Absolute configuration of side chains of polyhydroxylated steroidal compounds from the starfish *Henricia derjugini*

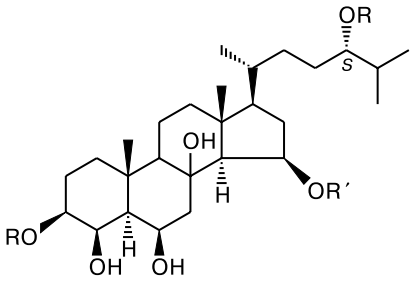
N. V. Ivanchina, A. A. Kicha, A. I. Kalinovsky, and V. A. Stonik*

Pacific Institute of Bioorganic Chemistry of the Far-Eastern Branch of the Russian Academy of Sciences, 159 prosp. 100-letiya Vladivostoka, 690022 Vladivostok, Russian Federation. Fax: +7 (423 2) 31 4050. E-mail: ivanchina@piboc.dvo.ru

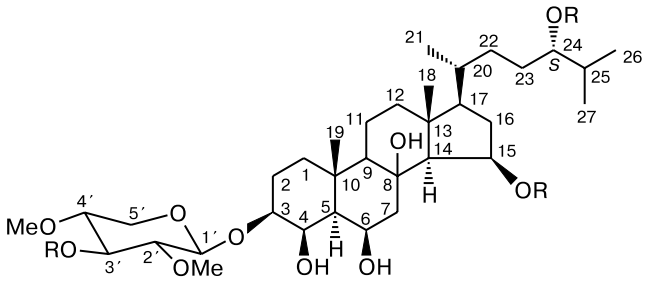
The absolute configurations of the side chains of polyhydroxylated steroids from the starfish *Henricia derjugini* were determined by Mosher's method using ^{1}H NMR spectra of *R*-(+)- and *S*-(−)-α-methoxy-α-(trifluoromethyl)phenylacetates of these compounds. The chiral centers have the (24*S*) configuration in a steroidal hexaol and henricioside H_1, the (24*R*,25*S*) configuration in henricioside H_2, and the (24*R*,25*R*) configuration in henricioside H_3.

Key words: starfishes, steroids, glycosides, MTPA esters, absolute configuration.

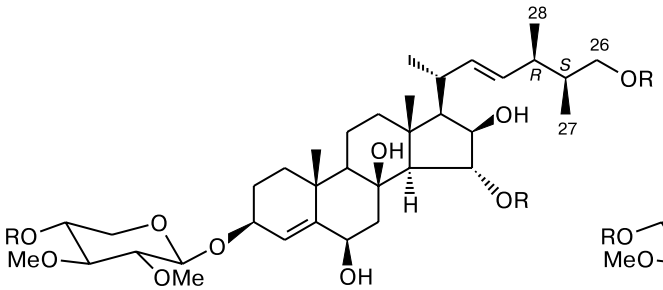
The determination of absolute configurations of chiral centers in natural compounds is of importance for understanding their biosynthesis and the structure—biological activity relationship. In continuation of our studies on steroid metabolites from Far-Eastern starfishes,[1,2] we determined the absolute configurations of the side chains of hexaol (**1**) and henriciosides H_1 (**2**), H_2 (**3**), and H_3 (**4**) isolated earlier from the starfish *Henricia derjugini*.[3] We used Mosher's method[4,5] based on NMR spectroscopic studies of esters of (*R*)- and (*S*)-α-methoxy-α-(trifluoromethyl)phenylacetic acid (MTPA, Mosher's reagent), which involves analysis of the changes in the chemical shifts of the protons at the chiral center and adjacent positions. The assignment of the signals for the



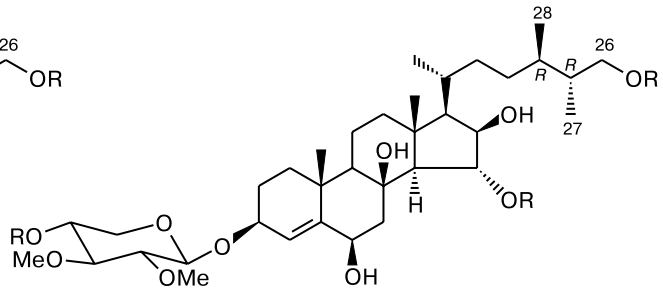
1, 5, 6



2, 7a,b



3, 8a,b



4, 9a,b

R = R′ = H (**1—4**), R = (*R*)-$CF_3PhC^*(OMe)CO$, R′ = H (**5**), R = R′ = (*S*)-$CF_3PhC^*(OMe)CO$ (**6**), R = (*R*)-$CF_3PhC^*(OMe)CO$ (**7a, 8a, 9a**), (*S*)-$CF_3PhC^*(OMe)CO$ (**7b, 8b, 9b**)

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protons in the ^{1}H NMR spectra of MTPA esters **5**—**9** was made based on ^{1}H—^{1}H COSY experiments.

