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论 著

膜荚黄芪中皂苷类化学成分研究

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摘要 **目的:**研究膜荚黄芪中皂苷类化学成分。**方法:**采用硅胶柱色谱和HPLC制备色谱方法分离纯化得到单体化合物,采用有机波谱方法鉴定化合物结构。**结果:** 从膜荚黄芪乙醇提取物中分离得到7个皂苷类化合物, 分别为Cyclocanthoside A (1), Isoastragaloside Ⅳ (2), Cyclocanthoside E (3), Astragaloside Ⅶ (4), Astragaloside Ⅲ (5), Astragaloside Ⅵ (6), 黄芪甲苷Ⅳ (7)。**结论:**化合物1为首次从该植物中分离得到。

关键词 膜荚黄芪;化学成分;色谱分离;皂苷类;Cyclocanthoside A
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Studies on Astragalosides from *Astragalus membranceus*(Fisch) Bge

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Abstract **Objective:** To study astragalosides from *Astragalus membranceus* (Fisch) Bge. **Methods:** Chemical constituents were isolated and purified by repeated column chromatography (silica geland preparative HPLC). Their structures were elucidated on the basis of spectral data analysis. **Results:** Seven compounds (1~7) were isolated and their structures were identified by comparison of their spectral data with literature values as follows: Cyclocanthoside A (1), Isoastragaloside Ⅳ (2), Cyclocanthoside E (3),Astragaloside Ⅶ (4), Astragaloside Ⅲ (5), Astragaloside Ⅵ (6), Astragaloside Ⅳ (7). **Conclusion:** Compounds 1 has been isolated from this plant for the first time.

Key words *Astragalus membranceus*(Fisch) Bge; chemical constituents; chromatographic separation; Astragalosides; Cyclocanthoside A

膜荚黄芪(*Astragalus membranceus*(Fisch) Bge)是豆科黄芪属植物,是黄芪的正品之一,为常用中药[1],具有补气固表,利尿脱毒,益气补中之功效[2]。用于久泻脱肛,久溃不敛,内热消渴,慢性肾炎蛋白尿、糖尿病等[3]。黄芪的化学成分主要为三萜皂苷类、黄酮类和多糖类[4],本文主要对膜荚黄芪中皂苷类成分进行了研究。

1 材料与方法

1.1 仪器、试剂及材料 核磁共振仪:Bruker AV 400 instrument (TMS内标); 液质联用色谱仪:Alliance 2695, Quattro Micro TM ESI (Waters);半制备高效液相色谱仪:日本分光公司(JASCO),PU-2089(泵),RI-2031和UV-2075 (检测器); 制备HPLC色谱柱:YMC-Pack SIL SL12S05-2510WT (10 mm×250 mm);氘代试剂(ALDRICH公司);柱色谱和薄层色谱用硅胶均系青岛海洋化工厂生产, 所用试剂均系分析纯。

膜荚黄芪于2010年购买于陕西, 由天津医科大学药学院唐生安副教授鉴定, 标本(D20100415)存放于天津医科大学药学院。

1.2 提取分离 将黄芪乙醇提取物881g, 溶于水(4 500 mL),先后用20%、80%醇沉,得到两个组分(1101-1102)。将1102经AB-8柱分离,以5%乙醇为流动相洗脱,得到5个组分(1201-1205)。

1201经Toyopearl HW-40柱分离, 以二氯甲烷-甲醇(1:1)为流动相洗脱,得到5个组分(3201-3205)。3202经HPLC纯化,以甲醇-水(8:2)为流动相,得到12个组分(3301-3312)。3307经制备薄层色谱分离,以二氯甲烷-甲醇(2:1)为展开剂,得到化合物1(5.3 mg)、化合物2(12.4 mg)、化合物3(21.4 mg)。3305经GPC纯化,以甲醇为流动相,得到11个组分(3501-3511),得到化合物7(5.7 mg)。3503经制备薄层色谱分离,以二氯甲烷-甲醇(2:1)为展开剂,得到化合物4(10.7 mg)。

1201经HPLC纯化,以甲醇-水(8:2)为流动相,得到8个组分(2801-2808),得到化合物6(240.7 mg)。2808经制备薄层色谱分离,以二氯甲烷-甲醇(2:1)为展开剂,得到化合物5(45.9 mg)。

