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A New Chromone from Agarwood and Pyrolysis Products of Chromone Derivatives

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A new chromone, 2-(2-4′-methoxyphenylethyl)chromone (I) was isolated together with 2-(2-phenylethyl)chromone (II: flidersiachromone) from agarwood (Japanese name; JINKOH). On pyrolysis at 150 °C, I and II were found to produce 4-methoxybenzaldehyde and benzaldehyde, respectively. It is considered that these chromones, which are odorless at room temperature, contribute to the pleasant, lasting odor obtained when agarwood is burnt as an incense.

Keywords——agarwood; 2-(2-4′-methoxyphenylethyl)chromone; 2-(2-phenylethyl)chromone; ^{1}H-NMR spectrum; ^{13}C-NMR spectrum; pyrolysis product

Agarwood (Japanese name; JINKOH) has been widely used as an incense from ancient times in the Orient. The structures of several constituents from agarwood, several sesquiterpenes, chromone derivatives, *etc.*, have been reported.[1-3] Although agarwood has only a slight odor at room temperature, it is well known that it generates a pleasant odor for a considerable time when heated. The odor arises from a very complicated mixture of volatile sesquiterpenes, pyrolyzed products and others.[4] Two chromones were isolated from the residue on steam distillation of an acetone extract of agarwood and subjected to pyrolysis. In this paper, we describe the isolation and structure determination of these chromones, which produce a pleasant odor when heated.

Agarwood was treated as shown in Chart 1 to give a neutral part, whose gas chromatogram (shown in Fig. 1) gave two major peaks. The retention times and the mass spectra (MS) of peaks II and I by gas chromatography-mass spectrometry (GC-MS) correspond to those of fr. 16 and fr. 12. Two small peaks with retention times of 15 and 24 min were identified as benzylacetone and 4-methoxyacetophenone by comparing their retention times and MS with those of authentic samples by GC-MS. However, they have been reported to be artifacts.[1]

Compound I, a pale yellow highly viscous oil, gave M^+ 280.1080 on high-resolution mass spectrometry (HRMS), which was consistent with the molecular formula $C_{18}H_{16}O_3$. The infrared (IR) absorption spectrum of I at 1644 cm^{-1} suggested the presence of a carbonyl group. A singlet at 178.10 ppm in the carbon-13 nuclear magnetic resonance (^{13}C-NMR) spectrum suggested the presence of a carbonyl group similar to the one present in flavones. A methoxyl group was suggested by the ^{13}C-NMR signal at 55.16 ppm (q) and the proton nuclear magnetic resonance (^{1}H-NMR) signal at 3.75 ppm (s). The signals at 32.07 (t) and 36.30 ppm (t) in the ^{13}C-NMR spectrum suggested a $-CH_2-CH_2-$ moiety. The position of the methoxyl group was decided by the assignments of the signals of carbons 1′—6′ in the ^{13}C-NMR spectrum[3] and the detection of 4-methoxybenzaldehyde in the pyrolysis products

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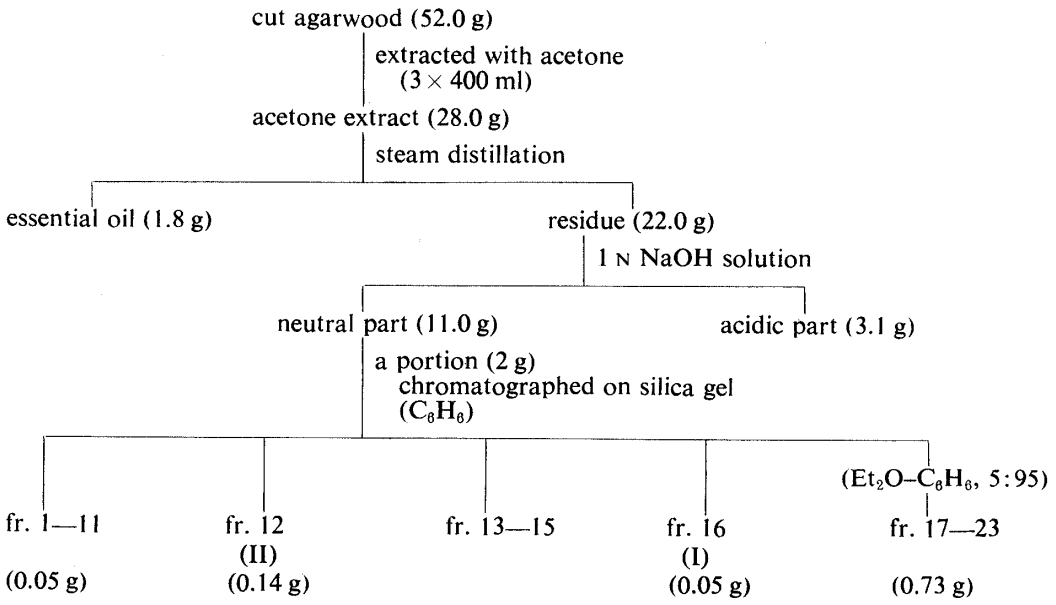

