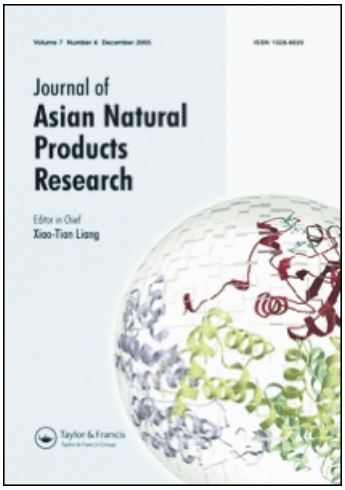

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Two new terpenoid glucosides from *Aster flaccidus*

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Two new terpenoid glucosides from *Aster flaccidus*

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Two new terpenoid glucosides, namely 2-O-β-D-glucopyranoside-vicodiol (**1**) and 10-O-β-D-glucopyranoside-oplopanone (**2**), along with seven known compounds, were isolated from the aerial part of *Aster flaccidus* (composite), a traditional Chinese herb medicine. The structures of **1** and **2** were established by spectroscopic methods, especially 2D NMR experiments.

Keywords: *Aster flaccidus*; 2-O-β-D-glucopyranoside-vicodiol; 10-O-β-D-glucopyranoside-oplopanone

1. Introduction

Aster is a complex genus in plant taxonomy due to its variable nature of the tendency towards interspecific hybridization and polyploidy [1]. Many species of this genus are well known for their significant biological activities, such as antipyretic, detoxicant, expectorant and antitussive [2,3]. A series of novel biological active structures from this genus have been reported in the past decades. These compounds include monoterpenoid derivatives mainly with a bicyclo[2.2.1] carbon skeleton [4,5], diterpenoid derivatives [6–10], oleanane type triterpenoids [11–13] showing good inhibitory activity against DNA synthesis in human leukemia HL-60 cells and inhibiting effects on collagenase and mucinase, lignans, acetylenic glycosides [14], and coumarins [15]. Especially, a group of cyclopeptides with antitumor activities has been isolated from *Aster tataricus* [16,17].

Aster flaccidus Bunge, a medicinal herb, is widely distributed in China, and some other Asian countries [1]. It has been applied in Traditional Chinese Medicine for the treatment of pneumonia, pulmonary tuberculosis and chincough [3].

In the current project, two new terpenoid glucosides, 2-O-β-D-glucopyranoside-vicodiol (**1**) and 10-O-β-D-glucopyranoside-oplopanone (**2**), along with seven know compounds were isolated from *A. flaccidus*. Herein, we report the isolation and structure elucidation of two new terpenoid glycosides.

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2. Results and discussion

Compound **1**, an amorphous powder, showed a pseudo molecular ion peak at *m/z* 355 $[M + Na]^+$ in the positive mode ESI-MS. Its molecular formula was determined as $C_{16}H_{28}O_7$ by the HR-EIMS at *m/z* 170.1312 $[C_{10}H_{18}O_2, M-C_6H_{10}O_5]^+$, and combined with the ^1H and ^{13}C NMR data. IR spectrum of **1** showed the presence of hydroxyl (3363 cm^{-1}). An anomeric proton at δ 4.25 (1H, d, $J = 7.8$ Hz) in the ^1H NMR, and the carbon signals at δ 103.6, 75.7, 78.7, 72.3, 78.4 and 63.4 in the ^{13}C NMR showed the presence of a β-glucopyranosyl moiety in **1**. The ^1H NMR spectrum of **1** revealed the existence of two methyl signals at δ 0.91 (3H, s) and 0.98 (3H, s). Except for the β-glucopyranosyl moiety, the ^{13}C NMR spectrum (table 1) showed that the aglycone of **1** comprised two methyls, four methylenes (one was oxygenated), two methines (one was oxygenated) and two quaternary carbons. The data mentioned above implied a monoterpenoid feature for the aglycone of **1**. The aglycone of **1** likely has a bicyclo[2.2.1] carbon skeleton by comparing the NMR data with those of vicodiol [18] and 8-hydroxyborneol [19], and confirmed by HMBC correlations (figure 1). Vicodiol and 8-hydroxyborneol are two isomers differing at the location of one hydroxyl at C-8 or C-9. The NOESY spectrum of **1** further indicated that the aglycone of **1** was vicodiol as judged by the strong NOE correlations of H-8 with H-3β and H-2 (figure 1). The downfield shifted carbon signal at δ 84.6 assigned for C-2 suggested that the