Earlier,[3] we have elucidated the structures of steroids from the Far-Eastern starfish *Henricia derjugini* and found that compounds **1** and **2** contain a side chain bearing the 24-hydroxy group. The (*R*) configuration of the chiral centers C(20) of these compounds is evident from the chemical shifts of the doublets for the methyl protons $H_3C(21)$ at δ 0.94, because the spectra of (20*S*)-steroids contain signals for the protons $H_3C(21)$ at higher field (δ 0.83) compared to (20*R*)-steroids (δ 0.90—0.96).[6] According to the published data,[5] the ^{1}H NMR spectra of *R*-MTPA esters of 24-hydroxysteroids having the (24*S*) configuration contain doublets of the 26- and 27-methyl groups at higher field compared to the corresponding signals in the spectra of the related *S*-MTPA esters with the same configuration. For the (24*R*) isomers, the situation is reverse. For example, the spectrum of *R*-MTPA ester of amurensoside A from *Asterias amurensis* having the (24*S*) configuration contains the signals for the protons $H_3C(26)$ and $H_3C(27)$ at δ 0.84 (d, 3 H, J = 6.5 Hz) and 0.86 (d, 3 H, J = 6.5 Hz), whereas the corresponding signals in the spectrum of *S*-MTPA ester are observed at δ 0.89 (d, 3 H, J = 6.5 Hz) and 0.91 (d, 3 H, J = 6.5 Hz).[7]

Analysis of the ^{1}H NMR spectra of esters **5** and **7a** demonstrated that the signals for the protons $H_3C(26)$ and $H_3C(27)$ appear at δ 0.83 (d, 3 H, J = 7.0 Hz) and 0.85 (d, 3 H, J = 7.0 Hz) for ester **5** and at δ 0.80 (d, 3 H, J = 7.0 Hz) and 0.82 (d, 3 H, J = 7.0 Hz) for ester **7**. In the spectra of *S*-MTPA esters of these steroids, the signals for the protons $H_3C(26)$ and $H_3C(27)$ are observed at δ 0.93 (d, 6 H, J = 7.0 Hz) for the hexaol derivative (**6**) and at δ 0.89 (d, 3 H, J = 7.0 Hz) and 0.92 (d, 3 H, J = 7.0 Hz) for the henricioside H_1 derivative (**7b**). This suggests that the side chains in compounds **1** and **2** possess the (24*S*) configuration, and hence henricioside H_1 (**2**) is identical to laevisculoside I from the starfish *Henricia laeviuscula*.[8]

Earlier,[3] we have found that henriciosides H_2 (**3**) and H_3 (**4**) contain the Δ^{22}-24-methyl-26-hydroxycholestane and 24-methyl-26-hydroxycholestane side chains, respectively. The chiral centers C(20) in these compounds have the (20*R*) configuration, as evidenced by the chemical shifts of the protons $H_3C(21)$ at δ 1.02 for compound **3** (according to the published data[6] for (20*R*)-Δ^{22}-steroids, the signal for the protons $H_3C(21)$ appears at δ 1.04) and at δ 0.93 for compound **4**. In addition, the side chains of these glycosides contain two more chiral centers, *viz.*, C(24) and C(25). Hence, four pairs of stereoisomers are possible for these compounds, *viz.*, two *threo* isomers (24*R*,25*S* and 24*S*,25*R*) and two *erythro* isomers (24*S*,25*S* and 24*R*,25*R*). The general procedure for determining the absolute configurations in such side chains of steroids involves the following steps. First, the relative configurations of the substituents (*erythro* or *threo*) are established by comparing the ^{13}C NMR spectra of steroids with the spectra of model compounds[5] and then the configuration of C(25) and, as a consequence, of C(24), are determined from analysis of the ^{1}H NMR spectra of *R*- and *S*-MTPA esters. The published data (Table 1) show that the signals for two equivalent protons at C(26) are located closer to each other in the spectra of *R*-MTPA derivatives of (25*S*) isomers than those in the spectra of the corresponding (25*R*) isomers. The reverse situation is observed in the spectra of *S*-MTPA esters of the (24*R*) isomers.

