糙枝金丝桃间苯三酚类成分的研究

徐 雯[1],许 芳[2],高 万[2],李晓秀[3],徐 芳[4],赵 军[4],吉腾飞[2]*,刘 波[3]*

[1]新疆维吾尔自治区第三人民医院,乌鲁木齐 830011;[2] 中国医学科学院 北京协和医学院药物研究所 天然药物活性物质与功能国家重点实验室,北京 100050;[3] 沈阳医学院药学院,沈阳 110034;[4]新疆药物研究所维吾尔药重点实验室,乌鲁木齐 830004

摘 要:对藤黄科金丝桃属植物糙枝金丝桃 *Hypericum scabrum* 地上部分的化学成分进行了研究。利用多种色谱技术从糙枝金丝桃乙醇提取物中分离得到了 10 个间苯三酚类成分,包括 1 个新化合物,命名为 hyperibrin H(**1**);其他化合物被分别鉴定为 hypermongone A(**2**)、hypermongone E(**3**)、hypermongone F(**4**)、hypermongone G(**5**)、hypermongone H(**6**)、sampsonione L(**7**)、garcinielliptone I(**8**)、propolone C(**9**)、garcinielliptone N(**10**)。化合物 **2**~**10** 均为首次从该植物中分离得到。化合物 **5** 和 **6** 在 10 μM 浓度下对谷氨酸诱导的神经元损伤具有保护作用。

关键词:糙枝金丝桃;间苯三酚;神经保护活性

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Polyprenylated acylphloroglucinol derivatives from *Hypericum scabrum*

XU Wen[1], XU Fang[2], GAO Wan[2], LI Xiao-xiu[3], XU Fang[4], ZHAO Jun[4], JI Teng-fei[2]*, LIU Bo[3]*

[1]*The Third People's Hospital of Xinjiang Uygur Autonomous Region, Urimuqi 830011, China*;

[2]*State Key Laboratory of Bioactive Substance and Function of Natural Medicines, Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing 100050, China*;

[3]*Shenyang Medical College, Shenyang 110034, China*;

[4]*Key Laboratory for Uighur Medicine, Institute of Materia Medica of Xinjiang, Urumqi 830004, China*

Abstract: To study the chemical constituents from the aerial part of *Hypericum scabrum*, ten polyprenylated acylphloroglucinol derivatives were isolated from the ethanol extract of *H. scabrum*, including a new compound hyperibrin H (**1**). The other compounds were elucidated as: hypermongone A (**2**), hypermongone E (**3**), hypermongone F (**4**), hypermongone G (**5**), hypermongone H (**6**), sampsonione L (**7**), garcinielliptone I (**8**), propolone C (**9**), and garcinielliptone N (**10**). Compounds **2**-**10** were isolated from this plant for the first time. Compounds **5** and **6** showed neuroprotective activity against glutamate-induced toxicity in SK-N-SH cells at 10 μM.

Key words: *Hypericum scabrum*; polyprenylated acylphloroglucinol; neuroprotective activity

藤黄科(Guttiferae)金丝桃属(*Hypericum*)植物在全国各地均有分布,尤以华东、华西、川北、贵州、新疆等地分布较为集中。全世界约有 400 余种,我国有 55 种 8 个亚种。该属植物在民间有 2 400 余年的用药历史,主要有清热解毒、散瘀止痛、祛风湿等功效[1]。金丝桃属植物中主要含有萘骈二蒽酮类、黄酮类、呫酮类和间苯三酚类成分,其中间苯三酚类成分因其新颖的化学结构和多样的药理活性而倍受关注[2,3]。

糙枝金丝桃(*Hypericum scabrum*)为金丝桃属多年生草本植物,为我国新疆特有种,且仅分布在天山、阿尔泰山、塔尔巴哈台山前山至中山地区[4]。为了进一步明确其药效物质基础,同时也为寻找结构新颖并具有较好药理活性的先导化合物,本文对糙枝金丝桃地上部分乙醇提取物的石油醚萃取部位的化学成分进行了分离纯化和结构鉴定,并测试了

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*通信作者 Tel:86-24-62215711;E-mail:liubopaul@163.com,jitf@imm.ac.cn

各化合物对谷氨酸诱导的神经元损伤的保护活性。

1　材料与方法

1.1　材料

糙枝金丝桃于2013年7月采自新疆维吾尔自治区阿尔泰地区,并由新疆师范大学生命科学与化学学院李进教授鉴定为藤黄科金丝桃属植物糙枝金丝桃 *Hypericum scabrum*,标本现存于中国医学科学院药物研究所植物标本室,标本号为 No. ID-S-2545。

