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PRENYLATED ANTHRANOIDS FROM *VISMIA* SPECIES*

R. MOURA PINHEIRO, M. MARQUINA MAC-QUHAE†, G. B. MARINI BETTOLO† and F. DELLE MONACHE†‡

Departamento de Quimica, Universidade Federal de Alagoas, 57.000 Maceio, Brazil; †Centro Chimica dei Recettori del C.N.R., Università Cattolica, Via della Pineta Sacchetti 644, Rome, Italy

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Key Word Index—*Vismia japurensis*; *V. cayennensis*; *V. mexicana*; Guttiferae; acetylvismione B; γ-hydroxyanthrone B; *cis*-γ-hydroxyferruginin A.

Abstract—The chemical compositions of the berries of three *Vismia* spp are reported. Two new prenylated anthranoids, acetylvismione B and γ-hydroxyanthrone B, were isolated from *V. japurensis* and *cis*-γ-hydroxyferruginin A from *V. mexicana*. Evidence was obtained for the presence of *cis*-α-farnesene in the latter.

INTRODUCTION

In the course of our chemosystematic investigation of the genus *Vismia*, we have reported on the structure elucidation of several prenylated anthranoids from the berries of eight *Vismia* species [1–4]. Similar compounds were also found in the leaves [5], barks [6] and root barks [7], as well as in the berries of *Psorospermum febrifugum* [8], belonging to the same tribe (Vismieae). The present paper deals with the results from the examination of the berries of *Vismia japurensis*§, *V. cayennensis*§ and *V. mexicana*. Recently, physcion, 7-(*trans*-3-methyl-l-butenyl) physcion and 7-(3-methyl-2-oxobutyl) physcion have been isolated from the bark and the wood of the first two species [9].

RESULTS AND DISCUSSION

α- and β-selinene and five prenylated anthranoids were isolated from the berries of *V. japurensis*. Three of the prenylated anthranoids, i.e. vismione A, γ-hydroxyferruginin A and 7-(*trans*-3-methyl-l-butenyl) physcion had been reported from other *Vismia* spp. [1, 4], whereas the remaining two (**1** and **2**) were new compounds.

Compound **1**, $C_{23}H_{24}O_6$ (MW 396), we have named acetylvismione B. Its UV and ^{1}H NMR spectra closely resembled those of vismione B (**2**); the only differences in **1** were the shift of the C-6 methyl signal from δ 1.43 to 1.63 and the presence of an acetyl group (δ 1.80), which was confirmed by IR spectroscopy. Small amounts of the same compound have now been isolated from *V. reichardtiana* [F. Delle Monache, unpublished work].

The second new compound, $C_{30}H_{36}O_5$, mp 188–190°, was an isomer of γ-anthrone A_3 (**3**), mp 231–235°, the main product of the thermal rearrangement of γ-hydroxyferruginin A (**4**) [4]. It showed in fact spectral data (see Experimental) for an anthrone heptasubstituted by three hydroxyl groups (two of which were H-bonded), a methyl group, two prenyl groups and a 3-hydroxymethyl-but-2-enyl chain. According to a previously described method [3], the single aromatic H must be located on C-2, as in **3**, on the basis of its pyridine-induced shift (+ 0.56 ppm) in the ^{1}H NMR spectrum; furthermore the chemical shifts (δ 3.60, 4H) of the methylenes of the two prenyl chains indicated both to be adjacent to one hydroxyl group. Thus structure **5** was the most likely for the new anthrone, which we have named γ-hydroxy anthrone B.

Unexpectedly, the berries of *V. cayennensis* did not contain any prenylated anthranoids and only chrysophanic acid, physcion, isocaryophyllene, β-selinene and *trans*-α-farnesene were isolated; notably, the last compound, a quite rare and unstable sesquiterpene, was obtained in large amount (1.2% of the berries).

