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ANDROSTANE AND PREGNANE 2β,19-HEMIKETAL STEROIDS FROM *TRICHILIA CLAUSSENII*

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Key Word Index—*Trichilia claussenii*; Meliaceae; pregnane and androstane steroids.

Abstract—The methanol extract of stems of *Trichilia claussenii* yielded three new steroids: 2α,3α-dihydroxyandrostan-16-one 2β,19-hemiketal, 2α,3β-dihydroxypregnan-16-one 2β,19-hemiketal, 2β,3β-dihydroxypregnan-16-one. Two known steroids 2β,3β,4β-trihydroxypregnan-16-one, 2α,3α,4β-trihydroxypregnan-16-one and a mixture of sitosterol and stigmasterol β-*O*-D-glucopyranosides were also isolated. The structures of the isolated compounds were determined on the basis of spectroscopic analysis.

INTRODUCTION

The Meliaceae is known to be a rich source of limonoids, which possess interesting biological activities against insects such as antifeeding, deterrent and inhibitors of ecdyasis [1]. As part of our interest in the chemistry of the family Meliaceae, we have recently reported the isolation of cycloartane triterpenoids, caryophyllene epoxide and a mixture of ω-phenyl alkanoic and alkenoic acids from the leaves of *Trichilia claussenii* DC. collected in Brazil [2]. In continuation of the study of this species, we have investigated the stems extracts of *T. claussenii*. We have not found limonoids in this plant, but here we report the isolation and identification of steroids from stems of *T. claussenii*.

RESULTS AND DISCUSSION

The methanol extract of the stems of *Trichilia claussenii* was submitted to solvent partition followed by several column chromatographies. This procedure led to the isolation of a series of steroids which were identified as following.

The DCIMS of **1** showed the [M+H] peak *m/z* 321 and the ^{13}C NMR spectrum showed 19 carbon signals. The multiplicities of the carbons determined by DEPT 135 led to the attribution of: 4 C, 5 CH, 9 CH_2 and 1 CH_3, allowing us to propose the molecular formula $C_{19}H_{28}O_4$ for compound **1**, an androstane steroid. Among the quaternary carbons one was attributed to a hemiketal (δ 107.8), one CH carbinolic (δ 73.2), one CH_2 carbinolic (δ 66.1), one carbonyl (δ 217.8) and only one methyl carbon (δ 17.8). The presence of only one methyl group led us to propose that the second one for androstane steroids was replaced by a hydroxymethylene group which is part of the cyclic hemiketal moiety (δ 4.10, 3.89, both *d*, *J* = 8.0 Hz). The ^1H NMR spectrum of **1** showed another AB coupling system for 2H-1 (δ 2.30, 2.40, both *d*, *J* = 11.2 Hz), which led us to propose the position of the hemiketal ring between C-2 and C-19. Other possibilities of ring closure of the hemiketal were ruled out mainly through analysis of the NMR data. Analysis of HMBC, HMQC and NOEDIF of **1**, together with the ^1H–^1H COSY of its acetate **1a** confirmed the positioning of the hemiketal ring. In the ^1H–^1H COSY a '*W*' coupling was observed between H-3 (δ 5.41, *ddd*, *J* = 1.7, 2.7, 3.3 Hz) and H-1β (δ 2.50, *dd*, *J* = 1.7, 11.5 Hz), indicating an α-configuration for the hydroxyl at C-3. In the HMBC experiment the following were the most important correlations observed: C-2/H-3, C-3/H-1β, C-5/H-1β, C-5/H-1α and C-3/H-5, other correlations are described in Table 3. NOEDIF was also used to confirm the structure for compound **1**: when H-19a was irradiated an NOE was observed with H-1β, H-11β and H-8. Irradiation of H-19b caused a NOE for H-4β, H-6β and H-8, other NOEs are described in Table 4.

All the information above confirmed the structure of **1** with this new arrangement containing the hemiketal between C-2 and C-19.

