Pergamon

0031-9422(95)00509-9

Phytochemistry, Vol. 40, No. 4, pp. 1317-1319, 1995

0031-9422/95 $9.50 + 0.00

A DIELS–ALDER-TYPE ADDUCT FROM *ARTOCARPUS HETEROPHYLLUS**

KAZUKI SHINOMIYA, MIWA AIDA, YOSHIO HANO and TARO NOMURA†

Faculty of Pharmaceutical Sciences, Toho University, 2-2-1, Miyama, Funabashi, Chiba 274, Japan

(*Received* 18 *April* 1995)

Key Word Index—*Artocarpus heterophyllus*; Moraceae; bark; chalcone; Diels–Alder-type adduct.

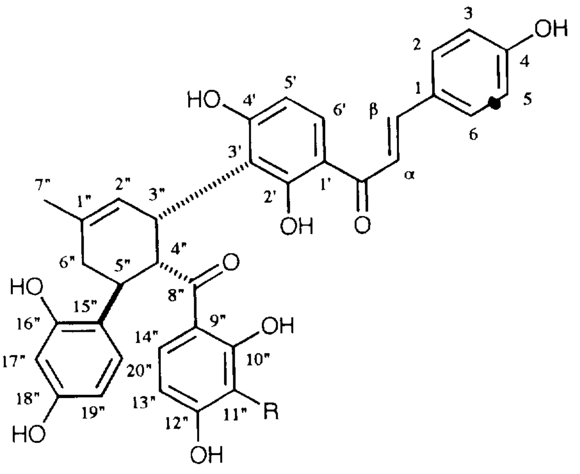
Abstract—A new natural Diels–Alder-type adduct, artonin X, along with two known Diels–Alder type adducts, were isolated from the bark of *Artocarpus heterophyllus*. The structure was elucidated by spectroscopic methods.

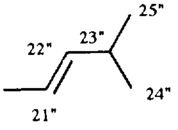
INTRODUCTION

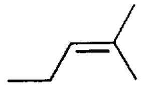
We have reported a series of isoprenoid-substituted phenols from species of the Moraceae [2, 3]. Some of these compounds are regarded biogenetically as natural Diels–Alder-type adducts of dehydroprenylphenols and chalcone derivatives, and showed interesting biological activities, such as a hypotensive effect, inhibitory activity against arachidonate 5-lipoxygenase, anti-tumour promoting activity, etc. [2, 3]. In continuation of our studies, we examined the phenolic constituents of *Artocarpus heterophyllus* and reported the characterization of a series of isoprenoid-substituted phenolic compounds [4–8]. Further extension of this work has led to the isolation of a new Diels–Alder-type adduct, artonin X (**1**), along with the known Diels–Alder-type adducts, kuwanon R (**2**) [9] and artonin D [5]. The present paper deals with the characterization of compound **1**.

RESULTS AND DISCUSSION

Artonin X (**1**) was obtained as yellow amorphous powder and gave a positive reaction with methanolic ferric chloride. The FAB mass spectrum of **1** showed a $[M + H]^+$ at m/z 663 and the ^{13}C NMR spectrum indicated the presence of 40 carbon atoms (Table 1). From these results, the molecular formula $C_{40}H_{38}O_9$ was suggested. The IR spectrum exhibited absorption bands due to hydroxyl, conjugated carbonyl and benzene ring moieties. The UV spectrum was similar to that of chalcone derivatives, such as kuwanon R (**2**) [9] and artonin D [5]. From these results, artonin X (**1**) is assumed to be a Diels–Alder-type adduct analogous to **2** and artonin D. This assumption was substantiated by comparing the ^{1}H NMR spectrum of **1** with that of **2** (Table 2). In the ^{1}H NMR spectrum of **1**, the chemical shifts and coupling constants of all the proton signals except those of the isoprenoid moiety resembled those of the relevant protons of **2** (Table 2). Furthermore, the chemical shift values of the carbon atoms, except those of the isoprenoid moiety, were in good agreement with those of the relevant carbon atoms of **2** (Table 1). The presence of a 3-methyl-1-butenyl moiety in the structure of **1** was confirmed by the ^{1}H NMR spectrum. The ^{13}C NMR spectrum indicated signals due to the following moieties: $\delta 23.1$ (CH_3- × 2), 33.9 ($^{H}{>}C{<}$), 117.4, 142.6 (–CH=CH–) [5]. These results suggest that the structure of artonin X is represented by formula **1**, including the relative configuration. Furthermore, the locations of the substituents on the methylcyclohexene ring and the isoprenoid moiety were confirmed with the aid of



1 : **R** =


2 : **R** =


---

*Part 24 in the series 'Constituents of the Moraceae Plants'. For Part 23, see ref. [1].