In the ^{13}C NMR spectrum of henricioside H_2 (**3**), the signals for the C(27) and C(28) atoms are observed at δ 14.5 and 17.7, respectively, which suggests the *threo* configuration of the methyl groups (see Table 1). Analysis of the ^{1}H NMR spectra of *R*- and *S*-MTPA esters of glycoside **3** demonstrated that the difference in the chemical shifts of H(26) and H´(26) for *R*-MTPA ester (**8a**) (Δδ 0.13) is smaller than that for *S*-MTPA ester (**8b**) (Δδ 0.35), which suggests the (*S*) configuration of the C(25) chiral center. Consequently, the C(24) center in compound **3** has the (*R*) configuration.

The stereochemistry of the side chain of henricioside H_3 (**4**) was determined analogously. The ^{13}C NMR spectrum of **4** has signals for C(27) and C(28) at δ 17.5 and 14.0, respectively, which is indicative of the *erythro* configuration of the side chain (see Table 1). In the ^{1}H NMR spectrum of *S*-MTPA ester (**9b**), the signals for the protons at C(26) are located closer to each other (Δδ 0.02 ppm) that the corresponding signals in the spectrum of *R*-MTPA ester (**9a**) (Δδ 0.24 ppm), which is evidence for the (*R*) configuration of C(25) and, as a consequence, the (*R*) configuration of C(24). It should be noted that steroids containing the 24-methyl-26-hydroxycholestane chain with the (24*R*,25*R*) configuration are described for the first time.

Experimental

The ^{1}H and ^{1}H—^{1}H COSY NMR spectra were recorded on a Bruker DPX 300 spectrometer at 300.13 MHz with $SiMe_4$ as the internal standard. Optical rotation was measured on a Perkin—Elmer 141 polarimeter.

Column chromatography was carried out using silica gel L (40/100 μm, Chemapol, Czech Republic). Fractions of MTPA esters were analyzed by TLC using a 9 : 5 toluene—ethanol system on Sorbfil plates (4.5×6.0 cm) with a fixed silica gel layer (5—17 μm); visualization was carried out by spraying with H_2SO_4 followed by heating to 100 °C.

Hexaol (**1**) and henriciosides H_1 (**2**), H_2 (**3**), and H_3 (**4**) were isolated from the starfish *Henricia derjugini*.[3]

Synthesis of MTPA esters. (*R*)- or (*S*)-α-Methoxy-α-(trifluoromethyl)phenylacetyl chlorides (Aldrich) (54 μmol) were added to solutions of compounds **1**—**4** (3.2, 2.4, 2.4, and 2.3 μmol, respectively) in dry pyridine (200 μL). The reaction mixture was kept at room temperature for 2 h and then concen-

Table 1. Selected NMR spectroscopic data for the side chains of known synthetic 24-methyl-26-hydroxysteroids, echinasteroside A, and henriciosides H_2 (**3**) and H_3 (**4**) (CD_3OD; δ)

Configuration	δ_C			δ_H			
	C(24)	C(27)*	C(28)*	$H_3C(27)$	$H_3C(28)$	$H_2C(26)$ (dd)	
				(d)		*R*-MTPA esters	*S*-MTPA esters
Steroids with Δ^{22}-24-methyl-26-hydroxycholestane side chain**							
(24*R*,25*S*) *threo*	39.7	13.8	17.1	0.90	0.95	4.19, 4.31	—
(24*S*,25*R*) *threo*	39.5	13.8	16.8	0.90	0.97	4.13, 4.38	—
(24*S*,25*S*) *erythro*	39.2	13.6	19.0	0.87	1.02	4.21***	—
(24*R*,25*R*) *erythro*	39.3	13.6	19.2	0.88	1.02	4.16, 4.21	—
Echinasteroside A**							
24*R*,25*S*	40.4	14.5	17.5	0.91	0.97	4.17, 4.33	4.06, 4.46
Henricioside H_2 (**3**)							
24*R*,25*S*	40.6	14.5	17.7	0.87	0.96	4.12, 4.25	4.03, 4.38
Steroids with saturated 24-methyl-26-hydroxycholestane side chain**							
(24*R*,25*S*) *threo*	35.1	12.0	14.8	0.83	0.81	4.23***	—
(24*S*,25*R*) *threo*	35.1	11.6	15.1	0.81	0.81	4.14, 4.34	—
(24*S*,25*S*) *erythro*	36.8	14.4	17.5	0.93	0.92	4.22, 4.32	—
(24*R*,25*R*) *erythro*	36.1	14.1	17.4	0.91	0.91	4.16, 4.38	—
Henricioside H_3 (**4**)							
24*R*,25*R*	36.1	14.0	17.5	0.88	0.89	4.13, 4.37	4.21, 4.23