Chart 1

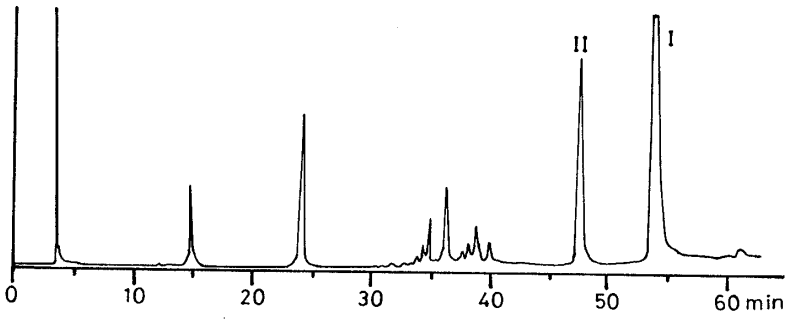

Fig. 1. Gas Chromatogram of the Neutral Part from Agarwood (See Chart 1)

Column: OV-1 wall coated glass open tubular column, 30 m × 0.28 mm i.d. Column temp.: programmed from 70 to 230 °C at 3 °C/min. Carrier gas: N_2, 0.8 ml/min. Detector: FID.

of I. These results are shown in Table I. Consequently, I was concluded to be 2-(2-4′-methoxyphenylethyl)chromone. Furthermore, the spectral data of I were in agreement with those of synthetic 2-(2-4′-methoxyphenylethyl)chromone.

Compound II, pale yellow needles, mp 65—66 °C, gave M^+ · 250.0981 by HRMS, which was consistent with the molecular formula $C_{17}H_{14}O_2$. The ^1H- and ^{13}C-NMR spectra of II are summarized in Table I. From the similarity of spectral data of II to those of I, the structure of II was determined to be 2-(2-phenylethyl)chromone (flidersiachromone).[5] Compound II was also synthesized by the same route as I.

Although these phenethylchromones I and II are odorless at room temperature, they yielded a pleasant odor when heated. Compounds I and II were subjected to pyrolysis in an air stream at 150 °C for 6 h, because incenses are generally burned at this temperature. The ether extracts of the volatiles obtained by the pyrolysis were analyzed by GC-MS, and 4-methoxybenzaldehyde from I and benzaldehyde from II were identified by comparing their MS and retention times with those of authentic samples. It is therefore considered that those chromones contribute, together with other volatiles, to the lasting pleasant odor of agarwood when burned as incenses.

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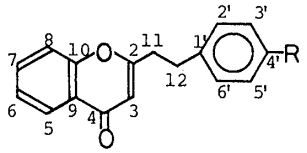
TABLE I. ^{1}H- and ^{13}C-NMR Chemical Shifts[a] for Compounds I and II in $CDCl_3$



I: R=OCH_3
II: R=H

Carbon No.	I (R=OCH_3)		II (R=H)	
	^{1}H-NMR	^{13}C-NMR	^{1}H-NMR	^{13}C-NMR
2		168.50 (s)		168.32 (s)
3	6.11 (s, 1H)	110.21 (d)	6.12 (s, 1H)	110.22 (s)
4		178.10 (d)		178.03 (s)
5	8.17 (m, 1H)	124.92 (d)	8.17 (m, 1H)	124.94 (d)
6		125.66 (d)		125.67 (d)
7		133.42 (d)		133.43 (d)
8		117.81 (d)		117.83 (d)
2′	7.19 (m, 7H)	129.24 (d)	7.37 (m, 8H)	128.63 (d)
6′		129.24 (d)		128.63 (d)
3′		114.06 (d)		128.29 (d)
5′		114.06 (d)		128.29 (d)
4′		158.32 (s)		126.54 (d)
1′		131.75 (s)		139.73 (s)
9		123.79 (d)		123.79 (s)
10		156.46 (s)		156.45 (s)
11	2.92 (m, 4H)	36.30 (t)	3.05 (m, 4H)	36.02 (t)
12		32.07 (t)		32.94 (t)
4′-OCH_3	3.75 (s, 3H)	55.16 (q)		

a) ppm from TMS.

Experimental

General——Column Chromatography: Kieselgel G (Merck, 70—230 mesh). GC: Shimadzu GC-5A, 0.28 mm × 30 m OV-1 glass wall coated open tubular column, programmed temperature 70—230 °C, 3 °C/min. IR: Jasco IR-G. GC-MS: Hitachi M-60 and M-80. ^{13}C-NMR: Varian CFT-20, 20 MHz ($CDCl_3$, tetramethylsilane (TMS)). ^{1}H-NMR: Varian CFT-20, 80 MHz ($CDCl_3$, TMS).

