Cathayanalactone G and other constituents from leaves and twigs of Callicarpa cathayana

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A B S T R A C T

Objective: To study the chemical constituents from the leaves and twigs of Callicarpa cathayana.
Methods: The chemical constituents were isolated and purified by column chromatography on silica gel, MCI gel CHF 20P/P120, Sephadex LH-20, and HPLC. The structures of the compounds were determined by HR-ESI-MS, 1D and 2D NMR data.
Results: A total of 24 compounds were isolated from the 85% methanol extract of leaves and twigs of C. cathayana. They were identified as cathayanalactone G (1), a new diterpene, and 23 known compounds as patagonic acid (2), (-)-16-hydroxycedroda-3,13-dien-16,15-olide-18-oic acid (3), 15-methoxypatagonic acid (4), oleanolic acid (5), usrosic acid (6), sairesinolic acid (7), pomolic acid (8), α-amyрин (9), tormentic acid (10), lupeol (11), 5,7-dihydroxy-3,4'-dimethoxyflavone (12), 5,4'-dihydroxy-3,7,3'-dimethoxyflavone (13), 5-hydroxy-3,6,7,4'-tetramethoxyflavone (14), salvigenin (15), kaemferol (16), astraсulin (17), pinoresinol 4-O-β-D-glucopyranoside (18), pinoresinol (19), β-sitosterol (20), β-sitosterol β-D-glucopyranoside (21), 5-hydroxy-coumarin (22), isocoumarin (23), and 4-hydroxyxycinnamic acid (24).
Conclusion: Compound 1 is a new labdane diterpene. Compounds 10, 13, 16 and 17 are isolated from the genus Callicarpa for the first time. Compounds 7, 8, 9, 12, 14, 23 and 24 were reported from C. cathayana for the first time.

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1. Introduction

The genus Callicarpa H. T. Chang contains about 190 species which grows in tropical and subtropical areas in Asia and Oceania. There are 46 species in China, mainly locate in southern China (Chen and Gilbert, 1994b). C. cathayana is distributed in the southern area of the Yangtze River (Chen and Gilbert, 1994a). The genus Callicarpa, as a medicinal plant, is widely used in China for the treatment of hemorrhage, decreasing swelling, and relieving pain. C. cathayana, as an endemic species to China, is also used for the same disease (Tu et al., 2013). Previous phytochemical investigations reported the existence of diverse components in C. cathayana, including clerodane diterpenoids (Wang et al., 2019), triterpenoids (Zhou et al., 2005), and flavonoids (Zhou et al., 2005), etc.

One new labdane diterpene, cathayanalactone G (1) and 23 known compounds (2–24) were isolated from the ethyl acetate soluble part of C. cathayana. Compounds 10, 13, 16, and 17 were isolated from the genus Callicarpa for the first time. Compounds 7, 8, 9, 12, 14, 23 and 24 were reported from C. cathayana for the first time.

2. Materials and methods

2.1. General

The Bruker AV-400 and AV-III-600 HD spectrometers were used in the NMR experiments (Bruker Corporation, Switzerland). UV spectra were acquired on a Shimadzu UV2401PC spectrophotometer (Shimadzu Corporation, Japan). IR spectra were recorded on a Thermo NICOLET iS10 spectrophotometer with KBr pellets (Thermo Fisher Scientific, USA). Optical rotations were obtained on a JASCO P-1020 polarimeter (Jasco Corporation, Japan). HR-ESI-MS were recorded on an Agilent 1100 HPLC/TOF spectrophotometer (Agilent Technologies, Santa Clara, USA). Semi-preparative HPLC was performed on an Agilent 1260 Liquid Chromatograph System (Agilent Technologies Inc., Waldbronn, Germany) with a Zorbax SB-C18 semi-preparative column (9.4 mm × 250 mm, Agilent Technologies Inc., Santa Clara, USA) and Zorbax SB-C18 analytical column (4.6 mm × 250 mm, Agilent...
2.2. Plant materials

In this study, the leaves and twigs of *C. cathayana* were collected in September 2017 in Honghe, Yunnan Province, China. The specimen was identified by Dr Xiao Chen, Kunming Institute of Botany, Chinese Academy of Sciences. A key specimen (YNU 20170045) was deposited at School of Chemical Science and Technology, Yunnan University.

2.3. Extraction and isolation

The dry powder of *C. cathayana* (7 kg) was extracted at room temperature with 85% MeOH (20L × 3 times). The extract was concentrated on a rotary evaporator to obtain the crude extract (450 g). The crude extract was suspended in H₂O and extracted with ethyl acetate (EA). The EA extract (107 g) was subjected to silica gel (80–100 mesh) column using CHCl₃-Acetone (50:1–0:1, volume percentage). Each fraction was evaporated to dryness to give nine fractions. Fraction 3–3 was separated by Sephadex LH-20 (MeOH). Fraction 3–8 was fractioned on Sephadex LH-20 (MeOH) to give five fractions. Fraction 3–8-1 was separated by HPLC (Zorbax SB-C18: 9.4 mm mesh) column (CH₂Cl₂-MeOH) to give two fractions. Fraction 2–8-1 was fractioned on silica gel (200–300 mesh) column (PE-Acetone) to give (27.8 mg). Fraction 2–6 was subjected to silica gel (200–300 mesh) column (PE-EA) to give seven fractions. Fraction 2–8-2 was fractioned on silica gel (200–300 mesh) column (CH₂Cl₂-MeOH) to give (10.9 mg) and (11.4 mg).

