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Gnetifolin L and O, Two Dimeric Stilbenes from *Gnetum Montanum*

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Abstract: Two new dimeric stilbenes, named gnetifolin L and gnetifolin O, were isolated from the alcoholic extract of lianas of *Gnetum montanum.* Their structures were elucidated mainly on the basis of spectroscopic data including 2D-NMR studies on peracetate derivatives.

Keywords: *Gnetum montanum*; lianas, stilbenes; gnetifolin L, O.

Gnetum montanum grows in the southern part of China and has been used for the treatment of bronchitis and arthritis in folk medicine[1]. Previously, an investigation of this species led to the isolation of some alkaloids and dibenzyl ether derivatives[2]. In our studies, ten components including resveratrol, isorhapontigenin, daucosterol, β-sitosterol, stearic acid, gnetifolin E, gnetol, isorhapontigenin-3-O-β-glucopyranoside, (-)ε-viniferin and gnetifolin C were obtained from this plant[3]. In the further study, four new dimeric stilbenes named gnetifolin M and N[4], gnetifolin L and O were isolated from this genus. This paper describes the isolation and structure determination of gnetifolin L and O. They were the first example in which an isorhapontigenin molecule was connected with another isorhapontigenin derivative molecule at the olefinic carbon C-7.

Gnetifolin L acetate **1**, colorless granular crystals, mp 176-178°C, $[\alpha]_D$=-61.7 (c, 0.064, Me_2CO). The HR positive ion L-SIMS at 791.2310 ($[M+Na]^+$, requires 791.2304) accompanied with ^{1}HNMR of **1** gave a molecular composition of $C_{42}H_{40}O_{14}$ with six acetyl groups. The EIMS of the acetyl derivative showed a molecular ion at m/z 768$[M]^+$. The IR spectrum indicated the presence of carbonyl and aromatic groups at 1765.6 cm^{-1} and 1606.6, 1510.1 cm^{-1} respectively. Its UV spectrum exhibited absorptions at 282 nm (logε 4.17) (band II), 305 nm (logε 4.18) (band I). Comparison with characteristic absorptions of *trans* stilbene skeleton, band I showed hypochromic shifts of about 15 nm, suggesting that the characteristic *trans* stilbene system was disturbed by some steric hindrance. The ^{1}HNMR spectrum (acetone-d_6) of **1** was quite complex in the region between δ 6.53~7.21 integrated for 13 protons, attributing to twelve aromatic protons and one olefinic proton [The ^{1}HNMR spectrum showed more distinctive signals, when measured in $CDCl_3$ (see **Table 1**)]. The signals at δ 3.69 (1H, dd, J=5.2, 10.3Hz, H-8b_1) and 3.29 (1H, dd, J=5.2,10.3Hz, H-8b_2) were due to two methylene protons. A methine proton at δ4.89 (1H, dd, J=5.2, 5.2Hz, H-7b) was evidently vicinal to this methylene

group on the basis of the coupling constants. Those assignments as well as the locations of the thirteen protons were supported by the ^{1}H-^{1}H COSY and ^{13}CNMR spectra data. H-10a, H-12a, H-14a and H-10b, H-12b, H-14b attributed to two sets of AB_2 system located on the aromatic rings A and C respectively. H-2a, H-3a, H-6a and H-2b, H-3b, H-6b belonged to two sets of ABX system placed at rings B and D respectively. The ^{13}CNMR and DEPT spectra of **1** showed thirty signals representing forty carbons. ^{13}C-^{1}H COSY spectrum showed the existence of thirteen quaternary carbons in the range of 131.57~152.30 **(Table 2)**, twelve unsubstitued aromatic and one olefinic carbons, one methylene and one methine group at δ111.21~126.67, 38.57 and 43.90, respectively. Two signals at δ 56.15 and 56.13 were attributed to methoxyl groups. The remaining six signals at δ 169.19~169.46 and 20.43~20.92 were the six-acetyl groups. The linkage and the location of the methoxyl groups were elucidated by HMBC analysis. **(Figure 2)** According to these spectral data, gnetifolin L was deduced to be an isorhapontigenin dimer derivative. Thus the structure of **1** was shown as. **(Figure 1)**

