross peak with the methine hydrogens (H-7c and H-8c). These results indicated that the strong steric hindrance disturbs the free rotation of ring C_1 in solution, which results from separation of the signals due to C-2c(6c) or at C-3c(5c) both in the ^{1}H- and ^{13}C NMR spectra. This speculation also explains well the upper field shift of aromatic protons on ring B_1 (H-5b and H-6b) and ring C_1 (H-2c and H-3c) which were caused by the anisotropic effects of rings C_1 and B_1 (Fig. 5a). The framework of tribenzobicyclo[3.3.2]decatriene system and α configuration of ring A_1 contributes to the upper field shift of H-2a(6a) and H-14a since these protons are situated above rings A_2 and A_1 (Fig. 5b). The upper field shift of OH-13b that is located above ring C_2 can be explained by the relative configuration. On the basis of these results, the relative structure of vaticanol G was characterized as **1**, where three resveratrol units form a novel bridged skeleton of tribenzobicyclo[3.3.2]decatriene system.

Sotheeswaran et al. reported previously the structure of copallipherol A isolated from *Vateria copallifera* (Dipterocarpaceae).[13] The spectral identity of capalliphenol A and vaticanol G implies that both compounds will be the same.

Vaticaside D (**2**), $[\alpha]_D^{25}=+92°$ (MeOH) was isolated as a brown amorphous powder. Its molecular formula was established to be $C_{48}H_{42}O_{14}$ by the results of the HR-FABMS ($[M-H]^-$: *m/z* 841.2512) and the ^{13}C NMR spectral data. The presence of a β-glucopyranosyl moiety was supported by the NMR spectra (see Section 3) which showed six carbon signals owing to a glucose at δ_C 101.3, 74.4, 77.3, 71.0, 77.8, 62.4 and an anomeric proton at δ_H 4.85 (1H, d, J=7.3 Hz). The ^{1}H- and ^{13}C NMR spectral data except for the β-glucopyranosyl moiety showed closed similarities to those of vaticanol G. Acid hydrolysis of **2** with H_2SO_4 in MeOH gave vaticanol G. These results indicated that **2** was an *O*-β-glucopyranoside of vaticanol G. To confirm the glucosidic linkage, the ^{1}H- and ^{13}C NMR spectral signals due to the aglycone moiety were assigned by ^{1}H–^{1}H COSY, ^{1}H–^{1}H long-range COSY, ^{13}C–^{1}H COSY and COLOC spectra. The down field shift due to H-10c, 12c and 14c (δ 6.23, 6.36 and 6.12) indicated that the glucopyranosyl moiety was attached to ring C_2. In the NOE experiment, the aromatic protons (H-10c and 12c) were enhanced when the anomeric proton (δ 4.85) was irradiated. Therefore, the glucosyl moiety was attached at C-11c of vaticanol G. The structure of **2** was then characterized as vaticanol G 11c-*O*-β-glucopyranoside.

Vaticanol D (**3**) is a first instance of a resveratrol hexamer as natural product. The structure is composed of two trimeric units of resveratrol (trimer 1 and 2, Fig. 1). The detail spectral data and the structure elucidation including the relative stereochemistry of **3** have been reported in our previous communication.[29]

Vaticanol H (**4**), $[\alpha]_D^{25}=+77°$ (MeOH) obtained as a brown amorphous powder showed a $[M+H]^+$ ion at *m/z* 1361.4203 in the positive ion HR-FABMS corresponding to the empirical formula $C_{84}H_{64}O_{18}$ and was regarded as another resveratrol hexamer. Analysis of the ^{1}H- and ^{13}C NMR spectral data including ^{1}H–^{1}H COSY and HMQC (Tables 2 and 3, measured at rt in CD_3COCD_3) showed the signals assignable to six resveratrol units (aromatic rings A_1–F_1, A_2–F_2 and the aliphatic sequences of H-8a/H-7a/H-8b/H-7b,

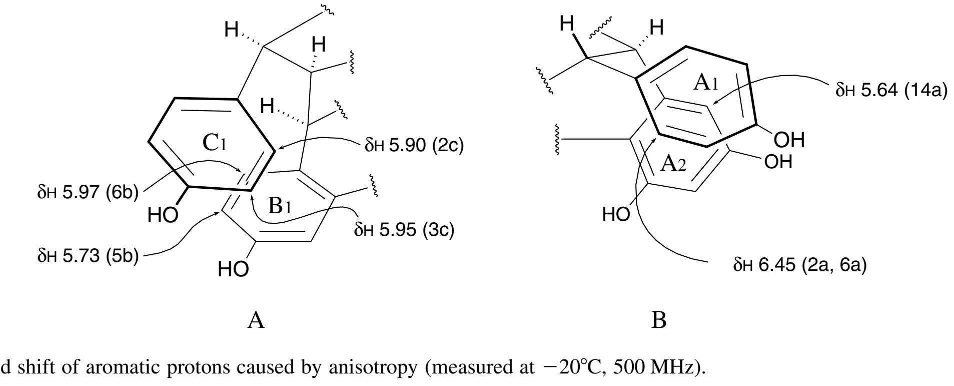

Figure 5. Upper field shift of aromatic protons caused by anisotropy (measured at −20°C, 500 MHz).

