

血芙蓉化学成分的研究

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摘要: **目的** 研究血芙蓉 *Teucrium viscidum* Bl. 的化学成分。**方法** 血芙蓉 70% 乙醇提取物采用硅胶、ODS、Sephadex LH-20 凝胶柱进行分离纯化, 根据理化性质及波谱数据鉴定所得化合物的结构。**结果** 从中分离得到 20 个化合物, 分别鉴定为 20 β -羟基熊果酸 (1)、 β -谷甾醇 (2)、羽扇豆醇 (3)、齐墩果酸 (4)、木犀草素 (5)、槲皮素 (6)、芹菜素 (7)、 β -胡萝卜苷 (8)、芹菜素-7-*O*- β -D-葡萄糖苷 (9)、teuvisone (10)、lipidiol (11)、teucvisin B (12)、1, 5, 9-epideoxyloganin (13)、1, 5, 9-epideoxyloganic acid (14)、5-epideoxyloganin (15)、argylioside (16)、8-epideoxyloganic acid (17)、radiatoside E (18)、radiatoside F (19)、enmenol-glucoside (20)。**结论** 化合物 1、3、7、9、13 ~ 20 为首次从该植物中分离得到, 化合物 1、13~20 为首次从石蚕属植物中分离得到。

关键词: 血芙蓉; 化学成分; 分离鉴定

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Chemical constituents from *Teucrium viscidum*

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ABSTRACT: **AIM** To study the chemical constituents from *Teucrium viscidum* Bl. **METHODS** The 70% ethanol extract from *T. viscidum* was isolated and purified by silica, ODS and Sephadex LH-20, then the structures of obtained compounds were identified by physicochemical properties and spectral data. **RESULTS** Twenty compounds were isolated and identified as 20 β -hydroxy ursolic acid (1), β -sitosterol (2), lupenol (3), oleanolic acid (4), luteolin (5), quercetin (6), apigenin (7), β -daucosterol (8), apigenin-7-*O*- β -D-glucoside (9), teuvisone (10), lipidiol (11), teucvisin B (12), 1, 5, 9-epideoxyloganin (13), 1, 5, 9-epideoxyloganic acid (14), 5-epideoxyloganin (15), argylioside (16), 8-epideoxyloganic acid (17), radiatoside E (18), radiatoside F (19), enmenol-glucoside (20). **CONCLUSION** Compounds 1, 3, 7, 9, 13–20 are isolated from this plant for the first time, and compounds 1, 13–20 are isolated from genus *Teucrium* for the first time.

KEY WORDS: *Teucrium viscidum* Bl.; chemical constituents; isolation and identification

血芙蓉为唇形科石蚕属植物血芙蓉 *Teucrium viscidum* Bl. 的地上部分, 广泛分布于山西、江苏、浙江、福建、台湾、江西等地^[1], 主要含有萜类、黄酮类、苯丙素类等成分, 具有消炎镇痛、清热解毒、健脾利湿、助消化、抗疟疾等功效^[2]。近年来石蚕属植物的药用价值引起了人们的关注, 但相关研究还很欠缺, 本实验对该属成员血芙蓉化学成分进行分析, 从而为相关临床用药提供科学依据。

1 材料

Bruker 400 MHz 超导核磁共振波谱仪、Esquire 6000 离子阱液质联用仪 (德国 Bruker 公司); RE-300 旋转蒸发仪 (英国 Stuart 公司); V-500 隔膜式真空泵 (瑞士 Buchi 公司); KQ-50DE 台式数控超声波清洗器 (昆山市超声仪器有限公司); 柱色谱、薄层硅胶 (青岛海洋化工有限公司); Sephadex LH-20 (美国 Ge 公司); GEL ODS-A12

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nm S-75 μm YMC (日本 YMC 公司)。石油醚、氯仿、乙酸乙酯、正丁醇、丙酮、甲醇均为分析纯, 购于北京化学试剂厂。

血芙蓉采自山西省临汾市, 由北京工业大学生命科学与生物工程学院黄胜阳副教授鉴定为唇形科石蚕属植物血芙蓉 *Teucrium viscidum* Bl. 的干燥地上部分, 标本保存于北京工业大学生命科学与生物工程学院中药与天然药物实验室。

2 提取与分离

取干燥血芙蓉 5.0 kg, 粉碎, 70% 乙醇加热超声提取 3 次, 每次 1.5 h, 减压回收乙醇得到浸膏, 以水悬浮后分别用氯仿、乙酸乙酯、正丁醇萃取, 萃取相减压浓缩, 得到各萃取物。氯仿萃取物 (7.26 g) 用硅胶 (100~200 目) 进行柱色谱分离, 以石油醚-乙酸乙酯 (1:0~0:1) 及乙酸乙酯-甲醇 (1:0~1:1) 梯度洗脱, 收集流份, 合并相同组分, 再依次用硅胶 (200~300 目) 进行柱色谱纯化, 以氯仿-丙酮溶剂系统洗脱, 分别得到化合物 **1** (40.36 mg)、**2** (33.45 mg)、**3** (13.15 mg)。乙酸乙酯萃取物 (48.36 g) 用硅胶柱色谱进行分离, 以氯仿-甲醇 (60:1~0:1) 梯度洗脱, 等流份收集, 经 TLC 检测后合并, 再反复用 Sephadex LH-20 凝胶柱色谱纯化, 分别得到化合物 **4** (17.15 mg)、**5** (21.33 mg)、**6** (20.09 mg)、**7** (11.45 mg)、**8** (9.78 mg)、**9** (19.55 mg)。正丁醇萃取物 (102.39 g) 用 ODS 反相硅胶进行柱色谱分离, 以甲醇-水按 20%、40%、60%、80%、100% 梯度洗脱, 相应洗脱物再经 Sephadex LH-20 凝胶柱色谱分离, 分别得到化合物 **10** (6.16 mg)、**11** (13.28 mg)、**12** (30.74 mg)、**13** (13.28 mg)、**14** (13.15 mg)、**15** (43.46 mg)、**16** (30.74 mg)、**17** (23.15 mg)、**18** (43.46 mg)、**19** (22.66 mg)、**20** (32.86 mg)。