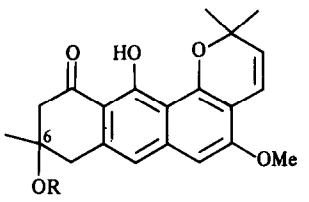
In addition to known compounds, i.e. isocaryophyllene, 7-(*trans*-3-methyl-1-butenyl) physcion, vismione A, vismione B [1], ferruginin A [2] and γ,γ′-dihydroxyferruginin A [4], two new compounds were isolated from the chloroform extract of *V. mexicana*. The first, $C_{15}H_{24}$ (MW 204), was a sesquiterpene, whose ^{1}H NMR spectrum closely resembled that of *trans*-α-farnesene (**6**) and the structure **7**, corresponding to *cis*-α-farnesene, was postulated for it. The main difference between the spectra of the two isomers was the lower field chemical shift (δ ~ 6.70) of the H-11 in **7** with respect to that of **6** (δ ~ 6.25); moreover in the latter the H-9 signal emerged (δ 5.30, *t*, *br*) from the unsaturated protons envelope. To our knowledge *cis*-α-farnesene had not been isolated from a natural source, although it had been obtained in an impure state (and not described) by decomposition of farnesyl diphenyl phosphate [10]. We attempted to confirm the structure of **6** by comparison of its ^{13}C NMR data with those of *trans*-α-farnesene, but unfortunately after a few days of storage our sample was completely changed leaving the structural problem unresolved.

The second compound from *V. mexicana* was a pigment, $C_{30}H_{36}O_5$ (MW 476), whose UV and MS data and most of its ^{1}H NMR signals were identical to those of γ-

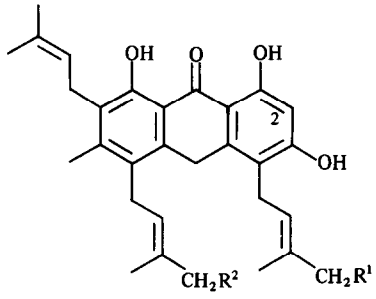
*Part 10 in the series "Chemistry of *Vismia* genus". For part 9 see ref. [7].

‡To whom correspondence should be addressed.

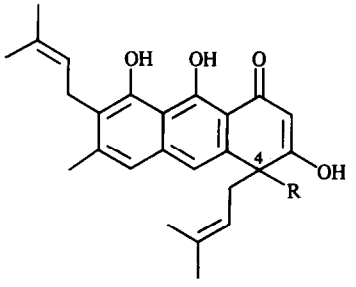
§A preliminary account on the fruit components of these two species was presented at 13th International Symposium on the Chemistry of Natural Products, Pretoria, August 1982.

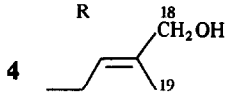


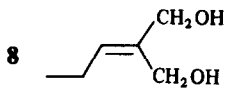
R
1 Ac
2 H

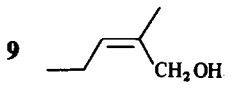


R¹ R²
3 OH H
5 H OH









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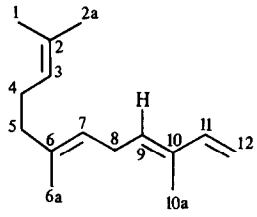
8
9



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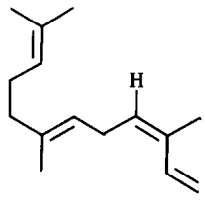

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hydroxyferruginin A (**4**), previously isolated from other *Vismia* spp. [3, 4]. The only difference was a lower field chemical shift of the CH_2–OH singlet (δ3.97 *vs* 3.63). An identical rotatory power (+ 59.3° *vs* + 59.0°) excluded the possibility of a difference at the chiral centre (C-4). Recently, the *E*-configuration of the 3-hydroxymethyl-but-2-enyl chain in **4** has been established by ^{13}C NMR analysis [11] and it should be named *trans*-γ-hydroxy-ferruginin A. Comparison of its ^{13}C NMR data with those of **4** and γ,γ'-dihydroxyferruginin A (**8**) (Table 1) as well as the model compounds tiglic and angelic alcohols [12], showed the new pigment from *V. mexicana* to be *cis*-γ-hydroxyferruginin A (**9**). From the acetone extract of this species quercetin, (−)-epicatechin and procyanidin B_2 were isolated, the last having been reported from the leaves of *V. guaianensis* [5].

