

THE STRUCTURES OF FOUR NEW DITERPENOID ALKALOIDS

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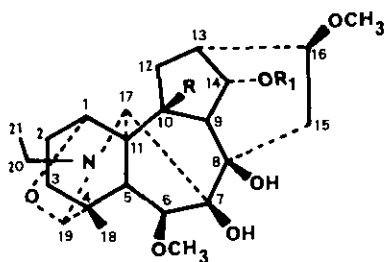
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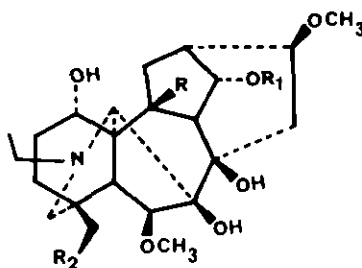
Abstract - Together with karakoline, dihydrogadesine and 14-acetyldihydrogadesine, the new alkaloids 14-benzoylgadesine and 14-benzoyldihydrogadesine were isolated from Delphinium cardiopetalum. The new bases gadeline and 14-acetylgadesine were also isolated from Delphinium pentagynum. The structures of the new compounds were determined with the aid of ¹H and ¹³C-nmr spectroscopy and chemical correlation to known alkaloids. The ¹³C-nmr chemical shifts for gadesine, dihydrogadesine and 14-acetyldihydrogadesine are also presented.

Further studies on plants of Delphinium cardiopetalum DC and D. pentagynum Lam led to the isolation of the new alkaloids 14-benzoylgadesine (2) and 14-benzoyldihydrogadesine (7) from the former, and gadeline (4) and 14-acetylgadesine (3) from the latter.

14-Benzoylgadesine (2), C₃₀H₃₉NO₇,¹ was isolated as a resin; ir (KBr), 3490 (OH), 1725, 1280 and 715 (benzoate), 1000 and 850 cm⁻¹; ms, 525 (1%) M⁺, 510 (68%) M⁺-CH₃, 492 (100%) |M⁺-CH₃|-H₂O, and 469 (13%) M⁺-C₃H₄O. The ir absorptions at 1000 and 850 cm⁻¹, and the loss of acrolein in the ms pointed out the existence of a carbinolamine inner ether in the molecule.^{2,3} The ¹H-nmr spectrum (200 MHz, CDCl₃) showed signals at δ 1.01 (3H, s, CH₃), 1.10 (3H, t, J = 7 Hz, N-CH₂-CH₃), 3.32 and 3.34 (3H each, s, two OCH₃), 3.77 (1H, m, W₂¹ = 8 Hz, C-18H), 3.87 (2H, s, C-6αH and C-19H), 5.12 (1H, t, J = 4.5 Hz, C-14βH), 7.46 and 7.84 (3H and 2H, m, aromatic protons).



- 1 R = R₁ = H
 2 R = H; R₁ = Bz
 3 R = H; R₁ = Ac
 4 R = OH; R₁ = Bz



- 5 R = R₁ = H; R₂ = OCH₃
 6 R = R₁ = R₂ = H
 7 R = R₂ = H; R₁ = Bz
 8 R = R₂ = H; R₁ = Ac
 9 R = OH; R₁ = Bz; R₂ = H

14-Acetylgadesine (3), C₂₅H₃₇NO₇, was obtained as a resin; ir (KBr), 3450 (OH), 1730 and 1240 (acetate), 1090 (C-O), 990 and 890 cm⁻¹ (inner ether)²; ms, 463 (1%) M⁺, 448 (57%) M⁺-CH₃, 430 (100%) |M⁺-CH₃|-H₂O, and 407 (14%) M⁺-C₃H₄O³; the ¹H-nmr (CDCl₃) gave signals at δ 0.94 (3H, s, CH₃), 1.04 (3H, t, J = 7 Hz, N-CH₂-CH₃), 2.03 (3H, s, acetate), 3.29 (6H, s, two OCH₃), 3.69 (2H, m, W₂¹ = 8 Hz, C-1βH), 3.79 (2H, s, C-6αH and C-19H), and 4.76 (1H, t, J = 4.5 Hz, C-14βH).

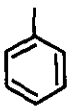
On the other hand, the alkaloids (2) and (3) proved to be identical (ir, ¹H-nmr, and ms) with the products obtained by treatment of gadesine (1)⁴ with BzOCl and Ac₂O in pyridine, respectively, and therefore their structures were definitively established.

14-Benzoyldihydrogadesine (7), C₃₀H₄₁NO₇, had mp 199-202°C and crystallized from ethyl acetate; ir (KBr), 3420 (OH), 1715, 1275 and 715 (benzoate), 1120 and 1085 cm⁻¹ (C-O); ms, 527 (20%) M⁺, 512 (80%) M⁺-CH₃, 510 (70%) M⁺-OH, 496 (80%) M⁺-OCH₃, and 494 (100%) |M⁺-CH₃|-H₂O. Its ¹H-nmr spectrum (CDCl₃) displayed signals at δ 1.08 (3H, s, CH₃), 1.10 (3H, t, J = 7 Hz, N-CH₃-CH₃), 3.35 (6H, s, two OCH₃), 3.76 (1H, m, W₂¹ = 7 Hz, C-1βH), 3.96 (1H, s, C-6αH), 5.10 (1H, t, J = 5 Hz, C-14βH), 7.42 and 8.12 (3H and 2H, m, aromatic protons).

