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FURTHER NORDITERPENOID ALKALOIDS FROM *DELPHINIUM CARDIOPETALUM*

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Key Word Index—*Delphinium cardiopetalum*; Ranunculaceae; norditerpenoid alkaloids; 14-benzoylnudicaulidine; 14-isobutyrylnudicaulidine; 14-(2-methylbutyryl)-nudicaulidine, 14-*cis*-cinnamoylnudicaulidine; 14-*trans*-cinnamoylnudicaulidine; 8-methylsachaconitine; 14-benzoyldihydrogadesine; nudicaulidine.

Abstract—A further study of the alkaloidal constituents of *Delphinium cardiopetalum* led to the isolation of six new norditerpenoid alkaloids, 14-benzoylnudicaulidine, 14-isobutyrylnudicaulidine, 14-(2-methylbutyryl)-nudicaulidine, 14-*cis*-cinnamoylnudicaulidine, 14-*trans*-cinnamoylnudicaulidine and 8-*O*-methylsachaconitine, together with the known alkaloids, 14-benzoyldihydrogadesine and nudicaulidine. The structures of the new alkaloids were determined by NMR spectroscopy and partial synthesis in the case of our compounds. © 1997 Elsevier Science Ltd. All rights reserved

INTRODUCTION

Delphinium cardiopetalum DC, (syn. *D. Verdunense* Balb.) is an annual herb distributed throughout the northern half of the Iberian Peninsula [1]. In previous work, we have isolated from plants collected in León (Spain), the alkaloids, hetisinone, 13-acetylhetisinone, cardiopetaline, cardiopetalidine, cardiopetamine, 13-acetylcardiopetamine, cardionine and atisinium chloride [2–5], and from plants collected in Lérida (Spain), the alkaloids, karakoline, dihydrogadesine, 14-acetyldihydrogadesine, 14-benzoyldihydrogadesine, cardionine, cardionidine, cossonidine, hetisine, hetisinone and atisinium chloride [5–9]. From an acidic extract the diterpenoid alkaloids, cardiopine, cardiopinine, cardiopimine, cardiopidine and cardiodine were also obtained [10]. Further investigation of the alkaloids contained in the acidic fraction of an ethanolic extract from plants collected in León has led to the isolation of 14-benzoylnudicaulidine (**1**), 14-isobutyrylnudicaulidine (**2**), 14-(2-methylbutyryl)-nudicaulidine (**3**), 14-*cis*-cinnamoylnudicaulidine (**4**), 14-*trans*-cinnamoylnudicaulidine (**5**), 8-*O*-methylsachaconitine (**8**) and the known compounds, 14-benzoyldihydrogadesine (**6**) and nudicaulidine (**7**).

RESULTS AND DISCUSSION

The molecular formulae of the new alkaloids, 14-benzoylnudicaulidine (**1**), $C_{30}H_{41}NO_7$, 14-isobutyrylnudicaulidine (**2**), $C_{28}H_{45}NO_7$, 14-(2-methylbutyryl)-nudicaulidine (**3**), $C_{29}H_{47}NO_7$, 14-*cis*-cinnamoylnudicaulidine (**4**), $C_{33}H_{45}NO_7$, 14-*trans*-cinnamoylnudicaulidine (**5**), $C_{33}H_{45}NO_7$, and 8-*O*-methylsachaconitine (**8**), $C_{24}H_{39}NO_4$, were derived from their EI mass, ^1H and ^{13}C NMR spectra. Their NMR spectra showed signals characteristic of norditerpenoid alkaloids [11, 12] and the mass spectra exhibited typical fragmentations of such compounds [13].

