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PHYTOCHEMISTRY

Eicosenones and methylated flavonols from *Amomum koenigii*

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Abstract

Two novel eicosenones, 1-methoxy-*E*-4-eicosen-3-one and 1-(4′-hydroxyphenoxy)-*E*-4-eicosen-3-one, together with eleven known methylated flavonols were isolated from the fruits of *Amomum koenigii*. Their structures were elucidated by spectroscopic techniques. © 1999 Elsevier Science Ltd. All rights reserved.

Keywords: *Amomum koenigii*; Zingiberaceae; Eicosenones; 1-Methoxy-*E*-4-eicosen-3-one; 1-(4′-Hydroxyphenoxy)-*E*-4-eicosen-3-one; Methoxyflavonols

1. Introduction

Amomum koenigii J. F. Gmelin is a member of the Zingiberaceae. Many species of this family, including ginger (*Zingiber officinale*), turmeric (*Curcuma longa*) and Cardamom (*Elettaria cardamomum*), have been used for centuries as foods, spices and perfumes and in traditional Chinese, Japanese and Indian medicines (Jurens et al., 1994). Antioxidant diarylheptanoids, curcuminoids (Jitoe et al., 1992; Wu & Su, 1996) and antimalarial peroxide constituents (Kamchonwongpaisan et al., 1995) have been reported recently from other species of the genus *Amomum*. The fruits of *A. koenigii* have been used as an aromatic stomachic in south-west regions of China (Fang, 1978). There have been no previous reports on the chemistry of this plant. As a part of our phytochemical surveys of the Zingiberaceae, we report here on the isolation and structure elucidation of two novel eicosenones, 1-methoxy-*E*-4-eicosen-3-one (**1**) and 1-(4′-hydroxyphenoxy)-*E*-4-eicosen-3-one (**2**), together with eleven known methylated flavonols, from the fruits of *Amomum koenigii*.

2. Results and discussion

Compound **1** was obtained as an oil. The molecular formula was determined to be $C_{21}H_{40}O_2$ (M^+ 324.3006, calc. 324.3028) by HREIMS. The IR and UV spectra showed the presence of an α,β-unsaturated ketone (1630 cm^{-1} and λ_{max} 250 nm). The ^{13}C NMR together with a DEPT spectrum indicated the presence of the characteristic signals due to a methyl group, a methoxyl group, an oxygenated methylene group, a double bond, a carbonyl group and fifteen methylene carbons (Table 1). The ^1H NMR spectrum showed the presence of a pair of *trans* olefinic protons and eight discrete methylene protons as four signals, a methyl group and a methoxyl group. The signal due to a methylene envelope was due to twelve methylene groups. The ^1H–^{13}C long-range COSY and ^1H–^1H COSY spectra of this compound gave good information for establishing the assignment of the partial structure of C-1–C-6. There was long-range correlations between the H-1 and the methoxyl carbon in the HMBC spectrum. This required that the methoxyl group was linked at the C-1 position. Likewise, the observation of the correlations between the carbonyl carbon and H-1, H-2 and H-5 in the HMBC spectrum (Figure 1) and the cross-peaks between the signals of H-1 and H-2 protons and H-5 and H-6 protons in the ^1H–^1H COSY spectrum indicated that the ketone must be at the C-3 and the double bond at C-4 and C-5 positions. From the above data, the structure of **1** was determined to be 1-methoxy-*E*-4-eicosen-3-one.

Compound **2** was obtained as a wax. The molecular formula was established as $C_{26}H_{42}O_3$ (M^+ 402.3108, calc. 402.3134) by HREIMS and its ^1H and ^{13}C NMR spectral data. The IR and UV spectra showed the presence of a hydroxyl group (3464 cm^{-1}) and an α,β-unsaturated

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Table 1
^{1}H and ^{13}C NMR data of compounds **1** and **2** ($CDCl_3$)[a]

