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A new Phenylpropanoid Derivative Isolated from *Carthamus tinctorius* L.

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Abstract: A new phenylpropanoid derivative, named carthamusin A **(1)**, along with two known compounds *β*-daucosterol (**2**) and stigmasterol (**3**) were isolated from *Carthamus tinctorius* L. The structures were elucidated by extensive 1D and 2D (HMBC, HMQC, ^{1}H-^{1}H COSY) NMR and MS spectroscopy.

Keywords: Compositae; *Carthamus tinctorius* L; phenylpropanoid; carthamusin A. © 2015 ACG Publications. All rights reserved.

1. Introduction

Compositae is the largest family in dicots all over the world and there are about 200 genus including 2000 species disputed in China, one of them is Genus Carthamus. Genus Carthamus has 18-20 species in the world in total and two species in China, one is *Carthamus tinctorius* L. and the other is *C. lanatus* L. [1].

The dry flower of *C. tinctorius* L. is a pretty widely-used traditional medicine in China, which is also called red flower or safflower. It is cultivated all over China, especially in Xinjiang (Uygur Autonomous Region), Henan, Zhejiang and Sichuan Province, China. As one of Traditional Chinese Medicines, safflower does hold an effective impact on eliminating the stasis and invigorating the blood circulation. The pharmacological studies as well indicate that safflower possesses several medicinal

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functions such as activating uterus, lowering hypertention and hyperlipemia [2]. Meanwhile it is endowed with properties as anti-inflammatory and analgesic, anti-aging and improving cardiovascular functions, etc. A large variety of compounds are isolated and identified from *C. tinctorius* L., for instance, flavonoids, alkaloids, lignanoids, polyacetylenes, spermidines, organic acids, etc [3, 4].

In the course of a continuing search for active compounds from *C. tinctorius* L., a new phenylpropanoid derivative, named 2-hydroxy-1-(3-hydroxy-3-(2-(2-methoxy-2-oxoethyl) phenyl) propanoyloxy) pentan-3-yl benzoate (**1**), along with *β*-daucosterol (**2**) and stigmasterol (**3**) were obtained from the aerial part of *C. tinctorius* L.. In the paper, isolation and elucidation of the compounds were reported.

2. Materials and Methods

2.1 General

1D and 2D-NMR spectra (^{1}H-NMR, ^{13}C-NMR, DEPT, HMBC, HMQC and ^{1}H-^{1}H COSY) were recorded on a *Bruker DRX-500* (^{1}H: 500 MHz and ^{13}C: 125 MHz; *Karlsruhe*, Germany). Chemical shifts are given as δ values related to TMS as an internal standard. Mass spectra were measured with *Agilent 1100 series* mass spectrometer and *Q-TOF micro YA019* mass spectrometer as ESI-MS and HR-ESI-MS, respectively. Column chromatography was carried out on silica gel (SiO_2; 100-200 and 300-400 mesh; *Yantai Huiyou*, P. R China), and TLC was carried out on plates coated with silica gel F_{254} (10-40 μm, *Yantai Zhigang*, P.R. China).

2.2 Material

The dried aerial part of *C. tinctorius* L. was collected from Xinxiang, Henan Province, P.R. China, in July, 2010. The plant material was identified by Prof. HUANG Bao-Kang, Department of Phytochemistry, Second Military Medical University. A dried specimen (20100725) was deposited in the herbarium of Department of Chemistry, Faculty of Basic Medicine, Shanghai Jiao tong University School of Medicine, Shanghai.

2.3 Extraction and isolation

The air-dried flowers of *C. tinctorius* L. (dry weight 2500.0 g) were extracted three times with 75% EtOH (3 × 20 L, each 48 h) at room temperature. The extract was evaporated *in vacuo* to afford a dark gum (112.8 g), which was diluted in H_2O and partitioned with petroleum ether (PE), dichloromethane (CH_2Cl_2) and ethyl acetate (EtOAc), yielding extracts of 30.1 g, 12.5 g and 24.2 g, respectively. The EtOAc extract (15.0 g) was subjected to silica gel column chromatography (300-400 mesh, 7.5 × 25 cm) eluting with stepwise gradient of CH_2Cl_2/MeOH (100:1, 50:1, 20:1, 10:1, 5:1 and 1:1, *v/v*) to afford 16 fractions, Then sub fraction Fr.6 (447.2 mg), was further purified by silical gel (100-200 mesh, 2.5 × 15 cm, PE- EtOAc 20:1-1:1) to yield compounds **1** (5.0 mg), **2** (15.0 mg) and **3** (7.0 mg).