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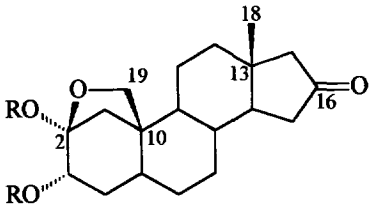

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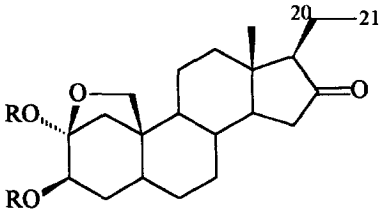
1a R=Ac



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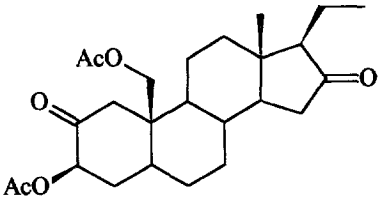
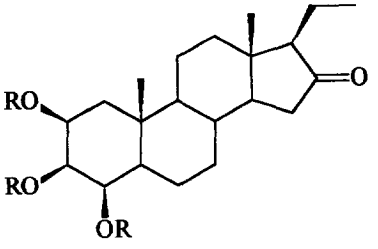


2b



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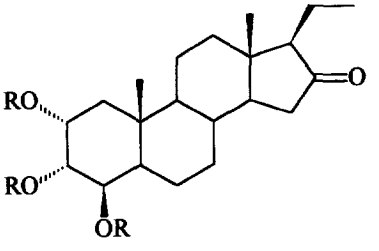
3a R=Ac



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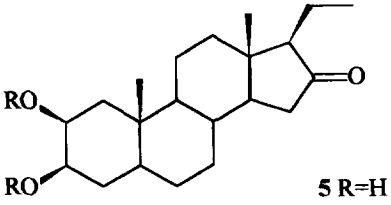

5 R=H
5a R=Ac

Compound **2** was also found to be a steroid very closely related to **1**. The *m/z* 349 $[M+H]^+$ peak observed for **2** in the DCIMS requires two more carbon atoms in relation to **1**, and this was confirmed by the ^{13}C NMR spectrum which showed 21 signals. The combination of the data above with the ^1H NMR spectrum showing a methyl signal (δ 1.04, *t*, $J = 7.2$ Hz) led to the molecular formula $C_{21}H_{32}O_4$ for this pregnane steroid. As observed for compound **1**, compound **2** also displays a hemiketal ring between C-2 and C-19. This observation was deduced on the basis of spectral analysis ^1H NMR, ^{13}C NMR, HMBC, HMQC and NOEDIF (Tables 1–4). For compound **2** the coupling constants obtained for H-3 (δ 4.15, *dd*, $J = 6.0$, 10.4) allowed us to propose a β-configuration for the hydroxyl group at C-3. Other differences observed in the ^1H NMR spectra of compounds **1** and **2** refer to the chemical shifts for H-1α and H-1β which are very close for compound **1** ($\Delta\delta$ 0.10) and more distinct for **2** ($\Delta\delta$ 1.17), this difference might be due to the influence of pyridine and its different association to the hydroxyl groups. To check and confirm this possibility ^1H NMR spectra for both compounds were run in methanol-d_4, and both H-1α and H-1β

Table 1. ^{13}C NMR data for steroids (pyridine-d_5) and acetates ($CDCl_3$) (δ, 100 MHz)

