Two 3α-Aminospirosolane Steroidal Alkaloids from *Solanum triste*

Anderson Maxwell,*,† Mohindra Seepersaud,‡ and Ramish Pingal

Department of Chemistry, University of the West Indies, St. Augustine, Trinidad and Tobago, West Indies

David R. Mootoo

Department of Chemistry, Hunter College, City University of New York, New York 10021

William F. Reynolds* and Stewart McLean

Department of Chemistry, University of Toronto, Toronto, Ontario M5S 1A1, Canada

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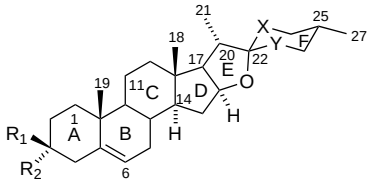
Two new 3α-aminospirosolane steroidal alkaloids, (22*S*,25*S*)- and (22*R*,25*R*)-3α-aminospirosol-5-ene (**2**) and (**3**), respectively, were isolated from the alkaloid fraction of the MeOH extract of the aerial parts of *Solanum triste*. Their structures were elucidated utilizing 1D and 2D NMR techniques and mass spectroscopy.

Solanum triste Jacq. (Solanaceae) is a tree of up to 7 m in height known to occur in moist, rocky localities in North Trinidad and in Venezuela, Martinique, and Dominica.[1] There is no recorded folkloric medicinal usage of this plant. As part of a systematic study of Trinidad *Solanum* species, we recently investigated the aerial parts of the plant. In an earlier paper,[2] we reported the isolation of the previously unknown (22*R*,-25*R*)-3β-aminospirosol-5-ene (**1**) and its dihydro derivative, (22*R*,25*R*)-3β-amino-5α-spirosolane, which had been prepared synthetically but which was unknown as a natural product. In this report we describe the isolation and structure elucidation of two further closely related and previously unreported steroidal alkaloids: (22*S*,25*S*)-3α-aminospirosol-5-ene (**2**) and (22*R*,25*R*)-3α-aminospirosol-5-ene (**3**).



1: $R_1 = NH_2$, $R_2 = H$, X = NH, Y = CH_2
2: $R_1 = H$, $R_2 = NH_2$, X = CH_2, Y = NH
3: $R_1 = H$, $R_2 = NH_2$, X = NH, Y = CH_2

The crude alkaloid fraction of the MeOH extract of the aerial parts of *S. triste* was subjected to VLC and column chromatography to yield six combined fractions. Preparative TLC of fraction II gave compound **2** as an amorphous solid. Its IR spectrum showed absorptions at 3410 (NH/OH) and 1640 (C=C) cm^{-1}. The ^{1}H-NMR spectrum (Table 1) showed the signals expected of a $\Delta^{5,6}$-spirosolane steroidal alkaloid[3−6]—two methyl singlets, two methyl doublets, a quartet due to an oxymethine proton, and an olefinic proton multiplet. The presence of three α-amino protons (δ 2.7, 2.75, and 3.23) indicated an amino group, which would most probably be at C-3. Signals in the ^{13}C-NMR spectrum attributable to C-5, C-6, C-16, C-22, and C-26[7,8] and one additional signal for a carbon-bearing nitrogen provided support for the proposed unsaturated aminospirosolane structure of **2**. EIMS fragments at *m/z* 114 and 138 corroborated this structure, while the peak at *m/z* 56 provided confirmation of the amino group at C-3.[9] HREIMS gave $[M]^+$ at *m/z* 412.3456 corresponding to the molecular formula, $C_{27}H_{44}N_2O$ expected for **2**. The fact that the C-3 proton and carbon chemical shifts of **2** differed appreciably from those of **1**[2] suggested that they had opposite configurations at C-3. Indeed, while the H-3 signal of **1** was a triplet with $J = 11$ Hz, that of **2** was a broad singlet ($W_{1/2} = 9$ Hz). The 3-NH_2 group was therefore assigned the α-configuration in **2**. The configuration at C-22 (ring F) was assigned with reference to the chemical shifts of C-22, C-23, and C-24, which corresponded to those of the 22*S*,25*S* group of spirosolane steroidal alkaloids.[7,10] Full assignment of the ^{1}H and ^{13}C chemical shifts of **2** was achieved with the aid of several 2D NMR experiments: ^{1}H−^{1}H COSY, HMQC, and HMBC, using procedures similar to those reported previously.[2]

