

朝鲜蓟叶中的酚性糖苷化合物

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摘要: 从朝鲜蓟 (*Cynara scolymus*) 叶中分离得到 2 个酚性糖苷化合物, 其中一个是新化合物, 通过波谱学方法确定其结构为 2-甲氧基-4-(2, 3-二羟基-丙酰基)-苯基-1-O-(6-O-没食子酰基)-D-吡喃葡萄糖苷 (1)。

关键词: 朝鲜蓟; 菊科; 酚性糖苷

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Phenolic Glucoside Gallates from the Leaves of *Cynara scolymus* (Compositae)

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Abstract: A new phenolic glucoside gallate, named 2-methoxy-4-(2, 3-dihydroxy-propionyl)-phenyl-1-O-(6-O-galloyl)-D-glucopyranoside (1), together with a known phenolic glucoside gallate (2), were isolated from the leaves of *Cynara scolymus* (Artichoke). The structure of 1 was elucidated mainly by extensive spectral methods (MS, IR, 1D and 2D NMR techniques).

Key words: *Cynara scolymus*; Compositae; Phenolic glycoside

Cynara scolymus L. (Artichoke) is an ancient herbaceous plant, belonging to the family Compositae and originating from the Mediterranean area. Today, artichoke is widely grown all over the world and its sprout is eaten as a vegetable. The leaves of artichoke have been used as a choleric and diuretic in traditional medicine since ancient times (Kirchhoff *et al.*, 1994). Various chemical constituents (Wang *et al.*, 2003; Shimoda *et al.*, 2003; Zhu *et al.*, 2004; Schütz *et al.*, 2004) from artichoke including polyphenols such as cynarin, caffeoylquinic acids and chlorogenic acids, flavonoids, sesquiterpenes and sesquiterpene glycosides have been found and have shown some

pharmacological activities (Dranik *et al.*, 1996; Kraft, 1997; Brown *et al.*, 1998) such as antibacterial, antioxidative, choleric, bileexpelling and hepatoprotective activities. We have further carried out a chemical investigation on the leaves of artichoke which is cultivated in Vietnam and isolated a new phenolic glucoside gallate, 2-methoxy-4-(2, 3-dihydroxy-propionyl)-phenyl-1-O-(6-O-galloyl)-D-glucopyranoside (1). This paper reports the isolation and structural elucidation of compound 1.

Results and Discussion

Compound 1 was obtained as white amorphous

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power and showed a quasi-molecular ion peak at m/z 549.1403 $[M + Na]^+$ (calcd for $C_{23}H_{26}O_{14}Na$ 549.1406) in its HRESIMS corresponding to the molecular formula $C_{23}H_{26}O_{14}$. The IR spectrum exhibited absorption bands for hydroxyls (3406 cm^{-1}), carbonyls (1720 and 1705 cm^{-1}) and aromatic moieties (1612 , 1516 , and 1351 cm^{-1}). The ^1H NMR data suggested the presence of a galloyl group $\delta_{\text{H}} 7.09$ (2H, s, H-2 and H-6), an ABX benzene ring with one methoxy group $\delta_{\text{H}} 3.88$ (3H, s, OMe), 7.15 (1H, d, $J = 8.8$ Hz, H-6), 7.57 (1H, d, $J = 1.7$ Hz, H-3), 7.37 (1H, dd, $J = 8.8$, 1.7 Hz, H-5), an anomeric proton signal $\delta_{\text{H}} 5.02$ (1H, d, $J = 7.7$ Hz, H-1), and a glycol group $\delta_{\text{H}} 5.18$ (1H, t, $J = 4.1$ Hz, H-8), 3.91 (1H, m, H-9), 3.72 (1H, m, H-9). The ^{13}C NMR spectrum and DEPT experiment displayed twenty-three carbon signals: one methyl, two methylenes, eleven methines and nine quaternary carbons, of which the signals at $\delta_{\text{C}} 152.5$ (s), 150.8 (s), 112.8 (d), 130.5 (s), 124.4 (d), 116.2 (d), and at $\delta_{\text{C}} 121.5$ (s), 110.4 (d), 146.6 (s), 139.9 (s), 146.6 (s), 110.4 (d) were attributed to two benzene rings. In addition, ^{13}C NMR data gave two carbonyl signals at $\delta_{\text{C}} 199.7$ (ketone group) and 168.0 (galloyl group), and one glucopyranose unit. Acid hydrolysis of 1 afforded D-glucose which was compared with authentic samples of D-glucose by TLC. The large $^3J_{\text{H}_1, \text{H}_2}$ coupling constant ($J = 7.7$ Hz) deduced the glucose possessed a β -anomeric configuration. As shown in the Table 1, the NMR spectral data of 1 were

