Bioorganic & Medicinal Chemistry Letters 20 (2010) 4451–4455

Contents lists available at ScienceDirect

Bioorganic & Medicinal Chemistry Letters

journal homepage: www.elsevier.com/locate/bmcl

# Petiolins J–M, prenylated acylphloroglucinols from *Hypericum pseudopetiolatum* var. *kiusianum*

Naonobu Tanaka [a], Mio Otani [a], Yoshiki Kashiwada [b], Yoshihisa Takaishi [b], Azusa Shibazaki [c], Tohru Gonoi [c], Motoo Shiro [d], Jun'ichi Kobayashi [a,*]

[a] *Graduate School of Pharmaceutical Sciences, Hokkaido University, Sapporo 060-0812, Japan*
[b] *Graduate School of Pharmaceutical Sciences, University of Tokushima, Tokushima 770-8505, Japan*
[c] *Medical Mycology Research Center, Chiba University, Chiba 260-0856, Japan*
[d] *Rigaku Corporation, Akishima 196-8666, Japan*

ARTICLE INFO

*Article history:*
Received 7 May 2010
Revised 7 June 2010
Accepted 8 June 2010
Available online 12 June 2010

*Keywords:*
*Hypericum pseudopetiolatum* var. *kiusianum*
Prenylated acylphloroglucinols
Petiolins J–M

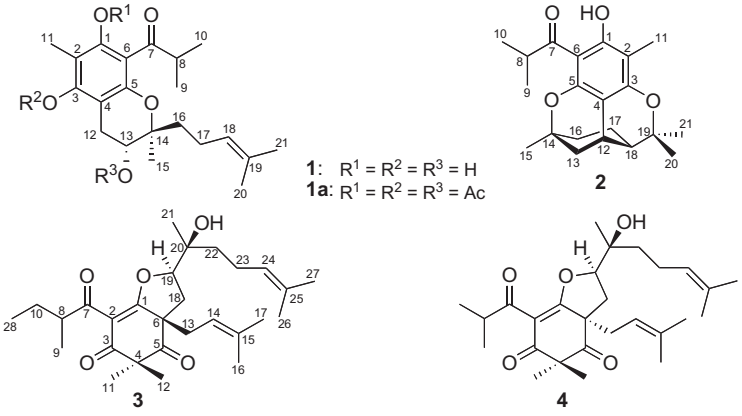
ABSTRACT

Four new prenylated acylphloroglucinols, petiolins J–M (**1**–**4**), were isolated from aerial parts of *Hypericum pseudopetiolatum* var. *kiusianum*, and the structures were elucidated by spectroscopic data and a single-crystal X-ray diffraction analysis. Petiolin J (**1**) exhibited antimicrobial activity.



The genus *Hypericum* (family Clusiaceae) are known to be a traditional medicine for the treatment of burns, bruises, swelling, inflammation, and anxiety as well as bacterial and viral infections.[1] During our search for structurally interesting compounds from *Hypericum* spp., we isolated prenylated acylphloroglucinols, petiolins A–D, chromone glucoside, petiolin E, and benzophenone rhamnosides, petiolins F–I.[2] Further investigation of the aerial parts of *H. pseudopetiolatum* var. *kiusianum* resulted in the isolation of four new prenylated acylphloroglucinols, petiolins J–M (**1**–**4**). In this Letter, we describe the isolation and structure elucidation of **1**–**4**.

The aerial parts of *H. pseudopetiolatum* var. *kiusianum* (360 g) were extracted with MeOH, and the extracts were partitioned between *n*-hexane and $H_2O$. *n*-Hexane-soluble portions were subjected to a silica gel column (*n*-hexane/EtOAc), a Sephadex LH-20 column (EtOH), a $C_{18}$ column (MeOH/$H_2O$) chromatographies, and then purified by $C_{18}$ HPLC (MeOH/$H_2O$) to yield petiolins J (**1**, 0.00054%), K (**2**, 0.00027%), L (**3**, 0.00019%), and M (**4**, 0.000089%).




* Corresponding author. Tel.: +81 11 706 3239; fax: +81 11 706 4989.
*E-mail address:* jkobay@pharm.hokudai.ac.jp (J. Kobayashi).

