Novel Bis(monoterpenoid) Indole Alkaloids from *Psychotria bahiensis*

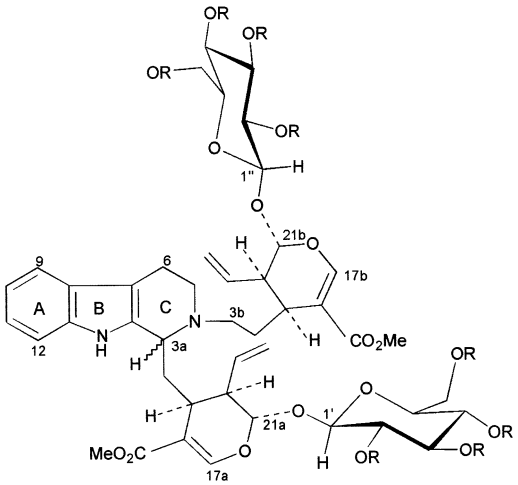
J. H. A. Paul,[†] A. R. Maxwell,*[,†] and W. F. Reynolds[‡]

Department of Chemistry, The University of the West Indies, St. Augustine, Trinidad, West Indies, and Department of Chemistry, The University of Toronto, Toronto, Ontario, M5S 1A1, Canada

Received November 29, 2002

Two new bis(monoterpenoid) indole alkaloid glucosides, bahienoside A (**1**) and bahienoside B (**2**), together with five known compounds, 5α-carboxystrictosidine, angustine, strictosamide, and (*E*)- and (*Z*)-vallesiachotamine, were isolated from the aerial parts of *Psychotria bahiensis* collected in Trinidad, West Indies. The structures of the compounds were elucidated using 1D and 2D NMR spectral methods, viz., ^{1}H, ^{13}C, ^{13}C DEPT, ^{1}H−^{1}H COSY, HSQC, HMQC, HMBC, and TOCSY aided by IR, UV, and circular dichroism measurements.

The genus *Psychotria*, which comprises about 1500 tropical species, is a rich source of polyindole,[1] monoterpenoid indole,[2] and isoquinoline alkaloids.[3−6] Some of these alkaloids are reported to show hallucinogenic[7] and cytotoxic[8] properties. In the course of our project to investigate *Psychotria* species in Trinidad, we studied the alkaloid fraction of the methanol extract of the aerial parts of the shrub *Psychotria bahiensis* DC. (syn *P. cuspidata* Bred. and *P. cornigera* Benth.) (Rubiaceae), on which no prior work was reported. This investigation resulted in the isolation of two new indole bis(monoterpenoid) glucoalkaloids **1** and **2**, along with several known alkaloids previously isolated from members of the Rubiaceae family.



1	H-3aβ	R = H
1a	H-3aβ	R = OAc
2	H-3aα	R = H

Results and Discussion

The major compound (**1**) was isolated as an amorphous solid, $[\alpha]_D$ −128°. Its IR spectrum showed absorbances typical of hydrogen-bonded −OH/NH (3500−3200 cm^{-1}), C═O (1700 cm^{-1}), C−O (1300 cm^{-1}), and vinylic/aromatic (1625 cm^{-1}) groups. The UV spectrum (MeOH) showed absorption maxima at 290 and 228 nm, which were consistent with the presence of both indole and β-alkoxyacrylate moieties. High-resolution electrospray mass spectrum (HRESMS) of **1** showed a $[M + H]^+$ peak at an exact mass of *m/z* 903.3715, corresponding to the formula $C_{44}H_{59}N_2O_{18}$, calculated as 903.3764. From the ^{1}H NMR data, the tetrahydro-β-carboline system was defined by the presence of two triplets at δ 7.05 (H-11, J = 8.0 Hz) and 6.95 (H-10, J = 8.0 Hz), two doublets at δ 7.35 (H-9, J = 8.0 Hz) and 7.25 (H-12, J = 8.0 Hz), and signals for two methylene groups at δ 3.13 (H-5) and 2.45 and 2.80 (H-6). The ^{1}H and ^{13}C NMR data clearly indicated the presence of two glucose moieties. The signals for the anomeric protons at δ_H 4.65 (d, J = 8.6 Hz, H-1′) and 4.75 (d, J = 7.1 Hz, H-1″) indicated the β-configuration for both glucose units. In the HMBC spectrum correlations were observed between these protons (H-1′ and H-1″) and C-21a and C-21b, respectively. This identified the points of attachment of the sugar units as C-21a and C-21b.