Table 2. ^1H NMR Spectral data (500 MHz) of **4**

No.	rt		−20°
	CD_3COCD_3	CD_3OD	CD_3COCD_3
2a,6a	6.92 (d, 8.8)	6.83 (d, 8.8)	6.92 (br s)
3a,5a	6.56 (d, 8.8)	6.51 (d, 8.8)	6.55 (br d)
7a	3.83 (t, 7.2)	3.73 (dd, 8.0, 5.3)	3.79 (d, 7.0)
8a	4.49 (d, 7.2)	4.40 (d, 5.3)	4.48 (d, 7.0)
10a,14a	6.18 (d, 2.0)	6.18 (d, 2.2)	6.14 (d, 1.7)
12a	6.15 (t, 2.0)	6.12 (t, 2.2)	6.12 (t, 1.7)
2b,6b	7.01 (d, 8.8)	6.95 (d, 8.8)	6.96 (d, 8.6)
3b,5b	6.44 (d, 8.8)	6.47 (d, 8.8)	6.41 (d, 8.6)
7b	4.68 (d, 7.2)	4.61 (d, 6.0)	4.62 (d, 7.9)
8b	4.91 (t, 7.2)	4.84 (dd, 8.0, 6.0)	4.87 (t, 7.9)
12b	5.93 (br s)	5.87 (s)	5.92 (s)
2c,6c	7.40 (d, 8.8)	7.21 (d, 8.8)	7.47 (d, 8.5)
3c,5c	6.44 (d, 8.8)	6.36 (d, 8.8)	6.47 (d, 8.5)
7c	6.06 (d, 12.3)	5.89 (d, 12.2)	6.08 (d, 12.1)
8c	6.37 (d, 12.3)	6.16 (d, 12.2)	6.40 (d, 12.1)
12c	5.89 (d, 2.0)	5.82 (d, 1.6)	5.85 (d, 2.0)
14c	6.58 (d, 2.0)	6.50 (d, 1.6)	6.59 (br s)
2d,6d[a]	6.44 (br s)	6.37 (br s)	6.39 (br s)
3d,5d[a]	6.44 (br s)	6.37 (br s)	6.39 (br s)
7d	4.52 (d, 3.2)	4.46 (d, 3.2)	4.50 (d, 3.2)
8d	4.60 (d, 3.2)	4.52 (d, 3.2)	4.57 (d, 3.2)
12d	6.20 (d, 2.2)	6.08 (d, 1.8)	6.21 (d, 2.2)
14d	5.68 (d, 2.2)	5.58 (d, 1.8)	5.67 (d, 2.2)
3e	6.03 (d, 2.4)	6.02 (d, 1.8)	6.01 (d, 2.2)
5e	5.74 (dd, 8.8, 2.4)	5.69 (dd, 7.4, 1.8)	5.70 (dd, 8.7, 2.2)
6e	5.96 (d, 8.8)	5.96 (d, 7.4)	5.92 (d, 8.7)
7e	4.79 (d, 2.2)	4.72 (d, 2.2)	4.76 (br s)
8e	3.75 (d, 6.8, 2.2)	3.80 (d, 6.5, 2.2)	3.69 (br d, 6.7)
12e	6.40 (s)	6.33 (s)	6.39 (s)
2f	5.89 (br d)	5.78 (br d)	5.88 (dd, 8.5, 1.6)
3f	5.96 (br d)	5.86 (br d)	5.94 (dd, 8.5, 2.4)
5f	6.65 (br d)	6.59 (br d)	6.64 (dd, 8.5, 2.4)
6f	7.08 (br d)	7.09 (br d)	7.08 (dd, 8.5, 1.6)
7f	3.44 (d, 6.8)	3.52 (d, 6.5)	3.41 (d, 6.7)
8f	3.98 (s)	3.94 (s)	3.95 (s)
10f	5.88 (br d, 1.2)	5.91 (br d, 0.6)	5.74 (br s)
14f	5.91 (br d, 1.2)	5.99 (br d, 0.6)	5.91 (br s)
OH[b]	7.73 (br s, OH–C-13e)		8.33 (br s, OH–C-11a,13a)
	8.08 (br s, OH–C-13f)		8.12 (br s, OH–C-11b)
			7.02 (br s, OH–C-13b)
			7.89 (br s, OH–C-13c)
			8.41 (br s, OH–C-11d)
			8.33 (br s, OH–C-13d)
			8.92 (br s, OH–C-11e)
			8.06 (br s, OH–C-13e)
			8.16 (br s, OH–C-11f)
			8.41 (br s, OH–C-13f)

All protons were assigned by the aid of $^1H-^1H$ COSY, HMQC and HMBC spectrum.

[a] Overlapping.

[b] Assignable hydroxyl groups are shown.

H-7c/H-8c, H-7d/H-8d and H-7e/H-8e/H-7f/H-8f). Signals due to a trimeric unit [resveratrol A (A_1-7a-8a-A_2)–resveratrol C (C_1-7c-8c-C_2)] resembled closely those of trimer 1 of vaticanol D (**3**).[29] The pattern of signals due to the other trimeric unit [resveratrol D (D_1-7d-8d-D_2)–resveratrol F (F_1-7f-8f-F_2), designated trimer 2 in Fig. 6] revealed the presence of an oxidative vaticanol G moiety by their signal similarity. The two sets of trimeric resveratrol structures including the relative configuration were confirmed by the correlations observed in the HMBC (Fig. 6) and ROESY (Fig. 7) spectrum of **4**. The correlations in the HMBC spectrum (H-7c/C-11f and H-7c/C-13f) supported the linkage between C-7c and C-12f. The relationship between H-7c and H-8c is *trans* on the basis of ROEs [H-7c/H-14c and H-8c/H-2c(6c)] and *J* value (12.3 Hz).[37,38] Then the structure of **4** was determined as in Fig. 1. The ^1H- and ^{13}C NMR spectral data (Tables 2 and 3) including HMBC spectrum (data not shown, measured in CD_3OD) supported the cause of separation of the signals due to the oxygenated aromatic carbons. When the ^1H- and ^{13}C NMR spectra were measured in CD_3COCD_3 at −20°C (Tables 2 and 3), the signals due to ring F_1 that is corresponded to ring C_1 in vaticanol G (**1**) displayed the same behaviors as that of **1**.

Vaticanol I (**5**), $[\alpha]_D^{25}=-60°$ (MeOH) was obtained as a brown amorphous powder. Its positive ion HR-FABMS (*m/z* 1361.4181 $[M+H]^+$) gave the molecular formula of $C_{84}H_{64}O_{18}$, and the formula corresponding to a resveratrol hexamer was supported by the ^1H- and ^{13}C NMR spectral