Position	**1**		**2**	
	^{1}H[b]	^{13}C[c]	^{1}H	^{13}C
1	3.68 t (6.4)	67.87 t	4.21 t (6.4)	63.98 t
2	2.79 t (6.4)	39.89 t	3.01 t (6.4)	39.39 t
3		198.54 s		198.55 s
4	6.05 d (15.9)	130.52 d	6.15 d (16.0)	130.46 d
5	6.74 dt (15.9, 7.1)	148.36 d	6.91 dt (16.0, 7.0)	149.15 d
6	2.22 m	32.51 t	2.22 m	32.58 t
7	1.46 m	28.08 t	1.47 m	28.06 t
8–17	1.26–1.28 m	28.99–29.75 t	1.25–1.28 m	28.98–29.69 t
18	1.26–1.28 m	22.69 t	1.25–1.28 m	22.69 t
19	1.26–1.28 m	31.93 t	1.25–1.28 m	31.93 t
20	0.87 t (6.1)	14.11 q	0.88 t (6.4)	14.11 q
1′				152.63 s
2′, 6′			6.73 s	116.08 d
3′, 5′			6.74 s	115.78 d
4′				150.03 s
OCH_3	3.33 s	58.84 q		

[a] Chemical shifts (δ) are in ppm with coupling constants (*J* in Hz) in parentheses.

[b] 500 MHz.

[c] 125 MHz.

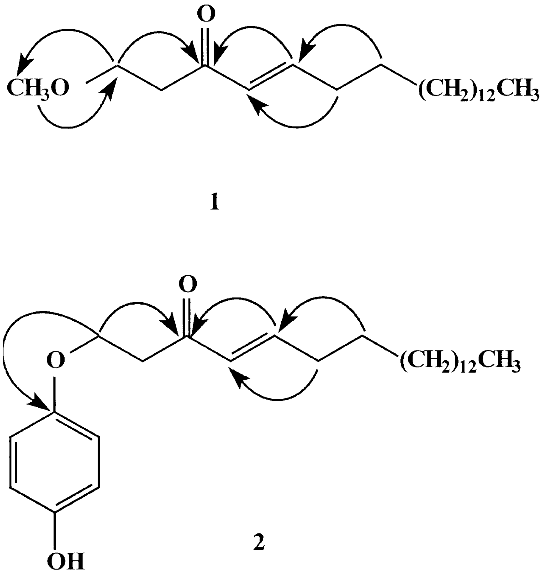
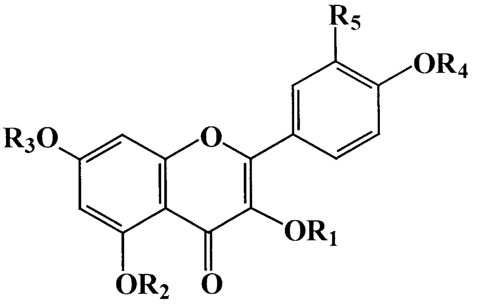


Fig. 1. Selected HMBC correlations in compounds **1** and **2**.

ketone (1671 cm^{-1} and λ_{max} 250 nm). Analysis of ^{1}H and ^{13}C NMR indicated that the spectral data of **2** were similar to those of **1**. The ^{1}H NMR spectrum exhibited the characteristic peaks for two *trans* olefinic protons in an α,*β*-unsaturated ketone, one adjacent to a methylene, four protons in two discrete methylene groups and four protons in a *para*-substituted phenyl group (Table 1). The ^{13}C NMR of **2** showed the characteristic signals due to a carbonyl group, a double bond, an oxygenated methylene group and a *para*-substituted phenyl group. The HMBC spectrum of **2** permitted the assignment of the locations of one carbonyl group at C-3, a double bond at C-4 and C-5 by the observation of the correlations between H-1 and C-3 and C-2 and H-5 and C-3. Furthermore, the correlations observed between H-1 and C-1′ (Fig. 1) enable us to assign the linkage between the 4-eicosen-3-one part and the 4′-hydroxyphenoxy part through C-1–C-1′ positions. Thus, **2** was elucidated as 1-(4′-hydroxyphenoxy)-*E*-4-eicosen-3-one.