0960-894X/$ - see front matter © 2010 Elsevier Ltd. All rights reserved.
doi:10.1016/j.bmcl.2010.06.047

**Table 1**
$^{1}H$ and $^{13}C$ NMR data for petiolins J (**1**) and K (**2**) in $CDCl_3$

| Position | **1** | | **2** | |
|---|---|---|---|---|
| | $^{13}C$ | $^{1}H$[a] | $^{13}C$ | $^{1}H$[a] |
| 1 | 163.3 | — | 163.4 | — |
| 2 | 102.2 | — | 107.0 | — |
| 3 | 157.9 | — | 160.6 | — |
| 4 | 97.1 | — | 106.2 | — |
| 5 | 153.3 | — | 155.9 | — |
| 6 | 105.0 | — | 105.0 | — |
| 7 | 210.6 | — | 210.0 | — |
| 8 | 39.4 | 3.88 (1H, sept, *J* = 6.7 Hz) | 39.0 | 3.80 (1H, sept, *J* = 6.7 Hz) |
| 9 | 19.3 | 1.18 (3H, d, *J* = 6.7 Hz) | 19.1 | 1.18 (3H, d, *J* = 6.7 Hz) |
| 10 | 19.8 | 1.18 (3H, d, *J* = 6.7 Hz) | 19.7 | 1.18 (3H, d, *J* = 6.7 Hz) |
| 11 | 7.1 | 2.12 (3H, s) | 7.2 | 2.00 (3H, s) |
| 12 | 25.8 | 2.91 (1H, dd, *J* = 16.6, 5.7 Hz)<br>2.62 (1H, dd, *J* = 16.6, 6.4 Hz) | 27.8 | 2.81 (1H, brs) |
| 13 | 66.5 | 3.96 (1H, t, *J* = 6.0 Hz) | 34.9 | 2.19 (1H, ddd, *J* = 13.5, 4.2, 2.7 Hz)<br>1.86 (1H, dd, *J* = 13.5, 1.7 Hz) |
| 14 | 80.2 | — | 76.0 | — |
| 15 | 18.9 | 1.37 (3H, s) | 28.8 | 1.42 (3H, s) |
| 16 | 37.4 | 1.78, 1.71 (each 1H, m) | 37.5 | 1.81 (1H, m)<br>1.47 (1H, ddd, *J* = 15.1, 13.3, 6.7 Hz) |
| 17 | 22.0 | 2.14 (2H, m) | 22.0 | 1.31, 0.86 (each 1H, m) |
| 18 | 123.5 | 5.01 (1H, t, *J* = 6.8 Hz) | 46.2 | 2.04 (1H, ddd, *J* = 13.2, 5.5, 2.7 Hz) |
| 19 | 132.5 | — | 84.7 | — |
| 20 | 17.6 | 1.61 (3H, s) | 29.7 | 1.56 (3H, s) |
| 21 | 25.7 | 1.69 (3H, s) | 24.3 | 1.06 (3H, s) |
| 1-OH | — | 14.17 (1H, s) | — | 14.11 (1H, s) |

[a] Coupling constants given (*J* in Hz) in parentheses.

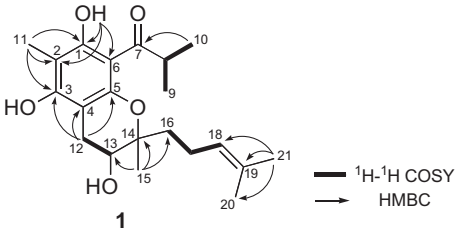



**Figure 1.** Selected 2D NMR correlations for petiolin J (**1**).

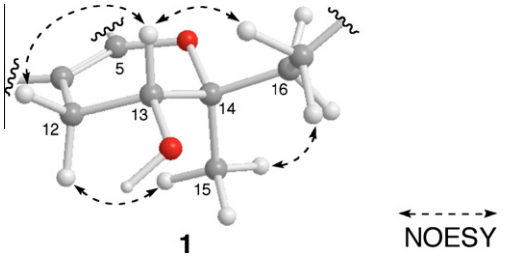



**Figure 2.** Selected NOESY correlations and relative stereochemistry for petiolin J (**1**) (C-1–C-3, C-6–C-11 and C-18–C21 were not shown).