†Author to whom correspondence should be addressed.

Table 1. ^{13}C NMR data for compounds **1** and **2** (δ values, 100 Hz)

Carbon	**1**	**2**
1	127.5	127.4
2	131.8	131.7
3	116.7	116.7
4	161.0	161.0
5	116.7	116.7
6	131.8	131.7
α	118.3	118.3
β	145.1	145.0
C=O	192.9	192.9
1′	113.9	113.9
2′	163.8	163.7
3′	116.1	115.8
4′	165.8	165.8
5′	110.1	110.2
6′	131.0	130.9
1″	135.0	134.8
2″	123.3	123.2
3″	32.8	32.5
4″	47.5	47.4
5″	36.3	36.4
6″	32.6	32.4
7″	23.8	23.8
8″	209.5	209.5
9″	113.4	113.3
10″	164.8	164.6
11″	113.0	117.3
12″	163.3	163.7
13″	108.5	108.1
14″	132.2	132.9
15″	121.8	121.7
16″	156.4	156.4
17″	103.7	103.6
18″	157.9	157.9
19″	107.5	107.5
20″	128.8	128.6
21″	117.4	22.2
22″	142.6	123.4
23″	33.9	131.4
24″	23.1	17.8
25″	23.1	25.8

a HMBC spectrum. On the other hand, our previous work established the *cis-trans* adduct {3″-H and 4″-H (*cis*), 4″-H and 5″-H (*trans*)} as 3″*S*,4″*R*,5″*S* with positive opitcal rotations, as found in **1** and **2**, while the all-*trans* {3″-H and 4″-H (*trans*), 4″-H and 5″-H (*trans*)} as 3″*R*,4″*R*,5″*S* displayed a negative rotaion [2, 10, 1]. Therefore, **1** was assigned the 3″*S*,4″*R*,5″*S*-configuration.

EXPERIMENTAL

General. ^{1}H and ^{13}C NMR were recorded using TMS as int. standard in acetone-d_6. Wakogel C-200 and B-5F (Wako Pure Chem.) were used for CC and TLC, respectively.

Table 2. ^{1}H-NMR data for compounds **1** and **2** (δ values, 400 MHz)*

Proton	**1**	**2**
2-, 6-H	7.70 (*d*, $J = 9$)	7.70 (*d*, $J = 9$)
3-, 5-H	6.90 (*d*, $J = 9$)	6.90 (*d*, $J = 9$)
α-H	7.69 (*d*, $J = 15$)	7.69 (*d*, $J = 15$)
β-H	7.77 (*d*, $J = 15$)	7.76 (*d*, $J = 15$)
5′-H	6.37 (*d*, $J = 9$)	6.37 (*d*, $J = 9$)
6′-H	7.93 (*d*, $J = 9$)	7.93 (*d*, $J = 9$)
2″-H	5.68 (*br s*)	5.68 (*br s*)
3″-H	4.19 (*br*)	4.19 (*br*)
4″-H	4.68 (*dd*, $J = 4$ and 5)	4.68 (*dd*, $J = 4$ and 5)
5″-H	3.81 (*m*)	3.81 (*m*)
6″-Ha	2.22 (*dd*, $J = 4$ and 17)	2.22 (*dd*, $J = 4$ and 17)
6″-Hb	2.52 (*br d*, $J = 17$)	2.51 (*br d*, $J = 17$)
7″-H3	1.94 (3H, *br s*)	1.94 (3H, *br s*)
13″-H	6.48 (*d*, $J = 9$)	6.45 (*d*, $J = 9$)
14″-H	8.34 (*d*, $J = 9$)	8.33 (*d*, $J = 9$)
17″-H	6.51 (*d*, $J = 2$)	6.51 (*d*, $J = 2$)
19″-H	6.30 (*dd*, $J = 2$ and 8)	6.31 (*dd*, $J = 2$ and 8)
20″-H	6.96 (*d*, $J = 8$)	6.97 (*d*, $J = 8$)
21″-H	6.54 (*d*, $J = 16$)	3.26 (2H, *br d*, $J = 7$)
22″-H	6.65 (*d*, $J = 16$)	5.16 (*br t*, $J = 7$)
23″-H	2.38 (*m*)	—
24″-H_3	1.03 (3H, *d*, $J = 7$)	1.59 (3H, *br s*)
25″-H_3	1.03 (3H, *d*, $J = 7$)	1.72 (3H, *br s*)
2′-OH	14.20 (*s*)	14.21 (*s*)
10″-OH	13.40 (*s*)	12.86 (*s*)

* Parentheses denote multiplicities and coupling constants in Hz.

