

霍山石斛化学成分研究

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摘要:研究霍山石斛 *Dendrobium huoshanense* Tang et Cheng 茎的化学成分。应用硅胶、Sephadex LH-20、MCI-gel、Rp-18 结合 Semi-prep HPLC 技术进行分离纯化,从霍山石斛茎中分离得到 29 个化合物,分别鉴定为 4,4'-二羟基-3,5-二甲氧基联苄(1)、batatasin III(2)、5,4'-二羟基-3-甲氧基联苄(3)、二氢松柏醇二氢对羟基桂皮酸酯(4)、对羟基苯丙酸甲酯(5)、二氢松柏醇(6)、二氢阿魏酸(7)、松柏醛-4-O-β-D-吡喃葡萄糖苷(8)、4-烯丙基-2,6-二甲氧基-苯基葡萄糖苷(9)、erythrosyringoylglycerol-4-O-β-D-glucopyranoside(10)、3,4,5-trihydroxyallylbenzene-3-O-β-D-glucopyranosyl-4-O-β-D-glucopyranoside(11)、(7S,8R)-syringylglycerol-8-O-4'-sinapyl ether 4-O-β-D-glucopyranoside(12)、3,4-二羟基-5-甲氧基苯甲醛(13)、对羟基苯甲酸(14)、5-hydroxylated isobenzofuran-1(3H)-one(15)、3,5-二甲氧基-4-羟基-苯甲醛(16)、4-羟基-3-甲氧基苯甲醛(17)、3,4,5-trimethoxyphenol-1-O-β-D-glucopyranoside(18)、天麻昔(19)、丁香脂素(20)、丁香脂素-4-O-β-D-葡萄糖苷(21)、丁香脂素-4,4'-O-β-D-二葡萄糖苷(22)、柚皮素(23)、2,6-二甲氧基对苯醌(24)、5-羟甲基糠醛(25)、tetrahydro-5-oxo-2-furancarboxylic acid methyl ester(26)、焦谷氨酸甲酯(27)、川芎哚(28)和尿嘧啶核苷(29)。其中化合物 5~19,21~29 位为首次从该植物中分离得到,化合物 8,10,11,15,16,18,26,28 为首次从石斛属中分离得到。

关键词:霍山石斛;化学成分;联苄;苯丙素

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Chemical constituents of *Dendrobium huoshanense* C. Z. Tang et S. J. Cheng

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Abstract: To investigate the chemical constituents of *Dendrobium huoshanense* Tang et Cheng. 29 compounds were isolated from this plant by multiple column chromatography, such as silica gel, Sephadex LH-20, MCI gel, Rp-18 and semi-preparation HPLC, their structures were elucidated by means of extensive spectroscopic analysis and identified as follows: 4,4'-dihydroxy-3,5-dimethoxybibenzyl (1), batatasin III (2), 5,4'-dihydroxy-3-methoxybibenzyl (3), dihydroconiferyl dihydrop-hydroxycinnamate (4), methyl 3-propionate (5), dihydroconiferyl alcohol (6), dihydroferulic acid (7), 4-O-β-D-glucopyranosyl coniferyl aldehyde (8), 4-allyl-2,6-dimethoxyphenyl glucopyranoside (9), erythrosyringoylglycerol-4-O-β-D-glucopyranoside (10), 3,4,5-trihydroxyallylbenzene-3-O-β-D-glucopyranosyl-4-O-β-D-glucopyranoside (11), (7S,8R)-syringylglycerol-8-O-4'-sinapyl ether 4-O-β-D-glucopyranoside (12), 3,4-dihydroxy-5-methoxybenzaldehyde (13), p-hydroxybenzoic acid (14), 5-hydroxylated isobenzofuran-1(3H)-one (15), 3,5-dihydroxy-4-hydroxy benzaldehyde (16), 4-hydroxy-3-methoxybenzaldehyde (17), 3,4,5-trimethoxyphenol-1-O-β-D-glucopyranoside (18), gastrodin (19), (+)-syringaresinol (20), (+)-syrin-

garesinol-4-O- β -D-glucopyranoside (**21**) , liriodendrin (**22**) , naringenin (**23**) , 2, 6-dimethoxy-p-benzoquinone (**24**) , 5-hydroxymethyl furfural (**25**) , tetrahydro-5-oxo-2-furanearboxylic acid methyl ester (**26**) , methyl pyroglutamate (**27**) , periloxyrine (**28**) and uridine (**29**) . Compounds **5-19**, **21-29** were isolated from this plant for the first time and **8, 10, 11, 15, 16, 18, 26, 28** were isolated from this genus.

Key words: *Dendrobium huoshanense*; chemical constituents; bibenzyl; phenylpropanoid

霍山石斛 *Dendrobium huoshanense* 为兰科石斛属多年生草本植物, 历史悠久, 始载于西汉《范子计然》, 后《名医别录》载“石斛生六安山谷水傍石上……”, 其“形短只寸许, 形如累米”, 俗称“米斛”, 为“中华仙草之最”^[1], 具益胃生津, 滋阴清热之功效^[2]。现代研究表明, 霍山石斛在抗肿瘤、降血糖、抗炎、保肝方面等表现出较好的生物活性^[3-6]。霍山石斛因其独立的区域分布和特有的内在品质, 致使野生资源匮乏, 一度列为珍稀濒危物种。历经数十年几代人的努力, 从原种保护、技术突破到产业发展, 现已建成一万亩栽培基地和3 000亩霍山石斛产业园, 成功保护了这一珍稀物种。随着霍山石斛林下仿野生栽培成功, 以霍山石斛为原料的各类产品相继涌现。霍山石斛中含有联苄和黄酮类成分, 近期 HPLC-ESI-MSⁿ、TLC 等技术已成功识别霍山石斛特征性的黄酮类成分夏佛塔昔^[3,7]。但由于霍山石斛价格昂贵, 其化学成分研究很少。本文以仿野生林下栽培的霍山石斛为研究对象, 综合利用多种色谱分离技术对其乙醇提取部位化学成分进行分离, 并利用波谱技术鉴定化合物结构。