Comparison between the ^1H and ^{13}C NMR spectra of compounds **1–5** with those of nudicaulidine (**7**) [14] (Table 1) clearly indicated that the new alkaloids are derivatives of the norditerpenoid alkaloid nudicaulidine possessing an acyloxy group at C-14α instead of a hydroxyl group. They displayed, among others, characteristic signals at δ_H 0.89 (3H, *s*) and δ_C 26.8 (*q*) for the angular methyl group, δ_H 1.03–1.05 (3H, *t*, $J = 7$ Hz), 2.78–2.80 and 2.88–2.89 (1H each, *dq*, $J \approx 14$ and 7 Hz), δ_C 51.0–51.1 (*q*) and 14.2 (*t*) for the *N*-ethyl group, δ_H 1.31–1.41 (1H, *br s*) and δ_C 54.6–54.8 (*d*) for the HC(5), δ_H 2.39–2.43 and 2.62–2.65 (1H each, *d*, $J \approx 12$ Hz) and δ_C 56.5–56.6 (*t*) for the $H_2C(19)$, δ_H 2.87–2.94 (1H, *br s*) and δ_C 64.4–64.5 (*d*) for the HC(17), δ_H 2.94–2.97 (1H, *dd*, $J \approx 10$ and 7 Hz), δ_C 84.1–84.6 (*d*) and 55.8 (*q*) for the C-1αH, βOMe, δ_H 3.85–3.92 (1H, *s*), δ_C 90.9–91.2 (*d*) and 58.2 (*q*) for the C-6αH, βOMe, δ_C 82.2–83.3 (*d*) and 55.9–56.2 (*q*) for the C-16αH, βOMe, 4.76–5.03 (1H, *t*, $J = 4.5$–5 Hz) and δ_C 75.5–76.9 (*d*) for the C-14αH, βOCOR, and δ_C 76.4–77.6 (*s*) and 87.5–89.5 (*s*) for

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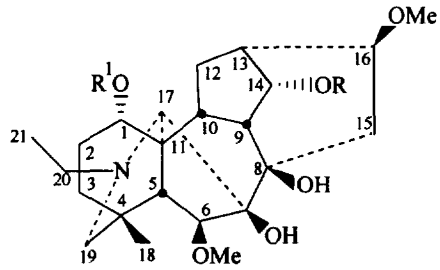
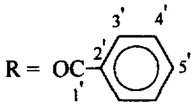
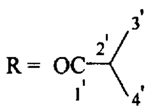
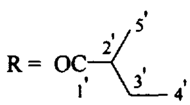
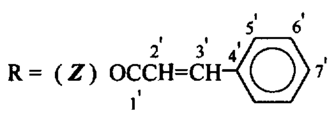
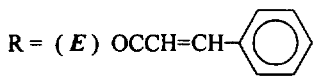


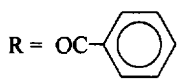
1  ; R^1 = Me

2  ; R^1 = Me

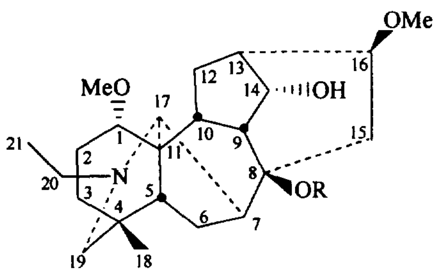
3  ; R^1 = Me

4  ; R^1 = Me

5  ; R^1 = Me

6  ; R^1 = H

7 R = H ; R^1 = Me



8 R = Me

9 R = H

the C-8 and C-7 tertiary hydroxyl groups, respectively. A benzoate group in **1** was evident from the NMR signals at δ_H 7.39 (2H, *t*, $J = 7.2$ Hz), 7.49 (1H, *t*, $J = 7.2$ Hz), 8.12 (2H, *d*, 7.2 Hz) and δ_C 166.9 (*s*), 130.9 (*s*), 128.3 (*d*), 129.8 (*d*), 132.4 (*d*), and from the mass spectral fragmentation ions at m/z $[M-105]^+$, 105 and 77. The isobutyrate group in **2** was indicated from signals at δ_H 1.17 and 1.18 (3H each, *d*, $J = 7.0$