1.2　仪器与试剂

Thermo Nicolet 5700 型傅立叶变换红外光谱仪(美国热电公司);Mercury-400、Inova-500 和 SYS-600 核磁共振仪(美国 Varian 公司);Agilent 1100 Series LC-MSD-Trap-SL 型质谱仪(美国 Agilent 公司);柱层析硅胶(200 ~ 300 目和硅胶 H)及薄层层析用硅胶 GF_{254}(青岛海洋化工厂);MCI CHP20/P120(日本三菱公司);葡聚糖凝胶 Sephadex LH-20(瑞典 Amersham Pharmacia 公司);Agilent 1260 型高效液相色谱仪(美国 Agilent 公司),Rp C_{18} 色谱柱(分析型:4.6 mm × 250 mm,5 μm;制备型:10 mm × 250 mm,10 μm,日本 YMC 公司)。

1.3　提取与分离

将干燥的糙枝金丝桃地上部分 15.0 kg,粉碎后用5倍量的95%乙醇加热回流提取3次,每次2 h,减压回收溶剂得浸膏 2.3 kg。将浸膏分散于5倍量的水中混悬,依次用石油醚、乙酸乙酯萃取,得石油醚萃取部位 750.0 g,乙酸乙酯萃取部位 550.0 g。将石油醚萃取部位经减压硅胶柱色谱分离,用石油醚/乙酸乙酯(100∶0→0∶100)梯度洗脱,洗脱液经薄层色谱检测,合并相似的流分,回收溶剂得到13个流分(Fr. A ~ Fr. M)。

Fr. A(169.2 g),经硅胶柱色谱分离,依次用石油醚/乙酸乙酯(100∶0→0∶100)梯度洗脱得九个亚组分(Fr. Aa ~ Fr. Ai)。Fr. Ac(37.9 g)经二醇基硅胶柱色谱分离,石油醚/二氯甲烷(1∶1)洗脱,得四个亚组分(Fr. Ac-1 ~ 4)。Fr. Ac-1 经反复硅胶 H 柱色谱,凝胶柱色谱(石油醚/氯仿/甲醇 = 5∶5∶1)和制备液相色谱(95%甲醇/水)分离得到化合物 **1**(12 mg,t_R = 32.2 min)、**5**(28 mg,t_R = 38.5 min)和 **10**(5 mg,t_R = 48.3 min)。Fr. Ad(12.0 g)经硅胶 H 柱色谱,二氯甲烷/乙酸乙酯(20∶1)洗脱,得八个亚组分(Fr. Ad-1 ~ 8)。Fr. Ad-3 经制备液相色谱(90%甲醇/水)纯化得化合物 **3**(5 mg,t_R = 33.1 min)。Fr. Ad-7 经制备液相(90%甲醇/水)纯化得化合物 **2**(14 mg,t_R = 35.6 min)、**4**(25 mg,t_R = 42.2 min)和 **6**(21 mg,t_R = 45.7 min)。Fr. Ae(1.0 g)经硅胶 H 柱色谱,凝胶柱色谱(石油醚/氯仿/甲醇 = 5∶5∶1)和制备液相色谱(90%甲醇/水)分离得到化合物 **9**(34 mg,t_R = 34.8 min)。Fr. Ah 经硅胶 H 柱色谱,石油醚/乙酸乙酯(4∶1→2∶1→0∶1)洗脱,再经制备液相色谱(90%甲醇/水)纯化得化合物 **7**(38 mg,t_R = 31.6 min)和 **8**(24 mg,t_R = 39.2 min)。

1.4　神经保护活性测定

应用神经母细胞瘤 SK-N-SH 细胞株建立谷氨酸诱导损伤的细胞筛选模型,以 MTT 法观察化合物 **1** ~ **10** 对 SK-N-SH 细胞成活率的影响。SK-N-SH 细胞在 37 ℃、含 5% CO_2 的孵箱中培养,培养基为 DMEM(含 10% 胎牛血清,100 U/mL 青霉素和 100 μg/mL 链霉素,pH 7.2 ~ 7.4)。用培养基将细胞分散,使成为密度为 1×10^5 个/mL 的单细胞悬液,并以每孔 0.1 mL 接种于 96 孔板。培养 24 h 后换含有受试化合物的培养基,并于给药后 1 h 加入白藜芦醇(终浓度为 50 mmol/L)继续培养。给药后 24 h 换含 MTT(0.5 mg/mL)无血清的培养基,培养 4 h,吸去培养液,加入 DMSO 振荡使溶解,570 nm 测定各孔吸光值。

