

A NEW AND A KNOWN DERIVATIVES OF 2-(2-PHENYLETHYL)
CHROMONE FROM A KIND OF AGARWOOD ("KANANKOH,"
IN JAPANESE) ORIGINATING FROM *AQUILARIA AGALLOCHA*

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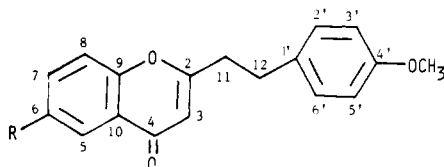
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Agarwood ("Jinkoh," in Japanese) is one of the most famous incenses in the Orient and has been widely used in the exotic Buddhist ceremony ("Koudoh," in Japanese) of traditional Japan for the past ten centuries. Sticks of the wood give, when heated, a glamorous fragrance, the constituents of which may be volatile sesquiterpenes, other volatiles, and thermal products of chromones (1) and other non-volatile compounds. From some kinds of agarwood originating from plants of the genus *Aquilaria* (Thymelaeaceae), a number of sesquiterpenes (2-8) and chromones (1,9) have been identified to date. Recently, we have characterized the component sesquiterpenes (8, 10) from the most expensive and precious kind of agarwood,

called "Kanankoh." In the present paper we deal with the isolation and structure elucidation of a known (1) and a new (2) derivatives of 2-(2-phenylethyl) chromone as further constituents of "Kanankoh" originating from *Aquilaria agallocha* Roxb.

Chromone 1, pale yellow plates, mp 60-61° [lit. (1) a pale yellow viscous oil] gave the molecular ion peak of the com-



1 R=H

2 R=OCH₃TABLE 1. ¹H-nmr (400 MHz) Data of 1 and 2 in CDCl₃^a

Protons	Compound	
	1	2
3-H	6.13 (s)	6.13 (s)
5-H	8.17 (dd, $J_{5,6}=7.8; J_{5,7}=1.5$)	7.55 (d, $J_{5,7}=3.0$)
6-H	7.37 (t, $J_{6,5}=J_{6,7}=7.8$) ^{b,c}	—
7-H	7.64 (td, $J_{7,6}=J_{7,8}=7.8; J_{7,5}=1.5$)	7.24 (dd, $J_{7,8}=9.1; J_{7,5}=3.0$)
8-H	7.43 (d, $J_{8,7}=7.8$) ^c	7.37 (d, $J_{8,7}=9.1$)
11-H ₂	2.89 (m, AA' of AA'BB')	2.89 (m, AA' of AA'BB')
12-H ₂	3.00 (m, BB' of AA'BB')	3.00 (m, BB' of AA'BB')
2', 6'-H ₂	7.11 (d-like) } (AA'XX', $J=8.7$)	7.11 (d-like) } (AA'XX', $J=8.7$)
3', 5'-H ₂	6.82 (d-like) }	6.82 (d-like) }
6-OCH ₃	—	3.89 (s)
4'-OCH ₃	3.77 (s)	3.78 (s)

^aAll chemical shifts are given in δ (ppm) and coupling constants in Hz. The assignments of the signals of 1 were performed in conjunction with ¹³C nmr (Table 2) and proton-carbon-13 selective decoupling analyses (Table 3) and those of 2 are based on the comparison with the established data of 1.

^bWhen H-5 was irradiated, this signal changed into doublet (proton spin decoupling).

^cWhen H-7 was irradiated, the signal multiplicities of both H-6 and H-8 changed into doublet and singlet, respectively (proton spin decoupling).

position $C_{18}H_{16}O_3$, together with the base peak (m/z 121) of C_8H_9O and two significant fragments (m/z 160 and 161), $C_{10}H_8O_2$ and $C_{10}H_9O_2$ (ms and hrms). The 1H -nmr and ^{13}C -nmr data of chromone **1** were essentially consistent with those published (1) for a known chromone, 2-[2-(4'-methoxyphenyl)-ethyl]chromone (**1**) from another kind ("Kyara," in Japanese) of agarwood. However, the reported 1H -nmr data are based on low resolution, and, therefore, only H-5 among the aromatic protons was assigned as a well resolved signal, giving only a little information for structure **1**. In addition, the ^{13}C -nmr data include erroneous results in assignments of C-5 and C-6. Therefore, based on detailed analyses of 1H -nmr (Table 1), ^{13}C -nmr (Table 2), and proton-carbon-13 selective decoupling data (Table 3), structure **1** for chromone **1** was further corroborated. The first full-assigned 1H -

TABLE 3. 1H - ^{13}C Selective Decoupling Data of **1** in $CDCl_3$ ^a

Irradiated protons	Enhanced carbons
3-H	3-C, 11-C ^b
5-H	5-C
6-H	6-C
7-H	7-C
8-H	8-C
11-H ₂	11-C
12-H ₂	12-C
2'(6')-H ₂	2'(6')-C ₂ , 12-C ^c
3'(5')-H ₂	3'(5')-C ₂

^aWhen each proton or each pair of protons was irradiated, the related carbon or carbons were enhanced due to disappearance of spin coupling (nOe effect).

^bThe assignment of C-11 was determined based on the fact that by irradiation of 3-H, the signal of C-11 together with that of C-3 was enhanced. According to this, the assignment of 11-H₂ (Table 1) was also established.

^cThe assignment of C-12 was determined based on the evidence that by irradiation of 2' and 6'-H₂, the signal of C-12 together with C-2' and -6' signal was enhanced. According to this, the assignment of 12-H₂ (Table 1) was also achieved.

