

北沙参中一个新香豆素苷

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摘要: 为了研究北沙参的化学成分, 本文通过大孔树脂吸附柱色谱、Sephadex LH-20及开放反相 ODS柱色谱进行化合物的分离, 利用多种波谱技术鉴定化合物结构。分离得到 9 个化合物, 鉴定为: bergaptol 5-O-β-D-gentiobioside (1)、(7R, 8S)-dehydronicoferylalcohol-4, 9-di-O-β-D-glucoside (2)、橙皮素 A (3)、(-)-seco-isolaricinesinol 4-O-β-D-glucopyranoside (4)、白花前胡苷 (5)、花椒毒酚 8-O-β-D-吡喃葡萄糖苷 (6)、5'-硫甲基腺苷 (7)、腺苷 (8)、色氨酸 (9)。化合物 1 为新化合物; 化合物 2 和 7 为首次从该属植物中分离得到。

关键词: 北沙参; 香豆素苷; bergaptol 5-O-β-D-gentiobioside

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A new coumarin glycoside from *Glehnia littoralis*

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Abstract: To study the chemical constituents from *Glehnia littoralis*, macroreticular resin column chromatography, repeated column chromatography on Sephadex LH-20 and reverse phase ODS were used to isolate the compounds whose structures were elucidated based on spectroscopic data (ESI-MS, 1D and 2D NMR). A new coumarin glycoside was isolated and identified as: bergaptol 5-O-β-D-gentiobioside (1), along with eight known compounds: (7R, 8S)-dehydronicoferylalcohol-4, 9-di-O-β-D-glucoside (2), cirtusin A (3), (-)-seco-isolaricinesinol 4-O-β-D-glucopyranoside (4), baihuaqianhuside (5), xanthotoxol 8-O-β-D-glucopyranoside (6), 5'-methylthioadenosine (7), adenosine (8), L-tryptophan (9). Compound 1 is a new coumarin glycoside, compounds 2 and 7 were isolated from this genus for the first time.

Key words: *Glehnia littoralis*; coumarin glycoside; bergaptol 5-O-β-D-gentiobioside

北沙参为伞形科植物珊瑚菜 *Glehnia littoralis* Fr. Schmidt ex Miq. 的干燥根。该植物主要分布于山东、辽宁、河北、浙江、江苏、广东、福建、台湾等地, 生于海边、沙滩或为栽培。夏秋两季采挖, 除去须根, 洗净, 稍晾, 置沸水中烫后除去外皮, 或洗净直接干燥。本品性甘, 味微苦, 微寒, 归肺、胃经。有养阴清肺、益胃生津之功效。主要用于肺热、燥咳、劳嗽痰血和热病津伤口渴^[1]。文献^[2-6]报道北沙参主要含有香豆素类、聚炔类、木脂素类、脂肪酸等化学成

分。本文采用大孔吸附柱色谱、Sephadex LH-20 及开放 ODS 柱色谱等从北沙参乙醇提取物的水溶性部分得到 9 个化合物并鉴定其结构。其中化合物 1 为新化合物, 化合物 2 和 7 为首次从该属植物中分离得到。

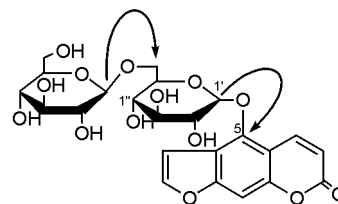


Figure 1 Structure and the key HMBC correlations of compound 1

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化合物 1 白色粉末, $[\alpha]_D^{20} - 5.0 (c 0.1, \text{MeOH})$ 。ESI-MS给出准分子离子峰 $[M + Na]^+ m/z$ 549.0和 $[M + Cl]^- m/z$ 560.8。根据 HR-ESI-MS显示准分子离子峰 $[M + Cl]^- m/z$ 561.1003 ($C_{23}H_{26}O_{14}Cl$, 计算值为 561.1011), 推出其分子式为 $C_{23}H_{26}O_{14}$ 。

1H NMR (300 MHz, DMSO- d_6) 谱中低场区给出 5 个烯质子信号 δ : 6.37 (1H, d, $J = 9.8$ Hz), 8.50 (1H, d, $J = 9.8$ Hz), 7.49 (1H, s), 7.37 (1H, d, $J = 2.2$ Hz), 7.97 (1H, d, $J = 2.2$ Hz), 提示为 5 位或 8 位氧取代的呋喃型香豆素^[2,3]。 1H NMR 谱还给出两个糖端基质子信号 δ 4.96 (1H, d, $J = 7.5$ Hz), 4.20 (1H, d, $J = 7.5$ Hz)。

