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CHEMICAL CONSTITUENTS FROM *Inula cappa*

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Inula cappa DC. (Compositae) is mainly distributed in the south of China. The plant of *I. cappa* has been used in Chinese folk medicine to treat rheumatism, laryngotracheitis, and abdominal pain [1]. Some chemical constituents of this plant have been reported previously [2–4]. In our chemical investigation of this plant, 33 compounds were isolated from the root of *I. cappa*.

The roots of *I. cappa* were collected in Lijiang, Yunnan province, China and authenticated as *I. cappa* by Prof. Li-Shan Xie of Kunming Institute of Botany, Chinese Academy of Sciences. A voucher specimen is deposited in the Herbarium of the School of Pharmacy, Second Military Medical University.

The air-dried root of *I. cappa* (10 kg) was refluxed with alcohol for 3 × 2 h, then the alcohol extract was concentrated *in vacuo* to an aqueous residue, which was extracted successively with petroleum ether, EtOAc, and *n*-BuOH. Each fraction was purified by column chromatography with silica gel and Sephadex LH-20 or RP-18 to yield compounds **1–33**.

The fractions were analyzed by spectroscopic methods, including NMR and mass spectrometry. All 33 compounds were determined as dammara-20,24-dien-3β-*O*-acetate (**1**) [5], dammara-20,24-dien-3β-ol (**2**) [5], epifriedelanol (**3**) [6], 3-friedelanone (**4**) [7], β-sitosterol (**5**) [8], daucosterol (**6**) [9], docosanoic acid (**7**) [10], linoleic acid (**8**) [11], *cis*-abienol (**9**) [12], isothymol (**10**) [13], vanillin (**11**) [4], protocatechualdehyde (**12**) [14], vanillic acid (**13**) [2], 4-hydroxybenzoic acid (**14**) [15], syringic acid (**15**) [4], coniferylaldehyde (**16**) [4], sinapylaldehyde (**17**) [16], *p*-coumaric acid (**18**) [17], 4-allyl-2,6-dimethoxyphenol-1-*O*-β-glucopyranoside (**19**) [18], vanillic acid-4-*O*-β-glucopyranoside (**20**) [19], tachioside (**21**) [18], isotachioside (**22**) [20], osmantolide (**23**) [21], zataroside A (**24**) [22], 3-methyl-2-thiophenecarboxylic acid (**25**) [23], 5-hydroxymethylfurfural (**26**) [24], apigenin (**27**) [4], luteolin-3′-*O*-β-D-glucopyranoside (**28**) [25], ceplignan (**29**) [26], chlorogenic acid (**30**) [27], macranthoin F (**31**) [28], macranthoin G (**32**) [28], and methyl-4,5-dicaffeoylquinate (**33**) [29]. All compounds, except for compounds **3–6**, **11**, **13**, **15**, and **26**, were isolated from *I. cappa* for the first time.

Dammara-20,24-dien-3β-*O*-acetate (1). White powder. EI-MS *m/z*: 468 $[M]^+$. PMR (300 MHz, $CDCl_3$, δ, ppm, J/Hz): 5.14 (1H, m, H-24), 4.74, 4.70 (each 1H, br.s, H-21), 4.51 (1H, dd, J = 4.7, 11.7, H-3), 2.08 (3H, s, Ac), 1.68, 1.64 (each 3H, br.s, CH_3-26 and 27), 0.98, 0.97, 0.84, 0.83, 0.82 (each 3H, s, CH_3-18, 19, 28, 29, 30); ^{13}C NMR (75 MHz, $CDCl_3$, δ, ppm): 38.8 (C-1), 27.0 (C-2), 80.9 (C-3), 37.9 (C-4), 56.0 (C-5), 18.2 (C-6), 35.3 (C-7), 40.5 (C-8), 50.9 (C-9), 37.1 (C-10), 21.4 (C-11), 27.1 (C-12), 45.3 (C-13), 49.4 (C-14), 31.4 (C-15), 24.9 (C-16), 47.8 (C-17), 15.6 (C-18), 15.9 (C-19), 152.7 (C-20), 107.5 (C-21), 38.8 (C-22), 28.9 (C-23), 124.5 (C-24), 131.4 (C-25), 25.7 (C-26), 17.7 (C-27), 28.0 (C-28), 15.4 (C-29), 16.2 (C-30), 170.9 (C=O), 21.3 ($\underline{C}H_3CO$).