Petiolin J (**1**)[3], was obtained as an optically inactive pale yellow oil {$[\alpha]_D^{22}$ 0 (*c* 0.80, MeOH)}. The molecular formula of **1**, $C_{21}H_{30}O_5$, was established by HRESIMS [*m/z* 361.2033 $(M-H)^-$, $\Delta$ +1.2 mmu]. The $^{1}H$ and $^{13}C$ NMR spectra (Table 1) showed the presence of one hydrogen-bonded hydroxy group, one 2-methylpropanoyl group, one fully substituted benzene ring, one trisubstituted olefin, one $sp^3$ quaternary carbon attached to an oxygen atom, one $sp^3$ oxygenated methine, three methylenes, and four tertiary methyls. The presence of a 1,3,5-trihydroxy benzene ring was implied by $^{13}C$ NMR chemical shifts of the aromatic carbons. From these data, **1** was presumed to be a prenylated acylphloroglucinol derivative having two isoprene units, one 2-methylpropanoyl group, and one methyl group. The $^{1}H$–$^{1}H$ COSY spectrum disclosed connectivities of C-12 to C-13 and C-16 to C-18, while HMBC correlations revealed connectivities of C-13 to C-15 and C-16 through C-14, C-18 to C-20 and C-21 through C-19. HMBC cross-peaks of $H_2$-12 to C-3, C-4, and C-5, $H_3$-11 to C-1, C-2, and C-3, and hydrogen-bonded hydroxy proton (OH-1) to C-1, C-2, and C-6 suggested that C-7, C-11, and C-12 were attached to C-6, C-2, and C-4, respectively (Fig. 1).

Triacetyl derivative of petiolin J (**1a**),[4] prepared by treatment with $Ac_2O$/pyridine, gave a down-field shifted signal of H-13 [$\delta_H$ 5.06 (1H, t, *J* = 5.6 Hz)], indicating the presence of a secondary hydroxy group at C-13. This evidence and the unsaturation degree of **1** implied connectivity of C-5 to C-14 through an ether linkage. Substitution pattern of a phloroglucinol moiety (C-1 to C-6) of **1** was confirmed by correlations for $H_3$-11 to 3-OAc, $H_3$-11 to 1-OAc, and $H_3$-9 to 1-OAc in the NOESY spectrum of **1a**. Thus, the gross structure of petiolin J (**1**) was assigned as shown.

In the NOESY spectrum measured in $CDCl_3$, beneficial correlations to assign the relative stereochemistry of **1** were not found due to conformational change of dihydropyran ring (C-4, C-5, and C-12 to C-14). Therefore, the NOESY spectrum of **1** was measured in $CD_3OD$, where the conformational change was not observed.[5]

The NOESY cross-peaks of $H_3$-15 to H-12a indicated that these protons were α-oriented, while the β-orientation of H-13 was revealed by the cross-peak of H-13 to H-12b (Fig. 2). Thus, the relative stereochemistry of petiolin J (**1**) was assigned as shown.

Petiolin K (**2**)[6] was obtained as an optically inactive colorless platelets {$[\alpha]_D^{22}$ 0 (*c* 0.40, MeOH)}. HRESIMS analysis revealed the molecular formula to be $C_{21}H_{28}O_4$ [*m/z* 367.1889 $(M+Na)^+$, $\Delta$ +0.9 mmu]. $^{1}H$ and $^{13}C$ NMR data of **2** (Table 1) indicated the presence of one hydrogen-bonded hydroxy group, one fully substituted benzene ring, one 2-methylpropanoyl group, two $sp^3$ quaternary carbons attached to an oxygen atom, two methines, three methylenes, and four tertiary methyl groups. These signals were similar to those of petiolin D,[2b] a prenylated acylphloroglucinol derivative having citran skeleton, except for resonances of C-1 to C-3, and C-11, indicating that **2** had different substituent at C-2 from that of petiolin D. The substituent was assigned to be a methyl group