^{13}C NMR (75 MHz, DMSO- d_6) 谱给出 23 个碳, 其中 11 个信号归属为呋喃香豆素母核, 余下 12 个糖基信号, 结合 1H NMR 谱推出其为呋喃香豆素双糖苷。化合物经酸水解, 与标准糖对照品共高效薄层色谱 (co-HP-TLC), 仅检测出葡萄糖。与文献^[7]报道的 bergaptol- O - β - D -glucopyranoside 的 1H NMR, ^{13}C NMR 谱数据比较, 基本一致, 只多了一组葡萄糖基信号, 且一组葡萄糖基 6 位碳信号向低场位移, 由此可推测两葡萄糖 1-6 位相连。

在 HMBC 谱中, 观察到糖的端基质子信号 δ 4.96 (H-1') 与 δ 147.3 (C-5), δ 4.20 (H-1'') 与 δ 69.1 (C-6') 有远程相关性, 确定该化合物为 5 位双葡萄糖基取代的呋喃香豆素苷, 且双葡萄糖 1-6 位相连。

至此, 确定该化合物的结构如图 1 所示, 根据 1H - 1H COSY 谱中所观察到的 H-3/H-4, H-9/H-10, 以及两个糖上的质子之间的相关峰, 并结合 HSQC 和 HMBC 谱数据, 确定了该结构各碳氢信号的归属和 C-H 远程偶合情况 (表 1)。

化合物 1 被确定为 bergaptol 5- O -[β - D -glucopyranosyl-(1 \rightarrow 6)- β - D -glucopyranosyl], 命名为 bergaptol 5- O - β - D -gentiobioside, 为新化合物。

实验部分

Shimadzu UV-2201 可见紫外光谱仪, Perkin-Elmer 241 MC 旋光仪, Agilent LC-MSD Trap-SL 质谱仪, QSTAR LCQ 高分辨质谱仪, Bruker ARX-300 或 Bruker ARX-600 型核磁共振仪 (TMS 内标), 大孔树脂 D101 (天津市海光化工有限公司), Sephadex LH-20 (Pharmacia 公司), ODS (YMC* GEL, 75 μ m), 所用试剂均为 AR 级。

Table 1 1H NMR and ^{13}C NMR data of compound 1 in DMSO- d_6

No.	HSQC		HMBC
	δ_C	δ_H	
2	160.2		3, 4-H
3	112.9	6.37 (1H, d, $J = 9.8$ Hz)	
4	140.2	8.50 (1H, d, $J = 9.8$ Hz)	
4a	107.6		3, 8-H
5	147.3		4, 1'-H
6	115.4		8, 9, 10-H
7	157.3		2, 6, 9-H
8	95.1	7.49 (1H, s)	
8a	151.8		4, 8-H
9	106.1	7.37 (1H, d, $J = 2.2$ Hz)	8, 10-H
10	146.8	7.97 (1H, d, $J = 2.2$ Hz)	9-H
1'	103.9	4.96 (1H, d, $J = 7.5$ Hz)	2', 6'-H
2'	73.9	3.43 (1H, m)	
3'	76.1	3.59 (1H, m)	5'-H
4'	70.1	3.20 (1H, m)	2'-H
5'	76.9	3.11 (1H, m)	1', 3'-H
6'	69.1	4.08 (1H, d, $J = 10.1$ Hz)	1''-H
		3.62 (1H, m)	
1''	103.5	4.20 (1H, d, $J = 7.5$ Hz)	2'', 6'', 6'-H
2''	73.7	2.99 (1H, m)	
3''	76.1	3.29 (1H, m)	5''-H
4''	70.1	3.07 (1H, m)	2''-H
5''	76.9	3.07 (1H, m)	1'', 3''-H
6''	61.1	3.66 (1H, d, $J = 5.9, 11.2$ Hz)	
		3.43 (1H, m)	