Analysis of the ^{1}H−^{1}H COSY and HMBC data for the remainder of the molecule confirmed the presence of two series of signals (labeled a and b) for two secologanin units. The attachment of one of the secologanin units was determined as follows. In the ^{1}H−^{1}H COSY spectrum, a strong cross-peak between the methine proton δ_H 3.95 (br s, H-3a) and one of the methylene protons at C-14a (δ_H 2.05, m) suggested that this secologanin unit was incorporated in the usual manner for indole monoterpenoid alkaloids. The attachment of the second secologanin unit was deduced from the following facts. In the ^{13}C DEPT experiment, C-5 was shown to be a methylene carbon. The proton signal at δ 8.42 (H-1) in the ^{1}H NMR spectrum of the acetylated compound **1a**, together with correlations seen in the HMBC spectrum between this proton and C-2, C-7, C-8, and C-13 (Figure 1), indicated that the indole nitrogen (N-1) was protonated and hence could not be the point of attachment. Further, the HMBC correlation observed between H-3b and C-5 (Figure 1) established that the point of attachment of the second secologanin unit was N-4. These data led to the indicated structure for compound **1**.

Compound **2** was obtained as an amorphous solid. The IR and UV spectra were nearly identical to those of compound **1**. The ES mass spectrum of compound **2** gave the same $[M + H]^+$ as for **1**, suggesting the same formula, $C_{44}H_{59}N_2O_{18}$. The major peaks in the mass spectrum of both compounds had identical *m/z* values; however the intensities were markedly different. Analysis of the ^{1}H, ^{13}C, and 2D NMR data led to the same bis(monoterpenoid) proposed structure as for **1**. However, in light of the opposite sign of

* To whom correspondence should be addressed. Tel: (868) 662-6013, 662-2002, ext. 2091. Fax: (868) 645 3771. E-mail: hodchem0@lycos.com.
[†] The University of the West Indies.
[‡] The University of Toronto.

10.1021/np020554a CCC: $25.00
Published on Web 05/10/2003

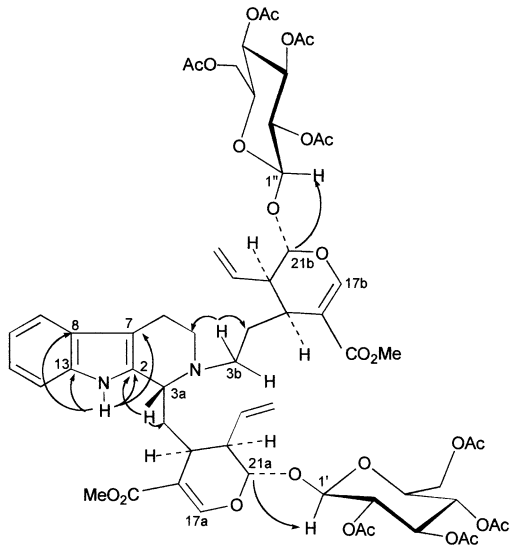


Figure 1. Important HMBC correlations observed for compound **1a**.

specific rotation ($[\alpha]_D$ +65°) of **2** compared to that of **1**, biogenetic considerations led to the conclusion that **1** and **2** differed in the configuration at C-3.

The chemical shifts of C-3 of the monoterpenoid indole alkaloids have been used to assign the configuration at this stereocenter in C-3 epimers. It has been found that for monoterpenoid indole alkaloids, the chemical shift for C-3 in the *S*-isomer is more downfield compared to that for the *R*-isomer.[7,9−11] The ^{13}C NMR data for compounds **1** and **2** suggest the *R*-configuration at C-3 for **1** and the *S*-configuration for **2**. Further support for these assignments was obtained from the CD spectrum for **1**, which exhibited a negative Cotton effect in the 270−300 nm region. This feature is characteristic of monoterpenoid indole alkaloids with the *R*-configuration at C-3.[12,13] Repeated attempts to obtain crystalline samples of **1** and **2** and crystallizable derivatives were unsuccessful.