C	1	1a	2	2a	2b	3	3a	4	4a	5	5a
1	39.9	38.6	43.8	42.4	48.3	44.5	40.7	41.8	37.3	43.7	41.1
2	107.8	108.6	105.8	108.5	202.5	72.7	70.5	66.4	67.6	70.0	69.9
3	73.2	71.7	74.2	72.3	75.1	72.8	68.9	74.9	68.7	72.6	72.4
4	37.5	33.8	38.4	38.3	35.3	77.2	71.9	77.3	74.0	33.6	29.4
5	39.7	39.1	42.9	42.3	43.8	50.2	47.6	44.0	43.6	45.9	45.4
6	29.5	28.5	29.4	28.9	27.2	26.5	24.7	25.5	23.7	28.7	27.9
7	32.0	31.5	31.8	31.5	31.8	32.7	31.9	32.9	31.9	32.5	32.0
8	36.5	36.6	36.0	36.3	34.0	34.0	33.8	34.1	33.7	34.0	34.0
9	46.3	45.8	46.1	45.8	53.2	56.7	55.7	55.6	54.9	55.4	55.1
10	48.4	47.6	47.6	48.1	43.4	35.6	35.4	37.6	37.2	36.0	35.7
11	20.9	20.7	20.8	20.9	21.1	20.4	20.2	20.2	20.0	21.1	20.8
12	37.8	37.7	37.7	34.1	37.9	38.1	37.9	38.0	37.9	38.3	38.2
13	38.8	38.8	41.7	41.8	41.9	42.1	42.1	42.1	42.1	42.2	42.2
14	51.5	51.6	50.2	50.4	50.8	50.5	50.3	50.5	50.4	50.4	50.4
15	39.4	39.7	38.5	37.7	38.3	38.5	38.4	38.5	38.4	38.5	38.4
16	217.8	217.9	218.2	218.7	218.6	218.4	219.3	218.5	219.3	218.5	219.3
17	55.9	55.7	65.0	65.2	65.1	65.1	65.2	65.0	65.2	65.2	65.4
18	17.8	17.9	13.1	13.4	13.4	13.5	13.4	13.4	13.5	13.5	13.4
19	66.1	68.0	67.1	67.7	63.1	17.4	15.3	16.1	14.8	14.9	14.4
20	—	—	17.9	17.6	17.6	18.0	17.6	18.0	17.6	18.1	17.6
21	—	—	13.6	13.3	13.5	13.6	13.4	13.6	13.5	13.7	13.5
OCOME	—	169.9	—	170.3	170.6	—	170.6	—	170.3	—	170.3
OCOMe	—	169.0	—	170.3	170.2	—	170.3	—	169.7	—	170.3
OCOMe	—	—	—	—	—	—	170.1	—	169.5	—	—
OCOMe	—	21.3	—	21.6	20.6	—	21.2	—	21.1	—	21.3
OCOMe	—	22.1	—	21.0	20.8	—	20.9	—	21.0	—	21.1
OCOMe	—	—	—	—	—	—	20.7	—	20.9	—	—

were shown to be more shielded in comparison with the chemical shifts observed in pyridine-d_5. When **2** was submitted to acetylation with acetic anhydride in pyridine and catalytic amounts of DMAP, two diacetates were obtained. One referring to the acetylation of the alcohol and hemiketal **2a**, and the second **2b** corresponding to the diacetate which originated from the opening of the hemiketal.

Compounds **3** and **4** were isolated from *T. schomburgkii* [3, 4] for the first time. All ^{13}C NMR spectra obtained for compounds **3** and **4** are in agreement with those reported in the literature (Table 1). However, in the ^1H NMR spectra for compounds **3** and **4**, it was not possible to observe the multiplicities for the carbinolic protons (H-2, H-3 and H-4), in spite of the fact that they displayed the same chemical shifts, when the spectra were run in the same solvent. However, the compounds were obtained as triacetate derivatives **3a** and **4a**,where the multiplicities of H-2, H-3 and H-4 were the same as observed for the natural products described in the literature. Compound **3a** showed in the ^1H NMR spectrum a *W*-coupling between H-2 and H-4, as described for the natural product **3** isolated from *T. schomburgkii* [3]. In the HMBC experiments due to the very close chemical shifts observed for C-2 and C-3 it was not possible to assign unequivocally each correlation. The following correlations for the carbinolic protons were observed for **3**: C-10/H-2, C-10/H-4,C-2 or C-3/H-2, C-2 or C-3/H-4, C-2 or C-3/H-3 and C-4/H-4. For compound **4** the correlations observed for the carbinolic protons were: C-1/H-3, C-10/H-4, C-2/H-4, C-3/H-2, C-3/H-3 and C-4/H-4. In the literature [3] the long-range ^1H–^{13}C correlations observed for a monoacetate of **3** are limited to those involving methyl hydrogens. Compounds **3** and **4** showed different melting points and $[\alpha]_D$ from those described in the literature. However, the duplication of the Me-18 signals observed in the ^1H NMR for compounds **2** and **4** suggests the epimerization of C-17 when the NMR spectra were run in pyridine.