Figure 1 R=H, Ac

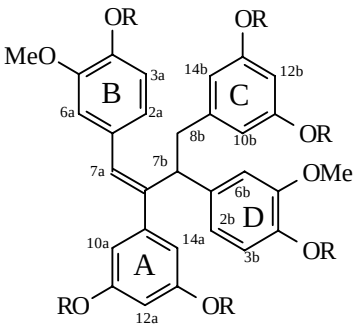
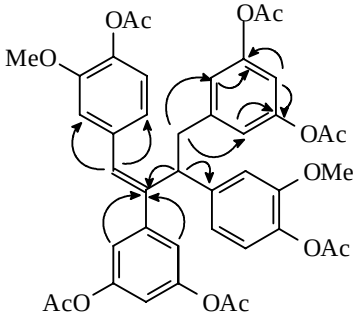


Figure 2 HMBC(→) spectrum of Gnetifolin L acetate



Gnetifolin O acetate **2**, amorphous powder, mp 123~125°C, $[\alpha]_D$=-17 (c, 0.05, Me_2CO). The HR positive ion L-SIMS at $[M+Na]^+$ 849.2365 (requires 849.2358), showed a molecular composition of $C_{44}H_{42}O_{16}$. The EIMS spectrum revealed a fragment ion peak at $[M-60]^+$ 766, indicating an aliphatic acetyl group in the molecule. The IR spectrum indicated the presence of carbonyl groups and aromatic groups at 1766.7 cm^{-1} and 1605.6, 1510.7 cm^{-1} respectively. The UV spectrum exhibited characteristic absorptions of a *cis* stilbene conjugated system at 280 nm. ^{1}HNMR spectrum indicated that there were twelve aromatic protons of two ABX and two AB_2 systems and an olefinic proton in the region between δ6.39~6.90 ($CDCl_3$). The signals at δ4.31 (1H, d, J=10.6Hz, H-7b) and 6.30 (1H,d, J=10.6Hz, H-8b) (acetone-d_6) were due to two methine protons respectively. The above mentioned data were supported by the ^{1}H-^{1}H COSY spectrum. Signals between δ2.16~2.20 (18H, m) and 2.06b (3H,s) belong to seven acetyl protons. The remaining two signals at δ 3.39 and 3.68 were attributed to two methoxyl groups. The ^{13}CNMR spectrum of **2** showed thirty-three signals representing forty-four carbons. The ^{13}C-^{1}H COSY spectrum showed the existence of seven acetyl carbons, twelve unsubstitued aromatic and one olefinic carbons, thirteen quaternary carbons, two methine carbons and two methoxyl carbons at δ 20.40~21.09 and 168.99~170.35, 113.09~129.77,

135.63~152.63, 60.66 and 76.51, 55.71 and 56.28, respectively. The relative configurations of H-7b with H-8b, coupled relationship of two monomers and the location of methoxyl groups were determined by NOE difference experiments. Irradiation of H-8b gave NOE with H-7a and H-14b (H-10b) but no effect of H-7b, therefore H-8b was *trans* orientated with H-7b. Irradiation at δ3.68 and 3.84 methoxyl signals showed NOE on H-6a and H-6b indicating that the two methoxyls substituted at ring A and ring C respectively. Thus the structure of **2** was shown as. **(Figure 3)**