1 材料与方法

1.1 仪器与试剂

Bruker ARX-500、Bruker Avance-III 600、Bruker Ascend 800 型核磁共振波谱仪 (Bruker 公司, 瑞士); Agilent 1100 型高效液相制备色谱仪 (Agilent 公司, 美国); YMC 半制备色谱柱 (S-5 μm , 12 nm; 250 mm \times 10.0 mm)。Sephadex LH-20 (50 μm , GE 公司); MCI gel(北京赛谱锐思科技有限公司); 反相材料 Rp-18 (40 ~ 75 μm , 富士硅化学株式会社, 日本); 硅胶 (100 ~ 200 目、200 ~ 300 目, 青岛海洋化工厂); 薄层色谱用硅胶板 (GF254, 青岛海洋化工厂); 甲醇、乙腈 (色谱纯, 瑞典欧森巴克化学公司); 其他试剂均为分析纯; 水为超纯水; 显色剂为碘蒸气或 10% 硫酸-乙醇溶液 (105 °C 加热显色) 或在紫外灯 254 nm 或 365 nm 处观察荧光。

1.2 材料

霍山石斛于 2017 年 7 月购自安徽霍山县长冲中药材开发有限公司, 经安徽中医药大学刘守金教授鉴定为兰科植物霍山石斛 *Dendrobium huoshanense*

Tang et Cheng 的干燥地上茎。

1.3 提取与分离

霍山石斛粗粉 9.8 kg, 乙醇渗漉提取, 合并渗漉液, 减压回收溶剂至无醇味的流浸膏, 加适量蒸馏水分散, 依次用石油醚、乙酸乙酯、正丁醇萃取 3 次, 减压回收得石油醚部位 (425 g)、乙酸乙酯部位 (160 g), 正丁醇部位 (340 g)。水层减压回收至稠浸膏, 为水部位。

取石油醚部位 (400 g), 经硅胶柱色谱 (二氯甲烷-甲醇 = 100:0 \rightarrow 80:20) 梯度洗脱, TLC 检识合并相同的流份, 得到 Fr. 2 (73 g)。将 Fr. 2 经 MCI 柱色谱 (甲醇-水 = 60:40 \rightarrow 100:0) 梯度洗脱, TLC 检识合并得到流份 Fr. 2.1 ~ Fr. 2.7。Fr. 2.1 (12 g) 经硅胶柱色谱, 石油醚:丙酮 = 5:1 \rightarrow 1:1 洗脱得到 Fr. 2.1.1 ~ Fr. 2.1.10; 取 Fr. 2.1.4 (0.1 g) 经 Sephadex LH-20 柱色谱 (甲醇), 硅胶柱色谱 (二氯甲烷-甲醇 = 19:1) 得化合物 **25** (5 mg); Fr. 2.1.9 (0.6 g) 依次经 Sephadex LH-20 柱色谱 (甲醇)、制备柱色谱得到化合物 **29** (15 mg, $t_{\text{R}} = 19 \text{ min}$, 甲醇-水 = 10:90)。将 Fr. 2.2 (5.4 g) 经硅胶柱色谱 (二氯甲烷-甲醇 = 19:1 \rightarrow 3:1) 得到 Fr. 2.2.4, Sephadex LH-20 柱色谱 (甲醇) 洗脱后经 YMC 半制备色谱柱得到化合物 **5** (5 mg, $t_{\text{R}} = 14 \text{ min}$, 乙腈-水 = 10:90) 和 **11** (12 mg, $t_{\text{R}} = 9 \text{ min}$, 甲醇-水 = 10:90); 取 Fr. 2.3 (1.2 g) 依次经硅胶柱色谱 (二氯甲烷-甲醇 = 8:1) 和 Sephadex LH-20 (甲醇) 得到化合物 **14** (4 mg)。取 Fr. 2.5 (0.1 g) 经 YMC 半制备色谱柱得到化合物 **26** (5 mg, $t_{\text{R}} = 11 \text{ min}$, 乙腈-水 = 24:76) 和 **27** (8 mg, $t_{\text{R}} = 12 \text{ min}$, 乙腈-水 = 24:76)。取 Fr. 2.6 (0.2 g) 经 Sephadex LH-20 柱色谱 (氯仿-甲醇 = 1:1) 和 YMC 半制备色谱柱得到化合物 **15** (8 mg, $t_{\text{R}} = 28 \text{ min}$, 乙腈-水 = 15:85) 和化合物 **16** (3 mg, $t_{\text{R}} = 21 \text{ min}$, 乙腈-水 = 15:85)。取 Fr. 2.7 (2.1 g) 经硅胶柱色谱 (二氯甲烷-甲醇 = 49:1 \rightarrow 5:1) 洗脱, 得到流份 Fr. 2.7.1 ~ Fr. 2.7.7。将 Fr. 2.7.2 经 YMC 半制备色谱柱得到化合物 **6** (3 mg, $t_{\text{R}} = 11 \text{ min}$, 乙腈-水 = 30:70)。取 Fr. 2.7.5 经 YMC 半制备色谱柱得到化合物 **7** (5 mg, $t_{\text{R}} = 29 \text{ min}$, 乙腈-水 = 23:77)。取 Fr. 2.9 (12.6 g) 经硅胶柱色谱 (氯仿-丙酮 = 5:1) 洗

脱, TLC 检识合并得到流份 Fr. 2.9.1~Fr. 2.9.4, 取 Fr. 2.9.1 经硅胶柱色谱(氯仿-丙酮 = 12:1)洗脱后得化合物 **13**(17 mg)。取 Fr. 2.9.2 经 Sephadex LH-20 柱色谱(氯仿-甲醇 = 1:1)洗脱后得化合物 **24**(3 mg)。取 Fr. 2.9.3 依次经 Sephadex LH-20 柱色谱(氯仿-甲醇 = 1:1)、YMC 半制备色谱柱得到化合物 **3**(3 mg, t_R = 17 min, 乙腈-水 = 43:57)和化合物 **9**(2 mg, t_R = 6 min, 乙腈-水 = 43:57)。

取乙酸乙酯部位(150 g), 经硅胶柱色谱(200~300 目), 使用二氯甲烷-甲醇(95:5→80:20)梯度洗脱, 得到流份 Fr. 1~Fr. 7。取 Fr. 2 经 MCI 柱色谱, 甲醇-水梯度洗脱得到流份 Fr. 2.1~Fr. 2.4。取 Fr. 2.3 经 Sephadex LH-20 柱色谱(甲醇)洗脱后得到流份 Fr. 2.3.1~Fr. 2.3.3, 将 Fr. 2.3.1 经硅胶柱色谱(石油醚-乙酸乙酯 = 2:1)梯度洗脱得化合物 **1**(32 mg)。将 Fr. 2.3.2 经硅胶柱色谱(石油醚-乙酸乙酯 = 2:1)梯度洗脱得化合物 **2**(11 mg)。将 Fr. 2.3.3 经硅胶柱色谱(石油醚-乙酸乙酯 = 3:1)梯度洗脱得化合物 **23**(8 mg)。取 Fr. 2.4 经 Sephadex LH-20 柱色谱(甲醇)洗脱后得到流份 Fr. 2.4.1~Fr. 2.4.3, 将 Fr. 2.4.1 经硅胶柱色谱(石油醚-乙酸乙酯 = 3:1)梯度洗脱得化合物 **4**(26 mg)。将 Fr. 2.4.2 经硅胶柱色谱(石油醚-乙酸乙酯 = 17:1)梯度洗脱得化合物 **28**(5 mg)。

