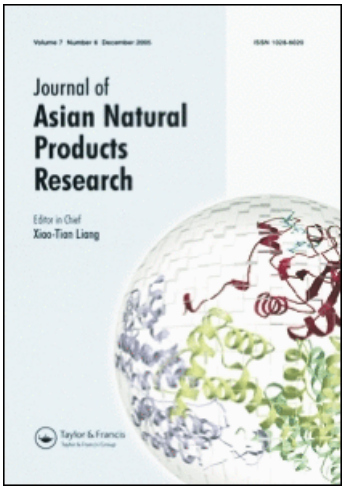

Journal of Asian Natural Products Research
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713454007

Two new dimeric stilbenes from the stem bark of *Morus australis*

Qing-Jian Zhang[a]; Zhong-Fei Zheng[a]; Ruo-Yun Chen[a]; De-Quan Yu[a]
[a] The Key Laboratory of Bioactive Substances and Resources Utilization of Chinese Herbal Medicine (Peking Union Medical College), Ministry of Education, Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China

To cite this Article Zhang, Qing-Jian , Zheng, Zhong-Fei , Chen, Ruo-Yun and Yu, De-Quan(2009) 'Two new dimeric stilbenes from the stem bark of *Morus australis*', Journal of Asian Natural Products Research, 11: 2, 138 — 141
To link to this Article: DOI: 10.1080/10286020802573404
URL: http://dx.doi.org/10.1080/10286020802573404

Journal of Asian Natural Products Research
Vol. 11, No. 2, February 2009, 138–141

Two new dimeric stilbenes from the stem bark of *Morus australis*

Qing-Jian Zhang, Zhong-Fei Zheng, Ruo-Yun Chen and De-Quan Yu*

The Key Laboratory of Bioactive Substances and Resources Utilization of Chinese Herbal Medicine (Peking Union Medical College), Ministry of Education, Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China

(*Received 17 June 2008; final version received 29 September 2008*)

Two new dimeric stilbenes austrafuran B (**1**) and austrafuran C (**2**) were isolated from the bark of *Morus australis*. Their structures were elucidated on the basis of spectroscopic methods.

Keywords: *Morus australis*; dimeric stilbene; austrafuran B; austrafuran C

1. Introduction

Morus, an economically and medically important genus, has 16 known species, 11 of them in China. In the previous papers, we reported the isolation and structure elucidation of four new benzofuran derivatives from the bark of *Morus macroura* [1,2] and the stem of *Morus australis*. The continuous phytochemical investigation of the EtOH extract of the bark of *M. australis* resulted in the isolation and structure elucidation of two new dimeric stilbenes austrafurans B (**1**) and C (**2**).

2. Results and discussion

Austrafuran B (**1**) was obtained as a brown powder, $[\alpha]_D^{20}$ −3.2 ($c = 0.09$, MeOH), which exhibited a bright blue fluorescence under UV light at 365 nm. The molecular formula of **1** was deduced as $C_{28}H_{20}O_8$ based on a molecular ion peak at *m/z* 484.1135 $[M]^+$ in its HR-FAB-MS spectrum. The IR spectrum of **1** exhibited absorption bands ascribable to hydroxyl (3357 cm^{-1}) and aromatic (1610 and 1454 cm^{-1}) groups. The UV spectrum of **1** showed absorption maxima at 225, 286, 320, and 333 nm, which were similar to those of a 2-phenylbenzofuran derivative austrafuran A [3].

The ^{1}H NMR spectrum of **1** showed 12 aromatic resonances. A set of ABX proton signals at δ_H 7.06 (1H, d, $J = 8.0$ Hz, H-6″), 6.29 (1H, dd, $J = 8.0$, 2.0 Hz, H-5″), and 6.47 (1H, d, $J = 2.0$ Hz, H-3″) was assigned to a 2,4-dihydroxyphenyl moiety. Two sets of AX_2 proton signals at δ_H 6.74 (2H, d, $J = 1.6$ Hz, H-2′, 6′), 6.30–6.33 (3H, m, H-4′, 10″, 14″), and 6.22 (1H, brs, H-12″) were attributable to two 3,5-dihydroxyphenyl moieties. Two doublets at δ_H 7.47 (1H, d, $J = 8.0$ Hz, H-4) and 6.89 (1H, d, $J = 8.0$ Hz, H-5) and a singlet at δ_H 7.07 (1H, s, H-3) were assigned to a benzofuran moiety. These aromatic moieties, together with two coupled doublets at δ_H 5.86 (1H, d, $J = 4.8$ Hz, H-7″) and 4.83 (1H, d, $J = 4.8$ Hz, H-8″), suggested that **1** was a dimeric stilbene [1,2]. The ^{13}C NMR spectrum of **1** showed 24 carbon resonances, including 22 aromatic and two aliphatic carbon signals, which were similar to the corresponding data of macrourins B and D [1,2]. The data of ^{13}C NMR were assigned (Table 1) according to the HSQC and HMBC experiments.