Figure 3 R=H, Ac

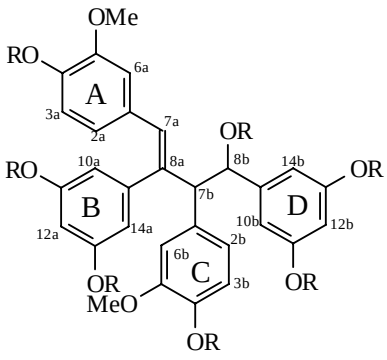


Figure 4 NOEDS of Gnetifolin O acetate

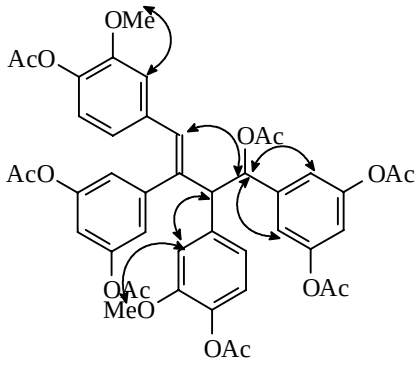


Table 1 ^{1}HNMR (500MHz, $CDCl_3$, acetone-d_6) data of acetylated gnetifolin L

proton	δ ($CDCl_3$)	δ (acetone-d6)	proton	δ ($CDCl_3$)	δ (acetone-d6)
2a	6.93(br s)	6.92-7.04(m)	2b	6.91(br s)	7.15(br s)
3a	6.98(d,8.0)	6.92-7.04(m)	3b	6.97(d,8.0)	7.18(br s)
6a	6.80(br s)	6.92-7.04(m)	6b	6.58(2.4)	6.80(2.4)
7a	7.04(br)	7.21(br s)	7b	4.68(dd, 5.1, 5.1)	4.89(dd, 5.2, 5.2)
10a	6.88(m)	6.92-7.04(m)	$8b_1$	3.58(dd, 5.1, 10.3)	3.69(dd, 5.2, 10.3)
12a	6.79(m)	6.92-7.04(m)	$8b_2$	3.23(dd, 5.1, 10.3)	3.29(dd, 5.2, 10.3)
14a	6.88(m)	6.92-7.04(m)	10b	6.53(d, 2.1)	6.73(d, 2.1)
			12b	6.69(d, 2.1)	6.69(d, 2.1)
			14b	6.53(d, 2.1)	6.76(d, 2.1)

2×OCH_3: 3.69(s), 3.84(s); ($CDCl_3$) 3.69(s), 3.84(s); (acetone-d_6)
6×Ac: 2.31, 2.29, 2.27, 2.17(2), 2.07(CDC_{l3}); 2.24-2.34(acetone-d_6)

Table 2 ^{13}CNMR (125MHz acetone-d_6) data of acetylated gnetifolin **L**

carbon	δ	carbon	δ	carbon	δ	carbon	δ
1a	136.89	8a	143.03	1b	131.57	8b	38.57
2a	136.69	9a	140.67	2b	119.25	9b	139.07
3a	120.41	10a	119.95	3b	111.21	10b	120.41
4a	150.38	11a	151.87	4b	150.69	11b	151.77
5a	152.30	12a	112.97	5b	143.19	12b	114.26
6a	123.23	13a	151.87	6b	117.31	13b	151.77
7a	126.87	14a	119.95	7b	43.90	14b	120.41

6×Ac: 20.43, 20.74, 20.82(2), 20.92(2), 169.19, 169.30,169.32(2), 169.46(2)
2×OCH_3: 56.15, 56.13

Table 3 ^{1}HNMR($CDCl_3$, acetone-d_6, 500Hz) data of acetylated gnetifolin O

proton	δ ($CDCl_3$)	δ (acetone-d_6)	proton	δ ($CDCl_3$)	δ (acetone-d_6)
2a	6.85(dd,8.1,1.9)	6.88(m)	2b	6.73(dd,8.1,1.9)	6.88(m)
3a	6.89(d, 8.1)	6.96(d, 8.1)	3b	6.88(d, 8.1)	6.95(d, 8.1)
6a	6.39(d,1.9)	6.43(d,1.9)	6b	6.62(d,1.9)	6.99(d, 1.8)
7a	6.78(br s)	6.75(d,1.9)	7b	3.95(10.7)	4.31(d,10.6)
			8b	6.29(10.7	6.30(d,10.6)
10a	6.54(d, 2.1)	6.59(d, 2.1)	10b	6.62(d,1.9)	6.90(d,1.9)
12a	6.82(t, 2.1)	6.89(m)	12b	6.74(t,1.9)	6.74(t, 1.8)
14a	6.54(d, 2.1)	6.59(d, 2.1)	14b	6.62(d,1.9)	6.90(d,1.9)
5a-OCH	3.43(s)	3.39(s)	5b-OCH_3	3.68(s)	3.68(s)
3					

δ (7×Ac, acetone-d_6): 2.16-2.20 (18H, m), 2.06 (3h, s)
δ (7×Ac, $CDCl_3$): 2.27 (3H, s), 2.26 (3H, s), 2.23 (6H, s), 2.22 (6H, s), 2.10 (3H,s)

Table 4 ^{13}CNMR(acetone-d_6, 125MHz) data of acetylated gnetifolin O

carbon	δ	carbon	δ	carbon	δ	carbon	δ
1a	135.63	8a	143.56	1b	138.45	8b	76.51
2a	123.28	9a	140.31	2b	123.28	9b	139.97
3a	129.77	10a	120.51	3b	120.24	10b	120.81
4a	151.59	11a	152.62	4b	151.76	11b	151.95
5a	141.78	12a	116.02	5b	140.38	12b	115.23
6a	113.09	13a	152.62	6b	113.20	13b	151.95
7a	123.28	14a	120.64	7b	60.66	14b	120.81

δ (7×Ac): 20.40, 20.83(2), 20.88(3), 21.09, 168.99, 169.37(2), 169.50(2), 170.35
δ(2×OMe): 55.71(5a-OMe), 56.28(5b-OMe)

Acknowledgments

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