2　结果与讨论

2.1　结构鉴定

化合物 1　无色油状物;HR-ESI-MS:*m/z* 567.404 5 $[M + H]^+$(calcd for $C_{36}H_{55}O_5$,567.404 4)确定化合物的分子式为 $C_{36}H_{54}O_5$;^{1}H NMR 谱显示三个烯氢质子信号(δ_H 4.92,1H,t,J = 7.0 Hz;4.97,1H,t,J = 6.2 Hz;5.08,1H,t,J = 7.0 Hz),九个甲基信号(δ_H 1.00、1.23、1.23、1.53、1.65、1.66、1.66、1.67、1.71)以及一个仲丁基信号(δ_H 2.24,1H,m;1.14,3H,d,J = 6.6 Hz;1.34/1.69,2H,m;0.86,3H,t,J = 7.4 Hz)。^{13}C NMR 谱显示36个碳信号,包含三个羰基碳信号(δ_C 194.4、206.7、210.8)和六个烯碳信号(δ_C 119.8、122.0、22.2、133.6、133.7、134.5)(见表1)。从 HMBC 谱中可观察到 H_2-15(δ_H1.90/2.48)与 C-1、C-7、C-8、C-16、C-17、C-36 相关;H_2-21(δ_H3.11/3.31)与 C-2、C-3、C-4、C-22、C-23 相关;H_2-26(δ_H2.46)与 C-4、C-5、C-6、C-9、C-27、C-28 相关;H_2-31(δ_H1.58/2.03)与 C-6、C-7、C-8、C-32、C-33、C-36 相关;H_3-36(δ_H1.00)与 C-1、C-7、C-8、C-15 相关,如图1所示,推断化合物 **1** 是与 Hyphenrone E[5] 具有相同平面结构的间苯三酚

表 1 化合物 1 的 ^{1}H NMR(400 MHz)和 ^{13}C NMR(100 MHz)数据($CDCl_3$)

Table 1 ^{1}H NMR (400 MHz) and ^{13}C NMR (100 MHz) data of compound **1** ($CDCl_3$)

No.	δ_C	δ_H (J in Hz)	No.	δ_C	δ_H (J in Hz)
1	74.5		19	25.9	1.23,s
2	166.5		20	25.5	1.23,s
3	129.3		21	22.9	3.11,dd(15.2,6.2) 3.31,dd(15.2,6.2)
4	194.4		22	122.2	4.97,t(6.2)
5	64.2		23	133.6	
6	40.2	1.50,m 1.87,m	24	18.2	1.71,s
7	36.9	1.95,m	25	25.6	1.67,s
8	45.3		26	29.5	2.46,m
9	206.7		27	119.8	5.08,t(7.0)
10	210.8		28	134.5	
11	48.0	2.24,m	29	18.2	1.65,s
12	17.6	1.14,d(6.6)	30	26.1	1.66,s
13	26.6	1.34,m 1.69,m	31	26.9	1.58,m 2.03,m
14	11.6	0.86,t(7.4)	32	122.0	4.92,t(7.0)
15	33.4	1.87,m 2.50,m	33	133.7	
16	24.3	1.56,m 1.82,m	34	18.0	1.53,s
17	88.0	3.84,d(9.4)	35	26.0	1.66,s
18	72.7		36	17.0	1.00,s

类衍生物。从 ROESY 谱图中可观察到 H_2-31(δ_H 2.03/1.58)与 H_3-36(δ_H 1.00)相关;H_3-36(δ_H 1.00)与 H-6a(δ_H 1.50)相关;H-31(δ_H 2.03)与 H-15a(δ_H 1.90)相关;H-17(δ_H 3.84)与 H-15b(δ_H 2.50)相关;以及 H_2-26(δ_H 2.46)与 H-6a(δ_H 1.50)相关,如图 1 所示,说明 C-8、C-5 和 C-7 位取代基均为 β 构型,H-17 为 α 构型。化合物 **1** 的 CD 谱与已知化合物 hyperscabrone D[6] 非常相似,如图 2 所示,由此可确定化合物 **1** 的绝对构型为 1*S*、5*R*、7*S*、8*R* 和 17*R*,将该化合物命名为 hyperibrin H。化合物 **1** 的详细结构鉴定数据原始图谱可从本刊官网免费下载(www. trcw. ac. cn)。