Compound **3** resulted from the preparative TLC of fraction III and was obtained as an amorphous solid. Its IR (3410 and 1640 cm^{-1}) and MS data ($[M]^+$ 412.3452 and fragments at 114, 138, and 56) were identical to those of **2**, suggesting that **3** was isomeric with **2**. However, characteristic differences in ^{1}H chemical shifts for H-16, H-20, and H-26[2,4] and in the ^{13}C chemical shifts for C-22, C-23, C-24, and C-26[10] indicated that the ring-F configuration was different in the two compounds. Compound **3** belongs to the 22*R*,25*R*-spirosolane family. Assignment of its ^{1}H- and ^{13}C-NMR spectral data was achieved by the same combination of 2D NMR experiments as performed for **2**.

Our studies on *S. triste* have now yielded three of the four possible diastereomers (with respect to the chiral centers C-3 and C-22) of the parent 3-aminospirosol-5-ene.

Experimental Section

General Experimental Procedures. Procedures are as described in an earlier paper.[2]

† Telephone/Fax: (809) 645-7132. E-mail: ARM@chem.uwi.tt.
‡ Present address: Department of Chemistry, Hunter College, CUNY, New York 10021.
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Table 1. NMR Data for Compounds **2** and **3** in $CDCl_3$ at 500 MHz

	compound							
	2				**3**			
position	^{1}H [*J*(Hz)]			^{13}C	^{1}H [*J*(Hz)]			^{13}C
1	1.34		1.62	33.02	1.35		1.60	33.08
2	1.54		1.81 tt (14.0, 4.1)	28.91	1.48		1.80 tt (14.0, 3.6)	29.63
3			3.23 br s ($W_{1/2}$ 9.0)	46.88			3.16 m ($W_{1/2}$ 9.0)	46.79
4	1.93 br d (14.0)		2.58 br d (14.0)	39.48	1.88		2.58 br d (14.1)	40.16
5				138.59				139.13
6		5.38 br d (5.2)		123.42		5.36 br d (5.2)		122.83
7	1.60		2.00	32.19	1.62		2.02	32.16
8			1.62	31.33			1.60	31.36[b]
9	1.05			50.38	1.06			50.46
10				37.54				37.56
11	1.54		1.46 dd (13.0, 4.1)	20.60	1.54		1.46	20.61
12	1.17 dt (13.1, 4.5)		1.74 dt (13.1, 4.1)	39.93	1.18 dt (13.0, 4.3)		1.76	39.98
13				40.59				40.50
14	1.08			56.00	1.11			56.56
15	2.00		1.29	32.74	2.00		1.32	32.16
16	4.15 q (7.7)			78.51	4.28 q (7.7)			78.71
17	1.62			61.90	1.72			62.78
18		0.85 s		16.73		0.81 s		16.42
19		1.03 s		18.87		1.02 s		18.88
20			1.66	43.01			1.89	41.23
21		0.98 d (7.2)		15.92		0.94 d (7.2)		15.28
22				99.15				98.23
23	1.66		1.36	26.66	1.60		1.67	34.07
24	1.62		1.34	28.55	1.62		1.42	30.31
25			1.60	31.02			1.56	31.41[b]
26	2.72[a] t (11.0)		2.75[a] dd (11.0, 5.5)	50.23	2.60 t (11.0)		2.65 br dd (11.0, 4.6)	47.67
27		0.86 d (7.2)		19.35		0.84 d (7.2)		19.32

[a] Signals partially overlapped. [b] Assignments may be interchanged within the column.

