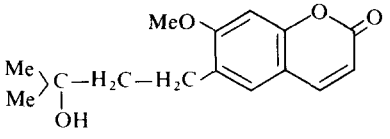
Table 1. 90 MHz ^{1}H NMR spectrum of dihydrosuberenol (1)

3-H	4-H	5-H	1′-H	2′-H	7-OMe	8-H	Me_2C	3′-OH
6.30 *d* (1 H), J = 10 Hz	7.68 *d* (1 H), J = 10 Hz	7.30 *s* (1 H)	2.8 *m* (2 H)	1.8 *m* (2 H)	3.96 *s* (3 H)	6.86 *s* (1 H)	1.86 *s* (6 H)	1.64 *s* (1 H) disappeared on D_2O exchange

Chemical shift values are in δ in $CDCl_3$ using TMS as int. ref.

methoxyl substituent at C-6 and C-7, respectively. The mass spectral fragmentation pattern was in good agreement with the schemes proposed for methoxyprenylated coumarin derivatives [6, 7]. Prominent peaks were observed at m/z 262 (M^+, 2%), 244 ($M^+ - H_2O$, 45%), 229 ($244 - CH_3$, 85%), 189 ($M^+ - C_4H_9O$, 100%), 159 ($189 - CH_2O$, 3%), 131 ($159 - CO$, 3%), 77 ($C_6H_5^+$, 3%) and 59 ($Me_2 - C^+ - OH$, 52%).



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All these spectral evidences clearly indicate structure **1** for the coumarin, and the assignment as dihydrosuberenol also received further confirmation by its partial synthesis from suberenol, another constituent isolated from the plant under investigation, through catalytic hydrogenation in the presence of Pd–C. The IR, ^{1}H NMR and MS data of the synthetic compound were identical to those of the natural one.

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A PUNGENT PRINCIPLE FROM *ALPINIA OXYPHYLLA*

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Key Word Index—*Alpinia oxyphylla*; Zingiberaceae; yakuchi; pungent principle; diarylheptanoid; yakuchinone-A; 1-(4′-hydroxy-3′-methoxyphenyl)-7-phenyl-3-heptanone; yakuchinone-B; *trans*-1-(4′-hydroxy-3′-methoxyphenyl)-7-phenylhept-1-en-3-one; zingerone.

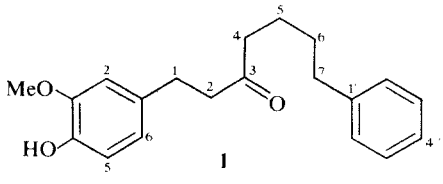
Abstract—A pungent diarylheptanoid isolated from *Alpinia oxyphylla* has been characterized as *trans*-1-(4′-hydroxy-3′-methoxyphenyl)-7-phenylhept-1-en-3-one(yakuchinone-B) by spectroscopic methods and by synthesis.

INTRODUCTION

The pungent principles of zingiberaceous plants form a class of natural products which are based on a 4-hydroxy-3-methoxyphenyl group; for example, zingerone [1], gingerols [2], shogaols [3], paradols [4] and so on. In a continuation of the study of the chemical nature of the pungent components, we have previously reported on the isolation and characterization of 1-(4′-hydroxy-3′-methoxyphenyl)-7-phenyl-3-heptanone (**1**) from the $CHCl_3$-soluble fraction of *A. oxyphylla* Miquel [5]. In this paper, we wish to report on the identification of a new pungent substance, *trans*-1-(4′-hydroxy-3′-methoxyphenyl)-7-phenylhept-1-en-3-one (**2**), from the same source.

RESULTS AND DISCUSSION

Compound **2** was isolated from the $CHCl_3$-soluble fraction of a methanolic extract of the pericarp. It was purified by column chromatography on Sephadex LH-20 (MeOH) followed by recrystallization from MeOH. As it had pungency like **1**, we decided that it must have a very similar structure to that of **1**. The MS showed peaks at *m/z* 310 (M^+, $C_{20}H_{22}O_3$), 192 (McLafferty rearrangement) and 177 (base peak), which were all two mass units lower than the corresponding peaks in the MS of **1**. Peaks at *m/z* 161 and 91, however, were common to both compounds. The presence of a conjugated ketone group was shown by



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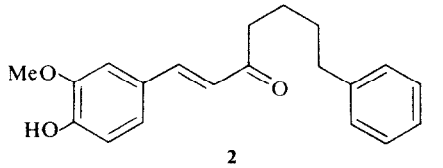