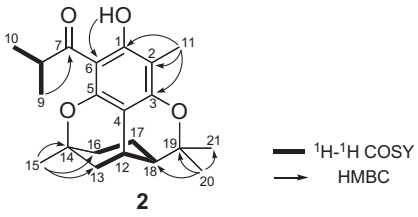



**Figure 3.** Selected 2D NMR correlations for petiolin K (**2**).

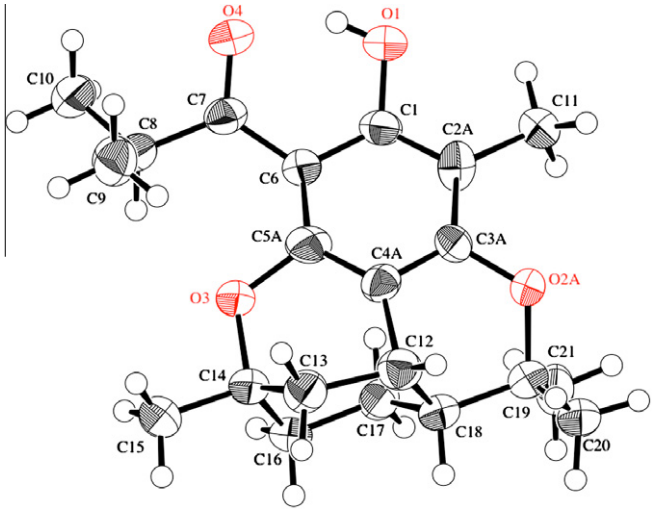



**Figure 4.** ORTEP drawing of petiolin K (**2**).

by HMBC correlations for $H_3$-11 to C-1, C-2, and C-3 (Fig. 3). A single-crystal X-ray diffraction analysis of **2** was performed to confirm the assignment described above.[7] It revealed the structure of **2**, and also suggested that **2** was a racemate. The ORTEP drawing of one enantiomer of **2** was shown in Figure 4.

Petiolin L (**3**)[8] was obtained as an optically active pale yellow oil {$[\alpha]_D^{22}$ −72.5 (*c* 0.13, MeOH)}. The molecular formula of **3**, $C_{28}H_{42}O_5$, was deduced from HRESIMS [*m/z* 481.2936 (M+Na)$^+$, $\Delta$ +1.1 mmu]. The $^{13}$C NMR (Table 2) spectrum disclosed the existence of three ketone carbonyl carbons, four sp$^2$ quaternary carbons, two sp$^2$ methines, three sp$^3$ quaternary carbons, two sp$^3$ methines, five sp$^3$ methylenes, and nine methyl groups. The $^1$H–$^1$H COSY spectrum revealed connectivities of C-8 to C-9, C-8 to C-28, C-13 to C-14, C-18 to C-19, and C-22 to C-24. HMBC correlations for $H_3$-21 to C-19, C-20 ($\delta_C$ 73.7), and C-22 indicated that an oxygenated sp$^3$ quaternary carbon (C-20) was attached to C-19, C-21, and C-22. Connectivities from C-1 to C-5, C-13, and C-18 through C-6 were deduced from HMBC cross-peaks of $H_2$-13 to C-1, C-5, and C-6, and $H_2$-18 to C-1 and C-5. HMBC correlations for $H_3$-11 to C-3, C-4, C-5, and C-12 suggested connectivties from C-11 to C-3, C-5, and C-12 through C-4. The chemical shift of C-19 ($\delta_C$ 91.4) implied the presence of an ether linkage between C-1 and C-19. The chemical shift of C-2 ($\delta_C$ 116.7) suggested that this carbon was attached to C-1, C-7, and C-3. Thus, the gross structure of petiolin L was elucidated as shown in Figure 5.

The relative stereochemistry of petiolin L (**3**) was deduced from NOESY data. NOESY correlations for $H_3$-11/H-14 and H-13a/H-18b suggested that H-18b, $CH_3$-11, and isoprenyl group attached to C-6 were β-oriented, while the α-orientation of H-19 was assigned based on the correlation for H-18a/H-19. NOESY cross-peaks of H-22b/H-18b, H-19/H-22a, and H-19/$H_3$-21 implied the relative stereochemistry of C-19 and C-20 as shown in Figure 6. The proposed relative stereochemistry of **3** was supported by resemblance