Table 1. ^1H and ^{13}C NMR data of compounds **1** and **2**

	1*		***2**†*	
No	δ_c	δ_H *(J, Hz)*	δ_c	δ_H *(J, Hz)*
1	55.2		55.8	1.71 (1H, m)
2	84.6	4.17 (1H, br d, 8.7)	27.0	1.92 (1H, m)
				1.36 (1H, m)
3	36.8	1.24 (1H, m)	30.0	1.44 (1H, m)
		2.24 (1H, m)		1.97 (1H, m)
4	43.4	1.89 (1H, dd, 8.9, 4.0)	215.1	
5	29.6	1.30 (1H, m)	57.0	2.71 (1H, m)
		1.70 (1H, m)		
6	28.7	2.24 (1H, m)	48.2	1.85 (1H, m)
		1.24 (1H, m)		
7	51.1		50.8	1.11 (1H, m)
8	66.0	3.60 (1H, d, 11.2)	24.0	1.61 (1H, m)
		3.34 (1H, d, 11.2)		1.12 (1H, m)
9	15.4	0.98 (3H, s)	39.9	1.94 (1H, m)
				1.48 (1H, m)
10	15.0	0.91 (3H, s)	81.5	
11			30.9	1.47 (1H, m)
12			16.3	0.90 (3H, d, 6.8)
13			22.6	0.66 (3H, d, 6.8)
14			18.8	1.25 (3H, s)
15			30.0	2.18 (3H, s)
Glu-1	103.6	4.25 (1H, d, 7.8)	98.2	4.25 (d, 7.8)
Glu-2	75.7	3.16 (1H, dd, 8.8, 8.1)	75.6	3.10 (1H, m)
Glu-3	78.7	3.33 (1H, dd, 9.1, 8.6)	78.5	3.34 (1H, m)
Glu-4	72.3	3.28 (1H, dd, 8.8, 9.5)	72.1	3.29 (1H, m)
Glu-5	78.4	3.21 (1H, dd, 5.7, 2.4)	77.9	3.24 (1H, m)
Glu-6	63.4	3.84 (1H, dd, 11.8, 2.3)	63.2	3.81 (1H, dd, 11.8, 2.1)
		3.66 (1H, dd, 11.8, 5.7)		3.63 (1H, dd, 11.8, 5.4)

* Measured at 500 MHz in CD_3OD.
† Measured at 400 MHz in CD_3OD.

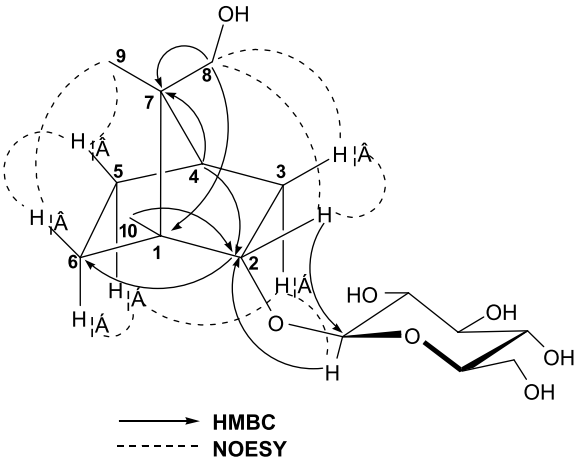

Figure 1. Selected HMBC and NOESY correlations of **1**.

β-glucopyranosyl moiety was attached to C-2, and this was confirmed by HMBC correlation between C-2 and the anomeric proton H-1′. The structure of **1** was therefore elucidated and designated as 2-O-β-D-glucopyranoside-vicodiol.