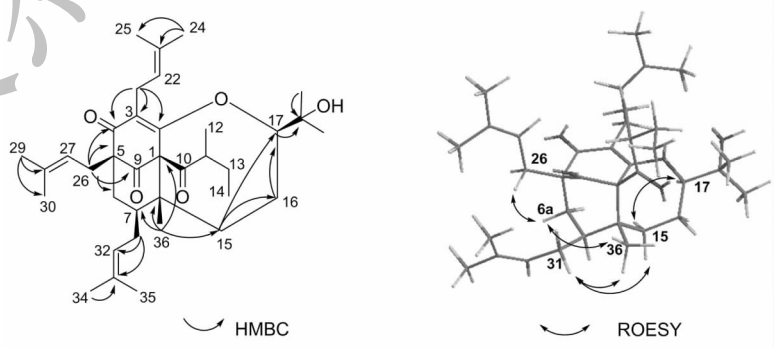

图 1 化合物 1 的主要 HMBC 和 ROESY 相关

Fig. 1 Key HMBC and ROESY correlations of compound **1**

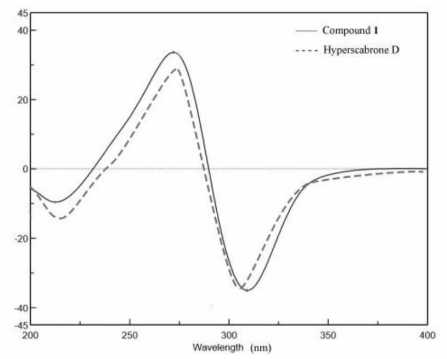

图2　化合物1和hyperscabrone D的CD谱

Fig. 2　CD spectra of compound **1** and hyperscabrone D

化合物2　无色油状物;ESI-MS:*m/z* 535.3 [M + Na]$^+$,分子式为$C_{32}H_{48}O_5$。^{1}H NMR(400 MHz, $CDCl_3$)δ:1.28(1H,t,*J* = 13.6 Hz,H-6a),1.92(1H,dd,*J* = 13.6,4.4 Hz,H-6b),1.61(1H,m,H-7),2.88(1H,dd,*J* = 14.6,10.0 Hz,H-10a),3.06(1H,dd,*J* = 14.6,10.0 Hz,H-10b),4.62(1H,t,*J* = 10.0 Hz,H-11),1.24(3H,s,H-13),1.33(3H,s,H-14),1.22(3H,s,H-15),1.70(1H,m,H-16a),2.11(1H,m,H-16b),4.92(1H,t,*J* = 6.4 Hz,H-17),1.53(3H,s,H-19),1.66(3H,s,H-20),1.42(1H,m,H-21a),1.81(1H,m,H-21b),2.00(1H,m,H-22a),2.20(1H,m,H-22b),5.00(1H,t,*J* = 6.4 Hz,H-23),1.59(3H,s,H-25),1.66(3H,s,H-26),1.11(3H,s,H-27),2.16(1H,m,H-29),1.17(3H,d,*J* = 6.4 Hz,H-30),1.36(1H,m,H-31a),1.69(1H,m,H-31b),0.88(3H,t,*J* = 7.6 Hz,H-32);^{13}C NMR(100 MHz,$CDCl_3$)δ:74.8(C-1),172.0(C-2),120.0(C-3),191.1(C-4),60.1(C-5),41.8(C-6),44.6(C-7),47.1(C-8),206.5(C-9),26.9(C-10),93.7(C-11),71.4(C-12),25.1(C-13),26.5(C-14),16.0(C-15),28.0(C-16),122.4(C-17),133.6(C-18),18.0(C-19),25.9(C-20),39.2(C-21),25.4(C-22),124.5(C-23),132.3(C-24),17.9(C-25),25.8(C-26),12.9(C-27),208.5(C-28),47.4(C-29),17.2(C-30),27.2(C-31),11.9(C-32)。以上数据与文献[7]报道的化合物对比一致,鉴定为hypermongone A。