**Table 2**
$^1$H and $^{13}$C NMR data for petiolins L (**3**) and M (**4**) in $CDCl_3$

| Position | **3** | | **4** | |
|---|---|---|---|---|
| | $^{13}$C | $^1$H[a] | $^{13}$C | $^1$H[a] |
| 1 | 170.3 | — | 170.1 | — |
| 2 | 116.7 | — | 116.1 | — |
| 3 | 193.6 | — | 193.9 | — |
| 4 | 56.0 | — | 55.5 | — |
| 5 | 206.1 | — | 205.3 | — |
| 6 | 70.4 | — | 69.2 | — |
| 7 | 208.0 | — | 207.0 | — |
| 8 | 43.0 | 3.11 (1H, m) | 37.7 | 2.93 (1H, sept, *J* = 6.7 Hz) |
| 9 | 17.6 | 1.10 (3H, d, *J* = 6.8 Hz) | 20.1 | 1.04 (3H, d, *J* = 6.7 Hz) |
| 10 | 26.9 | 1.49, 1.33 (each 1H, m) | 20.1 | 1.06 (3H, d, *J* = 6.7 Hz) |
| 11 | 26.5 | 1.19 (3H, s) | 25.8 | 1.30 (3H, s) |
| 12 | 21.2 | 1.25 (3H, s) | 22.2 | 1.25 (3H, s) |
| 13 | 31.7 | 3.28 (1H, dd, *J* = 13.4, 8.0 Hz)<br>2.71 (1H, dd, *J* = 13.4, 7.0 Hz) | 31.6 | 3.14 (1H, dd, *J* = 14.3, 7.4 Hz)<br>2.72 (1H, dd, *J* = 14.3, 6.7 Hz) |
| 14 | 116.7 | 4.72 (1H, brt, *J* = 7.3 Hz) | 117.8 | 4.80 (1H, brt, *J* = 6.5 Hz) |
| 15 | 137.0 | — | 136.5 | — |
| 16 | 17.7 | 1.62 (3H, s) | 17.9 | 1.62 (3H, s) |
| 17 | 26.0 | 1.61 (3H, s) | 25.8 | 1.60 (3H, s) |
| 18 | 27.0 | 3.09 (1H, dd, *J* = 14.8, 7.3 Hz)<br>2.89 (1H, dd, *J* = 14.8, 10.4 Hz) | 27.1 | 3.02 (1H, dd, *J* = 14.9, 9.0 Hz)<br>2.93 (1H, dd, *J* = 14.9, 10.6 Hz) |
| 19 | 91.4 | 4.69 (1H, dd, *J* = 10.4, 7.3 Hz) | 91.4 | 4.74 (1H, t, *J* = 9.3 Hz) |
| 20 | 73.7 | — | 73.3 | — |
| 21 | 23.4 | 1.30 (3H, s) | 22.9 | 1.28 (3H, s) |
| 22 | 36.7 | 1.58, 1.43 (each 1H, m) | 37.0 | 1.53, 1.46 (each 1H, m) |
| 23 | 22.0 | 2.15, 2.04 (each 1H, m) | 21.8 | 2.12, 2.04 (each 1H, m) |
| 24 | 123.8 | 5.12 (1H, brt, *J* = 7.0 Hz) | 123.5 | 5.10 (1H, t, *J* = 7.0 Hz) |
| 25 | 132.0 | — | 132.4 | — |
| 26 | 17.9 | 1.63 (3H, s) | 17.5 | 1.62 (3H, s) |
| 27 | 25.7 | 1.70 (3H, s) | 25.5 | 1.67 (3H, s) |
| 28 | 11.3 | 1.06 (3H, d, *J* = 6.7 Hz) | — | — |

[a] Coupling constants given (*J* in Hz) in parentheses.

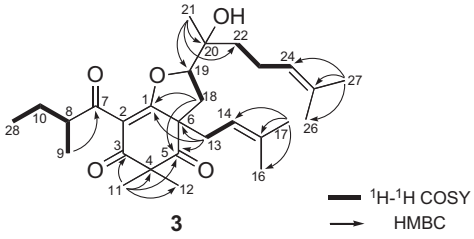



**Figure 5.** Selected 2D NMR correlations for petiolin L (**3**).

of $^{13}$C chemical shifts for C-18 to C-22 of **3** with those of the corresponding position in petiolin C.[2a] Thus, the relative stereochemistry of petiolin L was assigned as shown.