Table 3. ^{13}C NMR Spectral data (125 MHz) of **4**

	δC						
No.	rt		−20°	No.	rt		−20°
	CD_3COCD_3	CD_3OD	CD_3COCD_3		CD_3COCD_3	CD_3OD	CD_3COCD_3
1a	133.44	135.38	133.00	1d	139.99	140.67	139.57
2a,6a	131.02	131.10[m]	n.o.	2d,6d	130.24[b]	130.65	n.o.
3a,5a	115.36	115.64	n.o.	3d,5d	114.61	115.10	n.o.
4a	156.57[a]	156.41	n.o.	4d	156.30[e]	155.58	n.o.
7a	61.76	63.12[n]	61.53	7d	57.24	57.64	56.86
8a	54.75	55.82	54.23	8d	50.41	50.92	50.13
9a	148.17	149.26	148.36	9d	142.09	142.70	141.56
10a,14a	107.04	107.46	106.71	10d	126.29	126.95	125.83
11a,13a	159.11	159.03	158.74	11d	153.23	153.28	153.09
14a	101.42	101.36	100.82	12d	102.06[k]	101.92	101.42[h]
1b	139.36	140.00	139.26	13d	155.93	155.92	155.72
2b,6b	130.23[b]	130.41	130.09	14d	111.66	111.88	111.15
3b,5b	114.76[c]	114.95	114.21	1e	129.21	130.19	128.78
4b	154.97[d]	154.93[f]	154.62	2e	141.79	142.36	141.88
7b	39.73	40.03	39.65	3e	119.43	119.67	119.15
8b	53.84[j]	53.84	53.84	4e	154.89[l]	154.73	154.81[i]
9b	149.07	149.71	148.88	5e	112.85	113.09	112.5
10b	122.80	123.32	122.29	6e	135.02	135.44	134.75
11b	154.92[d]	154.85[f]	155.39	7e	42.83	43.39	42.41
12b	103.66	104.10	102.83	8e	53.84[j]	54.19	53.51
13b	152.11	152.18	151.95	9e	146.93	147.54	146.66
14b	122.24	123.07	121.52	10e	117.47	118.68	116.89
1c	137.63	137.99	138.52	11e	154.89[l]	155.50	154.85[i]
2c,6c	131.11	131.58	130.91	12e	102.06[k]	102.33	101.52[h]
3c,5c	114.80[e]	114.80	114.48	13e	152.96	152.72	152.74
4c	155.36	155.04	155.20	14e	121.75	122.86	121.11
7c	40.63	40.96	40.30	1f	137.29	138.31	137.76
8c	45.15	45.34	45.00	2f	127.64	127.94	127.36
9c	147.07	147.75	146.82	3f	116.16	116.31	115.82
10c	120.82	121.19	120.57	4f	155.57[e]	156.29	156.21[g]
11c	156.55[a]	157.08	156.42[g]	5f	114.17	114.41	113.87
12c	100.44	100.41	99.81	6f	130.73	131.10[m]	130.65
13c	155.69	155.65	155.39	7f	62.39	63.12[n]	61.95
14c	105.17	105.12	104.79	8f	56.41	57.15	55.91
				9f	143.40	143.90	142.82
				10f	107.34	107.20	106.5
				11f	156.42	156.34	156.34
				12f	118.09	118.51	117.86
				13f	157.36	158.17	157.14
				14f	108.75	108.96	108.37

All carbons were assigned by the aid of HMQC and HMBC spectrum; n.o.: not observed signal.

[a–i] Interchangeable.

[j–n] Overlapping.

data. After analysis of ^{1}H–^{1}H COSY and HMQC, the ^{1}H- and ^{13}C NMR spectral data (Table 4) supported the presence of six 4-hydroxyphenyl groups (designated the aromatics as A$_1$–F$_1$), two 3,5-dihydroxyphenyl groups (A$_2$ and F$_2$), a 3,5-dioxygenated-1,2,6-trisubstituted benzene ring (B$_2$), two 3,5-dioxygenated-1,2-disubstituted benzene rings (C$_2$ and D$_2$) and four sequences of aliphatic protons in this order (H-8a/H-7a/H-8b/H-7b, H-7c/H-8c, H-7d/H-8d and H-7e/H-8e/H-7f/H-8f) as drawn in bold line in Fig. 8. Among the signals, three resveratrol units [resveratrol A (A$_1$-7a-8a-A$_2$)–resveratrol C (C$_1$-7c-8c-C$_2$), designated trimer 1 in Fig. 8] resembled those of vaticanol D (**3**)[29] and vaticanol H (**4**) at a same partial unit, which was concluded by the similar patterns of signals and the correlations observed in the HMBC and ROESY spectrum of **5** (Figs. 8 and 9). The structure of another trimer moiety [resveratrol D (D$_1$-7d-8d-D$_2$)–resveratrol F (F$_1$-7f-8f-F$_2$), designated trimer 2 in Fig. 8] was determined as follows. Significant correlations via ^3J were observed in the HMBC spectrum (Fig. 8) between H-7d/C-2d(6d), H-8d/C-14d, H-7e/C-2e(6e), H-7f/C-2f(6f) and H-8f/C-10f(14f), indicating that rings D1, D2, E1, F1 and F2 were attached to C-7d, C-8d, C-7e, C-7f and C-8f, respectively. The correlations observed between H-7e/C-9d and H-7e/C-11d supported the connections between C-7e/C-10d. After complete assignment of all the quaternary carbons on the above benzene rings (A$_1$–F$_1$, A$_2$–D$_2$ and F$_2$), the other six quaternary aromatic carbons (C-9e–C-14e) in the ^{13}C NMR spectrum were considered to be those of the 3,5-dioxygenated benzene ring, where the carbons are all substituted (E$_2$). Two oxygenated carbon signals (C-11e and C-13e) among these carbons were correlated with H-7c, which indicated that C-7c was linked to C-12e. The other C–C linkages (C-8d–C-10e, C-8e–C-9e and C-8f–C-14e) were substantiated by the correlations (H-8d/C-11e, H-8e/C-9e and H-8f/C-13e). Although no long-range correlation between H-7d/C-11e was observed, the presence of a dihydrofuran ring was deduced after considering the molecular formula. The planar structure of