very similar to those of compound 2 (Ishimaru *et al.*, 1987; Saijo *et al.*, 1989), which suggested that compound 1 possessed the β -D-glucopyranose unit. Similarly, the same biogenetic point of view also suggested that compound 1 and 2 had the same β -D-configuration for the glucopyranose. In the HMBC spectrum (Fig. 2), the correlations between signals at $\delta_{\text{H}} 4.61$ (dd, $J = 11.8$, 2.2 Hz, H-6), $\delta_{\text{H}} 4.36$ (dd, $J = 11.8$, 8.0 Hz, H-6) and $\delta_{\text{C}} 168.0$ (s, C-7), and $\delta_{\text{H}} 5.02$ (d, $J = 7.7$ Hz, H-1) and $\delta_{\text{C}} 152.5$ (s, C-1) indicated that the aglycone was linked at the C-1 position and the galloyl group was linked at the C-6 position of the glucose unit. The correlations between signals at $\delta_{\text{H}} 3.88$ (s, OMe) and $\delta_{\text{C}} 150.8$ (s, C-2), $\delta_{\text{H}} 7.09$ (s, H-2 and H-6) and $\delta_{\text{C}} 168.0$ (s, C-7), $\delta_{\text{H}} 7.57$ (d, $J = 1.7$ Hz, H-3), $\delta_{\text{H}} 7.37$ (dd, $J = 8.8$, 1.7 Hz, H-5) and $\delta_{\text{C}} 199.7$ (s, C-7), $\delta_{\text{H}} 5.18$ (t, $J = 4.1$ Hz, H-8) and $\delta_{\text{C}} 199.7$ (s, C-7), $\delta_{\text{C}} 130.5$ (s, C-4), and $\delta_{\text{H}} 3.91$ (m, H-9), $\delta_{\text{H}} 3.72$ (m, H-9) and $\delta_{\text{C}} 199.7$ (s, C-7), $\delta_{\text{C}} 75.6$ (d, C-8) revealed that the OMe, C-1, C-4, C-7 and C-8 were linked at the C-2, C-7, C-7, C-8 and C-9 positions, respectively. Moreover, the ROESY correlation of H-3 and H₃-OMe supported the link order between methoxy group and glucose unit with benzene moiety. Therefore, compound 1 was elucidated as 2-methoxy-4-(2,3-dihydroxy-propionyl)-phenyl-1-O-(6-O-galloyl)- β -D-glucopyranoside.

