Kobe Women's College of Pharmacy
4-19-1 Motoyamakita-machi,
Higashinada-ku, Kobe 658, Japan

Masayoshi Ito
Akiko Kodama
Kiyoshi Tsukida

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Isolation of Agarofuran-type Sesquiterpenes from *Alpinia japonica* (Thunb.) Miq.[1]

A new sesquiterpene, 3α,4α-oxidoagarofuran (**2**) was isolated besides 4-hydroxydihydroagarofuran (**1**), α-agarofuran (**3**) and β-eudesmol (**4**) from the rhizomes of *Alpinia japonica.*

Biogenetically, it is interesting that β-eudesmol is isolated from same plant together with agarofurans, which possess 10-epimeric eudesmane carbon skeleton.

Keywords——Zingiberaceae; *Alpinia japonica* (Thunb.) Miq.; sesquiterpene; 4α-hydroxydihydroagarofuran; 3α,4α-oxidoagarofuran; α-agarofuran; β-eudesmol; 10-epi-eudesmane-type

The seeds of *Alpinia japonica* (Thunb.) Miq. (Zingiberaceae) are used as an aromatic stomachic under the name, "Izu-shukusha" (伊豆縮砂), in Japan.

Several flavonoids (alpinon, izalpinin, kumatakenin and rhamnocitrin) and monoterpenes (camphor and cineole) have been isolated from the seeds by Kimura and co-workers.[2] They have also reported the presence of sesquiterpene alcohols in the essential oil of the seeds, but little has been known about their structures.[2d]

In this paper, we wish to report the isolation and characterization of four sesquiterpenes including a new compound from the rhizomes of this plant.

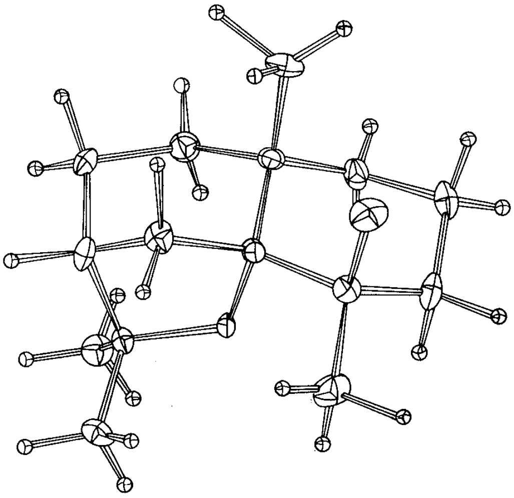

Fig. 1. Perspective View of the Molecular Structure of Compound **1**

The fresh rhizomes were extracted with methanol, and the aqueous methanolic extracts were partitioned with petroleum ether. The petroleum ether soluble fraction was repeatedly separated and purified by silica gel and silver nitrate impregnated silica gel chromatography to give four compounds (**1**—**4**).

Compound (**1**), $C_{15}H_{26}O_2$, colorless needles, mp 128.5—129.5°, showed a strong hydroxyl absorption band at 3430 cm^{-1} in the IR spectrum. The ^1H-NMR spectrum ($CDCl_3$) revealed four tertiary methyl signals (δ 1.17, 1.21, 1.27, 1.36), and the ^{13}C-NMR spectrum ($CDCl_3$) indicated the presence of ether linkage [δ 82.1 (s), 87.8 (s)]. Taking account of its molecular formula, we assumed from above facts that compound (**1**) might be 4α-hydroxydihydroagaro-

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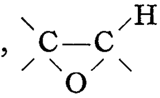
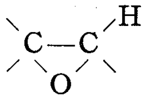
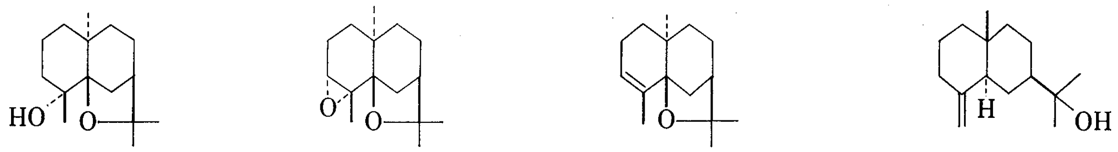
[1] Studies on Zingiberaceous Plants. Part I.