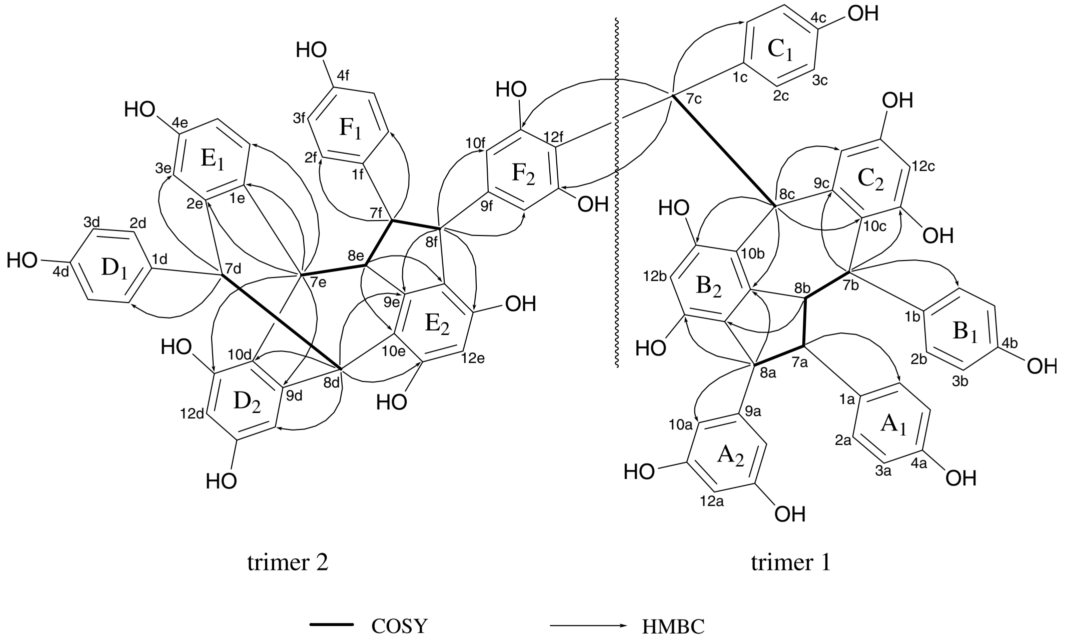

Figure 6. Selected 2D NMR data of **4**.

trimer 2 was then depicted as shown in Fig. 8, where C-12e of trimer 2 links to C-7c of trimer 1. The stereochemistry of trimer 2 was determined on the basis of ROESY experiment (Fig. 9). The ROEs between H-2d(6d)/H-8d and H-14d/H-7d suggested *trans* orientation of rings D_1 (H-7d:α) and D_2 (H-8d:β). Significant ROEs were also observed between H-2e(6e)/H-8d, H-2e(6e)/H-7f, H-2f(6f)/H-7e, H-2f(6f)/H-8f, H-10f(14f)/H-7f and H-8e/H-8f, indicating that the relative configuration of methine hydrogens at C-7e, C-8e, C-7f and C-8f were α, α, β and α, respectively. The relative stereochemistry of vaticanol I was then characterized as **5**. Two trimeric structures (trimer 1 and trimer 2) of vaticanols D (**3**) and I (**5**) are identical. In the case of vaticanol D, trimer 2 and trimer 1 is connected at C-12f and C-7c, while trimer 2 and trimer 1 is connected at C-12e and C-7c in vaticanol I. The difference of connective positions adds the variation to the structure of resveratrol hexamers.

Vaticanol J (**6**), a brown amorphous powder, $[\alpha]_D^{25}=-69°$ (MeOH), has the molecular formula of $C_{98}H_{74}O_{21}$ supported by the negative ion HR-FABMS ($[M-H]^-$: *m/z* 1585.4644). Aanalysis of ^1H- and ^{13}C NMR spectral data including $^1H-^1H$ COSY and HMQC of **6** (Table 5) showed the signals assignable to seven resveratrol units (aromatic rings A_1–G_1, A_2–G_2 and aliphatic sequences of H-8a/H-7a/H-8b/H-7b, H-7c/H-8c, H-7d/H-8d, H-7e/H-8e/H-7f/H-8f and H-7g/H-8g). The connections involving the stereochemistry of three resveratrol units [resveratrol A (A_1-7a-8a-A_2)–resveratrol C (C_1-7c-8c-C_2)] and four resveratrol units [resveratrol D (D_1-7d-8d-D_2)–resveratrol G (G_1-7g-8g-G_2)] were determined to be identical to those of vaticanol D (**3**)[29] and vaticanol B[28] in respect to the corresponding partial unit. The results of correlations observed in the HMBC and ROESY spectrum are shown in Fig. 10. The linkage between C-7c and C-12e was confirmed by the correlations (H-7c/C-11e, H-7c/C-13e and H-8c/C-12e) in

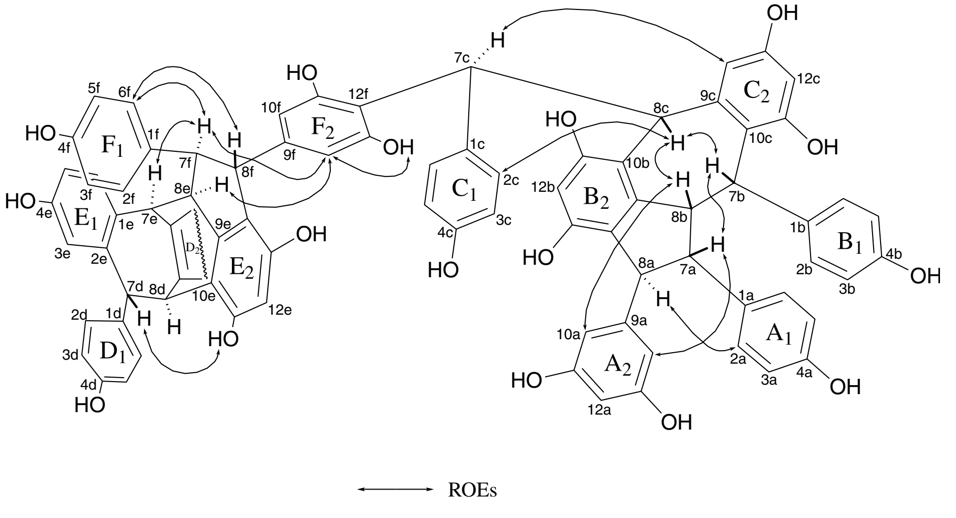

Figure 7. Selected ROEs observed in the ROESY spectrum of **4**.