3 结构鉴定

化合物 **1**: 白色针状结晶 $[\text{CHCl}_3 - (\text{CH}_3)_2\text{CO}]$, ESI-MS m/z : 471.4 $[\text{M}-\text{H}]^-$ 。¹H-NMR (400 MHz, CDCl_3) δ : 11.79 (1H, brs, -COOH), 5.34 (1H, t, $J=3.6, 3.6$ Hz, H-12), 3.40 (1H, s, -OH), 3.14 (1H, m, H-3), 2.25 (1H, s, H-18), 1.07 (3H, s, H-23), 0.95 (3H, s, H-27), 0.91 (3H, d, $J=6.6$ Hz, H-30), 0.81 (3H, s, H-26), 0.78 (3H, d, $J=6.6$ Hz, H-29), 0.69 (3H, s, H-24), 0.67 (3H, s, H-25); ¹³C-NMR (100 MHz, CDCl_3) δ : 179.1 (C-28), 138.6 (C-13), 124.9 (C-12), 77.1

(C-3), 74.6 (C-20), 55.3 (C-5), 52.8 (C-18), 46.9 (C-9), 42.8 (C-14), 39.9 (C-17), 39.1 (C-19), 38.9 (C-4), 38.3 (C-1), 37.6 (C-10), 37.5 (C-8), 36.3 (C-22), 33.3 (C-7), 29.8 (C-21), 28.4 (C-23), 28.1 (C-15), 27.6 (C-2), 24.0 (C-16), 23.7 (C-27), 23.2 (C-11), 21.8 (C-30), 18.5 (C-6), 17.8 (C-29), 17.4 (C-26), 16.2 (C-24), 15.9 (C-25)。以上数据与文献 [3] 基本一致, 故鉴定为 20 β -羟基熊果酸。

化合物 **2**: 无色针状结晶 $[\text{CHCl}_3 - (\text{CH}_3)_2\text{CO}]$ 。其氯仿溶液点于薄层板上并喷洒 10% 硫酸-乙醇溶液加热显紫红色, 与 β -谷甾醇对照品共薄层在 3 种不同溶剂系统中展开, R_f 值及显色均一致, 故鉴定为 β -谷甾醇^[4]。

化合物 **3**: 白色粉末 $[(\text{CH}_3)_2\text{CO}]$, ESI-MS m/z : 427.4 $[\text{M}+\text{H}]^+$ 。¹H-NMR (400 MHz, CDCl_3) δ : 4.67 (1H, d, $J=2.4$ Hz, H-29a), 4.55 (1H, d, $J=2.4$ Hz, H-29b), 3.19 (1H, dd, $J=4.8, 11.4$ Hz, H-3), 1.67 (3H, s, H-30), 1.07 (3H, s, H-26), 0.98 (3H, s, H-23), 0.93 (3H, s, H-27), 0.86 (3H, s, H-25), 0.78 (3H, s, H-28), 0.75 (3H, s, H-24); ¹³C-NMR (100 MHz, CDCl_3) δ : 150.8 (C-20), 109.5 (C-29), 78.3 (C-3), 54.9 (C-5), 50.4 (C-9), 48.4 (C-18), 48.2 (C-19), 42.8 (C-17), 42.5 (C-14), 40.8 (C-8), 40.0 (C-22), 39.2 (C-4), 38.7 (C-1), 38.3 (C-13), 37.2 (C-10), 35.4 (C-16), 34.1 (C-7), 29.8 (C-21), 28.2 (C-23), 27.2 (C-2), 27.1 (C-15), 25.3 (C-12), 21.4 (C-11), 19.5 (C-30), 18.5 (C-6), 18.3 (C-28), 16.5 (C-25), 16.1 (C-26), 15.3 (C-24), 14.5 (C-27)。以上数据与文献 [5] 基本一致, 故鉴定为羽扇豆醇。

化合物 **4**: 白色结晶性粉末 $[(\text{CH}_3)_2\text{CO}]$, ESI-MS m/z : 455.4 $[\text{M}-\text{H}]^-$ 。¹H-NMR (400 MHz, $\text{DMSO}-d_6$) δ : 5.13 (1H, t, $J=3.6, 3.6$ Hz, H-12), 4.26 (1H, s, -OH), 3.33 (1H, s, H-5), 1.11 (3H, s, H-27), 0.96 (3H, s, H-23), 0.93 (3H, s, H-30), 0.92 (3H, s, H-24), 0.89 (3H, s, H-29), 0.81 (3H, s, H-25), 0.76 (3H, s, H-26); ¹³C-NMR (100 MHz, $\text{DMSO}-d_6$) δ : 178.7 (C-28), 138.6 (C-13), 125.0 (C-12), 77.3 (C-3), 55.2 (C-5), 52.8 (C-17), 47.5 (C-9), 47.3 (C-19), 42.1 (C-18), 40.6 (C-14), 39.8 (C-8), 38.9 (C-4), 38.8 (C-10), 38.7 (C-1), 36.8 (C-