5α-Carboxystrictosidine, angustine, strictosamide, and (*E*)- and (*Z*)-vallesiachotamine were identified by comparison of their physical and spectral data with those reported in the literature.[2,14−16]

This is the first report of terpenoid indole alkaloids incorporating two secologanin units. It is also interesting from a biogenetic point of view that in the major isomer, bahienoside A (**1**), the configuration at C-3 is *R*.

Experimental Section

General Experimental Procedures. Melting points were determined on a Reichert hot stage apparatus and were uncorrected. NMR spectra were measured in $CDCl_3$ or CD_3OD on either a Bruker Avance DRX-400 spectrometer or a Varian Unity-500 instrument. Optical rotations were measured on a Polartronic D digital polarimeter in $CHCl_3$ or MeOH and CD spectra on a JASCO J-810 spectropolarimeter. Low-resolution MS data were obtained on a Micromass 70S-250 mass spectrometer, and high-resolution mass data were obtained on an MDS Sciex QStar mass spectrometer. TLC was performed on silica gel 60 $PF_{254+366}$. Plates were 0.25 mm thick for analytical TLC and 1.0 mm thick for preparative work. CC was on Merck silica gel 60 (70−230 mesh ASTM). All solvents were redistilled.

Plant Material. *P. bahiensis* was collected near the base of the Maracas Waterfall, St. Joseph, Trinidad, in January 2001. A voucher specimen is lodged at the National Herbarium of Trinidad and Tobago [TRIN 34712].

Extraction and Isolation. The dried and ground aerial parts of *P. bahiensis* (1.2 kg) were extracted exhaustively with MeOH at room temperature. Evaporation of the solvent yielded 144.8 g of a dark green residue. The MeOH extract (82.3 g) was triturated with 1 M HCl (6 × 100 mL), and the combined acidic fraction was extracted with CH_2Cl_2 (3 × 300 mL). The aqueous layer was basified with concentrated NH_4OH (60 mL) and then extracted with EtOAc (3 × 200 mL). This yielded 686 mg of EtOAc-soluble bases and a precipitate (6.8 g).

The precipitate (2.5 g) was subjected to CC on silica gel using $CHCl_3$ and MeOH mixtures of increasing polarity to give three major fractions (I−III). Repeated CC of fraction II using gradient elution with mixtures of $CHCl_3$ in MeOH gave compound **1** (182.0 mg). Similarly, fraction III gave 5α-carboxystrictosidine (15.2 mg) and fraction I, angustine (3.6 mg).

The EtOAc-soluble bases (0.6 g) were separated by CC on silica gel using $CHCl_3$−MeOH mixtures of increasing polarity and gave two major fractions (A and B). CC of the major fraction B (485 mg) using $CHCl_3$−acetone mixtures of increasing polarity gave compound **2** (11.4 mg) and strictosamide (6.2 mg). Repeated preparative TLC of fraction A in pentane−Et_2O (1:1) gave (*E*)- and (*Z*)-vallesiachotamine (R_f 0.43, 7.5 mg and R_f 0.53, 15.3 mg, respectively).