取正丁醇部位(320 g), 经硅胶柱色谱(100~200 目, 二氯甲烷-甲醇 = 100:0→65:35)梯度洗脱, TLC 检识合并得到流份 Fr. 1~Fr. 5。取 Fr. 2 经 Rp-18 柱色谱, 采用甲醇-水梯度洗脱, TLC 检识合并相同流份, 得 Fr. 2.1~Fr. 2.3, 将 Fr. 2.2 依次经 Sephadex LH-20 柱色谱、硅胶柱色谱(二氯甲烷-甲醇 = 7:1)洗脱后得到化合物 **21**(14 mg)。将 Fr. 3 经硅胶柱色谱(二氯甲烷-甲醇 = 19:1→4:1)梯度洗脱, TLC 检识合并得到流份 Fr. 3.1~Fr. 3.4。取 Fr. 3.1 依次经 Sephadex LH-20 柱色谱、Rp-18 反相柱色谱(30% 甲醇水)、硅胶柱色谱(二氯甲烷-甲醇 = 24:1)洗脱后得化合物 **8**(5 mg)和化合物 **20**(7 mg)。取 Fr. 4 经 MCI 反相柱色谱, 采用甲醇-水梯度洗脱, TLC 检识合并相同流份, 得 Fr. 4.1~Fr. 4.5, 取 Fr. 4.2 依次经 Sephadex LH-20 柱色谱、Rp-18 反相柱色谱(30% 甲醇水)、Sephadex LH-20 柱色谱洗脱后得到化合物 **18**(18 mg)。

取水部位样品, 经大孔树脂柱色谱, 采用乙醇-水(水、30% 乙醇、60% 乙醇、95% 乙醇)洗脱, TLC 检识合并得到流份 Fr. 1 和 Fr. 2(95% 乙醇洗脱

段)。取 Fr. 2 经硅胶柱色谱(二氯甲烷-甲醇 = 90:10→2:1)洗脱后得到流份 Fr. 2.1~Fr. 2.5。取 Fr. 2.2 经反复 Rp-18 反相柱色谱(42% 甲醇-水)得化合物 **10**(17 mg)和 **19**(12 mg)。取 Fr. 2.3 依次经 Sephadex LH-20 柱色谱、Rp-18 反相柱色谱(30% 甲醇-水)洗脱得化合物 **17**(4 mg)和 **12**(5 mg)。取 Fr. 2.4 依次经 Sephadex LH-20 柱色谱、Rp-18 反相柱色谱(35% 甲醇-水)洗脱得化合物 **22**(26 mg)。

2 结构鉴定

化合物 1 白色针状结晶(甲醇); ESI-MS: m/z 275 [M + H]⁺; ¹H NMR(600 MHz, CDCl₃) δ : 7.01(2H, d, J = 8.4 Hz, H-2', -6'), 6.74(2H, d, J = 8.4 Hz, H-3', -5'), 6.34(2H, s, H-2, -6), 3.83(3H × 2, s, OCH₃-3, -5), 2.78(4H, m, H- α , - α'); ¹³C NMR(150 MHz, CDCl₃) δ : 153.7(s, C-4'), 148.8(s × 2, C-3, -5), 133.8(s, C-4), 132.9(s, C-1), 132.8(s, C-1'), 129.7(d × 2, C-2', -6'), 115.1(d × 2, C-3', -5'), 105.1(d × 2, C-2, -6), 38.4(t, C- α), 37.3(t, C- α'), 56.3(q × 2, OCH₃-3, -5)。以上核磁数据与文献报道^[8]一致, 鉴定该化合物为 4,4'-二羟基-3,5-二甲氧基联苄。

化合物 2 白色针状结晶(甲醇); ESI-MS: m/z 245 [M + H]⁺; ¹H NMR(600 MHz, CDCl₃) δ : 7.13(1H, t, J = 7.8 Hz, H-5'), 6.74(1H, d, J = 7.8 Hz, H-6'), 6.66(1H, d, J = 7.8 Hz, H-4'), 6.32(1H, s, H-2'), 6.31(1H, s, H-6), 6.26(1H, s, H-2), 6.24(1H, s, H-4), 2.76(4H, m, H- α , - α'), 3.75(3H, s, OCH₃-3); ¹³C NMR(150 MHz, CDCl₃) δ : 160.8(s, C-3), 156.6(s, C-5), 155.5(s, C-3'), 144.5(s, C-1'), 143.6(s, C-1), 129.6(d, C-5'), 121.0(d, C-6'), 115.3(d, C-2'), 112.9(d, C-4'), 108.0(d, C-6), 106.9(d, C-2), 99.1(d, C-4), 37.7(t, C- α), 37.4(t, C- α'), 55.3(q, OCH₃-3)。以上核磁数据与文献报道^[8]一致, 鉴定该化合物为 batatasin III。

化合物 3 白色针状结晶(甲醇); ESI-MS: m/z 245 [M + H]⁺; ¹H NMR(600 MHz, CDCl₃) δ : 7.02(2H, d, J = 8.4 Hz, H-2', -6'), 6.74(2H, d, J = 8.4 Hz, H-3', -5'), 6.31(1H, s, H-6), 6.26(1H, s, H-2), 6.24(1H, s, H-4), 2.78(4H, m, H- α , - α'), 3.75(3H, s, OCH₃-3); ¹³C NMR(150 MHz, CDCl₃) δ : 160.8(s, C-3), 156.5(s, C-5), 153.7(s, C-4'), 144.5(s, C-1), 133.9(s, C-1'), 129.6(d × 2, C-2', -6'), 116.3(d × 2, C-3', -5'), 108.0(d, C-6), 106.8

(d, C-2), 99.0 (d, C4), 37.7 (t, C- α), 37.4 (t, C- α'), 55.3 (q, OCH₃-3)。以上核磁数据与文献报道^[8]一致, 鉴定该化合物为5,4'-二羟基-3-甲氧基联苄。