29), 36.7 (C-21), 33.2 (C-7), 30.7 (C-22), 28.7 (C-20), 28.0 (C-23), 27.5 (C-15), 24.3 (C-2), 23.7 (C-27), 23.3 (C-30), 21.5 (C-16), 18.5 (C-11), 17.5 (C-6), 17.4 (C-26), 16.5 (C-24), 15.7 (C-25)。以上数据与文献 [6] 基本一致, 故鉴定为齐墩果酸。

化合物 5: 白色结晶性粉末 $[(\text{CH}_3)_2\text{CO}]$, ESI-MS m/z : 285.0 $[\text{M-H}]^-$ 。 $^1\text{H-NMR}$ (400 MHz, $\text{DMSO}-d_6$) δ : 12.97 (1H, s, OH-5), 10.67 (1H, s, OH-7), 9.82 (1H, s, OH-4'), 9.60 (1H, s, OH-3'), 7.42 (2H, dd, $J=6.8, 8.8$ Hz, H-2', 6'), 6.90 (1H, d, $J=8.8$ Hz, H-5'), 6.66 (1H, s, H-3), 6.44 (1H, d, $J=2.0$ Hz, H-8), 6.19 (1H, d, $J=2.0$ Hz, H-6); $^{13}\text{C-NMR}$ (100 MHz, $\text{DMSO}-d_6$) δ : 182.1 (C-4), 164.6 (C-7), 164.3 (C-2), 161.9 (C-5), 157.7 (C-9), 150.1 (C-4'), 146.2 (C-3'), 121.9 (C-1'), 119.4 (C-6'), 116.5 (C-5'), 113.8 (C-2'), 104.2 (C-10), 103.3 (C-3), 99.3 (C-6), 94.3 (C-8)。以上数据与文献 [7] 基本一致, 故鉴定为木犀草素。

化合物 6: 黄色粉末 (CH_3OH), ESI-MS m/z : 301.0 $[\text{M-H}]^-$ 。 $^1\text{H-NMR}$ (400 MHz, $\text{DMSO}-d_6$) δ : 12.48 (1H, s, OH-5), 10.77 (1H, s, OH-7), 9.36 (3H, brs, OH-3, 4', 3'), 7.67 (1H, d, $J=2.0$ Hz, H-2'), 7.54 (1H, dd, $J=2.0, 8.8$ Hz, H-6'), 6.88 (1H, d, $J=8.8$ Hz, H-5'), 6.40 (1H, d, $J=2.0$ Hz, H-8), 6.18 (1H, d, $J=2.0$ Hz, H-6); $^{13}\text{C-NMR}$ (100 MHz, $\text{DMSO}-d_6$) δ : 176.3 (C-4), 164.4 (C-2), 161.2 (C-9), 156.6 (C-7), 148.2 (C-5), 147.3 (C-4'), 145.2 (C-3'), 136.2 (C-1'), 122.4 (C-6'), 120.4 (C-5'), 116.1 (C-2'), 115.5 (C-10), 103.4 (C-3), 98.6 (C-8), 93.8 (C-6)。以上数据与文献 [8] 基本一致, 故鉴定为槲皮素。

化合物 7: 淡黄色针状结晶 (CH_3OH), ESI-MS m/z : 269.0 $[\text{M-H}]^-$ 。 $^1\text{H-NMR}$ (400 MHz, $\text{DMSO}-d_6$) δ : 12.96 (1H, s, OH-5), 10.59 (1H, s, OH-7), 10.57 (1H, s, OH-4'), 7.93 (2H, d, $J=8.8$ Hz, H-2', 6'), 6.93 (2H, d, $J=8.8$ Hz, H-3', 5'), 6.78 (1H, s, H-3), 6.48 (1H, brs, H-8), 6.19 (1H, brs, H-6); $^{13}\text{C-NMR}$ (100 MHz, $\text{DMSO}-d_6$) δ : 182.2 (C-4), 164.8 (C-7), 164.2 (C-2), 161.9 (C-5), 161.6 (C-4'), 157.8 (C-9), 128.9 (C-2', 6'), 121.6 (C-1'), 116.4 (C-3', 5'), 104.1 (C-10), 103.3 (C-3), 99.3 (C-6), 94.4 (C-8)。以上数据与

文献 [9] 基本一致, 故鉴定为芹菜素。

化合物 8: 白色无定型粉末 (CH_3OH), 不溶于氯仿, Liebermann-Burchard、Molish 反应阳性, 表明该化合物为甾体苷类。其与 β -胡萝卜苷对照品共薄层在 3 种不同溶剂系统中展开时, R_f 值及显色均一致, 故鉴定为 β -胡萝卜苷。

