Terpenoids from the Medicinal Plant *Maytenus ilicifolia*

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Four new terpenoids (**1**−**4**) were isolated from the root bark of *Maytenus ilicifolia*. Their structures were determined by spectroscopic studies, and complete ^{1}H and ^{13}C NMR assignments were achieved by 2D NMR spectroscopy. We also report an efficient method for the separation of quinonemethide triterpenes based on centrifugal partition chromatography.

In the search for biologically active compounds in South American medicinal plants,[1] we studied the constituents of the roots of *Maytenus ilicifolia* Mart. ex Reissek (Celastraceae). *M. ilicifolia* is a medicinal plant popularly known as "espinheira-santa" or "cangorosa" and found in the southern region of Brazil, Paraguay, Uruguay, and Argentina.[2] This plant is traditionally used for its analgesic, antiulcerogenic, antiseptic, and anticancer properties. In Paraguay, the plant is also used as a fertility-regulating agent.[3] Previous studies of this species have led to the isolation of several triterpenoids,[4] alkaloids,[5] and glucosides.[6] In this paper we describe the isolation and structural elucidation of four new terpenoids, milicifolines A−D (**1**−**4**) (Figure 1). The roots of *M. ilicifolia* (1.0 kg) were extracted with *n*-hexane/Et_2O (1:1) in a Soxhlet apparatus to yield a dark red residue (25 g). This extract was repeatedly chromatographed on Sephadex LH-20 and Si gel to afford **1**−**4**, together with eight known terpenoids, tingenone,[7] pristimerin,[8] netzahuolcoyene,[9] 7,8-dihydroxuxuarine Eα,[4b] 6-oxopristimerol,[10] cheilocline C,[11] β-sitosterol,[12] and 7,8-dihydroscutidin αB.[13]

Compound **1** was isolated as a brown, amorphous solid (9.5 mg). Its IR spectrum showed absorption bands for hydroxy (3371 cm^{-1}) and carbonyl groups (1700, 1638 cm^{-1}). Its ^{1}H NMR spectrum displayed resonances for a methoxy group (δ 3.96) and six methyl groups, which included four angular methyls (δ 1.55, 1.36, 1.00, 0.98), one methyl doublet at δ 0.99 (J = 6.7 Hz), and one methyl on an aromatic ring at δ 2.68. The latter must be coplanar with a carbonyl moiety because of its chemical shift.[14] In the low-field region, an AMX spin system [δ 7.71 dd (J = 1.9, 8.3 Hz); 7.59 d (J = 1.9 Hz), 6.97 d (J = 8.3 Hz)] attributable to a 1,3,4-trisubstituted aryl group appeared together with two singlets at δ 6.93 and 6.28. These data, together with the ^{13}C NMR, HMBC, and ROESY spectra, indicated that **1** was a phenolic triterpene related to the previously reported 6-oxotingenol[15] with a 3,4-disubstituted aromatic ester at C-2 or C-3. The substitution and location of the benzoate moiety were determined on the basis of HMBC and ROESY correlations depicted in Figure 2. The HMBC correlations established the position of the OMe group at C-4′, while the NOE effect between Me-23 and the methoxy group established the location of the ester moiety at C-3. This conclusion agrees with the fact that phenolic triterpenes with an acyl group at C-2 have never been isolated. The above-mentioned data allowed us to establish the structure of **1** as 3-(3′-methoxy-4′-hydroxybenzoyl-oxy)-6-oxotingenol. Compound **1** represents the first example of a 6-oxophenolic triterpene with a vanillate group.

Compound **2** was isolated as an amorphous, white solid with the molecular formula $C_{43}H_{58}O_3$. The ^{1}H NMR, ^{13}C NMR, and