化合物4 白色针状结晶(甲醇); ESI-MS: *m/z* 331 [M + H]⁺; ¹H NMR(600 MHz, CDCl₃) δ : 7.05 (2H, d, *J* = 8.4 Hz, H-2', -6'), 6.82 (1H, d, *J* = 7.8 Hz, H-6), 6.74 (2H, d, *J* = 8.4 Hz, H-3', -5'), 6.65 (1H, s, H-2), 6.63 (1H, d, *J* = 7.8 Hz, H-5), 4.08 (2H, t, *J* = 6.0 Hz, H-9), 2.87 (2H, t, *J* = 6.0 Hz, H-7), 2.60 (2H, t, *J* = 7.8 Hz, H-8'), 2.55 (2H, t, *J* = 7.8 Hz, H-7'), 1.87 (2H, m, H-8), 3.86 (3H, s, OCH₃-3); ¹³C NMR(150 MHz, CDCl₃) δ : 173.6 (s, C-9'), 154.3 (s, C-4'), 146.5 (s, C-3), 143.7 (s, C-4), 133.2 (s, C-1), 132.3 (s, C-1'), 129.4 (d \times 2, C-2', -6'), 121.0 (d, C-6), 115.4 (d \times 2, C-3', -5'), 114.5 (d, C-5), 111.0 (d, C-2), 64.0 (t, C-9), 36.3 (t, C-8'), 31.8 (t, C-7), 30.4 (t, C-8), 30.2 (t, C-7'), 55.9 (q, OCH₃-3)。以上核磁数据与文献报道^[9]一致, 鉴定该化合物为二氢松柏醇二氢对羟基桂皮酸酯。

化合物5 白色针状结晶(甲醇); ESI-MS: *m/z* 181 [M + H]⁺; ¹H NMR(CD₃OD, 500 MHz) δ : 7.00 (2H, d, *J* = 8.6 Hz, H-2, -6), 6.68 (2H, d, *J* = 8.6 Hz, H-3, -5), 2.80 (2H, t, *J* = 7.5 Hz, H-7), 2.26 (2H, t, *J* = 7.5 Hz, H-8), 3.64 (3H, s, OCH₃-9); ¹³C NMR(125 MHz, CD₃OD) δ : 175.3 (s, C-9), 156.8 (s, C-4), 132.7 (s, C-1), 130.2 (d \times 2, C-2, -6), 116.2 (d \times 2, C-3, -5), 37.1 (t, C-7), 31.2 (t, C-8), 52.0 (q, OCH₃-9)。以上核磁数据与文献报道^[10]一致, 鉴定该化合物为对羟基苯丙酸甲酯。

化合物6 白色针状结晶(甲醇); ESI-MS: *m/z* 183 [M + H]⁺; ¹H NMR(600 MHz, CD₃OD) δ : 6.76 (1H, d, *J* = 1.8 Hz, H-2), 6.68 (1H, d, *J* = 7.8 Hz, H-5), 6.62 (1H, dd, *J* = 7.8, 1.8 Hz, H-6), 3.54 (2H, t, *J* = 6.5 Hz, H-9), 2.57 (2H, t, *J* = 7.8 Hz, H-7), 1.77 (2H, m, H-8), 3.83 (3H, s, OCH₃-3); ¹³C NMR(150 MHz, CD₃OD) δ : 150.0 (s, C-3), 145.7 (s, C-4), 135.1 (s, C-1), 121.9 (d, C-6), 116.2 (d, C-5), 113.3 (d, C-2), 62.4 (t, C-9), 35.9 (t, C-7), 32.8 (t, C-8), 56.5 (q, OCH₃-3)。以上核磁数据与文献报道^[11]一致, 鉴定该化合物为二氢松柏醇。

化合物7 白色针状结晶(甲醇); ESI-MS: *m/z* 197 [M + H]⁺; ¹H NMR(600 MHz, CD₃OD) δ : 6.80

(1H, d, *J* = 1.8 Hz, H-2), 6.69 (1H, d, *J* = 7.8 Hz, H-5), 6.64 (1H, dd, *J* = 7.8, 1.8 Hz, H-6), 2.81 (2H, t, *J* = 7.8 Hz, H-7), 2.54 (1H, t, *J* = 7.8 Hz, H-8), 3.83 (3H, s, OCH₃-3); ¹³C NMR(150 MHz, CD₃OD) δ : 177.4 (s, C-9), 149.0 (s, C-3), 145.9 (s, C-4), 133.9 (s, C-1), 121.8 (d, C-6), 116.3 (d, C-5), 113.2 (d, C-2), 37.5 (t, C-7), 31.9 (t, C-8), 56.5 (q, OCH₃-3)。以上核磁数据与文献报道^[12]一致, 鉴定该化合物为二氢阿魏酸。

化合物8 白色针状结晶(甲醇); ESI-MS: *m/z* 339 [M - H]⁻; ¹H NMR(600 MHz, CD₃OD) δ : 9.62 (1H, d, *J* = 8.0 Hz, -CHO), 7.63 (1H, d, *J* = 15.8 Hz, H-7), 7.32 (1H, d, *J* = 1.9 Hz, H-2), 7.26 (1H, d, *J* = 8.3 Hz, H-5), 7.22 (1H, dd, *J* = 1.9, 8.3 Hz, H-6), 6.73 (1H, dd, *J* = 15.8, 8.0 Hz, H-8), 4.99 (1H, d, *J* = 7.6 Hz, H-1'), 3.30 ~ 3.90 (6H, m, H-2' ~ 6'), 3.90 (3H, s, -OCH₃); ¹³C NMR(150 MHz, CD₃OD) δ : 196.2 (d, -CHO), 155.3 (s, C-3), 151.2 (s, C-4), 130.5 (s, C-1), 128.4 (d, C-7), 124.6 (d, C-8), 117.4 (d, C-6), 112.9 (d, C-5), 108.1 (d, C-2), 102.2 (d, C-1'), 78.5 (d, C-5'), 78.0 (d, C-3'), 74.9 (d, C-2'), 71.4 (d, C-4'), 62.6 (t, C-6'), 56.9 (q, OCH₃-3)。以上核磁数据与文献报道^[13]一致, 鉴定该化合物为松柏醛-4-*O*- β -D-吡喃葡萄糖苷。