3. Results and discussion

The 75% extract of aerial parts of *C. tinctorious* L. afforded **1** by silica gel chromatography. The structure of compound **1** was elucidated by extensive 1D and 2D NMR spectroscopy as follows.

Table 1. ^{1}H- and ^{13}C-NMR spectral (500 MHz and 125 MHz, resp.) data of compound **1** in $CDCl_3$

No	δ_H *J*(*Hz*)	δ_C	HMBC
1	3.92, 1H, dd *J* = 5.0, 4.5 Hz	64.58	
	3.81, 1H, dd, *J* = 4.5, 4.0 Hz		
2	4.75, 1H, m	55.01	C1, C1'
3	4.22, 1H, m	77.4	C1
4	1.24, 2H, m	29.70	
5	0.87, 3H, t, *J* = 2.0 Hz	15.00	
1'	/	170.77	
2'	2.74, 2H, d, *J* = 6.0 Hz	37.44	C3', C4', C5', C9'
3'	4.33, 1H, t, *J* = 6.0, 6.0 Hz	49.49	
4'	/	136.69	
5'	7.06, 1H, d, *J* = 7.0 Hz	129.14	C6', C9'
6'	7.21, 1H, m	127.15	C7'
7'	7.22, 1H, m	129.24	C6'
8'	7.42, 1H, d, *J* = 7.5 Hz	128.64	C4', C5', C9'
9'	/	136.61	
10'	3.20, 1H, d, *J* = 5.5 Hz	38.40	C4', C8', C9', C11'
	3.04, 1H, d, *J* = 5.5 Hz		C4', C8', C9', C11'
11'	/	170.31	
12'	2.01, 3H, s	20.79	C11'
1"	/	167.14	
2"	/	133.65	
3"	7.15, 1H, m	128.59	C1"
4"	7.12, 1H, m	126.76	C6"
5"	7.27, 1H, m	128.77	C4"'
6"	7.50, 1H, t, *J* = 7.6, 7.0 Hz	131.93	C7"
7"	7.70, 1H, d, *J* = 7.6 Hz	127.07	C1", C4", C6"
2-OH	6.75, 1H, s		
3'-OH	5.95, 1H, s		

Compound **1** was obtained as white crystals and can be dissolved in dichloromethane easily. The molecular formula of **1** was determined as $C_{24}H_{28}O_8$, by HR-ESI-MS (*m/z*: 444.0500 $[M+H]^+$, $C_{24}H_{28}O_8$; calc. 444.0507), and its value of unsaturation was 11. The ^{13}C-NMR and DEPT spectrum of compound **1** indicated 24 C-atoms, including one Me group and one OCH_3, four CH_2, twelve CH, two of which are O-bearing CH groups, six quaternary C-atoms, including three C-atoms of C=O at δ_C 167.14 (C-1"), 170.31 (C-11') and 170.77 (C-1'). ^{13}C-NMR datas also showed there were twelve

characteristic aromatic carbon signals between δ_C 120 and 140, in which three carbons are quaternary at δ_C 133.65 (C-2''), 136.61(C-9') and 136.69 (C-4'), indicating there are two aromatic rings, of which one is mono-substituted and the other is di-substituted. The ^{1}H-NMR spectrum of compound **1** also displayed two separate peak signals for two OH groups at δ_H 5.95 (1H, s) and 6.75 (1H, s).

With the aid of HMQC, HMBC and ^{1}H-^{1}H COSY experiments, all the ^{1}H and ^{13}C NMR signals of compound **1** were assigned as shown in Table 1 and Figure 2. In the ^{1}H-^{1}H COSY spectrum, the main structure connections were signed with bold bond in Figure 2 as below:

i. H-2' (2.74, 2H, d, *J* = 6.00 Hz) showed a connection to H-3' (4.33, 1H, t, *J* = 6.0, 6.0 Hz), which also connected 3'-OH (5.95, 1H, s);

ii. Connections of H-1 (3.92, 1H, dd, *J* = 5.0, 4.5 Hz; 3.81, 1H, dd, *J* = 4.5, 4.0 Hz), H-2 (4.75, 1H, m) and 2-OH (6.75, 1H, s) were observed;

iii. There is a connection between H-4 (1.24, 2H, m) and H-5 (0.87, 3H, t, *J* = 2.0 Hz).