Table 4. ^{1}H- and ^{13}C NMR spectral data of **5**

No.	δH	δC	No.	δH	δC
1a		132.94	1d		131.85
2a,6a	6.91 (d, 8.8)	131.21[b]	2d, 6d	7.28 (d, 8.8)	130.00
3a,5a	6.52 (d, 8.8)	115.21	3d, 5d	6.78 (d, 8.8)	116.17
4a (OH)	8.02 (br s)[a]	156.33[c]	4d (OH)	8.49 (br s)[a]	158.36
7a	4.05 (t, 8.0)	61.48	7d	5.71 (d, 11.8)	90.49
8a	4.58 (d, 8.0)	54.02	8d	4.33 (br d, 11.8)	50.50
9a		148.27	9d		141.74
10a,14a	6.42 (d, 2.0)	107.67[d]	10d		124.97
11a,13a (OH)	8.16 (br s)	158.93	11d (OH)	8.26 (br s)	155.74[f]
12a	6.22 (t, 2.0)	101.83[e]	12d	6.30 (d, 2.0)	101.83[e]
1b		138.77	13d (OH)	7.83 (br s)[a]	156.33[c]
2b,6b	6.70 (d, 8.8)	129.93	14d	6.33 (d, 2.0)	106.32
3b,5b	6.13 (d, 8.8)	114.50	1e		133.29
4b (OH)	7.54 (br s)[a]	154.49	2e,6e	7.09 (d, 8.8)	130.45
7b	4.52 (d, 8.0)	39.95	3e,5e	6.54 (d, 8.8)	115.36
8b	4.93 (t, 8.0)	52.94	4e (OH)	8.03 (br s)	155.74[f]
9b		148.69	7e	5.21 (d, 3.4)	37.39
10b		122.72	8e	3.58 (br d)	51.82
11b (OH)	7.54 (br s)	154.89	9e		139.46
12b	5.90 (s)	103.41	10e		116.35
13b (OH)	6.33 (br s)	152.22	11e		157.36
14b		121.37	12e		116.23
1c		137.71	13e (OH)	5.56 (br s)	152.18
2c,6c	7.41 (d, 8.8)	131.21[b]	14e		120.66
3c,5c	6.50 (d, 8.8)	115.14	1f		132.41
4c (OH)	8.01 (br s)[a]	155.45	2f,6f	6.97 (d, 8.8)	129.82
7c	5.94 (d, 12.6)	40.35	3f,5f	6.69 (d, 8.8)	115.82
8c	6.14 (d, 12.6)	46.14	4f (OH)	7.94 (br s)[a]	156.79
9c		146.26	7f	3.75 (dd, 11.4, 10.2)	61.60
10c		121.42	8f	4.17 (d, 10.2)	57.98
11c (OH)	7.29 (br s)	156.46	9f		145.82
12c	5.86 (d, 2.0)	100.59	10f,14f	6.27 (d, 2.0)	107.67[d]
13c (OH)	7.53 (br s)	155.54	11f,13f (OH)	8.22 (br s)	159.76
14c	6.62 (d, 2.0)	105.15	12f	6.24 (t, 2.0)	102.37

Measured in CD_3COCD_3. 500 MHz (^{1}H NMR) and 125 MHz (^{13}C NMR).

[a] Interchangeable.

[b–f] Overlapping.

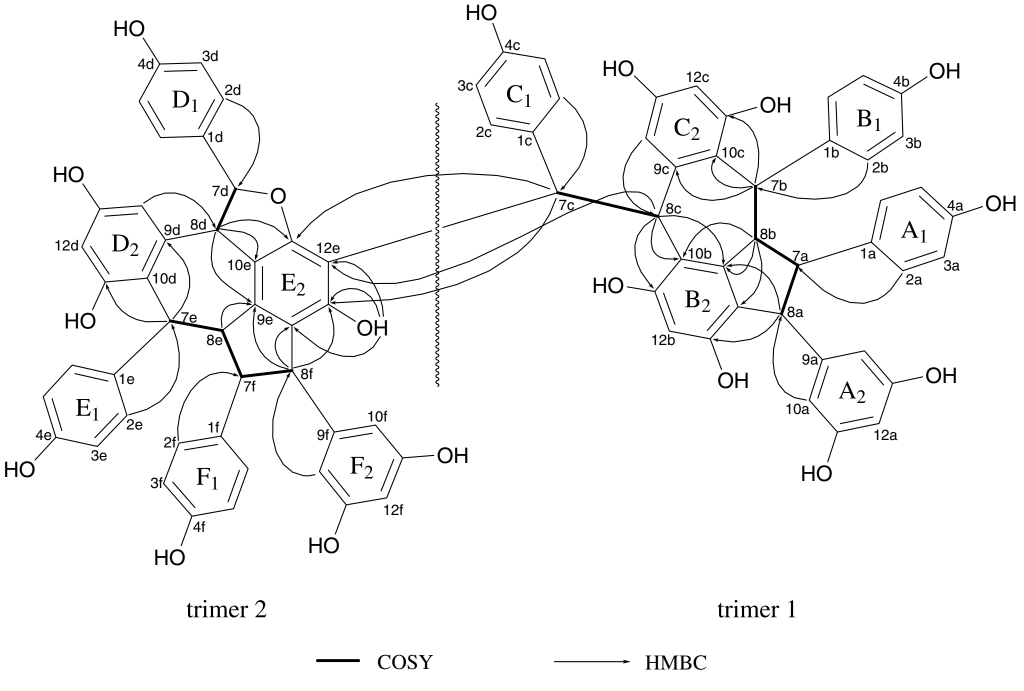

Figure 8. Selected 2D NMR data of **5**.

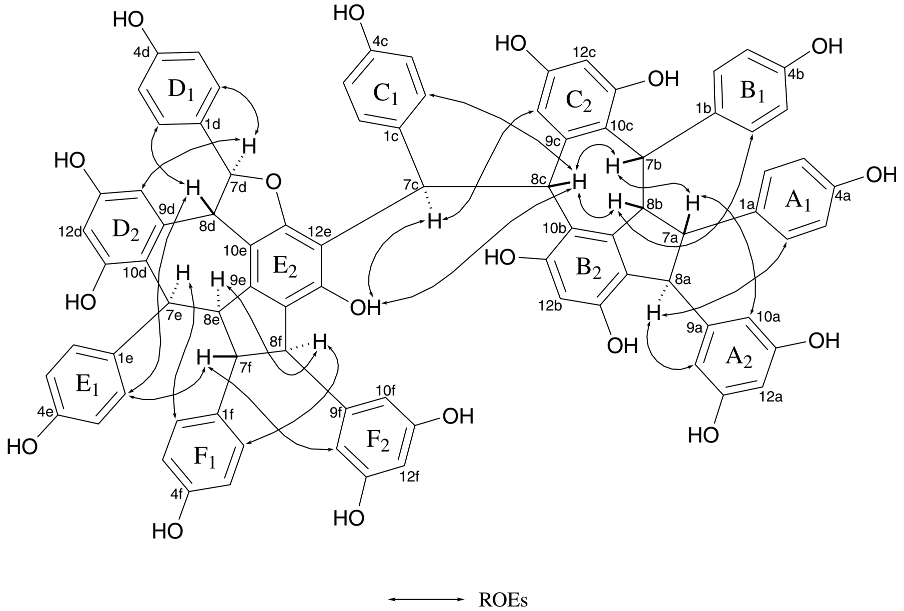

Figure 9. Selected ROEs observed in the ROESY spectrum of **5**.

the HMBC spectrum. Then the structure of **6** was determined as shown in Fig. 10. The relative configurations were identical to those of **5** in the hexameric unit (resveratrol A–F, Fig. 9). The orientation of the dihydrofuran ring (ring F_2–O–C-7g–C-8g) was confirmed to be *trans* by the results of ROEs [H-2g(6g)/H-8g and H-10g(14g)/H-7g].