Hz), 2.55 (1H, *sept*, $J = 7.0$ Hz) and δ_C 177.4 (*s*), 33.8 (*d*), and 18.9 (*q*) and from ions at *m/z* $[M-71]^+$ and 71, as was the 2-methylbutyrate group in **3** from the signals at δ_H 0.91 (3H, *t*, $J = 7.4$ Hz), 1.16 (3H, *d*, $J = 6.9$ Hz) and δ_C 176.9 (*s*), 41.2 (*d*), 26.6 (*t*), 16.2 (*q*) and 11.6 (*q*), and from ions at *m/z* $[M-85]^+$, 85 and 57. The *cis*-cinnamate group in **4** was identified from signals at δ_H 6.03 and 6.88 (1H each, *d*, $J = 12.6$ Hz), 7.31 (3H, *m*), 7.65 (2H, *d*, $J = 7.2$ Hz) and δ_C 166.8 (*s*), 120.5 (*d*), 142.9 (*d*), 135.0 (*s*), 127.9 (*d*), 129.9 (*d*) and 128.8 (*d*), and from ions at *m/z* $[M-131]^+$, 147, 131, 103 and 77, as was the *trans*-cinnamate group in **5** from signals at δ_H 6.47 and 7.29 (1H each, *d*, $J = 16.0$ Hz), 7.35 (3H, *m*), 7.52 (2H, *m*) and δ_C 167.3 (*s*), and, as well as 118.8 (*d*) from similar fragments to those ions in **4**.

Treatment of nudicaulidine (**7**) with benzoyl chloride, isobutyric anhydride, 2-methylbutyric anhydride or *trans*-cinnamoyl chloride in pyridine gave the corresponding esters **1**, **2**, **3** and **5**, respectively, identical with the natural alkaloids.

The NMR spectra of 8-*O*-methylsachaconitine (**8**), $C_{24}H_{39}NO_4$, gave signals at δ_H 0.78 (3H, *s*) and δ_C 26.4 (*q*) characteristic of an angular methyl group, δ_H 1.06 (3H, *t*, $J = 7.0$ Hz) and δ_C 49.3 (*t*) and 13.6 (*q*) of an *N*-ethyl group, and δ_H 3.15, 3.26 and 3.37 (3H each, *s*) and δ_C 48.3 (*q*) and 56.4 (*q*) of three methoxyl groups. The ^{13}C NMR spectrum (Table 1) showed only three singlets upfield from 80 ppm at δ_C 34.5 (C-4), 49.2 (C-10) and 78.1 (C-8), indicating that the compound is an aconitine-type norditerpenoid alkaloid possessing a tertiary methoxyl group at C-8 (δ_C 48.3, *q*) [11, 12]. The one-proton signals at δ_H 3.06 (*dd*, $J = 10.7$ and 6.7, H-1β), 3.38 (*br t*, $J = 4.0$ Hz, H-16α) and 4.00 (*br q*, $J = 5.9$ Hz), which became a *t* of $J = 4.8$ Hz when D_2O was added, (H-14β), and the resonances at δ_C 75.1 (*d*, C-14), 82.3 (*d*, C-16), 86.3 (*d*, C-1) and 56.4 (*q*, C-1′ and C-16′) suggested the presence of two methoxyl groups at C-1α and C-16β and a hydroxyl group at C-14α in the molecule [11, 12]. The ^{13}C NMR spectrum of **8** (Table 1) was in agreement with the proposed structure and assignments were made by comparison with the spectrum of sachaconitine (**9**) [15]. Considering the ^{13}C NMR data given in our work for compounds **1**–**5** and **7**, the C-10 and C-13 carbon resonances for sachaconitine [15] have been re-assigned. In the ^1H NMR spectrum of 8-*O*-methylsachaconitine, the C-14αH signal appeared as a *br q* of $J = 5.9$ Hz, which changed into a *t* of $J = 4.8$ Hz when D_2O was added. This situation has been found in other aconitine-type norditerpenoid alkaloids possessing methoxyl groups at C-8 and C-16β, probably due to the existence of strong intramolecular hydrogen bonds between the *O*-14H and both *O*-8 and *O*-16 [14, 16, 17].

EXPERIMENTAL

General. Mps: uncorr. EIMS and HR measurements: 70 eV. NMR: Bruker AMX-400 and WP-22 SY spectrometers, with TMS as int. standard. Alumina Merck Art. 1077 and 5581 was used for CC, TLC and prep. TLC, respectively; spots on chromatograms were detected with Dragendorff's reagent.

Plant material. Plants were collected outside León city, Spain, by D. Jiménez, Botany Department, Faculty of Pharmacy, Universidad Complutense, Madrid, where a voucher specimen has been deposited.

