

One New A-type Proanthocyanidin Trimer from *Lindera aggregata* (Sims) Kosterm.

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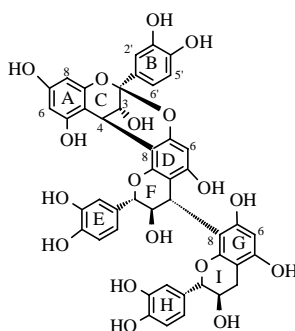
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Abstract: One new A – type proanthocyanidin trimer, lindetannin trimer, was isolated from the stems of *Lindera aggregata* (Sims) Kosterm.. Its structure was elucidated by spectral and chemical methods.

Keywords: *Lindera aggregata*, lauraceae, tannin, lindetannin trimer.

In our previous paper^{1,2}, we have reported some constituents from the leaves of *Lindera aggregata* (Sims) Kosterm.. Further investigation on the stems of this plant led to the isolation of one new proanthocyanidin trimer: lindetannin trimer **1**. In this letter, we described its structural elucidation.

Figure 1 The structure of compound **1**



Lindetannin trimer **1** (**Figure 1**) was obtained as freeze-dried powder, $[\alpha]_D^{25}$ -102.3 (c 1.21, MeOH). IR (v, KBr, cm^{-1}): 3245, 1610, 1512, 1450, 1290, 1078. UV (MeOH) λ_{max} : 280 nm. Positive to the ferric chloride (dark green) and the anisaldehyde-sulfuric acid (orange-red) reagents. Compound **1** showed a molecular formula of $\text{C}_{45}\text{H}_{36}\text{O}_{18}$ from the high resolution negative FAB-MS (m/z $[\text{M}-1]^-$ 863.1834,

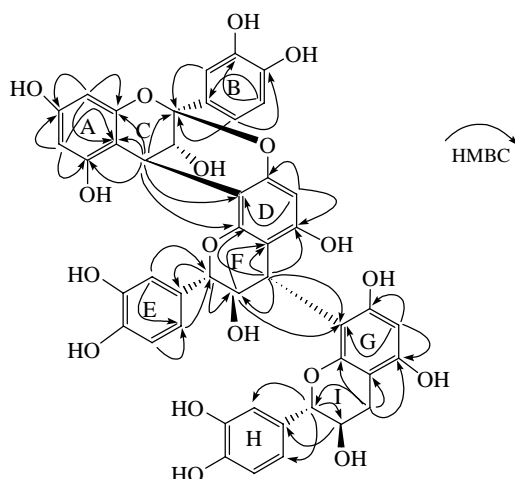
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calcd 863.1822) and ^1H and ^{13}C NMR spectra (**Table 1**), which was assumed to be a trimeric proanthocyanidin. The ^1H NMR spectrum exhibited the presence of an A-type unit from AB coupling system at δ_{H} 3.64 and 3.72 (each, d, $J = 3.4\text{Hz}$). This was also supported from its ^{13}C NMR spectrum. B-type chemical shifts at δ_{C} 28.8, 67.2 and 100.2 ppm were characteristic chemical shifts of the C-4, C-3 and the quaternary C-2 in the pyran ring directly involved in the A-type interflavanoid banding, as earlier outlined^{3,4}.

HPLC analysis showed **1** to be predominantly a single compound. By comparing with authentic compound epicatechin - (4 β -8, 2 β -O-7) - epicatechin - (4 β -8) - epicatechin⁵ (cinnamtannin B₁) on TLC, which was also isolated from the same plant, compound **1** was different from cinnamtannin B₁ and gave characteristic signals: 3.04 (dd, 1H, $J = 16.1, 9.3\text{ Hz}$), 2.44 (dd, 1H, $J = 16.1, 10.0\text{ Hz}$) in the high field of ^1H -NMR spectrum. This indicated that a catechin terminal unit, which was also supported by acid-catalyzed degradation (with benzylmercaptane / acetic acid in EtOH).

