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DITERPENOID ALKALOIDS FROM *DELPHINIUM CAERULEUM*

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Key Word Index—*Delphinium caeruleum*; Ranunculaceae; diterpenoid alkaloids; caerunine.

Abstract—A new diterpenoid alkaloid, caerunine, was isolated from *Delphinium caeruleum* and its structure elucidated on the basis of spectral data. Four known alkaloids, talitine B, delpheline, delbrunine and 14-acetyldelcosine were also isolated.

INTRODUCTION

The isolation and structural elucidation of a series of C_{19}-diterpenoid alkaloids from *Delphinium caeruleum* Jacq. ex cambss were reported in a previous paper [1]. Continued investigation on the constituents of this species has now resulted in the isolation of another new diterpenoid alkaloid, caerunine (**1**), and the four known alkaloids, talitine B (**2**), delpheline (**3**), delbrunine (**4**) and 14-acetyldelcosine (**5**). The structure of the new alkaloid was elucidated on the basis of spectral evidence; the known alkaloids were identified by comparison of the spectral data with those in the literature.

RESULTS AND DISCUSSION

The molecular formula $C_{24}H_{35}NO_7$ of caerunine (**1**) was derived from spectral evidence. Spectral data indicated the presence of a hydroxyl group and an azomethine (–N=C) (IR bands at 3300–3345 and 1668 cm^{-1}), four methoxyl groups (^1H NMR: δ 3.32 and 3.48, each 3H, *s*; 3.35, 6H, *s*) and a methylenedioxyl ($-OCH_2O-$) group (4.99, 1H, *s*; 5.12, 1H, *s*). in the ^1H NMR spectrum of **1** there were no signals in the positions expected for NCH_3 or NEt groups, and a broad singlet at δ 7.54 was consistent with the presence of a C(19)-azomethine [2, 3].

In the ^{13}C NMR spectrum, the 24 signals corresponded to 24 carbon atoms in the molecule. Multiplicities were determined by DEPT. The doublet at δ 166.8 was assigned to C(19) of the azomethine [4] and the downfield signals at 48.5 to C(4) possessing an adjacent double bond as N=C(19) [5]. Comparison of the ^{13}C NMR spectral data for caerunine with those for the known alkaloid talitine B (Table 1) suggested that the four quartet signals at δ 55.7, 58.0, 56.3 and 59.5 in caerunine can be assigned to C(1)-OMe, C(14)-OMe, C(16)-OMe and C(18)-OMe, respectively; the quaternary carbon signal at δ 78.5 can be ascribed to C(1) possessing a hydroxyl group [6]. In the EI mass spectrum of **1**) the abundant demethoxylated $[M]^+$ indicated the presence of C(1)-α-OMe [7].

On the basis of the above evidence, the structure of caerunine was thus assigned as **1**.

EXPERIMENTAL

General. Mps: uncorr. NMR: ^1H (400 MHz) and ^{13}C (100 MHz), $CDCl_8$, TMS as int. standard. MS: 70 eV. CC: 200–300 mesh alumina and silica gel. TLC: silica gel GF_{254}. The herb was collected from Gansu Province in September 1993. It was identified by Prog. Xun Pan, Department of Pharmacy, Lanzhou Medical College. A voucher specimen is deposited in the Department of Biology, Lanzhou University.

Extraction and isolation. Powdered herb (1.5 kg) was extracted with 95% EtOH for 1 week at room temp. After removal of EtOH under red. pres., 50 g of syrup remained, which was dissolved in 2% H_2SO_4 soln. The acid soln, after extracting with Et_2O, was made alkaline with conc. NH_4OH soln to pH 10–11 and extracted with $CHCl_3$. From the combined $CHCl_3$ extracts, 6.6 g of crude alkaloids were obtained. When the crude alkaloids were subjected to CC on alumina with petrol–Me_2CO as eluent and subjected to prep. TLC using hexane–Et_2NH (4:1) as eluent, 10–100 mg of the compounds **1–5** were obtained, each being purified further by repeated recrystallization.

Caeruine (**1**). Amorphous powder (16 mg). $[\alpha]_D^{20}$ −4.2° ($CHCl_3$, 0.25). MS *m/z* (rel. int.): 499 $[M]^+$ (38), 418 $[M\text{-}31]^+$ (50). IR ν_{max}^{KBr} cm^{-1}; 3450–3300 (OH), 2925, 1668 (C=N), 1458, 1202, 1092. ^1H NMR ($CDCl_3$): δ 3.32, 3.48 (each 3H, *s*, 2 × OCH_3), 3.35 (6H, *s*, 2 × OCH_3), 4.99, 5.12 (each 1H, *s*, $-OCH_2O-$), 4.08 (1H, C(17)-H), 7.54 (1H, *br s*, C(19)-H). ^{13}C NMR: Table 1.