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2 结果

从膜荚黄芪中分离得到 7 个化合物。

2.1 化合物 1 Cyclocanthoside A,白色粉末。ESI-MSm/z625.1 $[M+H]^+$ (分子式 $C_{35}H_{60}O_9$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.24 (1H, br.s, H-19α), 0.42 (1H, br.s, H-19β), 0.86 (3H, s, 30-CH_3), 0.90 (3H, s, 29-CH_3), 1.00 (3H, s, 27-CH_3), 1.04 (3H, s, 21-CH_3), 1.07 (3H, s, 18-CH_3), 1.14 (3H, s, 26-CH_3), 1.24 (3H, s, 28-CH_3), 4.89 (1H, d, J = 19.32 Hz,H-1′);^{13}C-NMR (DMSO-d_6, 100 MHz)δ:31.7 (C-1), 29.8 (C-2), 87.8 (C-3), 42.1 (C-4), 53.3 (C-5), 67.1 (C-6), 37.8 (C-7), 46.5 (C-8), 21.0 (C-9), 28.7 (C-10), 26.0 (C-11), 32.9 (C-12), 45.2 (C-13), 46.3 (C-14), 48.2 (C-15), 71.0 (C-16), 56.6 (C-17), 18.3 (C-18), 29.5 (C-19), 29.0 (C-20), 18.8 (C-21), 33.0 (C-22), 27.7 (C-23), 77.2 (C-24), 72.2 (C-25), 25.4 (C-26), 26.6 (C-27), 16.4 (C-28), 28.3 (C-29), 20.1 (C-30), 106.5 (C-1′), 74.3 (C-2′), 77.2 (C-3′), 70.1 (C-4′), 66.0 (C-5′)。

2.2 化合物 2 IsoastragalosideⅣ,白色粉末。ESI-MSm/z801.2 $[M+H]^+$ (分子式 $C_{42}H_{72}O_{14}$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.24 (1H, br.s, H-19α), 0.44 (1H, br.s, H-19β), 0.89 (3H, s, 30-CH_3), 0.90 (3H, s, 29-CH_3), 1.14 (3H, s, 27-CH_3), 1.16 (3H, s, 21-CH_3), 1.21 (3H, s, 18-CH_3), 1.23 (3H, s, 26-CH_3), 1.24 (3H, s, 28-CH_3), 4.85 (1H, m,H-1′), 4.87 (1H, m, H-1″); ^{13}C-NMR (DMSO-d_6, 100 MHz)δ:32.0 (C-1), 30.0 (C-2), 87.8 (C-3), 42.1 (C-4), 53.3 (C-5), 67.1 (C-6), 38.0 (C-7), 46.4 (C-8), 20.7 (C-9), 29.0 (C-10), 26.0 (C-11), 33.0 (C-12), 45.0 (C-13), 45.8 (C-14), 46.3 (C-15), 74.0 (C-16), 57.9 (C-17), 21.3 (C-18), 30.3 (C-19), 86.6 (C-20), 27.5 (C-21), 35.2 (C-22), 25.6 (C-23), 81.7 (C-24), 78.1 (C-25), 23.0 (C-26), 25.1 (C-27), 16.4 (C-28), 28.4 (C-29), 20.2 (C-30), 106.5 (C-1′), 74.3 (C-2′), 77.2 (C-3′), 70.1 (C-4′), 66.0 (C-5′), 97.7 (C-1″), 72.6 (C-2″), 77.4 (C-3″), 70.5 (C-4″), 76.9 (C-5″), 61.6 (C-6″)。

2.3 化合物 3 Cyclocanthoside E,白色粉末。ESI-MSm/z787.4 $[M+H]^+$ (分子式 $C_{41}H_{70}O_{14}$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.19 (1H, br.s, H-19α), 0.45 (1H, br.s,H-19β), 0.86 (3H, s, 28-CH_3), 0.90 (3H, s, 18-CH_3), 1.00 (3H, s, 30-CH_3), 1.04 (3H, s, 26-CH_3), 1.05 (3H, s, 27-CH_3), 1.20 (3H, s, 29-CH_3), 1.23 (3H, s, 21-CH_3), 4.87 (1H, d, J = 7.0 Hz,H-1″), 4.92 (1H, br.s, H-1′);^{13}C-NMR (DMSO-d_6, 100 MHz)δ:29.7 (C-1), 29.5 (C-2), 87.8 (C-3), 42.0 (C-4), 51.9 (C-5), 77.2 (C-6), 33.7 (C-7), 45.3 (C-8), 20.4 (C-9), 29.2 (C-10), 26.0 (C-11), 32.9 (C-12), 45.3 (C-13), 45.4 (C-14), 47.5 (C-15), 70.1 (C-16), 56.6 (C-17), 18.3 (C-18), 28.2 (C-19), 29.0 (C-20), 18.5 (C-21), 31.8 (C-22), 27.7 (C-23), 78.3 (C-24), 72.1 (C-25), 25.5 (C-26), 26.6 (C-27), 16.4 (C-28), 27.9 (C-29), 19.8 (C-30), 106.5 (C-1′), 74.3 (C-2′), 77.1 (C-3′), 70.6 (C-4′), 66.0 (C-5′), 103.9 (C-1″), 74.6 (C-2″), 77.8 (C-3″), 71.1 (C-4″), 77.0 (C-5″), 61.8 (C-6″)。