The ^1H NMR and ^{13}C NMR spectra for compound **5** were very similar to those for **3** and **4**. The only difference observed was due to the presence of only two hydroxyl groups attached to the ring A. The positioning of the hydroxyls and their stereochemistry were determined through analysis of ^1H NMR and ^{13}C NMR of **5** and its diacetate **5a**. The signals (δ 4.04, *m*, and δ 3.65 *ddd*, $J = 4.0, 4.8, 11.2$ Hz) displayed in ^1H NMR of **5** led us to propose a *cis*-relationship between H-2 and H-3, where H-2 is equatorial and H-3 is axial. This was confirmed by the ^1H–^1H COSY spectrum of **5a** which showed that the acetylcarbonilic protons are coupling to each other, and with two other different protons. Therefore, the hydroxyls are vicinals and located at C-2 and C-3. The comparison of the chemical shifts and multiplicities of H-2 in **5**,

Table 2. ^{1}H NMR data for **1** and **2** (pyridine-d_5, δ, 400 MHz)

H	1	2
1α	2.40 *d* (10.8)	1.41 *d* (11.6)
1β	2.30 *d* (10.4)	2.58 *d* (11.6)
3	4.38 *m*	4.15 *dd* (6.0, 10.4)
4α	2.01	2.23
4β	1.85	1.73
5	1.30	1.37
6α	1.55	1.45
6β	1.20	1.12
7α	1.28	1.38†
7β	1.43	1.41†
8	0.85	0.68
9	1.18	1.09
11α	*	1.62
11β	1.35	1.33
12	1.60	1.21
14	1.27	1.20
15α	2.15 *dd* (7.6, 18.0)	2.18
15β	1.83	1.65
17α	1.92 *d* (16.8)	1.60
17β	2.06 *d* (16.8)	—
18	0.66 *s*	0.50 *s*
19a	4.10 *d* (8.0)	4.08 *d* (8.0)
19b	3.89 *d* (8.0)	3.87 *d* (8.0)
20	—	1.19
21	—	1.04 *t* (7.2)

Coupling constants (Hz, in parentheses).
* Not assigned.
† May be interchangeable.
Assignment based on ^{1}H NMR, ^{1}H–^{1}H COSY, HMBC, HMQC and NOEDIF.

Table 3. HBMC correlations for **1** and **2**

C	H 1	H 2
1	19a, 19b, 3	*
2	3, 19b, 1β, 4α	19a, 1α, 1β, 4α, 4β
3	1β, 4α, 5	3, 1α, 1β, 4α, 4β
4	*	3
5	1α, 1β, 19a, 19b, 3	1α, 1β, 19a, 19b, 4β, 6α
6	4β	4β, 1β
7	*	8
8	*	11α, 15β, 6β, 6α, 8
9	19a, 1β, 12	11α
10	19a, 19b, 4α	1α, 1β, 19a, 19b, 4α, 6α
11	*	11β, 12
12	*	18, 11β
13	15α, 17α, 18, 12, 14	18, 17, 15α, 15β, 14, 11α
14	15β, 17β, 18, 12	15β, 17, 18
15	17β	*
16	15α, 15β, 17α, 17β	17, 15α, 15β, 14
17	17α, 17β, 18, 14	15β, 14, 21, 18
18	17α, 17β, 18, 14	17, 14, 18
19	1α, 19b	19b, 1α
20	—	17, 21
21	—	17, 21

* Not observed.

Table 4. NOEDIF for **1** and **2**

H	Observed NOE 1	2
19a	H-19b, H-1β, H-11β, H-8	H-19b, H-1β, H-11β, H-8
3	H-4α, H-4β	H-4α, H-1α
1β	*	H-19a, H-11α, H-1α
19b	H-19a, H-4β, H-6β, H-8	H-19a, H-4β, H-6β, H-8
15α	*	H-17, H-14
4α	*	H-3, H-4β, H-6α
18	H-15β, H-17β	H-15β, H-11β
4β	*	H-4α, H-19b
1α	*	H-3, H-1β
6α	*	H-4α
21	*	H-17
8	H-19a, H19b, H-7β	H-19a, H19b, H-7β

* Not observed.

with the data of **3** and **4**, allowed us to propose the configuration for H-2 equatorially oriented, and H-3 axially. Therefore, both hydroxyls have the β-configuration. The possibility of different stereochemistry for both hydroxyls was ruled out through comparison of the ^{13}C NMR with models from the literature [5].