Table 1. ^{13}C NMR data (δ-values)

Compound	C-18	C-19
9	22.0	62.0
4 [11]	68.4	14.9
8 [11]	66.1	59.8
Angelic alcohol [12]	21.3	60.5
Tiglic alcohol [12]	68.3	13.3

EXPERIMENTAL

Plant material. The fruits of *V. japurensis* Reich. were collected near km 30 of the Manaus-Caracarai road (Brazil) in May 1981 (Voucher specimen 98466, Herbarium of the INPA-DPN, Manaus).

The fruits of *V. cayennensis* (Jacq.) Pers. (syn. *V. acuminata* Pers.; syn. *V. floribunda* Sprague) were collected near Belém (Brazil) in May 1981. They were identified by Dr. E. Van den Berg of the Museum Goeldhi (Belém) where a voucher sample is deposited.

The fruits of *V. mexicana* Schlecht were collected near La Laguna (Xico, Vera Cruz, Mexico) in August 1982. They were identified by Dr. A. Gomez Pompa of INIREB (Ciudad de Mexico) where a voucher sample is deposited.

Isolation of the constituents of V. japurensis. The fresh fruits (800 g) were extracted with cold $CHCl_3$ (× 3) and the pooled extracts evaporated. Part (6.4 g) of the residue (56 g) was chromatographed on silica gel to give six fractions: J_1 (410 mg; $CHCl_3$), J_2 (1.4 g; $CHCl_3$), J_3 (1.1 g; $CHCl_3$), J_4 (620 mg; $CHCl_3$–MeOH, 49:1), J_5 (550 mg; $CHCl_3$–MeOH, 19:1) and J_6

(1.4 g; $CHCl_3$–MeOH, 19:1). Further purification gave: α-selinene (50 mg) and β-selinene (90 mg) from J_1 ($AgNO_3$–silica gel, 1:9; C_6H_6); 7-(*trans*-3 methyl-l-butenyl) physcion (87 mg) and triglycerides from J_2 (crystallization from C_6H_6–hexane); 7-(*trans*-3-methyl-1-butenyl) physcion (32 mg), vismione A (25 mg) and acetylvismione B (425 mg) from J_3 (silica gel, $CHCl_3$); γ-hydroxyanthrone B (410 mg) from J_5 (crystallization from CH_2Cl_2); *trans*-γ-hydroxyferruginin A (250 mg, impure) from J_6 (silica gel; $CHCl_3$–MeOH, 19:1). Fraction J_4 (mainly fatty acids) was not further examined.

Isolation of the constituents of V. cayennensis. The fresh fruits (300 g) were extracted as above. The residue (22.4 g) was chromatographed on silica gel to give five fractions: C_1 (8.2 g; CH_2Cl_2), C_2 (3.7 g; CH_2Cl_2), C_3 (3.6 g, $CHCl_3$), C_4 (200 mg, $CHCl_3$) and C_5 (5 g; $CHCl_3$–MeOH, 9:1). Further purification gave: (−)-isocaryophyllene (150 mg), β-selinene (45 mg), *trans*-α-farnesene (3.7 g), triglycerides (1.8 g) and three unidentified sesquiterpenes from C_1 (silica gel, heptane, followed by $AgNO_3$–silica gel, 1:9; C_6H_6); triglycerides, chrysophanic acid (250 mg) and physcion (105 mg) from C_2 (partition between heptane–MeOH 10% water followed by silica gel, C_6H_6-heptane, 3:2, of the MeOH soluble fraction); β-sitosterol (impure) from C_4. Fractions C_3 (fatty acids) and C_5 were not further examined.