2.4 化合物 4 AstragalosideⅦ, 白色粉末。ESI-MSm/z947.3 $[M+H]^+$ (分子式 $C_{47}H_{78}O_{19}$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.19 (1H, br.s, H-19α), 0.45 (1H, br.s, H-19β), 0.89 (3H, s, 28-CH_3), 0.91 (3H, s, 21-CH_3), 1.14 (3H, s, 26-CH_3), 1.16 (3H, s, 30-CH_3), 1.18 (3H, s, 18-CH_3), 1.22 (3H, s, 27-CH_3), 1.23 (3H, s, 29-CH_3), 4.85 (1H, m,H-1″), 4.87 (1H, m, H-1′), 4.88 (1H, m, H-1‴);^{13}C-NMR (DMSO-d_6, 100 MHz)δ: 31.8 (C-1), 29.7 (C-2), 87.8 (C-3), 42.0 (C-4), 52.0 (C-5), 78.4 (C-6), 34.2 (C-7), 45.5 (C-8), 20.8 (C-9), 28.8 (C-10), 25.7 (C-11), 33.1 (C-12), 45.8 (C-13), 45.8 (C-14), 45.7 (C-15), 73.9 (C-16), 57.9 (C-17), 21.0 (C-18), 29.1 (C-19), 86.7 (C-20), 27.5 (C-21), 35.3 (C-22), 25.7 (C-23), 81.7 (C-24), 78.1 (C-25), 22.9 (C-26), 25.2 (C-27), 16.4 (C-28), 28.0 (C-29), 19.9 (C-30), 106.5 (C-1′), 72.7 (C-2′), 77.0 (C-3′), 70.1 (C-4′), 66.0 (C-5′), 103.9 (C-1″), 74.3 (C-2″), 77.1 (C-3″), 70.7 (C-4″), 77.1 (C-5″), 61.7 (C-6″), 97.8 (C-1‴), 74.5 (C-2‴), 77.5 (C-3‴), 70.6 (C-4‴), 77.8 (C-5‴), 61.8 (C-6‴)。

2.5 化合物 5 AstragalosideⅢ, 白色粉末。ESI-MSm/z785.3 $[M+H]^+$ (分子式 $C_{41}H_{68}O_{14}$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.19 (1H, br.s, H-19α), 0.45 (1H, br.s, H-19β), 0.88 (3H, s, 30-CH_3), 0.89 (3H, s, 29-CH_3), 1.02 (3H, s, 27-CH_3), 1.11 (3H, s, 21-CH_3), 1.13 (3H, s, 18-CH_3), 1.18 (3H, s, 26-CH_3), 1.21 (3H, s, 28-CH_3), 5.05 (1H, m,H-1′), 5.43 (1H, m, H-1″); 13C-NMR (DMSO-d_6, 100 MHz)δ: 31.5 (C-1), 29.6 (C-2), 87.4 (C-3), 41.5 (C-4), 52.7 (C-5), 66.5 (C-6), 37.5 (C-7), 45.9 (C-8), 20.2 (C-9), 28.5 (C-10), 25.4 (C-11), 32.4 (C-12), 44.2 (C-13), 45.2 (C-14), 45.7 (C-15), 75.2 (C-16), 57.3 (C-17), 20.7 (C-18), 29.3 (C-19), 86.2 (C-20), 26.5 (C-21), 34.0 (C-22), 25.4 (C-23), 81.1 (C-24), 70.5 (C-25), 27.2 (C-26), 27.8 (C-27), 15.6 (C-28), 27.8 (C-29), 19.7 (C-30), 105.7 (C-1′), 80.6 (C-2′), 76.1 (C-3′), 69.4 (C-4′), 65.1 (C-