化合物3　无色油状物;ESI-MS:*m/z* 535.3 [M + Na]$^+$,分子式为$C_{32}H_{48}O_5$。^{1}H NMR(400 MHz, $CDCl_3$)δ:1.43(1H,t,*J* = 13.6 Hz,H-6a),1.92(1H,dd,*J* = 13.6,4.4 Hz,H-6b),1.57(1H,m,H-7),2.88(1H,dd,*J* = 14.6,10.0 Hz,H-10a),2.98(1H,dd,*J* = 14.6,10.0 Hz,H-10b),4.78(1H,t,*J* = 10.0 Hz,H-11),1.21(3H,s,H-13),1.27(3H,s,H-14),1.32(3H,s,H-15),1.74(1H,m,H-16a),2.11(1H,m,H-16b),4.92(1H,t,*J* = 6.4 Hz,H-17),1.53(3H,s,H-19),1.66(3H,s,H-20),1.39(1H,m,H-21a),1.91(1H,m,H-21b),1.91(1H,m,H-22a),2.11(1H,m,H-22b),5.05(1H,t,*J* = 6.4 Hz,H-23),1.59(3H,s,H-25),1.66(3H,s,H-26),1.02(3H,s,H-27),1.91(1H,m,H-29),1.12(3H,d,*J* = 6.4 Hz,H-30),1.32(1H,m,H-31a),1.76(1H,m,H-31b),0.80(3H,t,*J* = 7.2 Hz,H-32);^{13}C NMR(100 MHz,$CDCl_3$)δ:83.7(C-1),187.6(C-2),117.7(C-3),176.8(C-4),50.7(C-5),39.7(C-6),43.7(C-7),48.1(C-8),206.6(C-9),27.8(C-10),92.7(C-11),72.3(C-12),23.7(C-13),25.0(C-14),16.0(C-15),27.2(C-16),122.5(C-17),133.6(C-18),18.0(C-19),25.9(C-20),36.8(C-21),25.4(C-22),124.5(C-23),131.3(C-24),17.9(C-25),25.8(C-26),13.7(C-27),209.3(C-28),48.9(C-29),16.7(C-30),27.2(C-31),11.7(C-32)。以上数据与文献[7]报道的化合物对比一致,鉴定为hypermongone E.

化合物4　无色油状物;ESI-MS:*m/z* 535.3 [M + Na]$^+$,分子式为$C_{32}H_{48}O_5$。^{1}H NMR(400 MHz, $CDCl_3$)δ:1.41(1H,t,*J* = 13.6 Hz,H-6a),1.96(1H,dd,*J* = 13.6,4.4 Hz,H-6b),1.65(1H,m,H-7),2.88(1H,dd,*J* = 14.6,10.0 Hz,H-10a),3.04(1H,dd,*J* = 14.6,10.0 Hz,H-10b),4.78(1H,t,*J* = 10.0 Hz,H-11),1.21(3H,s,H-13),1.30(3H,s,H-14),1.32(3H,s,H-15),1.78(1H,m,H-16a),2.14(1H,m,H-16b),4.96(1H,t,*J* = 6.4 Hz,H-17),1.57(3H,s,H-19),1.70(3H,s,H-20),1.44(1H,m,H-21a),1.91(1H,m,H-21b),1.91(1H,m,H-22a),2.11(1H,m,H-22b),5.05(1H,t,*J* = 6.4 Hz,H-23),1.59(3H,s,H-25),1.64(3H,s,H-26),1.02(3H,s,H-27),1.85(1H,m,H-29),1.12(3H,d,*J* = 6.4 Hz,H-30),1.32(1H,m,H-31a),1.74(1H,m,H-31b),0.80(3H,t,*J* = 7.2 Hz,H-32);^{13}C NMR(100 MHz,$CDCl_3$)δ:83.8(C-1),187.6(C-2),117.6(C-3),176.9(C-4),50.6(C-5),39.9(C-6),43.3(C-7),48.0(C-8),206.8(C-9),27.6(C-10),93.2(C-11),72.3(C-12),24.2(C-13),25.4

(C-14),15.4(C-15),27.5(C-16),122.6 (C-17),133.6(C-18),18.0(C-19),25.9(C-20),36.8(C-21),25.4(C-22),124.9(C-23),131.3(C-24),17.9(C-25),25.8(C-26),13.9(C-27),209.3(C-28),48.9(C-29),16.7(C-30),27.2(C-31),11.7(C-32)。以上数据与文献[7]报道的化合物对比一致,鉴定为 hypermongone F。

