

This article was downloaded by:

On: 22 January 2011

Access details: *Access Details: Free Access*

Publisher *Taylor & Francis*

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



Journal of Asian Natural Products Research

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t713454007>

A novel 1,10-*seco* withanolide from *Physalis peruviana*

Sheng-Tao Fang^{ab}, Ji-Kai Liu^a, Bo Li^a

^a State Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, China ^b Graduate School of the Chinese Academy of Sciences, Beijing, China

Online publication date: 13 July 2010

To cite this Article Fang, Sheng-Tao , Liu, Ji-Kai and Li, Bo(2010) 'A novel 1,10-*seco* withanolide from *Physalis peruviana*', Journal of Asian Natural Products Research, 12: 7, 618 – 622

To link to this Article: DOI: 10.1080/10286020.2010.482523

URL: <http://dx.doi.org/10.1080/10286020.2010.482523>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

NOTE

A novel 1,10-*seco* withanolide from *Physalis peruviana*

Sheng-Tao Fang^{ab}, Ji-Kai Liu^a and Bo Li^{a*}

^aState Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming 650204, China; ^bGraduate School of the Chinese Academy of Sciences, Beijing 100039, China

(Received 28 December 2009; final version received 29 March 2010)

A novel 1,10-*seco* withanolide, 1,10-*seco* withaperuvin C (**1**), together with four known withanolides, 4 β -hydroxywithanolide E (**2**), visconolide (**3**), withanolide F (**4**), and withaphysanolide (**5**), was isolated from the aerial parts of *Physalis peruviana*. The structures of compounds **1–5** were determined on the basis of spectroscopic methods including extensive 1D and 2D NMR analysis. In addition, the possible biogenetic relationships among these five withanolides are discussed.

Keywords: *Physalis peruviana*; 1,10-*seco* withaperuvin C; withanolide; steroid

1. Introduction

The genus *Physalis* (Solanaceae) includes about 120 species mainly distributed in South and North America. Five species of this genus are found in China [1]. *Physalis peruviana* is a common plant in China, and its fruit is edible, called ‘cape gooseberry’. It is also a medicinal plant widely used in folk medicine for treating diseases such as malaria, asthma, hepatitis, dermatitis, diuretics, and rheumatism [2,3]. In previous studies, a series of withanolides had been isolated from this plant [4–12]. In this paper, we report the isolation and elucidation of a new 1,10-*seco* withanolide, 1,10-*seco* withaperuvin C (**1**), together with four known withanolides: 4 β -hydroxywithanolide E (**2**) [13,14], visconolide (**3**) [15], withanolide F (**4**) [16], and withaphysanolide (**5**) [14] from the aerial parts of *P. peruviana* (Figure 1). Compound 1,10-*seco* withaperuvin C (**1**) is the first example of steroids with a unique 1,10-*seco* withanolide skeleton isolated from the genus *Physalis*.

2. Results and discussion

Compound **1** was isolated as a white amorphous solid, and showed a quasi-molecular ion peak $[M+Na]^+$ at m/z 509 in its positive ESI-MS. Its molecular formula was established as $C_{28}H_{38}O_7$ by HR-ESI-MS at m/z 509.2520. The IR spectrum showed strong absorptions at 3424 and 1708 cm^{-1} , indicating the presence of hydroxyl and ester groups. The 1H NMR and ^{13}C NMR spectra of **1** showed the presence of 28 carbons consisting of two carbonyls, three carbon–carbon double bonds including two four-substituted and one-disubstituted, four quaternary carbons including three oxygen-bearing functional groups, four sp^3 methines including two oxygen-bearing functional groups, seven methylenes, and five methyls. Comparison of the NMR spectral data of **1** with those of the known withaperuvin C [17] indicated that compound **1** is also a withanolide derivative, and they have the same substituent patterns and relative configurations in

*Corresponding author. Email: libo@mail.kib.ac.cn

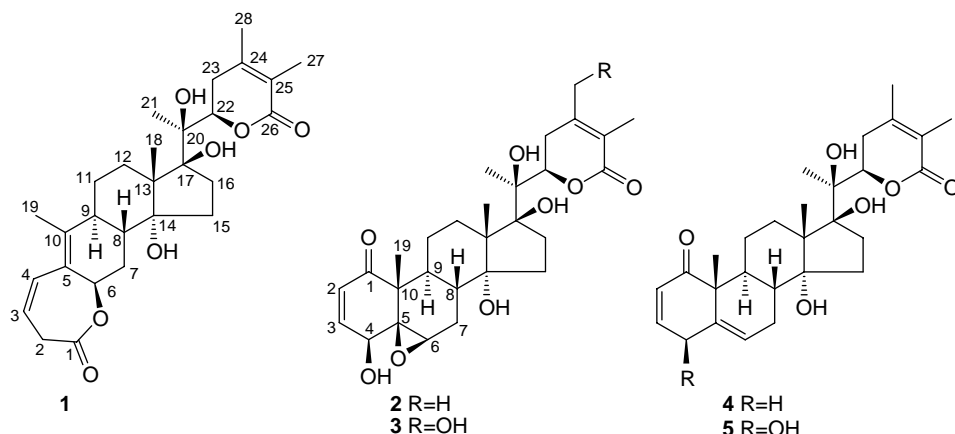


Figure 1. Structures of compounds 1–5.