Material——Agarwood (Kyara) from Vietnam.

Isolation of 2-(2-4′-Methoxyphenylethyl)chromone (I) and 2-(2-Phenylethyl)chromone (II)——Cut wood (52 g) was extracted 3 times with 400 ml each of acetone. Evaporation of the combined acetone solution gave a dark brown, viscous extract (28 g). The extract was steam-distilled to give an essential oil (1.8 g) and a residue (22 g). The residue was fractionated into neutral and acidic parts by extracting it with 1 N NaOH solution. A portion (2 g) of the neutral part was chromatographed on Kieselgel G. Elution with C_6H_6 afforded 0.14 g of fr. 16 (I) and 0.05 g of fr. 12 (II). I: pale yellow viscous oil. IR ν_{max}^{Nujol} cm^{-1}: 1644, 1606, 1510, 1460, 1380. MS *m/z*: 280 ($M^{+\cdot}$, 11%), 161 (2%), 121 (100%). HRMS Calcd for $C_{18}H_{16}O_3$: 280.1098. Found: 280.1080. II: pale yellow needles. IR ν_{max}^{KBr} cm^{-1}: 1642, 1601, 1460, 1380. MS *m/z*: 250 ($M^{+\cdot}$, 44%), 91 (100%), 65 (7%). HRMS Calcd for $C_{17}H_{14}O_2$: 250.0970. Found: 250.0981. ^{1}H- and ^{13}C-NMR chemical shifts are given in Table I.

Synthesis of 2-(2-4′-Methoxyphenylethyl)chromone (I)——A mixture of 0.06 mol each of 3-4′-methoxyphenylpropionic acid (11.5 g) and thionyl chloride (8.0 g) was heated at 85 °C for 40 min. 2-Hydroxyacetophenone (0.06 mol, 9.3 g) was added to the reaction mixture at room temperature. The mixture was heated at 95 °C for 25 min, then the temperature was raised to 140 °C. The mixture was cooled to room temperature and poured onto crushed ice. The oily product was extracted with ether. Removal of the ether left crude 2′-acetylphenyl 3-4′-methoxyphenylpropionate (III) (10 g). Dry KOH powder (2.0 g) was added to III dissolved in 30 ml of dry pyridine, and the mixture was stirred for 15 min. The reaction product was dissolved in 10% acetic acid and extracted with ether. Evaporation of ether gave crude 1-2′-hydroxyphenyl-5-4′-methoxyphenyl-1,3-pentanedione (IV). On heating of IV with 2 ml of conc. H_2SO_4 in 50 ml of glacial acetic acid, IV was converted into I, which was extracted with ether and purified by Kieselgel G chromatography (total yield, 27%). The spectral data were in agreement with those of the isolates.

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Pyrolysis——Both synthetic and isolated I and II were subjected to pyrolysis using the apparatus described by Zlatkis and Kim.[6] Air flow rate: 1 ml/min. Temperature, 150 °C for 6 h. Volatiles were adsorbed on TENAX GC, desorbed with ether, and analyzed by GC-MS. The amount of sample used was 5 mg. Volatile from I (4-methoxybenzaldehyde) MS *m/z*: 136 ($M^{+\cdot}$, 90.7%), 135 (94%), 77 (18%). Volatile from II (benzaldehyde) MS *m/z*: 106 ($M^{+\cdot}$, 100%), 105 (94%), 77 (53%).

References

1) K. Kafuku and N. Ichikawa, *Nippon Kagaku Kaishi*, **56**, 1155 (1935); *idem, ibid.*, **60**, 1247 (1939).
2) T. C. Jain, M. L. Maheshwari, and S. C. Bjattacharyya, *Perfume. Essent. Oil Rec.*, **53**, 294 (1962); K. R. Varma, M. L. Maheshwari, and S. C. Bjattacharyya, *Tetrahedron*, **21**, 115 (1965); E. Yoshii, T. Koizumi, T. Oribe, F. Takeuchi, and K. Kubo, *Tetrahedron Lett.*, **41**, 3921 (1978); T. Nakanishi, E. Yamagata, K. Yoneda, and I. Miura, *Phytochemistry*, **20**, 1597 (1981).
3) Y. Shimada, T. Tominaga, T. Konishi, and S. Kiyosawa, *Chem. Pharm. Bull.*, **30**, 3791 (1982).
4) T. Nagashima, *The Takasago Times*, **81**, 25 (1984).
5) K. Picker, E. Ritchie, and W. C. Taylor, *Aust. J. Chem.*, **29**, 2023 (1976).
6) A. Zlatkis and K. Kim, *J. Chromatogr.*, **126**, 475 (1976).

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