* Assignment may be interchanged.
** Published data.[5]
*** A broadened doublet.

trated *in vacuo*. The resulting *R*- and *S*-MTPA esters were purified on a column with silica gel (1×2 cm) using chloroform and then a 10 : 1 chloroform—ethanol mixture as eluents.

(24*S*)-5α-Cholestane-3β,4β,6β,8,15β,24-hexaol 3,24-di[*R*-(methoxy)(trifluoromethyl)phenylacetate] (5), amorphous powder; $[\alpha]_D$ +35.0 (*c* 0.3, MeOH), R_f 0.93. ^{1}H NMR (CD_3OD), δ: 0.83 (d, 3 H, Me(26)C, *J* = 7.0 Hz); 0.85 (d, 3 H, Me(27)C, *J* = 7.0 Hz); 0.94 (d, 3 H, Me(21)C, *J* = 6.5 Hz); 1.03 (d, 1 H, H(14), *J* = 5.4 Hz); 1.27 (s, 3 H, Me(18)C); 1.35 (m, 1 H, H(16′)); 1.38 (m, 1 H, H(5)); 1.47 (s, 3 H, Me(19)C); 1.50 (m, 1 H, H(23)); 1.68 (dd, 1 H, H_{ax}(7), *J* = 3.0 and 14.1 Hz); 1.74 (m, 1 H, H(23′)); 1.83 (m, 1 H, H_{ax}(2)); 1.90 (m, 1 H, H(25)); 2.16 (m, 1 H, H_{eq}(2)); 2.25 (m, 1 H, H(16)); 2.40 (dd, 1 H, H_{eq}(7), *J* = 2.7 and 14.4 Hz); 4.25 (m, 1 H, H(6)); 4.29 (m, 1 H, H(4)); 4.40 (ddd, 1 H, H(15), *J* = 1.8, 5.4, and 7.2 Hz); 4.90 (m, 1 H, H(24)); 4.95 (m, 1 H, H(3)).

(24*S*)-5α-Cholestane-3β,4β,6β,8,15β,24-hexaol 3,15,24-tri[*S*-(methoxy)(trifluoromethyl)phenylacetate] (6), amorphous powder; $[\alpha]_D$ −58.3 (*c* 0.23, MeOH), R_f 0.96. ^{1}H NMR (CD_3OD), δ: 0.89 (d, 3 H, Me(21)C, *J* = 6.4 Hz); 0.93 (two d, 3 H each, Me(26)C and Me(27)C, *J* = 6.7 Hz); 1.10 (s, 3 H, Me(18)C); 1.25 (m, 1 H, H(16′)); 1.28 (m, 1 H, H(14)); 1.29 (m, 1 H, H(5)); 1.37 (s, 3 H, Me(19)C); 1.63 (dd, 1 H, H_{ax}(7), *J* = 3.0 and 14.4 Hz); 1.92 (dd, 1 H, H_{eq}(7), *J* = 2.4 and 14.1 Hz); 1.96 (m, 1 H, H(25)); 2.37 (m, 1 H, H(16)); 4.10 (m, 1 H, H(6)); 4.36 (m, 1 H, H(4)); 4.91 (m, 2 H, H(3), H(24)); 5.42 (ddd, 1 H, H(15), *J* = 1.8, 6.1, and 7.9 Hz).