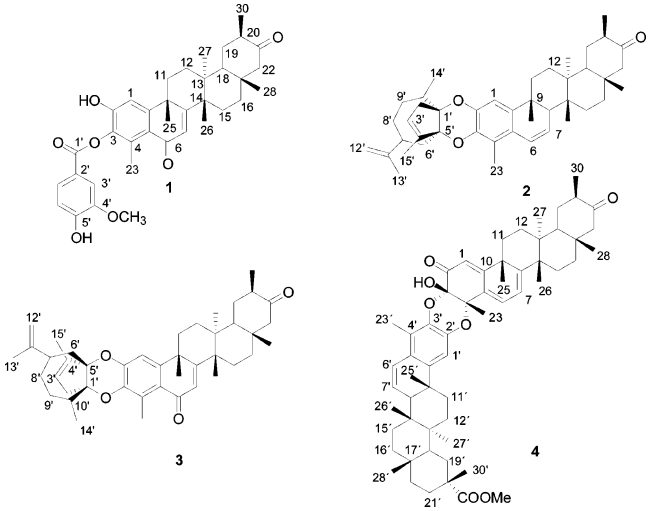

Figure 1. Structures of milicifolines A−D (**1**−**4**).

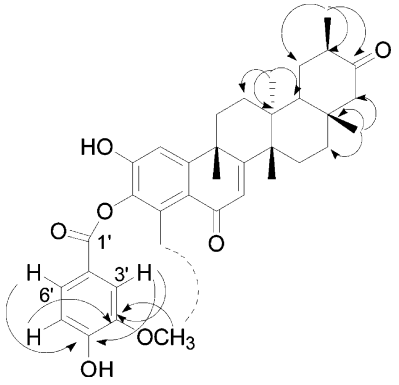

Figure 2. Selected HMBC (—) and ROESY (---) correlations for compound **1**.

DEPT spectra revealed that **2** was a sesquiterpene-triterpene adduct related to the cheiloclines A−I recently published by us.[11] We have proposed that this type of adduct is formed by a hetero-Diels−Alder reaction between the *o*-quinonoid form of the triterpenoid unit and the tetrasubstituted double bond of the sesquiterpene.[11] The ^{1}H NMR spectrum of **2** showed two double doublets at δ 6.67 (J = 3.0, 9.9 Hz) and 5.92 (J = 2.9, 9.9 Hz), a singlet at δ 6.65, a methyl doublet at δ 1.06 (J = 6,8 Hz), and resonances for five angular methyls (δ 2,18, 1.33, 1.11, 1.01, 0.99). These resonances are characteristic of H-6, H-7, H-1 and the corresponding methyls, Me-30, Me-23, Me-25, Me-26, Me-28, and Me-27, in a triterpene skeleton of the type 9,11-dihydroisotingenona III.[4d] The ^{1}H NMR spectrum also showed the presence of one vinylic proton (δ 5.55,

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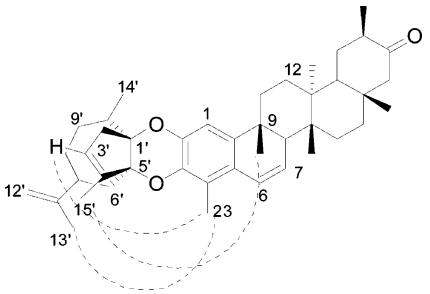

Figure 3. Selected ROESY correlations for compound **2**.

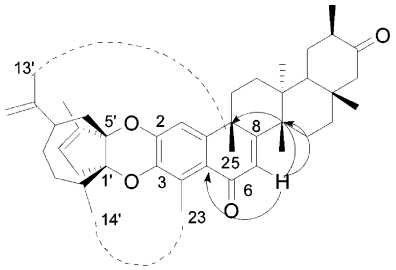

Figure 4. Selected HMBC (—) and ROESY (---) correlations for compound **3**.

1H, bs), two singlets at δ 4.67 and 4.65, a secondary methyl at δ 1.23 (J = 3.3 Hz), and two olefinic methyls at δ 1.71 (d, J = 1.6 Hz) and 1.75 (s). These resonances are attributable to H-3′, H-12′a, H-12′b, and the methyls, Me-14′, Me-15′, and Me-13′, present in the sesquiterpene unit derived from guaia-1(5),3(4),11(3)-triene.[11] The sequiterpene unit of **2** showed ^{13}C NMR spectroscopic data similar to those of cheilocline D.[11] The unequivocal assignment of all ^{13}C NMR resonances was done by analysis of the HSQC and HMBC correlations. The type of linkage between the units [2-O-5′][3-O-1′] and the β-disposition of the cyclopentene ring was established by the NOEs observed in the ROESY spectrum (Figure 3). Thus, the NOEs observed from Me-23 to H-3′ and Me-13′ and from Me-15′ to Me-25 were consistent with the assigned structure.