Petiolin M (**4**)[9] was obtained as an optically active pale yellow oil {$[\alpha]_D^{22}$ −110.0 (*c* 0.17, MeOH)}. The HRESIMS of **4** revealed the molecular formula to be $C_{27}H_{40}O_5$ [*m/z* 467.2776 (M+Na)$^+$, $\Delta$ +0.8 mmu], which was smaller by 14 mass units as compared with **3**. $^1$H and $^{13}$C NMR data of **4** (Table 2) were similar to those of **3**, except for signals of an acyl side-chain at C-2 and chemical shifts of $H_3$-11, $H_2$-13, H-14, $H_2$-18, and H-19. The acyl side-chain of **4** was assigned to be a 2-methylpropanoyl group from $^1$H and $^{13}$C NMR resonances [$\delta_H$ 2.93 (1H, sept, *J* = 6.7 Hz), 1.06 and 1.04 (each 3H, d, *J* = 6.7 Hz); $\delta_C$ 207.0, 37.7, 20.1 × 2]. NOESY correlations for $H_3$-12/H-14, H-13a/H-18a, and H-18a/H-19 suggested that $CH_3$-12, H-18a, H-19, and the prenyl group at C-6 were α-oriented (Fig. 7). The relative stereochemistry of C-19 and C-20 were

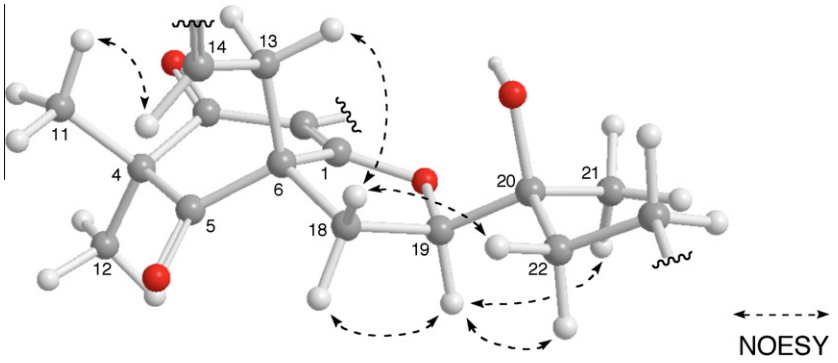



**Figure 6.** Selected NOESY correlations and relative stereochemistry for petiolin L (**3**) (C-7–C-10, C-15–C-17 and C-24–C-28 were not shown).

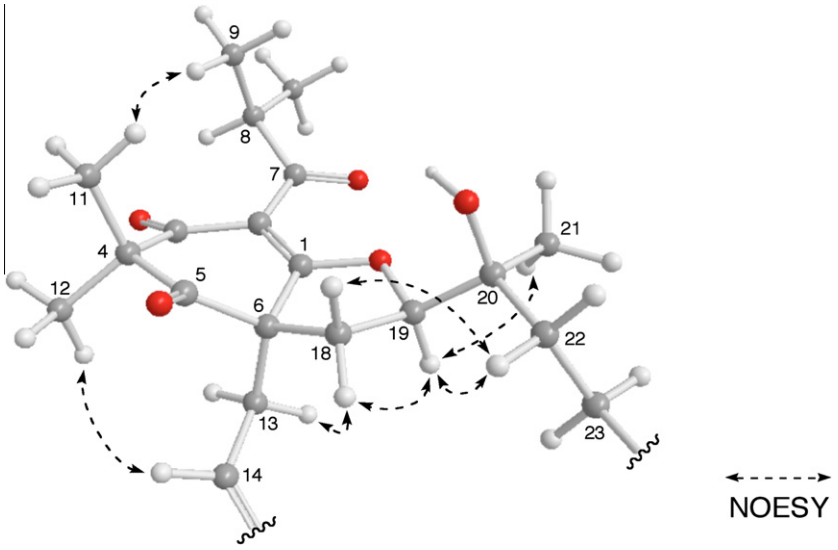



**Figure 7.** Selected NOESY correlations and relative stereochemistry for petiolin M (**4**) (C-15–C-17 and C-24–C-27 were not shown).

assigned as same as those of **3** based on NOESY cross-peaks of H-19/$H_3$-21, H-18b/H-22a, and H-19/H-22a. Thus, the structure of petiolin M was elucidated to be **4**.