Bahienoside A (1): creamy-white amorphous solid (EtOAc); mp 156−158 °C; $[\alpha]^{25}_D$ −128° (*c* 0.003, MeOH); UV (MeOH) λ_{max} (log ϵ) 284 (sh), 228 (4.63) nm; IR (Nujol) ν_{max} 3500−3200, 1700, 1625, 1300, 1200, 1175, 1100−1000, 950, 850 cm^{-1}; ^{1}H NMR (CD_3OD, 400 MHz) δ 7.55 (1H, s, H-17a), 7.40 (1H, s, H-17b), 7.35 (1H, d, J = 8.0 Hz, H-9), 7.25 (1H, J = 8.0 Hz, H-12), 7.05 (1H, t, J = 8.0 Hz, H-11), 6.95 (1H, t, J = 8.0 Hz, H-10), 5.82 (1H, ddd, J = 18.0, 10.0, 2.0 Hz, H-19a), 5.70 (1H, dd, J = 18.0, 10.0 Hz, H-19b), 5.55 (1H, d, J = 7.1 Hz, H-21a), 5.45 (1H, d, J = 8.0 Hz, H-21b), 5.41 (1H, d, J = 18.0 Hz, H_1-18a), 5.38 (1H, d, J = 18.0 Hz, H_1-18b), 5.29 (1H, d, J = 10.0 Hz, H_2-18a), 5.22 (1H, d, J = 10.0 Hz, H_2-18b), 4.75 (1H, d, J = 7.1 Hz, H-1″), 4.65 (1H, d, J = 8.6 Hz, H-1′), 3.95 (br s, H-3a), 3.90 (2H, m, H_1-6′, H_1-6″), 3.71 (1H, s, H-23a), 3.70 (1H, m, H_2-6′), 3.68 (1H, m, H_2-6″), 3.65 (1H, s, H-23b), 3.45 (1H, m, H-5″), 3.40 (1H, m, H-5′), 3.35 (1H, m, H-4″), 3.31 (1H, m, H-4′), 3.30 (1H, m, H-3″), 3.25 (3H, m, H-2″, H-3′, H-15a), 3.20 (1H, m, H-2′), 3.13 (2H, m, H-5), 2.95 (1H, m, H-15b), 2.85 (1H, m, H-20a), 2.80 (2H, m, H_2-6, H-20b), 2.75 (1H, m, H_1-3b), 2.65 (1H, m, H_2-3b), 2.45 (1H, br d, J = 14.5 Hz, H_1-6), 2.25 (1H, m, H_1-14b), 2.05 (1H, br s, H_2-14a), 1.85 (1H, br s, H_1-14a), 1.55 (1H, m, H_2-14b); ^{13}C NMR (CD_3OD, 100 MHz) δ 169.7 (C, C-22a), 169.5 (C, C-22b), 154.0 (CH, C-17a), 153.2 (CH, C-17b), 137.8 (C, C-13), 136.2 (CH, C-19a), 135.7 (CH, C-19b), 135.0 (C, C-2), 128.4 (C, C-8), 122.0 (CH, C-11), 120.6 (CH, C-9), 120.1 (CH_2, C-18b), 119.8 (CH_2, C-18a), 119.7 (CH, C-10), 112.1 (C, C-16a), 112.0 (CH, C-12) 112.0 (C, C-16b), 107.3 (C, C-7), 100.4 (CH, C-1′), 100.3 (CH, C-1″), 98.5 (CH, C-21b), 98.2 (CH, C-21a), 78.4 (CH, C-5′), 78.3 (CH, C-5″), 78.1 (CH, C-3″), 78.0 (CH, C-3′), 74.8 (CH, C-2″), 74.6 (CH, C-2′), 71.6 (2 × CH, C-4″, C-4′), 62.9 (CH_2, C-6′), 62.8 (CH_2, C-6″), 58.8 (CH, C-3a), 52.1 (2 × CH, C-23a, C-23b), 52.0 (CH_2, C-3b), 45.5 (CH, C-20a), 44.8 (2 × CH_2, C-5, C-20b), 36.9 (CH_2, C-14a), 31.5 (CH, C-15a), 30.3 (C, C-15b), 28.0 (CH_2, C-14b), 17.6 (CH_2, C-6); ESMS m/z 903.4 $[M + H]^+$ (100), 565 (39), 547 (43), 531 (76), 529 (42), 527 (24), 413 (17), 411 (35), 393 (48), 390 (20), 335 (21), 301 (17), 297 (12); HRESMS m/z 903.3715 (calcd for $C_{44}H_{59}N_2O_{18}$, 903.3764); CD (*c* 5.54 × 10^{-4} M, MeOH) λ_{max} nm ($\Delta\epsilon$) 338 (+0.01), 281 (−0.13), 275 (−0.11).