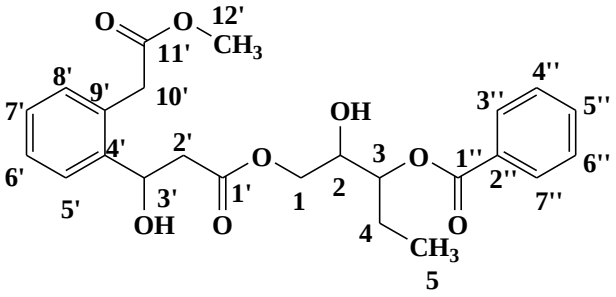

Figure 1. The structure of compound 1 isolated from *C. tinctorious* L.

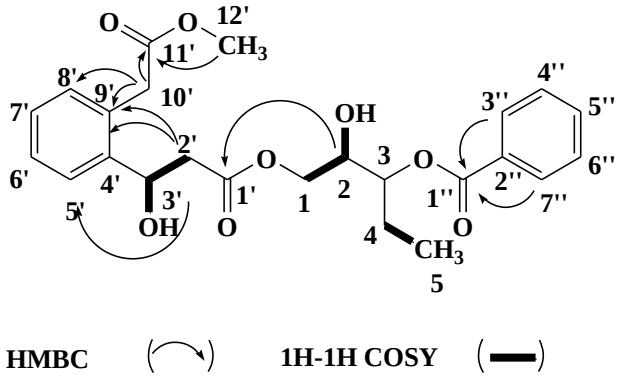

Figure 2. Key correlations in the HMBC and ^{1}H-^{1}H COSY spectrum of compound 1

From HMBC, the correlations between H-2' and aromatic carbon signals C-4'/C-5'/C-9' were also observed, which are marked with curved arrows in Figure 2 The HMBC spectrum also shown two correlations, one is two protons of Ha-10' (3.04, 1H, d, *J* = 5.5 Hz) and Hb-10' (3.20**,** 1H, d, *J* = 5.5 Hz) to C-4'/C-8'/C-9', the other is H-12' (2.01, 3H, s) to C-11', indicated a methyl acetate group was located at C-9'. Besides, two aromatic protona H-3'' (7.15, 1H, m) and H-7'' (7.70, 1H, d, *J* = 7.6 Hz), along with a carbonyl carbon C-1'' revealed the aromatic ring was allocated with a carbonyl group at C-2'. On the basis of the above evidence, compound 1 was elucidated as carthamusin A [2-hydroxy-1-(3-hydroxy-3-(2-(2-methoxy-2-oxoethyl) phenyl) propanoyloxy) pentan-3-yl benzoate].

The two known compounds *β*-daucosterol (**2**) and stigmasterol (**3**) [5] were identified through direct comparison with standard compounds.

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References

[1] Science Press, Flora of China (1983). Beijing: *Science Press*.**78**, 186

[2] Jiangsu New School of Medicine. Dictionary of Traditional Chinese Medicine (1986). Shanghai: *Shanghai Science and Technology Press*. 992-994

[3] Y.M. Li and Q.M. Che (1998). Chemical constituents from *Carthamus tinctorius* L., *Acta. Pharmaceutica Sini*. **33(8)**, 626-628.

[4] X.J. Hu, S. Yin, T.T. Yuan, Y.J. Wang, Z.R. Huang and L. Yang (2013). Advanced studies on chemical constituents and pharmacological activities of *Carthamus tinctorius* L., *J Pharmaceu Prac*. **31(3)**, 161-168.

[5] Y.M. Liu, J.S. Yang and Q.H. Liu (2005). Studies on chemical constituents of *Carthamus tinctorius*, *Chin Tradit Herb Drugs.* **4(28)**, 288-289.

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