Compound **3** was isolated as an amorphous, yellow solid with negative specific rotation ($[\alpha]_D^{20}$ −58.6, *c* 0.2, $CHCl_3$) and molecular formula $C_{43}H_{56}O_4$. Its IR spectrum showed the existence of carbonyl groups (1707 and 1646 cm^{-1}), an aromatic nucleus (1589, 1474, and 1378 cm^{-1}), and a terminal methylene (888 cm^{-1}). Its ^{1}H NMR spectrum showed resonances similar to **2** for the protons assignable to the sesquiterpenoid unit, but not for the hydrogens corresponding to the triterpenoid unit. The main differences were the lack of the double doublets assignable to H-6 and H-7, the presence of a singlet at δ 6.26, and the downfield shift of Me-23. The ^{13}C NMR spectrum of **3** confirmed the existence of an additional carbonyl group at δ 187.5 and the presence of a trisubstituted vinylic moiety. The location of these functional groups at C-6, C-7, and C-8 was established by the correlations in the HMBC spectrum (Figure 4) and led to assigning a 6-oxotingenol-type structure for the triterpenoid moiety. The resonances attributable to the sesquiterpenoid unit were similar to those of cheilocline F.[11] The NOEs observed from Me-23 to Me-14′ and from Me-25 to Me-13′ are consistent with the α-disposition of the cyclopentene ring and with a substitution similar to that of cheilocline F[11] (Figure 4).

Compound **4** was isolated as a pale yellow solid. Its FABMS showed a molecular ion at *m*/*z* 884, and the molecular formula was determined to be $C_{58}H_{76}O_7$ on the basis of HRFABMS analysis and the ^{13}C NMR spectrum. Its IR spectrum showed bands for hydroxy (3407 cm^{-1}) and carbonyl groups (1711, 1673 cm^{-1}). A singlet at δ 6.71 assigned to an aromatic hydrogen (H-1′) and one conjugated double bond with the two vinylic protons as double doublets at δ 6.63 (J = 9.9, 2.8 Hz) and 5.90 (J = 9.9, 2.5 Hz), attributable to H-6′ and H-7′, respectively, were observed in the ^{1}H NMR spectrum. The spectrum also contains an ABC system of three vinylic protons at δ 6.35 (dd, J = 1.6, 6.4 Hz), 6.09 (d, J = 1.6 Hz), and 5.98 (d, J = 6.9 Hz) assignable to H-6, H-1, and H-7, characteristic of triterpenic quinoid systems. In addition, the spectrum showed resonances for nine angular methyls, one methyl doublet at δ 0.98 (J = 5,2 Hz), one methyl group on an aromatic ring at δ 2.05, and one methoxy singlet at δ 3.67. These data and the analysis of the ^{13}C NMR spectrum suggested that **4** was a triterpenoid dimer composed of pristimerin- and tingenone-type triterpenes, with one subunit in the quinoid form and the other in the aromatic form. Compound **4** showed ^{13}C NMR data for the aromatic unit similar to those of scutionin αA,7,8-dihydroscutionin βA, and netzascutionin αA,[15] suggesting that the unit derived from pristimerin was the aromatic unit, and thus, the quinoid unit is based on tingenone. This conclusion is in agreement with the NMR data described for xuxuarine and isoxuxuarine dimers, whose quinoid skeleton is of the tingenone type.[16,17] The structure proposed in Figure 1 was verified by analysis of the COSY, ROESY, HSQC, and HMBC spectra, which enabled the assignment of the resonances of the quinoid and aromatic triterpene units. A ROESY experiment showing correlations between H-6 and H-1′, and Me-23 and Me-25, confirmed that the linkages between the units were [3-O-3′] and [4-O-2′] with Me-23 and OH-3 β-oriented.

Since triterpenequinones and triterpenes derivatives isolated from *Maytenus* species tend to present high antitumoral activity,[18] we tested the new compounds against a panel of DNA damage checkpoint defective *Saccharomyces cerevisiae* mutants. Unfortunately, they did not exhibit cytotoxicity.