化合物 9: 黄白色结晶性粉末 (CH_3OH), ESI-MS m/z : 431.1 $[\text{M-H}]^-$ 。 $^1\text{H-NMR}$ (400 MHz, $\text{DMSO}-d_6$) δ : 12.96 (1H, s, OH-5), 10.40 (1H, s, OH-4'), 7.96 (2H, d, $J=8.8$ Hz, H-2', 6'), 6.94 (2H, d, $J=8.8$ Hz, H-3', 5'), 6.87 (1H, s, H-3), 6.83 (1H, d, $J=2.0$ Hz, H-8), 6.45 (1H, d, $J=2.0$ Hz, H-6), 5.07 (1H, d, $J=7.2$ Hz, H-1''), 3.71 ~ 3.20 (6H, m, 糖基质子); $^{13}\text{C-NMR}$ (100 MHz, $\text{DMSO}-d_6$) δ : 181.9 (C-4), 163.4 (C-2), 161.3 (C-7), 161.0 (C-5), 157.8 (C-4'), 157.4 (C-9), 129.1 (C-2', 6'), 121.5 (C-1'), 116.4 (C-3', 5'), 105.8 (C-10), 103.6 (C-3), 100.4 (C-6), 99.5 (C-1''), 95.3 (C-8), 77.6 (C-3''), 76.9 (C-5''), 73.6 (C-2''), 70.0 (C-4''), 61.1 (C-6'')。以上数据与文献 [10] 基本一致, 故鉴定为芹菜素-7- O - β - D -葡萄糖苷。

化合物 10: 黄白色无定型粉末 (CH_3OH), ESI-MS m/z : 353.2 $[\text{M}+\text{Na}]^+$ 。 $^1\text{H-NMR}$ (400 MHz, $\text{DMSO}-d_6$) δ : 6.90 (1H, s, H-14), 4.58 (1H, brs, H-7), 4.52 (1H, brs, OH-2), 4.05 (1H, d, $J=8.4$ Hz, H-20a), 3.64 (1H, m, H-2), 2.97 (1H, d, $J=8.4$ Hz, H-20b), 2.78 (1H, m, H-15), 2.20 (1H, dd, $J=12.8, 13.6$ Hz, H-1a), 2.06 (1H, d, $J=12.8$ Hz, H-1b), 1.82 (1H, m, H-6a), 1.67 (1H, m, H-3b), 1.56 (1H, dd, $J=12.0, 14.0$ Hz, H-6b), 1.27 (1H, dd, $J=6.4, 12.0$ Hz, H-5), 1.04 (3H, d, $J=6.8$ Hz, H-17), 1.03 (3H, d, $J=6.8$ Hz, H-16), 1.02 (1H, m, H-3a), 1.01 (3H, s, H-19), 0.82 (3H, s, H-18); $^{13}\text{C-NMR}$ (100 MHz, $\text{DMSO}-d_6$) δ : 179.2 (C-12), 176.4 (C-11), 150.9 (C-8), 147.9 (C-13), 139.2 (C-9), 132.2 (C-14), 68.5 (C-7), 67.3 (C-20), 62.5 (C-2), 49.1 (C-3), 41.7 (C-10), 41.1 (C-5), 38.3 (C-1), 34.2 (C-4), 33.4 (C-18), 26.9 (C-15), 26.8 (C-6), 21.6 (C-19), 21.4 (C-16), 21.2 (C-17)。以上数据与文献 [11] 基本一致, 故鉴定为 teuvisone。

化合物 11: 黄白色无定型粉末 (CH_3OH), ESI-MS m/z : 289.1 $[\text{M}+\text{Na}]^+$ 。 $^1\text{H-NMR}$ (400 MHz,

DMSO- d_6) δ : 5.08 (1H, s, H-14a), 4.94 (1H, s, H-14b), 4.48 (1H, dd, $J=2.4, 10.4$ Hz, H-6), 3.93 (1H, m, H-3), 3.89 (1H, m, H-8), 3.18 (1H, m, H-11), 3.04 (1H, d, $J=11.2$ Hz, H-9b), 2.79 (1H, m, H-1), 2.56 (1H, m, H-7), 2.32 (1H, d, $J=11.2$ Hz, H-9a), 2.21 (2H, m, H-2b, 4), 2.04 (1H, m, H-5), 2.03 (1H, m, H-2a), 1.47 (3H, d, $J=6.4$ Hz, H-15), 1.44 (3H, d, $J=8.0$ Hz, H-13); $^{13}\text{C-NMR}$ (100 MHz, DMSO- d_6) δ : 179.5 (C-12), 144.8 (C-10), 114.1 (C-14), 83.0 (C-6), 78.3 (C-3), 71.1 (C-8), 56.1 (C-7), 51.2 (C-5), 48.1 (C-9), 47.9 (C-4), 43.6 (C-1), 39.9 (C-11), 39.5 (C-2), 19.4 (C-15), 11.4 (C-13)。以上数据与文献 [12] 基本一致, 故鉴定为 lipidiol。