Plant material. Dried bark of *A. heterophyllus* Lamk. was collected in the Botanical Garden of Bogor, Indonesia, in March 1988, and was identified on site. A voucher specimen is deposited in the Herbarium of Toho University.

Extraction and isolation. Dried bark (20 kg) [9] was extracted with MeOH. The MeOH extract (1.1 kg) was extracted with benzene and Me_2CO, successively. The benzene and Me_2CO solns were evapd to give 420 g and 365 g of residues, respectively. The Me_2CO extract (300 g) was subjected to CC over silica gel (1200 g) using benzene–EtOAc as eluting solvent. The fr. (28 g) eluted with benzene–EtOAc (7:3) was rechromatographed over a silica gel (250 g) column using benzene–Me_2CO. The fr. (6 g) eluted with benzene–Me_2CO (17:3) was subjected to repeated silica gel (50 g) CC using $CHCl_3$–Me_2CO. The fr. (1.2 g) eluted with $CHCl_3$–Me_2CO (9:1) was fractionated by prep. TLC [silica gel, benzene–Me_2CO (2:1), *n*-hexane–Me_2CO (3:2)] and by prep. HPLC [*n*-hexane–EtOAc (1:1), $CHCl_3$–MeOH–H_2O (200:10:1), column, Senshu Pak SSC Silica 4251-N, $10\phi \times 250$ mm, detector, UV 254 nm] to give artonin X (**1**, 4 mg), kuwanon R (**2**, 5 mg) and artonin D (3 mg). Two known compounds, kuwanon R (**2**) and artonin D, were identified by comparison with authentic samples.

Artonin X (**1**). Yellow powder. $[\alpha]_D^{22}$ + 12° (MeOH; *c* 0.085). IR ν_{max}^{KBr} cm^{-1}: 3600–3200 (br), 1660, 1630, 1600, 1560, 1500. UV $\lambda_{\max}^{\mathrm{EtOH}}$ nm (log ε): 202 (4.35), 253 (3.96), 309 (3.87), 370 (4.02). FABMS m/z: 663 $[M + H]^+$.

REFERENCES

1. Hano, Y., Yamanaka, J., Nomura, T. and Momose, Y. (1995) *Heterocycles* **41**, 1035.
2. Nomura, T. (1988) in *Progress in the Chemistry of Organic Natural Products* (Herz, W., Grisebach, H., Kirby, C. W. and Tamm, Ch., eds), p. 87. Springer-Verlag, Vienna.
3. Nomura, T. and Hano, Y. (1994) *Nat. Prod. Rep.* **11**, 205.
4. Hano, Y., Aida, M., Shiina, M., Nomura, T., Kawai, T., Ohe, H. and Kagei, K. (1989) *Heterocycles* **29**, 1447.
5. Hano, Y., Aida, M. and Nomura, T. (1990) *J. Nat. Prod.* **53**, 391.
6. Hano, Y., Aida, M., Nomura, T. and Ueda, S. (1992) *J. Chem. Soc., Chem. Commun.* 1177.
7. Aida, M., Shinomiya, K., Hano, Y. and Nomura, T. (1993) *Heterocycles* **36**, 2243.
8. Aida, M., Shinomiya, K., Matsuzawa, K., Hano, Y. and Nomura, T. (1994) *Heterocycles* **39**, 847.
9. Ikuta (*née* Matsumoto), J., Fukai, T., Nomura, T. and Ueda, S. (1988) *Chem. Pharmacol. Bull.* **34**, 2471.
10. Hano, Y., Suzuki, S., Kohno, H. and Nomura, T. (1988) *Heterocycles* **27**, 75.
11. Hano, Y., Suzuki, S., Nomura, T. and Iitaka, Y. (1988) *Heterocycles* **27**, 2315.