Compound **2** was obtained as a white amorphous powder. It showed pseudo molecular ion peaks at *m/z* 423 $[M + Na]^+$, 823 $[2M + Na]^+$ in positive mode ESI-MS. The molecular formula of **2** was determined as $C_{21}H_{36}O_7$ by HR-EIMS at *m/z* 238.1932 [$C_{15}H_{26}O_2$, $M-C_6H_{10}O_5]^+$, and in combination of its ^{1}H and ^{13}C NMR spectra (table 1). The strong absorptions at 3381 and 1704 cm^{-1} in the IR spectrum of **2** were assignable to the presence of hydroxyl and ketone groups, respectively. The ^{1}H NMR spectrum showed the presence of four methyl groups, two of which at δ 0.66 and 0.90 (each 3H, d, $J = 6.8$) were linked to the same methine group to form an isopropane, and one of which at δ 2.18 (3H, s) was considered to be next to the ketone carbonyl. ^{13}C NMR signals for the sugar moiety and ^{1}H NMR signal for the anomeric proton at δ 4.25 (1H, d, $J = 7.8$ Hz) showed the presence of β-glucopyranosyl moiety. Fifteen carbon signals, including four methyls, four methylenes, five methines, and two quaternary carbons in the aglycone moiety, were resolved by ^{13}C NMR (with DEPT) data (table 1), implying that **2** was a sesquiterpenoid glycoside. The aforementioned spectral data also suggested that aglycone of **2** was likely oplopanone [20], which was confirmed by HMBC and NOESY spectra (figure 2). Comparing the ^{13}C NMR data of **2** with those of oplopanone, the quaternary carbon at δ 81.5 assigned to C-10 in **2** was severely down field shifted, suggesting that the sugar moiety was linked to the C-10, which was confirmed by HMBC correlation between H-1′ and C-10. The obviously up-field shifted carbon signal at δ 98.2 assignable to the anomeric carbon C-1′ was considered to be caused by the γ-gauche effect of C-14 methyl group which could be envisaged by the strong NOESY correlation between H-1′ and H-14. The tendency of the up-field shifted anomeric carbon signal of β-glucopyranosyl in **2** is much like the cases in rehmaionosides A and C [21]. The structure of **2** was therefore elucidated.

Seven known compounds were identified as α-spinasterol (**3**) and its glycoside (**4**) [22], alaschanioside A (**5**) [23], lariciresinol 9-O-β-D-glucopyranoside (**6**) [24], alangilignoside D (**7**) [25], syringaresinol (**8**) [26], 2,6-dimethoxy-4-(2-propenyl)-phenyl-β-D-glucoside (**9**) [27] by comparison of their spectral data with those reported in the literature.

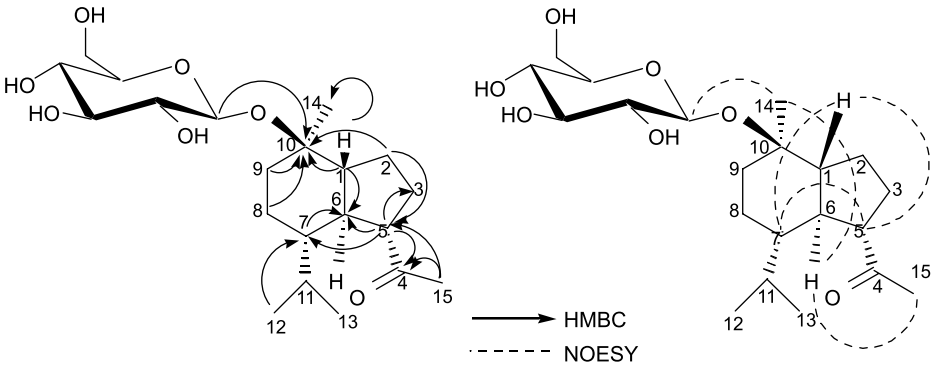

Figure 2. Key HMBC and NOESY correlations of **2**.

3. Experimental

3.1 General experimental procedures

Optical rotations were determined on a Perkin-Elmer 341 polarimeter. IR spectra were recorded on a Perkin-Elmer 577 spectrometer with KBr disks. NMR spectra were measured on a Bruker AM-400 and AM-500 spectrometers with TMS as internal standard. EIMS (70 eV) and ESIMS were carried out on a Finnigan MAT95 mass spectrometer and a Finnigan LCQ^{DECA} instrument, respectively. All solvents used were of analytical grade (Shanghai Chemical Co., Shanghai, China). Silica gel (200–300 mesh) was used for column chromatography, and a precoated silica gel GF254 plate (Qingdao Haiyang Chemical Plant, Qingdao, People's Republic of China) was used for TLC. C18 reversed-phase silica gel (150–200 mesh, Merck), MCI gel (CHP20P, 75–150 μm, Mitsubishi Chemical Industries Ltd) and Sephadex LH-20 gel (Amersham Biosciences) were also used for column chromatography.