化合物 **12**: 黄色无定型粉末 (CH_3OH), ESI-MS m/z : 425.2 $[\text{M}+\text{Na}]^+$ 。 $^1\text{H-NMR}$ (400 MHz, DMSO- d_6) δ : 7.49 (1H, s, H-15), 7.44 (1H, s, H-16), 6.35 (1H, s, H-14), 5.25 (1H, dd, $J=7.2, 8.8$ Hz, H-12), 4.66 (1H, d, $J=7.8$ Hz, 19a), 4.49 (1H, t, $J=3.2, 3.2$ Hz, H-6), 4.35 (1H, d, $J=12.4$ Hz, H-19b), 2.75 (1H, dd, $J=3.2, 7.2$ Hz, H-4), 2.44 (1H, dd, $J=11.6, 14.0$ Hz, H-11a), 2.39 (1H, m, H-7b), 2.31 (1H, dd, $J=7.2, 14.0$ Hz, H-11b), 2.24 (1H, m, H-7a), 2.09 (3H, s, $\text{CH}_3\text{COO-19}$), 2.04 (1H, m, H-1b), 1.91 (1H, m, H-8), 1.89 (1H, m, H-3b), 1.87 (1H, m, H-2a), 1.76 (1H, m, H-1a), 1.70 (1H, m, H-10), 1.58 (1H, m, H-3a), 1.51 (1H, m, H-2b), 1.01 (3H, d, $J=6.4$ Hz, H-17); $^{13}\text{C-NMR}$ (100 MHz, DMSO- d_6) δ : 177.5 (C-20), 177.1 (C-18), 170.2 ($-\text{CH}_3\text{COO}$), 144.6 (C-15), 140.2 (C-16), 125.3 (C-13), 108.2 (C-14), 77.9 (C-6), 72.1 (C-12), 59.5 (C-19), 50.4 (C-9), 47.1 (C-10), 46.0 (C-5), 45.7 (C-4), 41.9 (C-11), 34.5 (C-8), 29.0 (C-7), 24.5 (C-3), 21.1 ($-\text{Ac}$), 20.9 (C-2), 19.8 (C-1), 16.5 (C-17)。以上数据与文献 [13] 基本一致, 故鉴定为 teucvisin B。

化合物 **13**: 白色无定型粉末 (CH_3OH), ESI-MS m/z : 375.2 $[\text{M}+\text{H}]^+$ 。 $^1\text{H-NMR}$ (400 MHz, DMSO- d_6) δ : 7.30 (1H, s, H-3), 5.24 (1H, d, $J=4.0$ Hz, H-1), 4.48 (1H, d, $J=7.6$ Hz, H-1'), 3.65 (1H, m, H-6'b), 3.45 (1H, m, H-6'a), 3.38 (1H, m, H-5'), 3.32 (1H, m, H-3'), 3.27 (1H, m, H-4'),

3.21 (1H, s, H-2'), 3.17 (3H, s, $-\text{OCH}_3$), 2.75 (1H, m, H-5), 2.31 (1H, m, H-9), 2.24 (1H, m, H-8), 1.91 (1H, m, H-6a), 1.70 (1H, m, H-7a), 1.50 (1H, m, H-6b), 1.21 (1H, m, H-7b), 1.03 (3H, d, $J=6.8$ Hz, H-10); $^{13}\text{C-NMR}$ (100 MHz, DMSO- d_6) δ : 168.5 (C-11), 151.5 (C-3), 112.2 (C-4), 102.7 (C-1'), 99.0 (C-1), 77.8 (C-5'), 77.2 (C-3'), 74.5 (C-2'), 70.1 (C-4'), 61.3 (C-6'), 49.1 (C-12), 42.9 (C-9), 35.8 (C-8), 33.1 (C-5), 32.5 (C-7), 31.3 (C-6), 16.6 (C-10)。以上数据与文献 [14] 基本一致, 故鉴定为 1, 5, 9-epideoxyloganin。

化合物 **14**: 白色无定型粉末 (CH_3OH), ESI-MS m/z : 359.1 $[\text{M-H}]^-$ 。 $^1\text{H-NMR}$ (400 MHz, DMSO- d_6) δ : 11.72 (1H, s, $-\text{COOH}$), 7.31 (1H, s, H-3), 5.24 (1H, d, $J=4.0$ Hz, H-1), 4.48 (1H, d, $J=7.6$ Hz, H-1'), 4.42 (1H, m, H-6'b), 4.09 (1H, m, H-6'a), 3.65 (1H, m, H-5'), 3.46 (1H, m, H-3'), 3.15 (1H, m, H-4'), 3.09 (1H, m, H-2'), 3.00 (1H, m, H-5), 2.26 (1H, m, H-9), 2.21 (1H, m, H-8), 1.91 (1H, m, H-6a), 1.70 (1H, m, H-7a), 1.50 (1H, m, H-6b), 1.21 (1H, m, H-7b), 1.01 (3H, d, $J=6.4$ Hz, H-10); $^{13}\text{C-NMR}$ (100 MHz, DMSO- d_6) δ : 168.4 ($-\text{COO}$), 151.5 (C-3), 112.2 (C-4), 102.7 (C-1'), 99.0 (C-1), 77.8 (C-5'), 77.2 (C-3'), 74.5 (C-2'), 70.2 (C-4'), 61.4 (C-6'), 42.9 (C-9), 35.8 (C-8), 33.1 (C-5), 32.5 (C-7), 31.3 (C-6), 16.7 (C-10)。以上数据与文献 [15] 基本一致, 故鉴定为 1, 5, 9-epideoxyloganic acid。