2

a bathochromic shift of the UV spectrum upon the addition of aq. NaOH, and an absorption maximum at 1640 cm^{-1} in the IR spectrum. The ^1H NMR spectrum indicated the presence of an OMe group [δ 3.91 (3H)] and a phenolic hydroxy group [δ 5.99 (1H, disappearing with D_2O)]. Four side-chain methylene groups were observed in the regions δ 1.5–1.9 (4H) and 2.5–2.9 (4H) as two overlapping multiplets. Two doublets at δ 6.58 (1H) and 7.47 (1H), $J_{1,2}$ = 16 Hz, were assigned to H-2 and H-1. Hence the double bond in **2** was *trans*. In the remaining aromatic region of the ^1H NMR spectrum of **2**, there was an overlapping multiplet consisting of eight protons attached to two benzene rings (δ 6.8–7.3). The ^{13}C NMR spectrum showed that in a methoxyl group and the hydroxyl group were attached to C-3′, and C-4′ respectively of aromatic ring-A. Hydrogenation of **2** with Pd/C in benzene proceeded smoothly to give **1**. The above evidence showed that **2** must be *trans*-1-(4′-hydroxy-3′-methoxyphenyl)-7-phenylhept-1-en-3-one.

Finally, the structure of **2** was confirmed by synthesis using a Claisen–Schmidt-like reaction. In our previous synthesis of **1**, we employed the condensation of benzylvanillin with 6-phenyl-2-hexanone in the presence of ethanolic KOH. This time, however, without covering of phenolic hydroxyl by a benzyl group, we condensed vanillin with 6-phenyl-2-hexanone using the weak acid–weak base (acetic acid–pyrrolidine) combination favoured by Locksley and Rainy [6] for dihydroparadols. As a result, we obtained **2** in high yield (80%) and the spectral data were in perfect agreement with those of the natural product.

This is the first report of this compound. We propose that compounds **1** and **2** should be named yakuchinone-A and yakuchinone-B respectively, because the Japanese name for the fruit from which they were isolated is Yakuchi.

Table 1. ^{13}C NMR spectral data of compounds **1** and **2**

Carbon(s)	1	2
1	29.5	142.8
2	44.6	123.7
3	210.2	200.4
4	42.8	40.3
5	23.4	24.1
6	30.9	31.0
7	35.7	35.6
1′	132.9	126.8
2′	111.0	109.7
3′	146.3	146.9
4′	143.8	148.3
5′	114.3	114.9
6′	120.6	123.2
1″	142.1	142.1
2″6″	128.2	128.1
3″5″	128.2	128.9
4″	125.6	125.6

The pungency of **2** was compared with **1** and zingerone by our previous method [5]. The threshold concentration of **2** was found to be 1.6×10^{-7} mol/ml, i.e. its pungency was about 5 times weaker than that of **1** (3.2×10^{-8} mol/ml), but stronger than that of zingerone (4.0×10^{-6} mol/ml).

EXPERIMENTAL

Mps are uncorr.

Isolation of compound **2**. The methanolic extract of the pericarp, after washing with *n*-hexane, was evapd. The residue was then divided into $CHCl_3$- and H_2O-soluble fractions. Compound **2** was purified from the $CHCl_3$-soluble fraction by Sephadex LH-20 column using MeOH and finally by recrystallization from MeOH, mp 100.5–100.7°. $C_{20}H_{22}O_3$, yellow needles. UV λ_{max}^{MeOH} nm (log ε): 225 (4.08), 336 (4.40); $\lambda_{max}^{MeOH+NaOH}$ nm: 255, 404; IR ν_{max}^{KBr} cm^{-1}: 1640 (C=O); ^1H NMR ($CDCl_3$): δ 1.72 (*m*, 4H), 2.66 (*m*, 4H), 3.91 (*s*, 3H), 5.99 (*s* (*br*), 1H, lost with D_2O), 6.58 (*d*, 1H, J = 16 Hz), 6.8–7.3 (*m*, 8H), 7.47 (*d*, 1H, J = 16 Hz); MS *m/z* (rel. int.): 310 [M]$^+$ (50), 205 (14), 192 (17), 177 (100), 161 (13), 150 (41), 137 (59), 117 (16), 91 (33).