*Corresponding author. Email: dqyu@imm.ac.cn

ISSN 1028-6020 print/ISSN 1477-2213 online

DOI: 10.1080/10286020802573404
http://www.informaworld.com

Table 1. ^{13}C NMR (100 MHz) spectral data of **1** and **2**.

No.	**1**[a]	**2**[b]	No.	**1**[a]	**2**[b]
2	155.7	156.6	1″	119.7	115.7
3	102.7	102.2	2″	156.5	157.1
3a	124.5	123.6	3″	103.5	103.4
4	121.7	107.8	4″	159.1	159.4
5	106.9	142.7	5″	107.3	107.9
6	160.3	143.6	6″	128.6	130.9
7	112.8	99.6	7″	89.7	75.3
7a	152.4	150.6	8″	55.4	80.1
1′	133.2	133.2	9″	145.8	140.2
2′, 6′	107.7	103.9	10″, 14″	106.7	107.3
3′, 5′	159.6	159.8	11″, 13″	159.4	158.9
4′	103.4	103.7	12″	102.0	103.4

[a] Acetone-d_6.
[b] CD_3OD.

In the HMBC spectrum of **1**, the $^{13}C—^{1}H$ long-range correlations between H-7″ and C-6, C-6″ and that between H-8″ and C-6, C-7, C-10″, and C-14″ confirmed the connection of **1** as shown in Figure 1. The relative configuration of the dihydrofuran ring could be deduced from the coupling constant of two aliphatic protons according to the reference [4]. The *trans*-configuration corresponded to a coupling constant 3.5–7.5 Hz, the *cis* corresponded to 7.0–10.0 Hz. The coupling constant ($J = 4.8$ Hz) of H-7″ and H-8″ of **1** suggested *trans*-configuration in the dihydrofuran ring, which was similar to those of amurensin D [5]. Thus, the structure of austrafuran B (**1**) was determined as shown in Figure 1.

Austrafuran C (**2**) was obtained as a brown powder, $[\alpha]_D^{20} - 3.1$ ($c = 0.19$, MeOH). The IR spectrum of **2** exhibited absorption bands ascribable to hydroxyl (3353 cm^{-1}) and aromatic groups (1608 and 1454 cm^{-1}). The UV spectrum of **2** showed absorption maxima at 225, 287, 297, 325, and 339 nm, which were similar to those of austrafuran A [3]. The molecular formula of **2** was deduced as $C_{28}H_{20}O_9$ based on a molecular ion peak at m/z 500.1090 $[M]^+$ in its HR-FAB-MS spectrum. These evidences indicated that **2** was also a dimeric stilbene.

The ^{1}H NMR spectrum of **2** showed 12 aromatic and two aliphatic proton resonances that were similar to austrafuran B (**1**). A set of AX_2 proton signals at δ_H 6.87 (2H, d, $J = 2.0$ Hz, H-2′, 6′) and 6.37 (1H, s, H-4′), and three singlets at δ_H 7.08 (1H, s, H-4), 7.12 (1H, s, H-7), and 7.03 (1H, d, $J = 1.2$ Hz, H-3) were similar to the corresponding data of austrafuran A [3], which indicated the presence of a 5,6-dioxide 2-phenylbenzofuran moiety in **2**. Another set of AX_2 proton signals at δ_H 6.33 (2H, d, $J = 2.0$ Hz, H-10″, 14″) and 6.22 (1H, t, $J = 2.0$ Hz, H-12″), and a set of ABX proton signals at δ_H 7.15 (1H, d, $J = 8.0$ Hz, H-6″), 6.35 (1H, dd, $J = 8.0$, 2.4 Hz, H-5″), and 6.26 (1H, d, $J = 2.4$ Hz, H-3″), and two coupling aliphatic protons at δ_H 5.35 (1H, d, $J = 8.0$ Hz, H-7″) and 5.20 (1H, d, $J = 8.0$ Hz, H-8″) were attributed to a dihydrostilbene moiety. The deshielded doublets at δ_H 5.35 and 5.20 indicated two aliphatic carbons connected to oxygen besides aromatic rings.