Bahienoside B (2): pale yellow amorphous solid (EtOAc); mp 164−166 °C; $[\alpha]^{25}_D$ +65° (*c* 0.003, MeOH); UV (MeOH) λ_{max} (log ϵ) 286 (3.79), 226 (4.50) nm; IR (Nujol) ν_{max} 3500−3200, 1700, 1625, 1300, 1200, 1175, 1100−1000, 950, 850 cm^{-1}; ^{1}H NMR (CD_3OD, 400 MHz) δ 7.60 (1H, s, H-17a), 7.45 (1H, s, H-17b), 7.40 (1H, d, J = 8.4 Hz, H-9), 7.25 (1H, d, J = 8.4 Hz, H-12), 7.05 (1H, t, J = 8.4 Hz, H-11), 6.95 (1H, t, J = 8.4 Hz, H-10), 5.85 (1H, m, H-19a), 5.70 (1H, m, H-19b), 5.65 (1H, d, J = 8.4 Hz, H-21a), 5.46 (1H, d, J = 7.3 Hz, H-21b), 5.44 (1H, d, J = 12.6 Hz, H_1-18a), 5.40 (1H, d, J = 12.6 Hz, H_1-18b), 5.35 (1H, d, J = 10.5 Hz, H_2-18a), 5.25 (1H, d, J = 10.5 Hz, H_2-18b), 4.75, 4.65 (each 1H, d, J = 7.3 Hz, H-1′ and H-1″), 4.20 (1H, br s, H-3a), 3.85 (2H, m, H_1-6′, H_1-6″), 3.70 (1H, s, H-23a), 3.65 (3H, m, H_2-6′, H_2-6″, H-23b), 3.27−3.45 (5H, m,

H-3′, H-3″, H-4′ or H-4″, H-5′, H-5″), 3.35 (3H, m, H_1-5, H-5, H-20b), 3.27 (1H, m, H-15a), 3.25 (1H, m, H-4′ or H-4″), 3.18−3.23 (2H, m, H-2′, H-2″), 2.97 (2H, m, H_1-3b, H-15b), 2.90 (1H, m, H_1-6), 2.85 (1H, m, H-20a), 2.80 (1H, m, H_2-3b), 2.70 (1H, m, H_2-6), 2.35 (1H, m, H_2-14b), 2.15 (1H, m, H_2-14a), 1.95 (1H, m, H_1-14a), 1.70 (1H, m, H_1-14b); ^{13}C NMR (CD_3OD, 100 MHz) δ 170.0 (C, C-22a), 169.4 (C, C-22b), 154.7 (CH, C-17a), 153.5 (CH, C-17b), 138.0 (2 × C, C-2, C-13), 136.1 (CH, C-19a), 135.5 (CH, C-19b), 128.0 (C, C-8), 122.5 (C, C-11), 120.1 (CH_2, C-18b), 120.0 (CH, C-10), 119.8 (CH_2, C-18a), 118.7 (CH, C-9), 112.0 (CH, C-12), 111.5 (2 × C, C-16a, C-16b), 106.6 (C, C-7), 100.4 (2 × CH, C-1′/C-1″), 98.3 (CH, C-21b), 97.9 (CH, C-21a), 78.6 (CH, C-3′ or C-3″), 78.4 (CH, C-3′ or C-3″), 78.2 (CH, C-5′ or C-5″), 78.0 (CH, C-5′ or C-5″), 74.8 (CH, C-2′ or C-2″), 74.6 (CH, C-2′ or C-2″), 71.7 (CH, C-4′ or C-4″), 71.6 (CH, C-4′ or C-4″), 62.9 (CH_2, C-6′ or C-6″), 62.8 (CH_2, C-6′ or C-6″), 59.6 (CH, C-3a), 52.1 (CH, C-23a), 51.9 (2 × CH_2, C-3b, C-23b), 45.4 (CH, C-20a), 44.8 (2 × CH_2, C-5, C-20b), 36.7 (CH_2, C-14a), 31.6 (CH, C-15a), 30.5 (CH, C-15b), 27.4 (CH_2, C-14b), 17.4 (CH_2, C-6); ESMS *m*/*z* 903.4 $[M + H]^+$ (76), 565 (27), 547 (14), 531 (59), 529 (27), 527 (29), 413 (52), 411 (27), 393 (12), 284 (48), 313 (31), 301 (91), 297 (100); HRESMS *m*/*z* 903.3730 (calcd for $C_{44}H_{59}N_2O_{18}$, 903.3764).

Acetylation of 1. A sample of **1** (56 mg) was acetylated with Ac_2O−py (1:1) at room temperature overnight. General workup gave 70 mg of the octaactetate **1a**.