rings C, D and in their respective lactone ring, except for the major differences in the A/B rings. In the ^1H NMR spectrum, the signals at δ_{H} 3.84 (br d, $J = 17.3$ Hz), 3.18 (dd, $J = 17.3, 8.7$ Hz), 5.45 (br dd, $J = 11.4, 8.7$ Hz), and 6.55 (dd, $J = 11.4, 3.2$ Hz) were assigned to H-2 α , H-2 β , H-3, and H-4, respectively, on the basis of an analysis of the ^1H - ^1H COSY spectrum, and the downfield chemical shift at δ_{H} 1.79 (3H, s) implied that Me-19 was a vinylic methyl. In addition, a signal at δ_{H} 5.15 (1H, br s, H-6) together with the signal at δ_{C} 173.0 (C-1) in the ^{13}C NMR spectrum indicated that **1** possesses a 1,10-*seco* withanolide skeleton [19]. This was

confirmed by the analysis of the HMBC spectrum, in which long-range correlations were observed between C-1 and H-2 β , H-3 and H-6, between H-4 and C-5, C-6, and C-10, and between C-5 and Me-19, as shown in Figure 2. Therefore, a seven-membered β, γ -unsaturated lactone moiety was considered in ring A.

The β -configuration of the lactone bond at C-6 was established by a ROESY experiment (Figure 2). The ROESY spectrum showed the correlation between H-6 (δ 5.15, br s) and H-2 α , H-7 α and H-7 β , indicating that H-6 has the same configuration as H-2 α . Since a small coupling between H-2 α and H-3 in the

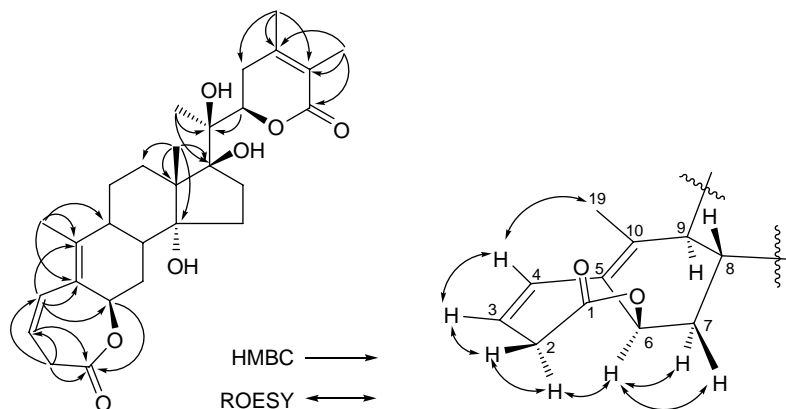


Figure 2. The key HMBC and ROESY correlations of compound 1.

^1H NMR spectrum was observed due to an approximate 90° dihedral angle between them, a β -configuration of the lactone bond at C-6 was inferred, which is in agreement with those of stolonilide I [18] and 1,10-*seco* withametelin B [19]. Therefore, the structure of **1** was deduced as shown in Figure 1, which was named 1,10-*seco* withaperuvin C.

In addition to the new 1,10-*seco* withanolide **1**, four known withanolides **2–5** were isolated from the aerial parts of *P. peruviana*. The possible biogenetic relationships among these five compounds are discussed in Scheme 1.

were measured on a Bio-Rad FTS-135 spectrometer. 1D and 2D NMR spectra were recorded on a Bruker AM-400 and DRX-500 instruments with TMS as an internal standard. ESI-MS and HR-ESI-MS were measured on VG AutoSpec-3000 and API Qstar-Pulsar LC/TOF mass spectrometers. Column chromatography (CC) was performed over silica gel (200–300 mesh; Qingdao Marine Chemical Inc., Qingdao, China). TLC was performed on precoated silica gel G plates (Qingdao Marine Chemical Inc.), and spots were visualized by spraying with 10% H_2SO_4 in EtOH, followed by heating.