The compounds (**3**–**6**) could be considered to be a complex of two stilbenoid oligomers. Vaticanol D (**3**), H (**4**) and I (**5**) are composed of a resveratrol trimer 1 and another resveratrol trimer 2 (Fig. 1), while vaticanol J (**6**) is composed of the trimer 1 and a tetramer (vaticanol B).[28] Up to now, various stilbenoid oligomers have been reported from Dipterocarpaceae,[1–20,26–33] Vitaceae,[23,35,36,39] Cyperaceae,[40,41] Gunetaceae,[42,43] Paeoniaceae,[44] Umbelliferae[45] and Leguminosae.[22,24,25,46,47] All of these stilbenoid oligomers are composed of less than pentameric units.[35,46] Hence the occurrence of stilbenoid hexamers (**3**[29]–**5**) and heptamer (**6**) is the first instance as natural product.

Of the stilbenoid oligmers **1**–**6** and other isolates from the same extract [vaticanols A–C[28] and E, vaticasides A and B[30]], cytotoxic activity against human tumor cell lines in vitro were exzamined.[48] Vaticanols D (**3**), H (**4**), I (**5**) and J (**6**) showed the cytotoxicity against KB cells with ED_{50} values at 11.8, 15.4, 11.0 and 10.7 μM, respectively.

3. Experimental

3.1. General procedures

The following instruments were used: FAB-MS spectra, JEOL JMS-DX-300 instrument; ^{1}H- and ^{13}C NMR spectra, JEOL JNM A-500 and EX-400 and (TMS as internal standard); UV spectra, Shimadzu UV-2200 spectrophotometer (in methanol solution); optical rotations, JASCO P-1020 polarimeter. The following adsorbents were used for purification: analytical TLC, Merck Kieselgel 60 F_{254} (0.25 mm); preparative TLC, Merck Kieselgel 60 F_{254} (0.5 mm); column chromatography, Merck Kieselgel 60, Pharmacia Fine Chemicals AB Sephadex LH-20 and Fuji Silysia Chemical Chromatorex; vacuum liquid chromatography (VLC), Merck Kieselgel 60; Medium-pressure column chromatography, Nacalai Tesque Silica Gel 60-C_{18} (250–350 mesh). The in vitro cytotoxicity assay was carried out according to procedures described in Rubinstein et al.[48]

3.2. Plant material

Stem bark of *V. rassak* was collected in Indonesia in October, 1997.

3.3. Extraction and isolation

The dried and ground stem bark (700 g) of *V. rassak* was extracted successively with acetone (3 L×24 h×3), MeOH (3 L×24 h×3) and 70% MeOH (3 L×24 h×3) at rt. The extract was concentrated in vacuo to yield respective residues; 120 g (acetone), 80 g (MeOH) and 35 g (70% MeOH). A part of the acetone extract (60 g) was subjected to chromatography on silica gel column eluted with a mixture of $CHCl_3$–MeOH increasing in the polarity to give 19 fractions (Fr. 1–19). Fr. 13 [$CHCl_3$–MeOH (5:1), 17 g] was dissolved in 50% MeOH and left to give **1** (15 g) as powder. Fr. 17 [$CHCl_3$–MeOH (5:1), 16 g] was further subjected to chromatography on reversed phase silica gel column eluted with a mixture of H_2O–MeOH to give seven fractions [Fr. 17_A (5% MeOH)–Fr. 17_G (40% MeOH)]. The fourth fraction [Fr. 17_D (20% MeOH, 4.2 g)] was further purified by repeated medium-pressure Liquid Chromatography (H_2O–MeOH system), Sephadex LH 20 (MeOH), VLC [$CHCl_3$–MeOH (5:1) and EtOAc–$CHCl_3$–MeOH–H_2O (40:20:5:1)] and PTLC [EtOAc–$CHCl_3$–MeOH–H_2O (15:8:4:1) and EtOAc–$CHCl_3$–MeOH (60:30:7)] to give **3**

Table 5. ^{1}H- and ^{13}C NMR spectral data of **6**

No.	δH	δC	No.	δH	δC
1a		133.61	1d		131.76
2a,6a	6.83 (d, 8.8)	131.05	2d,6d	7.17 (d, 8.8)	129.86
3a,5a	6.52 (d, 8.8)	115.29	3d,5d	6.73 (d, 8.8)	116.13
4a (OH)	7.95 (br s)	156.41[a]	4d (OH)	8.46 (br s)	158.28
7a	4.00 (t, 8.0)	61.67	7d	5.54 (d, 11.6)	90.15
8a	4.54 (d, 8.0)	54.28	8d	4.25 (dd, 11.6, 1.5)	50.35
9a		148.55	9d		141.80
10a,14a	6.45 (d, 2.0)	107.73	10d		124.93
11a,13a (OH)	8.27 (br s)	158.83	11d (OH)	8.16 (br s)	155.63
12a	6.24 (t, 2.0)	101.81	12d	6.24 (s)	101.81
1b		138.80	13d (OH)	7.82 (br s)	156.24
2b,6b	6.57 (d, 8.8)	129.77	14d	6.24 (s)	106.18
3b,5b	6.13 (d, 8.8)	114.55	1e		133.29
4b (OH)	7.54 (br s)	154.48	2e,6e	7.02 (d, 8.8)	130.54
7b	4.50 (d, 8.0)	39.84	3e,5e	6.55 (d, 8.8)	115.38
8b	4.80 (t, 8.0)	53.12	4e (OH)	8.11 (br s)	155.81
9b		148.85	7e	5.16 (d, 3.0)	36.77
10b		122.73	8e	2.96	53.29
11b (OH)	7.28 (br s)	154.89	9e	(ddd, 11.6, 3.0, 1.5)	138.38
12b	5.86 (s)	103.35	10e		116.51
13b (OH)	6.47 (br s)	152.08	11e		156.41[a]
14b		121.33	12e		115.90
1c		137.46	13e (OH)	5.30 (br s)	152.42
2c,6c	7.30 (d, 8.8)	131.47	14e		119.94
3c,5c	6.45 (d, 8.8)	115.08	1f		131.16
4c (OH)	7.76 (br s)	155.53	2f,6f	6.37 (d, 8.8)	129.32
7c	5.62 (d, 12.8)	40.70	3f,5f	6.47 (d, 8.8)	115.85
8c	5.92 (d, 12.8)	47.07	4f (OH)	7.95 (br s)	156.38
9c		146.38	7f	3.98 (t, 11.6)	56.57
10c		121.40	8f	4.60 (d, 11.6)	49.31
11c (OH)	7.25 (br s)	156.66	9f		140.20
12c	5.89 (d, 2.2)	100.38	10f		122.35
13c (OH)	7.71 (br s)	155.43	11f		161.99
14c	6.84 (d, 2.2)	104.85	12f	6.34 (d, 2.0)	97.10
			13f (OH)	8.36 (br s)	160.42
			14f	6.39 (d, 2.0)	107.68
			1g		133.97
			2g,6g	7.48 (d, 8.8)	128.50
			3g,5g	7.08 (d, 8.8)	116.33
			4g (OH)	9.00 (br s)	157.32
			7g	5.64 (d, 3.4)	93.21
			8g	4.81 (d, 3.4)	56.82
			9g		146.59
			10g,14g	6.33 (d, 2.0)	107.78
			11g,13g (OH)	8.20 (br s)	159.78
			12g	6.33 (t, 2.0)	102.37