Octaacetyl derivative (1a): creamy-white amorphous solid (MeOH); mp 122−124 °C; $[\alpha]^{25}_D$ −118° (*c* 0.003, $CHCl_3$); UV (MeOH) λ_{max} (log ϵ) 290 (sh, 4.01), 228 (4.61) nm; IR (Nujol) ν_{max} 1700, 1625, 1300, 1200, 1175, 1100−1000, 950, 850 cm^{-1}; ^{1}H NMR ($CDCl_3$, 400 MHz) δ 8.42 (1H, br s, H-1), 7.46 (1H, d, J = 7.4 Hz, H-9), 7.35 (1H, d, J = 2.4 Hz, H-17a) 7.33 (1H, d, J = 7.4 Hz, H-12), 7.30 (1H, d, J = 1.6 Hz, H-17b), 7.11 (1H, t, J = 7.4 Hz, H-11), 7.05 (1H, t, J = 7.4 Hz, H-10), 5.65 (1H, m, H-19b), 5.55 (1H, m, H-19a), 5.42 (1H, d, J = 17.2 Hz, H_1-18b), 5.40 (1H, d, J = 2.8 Hz, H-21b), 5.38 (1H, d, J = 17.2 Hz, H_2-18a), 5.36 (1H, d, J = 2.8 Hz, H-21a), 5.33 (1H, dd, J = 4.8, 1.6 Hz, H_2-18b) 5.30 (1H, dd, J = 4.8, 1.6 Hz, H_1-18a), 5.25 (1H, m, H-5′), 5.20 (1H, m, H-5″), 5.15 (1H, m, H-4′), 5.10 (1H, m, H-4″), 5.05 (1H, m, H-2″), 4.95 (1H, m, H-2′), 4.92 (1H, d, J = 7.6 Hz, H-1′), 4.88 (1H, d, J = 4.8 Hz, H-1″), 4.25 (4H, m, H_1-6′a, H_1-6″a, H_2-6′a, H_2-6″a), 3.82 (1H, dd, J = 8.0, 3.4 Hz, H-3a), 3.74 (1H, m, H-3″), 3.72 (1H, s, H-23a), 3.70 (1H, m, H-3′, H-23b), 3.09, (1H, m, H_2-5), 3.08 (1H, m, H-20a), 2.92 (1H, br s, H-15a), 2.85 (1H, m, H_1-6), 2.80 (3H, m, H_1-5, H-15b, H-20b), 2.75 (1H, m, H_2-3b), 2.55 (1H, d, J = 10.4 Hz, H_1-3b), 2.47 (1H, br d, J = 15.2 Hz, H_2-6), 2.32 (1H, dd, J = 9.4, 2.0 Hz, H_2-14b), 2.09, 2.08 (2 × 3H, s, s, 6′, 6″ C*H*$_3$C═O), 2.04, 2.03 (2 × 3H, s, s, 4′, 4″ C*H*$_3$C═O), 2.02, 1.99 (2 × 3H, s, s, 3′, 3″ C*H*$_3$C═O), 1.95 (1H, m, H_2-14a) 1.91 (2 × 3H, s, s, 2′, 2″ C*H*$_3$C═O), 1.85 (1H, br s, H_1-14a), 1.39 (1H, dd, J = 19.2, 9.4 Hz, H_1-14b); ^{13}C NMR, ($CDCl_3$, 100 MHz) δ 167.4 (CH, C-22a), 167.3 (CH, C-22b), 150.6 (CH, C-17a), 150.0 (CH, C-17b), 135.9 (C, C-2), 135.8 (C, C-13), 133.3 (CH, C-19a), 133.2 (CH, C-19b), 127.2 (C, C-8), 121.0 (2 × C, C-11, C-18a), 120.9 (CH_2, C-18b), 118.8 (CH, C-10), 117.9 (CH, C-9), 112.1 (2 × C, C-16a, C-16b), 110.8 (CH, C-12), 107.3 (C, C-7), 96.8 (CH, C-21a), 96.6 (CH, C-21b), 96.0 (CH, C-1″), 95.9 (CH, C-1′), 72.6 (CH, C-5″), 72.4 (CH, C-5′), 72.0 (2 × CH, C-3′, C-3′), 70.5 (2 × CH, C-2′, C-2″), 68.1 (CH, C-4″), 68.0 (CH, C-4′), 61.3 (2 × CH_2, C-6′, C-6″), 60.1 (CH, C-3a), 51.3 (CH_3, C-23a), 51.2 (CH_3, C-23b), 50.0 (CH_2, C-3b), 44.1 (CH, C-20b), 42.2 (CH, C-20a), 42.2 (CH_2, C-5), 34.0 (CH_2, C-14a), 29.9 (CH, C-15a), 27.5 (CH, C-15b), 26.2 (CH, C-14b), 21.1 (2 × *C*H$_3$C═O, C-6′, C-6″), 21.07 (3 × *C*H$_3$C═O, C-3′ or C-3″, C-4′, C-4″), 21.04 (*C*H$_3$C═O, C-3′ or C-3″), 20.98, 20.5 (2 × *C*H$_3$C═O, C-2′, C-2″), 16.7 (CH_2, C-6).