Hydrogenation of **2**. Compound **2** (200 mg) in C_6H_6 (30 ml) containing Pd–C (5%, 50 mg) was stirred under H_2 for 3 h. The product was chromatographed on Si gel with C_6H_6–EtOAc (9:1) and a yellowish oil (**1**) was obtained in 98% yield.

Synthesis of **2**. 6-Phenyl-2-hexanone (2.0 g, 1.12×10^{-2} mol) was added to a stirred mixture of HOAc (0.7 g) and pyrrolidine (0.8 g). Vanillin (1.7 g, 1.12×10^{-2} mol) in dry Et_2O (30 ml) was then added slowly at room temp. and the mixture stirred for 45 hr. When TLC showed that almost no vanillin remained, the mixture was poured into dil. HCl. The organic layer was removed, washed with H_2O, and shaken with satd $NaHSO_3$ soln. After separation, the organic layer was evapd. The product was chromatographed on Si gel using C_6H_6–EtOAc (9:1), and recrystallized from MeOH (2.8 g, 80%).

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HELIPYRONE FROM *ANAPHALIS ARANEOSA* AND ITS SYNTHESIS*

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(*Received* 8 *May* 1981)

Key Word Index—*Anaphalis araneosa*; Compositae; helipyrone; NMR spectra; synthesis; β-sitosterol; stigmasterol; anisic acid.

Abstract—The dimeric 4-hydroxy-2-pyrone, heliopyrone, was isolated from *Anaphalis araneosa* and its structure confirmed by spectral analysis and synthesis.

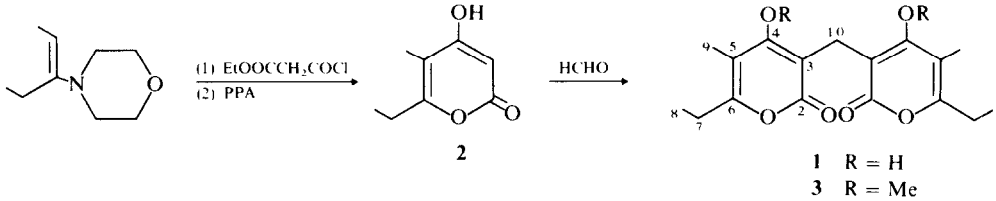
We earlier reported two new flavones from *Anaphalis araneosa* [1]. The petrol extract of the same plant yielded another crystalline compound, mp 218–220°, in addition to anisic acid and a mixture of β-sitosterol and stigmasterol. From extensive spectral data, the compound was identified as helipyrone (**1**), a dimeric 4-hydroxy-2-pyrone, isolated previously from *Helichrysum italicum* [2]. Helipyrone and several other derivatives containing the same pyrone unit have since been reported from a number of other *Helichrysum* species [3,4].

The ^{13}C NMR spectra of helipyrone was studied in detail. The assignments (see Experimental) were made on the basis of chemical shift rules and selective proton decoupling. It may be noted that the methylene bridge protons show long-range coupling to both C-3 ($^2J_{C,CH_2}$ = 6.1 Hz) and C-2 ($^3J_{C,CH_2}$ = 5.5 Hz). Consequently, the recent assignment [4] of C-3 and C-5 resonances in helipyrone and its derivatives needs to be interchanged.

The compound showed moderate *in vitro* antitumor activity against L5178Y cell culture carried out by Dr. T. Ikekawa, National Cancer Center Research Institute, Tokyo. Therefore, although a synthesis of helipyrone has already been reported [5] we accomplished the same result by a different route. Condensation of malonic ester half acid chloride with morpholine enamine of diethyl ketone followed by PPA cyclization of the crude reaction product yielded 6-ethyl-4-hydroxy-5-methyl-α-pyrone (**2**) [5]. Condensation of **2** with formaldehyde [5] furnished helipyrone (**1**).

EXPERIMENTAL

Flowering plants of *Anaphalis araneosa* DC (1.5 kg) were extrd with petrol as previously reported [1]. The extract was concd and extrd with 5% NaOH soln. The alkali-insol. part on chromatography over Si gel gave a mixture of β-sitosterol and stigmasterol (230 mg), mp 154°; M^+ *m/z* 414, 412. The alkali-



2

1 R = H
3 R = Me

* Part 65 in the series "Studies on Indian Medicinal Plants". For Part 64, see Dutta, P. K., Chakravarty, A. K., Chaudhury, U. S. and Pakrashi, S. C., *Indian J. Chem.* (in press).

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