The 19 degrees of unsaturation suggested the presence of a ring between the 2-phenylbenzofuran moiety and the dihydrostilbene moiety. In the ^{13}C NMR (Table 1) spectrum, carbon signals at δ_C 75.3 (C-7″) and 80.1 (C-8″), together with the typical *trans*

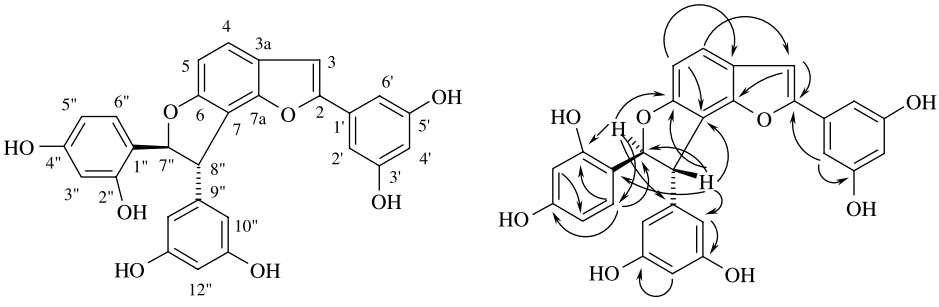

Figure 1. Structure and key HMBC correlations of **1**.

coupling ($J = 8.0$ Hz) and the chemical shifts of H-7″ and H-8″, indicated the existence of a 1,4-dioxane moiety with *trans*-relative configuration [3,4].

The linkage of 2-phenylbenzofuran and dihydrostilbene units was confirmed by the HMBC experiments. After optimizing the J value [$^{2,3}J_{(CH)}$] for a long-range correlation to 3 Hz [6], the HMBC cross-peaks for H-7″/C-5 and H-8″/C-6 were observed. Therefore, the structure of austrafuran C (**2**) was elucidated as shown in Figure 2.

3. Experimental

3.1 General experimental procedures

Optical rotations were obtained on a Perkin-Elmer 241 polarimeter (PerkinElmer, Waltham, MA, USA). The IR spectra were recorded on a Nicolet IMPACT-400 spectrophotometer (Thermo Electron, Madison, WI, USA) as KBr disks. The UV spectra were recorded on a Shimadzu UV-241 spectrophotometer (Shimadzu, Kyoto, Japan). Mass spectra were obtained on the AutoSpec Ultima-TOF instruments (Micromass, Manchester, UK). The ^{1}H (400 MHz) and ^{13}C (100 MHz) NMR spectra were recorded with Varian Mercury-400 spectrophotometer (Varian, Palo Alto, CA, USA). Silica gel (200–300 mesh) for column chromatography and silica gel GF254 for TLC were obtained from Qingdao Marine Chemical Factory, Qingdao, China. Size-exclusion chromatography was performed using Sephadex LH-20 (Pharmacia, Uppsala, Sweden). ODS (40–60 μm) for MPLC (Gilson, Villiers-le-Bel, France) was obtained from Merck Corp. Preparative HPLC was carried out on a Shimadzu LC10ATvp chromatograph (Shimadzu) using a Dynamax-60A C-18 column (20 × 300 mm, Rainin, Woburn, MA, USA).

3.2 Plant material

The stem bark of *M. australis* (10 kg) was collected in July 2005 from Xiushui County, Jiangxi Province, China, and identified by Prof. Ce-Ming Tan, Institute of Forest Botany, Jiujiang, Jiangxi Province, China. A voucher specimen (ID-21039) is deposited in the Herbarium of the Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College.

3.3 Extraction and isolation

The dried plant materials (10 kg) were powdered and refluxed with 95% EtOH thrice under reflux to give 1200 g of an extract, which was absorbed with 1800 g silica gel and eluted successively with petroleum ether, $CHCl_3$, EtOAc, acetone, and MeOH. The EtOAc fraction (290 g) was subjected to column chromatography over silica gel eluted with a $CHCl_3$—CH_3OH mixture with increasing polarity. Combination of similar fractions on the basis of TLC analysis afforded 13 fractions (A–M).

Fraction I (17.2 g) was subjected to a Sephadex LH-20 column (eluted with MeOH) to give five fractions. Fraction I-4 (1.0 g) was purified by silica gel column chromatography (eluted with petroleum ether–acetone, 3:2) to give four subfractions. Subfraction I-4-3 (500 mg) was separated by preparative MPLC (eluted by MeOH–H_2O, 50:50, 60:40, 70:30) to give six subfractions.

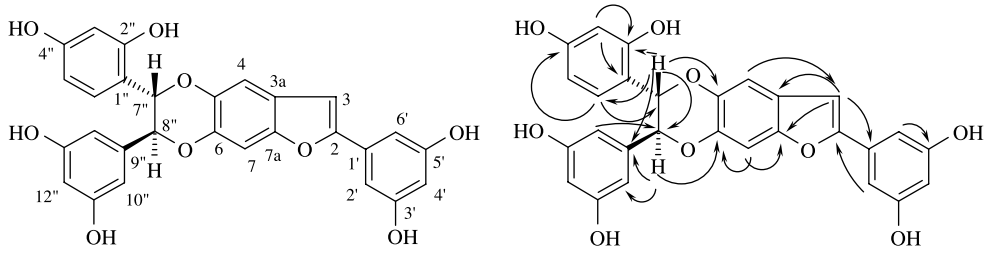

Figure 2. Structure and key HMBC correlations of **2**.