北沙参干燥根于 2006 年 8 月采集于山东省莱阳高格庄胡城村, 经沈阳药科大学高级工程师吴维春老师鉴定。

1 提取与分离

北沙参干燥根 (12.0 kg) 经 95% 乙醇 (60 L \times 3, 2, 2 和 1.5 h) 回流提取后, 继用水 (60 L \times 2, 1.5 和 1 h) 提取, 减压回收溶剂, 得到 95% 乙醇提取物和水提取物。将 95% 乙醇提取物混溶于水中, 依次用石油醚、乙酸乙酯萃取, 分别得到石油醚溶部分、乙酸乙酯溶部分和水溶部分。水溶部分 (184 g) 经大孔吸附树脂 D101 柱色谱, H_2O -EtOH 系统梯度洗脱, 得到 25% 乙醇洗脱流分: Fr. 2 (18 g); 50% 乙醇洗脱流分: Fr. 3 (10 g)。

Fr. 2 (18 g) 经 Sephadex LH-20 柱色谱, 水洗脱, 得到流分 Fr. 8 - 20, Fr. 21 - 23。Fr. 8 - 20 经 ODS 柱色谱, H_2O -MeOH 系统 (10: 90 \rightarrow 20: 80) 梯度洗脱, 得到化合物 9 (20 mg)。Fr. 21 - 23 经 ODS 柱色谱, H_2O -MeOH 系统 (20: 80 \rightarrow 50: 50) 梯度洗脱, 得到化合物 8 (12 mg)。

Fr. 3 (10 g) 经 Sephadex LH-20 柱色谱, H₂O-MeOH 系统梯度洗脱, 得到流分 Fr. 3.1 - Fr. 3.4。Fr. 3.1 经 Sephadex LH-20 柱色谱, 水洗脱, 得到流分 Fr. 10 - 16, Fr. 17 - 30。Fr. 10 - 16 经 ODS 柱色谱, H₂O-MeOH 系统 (20: 80 → 30: 70) 梯度洗脱, 得到化合物 1 (10 mg), 化合物 2 (8 mg), 化合物 5 (26 mg), 化合物 6 (17 mg)。Fr. 17 - 30 经 ODS 柱色谱, H₂O-MeOH 系统 (20: 80 → 50: 50) 梯度洗脱, 得到化合物 3 (35 mg), 化合物 4 (4 mg), 化合物 7 (8 mg)。

2 结构鉴定

化合物 1 白色粉末, $[\alpha]_D^{20} - 5.0^\circ$ (c 0.1, MeOH)。positive ESI-MS m/z 549 [M + Na]⁺, 503, 413, 386, 301, 139; negative ESI-MS m/z 561 [M + Cl]⁻, 485, 425, 339; negative HR-ESI-MS m/z 561.1003 ([M + Cl]⁻, 计算值为 561.1011)。¹H NMR 和 ¹³C NMR 数据见表 1。鉴定为 bergaptol 5-O-[β-D-glucopyranosyl-(1 → 6)-β-D-glucopyranosyl], 命名为 bergaptol 5-O-β-D-gentiobioside。

化合物 2 白色无定型粉末, $[\alpha]_D^{20} - 10.1^\circ$ (c 0.54, MeOH)。positive ESI-MS m/z 705 [M + Na]⁺, 621, 607, 591, 563, 551, 515, 503; negative ESI-MS m/z 717 [M + Cl]⁻, 613, 519。¹H NMR (600 MHz, CD₃OD) δ: 7.04 (1H, d, J = 8.3 Hz, H-5), 6.99 (2H, br s, H-2, 6), 6.94 (1H, br s, H-2'), 6.85 (1H, br d, J = 8.3 Hz, H-6), 6.44 (1H, d, J = 15.0 Hz, H-7'), 6.21 (1H, dt, J = 15.0, 4.9 Hz, H-8'), 5.58 (1H, d, J = 6.0 Hz, H-7), 4.86 (1H, d, J = 6.7 Hz), 4.26 (1H, d, J = 7.7 Hz), 4.06 (3H, m, H-9, 9'), 3.81 (3H, s, 3'-OCH₃), 3.74 (3H, s, 3-OCH₃), 3.66 (3H, m, H-6'', 6''', 9), 3.58 (1H, m, H-8), 3.43 (2H, m, H-6'', 6'''), 3.24 (3H, m, H-2'', 5'', 5'''), 3.15 (3H, m, H-3'', 3''', 4''), 3.02 (2H, m, H-2''', 4''')。¹³C NMR (150 MHz, CD₃OD) δ: 149.0 (C-3), 147.1 (C-4'), 146.3 (C-4), 143.7 (C-3'), 135.2 (C-1), 130.8 (C-1'), 128.9 (C-7'), 128.6 (C-5'), 128.3 (C-8'), 117.9 (C-6), 115.5 (C-5), 115.4 (C-6'), 110.7 (C-2), 110.6 (C-2'), 103.1 (C-1''), 100.2 (C-1'''), 86.6 (C-7), 77.1 (C-5''), 77.1 (C-5'''), 76.9 (C-3''), 76.9 (C-3'''), 73.6 (C-2''), 73.3 (C-1''), 70.5 (C-9), 70.1 (C-4'''), 69.7 (C-4''), 61.7 (C-9'), 61.1 (C-6'''), 60.7 (C-6''), 55.8 (3-OCH₃), 55.8 (3'-OCH₃), 50.8 (C-8)。以上数据与文献报道的 (7R, 8S)-dehydrodiconiferylalcohol-4, 9-di-O-β-D-glucoside^[8] 的数据一致。