2.4. Isolation and analysis

3. Results

One new labdane diterpene, cathayanalactone G (1) and 23 known compounds (2–24) were isolated from the ethyl acetate soluble part of *C. cathayana*. The structures of isolated compounds were identified by extensive spectroscopic analysis, including NMR and HR-ESI-MS, and compared with the literature data. The 23 known compounds were identified as patagonic acid (2) (Huang & Liu, 2004), (–)-16-hydroxycedrola-3,13-dien-16,15-olide (3) (Gao et al., 2013), 15-methoxypatagonic acid (4) (Costa et al., 1999), oleanolic acid (5) (Zhu et al., 2020), ursolic acid (6) (Kuang et al., 2019), sairesinic acid (7) (Wang & Fang, 2012), pomolic acid (8) (D’Abrosca et al., 2006), α-amyrin (9) (Liu et al., 2010), tormentic acid (10) (Rocha et al., 2007), lupeol (11) (Fotie et al., 2006), 5,7-dihydroxy-3,4′-dimethoxyflavone (12) (Wei et al., 2013), 5,4′-dihydroxy-3,7,3′-dimethoxyflavone (13) (Al-Dabbas et al., 2006), 5-hydroxy-3,6,7,4′-tetramethoxyflavone (14) (Hörrie et al., 1998), salvigenin (15) (Jassbi et al., 2002), kaempferol (16) (Ding et al., 2013), astragalin (17) (Jayasinghe et al., 2004), pinosinol 4-O-β-D-glucopyranoside (18) (Jia & Li, 1996), paulownin (19) (Angle et al., 2008), β-sitosterol (20) (Zou et al., 2020), β-sitosterol β-D-glucopyranoside (21) (Iseav et al., 2007), 5-hydroxy-coumarin (22) (Takaishi et al., 2008), isocoumopterin (23) (Jerezano et al., 2011), 4-hydroxyxannamic acid (24) (Xie et al., 2016) (Fig. 1).
Fig. 1. Structures of compounds isolated (1–24).
H-12 (δH 2.17). H-14 (δH 7.27) with H-15 (δH 4.73) confirmed the rest part of the structure. Therefore, the structure of cathayanalactone G was established as 8β-hydroxy-ent-labd-13-en-16,15-olide as shown in Fig. 1.

4. Discussion

The present study reported the identification of 24 compounds. There are a new labdane diterpenoid cathayanalactone G (1) and three known diterpenoids (2–4), seven triterpenoids (5–11), six flavonoids (12–17), two ligans (18, 19), two sterols (20, 21), two cumarins (22, 23), and a benzene derivative (24). In this study, four compounds (10, 13, 16 and 17) were isolated for the first time from the genus Callicarpa and eight compounds (7, 8, 9, 12, 14, 23 and 24) were reported from C. cathayana for the first time. According to the former research about the genus Callicarpa, the isolated diterpenes shows great anti-inflammatory activity. Further study about the anti-inflammatory activity of C. cathayana needs to be done. In summary, the present study enriches the chemical diversity and provided support for further study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Table 1

| No. | δc  | δh (mult, J = Hz) | HMBC | COSY |
|-----|-----|------------------|------|------|
| 1   | 39.3| 1.63 (1H, dt, J = 12.42, 4.80 Hz, xH) | H-20 | H-2β |
| 2   | 17.9| 1.54 (1H, dt, J = 13.98, 3.54 Hz, xH) | H-1β, 3β |
| 3   | 41.9| 1.29 (1H, m, xH) | H-18, 19 | H-2α |
| 4   | 32.8| 1.10 (1H, dd, J = 13.80, 3.90 Hz, xH) | H-18, 19 | H-2β |
| 5   | 56.0| 0.81 (1H, m) | H-18, 19, 20 | H-5 |
| 6   | 18.1| 1.66 (1H, dt, J = 13.98, 3.12 Hz, xH) | H-17 | H-6β |
| 7   | 41.8| 1.37 (1H, m, xH) | H-17 | H-17 |
| 8   | 72.3| 0.75 (1H, m) | H-17, 20 | H-9 |
| 9   | 58.9| 1.59 (1H, dd, J = 10.53, 5.31 Hz) | H-11α, 11β |
| 10  | 38.8| 1.44 (1H, m) | H-15 | H-15 |
| 11  | 23.1| 2.21, 2.17 (each 1H, m) | H-15 | H-15 |
| 12  | 28.3| 2.73 (1H, d, J = 1.62 Hz) | H-15 | H-15 |
| 13  | 133.5| 4.73 (2H, t, J = 1.62 Hz) | H-15 | H-15 |
| 14  | 146.2| 1.07 (3H, s) | H-15 | H-15 |
| 15  | 70.7| 0.76 (3H, s) | H-15 | H-15 |
| 16  | 175.7| 0.79 (3H, s) | H-15 | H-15 |
| 17  | 29.6| 0.88 (3H, s) | H-15 | H-15 |
| 18  | 20.8| 4.50 (1H, s) | H-15 | H-15 |
| 19  | 32.6| 4.50 (1H, s) | H-15 | H-15 |
| 20  | 14.2| 4.50 (1H, s) | H-15 | H-15 |
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