(24*S*)-3-*O*-(2,4-Di-*O*-methyl-β-D-xylopyranosyl)-5α-cholestane-3β,4β,6β,8,15α,24-hexaol 3′,15,24-tri[*R*-(methoxy)(trifluoromethyl)phenylacetate] (7a), amorphous powder; $[\alpha]_D$ +39.7 (*c* 0.3, MeOH), R_f 0.97. ^{1}H NMR (CD_3OD), δ: 0.80 (d, 3 H, Me(26)C, *J* = 7.0 Hz); 0.82 (d, 3 H, Me(27)C, *J* = 7.0 Hz); 0.93 (d, 3 H, Me(21)C, *J* = 5.8 Hz); 0.97 (m, 1 H, H_{ax}(7)); 0.99 (s, 3 H, Me(18)C); 1.02 (m, 1 H, H(5)); 1.36 (m, 1 H, H_{eq}(7)); 1.37 (s, 3 H, Me(19)C); 1.45 (d, 1 H, H(14), *J* = 9.9 Hz); 1.67 (both m, 1 H each, H_{ax}(2), H(16′)); 1.87 (m, 1 H, H(25)); 1.92 (m, 1 H, H_{eq}(2)); 2.06 (m, 1 H, H(16)); 2.98 (dd, 1 H, H(2′), *J* = 7.7 and 9.8 Hz); 3.27 (t, 1 H, H(5′), *J* = 10.0 Hz); 3.43 (m, 1 H, H(4′)); 3.53 (both s, 3 H each, OMe); 3.59 (m, 1 H, H(3)); 3.78 (m, 1 H, H(6)); 4.14 (m, 1 H, H(4)); 4.15 (dd, 1 H, H(5′), *J* = 5.0 and 11.2 Hz); 4.54 (d, 1 H, H(1′), *J* = 7.7 Hz); 4.90 (m, 1 H, H(24)); 5.15 (t, 1 H, H(3′), *J* = 9.5 Hz); 5.26 (td, 1 H, H(15), *J* = 2.8, 6.7, and 9.5 Hz).

(24*S*)-3-*O*-(2,4-Di-*O*-methyl-β-D-xylopyranosyl)-5α-cholestane-3β,4β,6β,8,15α,24-hexaol 3′,15,24-tri[*S*-(methoxy)(trifluoromethyl)phenylacetate] (7b), amorphous powder; $[\alpha]_D$ −51.4 (*c* 0.5, MeOH), R_f 0.96. ^{1}H NMR (CD_3OD), δ: 0.85 (d, 3 H, Me(21)C, *J* = 6.4 Hz); 0.89 (d, 3 H, Me(26)C, *J* = 7.0 Hz); 0.92 (d, 3 H, Me(27)C, *J* = 7.0 Hz); 0.97 (s, 3 H, Me(18)C); 1.16 (m, 1 H, H(5)); 1.32 (m, 1 H, H_{ax}(7)); 1.42 (s, 3 H, Me(19)C); 1.44 (d, 1 H, H(14), *J* = 10.0 Hz); 1.55 (m, 1 H, H(16′)); 1.70 (m, 1 H, H_{ax}(2)); 1.82 (dd, 1 H, H_{eq}(7), *J* = 3.0 and 14.0 Hz); 1.92 (m, 1 H, H(25)); 1.97 (m, 1 H, H_{eq}(2)); 2.08 (dd, 1 H, H(16), *J* = 8.4 and 14.5 Hz); 3.15 (dd, 1 H, H(2′), *J* = 7.4 and 9.5 Hz); 3.26 (both m, 1 H each, H(4′), H(5′)); 3.53 (both s, 3 H each, OMe); 3.64 (m, 1 H, H(3)); 4.08 (m, 1 H, H(6)); 4.09 (m, 1 H, H(5′)); 4.23 (m, 1 H, H(4)); 4.60 (d, 1 H, H(1′), *J* = 7.4 Hz); 4.89 (m, 1 H, H(24)); 5.15 (t, 1 H, H(3′); *J* = 9.5 Hz); 5.34 (td, 1 H, H(15), *J* = 2.8, 6.6, and 9.5 Hz).