Isolation of the constituents of V. mexicana. The fresh fruits (170 g) were extracted with cold $CHCl_3$ (×3) and Me_2CO (×3), successively. The residue (1.5 g) from $CHCl_3$ was chromatographed on silica gel to give six fractions: M_1 (610 mg; $CHCl_3$), M_2 (155 mg; $CHCl_3$), M_3 (200 mg, $CHCl_3$), M_4 (190 mg, $CHCl_3$–MeOH, 49:1), M_5 (180 mg, $CHCl_3$–MeOH, 19:1) and M_6 (105 mg, $CHCl_3$–MeOH, 9:1). Extended purification gave: (−)-isocaryophyllene (60 mg) and *cis*-α-farnesene (?, 130 mg) from M_1 (silica gel, hexane); vismione A (170 mg, crystallization from EtOH) from M_3; a mixture (50 mg) of vismione B and ferruginin A from M_4 (MeOH soluble fraction from partition between heptane–MeOH 10% water); *cis*-γ-hydroxyferruginin A (95 mg) from M_5 (silica gel; $CHCl_3$–MeOH, 19:1). Fractions M_2 and M_6 were not further processed: TLC and ^{1}H NMR evidence suggested the presence of 7-(*trans*-3-methyl-1-butenyl) physcion contaminated with the corresponding anthrone and bianthrones [1], and γ,γ′-dihydroxyferruginin A [4] respectively.

The residue (850 mg) from the Me_2CO extract was chromatographed on silica gel ($CHCl_3$–MeOH, 9:1) to give quercetin (40 mg) and (−)-epicatechin (110 mg), and procyanidin B_2 ($CHCl_3$–MeOH, 4:1). These compounds were identified by comparison with authentic specimens (procyanidin B_2 after acetylation).

Identification of the known compounds. (−)-Isocaryophyllene, α-selinene, β-selinene, β-sitosterol, 7-(*trans*-3-methyl-1-butenyl)physcion, chrysophanic acid, physcion, vismione A, vismione B, ferruginin A and *trans*-γ hydroxyferruginin A, γ,γ′-dihydroxyferruginin A were identified by comparison (TLC, ^{1}H NMR, mp or [α]) with authentic specimens previously isolated in our laboratory from *Vismia* spp.

Acetylvismione B (**1**). Mp 115–120° dec (red–brown crystals, CH_2Cl_2–heptane). Anal.: C, 70.0; H, 6.05; $C_{23}H_{24}O_6$ requires C, 69.68; H, 6.10%. UV $\lambda_{max}^{CHCl_3}$ nm (log ε): 255 (4.15), 301 (4.28), 398 (3.88); IR $\nu_{max}^{CHCl_3}$ cm^{-1}: 3350, 1725, 1620–1600; ^{1}H NMR (60 MHz, $CDCl_3$), δ14.57 (OH, *s*), 6.75 (H-10, *s*), 6.67 (H_α, *d*, *J* = 10 Hz), 6.45 (H-4 *s*), 5.55 (H_β, *d*, *J* = 10 Hz), 3.90 (OMe, *s*), 3.50–2.90 (4H, *m*), 1.80(OAc, *s*), 1.63 (3H, *s*), 1.52 (6H, *s*); EIMS (probe) 70 eV, *m/z* (real. int.): 396 $[M]^+$ (20), 381 (6), 336 (30), 321 (100), 306 (12), 295 (6), 288 (8), 283 (10), 278 (4), 270 (10); m* 191.7 (321 → 306).

γ-Hydroxyanthrone B (**5**). Mp 188–190° (yellow crystals, CH_2Cl_2). Anal.: C, 78.35; H, 7.78; $C_{30}H_{36}O_5$ requires C, 78.23; H, 7.88%. UV λ_{max}^{EtOH} nm: 235, 262, 317, 374; IR ν_{max}^{KBr} cm^{-1}: 3420, 3180, 1610–1600; ^{1}H NMR (60 MHz; $CDCl_3$–CD_3OD, 9:1): δ12.73 (OH, *s*), 12.43 (OH, *s*), 6.2 (H-2, *s*), 5.40–4.70 (3H, *m*), 4.20 ($\underline{CH_2}$–OH, *s*), 3.90 (CH_2 anthrone, *s*), 3.65–3.10 (6H, *m*), 2.23 Me, *s*), 1.83 (9H, *s*, *br*), 1.73 (6H, *s*, *br*); ^{1}H NMR (C_5D_5N): δ6.76 (H-2, *s*), 3.73 (2H, *d*), 3.60 (4H, *d*); EIMS (probe) 70 eV, *m/z* (rel. int.): 476 $[M]^+$ (67), 458 $[M-18]^+$ (76), 443 (22), 441 (15), 431 (11), 420 $[M-56]^+$ (30), 415 (61), 404 (50), 403 $[458-55]^+$ (85), 402 (68), 391 $[M-85]^+$ (100), 387 (39), 377 (17), 375 (22), 361 (41), 359 $[402-43]^+$ (100), 349 (87), 347 $[402-55]^+$ (65), 343 (22), 336 (44), 335 (26), 333 (28), 331 (35), 321 (19), 319 (35), 317 (24), 305 (44), 293 (61), 283 (24); metastable peaks at 440.7 (476 → 458), 321.2 (476 → 391) and 299.5 (402 → 347).