3.2 Plant material

The aerial part of *A. flaccidus* (Bunge) was collected from Shaanxi province and identified by Prof Xiao-An Wang, School of Biology, Shaanxi Normal University, China. A voucher specimen has been deposited at Shanghai Institute of Materia Medica (Accession number: AF-2002-1Y).

3.3 Extraction and isolation

The air-dried plant (3 kg) of *A. flaccidus* was ground and extracted with 95% ethanol at room temperature to give crude extract (149 g), which was then dissolved in water (3 L) to form a suspension, and then partitioned with petroleum ether, EtOAc, BuOH successively.

The EtOAc soluble fraction (25 g) was subjected to a MCI gel column eluted with MeOH–H_2O (50(50–100:0) to collect three major fractions E1–E3. Fraction E1 was applied to silica gel column chromatography eluted with petroleum ether–EtOAc (8:1) to afford **8** (30 mg). Fraction E2 was purified by silica gel column chromatography eluted with petroleum ether–

EtOAc (8:1) to give **3** (80 mg). Compound **4** (20 mg) was obtained from fraction E3 by column chromatography on a silica gel eluted with $CHCl_3$–MeOH (8:1).

The BuOH soluble fraction (20 g) was subjected to a MCI gel column chromatography eluted with MeOH–H_2O (0:100–100:0) to afford four major fractions B1–B4. Fraction B1 was applied to silica gel column chromatography eluted with EtOAc–MeOH–H_2O (20:1:0.1–5:1:0.1), then purified by C18 reversed-phase silica gel column (MeOH–H_2O, 1:9) to give **1** (6 mg). Fraction B2 was purified sequentially over silica gel column chromatography ($CHCl_3$–MeOH–H_2O, 4:1:0.1), and then C18 reversed-phase silica gel column chromatography (MeOH–H_2O, 20:80) to give **5** (35 mg). Purification of fraction B3 was carried out sequentially by a silica gel column chromatography (EtOAc–MeOH–HCOOH, 50:1:0.1–10:1:0.1), then C18 reversed-phase silica gel column chromatography (MeOH–H_2O, 20:80) to give a major compound, which was further purified by a Sephadex LH-20 gel to afford **2** (15 mg). Fraction B4 was separated on a silica gel column eluted with a mixture of $CHCl_3$–MeOH–H_2O (8:1:0.1) to yield compounds **6**, **7**, and **9** in turn.

3.3.1 2-O-β-D-glucopyranoside-vicodiol. (**1**) was obtained as a white amorphous powder; $[\alpha]_D^{20} = -29.2$ (*c* 0.75, MeOH); IR (KBr) ν_{max} (cm^{-1}): 3363, 2922, 1728, 1549,1464, 1078, 1018,754; ^1H NMR and ^{13}C NMR (CD3OD-d_4, 500 MHz) see table 1; positive ESIMS *m/z*: 355 $[M + Na]^+$; EIMS *m/z* (rel. int.): 170 (2), 163 (3), 153 (43), 135 (27), 108 (100), 95 (31), 73 (26), 57 (12); HR-EIMS *m/z*: 170.1312 $[M-C_6H_{10}O_5]^+$ (calcd for $C_{10}H_{18}O_2$, 170.1307).

3.3.2 10-O-β-D-glucopyranoside-oplopanone. (**2**) was obtained as a white amorphous powder; $[\alpha]_D^{20} = -22.7$ (*c* 1.03, in MeOH); IR (KBr) ν_{max} (cm^{-1}): 3381, 2933, 1704, 1454,1386, 1155, 1078, 1020, 756, 667; ^1H NMR and ^{13}C NMR (CD3OD-d_4, 400 MHz) see table 1; positive ESIMS *m/z*: 423 $[M + Na]^+$, 823 $[2M + Na]^+$; EIMS *m/z* (rel. int.): 238 $[M-C_6H_{10}O_5]^+$ (6), 221 (100), 203 (76), 177 (70), 153 (47), 135 (36), 107 (24), 95 (24), 85 (27), 81 (23), 70 (23), 69 (19), 55 (17); HR-EIMS *m/z*: 238.1932 $[M-C_6H_{10}O_5]^+$ (calcd for $C_{15}H_{26}O_2$, 238.1933).