These results reinforce some previous conclusions on structure−antitumoral activity relationships for this type of compounds. Thus, the presence of bulky acyl groups at C-3, like in compound **1**, decreases the activity of phenolic triterpenoids.[18] In relation to the inactivity of adducts **2**−**4**, the size of the molecules seems to play an important role for the activity since the triterpene units are cytotoxic.[11,18]

Pristimerin and netzahualcoyene, similar triterpenequinones differing in the presence of a double bond, were also isolated. Since they have very close TLC profiles, these two compounds cannot be separated by standard chromatographic techniques. Starting with a mixture of these two compounds (ca. 600 mg), we achieved a very efficient separation employing centrifuge partition chromatography (CPC).[19]

Experimental Section

General Experimental Procedures. UV spectra were recorded in absolute EtOH on a JASCO V-560 spectrophotometer. IR spectra were obtained using a Bruker IFS28/55 spectrophotometer. Optical rotations were measured with a Perkin-Elmer 241 automatic polarimeter. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ at 300 and 75 MHz, respectively, with TMS as internal reference. The 2D NMR experiments were conducted on a Bruker WP-400 SY NMR spectrometer in $CDCl_3$ at 400 MHz. High- and low-resolution mass spectra were obtained on a VG Autospec spectrometer. Macherey-Nagel polygram Sil G/UV254 and preparative TLC Sil G-100UV254 were used for TLC. Silica gel (0.2−0.63 mm) and Sephadex LH-20 were used for column chromathography. TLC plates were visualized by spraying with H_2SO_4/H_2O/AcOH (1:4:20) and heating.

Plant Material. Dried roots of *M. ilicifolia* collected in Paraguay's Chaco region were purchased in Asunción, Paraguay, in 2004. A voucher specimen is on file (FCQ-González 65) at the Herbarium of the Departamento de Botánica, Facultad de Ciencias Químicas, Universidad Nacional de Asunción.

Extraction and Isolation. Roots of *M. ilicifolia* (1 kg) were extracted with *n*-hexane/Et_2O (1:1) (2 L) in a Soxhlet apparatus for 48 h. Evaporation of the solvent under reduced pressure provided 25 g of a dark extract. This residue was chromatographed on Sephadex LH-20 eluting with n-hexanes/$CHCl_3$/MeOH (2:1:1) to afford 30 fractions. Fractions with similar TLC profile were combined and reduced to 10 fractions (A−J). Each one was rechromatographed on a silica gel

column, using mixtures of *n*-hexane/EtOAc of increasing polarity as eluent. Some of the eluted products were separated by preparative TLC and by CPC to yield 7,8-dihydroscutidin αB[13] (6.5 mg), dihydroisoxuxuarine Eα6[4b] (22.7 mg), 6-oxopristimerol[10] (4.8 mg), tingenone[7] (22.0 mg), cheilocline D,[11] β-sitosterol[12] (110.0 mg), pristimerin[8] (695.9 mg), netzahualcoyene[9] (447.9 mg), milicifoline A (9.5 mg), milicifoline B, milicifoline C (3.6 mg), and milicifoline D (4.1 mg).

Yeast Growth Assays. Standard methods for yeast culture and manipulations were used.[20]

Separation of Pristimerin and Netzahuaolcoyene by CPC. Even after performing conventional chromatographic techniques such as column chromatography, flash chromatography, or preparative TLC, the separation of pristimerin and netzahualcoyene was not feasible. Thus Fast-CPC equipment) with a rotor of 200 mL capacity was employed (FCPC-Kromaton, Angers, France). The fraction containing a mixture of these two compounds (ca. 600 mg) was chromatographed using a solvent system composed of heptane/EtOAc/MeOH/H_2O (8:1:6:1), which was separated using a separating funnel, employing the water fraction as stationary phase and the organic fraction as mobile phase. After packing the column with stationary phase, the mobile phase was pumped through at 6 mL·min^{-1} with a rotor speed of 800 rpm and detection at 430 nm. When the mobile phase was starting to elute, gentle injection of the sample (200−300 mg in 5 mL of solvent mixture) was carried out. After eluting ca. 50−60 mL of mobile phase, the eluted sample was collected in tubes containing 8−10 mL volume. Tubes containing the mixture of these compounds were mixed up, resuspended, and submitted to another CPC run. Final separation of these quinones was achieved after two or three CPC runs.