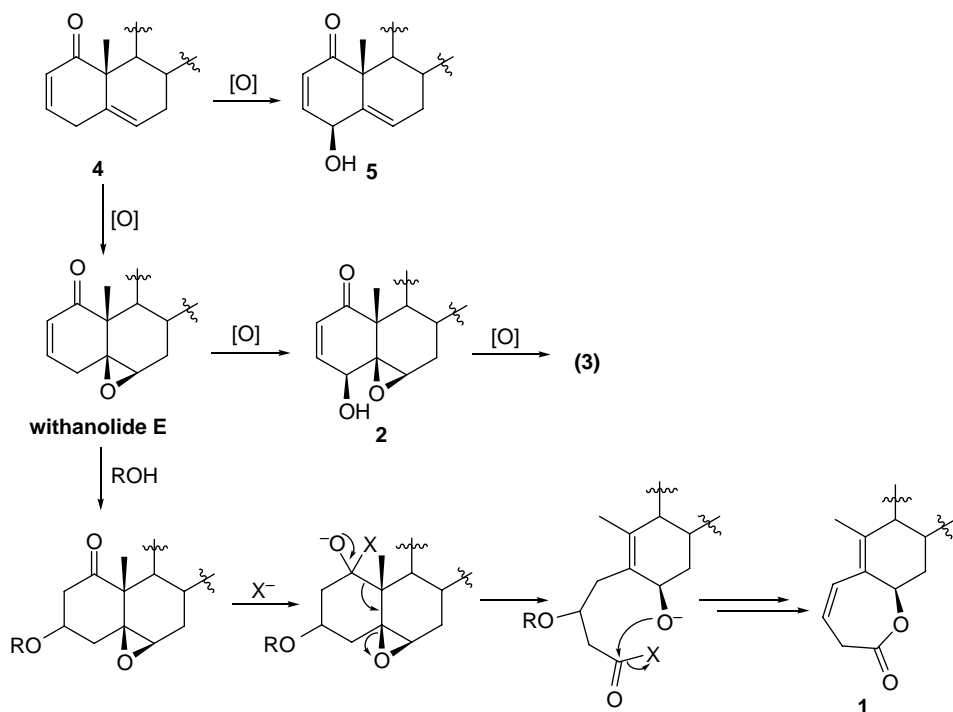
3. Experimental

3.1 General experimental procedures

Optical rotations were determined on a Horiba SEPA-300 spectropolarimeter. UV spectra were recorded on a Shimadzu UV-2401PC spectrophotometer. IR spectra

3.2 Plant material

The aerial parts of *P. peruviana* were collected from Kunming, Yunnan Province, China, in September 2005, and were identified by Prof. Chengmin Zhang, Kunming Institute of Botany. A voucher



Scheme 1. Possible biogenetic relationships of compounds 1–5.

Table 1. ^1H NMR (400 MHz) and ^{13}C NMR (100 MHz) spectral data for compound **1** in CDCl_3 (δ in ppm, J in Hz).

Position	δ_{H}	δ_{C}
1		173.0
2	3.84 (br d, $J = 17.3$) α -H, 3.18 (dd, $J = 17.3, 8.7$) β -H	35.6
3	5.45 (br dd, $J = 11.4, 8.7$)	116.7
4	6.55 (dd, $J = 11.4, 3.2$)	129.3
5		124.1
6	5.15 (br s)	73.8
7	2.04 (m), 1.81 (m)	29.5
8	2.05 (m)	36.9
9	2.57 (m)	39.5
10		143.4
11	2.00 (m), 1.43 (m)	25.5
12	2.39 (m), 1.43 (m)	31.1
13		55.0
14		82.0
15	1.79 (m), 1.67 (m)	37.1
16	2.77 (m), 1.50 (m)	37.9
17		87.5
18	1.13 (s)	21.2
19	1.79 (s)	15.7
20		78.9
21	1.43 (s)	19.6
22	4.86 (dd, $J = 12.2, 4.0$)	79.7
23	2.54 (m)	34.3
24		151.0
25		121.2
26		166.1
27	1.87 (s)	12.3
28	1.94 (s)	20.6

specimen (No. 20050911) is deposited in the State Key Laboratory of Phytochemistry and Plant Resources in West China, Kunming Institute of Botany, Chinese Academy of Sciences.