Trans-α-*farnesene* (**6**). Oil; ^{1}H NMR (60 MHz; $CDCl_3$): δ6.50–6.0 (1H, X part of ABX), 5.33 (H-9, *t*), 5.20–4.70 (4H, *m*), 2.80 (2H, *t*), 2.0 (4H, *d*, *br*), 1.80–1.55 (12H); ^{1}H NMR and IR spectra identical to those of Figs 1 and 3 in ref. [14]; ^{13}C NMR (25.2 MHz): δ141.4 (C-11), 136.4, 136.3 (C-6, C-10), 131.6 (C-9), 131.0 (C-2), 124.2, 122.0 (C-3, C-7), 110.3 (C-12), 39.7 (C-5), 27.3, 26.7 (C-4, C.8), 25.7 (C-1), 17.6, 16.1 (C-1a, C-6a), 11.6 (C-10a).

Cis-α-*farnesene* (?) (**7**). Oil; ^{1}H NMR (60 MHz; $CDCl_3$): δ6.95–6.45 (1H, X part of ABX), 5.40–4.85 (5H, *m*), 2.80 (2H, *t*), 2.0 (4H, *d*, *br*), 1.80 (3H, *d*, *br*), 1.70–1.55 (9H).

Cis-γ-*hydroxyferruginin A* (**9**). Mp 87–89° dec. (red crystals from hexane), $[\alpha]_D$ + 59.3 (*c* 0.7, $CHCl_3$). ^{1}H NMR (60 MHz; Me_2CO-d_6): δ 17.70 (1H, *s*, OH), 10.35 (1H, *s*, OH), 7.28 (1H, *s*, H-10), 7.05 (1H, *s*, H-5), 5.80 (1H, *s*, H-2), 5.10 (1H, *t*, *J* = 6 Hz), 4.90–4.50 (2H, *m*) 3.97 (2H, *s*), 3.45 (2H, *d*, *J* = 6 Hz), 3.10–2.65 (4H, *m*), 2.40 (3H, *s*), 1.82 (3H, *s*), 1.68 (3H, *s*), 160–1.40 (9H, *m*); ^{13}C NMR (25.2 MHz; dioxane-d_6): δ192.6 (CO), 180.8 (C-3), 164.9 (C-13), 155.9 (C-11), 142.7 (C-5), 140.7 (C-9), 139.6 (C-17), 137.9 (C-7), 135.5 (C-17′), 132.1 (C-22), 124.4 (C-8), 123.5 (C-10), 122.3, 120.2, 120.1 (C-16, C-16′, C-21), 116.0 (C-6), 112.7 (C-14), 109.7 (C-12), 105.9 (C-2), 62.0 (C-18), 51.2 (C-4), 41.1 (C-15, C-15′), 26.6, 26.5, 26.3 (C-20, C-23, C.18′), 22.0, 21.9 (C-19, C-24), 21.6 (C-19′), 18.9 (C-25); EIMS (probe) 70 eV, *m/z* (rel. int.): 476 $[M]^+$ (32), 458 $[M-18]^+$ (15), 420 (28), 415 (12), 407 (55), 403 (28), 402 (23), 391 (82), 389 (41), 387 (21), 377 (23), 365 (23), 361 (25), 359 (41), 351 (64), 349 (9), 347 (55), 339 (45), 336 (37), 335 (7), 333 (7), 331 (37), 305 (55), 293 (100), 281 (87).

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