Acknowledgment. The authors thank Dr. Alex Young of the University of Toronto for providing MS analyses, Dr. Zaka Imam of the Central Drug Research Institute, Lucknow, India, for the CD spectrum, and Mr. W. Johnson of the National Herbarium of Trinidad and Tobago for assistance in collecting and identifying the plant. Financial assistance from NSERC of Canada, the Campus Committee on Graduate Studies, and the Department of Chemistry at the University of the West Indies, St. Augustine, is gratefully acknowledged.

References and Notes

(1) Roth, A.; Kuballa, B.; Cabalion, P.; Anton, R. *Planta Med.* **1985**, *51*, 289.
(2) Solis, P. N.; Wright, C. W.; Gupta, M. P.; Phillipson, J. D. *Phytochemistry* **1993**, *33*, 1117−1119.
(3) Nagakura, N.; Itoh, A.; Tanahashi, T. *Phytochemistry* **1993**, *32*, 761−765.
(4) Itoh, A.; Tanahashi, T.; Nagakura, N. *Chem. Pharm. Bull.* **1989**, *37*, 1137−1139.
(5) Itoh, A.; Tanahashi, T.; Nagakura, N. *Phytochemistry* **1991**, *30*, 3117−3123.
(6) Itoh, A.; Tanahashi, T.; Nagakura, N.; Nayeshiro, H. *Phytochemistry* **1994**, *36*, 383−387.
(7) Achenbach, H.; Lottes, M.; Waibel, R.; Karikas, G. A.; Correa, M. D.; Gupta, M. P. *Phytochemistry* **1995**, *38*, 1537−1545.
(8) Roth, A.; Kuballa, B.; Bounthanh, C.; Cabalion, P.; Sévenet, T.; Beck, J. P.; Anton, R. *Planta Med.* **1986**, *52*, 450−453.
(9) Morita, H.; Ichihara, Y.; Takeya, K.; Watanabe, K.; Itokawa, H.; Motidome, M. *Planta Med.* **1989**, *55*, 288−289.
(10) Heckendorf, A. H.; Mattes, K. C.; Hutchinson, C. R.; Hagaman, E. W.; Wenkert, E. *J. Org. Chem.* **1976**, *11*, 2045−2047.
(11) Koch, M. C.; Plat, M. M.; Préaux, N.; Gottlieb, H. E.; Hagaman, E. W.; Schell, F. M.; Wenkert, E. *J. Org. Chem.* **1975**, *40*, 2836−2838.
(12) Ohmori, O.; Kumazawa, K.; Hoshino, H.; Suzuki, T.; Morishima, Y.; Kohno, H.; Kitajima, M.; Sakai, S.; Takayama, H.; Aimi, N. *Tetrahedron Lett.* **1998**, *39*, 7737−7740.
(13) Achenbach, H.; Benirschke, M. *Phytochemistry* **1997**, *44*, 1387−1390.
(14) Ferrari, F.; Messana, I.; Botta, B.; De Mello, J. F. *J. Nat. Prod.* **1986**, *49*, 1150−1151.
(15) Abreu, P.; Pereira, A. *Heterocycles* **1998**, *48*, 885−891.
(16) Waterman, P. G.; Zhong, S. *Planta Med.* **1982**, *45*, 28−30.

NP020554A