3.3 Extraction and isolation

The air-dried aerial parts (6.0 kg) of *P. peruviana* were extracted with MeOH at room temperature (4×40 liters). The extracts were combined and concentrated, and the residue was suspended in H_2O , and then successively partitioned with petroleum ether, CHCl_3 , and *n*-BuOH, respectively. The CHCl_3 -soluble extract (33 g) was subjected to CC (silica gel; CHCl_3 -MeOH 100:0-80:20) to afford 11

fractions (1-11). Fraction 8 was separated by repeated CC on silica gel, eluting with CHCl_3 -MeOH (30:1-15:1) and petroleum ether-Me₂CO (4:1-2:1) to afford **1** (10 mg) and **4** (234 mg). Fraction 6 provided **2** (425 mg) and **5** (34 mg) after being chromatographed over silica gel, eluting with petroleum ether-Me₂CO (3:1-2:1). Fraction 10 was subjected to a silica gel column with gradient elution (petroleum ether-Me₂CO 10:1-1:1), followed by repeated CC to obtain **3** (16 mg).

3.3.1 1,10-seco withaperuvin C (I)

A white amorphous solid; $[\alpha]_{\text{D}}^{22.8} + 76.1$ ($c = 0.18, \text{CHCl}_3$); UV (CHCl_3) λ_{max} ($\log \epsilon$) nm: 242 (3.93); IR (KBr) ν_{max} (cm^{-1}): 3424, 2923, 1708, 1388, 1288, 1137, 1088, 995; ^1H and ^{13}C NMR spectral data: see Table 1; ESI-MS: m/z 509 $[\text{M}+\text{Na}]^+$; HR-ESI-MS: m/z 509.2520 $[\text{M}+\text{Na}]^+$ (calcd for $\text{C}_{28}\text{H}_{38}\text{O}_7\text{Na}$, 509.2515).

Acknowledgements

The authors are grateful to the members of the analytical group for the spectral measurements in the Laboratory of Phytochemistry, Kunming Institute of Botany, Chinese Academy of Sciences.

References

- [1] Yunnan Institute of Botany, *Flora Yunnanica* (Science Press, Beijing, 1979), Tomus 2, p. 555.
- [2] R.C. Pietro, S. Kashima, D.N. Sato, A.H. Januario, and S.C. Franca, *Phyto-medicine* **7**, 335 (2000).
- [3] M.B.P. Soares, M.C. Bellintani, I.M. Ribeiro, T.C.B. Tomassini, and R.R. Santos, *Eur. J. Pharmacol.* **459**, 107 (2003).
- [4] Y. Oshima, H. Hikino, M. Sahai, and A.B. Ray, *J. Chem. Soc., Chem. Commun.* **10**, 628 (1989).
- [5] F. Frolow, A.B. Ray, M. Sahai, E. Glotter, H.E. Gottlieb, and I. Kirson, *J. Chem. Soc., Perkin Trans 1* **4**, 1029 (1981).
- [6] S. Ahmad, A. Malik, N. Afza, and R. Yasmin, *J. Nat. Prod.* **62**, 493 (1999).

- [7] A. Bagchi, P. Neogi, M. Sahai, A.B. Ray, Y. Oshima, and H. Hikino, *Phytochemistry* **23**, 853 (1984).
- [8] I. Kirson, A. Abraham, P.D. Sethi, S.S. Subramanian, and E. Glotter, *Phytochemistry* **15**, 340 (1976).
- [9] L.N. Dinan, S.D. Sarker, and V. Sik, *Phytochemistry* **44**, 509 (1997).
- [10] A. Ali, M. Sahai, and A.B. Ray, *J. Nat. Prod.* **47**, 648 (1984).
- [11] H.E. Gottlieb, I. Kirson, E. Glotter, A.B. Ray, and M. Sahai, *J. Chem. Soc., Perkin Trans 1* **12**, 2700 (1980).
- [12] M. Sahai, H.E. Gottlieb, A.B. Ray, A. Ali, E. Glotter, and I. Kirson, *J. Chem. Res. (S)* **12**, 346 (1982).
- [13] K. Sakurai, H. Ishii, S. Kobayashi, and T. Iwao, *Chem. Pharm. Bull.* **24**, 1403 (1976).
- [14] N.D. Abdullaev, E.A. Maslennikova, R.N. Tursunova, N.K. Abubakirov, and M.R. Yagudaev, *Chem. Nat. Compd.* **20**, 182 (1984).
- [15] N.D. Abdullaev, O.E. Vasina, V.A. Maslennikova, and N.K. Abubakirov, *Chem. Nat. Compd.* **21**, 616 (1985).
- [16] E. Glotter, A. Abraham, G. Gunzberg, and I. Kirson, *J. Chem. Soc., Perkin Trans 1* **4**, 341 (1977).
- [17] M. Sahai, P. Neogi, A.B. Ray, Y. Oshima, and H. Hikino, *Heterocycles* **19**, 37 (1982).
- [18] K. Iguchi, M. Iwashima, and K. Watanabe, *Chem. Lett.* **12**, 1109 (1995).
- [19] Y.H. Pan, X.C. Wang, and X.M. Hu, *J. Nat. Prod.* **70**, 1127 (2007).