5′), 104.0 (C-1″), 72.2 (C-2″), 76.7 (C-3″), 69.8 (C-4″), 75.9 (C-5″), 60.8 (C-6″)。

2.6 化合物6 AstragalosideⅥ，白色粉末。ESI-MSm/z947.6 $[M+H]^+$ (分子式 $C_{47}H_{78}O_{19}$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.16 (1H, d, J = 3.6 Hz,H-19α), 0.47 (1H, d, J = 3.6 Hz, H-19β), 0.89 (3H, s, 28-CH_3), 0.90 (3H, s, 21-CH_3), 1.02(3H, s, 26-CH_3), 1.10 (3H, s, 30-CH_3), 1.13 (3H, s, 18-CH_3), 1.16 (3H, s, 27-CH_3), 1.18 (3H, s, 29-CH_3), 4.85 (1H, m,H-1″), 4.96 (1H, m, H-1‴), 5.47 (1H, m, H-1′);^{13}C-NMR (DMSO-d_6, 100 MHz)δ: 32.5 (C-1), 31.2 (C-2), 87.2 (C-3), 41.5 (C-4), 51.3 (C-5), 80.5 (C-6), 34.0 (C-7), 44.3 (C-8), 20.4 (C-9), 27.8 (C-10), 25.4 (C-11), 33.1 (C-12), 44.2 (C-13), 45.2 (C-14), 44.9 (C-15), 74.1 (C-16), 57.2 (C-17), 20.2 (C-18), 29.1 (C-19), 86.2 (C-20), 26.5 (C-21), 34.0 (C-22), 27.6 (C-23), 81.4 (C-24), 70.5 (C-25), 27.2 (C-26), 27.9 (C-27), 15.6 (C-28), 29.6 (C-29), 19.3 (C-30), 104.0 (C-1′), 86.2 (C-2′), 76.1 (C-3′), 68.5 (C-4′), 65.1 (C-5′), 104.0 (C-1″), 75.9 (C-2″), 77.2 (C-3″), 72.2 (C-4″), 76.8 (C-5″), 61.3 (C-6″), 103.4 (C-1‴), 75.0 (C-2‴), 77.5 (C-3‴), 70.2 (C-4‴), 76.8 (C-5‴), 60.9 (C-6‴)。

2.7 化合物7 AstragalosideⅣ，白色粉末。ESI-MSm/z785.5 $[M+H]^+$ (分子式 $C_{41}H_{68}O_{14}$)。^{1}H NMR (DMSO-d_6, 400 MHz)δ:0.19 (1H, d, J = 3.7 Hz,H-19α), 0.47 (1H, d, J = 3.7 Hz, H-19β), 0.90 (3H, s, 21-CH_3, 28-CH_3), 1.02 (3H, s, 18-CH_3), 1.10 (3H, s, 26-CH_3), 1.13 (3H,s,30-CH_3), 1.16 (3H,s,27-CH_3), 1.18 (3H,s, 29-CH_3), 4.88 (1H, br.s,H-16α);^{13}C-NMR (DMSO-d_6, 100 MHz)δ: 32.5 (C-1), 31.9 (C-2), 87.3 (C-3), 41.5 (C-4), 51.4 (C-5), 77.9 (C-6), 34.0 (C-7), 44.9 (C-8), 20.3 (C-9), 28.2 (C-10), 25.3 (C-11), 33.5 (C-12), 44.2 (C-13), 45.3 (C-14), 45.1 (C-15), 73.8 (C-16), 57.2 (C-17), 20.4 (C-18), 29.2 (C-19), 86.2 (C-20), 26.5 (C-21), 34.0 (C-22), 28.3 (C-23), 80.5 (C-24), 70.5 (C-25), 27.2 (C-26), 27.5 (C-27), 15.9 (C-28), 27.8 (C-29), 19.5 (C-30), 106.1 (C-1′), 74.0 (C-2′), 76.6 (C-3′), 70.1 (C-4′), 65.5 (C-5′), 103.4 (C-1″), 72.2 (C-2″), 77.3 (C-3″), 69.6 (C-4″), 76.7 (C-5″), 61.3 (C-6″)。

3 讨论

本文对膜荚黄芪进行化学成分分离、纯化并得到单体化合物。通过核磁共振波谱、质谱等方法确定化合物的结构。结果表明，从膜荚黄芪分离得到7个化合物，^{1}H-NMR 和 ^{13}C-NMR 数据与文献报道一致，依次鉴定为 Cyclocanthoside A (1)[5]，IsoastragalosideⅣ (2)[5]，Cyclocanthoside E (3)[6]，AstragalosideⅦ (4)[7]，AstragalosideⅢ (5)[8]，AstragalosideⅥ (6)[9]，黄芪甲苷Ⅳ (7)[8]。其中1为本属植物中首次分离得到，丰富了豆科黄芪属植物化学成分研究。皂苷类成分是黄芪中非常重要的药理活性成分，抗炎抑炎、免疫调节、抗氧化和神经保护[10]。目前中药谱效关系研究中，以多成分协同作用为主，但各成分对药效的贡献程度不同。本文分离制备更多的单体化合物，进而对中药各单体化合物的药效关系进行研究，为进一步深入研究黄芪化学成分和药理作用提供了物质基础。

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