化合物9 白色无定型粉末(甲醇); ESI-MS: *m/z* 355 [M - H]⁻; ¹H NMR(800 MHz, CD₃OD) δ : 6.53 (2H, s, H-2, -6), 5.93 (1H, ddt, *J* = 16.8, 10.4, 7.2 Hz, H-8), 5.09 (1H, dd, *J* = 16.8, 1.6 Hz, H-9a), 5.03 (1H, dd, *J* = 10.2, 1.6 Hz, H-9b), 4.80 (1H, d, *J* = 7.2 Hz, H-1'), 3.77 (1H, dd, *J* = 12.0, 2.4 Hz, H-6'a), 3.65 (1H, dd, *J* = 12.0, 5.6 Hz, H-6'b), 3.39 (2H, d, *J* = 7.2 Hz, H-7), 3.46 (1H, m, H-3'), 3.33 (2H, m, H-2', -4'), 3.19 (1H, m, H-5'), 3.82 (3H \times 2, s, OCH₃-2, -6); ¹³C NMR(200 MHz, CD₃OD) δ : 154.3 (s \times 2, C-3, -5), 138.8 (d, C-8), 138.4 (s, C-1), 134.2 (s, C-4), 116.3 (t, C-9), 107.6 (d \times 2, C-2, -6), 105.7 (d, C-1'), 78.5 (d, C-3'), 78.0 (d, C-5'), 75.9 (d, C-2'), 71.5 (d, C-4'), 62.7 (t, C-6'), 41.5 (t, C-7), 57.1 (q \times 2, OCH₃-2, -6)。以上核磁数据与文献报道^[14]一致, 鉴定该化合物为4-烯丙基-2,6-二甲氧-苯基葡萄糖苷。

化合物10 白色无定型粉末(甲醇); ESI-MS: *m/z* 389 [M - H]⁻; ¹H NMR(800 MHz, D₂O) δ : 6.65

(2H, s, H-2, -6), 3.90 (1H, m, H-8), 3.58 (1H, dd, $J = 12.0, 4.0$ Hz, H-9a), 3.46 (1H, dd, $J = 12.0, 6.4$ Hz, H-9b), 2.80 (1H, dd, $J = 13.6, 4.8$ Hz, H-7a), 2.60 (1H, dd, $J = 13.6, 8.8$ Hz, H-7b), 4.95 (1H, d, $J = 7.2$ Hz, H-1'), 3.75 (1H, dd, $J = 12.0, 1.6$ Hz, H-6'a), 3.64 (1H, dd, $J = 12.0, 4.8$ Hz, H-6'b), 3.81 (3H \times 2, s, OCH₃-3, -5); ¹³C NMR (200 MHz, D₂O) δ : 152.4 (s \times 2, C-3, -5), 136.4 (s, C-4), 131.9 (s, C-1), 107.2 (d \times 2, C-2, -6), 72.8 (d, C-8), 64.9 (t, C-9), 39.0 (t, C-7), 103.1 (d, C-1'), 76.4 (d, C-3'), 75.8 (d, C-5'), 73.8 (d, C-2'), 69.5 (d, C-4'), 60.6 (t, C-6'), 56.3 (q \times 2, OCH₃-3, -5)。以上核磁数据与文献报道^[15]一致, 鉴定该化合物为 erythrosyringoylglycerol-4-O- β -D-glucopyranoside。

化合物 11 白色无定型粉末(甲醇); ESI-MS: m/z 489 [M - H]⁻; ¹H NMR (600 MHz, CD₃OD,) δ : 6.81 (1H, d, $J = 1.8$ Hz, H-2), 6.60 (1H, d, $J = 1.8$ Hz, H-6), 5.92 (1H, ddt, $J = 16.8, 10.2, 6.6$ Hz, H-8), 5.08 (1H, dd, $J = 16.8, 1.8$ Hz, H-9a), 5.08 (1H, dd, $J = 10.2, 1.8$ Hz, H-9b), 4.90 (1H, d, $J = 7.8$ Hz, H-1'), 4.82 (1H, d, $J = 7.8$ Hz, H-1''), 3.29 (2H, d, $J = 7.2$ Hz, H-7), 3.88 (1H, dd, $J = 12.0, 1.8$ Hz, H-6'a), 3.76 (1H, dd, $J = 12.0, 2.4$ Hz, H-6''a), 3.69 (1H, dd, $J = 12.0, 5.4$ Hz, H-6'b), 3.66 (1H, dd, $J = 12.0, 5.4$ Hz, H-6''b); ¹³C NMR (CD₃OD, 150 MHz) δ : 154.4 (s, C-3), 152.4 (s, C-5), 138.8 (s, C-8), 138.7 (s, C-1), 135.5 (s, C-4), 116.3 (t, C-9), 112.1 (d, C-6), 109.2 (d, C-2), 41.4 (t, C-7), 103.7 (d, C-1'), 78.5 (d, C-5'), 77.4 (d, C-3'), 75.2 (d, C-2'), 71.4 (d, C-4'), 62.5 (d, C-6'), 105.5 (d, C-1''), 78.5 (d, C-5''), 78.1 (d, C-3''), 75.8 (d, C-2''), 71.5 (d, C-4''), 62.7 (d, C-6'')。以上核磁数据与文献报道^[16]基本一致, 鉴定该化合物为 3,4,5-trihydroxyallylbenzene-3-O- β -D-glucopyranosyl-4-O- β -D-glucopyranoside。

化合物 12 白色无定型粉末(甲醇); ESI-MS: m/z 597 [M - H]⁻; ¹H NMR (800 MHz, DMSO-d₆) δ : 6.74 (2H, s, H-2, -6), 6.70 (2H, s, H-2', -6'), 6.44 (1H, d, $J = 16.8$ Hz, H-7'), 6.31 (1H, dt, $J = 16.8, 5.6$ Hz, H-8'), 4.85 (2H, d, $J = 5.6$ Hz, H-9'), 3.72 (3H \times 2, OCH₃-3, -5), 3.71 (3H \times 2, OCH₃-3', -5'), 4.86 (1H, d, $J = 8.0$ Hz, H-1''); ¹³C NMR (200 MHz, DMSO-d₆) δ : 152.7 (s \times 2, C-3', -5'), 151.9 (s \times 2, C-3, -5), 138.1 (s, C-4), 135.4 (s, C-