Extraction and isolation. Air-dried plants (7 kg) were extracted with 80% EtOH in a Soxhlet. After removing solvent under vacuum, the EtOH extract was treated with 0.5 M H_2SO_4 and filtered. The acidic soln was extracted with $CHCl_3$ to give a crude material that, since it gave a positive test with Dragendorff's reagent, was treated again with 0.5 M H_2SO_4 and filtered. The acid soln was basified to pH 12 and extracted with $CHCl_3$ to give a crude material (780 g). This material was chromatographed over a short column of neutral alumina eluting with hexane–EtOAc (1:1). The frs containing alkaloids were combined and partitioned between 0.5 M H_2SO_4 and $CHCl_3$. The aq. phase was basified to pH 10 with NH_4OH and extracted with $CHCl_3$ to give a crude alkaloidal fr. (320 mg). This was chromatographed on neutral alumina and eluted with mixts of hexane–EtOAc. The frs eluted with hexane–EtOAc (1:1) afforded nudicaulidine (**7**) (72 mg). Frs eluted with hexane–EtOAc (9:1) gave a mixt. of alkaloids, which after prep. TLC on 4 layers of alumina eluting ×3 with hexane–EtOAc (4:1), gave individual alkaloids in the following elution order: 14-(2-methylbutyryl)-nudicaulidine (**3**) (8.5 mg), 14-isobutyrylnudicaulidine (**2**) (4.3 mg), 14-benzoylnudicaulidine (**1**) (4.2 mg), 14-*trans*-cinnamoylnudicaulidine (**5**) (10 mg), 14-*cis*-cinnamoylnudicaulidine (**4**) (4.7 mg), 14-benzoyldihydrogadesine (**6**) (5 mg) and 8-*O*-methylsachaconitine (**8**) (4.2 mg). The known alkaloids nudicaulidine (**7**) [14, 18] and 14-benzoyldihydrogadesine (**6**) [6] were identified by comparison with authentic samples (TLC, IR, MS and NMR).

14-*Benzoylnudicaulidine* (**1**). Crystalline, mp 199–202°, from hexane–EtOAc. $[\alpha]_D = +48.6°$ (*c* 0.22, EtOH), $[M]^+$, *m/z* 541.3036 for $C_{31}H_{43}NO_7$ (calcd 541.3039). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3450, 3000, 2920, 1710, 1598, 1457, 1447, 1375, 1340, 1313, 1278, 1175, 1122, 1088, 1028, 982, 950, 905, 710. EIMS *m/z* (rel. int.): 541 (3) $[M]^+$, 527 (8), 526 (14), 511 (34), 510 (100), 494 (2), 492 (3), 478 (2), 476 (3), 436 (1), 414 (2), 389 (4), 122 (2), 105 (18), 77 (3), 71 (6), 58 (9), 32 (16). ^1H NMR ($CDCl_3$, 400 MHz): δ 0.97 (3H, *s*, H-18), 1.04 (3H, *t*, $J = 7.2$ Hz, H-21), 1.41 (1H, *s*, H-5), 2.40 and 2.63 (1H each, *d*, $J = 11.8$ Hz, H-19B and H-19A), 2.79 and 2.89 (1H each, *dq*, $J = 14.6$ and 7.3 Hz, H-20B and H-20A), 2.94 (1H, *s*, H-17), 2.98 (1H, *dd*, $J = 10.2$ and 7.1 Hz, H-1β), 3.25, 3.27 and 3.37 (3H each, *s*, 3×OMe), 3.85 (1H, *s*, H-6α), 3.89 (1H, *s*, disappearing when D_2O added), 5.03 (1H, *t*, $J = 4.8$ Hz, H-14β), 7.39 (2H, *t*, $J = 7.2$ Hz), 7.50 (1H, *t*, $J = 7.2$ Hz) and 8.12 (2H, *d*, $J = 7.2$ Hz) for the benzoyl group. ^{13}C NMR ($CDCl_3$, 100 MHz): Table 1.