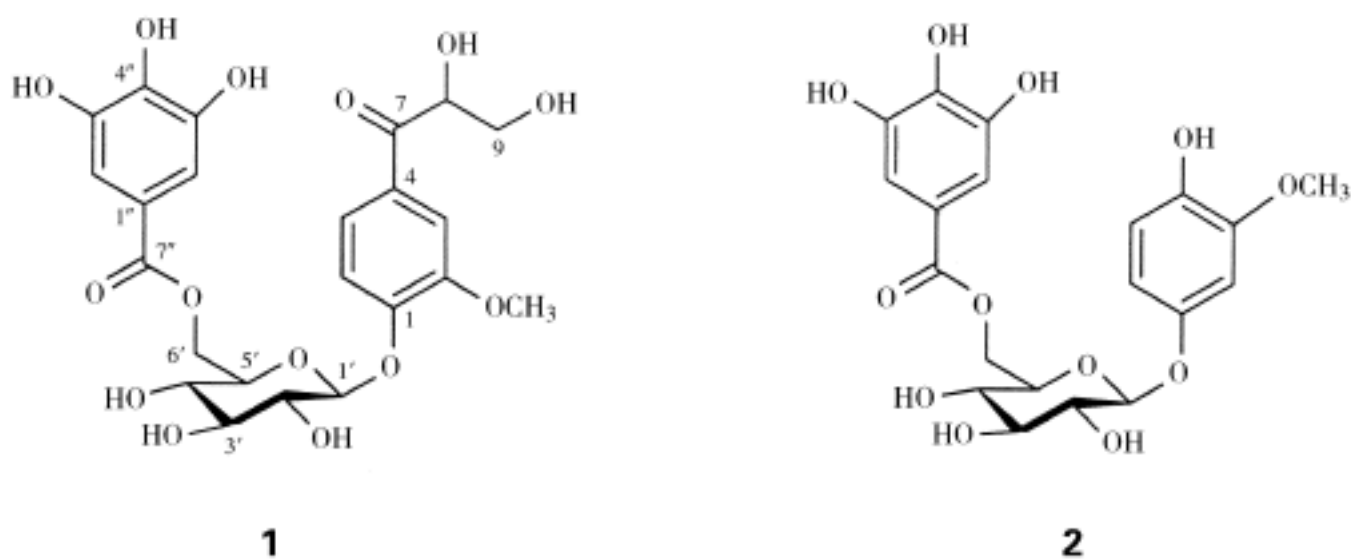


Fig. 1 Structures of compounds 1 and 2

Table 1 ^1H and ^{13}C NMR data (500 and 125 MHz, resp.) of 1 and 2 (in CD_3OD ; J values in Hz in parentheses)

No.	1		2	
	C	H	C	H
1	152.5 (s)		152.6 (s)	
2	150.8 (s)		103.9 (d)	6.69 (d, 2.8)
3	112.8 (d)	7.57 (d, 1.7)	149.1 (s)	
4	130.5 (s)		143.0 (s)	
5	124.4 (d)	7.37 (dd, 8.8, 1.7)	116.0 (d)	6.61 (d, 8.8)
6	116.2 (d)	7.15 (d, 8.8)	110.2 (d)	6.55 (dd, 8.8, 2.8)
7	199.7 (s)			
8	75.6 (d)	5.18 (t, 4.1)		
9	66.2 (t)	3.91 (m); 3.72 (m)		
-OMe	56.7 (q)	3.88 (s)	56.3 (q)	3.70 (s)
Glucose				
1	101.8 (d)	5.02 (d, 7.7)	103.9 (d)	4.72 (d, 7.7)
2	74.7 (d)	3.58 (m)	74.9 (d)	3.44 (m)
3	77.9 (d)	3.52 (m)	77.8 (d)	3.46 (m)
4	72.0 (d)	3.42 (m)	71.7 (d)	3.42 (m)
5	75.9 (d)	3.81 (m)	75.5 (d)	3.71 (m)
6	64.9 (t)	4.61 (dd, 11.8, 2.2); 4.36 (dd, 11.8, 8.0)	64.9 (t)	4.58 (dd, 11.6, 2.2); 4.42 (dd, 11.6, 6.6)
1	121.5 (s)		121.3 (s)	
2	110.4 (d)	7.09 (s)	110.2 (d)	7.09 (s)
3	146.6 (s)		146.4 (s)	
4	139.9 (s)		139.8 (s)	
5	146.6 (s)		146.4 (s)	
6	110.4 (d)	7.09 (s)	110.2 (d)	7.09 (s)
7	168.0 (s)		168.2 (s)	