化合物 5 无色油状物;ESI-MS:*m/z* 521.3 [M + Na]$^+$,分子式为 $C_{31}H_{46}O_5$。^{1}H NMR(400 MHz,$CDCl_3$)δ:1.43(1H,t,*J* = 13.6 Hz,H-6a),1.92(1H,m,H-6b),1.59(1H,m,H-7),2.87(1H,dd,*J* = 14.8,7.6 Hz,H-10a),2.98(1H,dd,*J* = 14.8,10.4 Hz,H-10b),4.77(1H,dd,*J* = 10.4,7.6 Hz,H-11),1.21(3H,s,H-13),1.26(3H,s,H-14),1.32(3H,s,H-15),1.72(1H,m,H-16a),2.12(1H,m,H-16b),4.92(1H,t,*J* = 7.2 Hz,H-17),1.57(3H,s,H-19),1.66(3H,s,H-20),1.39(1H,m,H-21a),1.91(1H,m,H-21b),1.91(1H,m,H-22a),2.11(1H,m,H-22b),5.05(1H,t,*J* = 6.4 Hz,H-23),1.59(3H,s,H-25),1.64(3H,s,H-26),1.02(3H,s,H-27),2.17(1H,m,H-29),1.05(3H,d,*J* = 6.4 Hz,H-30),1.13(1H,m,H-31);^{13}C NMR(100 MHz,$CDCl_3$)δ:83.8(C-1),187.6(C-2),117.6(C-3),176.8(C-4),50.7(C-5),39.6(C-6),43.6(C-7),48.0(C-8),206.7(C-9),27.8(C-10),92.7(C-11),72.2(C-12),23.8(C-13),25.0(C-14),15.5(C-15),27.2(C-16),122.7(C-17),133.7(C-18),18.0(C-19),25.9(C-20),36.8(C-21),25.1(C-22),124.9(C-23),131.3(C-24),17.7(C-25),25.8(C-26),13.7(C-27),209.9(C-28),42.2(C-29),20.6(C-30),21.6(C-31)。以上数据与文献[7]报道的化合物对比一致,鉴定为 hypermongone G。

化合物 6 无色油状物;ESI-MS:*m/z* 521.3 [M + Na]$^+$,分子式为 $C_{31}H_{46}O_5$。^{1}H NMR(400 MHz,$CDCl_3$)δ:1.41(1H,t,*J* = 13.6 Hz,H-6a),1.96(1H,m,H-6b),1.65(1H,m,H-7),2.87(1H,dd,*J* = 14.8,8.0 Hz,H-10a),3.03(1H,dd,*J* = 14.8,10.4 Hz,H-10b),4.81(1H,dd,*J* = 10.4,8.0 Hz,H-11),1.21(3H,s,H-13),1.30(3H,s,H-14),1.32(3H,s,H-15),1.78(1H,m,H-16a),2.14(1H,m,H-16b),4.96(1H,t,*J* = 7.2 Hz,H-17),1.57(3H,s,H-19),1.70(3H,s,H-20),1.47(1H,m,H-21a),1.91(1H,m,H-21b),1.91(1H,m,H-22a),2.11(1H,m,H-22b),5.05(1H,t,*J* = 6.0 Hz,H-23),1.59(3H,s,H-25),1.64(3H,s,H-26),1.02(3H,s,H-27),2.09(1H,m,H-29),1.05(3H,d,*J* = 6.4 Hz,H-30),1.13(1H,m,H-31);^{13}C NMR(100 MHz,$CDCl_3$)δ:83.8(C-1),187.6(C-2),117.7(C-3),177.0(C-4),50.7(C-5),39.6(C-6),43.2(C-7),48.0(C-8),206.7(C-9),27.6(C-10),93.3(C-11),72.1(C-12),24.1(C-13),25.5(C-14),15.5(C-15),27.5(C-16),122.6(C-17),133.6(C-18),18.1(C-19),26.0(C-20),36.7(C-21),25.1(C-22),124.9(C-23),131.3(C-24),17.7(C-25),25.8(C-26),13.9(C-27),209.7(C-28),42.3(C-29),20.6(C-30),21.6(C-31)。以上数据与文献[7]报道的化合物对比一致,鉴定为 hypermongone H。