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References

[1] Chinese Flora, *Chinese Flora*, **74**, pp. 238–240, Science Press, Beijing (1985).
[2] The Encyclopedia of Traditional Chinese Medicine, *The Encyclopedia of Traditional Chinese Medicine*, pp. 177–2348, Shanghai Science and Technology Press, Shanghai (1985).
[3] Dictionary of Traditional Chinese Medicine, *Dictionary of Traditional Chinese Medicine*, **1**, p. 864, Medicinal Science and Technology Press of China, Beijing (1993).
[4] T. Nagao, H. Okabe, T. Yamauchi. *Chem. Pharm. Bull.*, **36**, 571 (1988).
[5] D.L. Cheng, Y. Shao, L. Yang, P.X. Zou. *Acta. Bot. Sin.*, **35**, 311 (1993).
[6] S.J. Guo, L.M. Wang, D.L. Cheng. *Ind. J. Chem.*, **36**, 339 (1997).
[7] D.L. Cheng, X.P. Cao, H.X. Wei, L. He. *Phytochemistry*, **33**, 1181 (1993).

[8] C.Z. Wang, D.Q. Yu. *Phytochemistry*, **45**, 1483 (1997).
[9] S.J. Guo, J.P. Katalinic, L. He, D.L. Cheng. *Pharmazie*, **53**, 481 (1998).
[10] Y. Shao, M.F. Wang, C.T. Ho, C.K. Chin, S.W. Yang, G.A. Cordell, H. Lotter, H. Wagner. *Phytochemistry*, **49**, 609 (1998).
[11] Y. Shao, C.T. Ho, C.K. Chin. *J. Nat. Prod.*, **60**, 743 (1997).
[12] C.Z. Wang, D.Q. Yu. *Planta Med.*, **64**, 50 (1998).
[13] T. Nagao, Y. Iwase, H. Okabe. *Chem. Pharm. Bull.*, **41**, 1562 (1993).
[14] C.Z. Wang, D.Q. Yu. *Phytochemistry*, **48**, 711 (1998).
[15] K.A. Wilzer, F.R. Fronczek, L.E. Urbatsch, N.H. Fischer. *Phytochemistry*, **28**, 1729 (1989).
[16] H. Morita, S. Nagashima, K. Takeya, H. Itokawa. *Chem. Pharm. Bull.*, **43**, 1395 (1995).
[17] D.L. Cheng, Y. Shao, K. Zhao, R. Hartmann, E. Roeder. *Pharmazie*, **51**, 185 (1996).
[18] S. Vasanth, A.B. Kundu, K.K. Purushothaman. *J. Nat. Prod.*, **53**, 354 (1990).
[19] F. Bohlmann, J. Jakupovic, A. Schuster, R.M. King, H. Robinson. *Phytochemistry*, **21**, 2317 (1982).
[20] W.C. Su, J.M. Fang, Y.S. Cheng. *Phytochemistry*, **39**, 603 (1995).
[21] H. Sasaki, H. Nishimura, T. Morota, T. Katsuhara, M. Chin, H. Mitsuhashi. *Phytochemistry*, **30**, 1639 (1991).
[22] T. Furuya, Y. Orihara, Y. Tsuda. *Phytochemistry*, **28**, 2539 (1990).
[23] J.J. Gao, Z.J. Jia. *Ind. J. Chem.*, **34B**, 466 (1995).
[24] D.G. Marina, M. Antonio, M. Pietro, P. Lucio. *Heterocycles*, **36**, 2081 (1993).
[25] K. Yuasa, T. Ide, H. Otsuka, C. Ogimi, E. Hirata, A. Takushi, Y. Takeda. *Phytochemistry*, **45**, 611 (1997).
[26] K. Keiko, N. Toshihiro, K. Tetsuya, K. Toshio, S.H. Rolf. *Planta Med.*, **40**, 250 (1980).
[27] T.S. Wu, S.C. Huang, J.S. Lai, C.M. Teng, F.N. Ko, C.S. Kuoh. *Phytochemistry*, **32**, 449 (1993).