Milicifoline A (1): brown, amorphous solid; $[\alpha]_D^{20}$ −23.6 (*c* 0.1, $CHCl_3$); UV (EtOH) λ_{max} (log ϵ) 259.0 (3.50) nm; IR ν_{max} (film) 3371, 2924, 2361, 1700, 1638, 1589, 1528, 1458, 1350, 1205, 1045, 803, 732, 672 cm^{-1}; ESI *m*/*z* (%) 586 ([M]$^+$, 15), 495 (23), 467 (25), 436 (38), 435 (100), 420 (6), 334 (5); EIMS *m*/*z* (%) 478 (20), 436 ([M + 1 − $C_8H_7O_3$]$^+$, 100), 421 (80), 322 (25), 151 (50); HREIMS *m*/*z* 436.2620 [M]$^+$, calcd for $C_{28}H_{36}O_4$ 436.2614; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.7 (1H, dd, *J* = 1.9, 8.3 Hz, H-7′), 7.6 (1H, d, *J* = 1.9 Hz, H-3′), 7.0 (1H, d, *J* = 8.3 Hz, H-6′), 6.9 (1H, s, H-1), 6.28 (1H, s, H-7), 4.0 (3H, s, OCH_3), 2.90 (1H, d, *J* = 14.5 Hz, H-22 a), 2.68 (3H, s, Me-23), 1.55 (3H, s, Me-25), 1.36 (3H, s, Me-26), 1.00 (3H, s, Me-28), 0.99 (3H, d, *J* = 6.7 Hz, Me-30), 0.98 (3H, s, Me-27); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 214.0 (C, C-21), 187.7 (C, C-6), 171.3 (C, C-8), 170.0 (C, C-1′), 151.7 (C, C-10), 150.8 (C, C-5′), 148.2 (C, C-2), 146.2 (C, C-4′), 140.7 (C, C-3), 125.9 (CH, C-7), 125.6 (C, C-4), 125.2 (CH, C-6′), 122.5 (C, C-5), 121.3 (C, C-2′), 114.2 (CH, C-7′), 112.2 (CH, C-3′), 108.8 (CH, C-1), 56.1 (CH_3, OCH_3), 52.6 (CH_2, C-22), 44.4 (C, C-14), 43.5 (CH, C-18), 41.9 (CH, C-20), 40.3 (C, C-9), 40.1 (C, C-13), 38.5 (CH_3, C-25), 38.2 (C, C-17), 35.5 (CH_2, C-16), 34.3 (CH_2, C-11), 32.6 (CH_3, C-28), 32.0 (CH_2, C-19), 30.2 (CH_2, C-12), 28.4 (CH_2, C-15), 20.7 (CH_3, C-26), 19.7 (CH_3, C-27), 15.1 (CH_3, C-30), 13.7 (CH_3, C-23).

Milicifoline B (2): amorphous, white solid; $[\alpha]_D^{20}$ −32.1 (*c* 0.67, $CHCl_3$); UV (EtOH) λ_{max} nm (log ϵ) 299.5 (3.96), 252.0 (4.19) nm; IR ν_{max} (film) 2927, 2854, 1708, 1645, 1599, 1456, 1379, 1316, 1260, 1183, 1060, 979, 923, 800, 756, 668 cm^{-1}; EM *m*/*z* (%) 622 ([M]$^+$, 34), 422 (23), 217 (8), 202 (100), 188 (52), 159 (89), 145 (59), 91 (23); HREIMS *m*/*z* 622.4441 [M]$^+$, calcd for $C_{43}H_{58}O_3$ 622.4385; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.67 (1H, dd, *J* = 3.0, 9.9 Hz, H-6), 6.55 (1H, s, H-1), 5.92 (1H, dd, *J* = 2.9, 9.9 Hz H-7), 5.55 (1H, bs, H-3′), 4.67 (1H, bs, H-12′ a), 4.65 (1H, sa, H-12′ b), 2.18 (3H, s, Me-23), 1.75 (3H, s, Me-13′), 1.71 (3H, d, *J* = 1.6 Hz, Me-15′), 1.33 (3H, s, Me-25), 1.23 (3H, d, *J* = 3.3 Hz, Me-14′), 1.11 (3H, s, Me-26), 1.06 (3H, d, *J* = 6.8 Hz, Me-30), 1.01 (3H, s, Me-28), 0.99 (3H, s, Me-27); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 214.3 (C, C-21), 151.2 (C, C-11′), 145.1 (C, C-2), 143.3 (C, C-10), 142.8 (C, C-3), 140.6 (C, C-4′), 128.3 (CH, C-7), 128.2 (CH, C-3′), 125.7 (C, C-5), 124.6 (CH, C-6), 122.5 (C, C-4), 109.0 (CH, C-1), 108.6 (CH_2, C-12′), 96.8 (C, C-5′), 92.9 (C, C-1′), 53.9 (CH_2, C-22), 44.9 (CH_2, C-8), 43.5 (CH_2, C-18), 43.6 (CH_2, C-7′), 42.2 (CH_2, C-10′), 40.1 (CH_2, C-20), 39.4 (C, C-9), 38.4 (CH_2, C-2′), 38.3 (C, C-13), 38.2 (CH_2, C-6′), 35.7 (CH_2, C-8′), 35.4 (C, C-17), 35.3 (CH_2, C-16), 32.8 (CH_3, C-25), 32.8 (C, C-14), 32.7 (CH_2, C-9′), 31.7 (CH_2, C-11), 31.0 (CH_2, C-19), 29.9 (CH_2, C-12), 27.5 (CH_2, C-15), 22.7 (CH_3, C-28), 19.9 (CH_3, C-13′), 19.0 (CH_3, C-14′), 18.6 (CH_3, C-26), 16.1 (CH_3, C-27), 15.1 (CH_3, C-30), 12.5 (CH_3, C-15′), 10.8 (CH_3, C-23).