Plant Material. See Maxwell *et al.*[2]

Extraction and Isolation. The chromatographic separation (VLC and column chromatography) of the alkaloid portion of the crude extract into six combined fractions labeled I-VI has already been described.[2] Fraction II (50 mg) was subjected to preparative TLC on Si gel ($CHCl_3$-MeOH-NH_3 [aqueous]; 85:15:saturated) to yield a brown gum (20 mg) which, on precipitation from $CHCl_3$-MeOH-H_2O, yielded 12 mg (0.006%) of pure compound **2**. Si gel preparative TLC as described above on the more polar fraction III (70 mg) again gave a brown gum (30 mg), which was also precipitated from $CHCl_3$-MeOH-H_2O to yield 10 mg (0.005%) of pure compound **3**.

Compound 2: amorphous solid; mp 147−154 °C; IR ($CHCl_3$) ν max 3410 (NH), 1640 (C=C) cm^{-1}; EIMS (70 eV) *m/z* [M]$^+$ 412 (35), 384 (31), 300 (59), 138 (100), 114 (45), 56 (62); HREIMS *m/z* [M]$^+$ 412.3452, calcd for $C_{27}H_{44}N_2O$, 412.3456; ^{1}H-NMR and ^{13}C-NMR data, see Table 1.

Compound 3: amorphous solid; mp 166−170 °C; IR ($CHCl_3$) ν max 3410 (NH), 1640 (C=C) cm^{-1}; EIMS (70 eV) *m/z* [M]$^+$ 412 (35), 384 (31), 300 (59), 138 (100), 114 (45), 56 (62); HREIMS *m/z* [M]$^+$ 412.3452, calcd for $C_{27}H_{44}N_2O$, 412.3456; ^{1}H-NMR and ^{13}C-NMR data, see Table 1.

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References and Notes

(1) Howard, R. A. *Flora of the Lesser Antilles: Leeward and Windward Islands*; Arnold Arboreum, Harvard University: Jamaica Plain, MA, 1989; Vol. 6, pt. 3, p 296.
(2) Maxwell, A.; Seepersaud, M.; Pingal, R.; Mootoo, D. R.; Reynolds, W. F. *J. Nat. Prod.* **1995**, *58*, 625−628.
(3) Ripperger, H.; Schreiber, K. In *The Alkaloids*; Rodrigo, R. G. A., Ed.; Academic Press: New York, 1981; Vol. 19, Chapter 2, pp 81−192.
(4) Boll, P. M.; von Philipsborn, W. *Acta Chem. Scand.* **1965**, *19*, 1365−1370.
(5) Ripperger, H. *Phytochemistry* **1990**, *29*, 3375−3376.
(6) Chakravarty, A. K.; Das, B.; Ali, E.; Pakrashi, S. C. *J. Chem. Soc., Perkin Trans. I* **1984**, 467−474.
(7) Weston, R. J.; Gottlieb, H. E.; Hagaman, E. W.; Wenkert, E. *Aust. J. Chem.* **1977**, *30*, 917−921.
(8) Bird, G. J.; Collins, D. J.; Eastwood, F. W.; Exner, R. H.; Romanelli, M. L.; Small, D. D. *Aust. J. Chem.* **1979**, *32*, 783−796.
(9) Budzikiewicz, H. *Tetrahedron*, **1964**, *20*, 2267−2278.
(10) Eliel, E. L.; Baily, W. F.; Kopp, L. D.; Willer, R. L.; Grant, D. M.; Bertrand, R.; Christensen, K. A.; Dalling, D. K.; Dutch, M. W.; Wenkert, E.; Schell, F. M.; Cochran, D. W. *J. Am. Chem. Soc.* **1975**, *97*, 322−330.

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