化合物 **15**: 白色无定型粉末 (CH_3OH), ESI-MS m/z : 375.2 $[\text{M}+\text{H}]^+$ 。 $^1\text{H-NMR}$ (400 MHz, DMSO- d_6) δ : 7.31 (1H, s, H-3), 5.24 (1H, d, $J=4.0$ Hz, H-1), 4.48 (1H, d, $J=7.6$ Hz, H-1'), 4.42 (1H, m, H-6'b), 4.09 (1H, m, H-6'a), 3.65 (1H, m, H-5'), 3.46 (1H, m, H-3'), 3.17 (1H, m, H-4'), 3.09 (1H, m, H-2'), 3.00 (1H, m, H-5), 2.27 (1H, m, H-9), 2.24 (1H, m, H-8), 1.91 (1H, m, H-6a), 1.69 (1H, m, H-7a), 1.51 (1H, m, H-6b), 1.21 (1H, m, H-7b), 1.01 (3H, d, $J=6.4$ Hz, H-10); $^{13}\text{C-NMR}$ (100 MHz, DMSO- d_6) δ : 168.4 (C-11), 151.5 (C-3), 112.2 (C-4), 102.7 (C-1), 99.0 (C-1'), 77.8 (C-3'), 77.2 (C-5'), 74.5 (C-2'), 70.2 (C-4'), 61.4 (C-

6'), 49.1 (C-12), 42.9 (C-9), 35.8 (C-8), 33.1 (C-7), 32.5 (C-6), 31.3 (C-5), 16.7 (C-10)。以上数据与文献 [16] 基本一致, 故鉴定为 5-epideoxyloganin。

化合物 **16**: 黄色针状结晶 (CH₃OH), ESI-MS m/z : 727.2 [M+Na]⁺。¹H-NMR (400 MHz, DMSO-*d*₆) δ : 7.31 (1H, s, H-3), 6.41 (1H, dd, $J=2.0$, 6.4 Hz, H-3''), 5.43 (1H, d, $J=4.0$ Hz, H-1), 5.04 (1H, d, $J=4.0$ Hz, H-1''), 4.89 (1H, dd, $J=4.0$, 4.0 Hz, H-4''), 4.48 (1H, d, $J=7.2$ Hz, H-1'), 4.42 (1H, dd, $J=2.0$, 7.2 Hz, H-6''a), 4.07 (1H, d, $J=7.2$ Hz, H-1'''), 4.01 (1H, d, $J=13.2$ Hz, H-10'a), 3.65 (1H, d, $J=13.2$ Hz, H-10'b), 3.46 (1H, brs, H-7''), 2.98 (1H, m, H-5), 2.75 (1H, d, $J=7.2$ Hz, H-9''), 2.50 (1H, m, H-5''), 2.25 (1H, m, H-8), 2.23 (1H, m, H-9), 2.10 (1H, m, H-6a), 1.72 (1H, m, H-7a), 1.51 (1H, m, H-6b), 1.33 (1H, m, H-7b), 1.01 (3H, d, $J=7.2$ Hz, H-10); ¹³C-NMR (100 MHz, DMSO-*d*₆) δ : 168.4 (C-11), 151.5 (C-3), 141.3 (C-3''), 112.2 (C-4), 102.7 (C-4''), 98.9 (C-1'), 98.1 (C-1'''), 95.2 (C-1), 94.2 (C-1''), 80.5 (C-6''), 77.8 (C-3'), 77.3 (C-3'''), 77.2 (C-5'), 76.5 (C-5'''), 73.9 (C-2'), 73.5 (C-2''), 70.6 (C-4'), 70.2 (C-4'''), 65.2 (C-8''), 61.6 (C-6'), 61.4 (C-6''), 60.1 (C-10''), 58.7 (C-7''), 43.9 (C-9), 43.0 (C-9''), 37.0 (C-5''), 34.1 (C-8), 33.1 (C-7), 32.5 (C-5), 31.4 (C-6), 16.7 (C-10)。以上数据与文献 [17] 基本一致, 故鉴定为 argylioside。

化合物 **17**: 白色无定型粉末 (CH₃OH), ESI-MS m/z : 383.1 [M+Na]⁺。¹H-NMR (400 MHz, DMSO-*d*₆) δ : 7.31 (1H, s, H-3), 5.24 (1H, d, $J=4.0$ Hz, H-1), 4.48 (1H, d, $J=7.6$ Hz, H-1'), 3.65 (1H, dd, $J=2.8$, 11.6 Hz, H-6'b), 3.46 (1H, dd, $J=5.2$, 11.6 Hz, H-6'a), 2.75 (1H, m, H-5), 2.22 (1H, m, H-8), 2.11 (1H, m, H-9), 1.91 (1H, m, H-6b), 1.70 (1H, d, H-7b), 1.50 (1H, s, H-6a), 1.27 (1H, m, H-7a), 1.01 (3H, d, $J=6.8$ Hz, H-10); ¹³C-NMR (100 MHz, DMSO-*d*₆) δ : 168.5 (C-11), 151.4 (C-3), 112.2 (C-4), 102.7 (C-1'), 98.9 (C-1), 77.8 (C-3'), 77.2 (C-5'), 74.5 (C-2'), 70.2 (C-4'), 61.4 (C-6'), 43.0 (C-9), 35.8 (C-8), 33.1 (C-5), 32.5 (C-7), 31.4 (C-6), 16.7 (C-10)。以上数据与文献