Measured in CD_3COCD_3. 500 MHz (^{1}H NMR) and 125 MHz (^{13}C NMR).

[a] Overlapping.

(8 mg), **4** (22 mg), **5** (44 mg) and **6** (18 mg), respectively. The fifth fraction [Fr. 17_E (25% MeOH, 1.4 g)] was further purified with Sephadex LH 20 (MeOH), VLC [$CHCl_3$–MeOH (8:1)] and PTLC [EtOAc–$CHCl_3$–MeOH–H_2O (15:8:4:1) to give **2** (33 mg).

3.3.1. Vaticanol G (1).

A yellow amorphous powder. Negative ion HR-FAB-MS: $[M-H]^-$ *m/z* 679.1972 (Calcd 679.1968 for $C_{42}H_{31}O_9$); Negative ion FABMS: $[M-H]^-$ *m/z* 679; UV λ (nm): 218, 282; $[\alpha]_D^{25}=+151°$ (c=0.1, MeOH); The ^{1}H- and ^{13}C NMR spectral data are listed in Table 1.

3.3.2. Methylation of 1.

Vaticanol G (**1**) (500 mg) was allowed to react with K_2CO_3 (5 g) and MeI (1 g) in dry acetone (50 mL) under reflux for 4 h. The reaction mixture was treated in the usual manner and a part (50 mg) of the crude product (550 mg) was purified by PTLC [*n*-hexane–EtOAc (1:1)] to afford **1a** as an amorphous colorless solid (45 mg). The ^{1}H- and ^{13}C NMR spectral data are listed in Table 1.

3.3.3. Acetylation of 1.

Vaticanol G (**1**) (50 mg) was dissolved in a mixture of pyridine (1 mL) and acetic anhydride (1 mL). The reaction mixture was kept at rt for 24 h. The solution was treated in the usual manner and the resulting crude product (60 mg) was purified by PTLC [*n*-hexane–acetone (3:2)] to afford **1b** as an amorphous colorless solid (50 mg). ^{1}H NMR [400 MHz, $(CD_3)_2CO$] δ: 6.53 (2H, br d, H-2a, 6a), 6.77 (2H, br d, H-3a, 5a), 4.63 (1H, d, J=11.7 Hz, H-7a), 4.81 (1H, d, J=11.7 Hz, H-8a), 6.82 (1H, d, J=2.0 Hz, H-12a), 6.35 (1H, d, J=2.0 Hz, H-14a), 6.38 (1H, d, J=8.8 Hz, H-3b), 6.22 (1H, dd, J=8.8, 2.4 Hz, H-5b), 6.11 (1H, d, J=8.8 Hz, H-6b), 4.65 (1H, d, J=3.9 Hz, H-7b), 4.29 (1H, dd, J=11.3, 3.9 Hz, H-8b), 7.13 (1H, s, H-12b), 3.85 (1H, d,

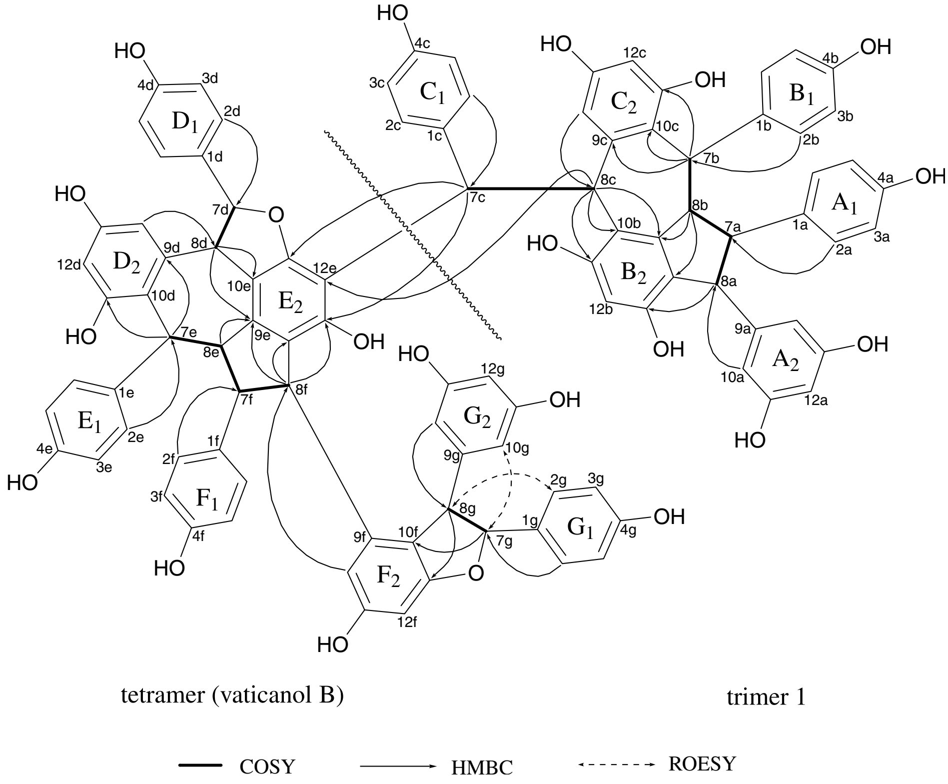

Figure 10. Selected 2D NMR data of **6**.