化合物 3 淡黄色粉末。¹H NMR (600 MHz, CD₃OD) δ: 7.10 (1H, d, J = 1.9 Hz, H-2), 7.09 (1H, d, J = 8.2 Hz, H-5'), 6.98 (1H, br s, H-2'), 6.94 (1H, br d, J = 8.2 Hz, H-6), 6.86 (2H, m, H-5, 6'), 6.50 (1H, d, J = 15.8 Hz, H-7'), 6.24 (1H, dt, J = 15.8, 5.6 Hz, H-8'), 4.86 (1H, d, J = 5.7 Hz, H-7), 4.81 (1H, d, J = 7.0 Hz, H-1''), 4.36 (1H, m, H-8), 4.19 (1H, d, J = 5.6 Hz, H-9'), 3.84 (1H, br d, J = 12.1 Hz, H-6''), 3.83 (1H, m, H-9), 3.80 (3H, s, 3-OCH₃), 3.79 (3H, s, 3'-OCH₃), 3.76 (1H, m, H-9), 3.67 (1H, dd, J = 12.1, 3.7 Hz, H-6''), 3.48 (1H, m, H-2''), 3.45 (1H, m, H-5''), 3.39 (1H, m, H-3''), 3.39 (1H, m, H-4'')。¹³C NMR (150 MHz, CD₃OD) δ: 151.8 (C-3'), 150.5 (C-3), 148.8 (C-4'), 147.4 (C-4), 137.7 (C-1), 132.9 (C-1'), 131.5 (C-7'), 128.5 (C-8'), 121.1 (C-6), 120.6 (C-6'), 118.6 (C-5), 117.6 (C-5'), 112.7 (C-2'), 111.2 (C-2), 103.1 (C-1''), 85.9 (C-8), 78.2 (C-3''), 77.8 (C-5''), 74.9 (C-2''), 73.8 (C-7), 71.3 (C-4''), 63.7 (C-9'), 62.5 (C-6''), 62.2 (C-9), 56.6 (3-OCH₃), 56.4 (3'-OCH₃)。以上数据与文献报道的橙皮素 A^[9] 的数据一致。

化合物 4 白色无定型粉末。与三氯化铁试剂反应阳性, 示为酚类化合物。¹H NMR (300 MHz, DMSO-d₆) δ: 7.05 (1H, d, J = 8.3 Hz, H-5), 6.78 (1H, d, J = 8.3 Hz, H-5'), 6.73 (2H, br s, H-2, 2'), 6.72 (1H, br d, J = 8.3 Hz, H-6), 6.61 (1H, br d, J = 8.3 Hz, H-6'), 4.93 (1H, d, J = 7.0 Hz, H-1''), 3.79 (6H, s, 3, 3'-OCH₃), 3.49 (4H, m, H-9, 9'), 3.36 ~ 3.41 (6H, m, H-2'' ~ H-6''), 2.65 (4H, m, H-7, 7'), 1.95 (2H, m, H-8, 8')。以上数据与文献报道的 (-)-seco-isolaricinesinol 4-O-β-D-glucopyranoside^[6] 的数据一致。