[18] 基本一致, 故鉴定为 8-epideoxyloganic acid。

化合物 **18**: 白色无定型粉末 (CH₃OH), ESI-MS m/z : 729.3 [M+Na]⁺。¹H-NMR (400 MHz, DMSO-*d*₆) δ : 7.31 (1H, s, H-3), 5.24 (1H, d, $J=8.8$ Hz, H-1), 5.02 (1H, d, $J=8.0$ Hz, H-1''), 4.77 (1H, d, $J=8.8$ Hz, H-6''a), 4.48 (1H, d, $J=7.8$ Hz, H-1'), 4.46 (1H, d, $J=7.8$ Hz, H-1'''), 3.81 (1H, m, H-3''a), 3.65 (1H, m, H-3''b), 3.94 (1H, d, $J=12.8$ Hz, H-10''a), 3.70 (1H, d, $J=12.8$ Hz, H-10''b), 3.60 (1H, brs, H-7''), 2.68 (1H, m, H-5), 2.41 (1H, m, H-9''), 2.25 (1H, brs, H-7''), 2.22 (1H, brs, H-8), 2.20 (1H, brs, H-9), 2.00 (1H, m, H-6b), 1.77 (1H, m, H-7b), 1.75 (1H, m, H-4''a), 1.50 (1H, m, H-6a), 1.48 (1H, m, H-4''b), 1.23 (1H, m, H-7a), 1.01 (3H, d, $J=7.2$ Hz, H-10); ¹³C-NMR (100 MHz, DMSO-*d*₆) δ : 168.4 (C-11), 151.5 (C-3), 112.8 (C-4), 103.3 (C-1''), 102.7 (C-1), 98.9 (C-1'), 98.7 (C-1'''), 77.8 (C-6''), 77.3 (C-3'), 77.2 (C-3'''), 76.9 (C-5'), 76.8 (C-5'''), 74.5 (C-2'), 73.9 (C-2''), 73.5 (C-4'), 70.5 (C-4'''), 65.7 (C-8''), 63.5 (C-3''), 61.5 (C-6'), 61.4 (C-6''), 60.4 (C-10''), 59.7 (C-7''), 44.0 (C-9), 43.0 (C-9''), 37.0 (C-5''), 34.1 (C-8), 33.1 (C-7), 32.5 (C-5), 31.3 (C-6), 24.8 (C-4''), 16.8 (C-10)。以上数据与文献 [19] 基本一致, 故鉴定为 radiatoside E。

化合物 **19**: 白色无定型粉末 (CH₃OH), ESI-MS m/z : 745.2 [M+Na]⁺。¹H-NMR (400 MHz, DMSO-*d*₆) δ : 7.31 (1H, s, H-3), 6.18 (1H, d, $J=6.4$ Hz, H-3''), 5.70 (1H, d, $J=4.4$ Hz, H-1), 5.68 (1H, d, $J=4.0$ Hz, H-1''), 5.24 (1H, d, $J=4.0$ Hz, H-4''a), 4.52 (1H, d, $J=6.0$ Hz, H-6''), 4.48 (1H, d, $J=7.8$ Hz, H-1'), 4.46 (1H, d, $J=7.8$ Hz, H-1'''), 4.01 (1H, d, $J=6.0$ Hz, H-7''), 3.97 (1H, d, $J=12.8$ Hz, H-10''a), 3.74 (1H, d, $J=12.8$ Hz, H-10''b), 2.95 (1H, m, H-5), 2.75 (1H, m, H-5''), 2.31 (1H, dd, $J=4.0$, 4.0 Hz, H-9''), 2.20 (1H, m, H-9), 2.16 (1H, m, H-8), 1.91 (1H, m, H-6b), 1.71 (1H, m, H-7b), 1.50 (1H, m, H-6a), 1.28 (1H, m, H-7a), 1.01 (3H, d, $J=7.2$ Hz, H-10); ¹³C-NMR (100 MHz, DMSO-*d*₆) δ : 168.8 (C-11), 152.6 (C-3), 141.0 (C-3''), 112.1 (C-4), 105.0 (C-4''), 99.3 (C-1'), 98.3

(C-1'''), 95.5 (C-1), 92.3 (C-1''), 84.5 (C-6''), 83.5 (C-7''), 80.2 (C-8''), 77.9 (C-3'), 77.6 (C-3'''), 76.9 (C-5'), 76.6 (C-5'''), 73.6 (C-2'), 73.4 (C-2'''), 71.2 (C-4'), 71.0 (C-4'''), 63.4 (C-10''), 62.6 (C-6'), 62.2 (C-6'''), 47.1 (C-9''), 43.8 (C-9), 36.4 (C-5''), 35.3 (C-8), 33.3 (C-7), 32.5 (C-5), 31.4 (C-6), 16.0 (C-10)。以上数据与文献 [19] 基本一致, 故鉴定为 radiatoside F。