Table 1. ^{13}C NMR chemical shifts assignments for compounds **1**–**5** and **7**–**9***

Carbon	1	7	2	3	4	5	8	9
1	84.6	85.5	84.6	84.5	84.1	84.5	86.3	86.7
2	26.6	25.9	26.6	26.3	26.6	26.6	26.6	26.3
3	37.3	37.3	37.9	37.4	38.2	37.4	37.8	37.8
4	34.0	34.3	34.1	34.0	35.8	33.9	34.5	34.7
5	54.8	55.1	54.8	54.7	54.7	54.6	50.9	49.5
6	91.1	90.8	91.2	91.1	91.1	90.9	24.1	25.2
7	88.6	89.2	88.5	88.5	87.5	89.5	40.0	45.9
8	77.4	76.5	77.5	77.4	76.4	77.6	78.0	72.9
9	43.1	45.1	43.1	43.2	42.2	42.8	45.6	47.1
10	45.5	46.1	45.7	45.7	45.8	45.6	45.9	45.9
11	49.1	48.5	49.1	49.1	49.1	49.1	49.2	51.0
12	28.3	27.8	28.3	29.7	28.4	28.3	28.5	27.8
13	37.8	36.5	37.4	37.8	37.3	38.2	38.0	38.5
14	76.0	75.2	75.7	75.5	76.9	75.8	75.1	75.7
15	34.1	33.0	34.3	33.7	34.0	34.0	33.5	38.0
16	82.2	81.8	82.3	82.3	82.3	82.2	82.3	82.3
17	64.5	64.9	64.4	64.5	64.5	64.4	62.4	62.5
18	26.8	26.8	26.8	26.8	26.8	26.8	26.4	26.3
19	56.5	56.6	56.6	56.5	56.5	56.5	56.7	57.5
20	51.1	51.1	51.0	51.0	51.0	51.0	49.3	49.5
21	14.2	14.3	14.2	14.2	14.2	14.2	13.6	13.7
1αOMe	55.8	55.9	55.8	55.8	55.8	55.8	56.4	56.3
6βOMe	58.2	58.5	58.2	58.2	58.2	58.2	—	—
8OMe	—	—	—	—	—	—	48.3	—
16βOMe	56.0	56.0	55.9	55.9	56.2	56.2	56.4	56.9
1′	166.9	—	177.4	176.9	166.8	167.3	—	—
2′	130.9	—	33.8	41.2	120.5	118.8	—	—
3′	128.3	—	18.9	26.6	142.9	144.5	—	—
4′	129.8	—	18.9	11.6	135.0	134.7	—	—
5′	132.4	—	—	16.2	127.9	128.6	—	—
6′	—	—	—	—	129.9	128.1	—	—
7′	—	—	—	—	128.8	129.8	—	—

* Carbon multiplicities established from DEPT data.

14-*Isobutyrylnudicaulidine* (**2**). Resin. $[\alpha]_D = +31°$ (*c* 0.1, EtOH). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3451, 2929, 1720, 1458, 1388, 1232, 1194, 1161, 1080, 1026, 985, 955. EIMS *m/z* (rel. int.): 507 (6) $[M]^+$, 492 (14), 477 (30), 476 (93), 474 (14), 460 (2), 444 (2), 436 (1), 404 (2), 122 (6), 110 (10), 85 (8), 71 (100), 58 (34), 55 (21). ^1H NMR ($CDCl_3$, 400 MHz): δ 0.97 (3H, *s*, H-18), 1.03 (3H, *t*, $J = 7.1$ Hz, H-21), 1.17 (3H, *d*, $J = 7.0$ Hz), 1.18 (3H, *d*, $J = 7.0$ Hz) and 2.55 (1H, *sept*, $J = 7.0$ Hz) for isobutyryl group, 1.38 (1H, *s*, H-5), 2.65 (1H, *d*, $J = 12.0$ Hz, H-19A), 2.78 and 2.88 (1H each, *dq*, $J = 14.0$ and 7.0 Hz, H-20B and H-20A), 2.87 (1H, *s*, H-17), 2.94 (1H, *dd*, $J = 10.2$ and 7.3 Hz, H-1β), 3.23, 3.28 and 3.39 (3H each, *s*, 3 × OMe), 3.85 (1H, *s*, disappearing when D_2O added), 3.86 (1H, *s*, H-6α), 4.76 (1H, *t*, $J = 4.5$ Hz, H-14β). ^{13}C NMR ($CDCl_3$, 100 MHz): Table 1.