In ^{13}C NMR spectra of **1**, the signals of upper and middle units were in good agreement with those of aesculitannin B⁵ (**Table 1**), except for the terminal unit signals [δ_{H} 3.92 (d, 1H, $J = 9.3\text{Hz}$, H-2I), 3.77 (m, 1H, H-3I), 2.44 (d, 1H, $J = 10.0, 16.1\text{Hz}$, H-4Ia) and 3.04 (d, 1H, $J = 9.3, 16.1\text{Hz}$, H-4Ib); δ_{C} 82.8 (C-2I), 69.6 (C-3I) and 30.8 (C-4I)], which indicated an epicatechin upper unit and a catechin middle unit supported from $J_{2,3}$ (9.3Hz, F-ring, (**Figure 2**)). Besides, the H-3, 4 *trans*-relative configuration of F ring was also confirmed by $J_{3,4}$ (9.3Hz). All conclusions mentioned were demonstrated by ^1H - ^1H COSY, HMQC and HMBC spectra of **1** (**Figure 2**). Upon these considerations, compound **1** was confirmed as epicatechin - (4 β -8, 2 β -O-7) - *ent*-catechin - (4 β -8) - catechin.

Figure 2 Main correlations in HMBC spectrum of compound **1**



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Table 1 NMR spectral data of **1**, cinnamtannin B₁ and aesculitannin B in CD₃OD(δppm)

Ring	No.	Cinnamtannin B ₁		1		Aesculitannin B	
		¹³ C	¹³ C	¹ H	¹³ C	¹ H	¹³ C
Upper unit							
C	2	99.9	100.2			100.11	
	3	67.1	67.2	3.64(d, 3.4)		67.05	
	4	28.8	28.8	3.72(d, 3.4)		28.91	
A	5	156.8	156.4			156.49	
	6	98.5	97.9	5.81(d, 2.2)		97.86	
	7	157.8	157.9			157.95	
	8	96.6	96.4	5.99(d, 2.2)		96.48	
	9	154.2	154.0			153.93	
	10	104.9	104.1			104.06	
B	1'	132.5	132.3			132.24	
	2'	115.7	115.7	7.09(d, 2.2)		115.68	
	3'	145.5	145-147			145.21	
	4'	146.6	145-147			145.50	
	5'	116.1	116.1	6.84(d, 8.2)		115.98	
	6'	119.9	119.9	6.97(dd, 2.2, 8.2)		119.82	
Middle unit							
F	2	78.9	84.3	4.46(d, 9.3)		84.48	
	3	72.6	74.3	4.34(t, 9.3)		73.87	
	4	38.3	38.9	4.43(d, 9.3)		39.04	
D	5	155.8	155.5			155.37	
	6	96.1	97.2	5.85(s)		97.21	
	7	151.1	151.2			151.20	
	8	106.4	106.6			106.86	
	9	151.8	156.2			152.21	
	10	106.7	108.9			108.93	
E	1'	131.8	131.2			131.06	
	2'	116.7	115.7	6.92(d, 1.7)		116.52	
	3'	145.9	145-147			146.10	
	4'	146.3	145-147			146.68	
	5'	115.7	115.7	6.66(d, 8.1)		116.34	
	6'	121.4	120.8	6.76(d, 8.1)		121.14	
Lower unit							
I	2	80.3	82.8	3.92(d, 9.3)		79.61	
	3	67.5	69.6	3.77(m)		67.61	
	4	29.8	30.8	2.44(d, 10.0, 16.1)		30.07	
				3.04(d, 9.3, 16.1)			
G	5	155.5	155.4			156.19	
	6	96.5	96.4	6.08(s)		96.57	
	7	155.8	152.3			156.16	
	8	108.9	108.7			108.55	
	9	155.8	154.9			155.26	
	10	100.1	102.4			100.97	
H	1'	133.2	132.3			132.92	
	2'	115.5	116.4	7.05(brs)		115.27	
	3'	145.3	145-147			145.87	
	4'	145.8	145-147			146.65	
	5'	116.0	116.4	6.84(d, 8.3)		115.68	
	6'	119.4	120.8	6.97(dd, 8.3, 2.2)		119.26	

Treatment of compound **1** with benzylmercaptane / acetic acid yielded catechin and

epicatechin - (4 β - 8) - benzylthioether, this reaction indicated that the upper unit was linked to middle unit *via* C-4 β / C-8 or C-4 β / C-6 interflavanoid bond. The specific linkage was established by examination of HMBC spectrum of **1** (Figure 2). The absolute configuration of **1** was also supported by the positive Cotton effect in the characteristic wavelength region (200 - 230 nm) of the CD spectrum^{5,6}.

Consequently, compound **1** was determined structurally as epicatechin (4 β - 8, 2 β - O - 7) - *ent* - catechin - (4 β - 8) - catechin.

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