Subfraction I-4-3-1 (90 mg) was further purified by preparative reversed phase HPLC on a C-18 column (eluted by MeOH–H_2O, 55:45) to yield compounds **1** (25 mg) and **2** (30 mg).

3.3.1 *Austrafuran B (**1**)*

Brown powder (acetone), $[\alpha]_D^{20}$ −3.2 (c = 0.09, MeOH); a bright blue fluorescence under UV light at 365 nm. UV λ_{max} (MeOH, log ε): 225 (4.60), 286 (4.19), 320 (4.45), and 333 (sh., 4.37) nm. IR (KBr) ν_{max}: 3357, 1610, and 1454 cm^{-1}. ^1H NMR (400 MHz, acetone-d_6): δ_H 6.74 (2H, d, J = 1.6 Hz, H-2′, 6′), 6.30–6.33 (3H, m, H-4′, 10″, 14″), 6.22 (1H, brs, H-12″), 7.06 (1H, d, J = 8.0 Hz, H-6″), 6.29 (1H, dd, J = 8.0, 2.0 Hz, H-5″), 6.47 (1H, d, J = 2.0 Hz, H-3″), 7.47 (1H, d, J = 8.0 Hz, H-4), 6.89 (1H, d, J = 8.0 Hz, H-5), 7.07 (1H, s, H-3), 5.86 (1H, d, J = 4.8 Hz, H-7″), and 4.83 (1H, d, J = 4.8 Hz, H-8″). ^{13}C NMR spectral data, see Table 1. HR-FAB-MS: m/z 484.1135 $[M]^+$ (calcd for $C_{28}H_{20}O_8$, 484.1158).

3.3.2 *Austrafuran C (**2**)*

Brown powder (MeOH), $[\alpha]_D^{20}$ −3.1 (c = 0.19, MeOH). UV λ_{max} (MeOH, log ε): 225 (4.30), 287 (3.95), 297 (3.90), 325 (4.21), and 339 (4.17) nm. IR (KBr) ν_{max}: 3353, 1608, and 1454 cm^{-1}. ^1H NMR (400 MHz, CD_3OD): δ_H 6.87 (2H, d, J = 2.0 Hz, H-2′, 6′), 6.37 (1H, s, H-4′), 6.33 (2H, d, J = 2.0 Hz, H-10″, 14″), 6.22 (1H, t, J = 2.0 Hz, H-12″), 7.15 (1H, d, J = 8.0 Hz, H-6″), 6.35 (1H, dd, J = 8.0, 2.4 Hz, H-5″), 6.26 (1H, d, J = 2.4 Hz, H-3″), 7.08 (1H, s, H-4), 7.12 (1H, s, H-7), 7.03 (1H, d, J = 1.2 Hz, H-3), 5.35 (1H, d, J = 8.0 Hz, H-7″), and 5.20 (1H, d, J = 8.0 Hz, H-8″). ^{13}C NMR spectral data, see Table 1. HR-FAB-MS: m/z 500.1090 $[M]^+$ (calcd for $C_{28}H_{20}O_9$, 500.1107).

Acknowledgements

This research program was supported by the National Natural Science Foundation of China (Nos 20432030 and 20572133) and the Key Laboratory of Bioactive Substances and Resources Utilization of Chinese Herbal Medicine, Peking Union Medical College, Ministry of Education.

References

[1] S.G. Sun, R.Y. Chen, and D.Q. Yu, *J. Asian Nat. Prod. Res.* **3**, 253 (2001).
[2] S.J. Dai, Z.B. Ma, S. Li, R.Y. Chen, and D.Q. Yu, *Chin. Chem. Lett.* **15**, 951 (2004).
[3] Q.J. Zhang, D.Z. Li, R.Y. Chen, and D.Q. Yu, *Chin. Chem. Lett.* **19**, 196 (2008).
[4] X.M. Li, N. Li, K.S. Huang, and M. Lin, *Acta Pharm. Sin.* **37**, 69 (2002).
[5] K.S. Huang, M. Lin, L.N. Yu, and M. Kong, *Tetrahedron* **56**, 1321 (2000).
[6] D. Lee, M. Cuendet, J.S. Vigo, J.G. Graham, F. Cabieses, H.H.S. Fong, J.M. Pezzuto, and A.D. Kinghorn, *Org. Lett.* **3**, 2169 (2001).