Milicifoline C (3): pale yellow, amorphous solid; $[\alpha]_D^{20}$ −58.6 (*c* 0.2, $CHCl_3$); UV (EtOH) λ_{max} (log ϵ) 299.0 (3.96), 252.0 (4.19) nm; IR ν_{max} (film) 3404, 2929, 1707, 1646, 1589, 1474, 1378, 1307, 1216, 1070, 1041, 980, 924, 888, 755, 666 cm^{-1}; EIMS *m*/*z* (%) 637 ([M + 1]$^+$, 100), 636 ([M]$^+$, 100), 417 (11), 202 (20); 159 (28), 145 (31); HREIMS *m*/*z* 636.4168 [M]$^+$, calcd for $C_{43}H_{56}O_4$ 636.4179; ^{1}H NMR ($CDCl_3$, 300 MHz) δ 6.83 (1H, s, H-1), 6.26 (1H, s, H-7), 5.55 (1H, bs, H-3′), 4.70 (1H, bs, H-12′ a), 4.66 (1H, bs, H-12′ b), 2.92 (1H, d, *J* = 14.9 Hz, H-22), 2.59 (3H, s, Me-23), 1.74 (3H, s, Me-13′), 1.69 (3H, bs, Me-15′), 1.65 (3H, s, Me-25), 1.38 (3H, s, Me-26), 1.27 (3H, d, *J* = 6.5 Hz, Me-30), 1.21 (3H, d, *J* = 6.8 Hz, Me-14′), 1.01 (1H, s, Me-28, Me-27); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 213.7 (C, C-21), 187.5 (C, C-6), 170.2 (C, C-8), 151.7 (C, C-10), 150.9 (C, C-11′), 149.7 (C, C-2), 143.3 (C, C-3), 140.7 (C, C-4′), 128.1 (CH, C-3′), 126.2 (CH, C-7), 125.2 (C, C-4), 122.4 (C, C-5), 111.4 (CH, C-1), 108.8 (CH_2, C-12′), 96.8 (C, C-5′), 92.8 (C, C-1′), 52.6 (CH_2, C-22), 44.3 (C, C-14), 43.5 (CH_2, C-18), 43.3 (CH_2, C-7′), 41.9 (CH_2, C-20), 39.9 (C, C-13), 39.3 (C, C-9), 39.3 (CH, C-10′), 38.8 (CH_2, C-2′), 38.7 (CH_3, C-25), 38.4 (CH_2, C-6′), 38.2 (C, C-17), 35.6 (CH_2, C-16), 35.4 (CH_2, C-8′), 34.3 (CH_2, C-11), 33.0 (CH_2, C-9′), 32.6 (CH_3, C-28), 32.0 (CH_2, C-19), 30.2 (CH_2, C-12), 28.4 (CH_2, C-15), 20.8 (CH_3, C-26), 20.0 (CH_3, C-13′), 19.7 (CH_3, C-27), 19.1 (CH_3, C-14′), 15.1 (CH_3, C-30), 13.2 (CH_3, C-23), 12.4 (CH_3, C-15′).