(22*E*,24*R*,25*S*)-3-*O*-(2,3-Di-*O*-methyl-β-D-xylopyranosyl)-24-methyl-5α-cholestane-4,22-diene-3β,6β,8,15α,16β,26-hexaol 4′,15,26-tri[*R*-(methoxy)(trifluoromethyl)phenylacetate] (8a), amorphous powder; $[\alpha]_D$ +28.3 (*c* 0.3, MeOH), R_f 0.96. ^{1}H NMR (CD_3OD), δ: 0.87 (d, 3 H, Me(27)C, *J* = 6.8 Hz); 0.87

(m, 1 H, H_{ax}(7)); 0.91 (d, 3 H, Me(28)C, J = 6.8 Hz); 1.00 (d, 3 H, Me(21)C, J = 6.5 Hz); 1.23 (s, 3 H, Me(18)C); 1.31 (m, 1 H, H(14)); 1.32 (s, 3 H, Me(19)C); 1.43 (dd, 1 H, H_{eq}(7), J = 2.8 and 14.8 Hz); 1.70 (m, 1 H, H(25)); 1.75 (m, 1 H, H_{ax}(2)); 1.96 (m, 1 H, H_{eq}(2)),; 1.98 (dd, 1 H, H(24), J = 7.1 and 14.2 Hz); 2.58 (m, 1 H, H(20)); 3.03 (dd, 1 H, H(2´), J = 7.5 and 9.0 Hz); 3.22 (dd, 1 H, H(5´), J = 9.9 and 11.4 Hz); 3.36 (t, 1 H, H(3´), J = 9.0 Hz); 3.55 (two s, 3 H each, OMe); 3.83 (t, 1 H, H(6), J = 3.0 Hz); 3.97 (dd, 1 H, H(5˝), J = 6.1 and 11.8 Hz); 3.98 (dd, 1 H, H(16), J = 2.2 and 8.3 Hz); 4.12 (dd, 1 H, H(26), J = 6.5 and 10.7 Hz); 4.14 (m, 1 H, H(3)); 4.25 (dd, 1 H, H´(26), J = 5.0 and 10.7 Hz); 4.47 (d, 1 H, H(1´), J = 7.4 Hz); 4.93 (m, 1 H, H(4´)); 5.23 (dd, 1 H, H(15), J = 1.8 and 10.5 Hz); 5.32 (dd, 1 H, H(23), J = 7.0 and 15.0 Hz); 5.35 (dd, 1 H, H(22), J = 7.0 and 15.0 Hz); 5.49 (br.s, 1 H, H(4)).

(22*E*,24*R*,25*S*)-3-*O*-(2,3-Di-*O*-methyl-β-D-xylopyranosyl)-24-methyl-5α-cholestane-4,22-diene-3β,6β,8,15α,16β,26-hexaol 4´,15,26-tri[*S*-(methoxy)(trifluoromethyl)phenylacetate] (8b), amorphous powder; $[\alpha]_D$ −91.4 (*c* 0.7, MeOH), R_f 0.96. ^{1}H NMR (CD_3OD), δ: 0.86 (d, 3 H, Me(27)C, J = 6.8 Hz); 0.93 (d, 3 H, Me(28)C, J = 6.8 Hz); 1.01 (d, 3 H, Me(21)C, J = 6.5 Hz); 1.19 (m, 1 H, H_{ax}(7)); 1.25 (s, 3 H, Me(18)C); 1.31 (m, 1 H, H(14)); 1.35 (s, 3 H, Me(19)C); 1.70 (m, 1 H, H(25)); 1.75 (m, 1 H, H_{ax}(2)); 1.89 (dd, 1 H, H_{eq}(7), J = 3.4 and 14.8 Hz); 1.97 (m, 1 H, H_{eq}(2)); 2.02 (dd, 1 H, H(24), J = 7.4 and 14.8 Hz); 2.58 (m, 1 H, H(20)); 2.98 (dd, 1 H, H(2´), J = 7.3 and 8.9 Hz); 3.23 (m, 1 H, H(3´)); 3.37 (m, 1 H, H(5´)); 3.55 (two s, 3 H each, OMe); 3.89 (dd, 1 H, H(16), J = 1.8 and 7.1 Hz); 4.03 (both m, 1 H each, H(5´´), H(26)); 4.10 (t, 1 H, H(6), J = 3.1 Hz); 4.18 (m, 1 H, H(3)); 4.38 (m, 1 H, H´(26)); 4.50 (d, 1 H, H(1´), J = 7.4 Hz); 4.93 (m, 1 H, H(4´)); 5.24 (dd, 1 H, H(15), J = 1.9 and 10.7 Hz); 5.36 (dd, 1 H, H(23), J = 7.6 and 15.1 Hz); 5.40 (dd, 1 H, H(22), J = 7.1 and 15.1 Hz); 5.58 (br.s, 1 H, H(4)).