[2] *a*) Y. Kimura and M. Hoshi, *Yakugaku Zasshi*, **57**, 147 (1937); *b*) Y. Kimura and M. Hoshi, *ibid.*, **55**, 1101 (1935); *c*) Y. Kimura, M. Takido and S. Takahashi, *ibid.*, **87**, 1132 (1967); *d*) Y. Kimura and M. Hoshi, *ibid.*, **53**, 794 (1933).

furan, which has already been isolated from fungus infected agarwood (*Aquilaria agallocha* Roxb.).[3] However, because the authentic sample was not available and this is a key compound for the structure elucidation of the following compounds (**2** and **3**), the structure of **1** was unequivocally determined by X-ray analysis.[4]

Compound (**2**) was obtained as colorless oil, $[\alpha]^{25}_{D}$ $-20.8°$ ($c=0.39$, EtOH); molecular formula, $C_{15}H_{24}O_2$ was comfirmed by high resolution mass spectrum, *m/e* 236.1764 (M^+, Calcd for $C_{15}H_{24}O_2$: 236. 1776); IR (liquid film) 2920, 1390, 1155, 1145, 1010, 970, 895 cm^{-1}, no hydroxyl absorption; ^{1}H-NMR ($CDCl_3$) 1.13, 1.25, 1.31, 1.37 (3H, each, s), 3.00 (1H, broad d,  $\underset{\diagdown O \diagup}{>C{-}C<^{H}}$); ^{13}C-NMR ($CDCl_3$) 18.6 (q), 20.7 (t), 22.7 (q×2), 24.3 (t), 30.0 (q), 31.8 (t), 32.1 (t), 36.9 (t), 37.5 (s), 44.3 (d), 59.9, 60.7 (s and d,  $\underset{\diagdown O \diagup}{>C{-}C<^{H}}$), 82.3 (s), 85.0 (s).

The above spectral evidences suggested that this compound might be an epoxide of α-agarofuran. Reductive cleavage of the epoxide (**2**) with lithium aluminum hydride gave colorless needles, which was identical with compound (**1**). Consequently, the compound (**2**) can be formulated as 3α,4α-oxidoagarofuran.



1 **2** **3** **4**

Chart 1

Compound (**3**), $C_{15}H_{24}O$, oily, was identified as α-agarofuran by comparison of the spectral data with those reported.[3]

Compound (**4**), $C_{15}H_{26}O$, colorless needles, mp 80.5—81.5°, was also identified as β-eudesmol by comparison with an authentic sample including specific rotation.

Agarofurans (**1**—**3**) possess the 10-epieudesmane skeleton, and could be supposed to form biosynthetically from hedycaryol in the conformation in which the methyl group are mutually *syn* but *anti* with respect to the $-(CH_3)_2OH$ grouping.[5] β-Eudesmol (**4**) could also be derived from the same precursor through another conformation. Therefore, it is noteworthy that we found these two types of sesquiterpene in the same plant. Only a few similar instances have been reported recently.[5,6]

Tokyo College of Pharmacy
1432-1, Horinouchi, Hachioji-shi,
Tokyo 192-03, Japan

Faculty of Pharmaceutical Sciences,
University of Tokyo, Hongo, Bunkyo-ku,
Tokyo 113, Japan

Hideji Itokawa
Kinzo Watanabe
Susumu Mihashi

Yoichi Iitaka

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3) M.L. Maheshwari, K.R. Varma and S.C. Bhattacharyya, *Tetrahedron*, **19**, 1519 (1963).
4) Detail data will be reported later.
5) I.A. Southwell, *Aust. J. Chem.*, **31**, 2527 (1978).
6) M. Rohmer, A.C. Schwartz and R. Anton, *Phytochemistry*, **16**, 773 (1977).