Petiolins J (**1**) and K (**2**) are optically inactive prenylated acylphloroglucinols possessing a methyl group on phloroglucinol moiety of chromane and citran skeleton, respectively. Petiolins L (**3**) and M (**4**) were optically active prenylated acylphloroglucinols, while petiolin C, biosynthetically related compound to **3** and **4**, was isolated as a racemate from the same plant material.[2a]

Petiolin J (**1**) exhibited antimicrobial activity against *Micrococcus luteus* (MIC, 8 μg/mL), *Cryptococcus neoformans* (16 μg/mL), and *Trichophyton mentagrophytes* (16 μg/mL), while petiolins J–M (**1**–**4**) showed no cytotoxicity against murine lymphoma L1210 cells and human epidermoid carcinoma KB cells (both $IC_{50}$ >10 μg/mL).

## Acknowledgments

We thank T. Akiyama and M. Inagaki, the Kochi Prefectural Makino Botanical Garden, for collection and botanical identification of the plant, S. Oka and A. Tokumitsu, Equipment Management Center, Hokkaido University, for measurements of HRESIMS. This work was partly supported by a grant from the Akiyama Life Science Foundation and a Grant-in-Aid for Scientific Research from the Ministry of Education, Culture, Sports, Science and Technology of Japan.

## References and notes

1. (a) Nahrstedt, A.; Butterweck, V. *Pharmacopsychiatry* **1997**, *30*, 129; (b) Dostalek, M.; Pistovcakova, J.; Jurica, J.; Tomandl, J.; Linhart, I.; Sulcavá, A.; Hadasova, E. *Life Sci.* **2005**, *78*, 239; (c) Medina, M. A.; Mrtínez-Poveda, B.; Amores-Sánchez, M. I.; Quesada, A. R. *Life Sci.* **2006**, *79*, 105; (d) Beerhues, L. *Phytochemistry* **2006**, *67*, 2201.
2. (a) Tanaka, N.; Kubota, T.; Ishiyama, H.; Araki, A.; Kashiwada, Y.; Takaishi, Y.; Mikami, Y.; Kobayashi, J. *Bioorg. Med. Chem.* **2008**, *16*, 5619; (b) Tanaka, N.; Kubota, T.; Ishiyama, H.; Kashiwada, Y.; Takaishi, Y.; Ito, J.; Mikami, Y.; Shiro, M.; Kobayashi, J. *Heterocycles* **2009**, *79*, 917; (c) Tanaka, N.; Kubota, T.; Kashiwada, Y.; Takaishi, Y.; Kobayashi, J. *Chem. Pharm. Bull.* **2009**, *57*, 1171.
3. *Petiolin J* (**1**): Pale yellow oil; $[\alpha]_D^{22}$ 0 (*c* 0.80, MeOH); UV (MeOH) $\lambda_{max}$ 294 ($\varepsilon$ 11,200) nm; IR (KBr) $\upsilon_{max}$ 3418 and 1613 $cm^{-1}$; $^1H$ and $^{13}C$ NMR data (Table 1); ESIMS *m/z* 361 $(M-H)^-$; HRESIMS: *m/z* 361.2033 $(M-H)^-$ (calcd for $C_{21}H_{29}O_5$, 361.2021).
4. *Petiolin J triacetate* (**1a**): $^1H$ NMR ($CDCl_3$): $\delta_H$ 5.06 (1H, t, *J* = 5.6 Hz, H-13), 5.02 (1H, t, *J* = 6.8 Hz, H-18), 3.13 (1H, sept, *J* = 6.8 Hz, H-8), 2.89 (1H, br d, *J* = 14.7 Hz, H-12a), 2.54 (1H, br d, *J* = 14.7 Hz, H-12b), 2.32 (3H, s, 3-OAc), 2.21 (3H, s, 1-OAc), 2.07 (3H, s, $H_3$-20), 2.04 (2H, m, $H_2$-17), 2.00 (3H, s, 13-OAc), 1.87 (3H, s, $H_3$-11), 1.66 (3H, s, $H_3$-21), 1.58 (2H, m, $H_2$-16), 1.28 (3H, s, $H_3$-15), 1.14 (3H, d, *J* = 6.8 Hz, $H_3$-10), and 1.13 (3H, d, *J* = 6.8 Hz, $H_3$-9); HRESIMS: *m/z* 511.2303 $(M+Na)^+$ (calcd for $C_{27}H_{36}O_8Na$, 511.2302).
5. Rosselli, S.; Bruno, M.; Maggio, A.; Bellone, G.; Formisano, C.; Mattia, C. A.; Micco, S. D.; Bifulco, G. *Eur. J. Org. Chem.* **2007**, 2504.
6. *Petiolin K* (**2**): Colorless platelets; mp 177–180 °C; $[\alpha]_D^{22}$ 0 (*c* 0.40, MeOH); UV (MeOH) $\lambda_{max}$ 295 ($\varepsilon$ 9600) nm; IR (KBr) $\upsilon_{max}$ 3734 and 1617 $cm^{-1}$; $^1H$ and $^{13}C$