(24*R*,25*R*)-3-*O*-(2,3-Di-*O*-methyl-β-D-xylopyranosyl)-24-methyl-5α-cholestane-3β,6β,8,15α,16β,26-hexaol 4´,15,26-tri[*R*-(methoxy)(trifluoromethyl)phenylacetate] (9a), amorphous powder; $[\alpha]_D$ +51.4 (*c* 1.4, MeOH), R_f 0.96. ^{1}H NMR (CD_3OD), δ: 0.85 (m, 1 H, H_{ax}(7)); 0.87 (d, 3 H, Me(27)C, J = 6.9 Hz); 0.88 (d, 3 H, Me(28)C, J = 6.9 Hz); 0.91 (d, 3 H, Me(21)C, J = 6.6 Hz); 1.19 (s, 3 H, Me(18)C); 1.28 (m, 1 H, H(14)); 1.31 (s, 3 H, Me(19)C); 1.43 (m, 1 H, H_{eq}(7)); 1.70 (m, 1 H, H_{ax}(2)); 1.77 (m, 1 H, H(25)); 1.92 (m, 1 H, H_{eq}(2)); 3.03 (dd, 1 H, H(2´), J = 7.3 and 9.0 Hz); 3.22 (dd, 1 H, H(5´), J = 10.1 and 11.2 Hz); 3.35 (t, 1 H, H(3´), J = 9.2 Hz); 3.56 (both s, 3 H each, OMe); 3.82 (t, 1 H, H(6), J = 2.9 Hz); 3.97 (dd, 1 H, H(5˝), J = 5.5 and 11.5 Hz); 4.08 (dd, 1 H, H(16), J = 1.9 and 7.9 Hz); 4.13 (m, 1 H, H(3)); 4.13 (dd, 1 H, H(26), J = 4.5 and 11.5 Hz); 4.37 (m, 1 H, H´(26)); 4.48 (d, 1 H, H(1´), J = 7.4 Hz); 4.93 (m, 1 H, H(4´)); 5.26 (dd, 1 H, H(15), J = 1.6 and 10.9 Hz); 5.49 (br.s, 1 H, H(4)).

(24*R*,25*R*)-3-*O*-(2,3-Di-*O*-methyl-β-D-xylopyranosyl)-24-methyl-5α-cholestane-3β,6β,8,15α,16β,26-hexaol 4´,15,26-tri[*S*-(methoxy)(trifluoromethyl)phenylacetate] (9b), amorphous powder; $[\alpha]_D$ −43.5 (*c* 0.8, MeOH), R_f 0.96. ^{1}H NMR (CD_3OD), δ: 0.86 (d, 3 H, Me(28)C, J = 7.0 Hz); 0.89 (d, 3 H, Me(27)C, J = 7.0 Hz); 0.90 (d, 3 H, Me(21)C, J = 6.6 Hz); 1.17 (m, 1 H, H_{ax}(7)); 1.20 (s, 3 H, Me(18)C); 1.29 (m, 1 H, H(14)); 1.34 (s, 3 H, Me(19)C); 1.73 (m, 1 H, H_{ax}(2)); 1.77 (m, 1 H, H(25)); 1.88 (m, 1 H, H_{eq}(7)); 1.96 (m, 1 H, H_{eq}(2)); 2.99 (dd, 1 H, H(2´), J = 7.3 and 9.0 Hz); 3.25 (t, 1 H, H(3´), J = 8.9 Hz); 3.38 (dd, 1 H, H(5´), J = 10.4 and 11.5 Hz); 3.55 (two s, 3 H each, OMe); 3.95 (dd, 1 H, H(16), J = 1.7 and 7.3 Hz); 4.02 (dd, 1 H, H(5˝), J = 5.5 and 11.4 Hz); 4.08 (t, 1 H, H(6), J = 2.7 Hz); 4.19 (m, 1 H, H(3)); 4.21 (m, 1 H, H(26)); 4.23 (m, 1 H, H´(26)); 4.50 (d, 1 H, H(1´), J = 7.4 Hz); 4.93 (m, 1 H, H(4´)); 5.26 (dd, 1 H, H(15), J = 1.4 and 10.6 Hz); 5.59 (br.s, 1 H, H(4)).

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