The alkaline hydrolysis of (7) furnished dihydrogadesine (6)⁵ and the KMnO₄ oxidation⁶ yielded 14-benzoylgadesine (2) (mp, ir, ms and ¹H-nmr identical); consequently its structure was elucidated.

Gadeline (4), C₃₀H₃₉NO₈, was also isolated as a resin; ir (KBr), 3430 (OH), 1705, 1280 and 713 (benzoate), 1090 (C-O), 990 and 890 cm⁻¹ (inner ether)²; ms, 541 (1%)

^{13}C Chemical shifts and assignments

Carbon	1	2	3	5	6	7	8	9	4
1	89.0	89.1	89.2	72.7	72.8	72.7	72.9	70.0	88.8
2	27.7	29.9	30.0	27.5	29.3	28.9	29.2	30.0	30.3
3	22.5	22.8	22.7	29.4	32.2	31.6	31.8	31.5	26.0
4	38.4	38.6	38.9	37.6	33.1	33.0	33.1	32.7	38.7
5	36.9	37.0	37.0	44.0	50.6	50.0	50.1	46.0	47.6
6	90.9	91.3	91.4	90.1	91.0	91.0	91.2	91.5	92.1
7	84.9	84.7	84.5	87.9	87.9	87.6	87.8	87.0	84.2
8	76.0	76.4	76.7	78.1	78.1	78.4	78.5	76.8	74.9
9	45.4	43.6	43.0	45.3	45.3	43.5	43.7	53.0	54.2
10	52.2	52.0	52.0	45.3	44.1	43.0	42.7	81.7	79.6
11	46.4	47.0	47.0	48.9	49.2	49.5	49.7	54.3	51.8
12	30.2	30.5	30.5	29.4	29.3	29.7	29.9	40.5	40.7
13	38.3	38.5	38.6	39.4	39.4	37.9	38.1	38.2	38.3
14	75.3	76.0	76.0	75.8	75.7	76.1	76.5	75.5	75.2
15	33.8	34.2	33.8	34.5	34.5	34.3	34.0	35.2	35.2
16	81.8	82.6	82.8	82.0	82.1	82.4	82.8	81.5	81.8
17	64.1	63.9	64.0	66.3	65.7	65.9	65.7	66.3	65.6
18	20.1	20.3	20.2	77.4	27.7	27.7	27.8	27.7	20.6
19	68.3	68.8	68.7	57.1	60.8	60.9	61.2	61.0	68.7
20	47.3	47.5	47.6	50.4	50.3	51.2	50.5	50.4	47.5
21	13.7	13.9	13.9	13.7	13.7	14.4	13.8	13.4	13.7
6'	58.4	58.6	58.5	57.4	58.0	58.0	58.0	58.2	58.6
16'	56.4	56.3	56.4	56.4	56.3	56.4	56.4	56.2	56.2
18'				59.1					
CO		166.9				166.5		166.6	167.0
		130.1				129.2		130.5	130.7
		130.1				129.8		130.0	130.1
		128.5				129.4		128.4	128.4
		132.8				132.7		132.8	132.8
CO			171.8				171.8		
CH ₃			21.6				21.6		

Chemical shifts in ppm downfield from TMS.
Solvent deuteriochloroform.

M^+ , 526 (100%) M^+-CH_3 , 508 (75%) $|M^+-CH_3|-H_2O$, 485 (33%) $M^+-C_3H_4O$,³ and 454 (10%) $|M^+-C_3H_4O|-OCH_3$. The 1H -nmr spectrum ($CDCl_3$) displayed signals at δ 0.98 (3H, s, CH_3), 1.06 (3H, t, $J = 7$ Hz, $N-CH_2-CH_3$), 3.25 and 3.31 (3H each, s, two OCH_3), 3.82 and 3.86 (1H each, s, ether C-6 α H or C-19H), 3.95 (1H, m, $W_{1/2} = 8$ Hz), 5.55 (1H, t, $J = 5$ Hz, C-14 β H), 7.38 and 8.10 (3H and 2H, m, aromatic protons). The 1H -nmr signal for the C-14 β H was shifted downfield by 0.43 ppm as compared with that of 14-benzoylgadesine (2), suggesting the existence of a tertiary hydroxyl group placed at C-10 in the molecule.

The $KMnO_4$ oxidation⁶ of gadenine (9)⁷ in aqueous acetone gave gadeline (4) in 66% yield (ir, ms and 1H -nmr identical), thus allowing the structure to be established.

The structures of the new alkaloids were also inferred from ^{13}C -nmr spectroscopy. The assignments reported in the Table were made taking into account known substituent effects, the spectra of gadenine⁷ and delcosine (5)⁸ and other published ^{13}C -nmr data for related diterpenoid alkaloids.

We have also isolated from Delphinium cardiopetalum karakoline,⁹ dihydrogadesine⁵ and 14-acetyldihydrogadesine,⁵ identified by comparison with authentic samples.

ACKNOWLEDGEMENT

This work has been partially financed by a grant from the Comisi3n Asesora de Investigaci3n Cientfifica y T3cnica.

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Received, 15th November, 1985