化合物 7 无色油状物;ESI-MS:*m/z* 541.2 [M + Na]$^+$,分子式为 $C_{33}H_{42}O_5$。^{1}H NMR(400 MHz,$CDCl_3$)δ:1.64(1H,m,H-6a),2.12(1H,dd,*J* = 12.4,4.0 Hz,H-6b),1.75(1H,m,H-7),7.44(2H,d,*J* = 8.4 Hz,H-12,16),7.22(2H,t,*J* = 8.0 Hz,H-13,15),7.38(1H,t,*J* = 8.0 Hz,H-14),3.04(1H,dd,*J* = 14.4,6.8 Hz,H-17a),3.14(1H,dd,*J* = 14.4,6.8 Hz,H-17b),5.05(1H,t,*J* = 7.2 Hz,H-18),1.66(3H,s,H-20),1.66(3H,s,H-21),1.88(1H,dd,*J* = 12.8,6.0 Hz,H-22a),2.71(1H,dd,*J* = 12.8,10.0 Hz,H-22b),4.63(1H,dd,*J* = 10.0,6.0 Hz,H-23),1.40(3H,s,H-25),1.24(3H,s,H-26),1.74(1H,m,H-27a),2.20(2H,m,H-27b),4.98(1H,m,H-28),1.72(3H,s,H-30),1.60(3H,s,H-31),1.21(3H,s,H-32),1.40(3H,s,H-33);^{13}C NMR(100 MHz,$CDCl_3$)δ:77.1(C-1),194.0(C-2),115.6(C-3),172.4(C-4),59.8(C-5),36.4(C-6),47.7(C-7),49.2(C-8),205.4(C-9),193.5(C-10),136.9(C-11),127.8(C-12),128.0(C-13),131.8(C-14),128.0(C-15),127.8(C-16),22.2(C-17),119.7(C-18),132.5(C-19),25.7(C-20),17.6(C-21),30.9(C-22),90.0(C-23),70.8(C-24),23.9(C-25),26.5(C-26),29.1(C-27),124.4(C-28),132.5(C-29),25.9(C-30),17.9(C-31),22.4(C-32),26.9(C-33)。以上数据与文献[8]报道的化合物对比一致,鉴定为 sampsonione L。

化合物 8 无色油状物;ESI-MS:*m/z* 519.3 [M + H]$^+$,分子式为 $C_{33}H_{42}O_5$。^{1}H NMR(400 MHz,$CDCl_3$)δ:1.52(1H,t,*J* = 12.8 Hz,H-6a),2.00

(1H,dd,J = 12.8,4.0 Hz, H-6b),1.67(1H,m,H-7),7.54(2H,d,J = 7.2 Hz,H-12,16),7.27(2H,t,J = 7.2 Hz,H-13,15),7.40(1H,t,J = 7.2 Hz,H-14),2.93(1H,dd,J = 14.8,7.2 Hz,H-17a),2.99(1H,dd,J = 10.4,7.2 Hz,H-17b),4.83(1H,dd,J = 10.4,7.2 Hz,H-18),1.24(3H,s,H-20),1.30(3H,s,H-21),2.45(1H,dd,J = 14.4,7.6 Hz,H-22a),2.60(1H,dd,J = 14.4,7.6 Hz,H-22b),5.10(1H,t,J = 7.6 Hz,H-23),1.67(3H,s,H-25),1.67(3H,s,H-26),2.18(2H,m,H-27),4.98(1H,t,J = 7.2 Hz,H-28),1.72(3H,s,H-30),1.58(3H,s,H-31),1.13(3H,s,H-32),1.40(3H,s,H-33);^{13}C NMR(100 MHz,$CDCl_3$)δ:79.0(C-1),187.9(C-2),117.4(C-3),176.1(C-4),55.8(C-5),39.3(C-6),43.7(C-7),48.0(C-8),206.3(C-9),193.3(C-10),136.6(C-11),127.9(C-12),128.3(C-13),132.1(C-14),127.9(C-15),128.3(C-16),27.5(C-17),92.5(C-18),72.0(C-19),23.7(C-20),25.0(C-21),28.9(C-22),118.3(C-23),135.4(C-24),25.8(C-25),18.1(C-26),26.8(C-27),122.5(C-28),133.8(C-29),26.1(C-30),19.2(C-31),15.8(C-32),23.7(C-33)。以上数据与文献[9]报道的化合物对比一致,鉴定为 garcinielliptone I。