Epifriedelanol (3). White powder. EI-MS *m/z*: 428 $[M]^+$. PMR (300 MHz, $CDCl_3$, δ, ppm, J/Hz) : 3.74 (1H, br.s, H-3), 1.17 (3H, s, CH_3-28), 1.01 (3H, s, CH_3-24), 1.00 (3H, s, CH_3-26), 0.99 (3H, s, CH_3-29), 0.96 (3H, s, CH_3-27), 0.94 (3H, s, CH_3-30), 0.93 (3H, d, J = 7.2, CH_3-23), 0.86 (3H, s, CH_3-25); ^{13}C NMR (75 MHz, $CDCl_3$, δ, ppm): 15.5 (C-1), 35.4 (C-2), 72.6 (C-3), 48.7 (C-4), 37.8 (C-5), 41.7 (C-6), 17.1 (C-7), 52.4 (C-8), 37.8 (C-9), 61.3 (C-10), 35.5 (C-11), 30.9 (C-12), 38.4 (C-13), 38.9 (C-14), 32.3 (C-15), 35.4 (C-16), 30.3 (C-17), 42.8 (C-18), 35.3 (C-19), 28.0 (C-20), 32.5 (C-21), 39.1 (C-22), 11.1 (C-23), 16.9 (C-24), 18.2 (C-25), 18.7 (C-26), 20.0 (C-27), 31.8 (C-28), 35.5 (C-29), 32.3 (C-30).

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***cis*-Abienol (9)**. Colorless oil. EI-MS *m/z*: 290 $[M]^+$. PMR (300 MHz, $CDCl_3$, δ, ppm, J/Hz) : 6.82 (1H, dd, J = 10.2, 17.1, H-14), 5.50 (1H, t, J = 7.2, H-12), 5.11 and 5.03 (each 1H, dd, H-15), 1.76, 1.16, 0.85, 0.82, 0.78 (each 3H, s, CH_3-16, 17, 18, 19, 20); ^{13}C NMR (75 MHz, $CDCl_3$, δ, ppm): 40.0 (C-1), 18.5 (C-2), 41.8 (C-3), 33.2 (C-4), 56.0 (C-5), 20.2 (C-6), 43.9 (C-7), 74.2 (C-8), 62.1 (C-9), 38.9 (C-10), 23.1 (C-11), 133.8 (C-12), 130.8 (C-13), 133.5 (C-14), 113.7 (C-15), 19.9 (C-16), 24.4 (C-17), 33.4 (C-18), 21.5 (C-19), 15.4 (C-20).

Methyl-4,5-dicaffeoylquinate (33). ESI-MS *m/z*: 529 $[M - H]^-$. PMR (400 MHz, CD_3OD, δ, ppm, J/Hz): 7.59 (1H, d, J = 16.3, H-7″), 7.58 (1H, d, J = 16.3, H-7′), 7.01 (1H, d, J = 2.0, H-2″), 7.01 (1H, d, J = 2.0, H-2′), 6.92 (1H, dd, J = 2.0, 8.3, H-6″), 6.89 (1H, dd, J = 2.0, 8.3, H-6′), 6.74 (1H, d, J = 8.3, H-5″), 6.73 (1H, d, J = 8.3, H-5′), 6.29 (1H, d, J = 16.3, H-8″), 6.28 (1H, d, J = 16.3, H-8′), 5.34 (1H, m, H-5), 5.07 (1H, m, H-4), 4.25 (1H, m, H-3), 3.74 (3H, s, OCH_3), 2.02~2.52 (4H, m, H-2, 6); ^{13}C NMR (100 MHz, CD_3OD, δ, ppm): 75.8 (C-1), 41.5 (C-2), 66.2 (C-3), 70.0 (C-4), 75.3 (C-5), 36.9 (C-6), 176.3 (C-7), 127.8 (C-1′), 115.2 (C-2′), 146.9 (C-3′), 149.7 (C-4′), 116.6 (C-5′), 123.3 (C-6′), 147.4 (C-7′), 115.0 (C-8′), 168.6 (C-9′), 127.9 (C-1″), 115.3 (C-2″), 146.9 (C-3″), 149.7 (C-4″), 116.6 (C-5″), 123.4 (C-6″), 147.5 (C-7″), 115.1(C-8″), 168.7 (C-9″), 53.1 (OCH_3).