Eleven known methylated flavonols, 5-hydroxy-3,7,4′-trimethoxyflavone (**3**) (Kamaya & Ageta, 1990), 5-hydroxy-3, 7,3′,4′-tetramethoxyflavone (**4**) (Valesi, Rodriguez, Vander Velde, & Mabry, 1972; Malan & Roux, 1979), 3,7-dihydroxy-5,4′-dimethoxyflavone (**5**) (Imperto, 1987), 3-hydroxy-5,7,4′-trimethoxyflavone (**6**) (Greenham, William, & Harborne, 1995), 5,4′-dihydroxy-3,7-dimethoxyflavone (**7**) (Herz, Fitzhenry, & Anderson, 1973), 3,5,7,4′-tetramethoxyflavone (**8**) (Joseph-Nathan, Abramo-Brano, & Tores, 1981), 3,7-dihydroxy-5,3′,4′-trimethoxyflavone (**9**) (Markham, Ternai, Stanley, Geiger, & Mabry, 1978), 5,3′-dihydroxy-3,7,4′-trimethoxyflavone (**10**) (Malan & Roux, 1979), 3,5-dihydroxy-7,3′,4′-trimethoxyflavone (**11**) (Valesi et al., 1972), 3,5,3′-trihydroxy-7,4′-dimethoxyflavone (**12**) (Wollenweber & Dietz, 1981) and 3,5,7,3′,4′-pentamethoxyflavone (**13**) (Joseph-Nathan et al., 1981) were also isolated from the fruits of *A. koenigii*. Their structures were identified by comparison of their melting points, UV, ^{1}H NMR and mass spectral data with those reported and further confirmed by comparison of their ^{13}C NMR data with those of model compounds, **4**, **8**, **9** and **14**. The carbon signals of **9** were assigned by means of HMQC and HMBC experiments. Several papers have already been published on ^{13}C NMR spectral studies on flavonoids (Calvert, Cambie, & Davis, 1979; Iinuma, Matsuura, & Kusuda, 1980; Horie et al., 1998), but the ^{13}C NMR data for some of these methylated flavonols do not appear to have been reported in the literature. Their ^{13}C chemical shift are listed in Table 2.

These eleven methylated flavonols fall neatly into two groups, methylated kaempferol and methylated quercetin derivatives. Methylated kaempferol derivatives have been reported from *Alpinia* (*A. japonica* and *A. kumatake* (Kimura, Takida, & Takahashi, 1967; Kimura, Takida, Takahashi, & Kimishima, 1967)) and *Zingiber* (*Z. zerumbet* (Nakatani, Jitoe, Masunda, & Yonemori, 1991)) genera of Zingiberaceae but no methylated quercetin derivatives have been reported from this family.



	R_1	R_2	R_3	R_4	R_5
3	CH_3	H	CH_3	CH_3	H
4	CH_3	H	CH_3	CH_3	OCH_3
5	H	CH_3	H	CH_3	H
6	H	CH_3	CH_3	CH_3	H
7	CH_3	H	CH_3	H	H
8	CH_3	CH_3	CH_3	CH_3	H
9	H	CH_3	H	CH_3	OCH_3
10	CH_3	H	CH_3	CH_3	OH
11	H	H	CH_3	CH_3	OCH_3
12	H	H	CH_3	CH_3	OH
13	CH_3	CH_3	CH_3	CH_3	OCH_3

3. Experimental

3.1. General

M.p.'s were uncorr. EIMS were obtained on a MAROMASS 7035E mass spectrometer at 70 eV. All spectra (^{1}H, ^{13}C, COSY, HMQC and HMBC) were recorded on a Bruker AMX 500 spectrometer (500 MHz for ^{1}H and 125 MHz for ^{13}C). Chemical shifts were reported in ppm with TMS as an int. standard.

3.2. Plant material

The fruits of *Amomum koenigii* used in this experiment were collected from the Yunnan Province of the People's Republic of China in October 1992. The plant was identified by Professor Xu Luo-Shan, Department of Pharmacognosy, China Pharmaceutical University, People's Republic of China. A voucher specimen (CPU9201076) was deposited in the herbarium of the China Pharmaceutical University.

3.3. Extraction and isolation

Dried fruits of *A. koenigii* (2.5 kg) were powdered and percolated with MeOH (3 × 12 l) at room temp. The concd extract gave a residue of 280 g. A portion of the residue (30 g) was suspended in 10% aqueous MeOH (1 l) and successively partitioned by hexane (3 × 1 l) and CH_2Cl_2 (3 × 1 l). The hexane extract (12.5 g) was subjected to CC over Si gel 60 and eluted under gradient conditions with increasing amounts of EtOAc in hexane to afford **1** (22 mg), **2** (10 mg), **3** (45 mg), **4** (500 mg) and **5** (15 mg). Compounds **1** and **2** were further purified on PTLC by using hexane–EtOAc (8:2) (**1**, $R_f = 0.6$; **2**, $R_f = 0.3$). The CH_2Cl_2 extract (4 g) was subjected to CC over Si gel 60 and eluted under gradient conditions with increasing amounts of MeOH in $CHCl_3$ to furnish **6** (10 mg), **7** (5 mg), **8** (12 mg), **9** (25 mg), **10** (7 mg), **11** (40 mg), **12** (13.5 mg) and **13** (5 mg).