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Table 1. ^{13}C NMR data for alkaloids **1–5**

C	1	2	3	4	5	C	1	2	3	4	5
1	81.0	83.3	83.1	71.8	72.5	16	81.5	81.6	18.9	81.5	82.7
2	23.6	25.1	26.9	27.2	27.2	17	62.4	61.8	63.7	65.8	66.1
3	28.7	32.0	36.9	29.4	29.8	18	75.3	79.4	25.3	77.9	77.3
4	48.5	39.2	33.9	37.1	37.5	19	166.8	52.6	57.3	57.4	57.2
5	51.8	53.1	55.5	42.0	43.5	N-CH_2		50.5	50.2	50.2	50.3
6	26.5	26.7	79.3	88.3	90.2	CH_3		13.9	13.9	13.9	13.6
7	90.9	90.6	92.8	92.1	87.6	1-OMe	55.7	55.3			
8	82.4	82.6	84.4	83.4	78.4	6-OMe				58.1	57.2
9	78.5	79.0	47.6	45.7	44.0	14-OMe	58.0	57.9	57.6		
10	38.9	43.5	40.3	46.6	38.0	16-OMe	56.3	56.0	56.1	56.2	56.3
11	52.0	51.3	50.4	50.7	49.2	18-OMe	59.5	59.4	59.3	59.2	59.1
12	30.9	30.1	28.1	29.0	29.4	14-CO					171.4
13	37.2	36.9	38.6	42.6	CH_3					21.4	
14	88.8	89.3	81.9	74.7	76.3						
15	33.5	36.1	33.5	36.5	33.8	$-OCH_2O-$	93.8	93.5	93.3	94.1	

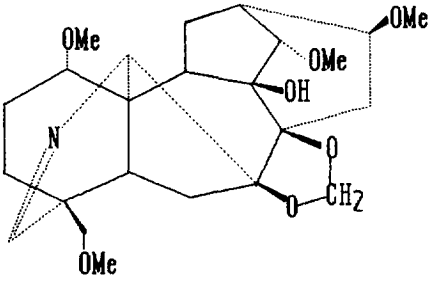
Assignment partly based on DEPT data.

Talitine B (**2**). Crystals (MeOH), mp 98–100°. MS *m/z* (rel. int.): 479 $[M]^+$ (5), 464(3), 448 $[M-OMe]^+$ (100). IR ν_{max}^{KBr} cm^{-1}; 3480 (OH), 1450, 1210, 1085; ^1H NMR ($CDCl_3$): δ 1.08 (3H, *t*, $J = 7$ Hz, N-Et), 3.27, 3.28, 3.32, 3.45 (each 3H, *s*, 4 × OMe), 4.97, 5.08 (each 1H, *s*, $-OCH_2O-$). ^{13}C NMR: Table 1. Mp and spectral data in good agreement with those reported in lit. [6].

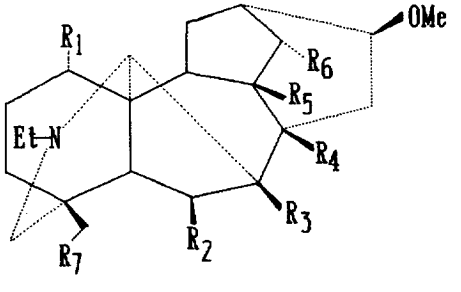
Delpheline (**3**). Amorphous powder (25 mg). MS *m/z* (rel. int.): 449 $[M]^+$ (10), 434 $[M-Me]^+$ (5), 418 $[M-OMe]^+$ (100), IR ν_{max}^{KBr} cm^{-1}: 3440, 1432, 1224, 1050. ^1H NMR ($CDCl_3$): δ 1.07 (3H, *t*, $J = 7$ Hz, N-Et), 3.30, 3.32, 3.40 (each 3H, *s*, 3 × OMe), 5.01, 5.10 (each 1H, *s*, $-OCH_2O-$). ^{13}C NMR: Table 1. Spectral data in good agreement with those in lit. [8].

Delbrunine (**4**). Amorphous powder (38 mg). MS *m/z* (rel. int.): 465 $[M]^+$ (18), 447 $[M-H_2O]^+$ (10), 434 $[M-OMe]^+$ (21). ^1H NMR ($CDCl_3$): δ 1.12 (3H, *t*, $J = 7$ Hz, N-Et), 3.33, 3.35, 3.37 (each 3H, *s*, 3 × OMe), 5.09, 5.12 (each 1H, *s*, $-OCH_2O-$). $^{13}CNMR$: Table 1. Spectral data in good agreement with lit. [9].

14-*Acetyldelcosine* (**5**). MS *m/z* (rel. int.): 495 $[M]^+$ (6), 477 $[M-H_2O]^+$ (66). ^1H NMR ($CDCl_3$): δ 1.07 (3H, *t*, $J = 7$ Hz, N-Et), 2.08 (3H, *s*, -OAc), 3.35, 3.40, 3.42 (each 3H, *s*, 3 × OMe). ^{13}C NMR: Table 1. Spectral data in good agreement with lit. [10].



1 Caerunine



	R_1	R_2	R_3 R_4	R_5	R_6	R_7
2	OMe	H	OCH_2O	OH	OMe	OMe
3	OMe	OH	OCH_2O	H	OMe	H
4	OH	OMe	OCH_2O	H	OH	OMe
5	OH	OMe	OH OH	H	OAc	OMe

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