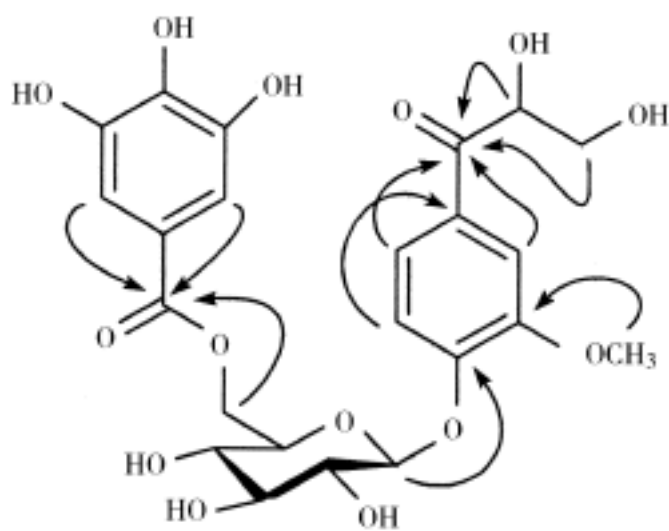


Fig. 2 Key HMBC correlations of compound 1

The known compound 2 and the new compound 1 shared similar physical and spectroscopic data, except that a 1, 3, 4-trisubstituted benzene moiety instead of a 1, 2, 4-trisubstituted one was located at the C - 1 position in 2. In addition, the 2, 3-dihydroxy-propionyl group linked at the C - 4 position of 1 was substituted for the hydroxyl group of 2. By detailed analysis of the NMR spectroscopic data and comparison with litera-

ture data, compound 2 was determined to be 4-hydroxy-3-methoxy-phenyl-1-*O*-(6-*O*-galloyl)- β -D-glucopyranoside (Ishimaru *et al.*, 1987; Saijo *et al.*, 1989).

Experimental

General experimental procedures TLC: visualization by heating silica-gel plates sprayed with 10% H_2SO_4 in EtOH. Silica gel (200 - 300 mesh, Qingdao Marine Chemical Inc., China), Lichroprep RP-18 gel (40 - 63 μm , Merck, Dramstadt, Germany) and Sephadex LH-20 (Amersham Biosciences, Sweden) were used for column chromatography. Optical rotation was measured on a Horbia SEPA-300 polarimeter. IR spectrum was obtained on a Bruker Tensor 27 instrument with KBr pellets. ^1H - and ^{13}C -NMR spectra were recorded on Bruker AM-400 and Bruker DRX-500 spectrometers in CD_3OD with TMS as an internal standard. FAB-MS was taken on a VG Auto Spec-3000 spectrometer, and HRESI-MS was recorded with an API QSTAR Pulsar 1 spectrometer.

Plant material The leaves of *Cynara scolymus* L. (Artichoke) were collected from Ho Chi Minh, Vietnam, in February, 2007. The plant was identified by Hsiehs Biotech Co.,

Ltd. . The voucher specimen (20070208-Tony-01) was deposited in the Herbarium of Kunming Institute of Botany, Chinese Academy of Sciences (CAS) .

Extraction and isolation The dried leaves of *Cynara scolymus* L. (Artichoke) (5 kg) were mashed and extracted with 75% ethanol at room temperature for 3 × 48 h. The extract was combined and concentrated to dryness under reduced pressure. The residue (380 g) was suspended in H₂O and partitioned, sequentially, with petroleum ether, EtOAc, and *n*-BuOH. The *n*-BuOH extract (60 g) was separated into nine fractions (F₁ - F₉) by column chromatography on silica gel using a CHCl₃ MeOH gradient. The fraction F₈ (6.1 g) eluted with CHCl₃ MeOH (1 : 1, v/v), mainly containing the polyphenolic derivatives, were further repeatedly separated by Sephadex LH-20 and RP-18 gel column chromatography (MeOH H₂O, 0 100 - 80 20), afforded the compounds 1 (7.0 mg) and 2 (7.5 mg) .