Milicifoline D (4): $[\alpha]_D^{20}$ +424.9 (*c* 0.4, $CHCl_3$); UV (EtOH) λ_{max} (log ϵ) 379.0 (2.68), 276.0 (2.74), 258.5 (2.77) nm; IR ν_{max} (film) 3407, 2927, 2361, 2338, 1711, 1673, 1601, 1574, 1459, 1377, 1314, 1197, 1143, 1065, 755, 668 cm^{-1}; FABMS *m*/*z* (%) 885 ([M + 1]$^+$, 19), 884 ([M]$^+$, 19), 619 (16), 420 (16), 201 (100), 154 (51); HRFABMS *m*/*z* 884.5556 [M]$^+$, calcd for $C_{58}H_{76}O_7$ 884.5591; ^{1}H NMR ($CDCl_3$, 300 MHz) 6.71 (1H, bs, H-1′), 6.63 (1H, dd, *J* = 2.8, 9.9 Hz, H-6′), 6.35 (1H, d, *J* = 6,4 Hz, H-6), 6.09 (1H, s, H-1), 5.98 (1H, d, *J* = 6.9 Hz, H-7), 5.90 (1H, dd, *J* = 2.5 Hz, 9.9 Hz, H-7′), 3.67 (3H, s, OMe), 2.89 (1H, d, *J* = 14.3 Hz, H-22a'), 2.05 (3H, s, Me-23′), 1.55 (3H, s, Me-23), 1.48 (3H, s, Me-25), 1.26 (3H, s, Me-26), 1.21 (3H, s, Me-30′), 1.11 (3H, s, Me-28′), 1.06 (3H, s, Me-26), 0.99 (3H, s, Me-27), 0.98 (3H, s, Me-28), 0.98 (3H, d, *J* = 5.2 Hz, Me-30), 0.87 (3H, s, Me-27′); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 213.6 (C, C-21), 191.1 (C, C-2), 179.3 (C, C1′'), 173.4 (C, C-10), 159.5 (C, C-8), 143.8 (C, C-10′), 141.6 (C, C-2′), 137.6 (C, C-3′), 131.1 (C, C-5), 129.2 (CH, C-7′), 126.1 (CH, C-6), 125.0 (C, C-5′), 124.0 (CH, C-6′), 122.5 (C, C-4′); 116.4 (CH, C-7), 115.8 (CH, C-1), 108.1 (CH, C-1′), 91.9 (CH, C-3), 78.8 (C, C-4), 52.5 (CH_2, C-22), 51.5 (CH_3, OMe), 45.5 (CH_2, C-8′), 44.4 (C, C-18′), 44.1 (C, C-14), 43.8 (CH, C-18), 41.8 (CH, C-20), 41.3 (C, C-9), 40.6 (CH, C-20′), 39.5 (C, C-13), 39.0 (C, C-17), 38.2 (C, C-9′), 38.2 (C, C-14′), 37.5 (C, C-13′), 36.6 (CH_2, C-11′)*, 36.4 (C, C-12′)*; 35.8 (CH_2, C-22′), 35.6 (CH_3, C-25), 35.4 (CH_2, C-16′), 33.5 (CH_2, C-11), 32.5 (CH_3, C-28), 32.1 (CH_2, C-19), 31.8 (CH_3, C-28′), 31.8 (CH_3, C-30′), 30.4 (C, C-17′), 30.0 (CH_2, C-12), 29.8 (CH_2, C-19′), 29.8 (CH_2, C-21′), 29.7 (CH_2, C-16); 28.3 (CH_2, C-15), 28.3 (CH_2, C-15′), 22.3 (CH_3, C-26), 22.3 (CH_3, C-25′), 22.1 (CH_3, C-23), 20.0 (CH_3, C-30), 17.5 (CH_3, C-26′), 17.0 (CH_3, C-27′), 15.0 (CH_3, C-27), 10.8 (CH_3, C-23′). *, interchangeable positions.

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