The androstane (**1**) and pregnane (**2**) 2β,19-hemiketal represent a novel group of steroids from plants [6]. The closest analogues of this nucleus would appear to be the pregnane-10,2-carbolactones isolated from the sponge species *Strongylophora* sp. [7]. Pregnane derivatives have been isolated from the Meliaceae (*Melia azedarach* var. *japonica* [8], *Melia toosendon* [9, 10], *Turrea villosa* [11] and *Trichilia schomburgkii* [3, 4]), Simaroubaceae (*Ailanthus grandis* [12]) and from Burseraceae (*Commiphora mukul* [13]). Thus, compounds **1** and **2** show a significant enlargement of the patterns of pregnanes production previously noted in the Rutales, and a significant chemotaxonomic evidence in favour of the link between these three families.

EXPERIMENTAL

General. IR: KBr. ^{1}H and ^{13}C NMR spectra were recorded at 400 and 100 MHz, respectively, with TMS as int. standard. MS: VG Platform II, PCDI (i-C_4H_{10}).

Plant material. Stems of *T. claussenii* were collected in Rio Claro, SP, Brazil, and a voucher is deposited in the Herbarium of Instituto de Biociências, Universidade Estadual Paulista, Rio Claro, SP, Brazil. The stems were dried, powdered and extracted with MeOH.

Isolation of constituents. The MeOH extract (45.7 g) was suspended in MeOH–H_2O (1:3) and partitioned with CH_2Cl_2–EtOAc–*n*-BuOH. The CH_2Cl_2 fr. was concd and then partitioned with hexane–MeOH. The MeOH fr. afforded 9 frs. after dry silica gel column using as eluent hexane–CH_2Cl_2–MeOH (10:10:1). Fr-8 after silica gel flash column hexane–CH_2Cl_2–MeOH (10:10:1), gradient elution afforded

26 frs. Fr. 8-11 afforded compound **5** (8.0 mg) after chromatography on silanized silica gel (Me_2CO–H_2O, 1:1). Column chromatography of fr. 8-12 on florisil (CH_2Cl_2–MeOH, 19:1) yielded 7 new frs. Fr. 8-12-5 after chromatography on silanized silica column (Me_2CO–H_2O, 1:1), afforded **5** (17.0 mg). Compound **5** (5 mg) was acetylated (Ac_2O–pyridine) to yield 1.2 mg of **5a**. CC of fr. 8-13 on silanized silica gel (Me_2CO–H_2O, 1:1) afforded **2** (32.0 mg). 6 mg of **2** were acetylated (Ac_2O–pyridine) and the acetate obtained was purified on flash silica gel column (hexane–$CHCl_3$–Me_2CO, 10:10:1.2) to yield **2a** (2.0 mg) and **2b** (3.0 mg). Fr. 8-15 afforded, after chromatography on florisil column (CH_2Cl_2–MeOH, 19:1), compound **1** (45.0 mg). Compound **1** (6 mg) was acetylated (Ac_2O–pyridine and catalytic amounts of DMAP) to yield **1a** (5.5 mg). Fr. 8-17 afforded after CC on florisil (CH_2Cl_2–MeOH, 19:1) compounds **3** (20.0 mg) and **4** (6.0 mg). Compound **3** (5 mg) was acetylated (Ac_2O–pyridine) to yield **3a** (2.6 mg). As described above fr. 8-18 yielded after CC on (CH_2Cl_2–MeOH, 19:1) and then silanized silica (MeOH–H_2O, 1:1) compound **4** (47.0 mg). Compound **4** (5 mg) was acetylated (Ac_2O–pyridine) to yield **4a** (4.5 mg). Fr. 8-19, after CC on silica gel (hexane–CH_2Cl_2–MeOH, 5:15:1.5), afforded a mixt. of sitosterol and stigmasterol glycosides (9.0 mg).

2α,3α-*Dihydroxyandrostan*-16-*one* 2β,19-*hemiketal* (**1**). Amorphous solid, mp 208–211°, $[\alpha]_D$ −108.4° (MeOH, *c* 0.078). DCIMS *m/z* (rel. int.): 321 $[M+H]^+$ (100), 320 $[M]^+$ (33), 303 (58), 285 (14), 255 (13), 233 (21), 215 (8), 60 (54). ^{13}C NMR: Table 1, ^1H NMR: Table 2, HMBC: Table 3, NOEDIF: Table 4.