14-(2-*Methylbutyryl*)-*nudicaulidine* (**3**). Resin. $[\alpha]_D = +44.5°$ (*c* 0.05, EtOH). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3348, 2980, 2932, 1719, 1458, 1380, 1296, 1269, 1155, 1089, 1028, 983, 862. EIMS *m/z* (rel. int.): 521 (13) $[M]^+$, 507 (12), 506 (37), 491 (96), 490 (100), 488 (45), 458 (9), 436 (3), 404 (5), 374 (4), 166 (5), 122 (11), 110 (18), 98 (13), 91 (11), 85 (51), 58 (68), 57 (100), 56 (48), 55 (32). ^1H NMR ($CDCl_3$, 400 MHz): δ 0.89 (3H, *s*, H-18), 0.91 (3H, *t*, $J = 7.4$ Hz, H-4′), 1.04 (3H, *t*, $J = 7.2$ Hz, H-21), 1.16 (3H, *d*, $J = 6.9$ Hz, H-5′), 1.38 (1H, *br s*, H-5), 2.39 and 2.63 (1H each, *d*, $J = 11.3$ Hz, H-19B and H-19A), 2.87 (1H, *br s*, H-17), 2.96 (1H, *dd*, $J = 10.0$ and 7.0 Hz, H-1β), 3.24, 3.28 and 3.40 (3H each, *s* 3 × OMe), 3.85 (1H, *s*, H-6α), 3.88 (1H, *s*, disappearing when D_2O added), 4.79 (1H, *t*, $J = 5.0$ Hz, H-14β). ^{13}C NMR ($CDCl_3$, 50 MHz): Table 1.

14-cis-*Cinnamoylnudicaulidine* (**4**). Resin. $[\alpha]_D = +4°$ (*c* 0.125, EtOH). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3421, 3000, 2930, 1710, 1656, 1458, 1400, 1375, 1318, 1168, 1089, 1026, 987, 868, 828, 698. EIMS *m/z* (rel. int.): 567 (1) $[M]^+$, 552 (3), 537 (8), 536 (22), 534 (4), 522 (1), 520 (1), 508 (1), 504 (1), 436 (1), 404 (2), 374 (2), 206 (3), 204 (3), 188 (3), 176 (3), 174 (3), 147 (11), 131 (100), 122 (9), 105 (13), 104 (16), 103 (83), 102 (17), 91 (13), 77 (44), 71 (21), 58 (39), 56 (11), 55 (16). ^1H NMR ($CDCl_3$, 400 MHz): δ 0.97 (3H, *s*, H-18), 1.04 (3H, *t*, $J = 7.1$ Hz, H-21), 1.37 (1H, *br s*, H-5), 2.39 and 2.62 (1H each, *d*, $J = 12.0$ Hz, H-19B and H-19A), 2.78 (1H, *dq*, $J = 14.2$ and 7.1 Hz, H-20B), 2.91 (1H, *br s*, H-17), 2.95 (1H, *dd*, $J = 7.2$ and 9.8 Hz, H-1β), 3.24, 3.30 and 3.38 (3H each, *s*, 3 × OMe), 3.85

(1H, *s*, disappearing when D_2O added), 3.89 (1H, *s*, H-6α), 4.83 (1H, *t*, $J = 4.5$ Hz, H-14β), 6.03 and 6.88 (1H, each, *d*, $J = 12.6$ Hz), 7.31 (3H, *m*) and 7.56 (2H, *d*, $J = 7.2$ Hz) for the *cis*-cinnamoyl group. ^{13}C NMR ($CDCl_3$, 50 MHz): Table 1.