NMR data (Table 1); ESIMS *m/z* 367 $(M+Na)^+$; HRESIMS: *m/z* 367.1889 $(M+Na)^+$ (calcd for $C_{21}H_{27}O_4Na$, 367.1880).

7. Petiolin K (**2**) was crystallized as colorless platelets from methanol/water. The crystal having approximate dimensions of 0.17 × 0.15 × 0.05 mm was mounted in a roop. All measurements were made on a Rigaku RAXIS PAPID imaging plate area detector with graphite monochromated Cu Kα radiation (1.54187 Å) at −180 °C. Crystal data: formula $C_{21}H_{28}O_4$, formula weight 344.45, Space group $P2_1/c$(#14), $a$ = 10.6011(2) Å, $b$ = 9.2563(2), $c$ = 18.9757(13), $a$ = 90.0000°, $b$ = 101.915(7), $g$ = 90.0000, $V$ = 1821.90(14) Å$^3$, $Z$ = 4, $D_{calcd}$ = 1.256 g/cm$^3$, 20,831 reflections measured, 3334 reflections unique, $2\theta_{max}$ = 136.5°, $R_{int}$ = 0.032, $R_1 = S||F_o|-|F_c||/S|F_o| = 0.0527$ for 2612 reflections with $I > 2s(I)$, $wR_2 = [S(w(F_o^2 - F_c^2)^2/Sw(F_o^2)^2)^{1/2} = 0.1618$ for all reflections, goodness of fit 1.110. The structure was solved by direct methods (SIR2002) and expanded using Fourier techniques. The non-hydrogen atoms were refined anisotropically. Hydrogen atoms were refined using the riding model. All calculations were performed using Crystal Structure except for refinement, which was performed using SHELXL-97. Crystallographic data for petiolin K (**2**) have been deposited at the Cambridge Crystallographic Data Center (deposition number CCDC 779157).
8. *Petiolin L* (**3**): Pale yellow oil; $[\alpha]_D^{22}$ −72.5 (*c* 0.13, MeOH); UV (MeOH) $\lambda_{max}$ 276 (ε 16,700) nm; IR (neat) $\upsilon_{max}$ 3462, 1730, 1698, and 1634 cm$^{-1}$; $^1$H and $^{13}$C NMR data (Table 2); ESIMS *m/z* 481 $(M+Na)^+$; HRESIMS: *m/z* 481.2936 $(M+Na)^+$ (calcd for $C_{28}H_{42}O_5Na$, 481.2925).
9. *Petiolin M* (**4**): Pale yellow oil; $[\alpha]_D^{22}$ −110.0 (*c* 0.17, MeOH); UV (MeOH) $\lambda_{max}$ 275 (ε 5500) nm; IR (KBr) $\upsilon_{max}$ 3396, 1733, 1702, and 1633 cm$^{-1}$; $^1$H and $^{13}$C NMR data (Table 2); ESIMS *m/z* 467 $(M+Na)^+$; HRESIMS: *m/z* 467.2776 $(M+Na)^+$ (calcd for $C_{27}H_{40}O_5Na$, 467.2768).