3.4. *1-Methoxy-*E*-4-eicosen-3-one (**1**)*

Transparent oil. EIMS *m/z* (rel. int.): 324 [M^+] (3), 293 (8), 265 (11), 199 (10), 129 (26), 83 (74), 71 (89), 55 (100), 43 (92). IR (CCl_4) ν_{max} cm^{-1}: 2926, 2855, 1630 (C=O), 1466, 978. UV ($CHCl_3$) λ_{max} nm (log ε): 250 (3.45). For ^{1}H and ^{13}C NMR, see Table 1.

3.5. *1-(4′-Hydroxyphenoxy)-*E*-4-eicosen-3-one (**2**)*

Colorless wax. EIMS *m/z* (rel. int.): 402 [M^+] (5), 318 (11), 293 (10), 265 (8), 175 (27), 136 (34), 124 (48), 110 (84), 96 (73), 82 (77), 55 (100), 43 (80). IR (CCl_4) ν_{max} cm^{-1}: 3464 (OH), 2921, 2851, 1671 (C=O), 1520, 983. UV ($CHCl_3$) λ_{max} nm (log ε): 250 (3.79), 287 (3.85). For ^{1}H and ^{13}C NMR, see Table 1.

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Table 2
^{13}C NMR data of compounds **3**–**13**[a]

	C2	C3	C4	C5	C6	C7	C8	C9	C10	C1′	C2′	C3′	C4′	C5′	C6′	OCH$_3$[d]	OCH$_3$	OCH$_3$	OCH$_3$	OCH$_3$
3	155.9	138.8	178.8	156.7	97.8	165.4	92.1	162.0	106.5	122.8	130.1	114.0	161.7	114.0	130.1	60.1	55.4	55.8		
4	155.6	138.8	178.6	156.6	97.7	165.3	92.1	161.9	105.9	122.8	110.7	148.6	151.3	110.4	122.1	60.0	55.7	55.8	55.9	
5	145.7	135.7	175.2	156.9	97.9	165.7	92.2	161.2	103.9	123.2	129.4	114.1	160.8	114.1	129.4		55.4	55.9		
6	142.3	137.5	171.9	158.9	95.7	164.4	92.5	160.7	106.3	123.6	128.9	114.1	160.6	114.1	128.9		55.4	55.8	56.4	
7	156.0	137.9	178.1	156.4	97.8	165.2	92.4	160.9	105.3	120.6	130.3	115.8	160.3	115.8	130.3	59.8	56.1			
8	152.7	141.1	174.1	158.8	95.7	163.9	92.4	161.2	109.5	123.3	129.8	113.9	161.0	113.9	129.8	59.9	55.4	55.7	56.4	
9	145.4	135.7	175.0	156.7	97.8	165.6	92.1	160.7	103.8	123.3	110.8	148.7	150.7	110.5	121.3		55.7	55.9	55.9	
10[b]	148.1	140.4	180.3	158.4	99.2	167.3	93.5	163.5	107.3	124.8	116.5	151.6	157.4	112.6	122.6	60.9	57.0	57.1		
11[c]	146.5	136.5	176.0	156.0	97.5	164.9	92.1	160.3	104.0	123.1	111.4	148.4	150.5	110.9	121.5		55.6	55.6	55.9	
12[c]	146.2	136.1	176.2	156.0	97.1	164.8	91.8	160.3	104.2	123.3	114.6	146.2	149.3	111.7	119.7		55.6	55.9		
13	152.6	141.2	174.0	158.8	95.8	163.9	92.5	161.1	109.5	123.4	111.3	148.7	150.9	110.8	121.6	59.9	55.8	55.9	56.1	56.4

[a] 125 HMz measured in $CDCl_3$

[b] In CD_3COCD_3.

[c] In DMSO-d_6.

[d] OCH_3 at C-3 position.

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