14-trans-*Cinnamoylnudicaulidine* (**4**). Resin. $[\alpha]_D = +72.1°$ (*c* 0.26, EtOH). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3460, 3000, 2930, 1706, 1639, 1455, 1450, 1378, 1341, 1311, 1281, 1183, 1090, 986, 869. EIMS *m/z* (rel. int.): 567 (2) $[M]^+$, 552 (9), 537 (30), 536 (78), 534 (12), 522 (2), 520 (2), 518 (2), 508 (2), 504 (2), 436 (3), 404 (3), 374 (3), 206 (2), 204 (2), 188 (2), 176 (3), 174 (2), 147 (9), 131 (100), 122 (9), 105 (7), 104 (14), 103 (76), 102 (17), 91 (13), 77 (39), 71 (23), 58 (41), 56 (13), 55 (17). ^1H NMR ($CDCl_3$, 400 MHz): δ 0.98 (3H, *s*, H-18), 1.05 (3H, *t*, $J = 7.2$ Hz, H-21), 1.41 (1H, *br s*, H-5), 2.43 and 2.63 (1H each, *d*, $J = 12.0$ Hz, H-19B and H-19A), 2.80 and 2.88 (1H each, *dq*, $J = 14.0$ and 7.0 Hz, H-20B and H-20A), 2.92 (1H, *br s*, H-17), 2.97 (1H, *dd*, $J = 10.2$ and 7.2 Hz, H-1β), 3.25, 2.29 and 3.32 (3H each, *s*, 3 × OMe), 3.86 (1H, *s*, disappearing when D_2O added), 3.92 (1H, *s*, H-6α), 4.91 (1H, *t*, $J = 4.8$ Hz, H-14β), 6.47 and 7.20 (1H each, *d*, $J = 16.0$ Hz), 7.35 (3H, *m*) and 7.52 (2H, *m*) for the *trans*-cinnamoyl group. ^{13}C NMR ($CDCl_3$, 50 MHz): Table 1.

8-O-*Methylsachaconitine* (**8**). Resin. $[\alpha]_D = +7°$ (*c* 0.06, EtOH). IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3448, 2929, 2856, 1457, 1364, 1143, 1089, 864. EIMS *m/z* (rel. int.): 405 (3) $[M]^+$, 390 (1), 375 (28), 374 (94), 372 (2), 360 (2), 358 (3), 342 (6), 121 (7), 120 (8), 107 (11), 97 (13), 95 (20), 94 (100), 91 (13), 85 (14), 84 (10), 83 (19), 77 (16), 71 (33), 69 (33), 65 (23), 57 (55), 55 (68). ^1H NMR ($CDCl_3$, 400 MHz): δ 0.78 (1H, *s*, H-18), 1.06 (3H, *t*, $J = 7.0$ Hz, H-21), 1.43 (1H, *d*, $J = 8.4$ Hz, H-5), 2.96 (1H, *br s*, H-17), 3.06 (1H, *dd*, $J = 10.7$ and 6.7 Hz, H-1β), 3.15, 3.26 and 3.37 (3H each, *s*, 3 × OMe), 3.38 (1H, *br t*, $J = 4.0$ Hz, H-16α), 3.66 (1H, *d*, $J = 7.2$ Hz, disappearing when D_2O added, 14-αOH), 4.0 (1H, *br q*, $J = 5.9$ Hz, becoming a *t*, $J = 4.8$ Hz when D_2O added, H-14β). ^{13}C NMR ($CDCl_3$, 50 MHz): Table 1.

Synthesis of alkaloids **1**, **2**, **3** *and* **5** *from nudicaulidine* (**7**). A mixt. of nudicaulidine (**7**) (10 mg), pyridine (0.5 ml) and the corresponding reagent (0.1 ml) (benzoyl chloride, isobutyric anhydride, (*S*)-2-methylbutyric anhydride or *trans*-cinnamoyl chloride) was kept at room temp. for 24 hr. Then, the solvent was removed under vacuum to afford the reaction product, which after prep. TLC on one layer of alumina, eluting with hexane–EtOAc (17:3), gave original nudicaulidine and the required ester: **1** (8 mg, 90% conversion, 72% yield), **2** (7.6 mg, 100% conversion, 65.5% yield), **3** (4.5 mg, 60% conversion, 54% yield) and **5** (8.2 mg, 90% conversion, 70% yield). The synthetic esters were identical with the respective natural alkaloids (TLC, MS and ^1H NMR).

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