Acid hydrolysis of 1 A solution of 6 mg of 1 in 0.8 M HCl (3 ml) was heated at 90 ° for 3 h, and the reaction mixture extracted three times with EtOAc. After addition of H₂O, the acidic solution was evaporated and then dried *in vacuo* to furnish a monosaccharide residue. From the residue, glucose was detected by co-TLC with authentic sample .

2-methoxy-4-(2, 3-dihydroxy-propionyl)-phenyl-1-O-(6-O-galloyl)-β-D-glucopyranoside (1) . C₂₃ H₂₆ O₁₄, white amorphous powder. [α]_D²⁵ -17° (c = 0.3, MeOH). IR (KBr) cm⁻¹: 3406, 1720, 1705, 1612, 1516, 1351. ¹H and ¹³C NMR: see Table 1. Negative FABMS *m/z* 525 [M-H]⁻; HRESIMS *m/z* 549.1403 [M+Na]⁺ (calcd for C₂₃ H₂₆ O₁₄ Na 549.1406) .

4-hydroxy-3-methoxy-phenyl-1-O-(6-O-galloyl)-β-D-glucopyranoside (2) . C₂₀ H₂₂ O₁₂, white amorphous powder. [α]_D²⁵ -31.3° (c = 0.5, Me₂CO). ¹H and ¹³C NMR: same as the data reported in Ishimaru *et al.* (1987) and Saijo *et al.* (1989) .

References:

- Brown JE, Rice-Evans CA, 1998. Luteolin-rich artichoke extract protects low density lipoprotein from oxidation *in vitro* [J]. *Free Radical Research*, 29: 247—255
- Dranik LI, Dolganenko LG, Slapke J *et al.*, 1996. Chemical composition and medical usage of *Cynara scolymus* L. [J]. *Rastit Resur*, 32: 98—104
- Ishimaru K, Nonaka GI, Nishioka I, 1987. Phenol glucoside gallates from *Quercus mongolica* and *Q. acutissima* [J]. *Phytochemistry*, 26 (4): 1147—1152
- Kraft K, 1997. Artichoke leaf extract—recent findings reflecting effects on lipid metabolism, liver, and gastrointestinal tracts [J]. *Phytomedicine*, 4: 369—378
- Kirchhoff R, Beckers C, Kirchhoff GM *et al.*, 1994. Increase in choleresis by means of artichoke extract. Results of a randomized placebo-controlled double-blind study [J]. *Phytomedicine*, 1: 107—115
- Schütz K, Kammerer D, Carle R *et al.*, 2004. Identification and quantification of caffeoylquinic acids and flavonoids from artichoke (*Cynara scolymus* L.) heads, juice, and pomace by HPLC-DAD-ESI MS [J]. *Journal of Agricultural and Food Chemistry*, 52: 4090—4096
- Shimoda H, Ninomiya K, Nishida N *et al.*, 2003. Anti-Hyperlipidemic sesquiterpenes and new sesquiterpene glycosides from the leaves of artichoke (*Cynara scolymus* L.): structure requirement and mode of action [J]. *Bioorganic & Medicinal Chemistry Letters*, 13: 223—228
- Saijo R, Nonaka GI, Nishioka I, 1989. Phenol glucoside gallates from *Mallotus japonicus* [J]. *Phytochemistry*, 28 (9): 2443—2446
- Wang MF, Simon JE, Aviles IF *et al.*, 2003. Analysis of antioxidative phenolic compounds in artichoke (*Cynara scolymus* L.) [J]. *Journal of Agricultural and Food Chemistry*, 51: 601—608
- Zhu XF, Zhang HX, Lo R, 2004. Phenolic compounds from the leaf extract of artichoke (*Cynara scolymus* L.) and their antimicrobial activities [J]. *Journal of Agricultural and Food Chemistry*, 52: 7272—7278