4'), 133.3 (s, C-1), 132.5 (s, C-1'), 130.2 (d, C-8'), 128.5 (d, C-7'), 105.0 (d \times 2, C-2, -6), 103.6 (d \times 2, C-2', -6'), 86.4 (d, C-8), 71.2 (d, C-7), 60.1 (t, C-9), 61.5 (t, C-9'), 102.9 (d, C-1''), 77.2 (d, C-5''), 76.5 (d, C-3''), 74.2 (d, C-2''), 69.9 (d, C-4''), 60.9 (t, C-6''), 56.3 (q \times 2, OCH₃-3', -5'), 55.9 (q \times 2, OCH₃-3, -5)。以上核磁数据与文献报道^[17]一致, 鉴定该化合物为 (7S, 8R) syringylglycerol-8-O-4'-sinapyl ether 4-O- β -D-glucopyranoside。

化合物 13 白色无定型粉末(甲醇); ESI-MS: m/z 169 [M + H]⁺; ¹H NMR (600 MHz, CD₃OD) δ : 9.68 (1H, s, H-7), 7.08 (1H, d, $J = 1.8$ Hz, H-2), 7.05 (1H, d, $J = 1.8$ Hz, H-6), 3.91 (3H, s, OCH₃-5); ¹³C NMR (150 MHz, CD₃OD) δ : 193.3 (d, C-7), 150.0 (s, C-5), 147.2 (s, C-3), 142.7 (s, C-4), 129.5 (s, C-1), 112.6 (d, C-2), 106.0 (d, C-6), 56.8 (q, OCH₃-5)。以上核磁数据与文献报道^[18]一致, 鉴定该化合物为 3,4-二羟基-5-甲氧基苯甲醛。

化合物 14 白色无定型粉末(甲醇); ESI-MS: m/z 139 [M + H]⁺; ¹H NMR (600 MHz, CD₃OD) δ : 7.87 (2H, d, $J = 8.4$ Hz, H-2, -6), 6.80 (2H, d, $J = 8.4$ Hz, H-3, -5); ¹³C NMR (150 MHz, CD₃OD) δ : 170.6 (s, C-7), 163.4 (s, C-4), 133.5 (s, C-1), 133.1 (d \times 2, C-2, -6), 116.3 (d \times 2, C-3, -5)。以上核磁数据与文献报道^[14]一致, 鉴定该化合物为对羟基苯甲醛。

化合物 15 白色针晶(甲醇); ESI-MS: m/z 151 [M + H]⁺; ¹H NMR (600 MHz, CD₃OD) δ : 7.42 (1H, d, $J = 9.0$ Hz, H-3), 7.18 (1H, dd, $J = 9.0, 1.8$ Hz, H-4), 7.18 (1H, d, $J = 1.8$ Hz, H-6), 5.28 (2H, s, H-8); ¹³C NMR (150 MHz, CD₃OD) δ : 173.8 (s, C-1), 160.0 (s, C-5), 139.7 (s, C-7), 127.9 (s, C-2), 124.6 (d, C-3), 124.1 (d, C-6), 111.0 (d, C-4), 71.5 (t, C-8)。以上核磁数据与文献报道^[19]一致, 鉴定该化合物为 5-hydroxylated isobenzofuran-1(3H)-one。

化合物 16 白色针晶(甲醇); ESI-MS: m/z 183 [M + H]⁺; ¹H NMR (600 MHz, CDCl₃) δ : 9.83 (1H, s, -CHO), 7.16 (2H, s, H-2, -6), 3.96 (3H \times 2, s, OCH₃-3, -5); ¹³C NMR (150 MHz, CDCl₃) δ : 190.8 (d, C-7), 147.3 (s \times 2, C-3, -5), 140.8 (s, C-4), 128.4 (s, C-1), 106.7 (d \times 2, C-2, -6), 56.5 (q \times 2, OCH₃-3, -5)。以上核磁数据与文献报道^[20]一致, 鉴定该化合物为 3,5-二甲氧基-4-羟基-苯甲醛。

化合物 17 白色针晶(甲醇);ESI-MS: m/z 153 [M + H]⁺;¹H NMR(600 MHz, CD₃OD) δ : 9.81 (1H, s, C-7), 7.41 (1H, d, J = 8.2 Hz, H-6), 7.40 (1H, d, J = 8.2 Hz, H-5), 6.85 (1H, d, J = 1.7 Hz, H-2), 3.89 (3H, s, OCH₃-3);¹³C NMR(150 MHz, CD₃OD) δ : 192.7 (d, C-7), 158.3 (s, C-3), 150.7 (s, C-4), 129.1 (s, C-1), 124.4 (d, C-6), 117.0 (d, C-5), 110.9 (d, C-2), 56.4 (q, OCH₃-3)。以上核磁数据与文献报道^[20]一致, 鉴定该化合物为3-羟基-4-甲氧基苯甲醛。

化合物 18 白色针晶(甲醇);ESI-MS: m/z 345 [M - H]⁻;¹H NMR(600 MHz, DMSO-*d*₆) δ : 6.38 (2H, s, H-2,-6), 4.78 (1H, d, J = 7.8 Hz, H-1'), 3.71 (2H, m, H-6'), 3.40 (1H, m, H-5'), 3.26 (1H, m, H-3'), 3.20 (1H, m, H-2'), 3.08 (1H, m, H-4'), 3.74 (3H \times 2, s, OCH₃-3,-5), 3.59 (3H, s, OCH₃-4);¹³C NMR(150 MHz, DMSO-*d*₆) δ : 154.5 (s, C-1), 153.6 (s \times 2, C-3,-5), 132.8 (s, C-4), 94.7 (d \times 2, C-2,-6), 101.5 (d, C-1'), 77.8 (d, C-3'), 77.3 (d, C-5'), 73.7 (d, C-2'), 70.6 (d, C-4'), 61.3 (t, C-6'), 60.6 (q, OCH₃-4), 56.2 (q \times 2, OCH₃-3,-5)。以上核磁数据与文献报道^[14]一致, 鉴定该化合物为3,4,5-trimethoxyphenol-1-*O*- β -D-glucopyranoside。

化合物 19 白色针晶(甲醇);ESI-MS: m/z 285 [M - H]⁻;¹H NMR(800 MHz, CD₃OD) δ : 7.27 (2H, d, J = 8.8 Hz, H-2,-6), 7.07 (2H, d, J = 8.8 Hz, H-3,-5), 4.54 (2H, s, H-7), 4.89 (1H, d, J = 7.2 Hz, H-1'), 3.89 (1H, dd, J = 12.0, 2.4 Hz, H-6'a), 3.70 (1H, dd, J = 12.0, 5.6 Hz, H-6'b), 3.46 (2H, m, H-2',-4'), 3.43 (1H, m, H-5'), 3.40 (1H, m, H-3');¹³C NMR(200 MHz, CD₃OD) δ : 158.6 (s, C-4), 136.8 (s, C-1), 129.6 (d \times 2, C-2,-6), 117.8 (d \times 2, C-3,-5), 64.9 (t, C-7), 102.6 (d, C-1'), 78.1 (d, C-3'), 78.0 (d, C-5'), 75.1 (d, C-2'), 71.5 (d, C-4'), 62.6 (t, C-6')。以上核磁数据与文献报道^[21]一致, 鉴定该化合物为天麻昔。