2α,3α-*Diacetoxyandrostan*-16-*one* 2β,19-*hemiketal* (**1a**). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 5.41 (*ddd*, *J* = 1.7, 2.7, 3.3 Hz, H-3), 4.06 (*d*, *J* = 8.0 Hz, H-19a), 3.86 (*d*, *J* = 8.0 Hz, H-19b), 2.50 (*dd*, *J* = 1.7, 11.5 Hz, H-1β), 2.20 (*dd*, *J* = 7.2, 18.0 Hz, H-15α), 2.13 (*d*, *J* = 18.0 Hz, H-17a), 2.07 (*s*, OCOMe), 2.00 (*s*, OCOMe), 1.99 (*d*, *J* = 11.5 Hz, H-1α), 1.95 (*d*, *J* = 18.0 Hz, H-17b), 1.87 (H-15β), 1.75 (H-4a), 1.73 (H-4b), 1.67 (H-5), 1.48 (H-14), 1.24 (H-6a), 1.01 (H-6b), 0.85 (*s*, H-18).

2α,3β-*Dihydroxypregnan*-16-*one* 2β,19-*hemiketal* (**2**). Amorphous solid, mp 140–143°, $[\alpha]_D$ −93.9° (MeOH, *c* 0.055). DCIMS *m/z* (rel. int.): 349 $[M+H]^+$ (53), 348 $[M]^+$ (44), 331 (100), 313 (24), 283 (18), 261 (7), 108 (6), 94 (7), 81 (10), 70 (12), 60 (34). ^{13}C NMR: Table 1, ^1H NMR: Table 2, HMBC: Table 3, NOEDIF: Table 4.

2α,3β-*Diacetoxypregnan*-16-*one* 2β,19-*hemiketal* (**2a**). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 5.37 (*dd*, *J* = 6.4, 9.6 Hz, H-3), 4.04 (*d*, *J* = 8.0 Hz, H-19a), 3.87 (*d*, *J* = 8.0 Hz, H-19b), 2.50 (*d*, *J* = 12.0 Hz, H-1β), 2.23 (*dd*, *J* = 7.6, 18.0 Hz, H-15α), 2.11 (H-4a), 2.08 (*s*, OCOMe), 2.06 (*s*, OCOMe), 2.03 (*d*, *J* = 12.0 Hz, H-1α), 1.73 (H-15β), 1.42 (H-4b), 1.38 (H-14), 1.03 (*t*, *J* = 7.2 Hz, H-21), 0.65 (*s*, H-18).

3β,19-*Diacetoxypregnan*-2,16-*dione* (**2b**). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 5.28 (*dd*, *J* = 7.2, 10.0 Hz, H-3), 4.33 (*d*, *J* = 11.6 Hz, H-19a), 4.21 (*d*, *J* = 11.6 Hz, H-19b), 2.76 (*d*, *J* = 14.8 Hz, H-1β), 2.24 (*dd*, *J* = 7.2, 18.0 Hz, H-15α), 2.16 (*s*, OCOMe), 2.08 (H-4a), 2.05 (*d*, *J* = 14.8 Hz, H-1α), 1.98 (*s*, OCOMe), 1.94 (H-4b), 1.02 (*t*, *J* = 7.6 Hz, H-21), 0.69 (*s*, H-18).

2β,3β,4β-*Trihydroxypregnan*-16-*one* (**3**). Amorphous solid, mp 234° (decomposition), $[\alpha]_D$ −44.0° (MeOH, *c* 0.041). DCIMS *m/z* (rel. int.): 351 $[M+H]^+$ (27), 333 (69), 315 (76), 297 (42), 246 (21), 86 (40), 60 (100). ^{13}C NMR: Table 1. ^1H NMR (pyridine-d_5): δ 4.56 (*sl*, H-2), 4.19 (*sl*, H-4), 3.82 (*sl*, H-3), 2.34 (*dd*, *J* = 3.2, 14.0 Hz, H-1β), 2.20 (*dd*, *J* = 7.6, 18.0 Hz, H-15α), 1.62 (*s*, H-19), 1.05 (*t*, *J* = 7.2 Hz, H-21), 0.59 (*s*, H-18).