化合物 5 白色粉末。¹H NMR (300 MHz, CD₃OD) δ: 7.63 (1H, dd, J = 8.5, 1.9 Hz, H-6), 7.57 (1H, d, J = 1.7 Hz, H-2), 7.21 (1H, d, J = 8.5 Hz, H-5), 5.02 (1H, d, J = 7.2 Hz, H-1'), 3.89 (3H, s, 3-OMe), 3.86 (1H, d, J = 5.2 Hz, H-6'), 3.68 (1H, dd, J = 12.0, 5.2 Hz, H-6'), 3.34 ~ 3.53 (4H, m, H-2' ~ H-5'), 3.01 (2H, q, J = 7.3 Hz, H-8), 1.16 (3H, t, J = 7.3 Hz, H-9)。¹³C NMR (75 MHz, CD₃OD) δ: 201.9 (C-7), 152.3 (C-4), 150.7 (C-3), 132.8 (C-1), 123.8 (C-6), 116.3 (C-5), 112.5 (C-2), 101.9 (C-1'), 78.3 (C-5'), 77.9 (C-3'), 74.8 (C-2'),

71.3 (C-4'), 62.5 (C-6'), 56.7 (3-OMe), 32.3 (C-8), 8.8 (C-9)。以上数据与文献报道的白花前胡苷^[10]的数据一致。

化合物 6 白色粉末, mp 210 ~ 211 °C。¹H NMR (300 MHz, DMSO-*d*₆) δ: 8.14 (1H, d, *J* = 9.6 Hz, H-4), 8.10 (1H, d, *J* = 2.2 Hz, H-10), 7.69 (1H, s, H-5), 7.09 (1H, d, *J* = 2.2 Hz, H-9), 6.44 (1H, d, *J* = 9.6 Hz, H-3), 5.62 (1H, d, *J* = 7.3 Hz, H-1')。 ¹³C NMR (75 MHz, CD₃OD) δ: 159.9 (C-2), 147.9 (C-10), 146.2 (C-7), 145.3 (C-4), 142.1 (C-8a), 128.8 (C-8), 126.0 (C-6), 116.4 (C-4a), 114.3 (C-3), 114.0 (C-5), 106.9 (C-9), 101.9 (C-1'), 77.6 (C-5'), 76.8 (C-3'), 73.9 (C-2'), 69.6 (C-4'), 60.5 (C-6')。

以上数据与文献报道的花椒毒酚 8-*O*-β-*D*-吡喃葡萄糖苷^[11]的数据一致。

化合物 7 白色无定型粉末。¹H NMR (300 MHz, DMSO-*d*₆) δ: 8.37 (1H, s, H-8), 8.16 (1H, s, H-2), 7.31 (2H, br s, 6-NH₂), 5.89 (1H, d, *J* = 6.0 Hz, H-1'), 4.75 (1H, dd, *J* = 5.7, 11.2 Hz, H-4'), 4.12 (1H, m, H-3'), 4.03 (1H, m, H-2'), 2.80 (2H, dddd, *J* = 6.9, 13.9, 16.4 Hz, H-5), 2.05 (3H, s, 5'-SM_e)。以上数据与文献报道的 5' 硫甲基腺苷^[12]的数据一致。

化合物 8 白色无定型粉末。¹H NMR (300 MHz, DMSO-*d*₆) δ: 8.33 (1H, s, H-8), 8.13 (1H, s, H-2), 7.35 (2H, br s, 6-NH₂), 5.86 (1H, d, *J* = 6.6 Hz, H-1'), 4.75 (1H, m, *J* = 5.2 Hz, H-4'), 4.14 (1H, m, H-3'), 3.95 (1H, m, H-2'), 3.66 (1H, m, H-5), 3.56 (1H, m, H-5)。以上数据与文献报道的腺苷^[13]的数据一致。

化合物 9 淡黄色粉末, 茚三酮反应显紫红色。¹H NMR (300 MHz, D₂O) δ: 7.62 (1H, d, *J* = 8.0 Hz, 4-H), 7.42 (1H, d, *J* = 8.0 Hz, 7-H), 7.19 (1H, s, 2-H), 7.16 (1H, t, *J* = 8.0 Hz, 6-H), 7.08 (1H, t, *J* = 8.0 Hz, 5-H), 3.93 (1H, dd, *J* = 7.5, 4.8 Hz, 11-H), 3.32 (1H, dd, *J* = 15.0, 7.5 Hz, 10-H), 2.98 (1H, dd, *J* = 15.0, 4.8 Hz, 10-H)。 ¹³C NMR (75 MHz, CD₃OD) δ: 177.2 (CO), 139.1 (C-8), 129.4 (C-9), 127.7 (C-2), 124.9 (C-4), 122.2 (C-5), 121.2 (C-6), 114.7 (C-7), 110.2 (C-3), 57.8 (C-11), 29.1

(C-10)。以上数据与文献报道的色氨酸^[14]的数据一致。

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