化合物 20 白色针晶(甲醇);ESI-MS: m/z 419 [M + H]⁺;¹H NMR(800 MHz, CDCl₃) δ : 6.51 (4H, s, H-2,-2',-6,-6'), 4.67 (2H, d, J = 3.2 Hz, H-7, 7'), 4.21 (4H, m, H-9,9'), 3.03 (2H, m, H-8,8'), 3.82 (3H \times 4, s, OCH₃-3,-3',-5,-5');¹³C NMR(200 MHz, CDCl₃) δ : 147.4 (s \times 4, C-3,-3',-5,-5'), 134.5 (s \times 2, C-4,-4'), 132.3 (s \times 2, C-1,-1'), 102.9 (d \times 4, C-2,-2',-6,-6'), 86.3 (d \times 2, C-7,-7'), 72.0 (t \times

2, C-9,-9'), 54.6 (d \times 2, C-8,-8'), 56.6 (q \times 4, OCH₃-3,-3',-5,-5')。以上核磁数据与文献报道^[14]一致, 鉴定该化合物为丁香脂素。

化合物 21 白色无定型粉末(甲醇);ESI-MS: m/z 579 [M - H]⁻;¹H NMR(800 MHz, DMSO-*d*₆) δ : 8.26 (1H, s, OH-4'), 6.65 (2H, s, H-2',-6'), 6.60 (2H, s, H-2,-6), 4.97 (1H, d, J = 4.8 Hz, H-7), 4.96 (1H, d, J = 3.2 Hz, H-7'), 4.18 (1H, dd, J = 7.2, 2.4 Hz, H-9a), 4.16 (1H, dd, J = 5.6, 3.2 Hz, H-9'a), 3.80 (1H, t, J = 4.0 Hz, H-9b), 3.78 (1H, t, J = 4.0 Hz, H-9b'), 3.05 (1H, m, H-8), 3.01 (1H, m, H-8'), 3.76 (3H \times 2, s, OCH₃-3',-5'), 3.75 (3H \times 2, s, OCH₃-3,-5), 4.88 (1H, d, J = 7.2 Hz, H-1''), 4.30 (1H, dd, J = 12.0, 6.4 Hz, H-6''a), 3.60 (1H, dd, J = 12.0, 4.8 Hz, H-6''b), 3.39 (1H, m, H-3''), 3.17 (2H, m, H-2'',-4''), 3.11 (1H, m, H-5'');¹³C NMR(150 MHz, DMSO-*d*₆) δ : 152.6 (s \times 2, C-3,-5), 147.9 (s \times 2, C-3',-5'), 137.2 (s, C-1), 134.8 (s, C-4'), 133.7 (s, C-4), 131.4 (s, C-1'), 104.2 (d \times 2, C-2,-6), 102.7 (d \times 2, C-2',6'), 85.4 (d, C-7), 85.1 (d, C-7'), 71.3 (t \times 2, C-9,-9'), 53.6 (d \times 2, C-8,-8'), 103.7 (d, C-1''), 77.2 (d, C-5''), 76.5 (d, C-3''), 74.2 (d, C-2''), 69.9 (d, C-4''), 60.9 (t, C-6''), 56.4 (q \times 2, OCH₃-3,-5), 56.0 (q \times 2, OCH₃-3',-5')。以上核磁数据与文献报道^[14]一致, 鉴定该化合物为丁香脂素-4-*O*- β -D-葡萄糖苷。

化合物 22 白色粉末(甲醇);ESI-MS: m/z 741 [M - H]⁻;¹H NMR(800 MHz, DMSO-*d*₆) δ : 6.66 (4H, s, H-2,-2',-6,-6'), 4.76 (2H, d, J = 4.0 Hz, H-7',-7'), 4.20 (2H, m, H-9a,-9'a), 3.94 (2H, d, J = 4.0 Hz, H-9b,-9b'), 3.15 (2H, m, H-8,8'), 4.97 (2H, d, J = 8.0 Hz, H-1'',-1'''), 3.84 (2H, m, H-3'',-3'''), 3.76 (2H, dd, J = 12.0, 1.6 Hz, H-6b'',-6b'''), 3.65 (2H, dd, J = 12.0, 5.6 Hz, H-6a'',-6a'''), 3.46 (2H, m, H-5'',-5'''), 3.39 (4H, m, H-2'',-2''', H-4'',-4'''), 3.79 (3H \times 4, s, -OCH₃);¹³C NMR(150 MHz, DMSO-*d*₆) δ : 154.6 (s \times 4, C-3,-3',-5,-5'), 139.6 (s \times 2, C-4,-4'), 135.7 (s \times 2, C-1,-1'), 105.4 (d \times 4, C-2,-2',-6,-6'), 87.3 (d \times 2, C-7,-7'), 73.2 (t \times 2, C-9,9'), 55.8 (d \times 2, C-8,-8'), 104.9 (d \times 2, C-1'',-1'''), 78.5 (d \times 2, C-3'',-3'''), 77.9 (d \times 2, C-5'',-5'''), 75.8 (d \times 2, C-2'',-2'''), 71.5 (d \times 2, C-4'',-4'''), 62.7 (t \times 2, C-6'',-6'''), 57.2 (q \times 4, OCH₃-3,-3',-5,-5')。以上核磁数据与

文献报道^[22]一致,鉴定该化合物为丁香脂素-4,4'-O-β-D-二葡萄糖昔。

化合物 23 白色针晶(甲醇);ESI-MS:*m/z* 273 [M + H]⁺;¹H NMR(600 MHz, DMSO-*d*₆) δ :12.15 (1H, s, OH-5), 10.82 (1H, s, OH-7), 9.61 (1H, s, OH-4'), 7.30 (2H, d, *J* = 8.4 Hz, H-2', -6'), 6.78 (2H, d, *J* = 8.4 Hz, H-3', 5'), 5.87 (2H, s, H-6, -8), 5.42 (1H, dd, *J* = 12.6, 3.0 Hz, H-2), 3.24 (1H, dd, *J* = 16.8, 12.6 Hz, H-3α), 2.68 (1H, dd, *J* = 16.8, 3.0 Hz, H-3eq);¹³C NMR(150 MHz, DMSO-*d*₆) δ :196.8 (s, C-4), 167.3 (s, C-7), 164.0 (s, C-5), 163.4 (s, C-9), 158.5 (s, C-4'), 129.3 (s, C-1'), 128.8 (d × 2, C-2', -6'), 115.6 (d × 2, C-3', -5'), 102.2 (s, C-10), 96.3 (d, C-6), 95.5 (d, C-8), 78.9 (d, C-2), 42.4 (t, C-3)。以上核磁数据与文献报道^[23]一致,鉴定该化合物为柚皮素。