化合物 **20**: 白色无定型粉末 (CH₃OH), ESI-MS m/z : 551.2 [M+Na]⁺。¹H-NMR (400 MHz, DMSO-*d*₆) δ : 5.14 (1H, d, J =2.4 Hz, H-17a), 5.08 (1H, d, J =2.4 Hz, H-17b), 4.97 (1H, s, H-15), 4.48 (1H, s, H-14), 4.18 (1H, d, J =7.8 Hz, H-1'), 4.07 (1H, d, J =7.8 Hz, H-20a), 3.65 (1H, dd, J =7.8, 11.2 Hz, H-20b), 3.51 (H, dd, J =7.8, 12.4 Hz, H-6'a), 3.49 (1H, d, J =7.8 Hz, H-6), 3.45 (1H, m, H-1), 3.40 (1H, dd, J =2.4, 12.4 Hz, H-6'b), 3.21-2.89 (4H, m, H-2', 3', 4', 5'), 2.45 (1H, d, J =7.2 Hz, H-13), 2.31-2.12 (3H, m, H-2, 9, 12), 1.91 (1H, m, H-11), 1.51 (1H, m, H-2), 1.40-1.25 (3H, m, H-3a, 11, 12), 1.23 (3H, m, H-3b, 5, 18), 0.86 (1H, s, H-19); ¹³C-NMR (100 MHz, DMSO-*d*₆) δ : 159.5 (C-16), 108.7 (C-17), 102.7 (C-1'), 98.9 (C-7), 83.8 (C-1), 77.3 (C-3'), 76.2 (C-5'), 74.5 (C-14), 73.9 (C-2'), 72.5 (C-6), 70.6 (C-4'), 70.2 (C-15), 63.3 (C-6'), 61.5 (C-20), 57.4 (C-5), 51.7 (C-8), 45.2 (C-13), 44.0 (C-9), 41.0 (C-10), 37.0 (C-3), 33.1 (C-4), 32.5 (C-12), 31.4 (C-18), 27.8 (C-2), 21.6 (C-19), 16.8 (C-11)。以上数据与文献 [20] 基本一致, 故鉴定为 enmenol-glucoside。

4 讨论

本实验从血芙蓉的乙醇提取物中分离得到 20 个化合物, 包括 2 个甾体类 (β -谷甾醇、 β -胡萝卜苷)、4 个黄酮类 (木犀草素、槲皮素、芹菜素、芹菜素-7-*O*- β -*D*-葡萄糖苷)、7 个环烯醚萜类 (5-epideoxyloganin、8-epideoxyloganic acid、1, 5, 9-epideoxyloganin、1, 5, 9-epideoxyloganic acid、argylioside、radiatoside E、radiatoside F)、1 个倍半萜类 (lipidiol)、3 个二萜类 (teuvisone、teuvisin B、enmenol-glucoside)、3 个三萜类 (20 β -羟基熊果酸、羽扇豆醇、齐墩果酸)。其中, 环烯醚萜类化

合物是一类具有半缩醛及环戊烷结构的单萜类化合物, 因其特殊的结构及丰富的药理活性, 在抗肿瘤、降血糖、抗炎、保肝、神经系统保护、心血管系统活性等方面受到了广泛的关注^[21-23]。本研究首次从血芙蓉中分离得到 7 个环烯醚萜类化合物, 可填补该植物化学成分研究方面的空白, 并为其药用开发提供参考。

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枇杷叶紫珠化学成分及其细胞毒活性和抗炎活性

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摘要: **目的** 研究枇杷叶紫珠 *Callicarpa kochiana* 的化学成分及其细胞毒活性和抗炎活性。**方法** 枇杷叶紫珠 90% 丙酮提取物采用硅胶、Sephadex LH-20、MCI、ODS、重结晶、半制备 HPLC 进行分离纯化, 根据理化性质及波谱数据鉴定所得化合物的结构。采用 CCK8 法、Griess 法、ELISA 法测定化合物 4~5 的细胞毒活性和抗炎活性。**结果** 从中分离得到 5 个化合物, 分别鉴定为 3, 7, 3', 4'-tetramethyl-quercetin (1)、pachypodol (2)、14 α -hydroxyisopimaric acid (3)、14 α -hydroxy-7, 15-isopimaradien-18-oic acid (4)、(16*R*) -16, 17-dihydroxyphyllolladan-3-one (5)。化合物 4 在一定浓度范围内对 7 种肿瘤细胞具有不同程度的抑制作用, 并可以减少 RAW264.7 细胞 NO、IL-10、MCP-1、TNF- α 的释放量。**结论** 化合物 1~5 均为首次从该植物中分离得到, 化合物 4 具有细胞毒活性和抗炎活性。

关键词: 枇杷叶紫珠; 化学成分; 分离鉴定; 细胞毒活性; 抗炎活性

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Chemical constituents from *Callicarpa kochiana* and their cytotoxic activity and anti-inflammatory activity

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ABSTRACT: **AIM** To study the chemical constituents from *Callicarpa kochiana* and their cytotoxic activity and anti-inflammatory activity. **METHODS** The 90% acetone extract from *C. kochiana* was isolated and purified by silica, Sephadex LH-20, MCI, ODS, recrystallization and semi-preparation HPLC, then the structures of obtained compounds were identified by physicochemical properties and spectral data. The cytotoxic activity and anti-inflammatory activity of the compounds 4-5 were determined by CCK8, Griess and ELISA methods. **RESULTS** Five compounds were isolated and identified as 3, 7, 3', 4'-Tetramethyl-quercetin (1), pachypodol (2), 14 α -hydroxyisopimaric acid (3), 14 α -hydroxy-7, 15-isopimaradien-18-oic acid (4), (16*R*) -16, 17-dihydroxyphyllolladan-3-one (5). Compound 4 showed different degrees of inhibitory action for the seven kinds of cancer cells and reduced the emission of NO、IL-10、MCP-1、TNF- α in RAW264.7 cells. **CONCLUSION** Compounds 1-5 are isolated from this plant for the first time, and compound 4 has cytotoxic activity and anti-inflammatory activity.

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