J=7.8 Hz, H-7c), 4.32 (1H, d, J=10.7 Hz, H-8c), 6.64 (2H, d, J=2.0 Hz, H-10c, 14c), 6.85 (1H, d, J=2.0 Hz, H-12c), 2.00 (3H, s, OAc), 2.05 (3H, s, OAc), 2.10 (3H, s, OAc), 2.17 (3H, s, OAc), 2.17 (3H, s, OAc), 2.18 (3H, s, OAc), 2.18 (3H, s, OAc), 2.22 (3H, s, OAc), 2.37 (3H, s, OAc). Signals due to ring C$_1$ (H-2c, 3c, 5c and 6c) were not observed because they were extremely broaden.

3.3.4. Vaticaside D (2). A brown amorphous powder. Negative ion HR-FABMS: $[M-H]^-$ m/z 841.2512 (Calcd 841.2496 for $C_{48}H_{41}O_{14}$); Negative ion FAB-MS: $[M-H]^-$ m/z 841; UV λ (nm): 217, 281; $[\alpha]_D^{25}=+92°$ (c=0.1, MeOH); ^{1}H NMR [400 MHz, $(CD_3)_2CO$] δ: 6.45 (4H, br s, H-2a, 3a, 5a, 6a), 4.56 (1H, d, J=3.9 Hz, H-7a), 4.65 (1H, d, J=3.9 Hz, H-8a), 6.20 (1H, d, J=2.4 Hz, H-12a), 5.67 (1H, d, J=2.4 Hz, H-14a), 6.08 (1H, d, J=2.4 Hz, H-3b), 5.76 (1H, dd, J=8.8, 2.4 Hz, H-5b), 6.02 (1H, d, J=8.8 Hz, H-6b), 4.90 (1H, d, J=2.9 Hz, H-7b), 3.81 (1H, dd, J=7.3, 2.9 Hz, H-8b), 6.49 (1H, s, H-12b), 5.96 (1H, br s, H-2c), 6.00 (1H, br s, H-3c), 6.71 (1H, br s, H-5c), 7.12 (1H, br s, H-6c), 3.59 (1H, d, J=7.3 Hz, H-7c), 4.14 (1H, s, H-8c), 6.23 (1H, d, J=2.2 Hz, H-10c), 6.36 (1H, t, J=2.2 Hz, H-12c), 6.12 (1H, d, J=2.2 Hz, H-14c), 7.45–8.53 (8H, br s, OH×8), 4.85 (1H, d, J=7.3 Hz, H-glc-1), 3.38 (1H, m, H-glc-2), 3.40 (1H, m, H-glc-3), 3.47 (1H, m, H-glc-4), 3.47 (1H, m, H-glc-5), 3.68, 3.78 (1H each, m, H-glc-6); ^{13}C NMR [100 MHz, $(CD_3)_2CO$] δ: 140.0 (C-1a), 130.3 (C-2a, 6a), 114.8 (C-3a, 5a), 155.5 (C-4a), 57.2 (C-7a), 50.3 (C-8a), 142.0 (C-9a), 126.1 (C-10a), 153.2(C-11a), 101.8 (C-12a), 155.9 (C-13a), 111.6 (C-14a), 129.3 (C-1b), 141.9 (C-2b), 119.5 (C-3b), 154.9 (C-4b), 112.9 (C-5b), 135.1 (C-6b), 42.8 (C-7b), 54.0 (C-8b), 147.0 (C-9b), 117.8 (C-10b), 155.1 (C-11b), 102.1 (C-12b), 153.1 (C-13b), 121.7 (C-14b), 137.0 (C-1c), 127.7 (C-2c)[†], 114.3 (C-3c)[‡], 155.5 (C-4c), 116.2 (C-5c)[‡], 130.8 (C-6c)[†], 62.9 (C-7c), 57.1 (C-8c), 147.5 (C-9c), 108.1 (C-10c), 159.6 (C-11c),101.7 (C-12c), 158.9 (C-13c), 108.6 (C-14c), 101.3 (C-glc-1), 74.4 (C-glc-2), 77.3 (C-glc-3), 71.0 (C-glc-4), 77.8 (C-glc-5), 62.4 (C-glc-6).

3.3.5. Acid hydrolysis of 2. A methanolic solution of 3% H_2SO_4 containing **2** (2 mg) was refluxed for 6 h. The reaction mixture was extracted with EtOAc and the EtOAc layer was concentrated. The residue was purified with PTLC [$CHCl_3$–MeOH (7:1)] to afford **1** (1 mg).

3.3.6. Vaticanol D (3). Positive ion HR-FABMS: $[M+H]^+$ m/z 1361.4155 (Calcd 1361.4171 for $C_{84}H_{65}O_{18}$); The ^{1}H- and ^{13}C NMR spectral data are described in the literature.[29]

3.3.7. Vaticanol H (4). A brown amorphous powder. Positive ion HR-FABMS: $[M+H]^+$ m/z 1361.4203 (Calcd 1361.4171 for $C_{84}H_{65}O_{18}$); Positive ion FAB-MS: $[M+H]^+$ m/z 1361; Negative ion FAB-MS: $[M-H]^-$ m/z 1359; UV λ (nm): 216, 281; $[\alpha]_D^{25}=+77°$ (c=0.1, MeOH); The ^{1}H- and ^{13}C NMR spectral data are shown in Tables 2 and 3, respectively.

3.3.8. Vaticanol I (5). A brown amorphous powder. Positive ion HR-FABMS: $[M+H]^+$ m/z 1361.4181 (Calcd 1361.4171 for $C_{84}H_{65}O_{18}$); Positive ion FAB-MS: $[M+H]^+$ m/z 1361; UV λ (nm): 215, 281; $[\alpha]_D^{25}=-60°$

[†] Interchangeable.

[‡] Interchangeable.

(c=0.1, MeOH); The ^{1}H- and ^{13}C NMR spectral data are shown in Table 4.

3.3.9. Vaticanol J (6). A brown amorphous powder. Negative ion HR-FABMS: $[M-H]^-$ m/z 1585.4644 (Calcd 1585.4643 for $C_{98}H_{73}O_{21}$); Negative ion FAB-MS: $[M-H]^-$ m/z 1585; Positive ion FAB-MS: $[M+H]^+$ m/z 1587; UV λ (nm): 217, 282; $[\alpha]_D^{25}=-69°$ (c=0.1, MeOH); The ^{1}H- and ^{13}C NMR spectral data are shown in Table 5.

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