TABLE 2. ^{13}C -nmr (100.35 MHz) Data of **1** and **2** in $CDCl_3$ ^a

Carbon No.	Compound	
	1	2
2	168.52, s	168.27, s
3	110.28, d	109.55, d
4	178.24, s	178.16, s
5	125.71, d	104.90, d
6	124.96, d	151.33, s
7	133.48, d	123.50, d
8	117.83, d	119.24, d
9	156.49, s	156.82, s
10	123.77, s	124.34, s
11	36.38, t	36.38, t
12	32.13, t	32.21, t
1'	131.77, s	131.80, s
2' and 6'	129.24, d	129.24, d
3' and 5'	114.08, d	114.06, d
4'	158.30, s	158.28, s
4'-OCH ₃	55.27, q	55.29, q
6-OCH ₃	—	55.93, q

^aChemical shift values are given in δ (ppm) and multiplicities are also given. The assignments of the signals of **1** were performed based on proton-carbon-13 selective decoupling analyses (Table 3) and those of **2** are based on comparison with the established data of **1**.

nmr data and the correct ^{13}C -nmr assignments are reported.

Chromone **2**, colorless crystals, mp 84-85°, possessed the molecular formula $C_{19}H_{18}O_4$ and gave the base peak (m/z 121) for C_8H_9O and a fragment ion (m/z 190) for $C_{11}H_{10}O_3$, both arising from bond fission between C-11 and C-12 (ms and hrms). The 1H -nmr spectrum of **2** was compared with that of **1** (Table 1) and suggested that **2** corresponded to the 6-methoxy derivative of **1**, i.e., 6-methoxy-2-[2-(4'-methoxyphenyl)-ethyl]-chromone. The established structure **2** was further corroborated by the ^{13}C -nmr evidence (Table 2) that C-6 and both adjacent carbons (C-5 and C-7) in **2** appear at lower field and at higher field, respectively, than those carbons of **1**.

On tlc, both **1** and **2** gave bright yellow chromophores after spraying with 1% $Ce(SO_4)_2$ -10% H_2SO_4 and heating. Qualitative tlc analyses of various kinds of agarwood suggested that both **1** and **2** are components characteristic of "Kanankoh," and in other kinds of wood

these chromones are entirely absent or occur in only small amounts.

EXPERIMENTAL

GENERAL EXPERIMENTAL PROCEDURES.—Melting points were determined on a Yanagimoto micro-melting point apparatus and are uncorrected. Spectra were recorded with the following instruments and conditions; ir, JASCO A-102; ms and hrms, JEOL model DX-300 with in-beam method at 70 eV; ^1H nmr (400 MHz), ^{13}C nmr (100.535 MHz), and proton-carbon-13 selective decoupling experiments, JEOL model GX-400 with TMS as internal standard. Preparative hplc was performed on a Waters instrument with a M 6000A pump, a UK 6 septumless injector, and a series R 401 differential refractometer. A micro-bonded silica-packed column (Waters μ Porasil: 7.8 mm \times 30 cm) was used, an eluant flow of 3 ml/min, with n-hexane-EtOAc (1:1) as eluent. Qualitative and preparative tlc was run on silica gel 60 F₂₅₄ with C₆H₆-EtOAc (10:1) as the developing solvent system.

PLANT MATERIAL.—"Kanankoh" used in this study was imported from Vietnam, and the original plant was identified by one of us (K.Y.) as *A. agallocha* from morphological and chemotaxonomical considerations. A voucher specimen is deposited at Faculty of Pharmaceutical Sciences, Osaka University.

EXTRACTION AND ISOLATION.—Crushed wood (2.5 g) was extracted with C₆H₆ (100 ml) for 3 h under reflux. Evaporation of the solvent in vacuo yielded an extract (780 mg) which was subjected to preparative Si gel tlc separation (CHCl₃-MeOH, 7:1) to furnish pure **1** and crude **2**. Pure **1** was crystallized from petroleum ether/Et₂O as pale yellow plates (42 mg), mp 60-61° [lit. (1) a pale yellow viscous oil]; ir ν max (CCl₄) 1650, 1610, 1510, 1460, 1375, 1240, 1035 [cf. lit. (1) nujol]; ms m/z (%) 280 (M⁺, 25), 161 (11), 160 (8), 121 (100), 91 (53); hrms m/z 280.1094 (calcd. for C₁₈H₁₆O₃ 280.1098), 161.0592 (calcd. for C₁₀H₉O₂ 161.0602), 160.0517 (calcd. for C₁₀H₈O₂ 160.0523), 121.0658 (calcd. for C₈H₅O 121.0653); ^1H nmr see Table 1; ^{13}C nmr see Table 2.

Crude **2** was further purified by hplc separation to give pure **2** which was crystallized from petroleum ether/Et₂O as colorless fine crystals (5 mg), mp 84-85°; ir ν max (CHCl₃) 1640, 1610, 1510, 1480, 1435, 1370, 1360, 1240, 1205, 1030; ms m/z (%) 310 (M⁺, 18), 190 (3), 121 (100), 91 (11); hrms 310.1208 (calcd. for C₁₉H₁₈O₄ 310.1206), 190.0628 (calcd. for C₁₁H₁₀O₃ 190.0629), 121.0645 (calcd. for C₈H₉O 121.0653); ^1H nmr see Table 1; ^{13}C nmr see Table 2.

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