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REFERENCES

1. Jiangsu New Medical College, *Dictionary of Chinese Herbal Medicine*, Shanghai People′s Publishing House, Shanghai, **2**, 1977, 698 pp.
2. Q. L. Guo, J. S. Yang, and J. X. Liu, *Chin. Trad. Pat. Med.*, **29**, 887 (2007).
3. Q. L. Guo, J. S. Yang, and J. X. Liu, *J. Chin. Med. Mater.*, **30**, 35 (2007).
4. H. G. Xie, H. W. Zhang, J. Zhang, L. Z. Xu, and Z. M. Zou, *Chin. J. Nat. Med.*, **5**, 193 (2007).
5. S. J. Dai and D. Q. Yu, *Chin. J. Nat. Med.*, **3**, 347 (2005).
6. J. Z. Yuan and Q. S. Sun, *J. Shenyang Pharm. Univ.,* **16**, 60 (1999).
7. X. W. Yang and J. Zhao, *Nat. Prod. Res. Dev.*, **15**, 490 (2003).
8. H. X. Lou, H. Q. Yuan, M. Ji, and D. Y. Xu, *Acta Acad. Med. Shandong*, **33**, 346 (1995).
9. Y. S. Li, S. D. Luo, M. Zhang, J. J. Chen, and Z. T. Wang, *Chin. J. Chin. Mater. Med.*, **26**, 835 (2001).
10. T. Wu, Z. H. Cheng, H. P. Liu, Y. Li, G. X. Chou, and Z. T. Wang, *Chin. Pharm. J.,* **40**, 1460 (2005).
11. J. M. Purcell, S. G. Morris, and H. Susi, *Anal. Chem.*, **38**, 588 (1966).
12. T. Hieda, Y. Mikami, Y. Obi, and T. Kisaki, *Agric. Biol. Chem.*, **46**, 2249 (1982).
13. P. Joseph-Nathan, J. D. Hernandez, L. U. Roman, E. G. Garcia, and V. Mendoza, *Phytochemistry*, **21**, 669 (1982).
14. D. C. Zhang, *Chin. Trad. Pat. Med.*, **5**, 24 (1982).
15. Q. Y. Zhang, Y. Y. Zhao, X. H. Liu, N. X. Zhang, Y. X. Cui, and T. M. Cheng, *Chin. J. Chin. Mater. Med.*, **25**, 101 (2000).
16. S. Yahara, T. Nishiyori, A. Kohda, T. Nohara, and I. Nishioka, *Chem. Pharm. Bull*., **39**, 2024 (1991).
17. N. Li, X. Li, and S. L. Yang, *J. Shenyang Pharm. Uni.*, **23**, 427 (2006).
18. T. Miyase, M. Kuroyanagi, T. Noro, A. Ueno, and S. Fukushima, *Chem. Pharm. Bull*., **33**, 4445 (1985).
19. D. C. Ren, S. H. Qian, N. Y. Yang, N. Xie, and J. A. Duan, *J. Chin. Med. Mater.*, **31**, 47 (2008).
20. S. Inoshiri, M. Sasaki, H. Kohda, H. Otsuka, and K. Yamasaki, *Phytochemistry*, **26**, 2811 (1987).
21. M. Sugiyama and M. Kikuchi, *Phytochemistry*, **30**, 3147 (1991).
22. M. S. Ali, M. Saleem, F. Akhtar, M. Jahangir, M. Parvez, and V. U. Ahmad, *Phytochemistry*, **52**, 685 (1999).
23. A. J. Carpenter and D. J. Chadwick, *J. Chem. Soc., Perkin Trans. 1*, 173 (1985).

24. D. S. Zhang, S. W. Huang, H. Y. Gao, B. H. Sun, J. Huang, and L. J. Wu, *J. Shenyang Pharm. Uni.*, **25**, 454 (2008).
25. K. R. Markham, B. Ternai, R. Stanly, H. Geiger, and T. J. Mabry, *Tetrahedron*, **34**, 1389 (1978).
26. W. L. Mei, H. F. Dai, and D. G. Wu, *Chem. J. Chin. Univ.*, **27**, 1480 (2006).
27. M. H. Gao, H. Li, L. Zhang, and S. X. Xiao, *J. Chin. Med. Mat.*, **31**, 682 (2008).
28. M. Chen, W. W. Wu, G. Q. Shen, S. Q. Luo, and H. T. Li, *Acta Pharm. Sin.*, **29**, 617 (1994).
29. P. Basnet, K. Matsushige, K. Hase, S. Kadota, and T. Namba, *Biol. Pharm. Bull.*, **19**, 1479 (1996).