化合物 9　无色油状物;ESI-MS:m/z 519.3 [M + H]$^+$,分子式为 $C_{33}H_{42}O_5$。^{1}H NMR(400 MHz,$CDCl_3$)δ:1.46(1H,m,H-6a),2.00(1H,dd,J = 13.6,4.4 Hz,H-6b),1.67(1H,m,H-7),7.58(2H,d,J = 8.0 Hz,H-12,16),7.35(2H,t,J = 8.0 Hz,H-13,15),7.48(1H,t,J = 7.6 Hz,H-14),2.96(2H,d,J = 10.0 Hz,H-17),4.65(1H,m,H-18),0.90(3H,s,H-20),0.90(3H,s,H-21),2.48(1H,m,H-22a),2.57(1H,m,H-22b),5.06(1H,m,H-23),1.70(3H,s,H-25),1.67(3H,s,H-26),1.65(1H,m,H-27a),2.13(1H,m,H-27b),4.96(1H,m,H-28),1.56(3H,s,H-30),1.67(3H,s,H-31),1.24(3H,s,H-32),1.34(3H,s,H-33);^{13}C NMR(100 MHz,$CDCl_3$)δ:70.6(C-1),171.9(C-2),118.3(C-3),188.1(C-4),65.3(C-5),41.8(C-6),43.2(C-7),47.0(C-8),206.9(C-9),193.2(C-10),137.2(C-11),128.5(C-12),128.2(C-13),132.8(C-14),128.2(C-15),128.5(C-16),26.5(C-17),93.5(C-18),70.6(C-19),23.7(C-20),26.4(C-21),29.3(C-22),119.5(C-23),134.7(C-24),18.1(C-25),26.0(C-26),27.7(C-27),122.3(C-28),133.5(C-29),17.9(C-30),25.9(C-31),15.7(C-32),24.1(C-33)。以上数据与文献[10]报道的化合物对比一致,鉴定为 propolone C。

化合物 10　无色油状物;ESI-MS:m/z 333.3 [M + H]$^+$,分子式为 $C_{22}H_{37}O_2$。^{1}H NMR(400 MHz,$CDCl_3$)δ:3.62(1H,s,H-2),2.35(1H,m,H-4),1.16(1H,m,H-5a),2.09(1H,m,H-5b),2.35(1H,m,H-6),2.40(1H,m,H-8),0.99(3H,d,J = 6.4 Hz,H-9),1.00(1H,d,J = 6.4 Hz,H-10),1.03(3H,s,H-11),1.00(3H,s,H-12),2.16(1H,m,H-13a),2.35(1H,m,H-13b),5.10(1H,t,J = 8.0 Hz,H-14),1.67(3H,s,H-16),1.66(1H,s,H-17),1.67(1H,m,H-18a),1.91(1H,m,H-18b),5.05(1H,m,H-19),1.57(3H,s,H-21),1.57(3H,s,H-22);^{13}C NMR(100 MHz,$CDCl_3$)δ:208.8(C-1),70.6(C-2),43.4(C-3),48.2(C-4),34.8(C-5),50.9(C-6),208.8(C-7),42.9(C-8),17.8(C-9),17.2(C-10),25.7(C-11),25.8(C-12),27.4(C-13),123.2(C-14),132.7(C-15),25.8(C-16),25.7(C-17),27.5(C-18),121.4(C-19),133.1(C-20),25.7(C-21),17.7(C-22)。以上数据与文献[11]报道的化合物对比一致,鉴定为 garcinielliptone N。

2.2　神经保护活性评价

应用神经母细胞瘤 SK-N-SH 细胞株建立谷氨酸诱导损伤的细胞筛选模型,以 MTT 法观察化合物 **1** ~ **10** 对 SK-N-SH 细胞成活率的影响。结果表明,化合物 **5** 和 **6** 具有一定的神经保护活性(见表 2)。

表 2　化合物 5 和 6 对谷氨酸诱导的神经元损伤的保护作用

Table 2　Neuroprotective effects of compounds **5** and **6** against glutamate-induced toxicity in SK-N-SH cell

化合物 Compound	浓度 Concentration (μM)	细胞存活率 Cell viability (%)
谷氨酸 *L*-Glutamic acid	27 mM	61.9
白藜芦醇 Resveratrol	10	72.6
5	10	71.6
6	10	65.6

注:白藜芦醇为阳性对照。

Note:Resveratrol was used as positive control.

3　讨论与结论

本文对糙枝金丝桃地上部分的乙醇提取物进行了化学成分研究,共分离鉴定了 10 个间苯三酚类成

分,其中化合物 **1** 为新化合物。并对各化合物的神经保护活性进行了测试,发现化合物 **5** 和 **6** 在 10 μM 浓度下对谷氨酸诱导的神经元损伤具有一定保护作用,化合物 **5** 与阳性对照白藜芦醇的活性相当。此外,间苯三酚类化合物多为无色油状物且具有多个手性中心,很难用经典的 X-Ray 单晶衍射实验来确定其绝对构型,但可以通过比较实验和计算 ECD 谱来进行确定。

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