化合物 24 浅黄色固体(甲醇);ESI-MS:*m/z* 169 [M + H]⁺;¹H NMR(600 MHz, CD₃OD) δ :5.92 (2H, s, H-3, -5), 3.81 (3H × 2, s, OCH₃-2, -6);¹³C NMR(150 MHz, CD₃OD) δ :189.4 (s, C-4), 177.9 (s, C-1), 159.4 (s × 2, C-2, -6), 108.1 (d × 2, C-3, -5), 57.2 (q × 2, OCH₃-2, -6)。以上核磁数据与文献报道^[24]一致,鉴定该化合物为2,6-二甲氧基对苯醌。

化合物 25 白色无定型粉末(甲醇);ESI-MS:*m/z* 127 [M + H]⁺;¹H NMR(500 MHz, CD₃OD) δ :9.52 (1H, s, -CHO), 7.38 (1H, d, *J* = 3.5 Hz, H-3), 6.58 (1H, d, *J* = 3.5 Hz, H-4), 4.60 (2H, s, H-6);¹³C NMR(125 MHz, CD₃OD) δ :179.5 (d, C-1), 163.2 (s, C-5), 153.9 (s, C-2), 124.9 (d, C-3), 110.9 (d, C-4), 57.6 (t, C-6)。以上核磁数据与文献报道^[25]一致,鉴定该化合物为5-羟甲基糠醛。

化合物 26 白色粉末(甲醇);ESI-MS:*m/z* 145 [M + H]⁺;¹H NMR(800 MHz, CD₃OD) δ :4.30 (1H, m, H-4), 2.48 (1H, m, H-3α), 2.34 (1H, m, H-3β), 2.30 (1H, m, H-2α), 2.16 (1H, m, H-2β), 3.75 (3H, s, OCH₃-5);¹³C NMR(200 MHz, CD₃OD) δ :181.1 (s, C-1), 174.5 (s, C-5), 52.9 (d, C-4), 30.3 (t, C-2), 25.8 (t, C-3), 57.1 (q, OCH₃-5)。以上核磁数据与文献报道^[26]一致,鉴定该化合物为tetrahydro-5-oxo-2-furancarboxylic acid methyl ester。

化合物 27 白色粉末(甲醇);ESI-MS:*m/z* 144 [M + H]⁺;¹H NMR(800 MHz, DMSO-*d*₆) δ :7.99 (1H, s, NH), 4.19 (1H, dd, *J* = 8.8, 4.8 Hz, H-5), 2.32 (1H, m, H-3a), 2.14 (1H, m, H-4a), 2.11 (1H,

m, H-4b), 1.98 (1H, m, H-3b), 3.67 (3H, s, COOCH₃);¹³C NMR(200 MHz, DMSO-*d*₆) δ :177.0 (s, C-2), 173.4 (s, COOCH₃), 52.1 (d, C-5), 28.9 (t, C-3), 24.5 (t, C-2), 54.7 (q, COOCH₃)。以上核磁数据与文献报道^[27]一致,鉴定该化合物为焦谷氨酸甲酯。

化合物 28 黄色针状结晶(甲醇);ESI-MS:*m/z* 265 [M + H]⁺;¹H NMR(DMSO-*d*₆, 800 MHz) δ :8.37 (1H, d, *J* = 4.8 Hz, H-3), 8.26 (1H, d, *J* = 7.8 Hz, H-5), 8.08 (1H, d, *J* = 4.8 Hz, H-4), 7.81 (1H, d, *J* = 7.3 Hz, H-8), 7.59 (1H, t, *J* = 7.3 Hz, H-7), 7.28 (1H, t, *J* = 8.0 Hz, H-6), 7.21 (1H, d, *J* = 3.2 Hz, H-3'), 6.59 (1H, d, *J* = 3.2 Hz, H-4'), 4.67 (2H, s, H-6');¹³C NMR(200 MHz, DMSO-*d*₆) δ :157.2 (s, C-5'), 152.6 (s, C-1'), 141.4 (s, C-8a), 138.7 (d, C-3), 133.6 (s, C-1), 130.9 (s, C-9a), 129.9 (s, C-4a), 128.9 (d, C-7), 122.1 (d, C-5), 121.1 (s, C-4b), 120.2 (d, C-6), 114.1 (d, C-4), 113.6 (d, C-8), 112.9 (d, C-3'), 110.1 (d, C-4'), 56.4 (t, C-6')。以上核磁数据与文献报道^[28]一致,鉴定该化合物为川芎哚。

化合物 29 白色粉末(甲醇);ESI-MS:*m/z* 243 [M - H]⁻;¹H NMR(800 MHz, CD₃OD) δ :8.01 (1H, d, *J* = 8.0 Hz, H-6), 5.89 (1H, d, *J* = 4.8 Hz, H-1'), 5.69 (1H, d, *J* = 8.0 Hz, H-5), 3.34 ~ 4.20 (5H, m, H-glc);¹³C NMR(200 MHz, CD₃OD) δ :164.9 (s, C-4), 151.1 (s, C-2), 141.3 (d, C-6), 101.3 (d, C-5), 89.3 (d, C-1'), 84.9 (d, C-4'), 74.3 (d, C-2'), 69.9 (d, C-3'), 60.9 (t, C-5')。以上核磁数据与文献报道^[12]一致,鉴定该化合物为尿嘧啶核昔。

3 结论

本实验从兰科石斛属植物霍山石斛中分离得到29个化合物,化合物类型涉及联苄、简单苯丙素、木脂素及其苷、苯甲酸衍生物等,其中联苄类化合物为多种石斛的主要成分,前期研究表明该类化合物具有中等强度的细胞毒活性^[29]。文中8个化合物首次从该属植物中分离得到,从一定程度上揭示了霍山石斛与其他种石斛药效物质基础存在着一定的差异。本文研究为霍山石斛活性成分后续研究及质量控制提供参考和指导。

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