2β,3β,4β-*Triacetoxypregnan*-16-*one* (**3a**). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 5.34 (*ddd*, *J* = 3.6 Hz, H-2), 5.27 (*ddd*, *J* = 1.2, 2.8, 3.6 Hz, H-4), 4.93 (*t*, *J* = 4.0 Hz, H-3), 2.22 (*dd*, *J* = 7.6, 18.4 Hz, H-15α), 2.09 (*s*, OCOMe), 1.98 (*s*, OCOMe), 1.25 (*s*, H-19), 1.02 (*t*, *J* = 7.6 Hz, H-21), 0.69 (*s*, H-18).

2α,3α,4β-*Trihydroxypregnan*-16-*one* (**4**). Amorphous solid, mp 217–220°, $[\alpha]_D$ −77.6° (MeOH, *c* 0.071). DCIMS *m/z* (rel. int.): 351 $[M+H]^+$ (39), 350 $[M]^+$ (84), 333 (47), 315 (88), 297 (46), 264 (100), 229 (39), 135 (30), 123 (38), 109 (37), 95 (41), 83 (55), 71 (49), 61 (56). ^{13}C NMR: Table 1. ^1H NMR (pyridine-d_5): δ 4.85 (*ddd*, *J* = 3.2, 4.0, 10.8 Hz, H-2), 4.66 (*t*, *J* = 2.8 Hz, H-3), 4.48 (*t*, *J* = 2.8 Hz, H-4), 2.21 (*dd*, *J* = 7.6, 18.0 Hz, H-15α), 1.46 (*s*, H-19), 1.07 (*t*, *J* = 7.2 Hz, H-21), 0.61 (*s*, H-18).

2α,3α,4β-*Triacetoxypregnan*-16-*one* (**4a**). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 5.26 (*ddd*, *J* = 3.2, 4.0, 12.4 Hz, H-2), 5.19 (*dt*, *J* = 2.8 Hz, H-4), 4.98 (*t*, *J* = 3.2 Hz, H-3), 2.23 (*dd*, *J* = 7.2, 18.0 Hz, H-15α), 2.13 (*s*, OCOMe), 2.09 (*s*, OCOMe), 1.99 (*s*, OCOMe), 1.12 (*s*, H-19), 1.03 (*t*, *J* = 7.2 Hz, H-21), 0.69 (*s*, H-18).

2β,3β-*Dihydroxypregnan*-16-*one* (**5**). Amorphous solid, $[\alpha]_D$ −86.9° ($CHCl_3$ *c* 0.049). DCIMS *m/z* (rel. int.): 335 $[M+H]^+$ (33), 334 $[M]^+$ (37), 333 (100), 331 (73), 317 (88), 315 (70), 313 (43), 299 (43), 297 (24), 248 (15), 231 (15), 121 (21), 109 (22), 107 (21), 95 (30), 123 (18), 93 (23), 81 (45). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 4.04 (*m*, H-2), 3.65 (*ddd*, *J* = 4.0, 4.8, 11.2 Hz, H-3), 2.21 (*dd*, *J* = 7.2, 18.0 Hz, H-15α), 1.04 (*s*, H-19), 1.02 (*t*, *J* = 7.2 Hz, H-21), 0.69 (*s*, H-18).

2β,3β-*Diacetoxypregnan*-16-*one* (**5a**). ^{13}C NMR: Table 1. ^1H NMR ($CDCl_3$): δ 5.29 (*m*, H-2), 4.83 (*ddd*, *J* = 3.7, 4.6, 12.0 Hz, H-3), 2.21 (*dd*, *J* = 7.5, 18.2 Hz, H-15α), 2.10 (*s*, OCOMe), 2.04 (*dd*, *J* = 3.0, 14.9 Hz, H-1β), 2.00 (*s*, OCOMe), 1.80 (H-4β), 1.73 (H-15β), 1.48 (H-4α), 1.45 (H-14), 1.25 (H-1α), 1.02 (*t*, *J* = 7.3 Hz, H-21), 0.99 (*s*, H-19), 0.68 (*s*, H-18).

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