[Chem. Pharm. Bull. 20(5) 987—989 (1972)]

UDC 547.913.02 : 581.192 : 582.583

Structure of Dehydrocurdione, a Sesquiterpenoid of *Curcuma zedoaria*[1]

Hiroshi Hikino, Chohachi Konno, and Tsunematsu Takemoto

Pharmaceutical Institute, Tohoku University[2]

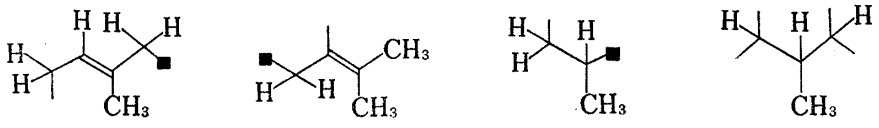
(Received November 1, 1971)

From zedoary, *Curcuma zedoaria* (Zingiberaceae), a new sesquiterpenic dione has been isolated and designated as dehydrocurdione whose structure has been elucidated as I based on the physico-chemical and chemical evidence.

We have reported the isolation and structure determination of a number of new sesquiterpenoids from zedoary, the rhizomes of *Curcuma zedoaria* Roscoe (Zingiberaceae).[3] Further survey has resulted in the isolation of another novel sesquiterpenoid of germacrane type which we have named dehydrocurdione. The present paper deals with the structure elucidation of dehydrocurdione as shown in I.

Dehydrocurdione exhibited in the mass spectrum the molecular ion peak at *m/e* 234, indicating it to have the molecular formula $C_{15}H_{22}O_2$. Of the two oxygen atoms in the molecule, one is revealed to participate in an unconjugated carbonyl in a six- or larger-membered ring (1710 cm^{-1}) and the other is shown to constitute an α,β-unsaturated carbonyl (222, 250 nm, 1687 cm^{-1}) by its ultraviolet (UV) and infrared (IR) spectra. The nuclear magnetic resonance (NMR) spectrum demonstrates the presence of a secondary methyl (0.99 ppm), three vinyl methyls (1.60, 1.72, 1.74 ppm), an isolated methylene (2.94, 3.14 ppm in an AB type), an isolated methylene (3.10, 3.14 ppm in an AB type), and a vinyl hydrogen (5.08 ppm, a doublet of doublets). The remaining five hydrogens appear as a complexed signal in the region 1.8—2.5 ppm. Further, nuclear magnetic double resonance (NMDR) experiments combined these hydrogens into a few groups. Thus, the vinyl hydrogen (5.08 ppm) is long-range coupled to the vinyl methyl hydrogens (1.60 ppm) and to the methylene hydrogens (2.94, 3.14 ppm). This observation, together with the signal shape of the vinyl hydrogen and the absence of an intramolecular nuclear Overhauser effect between the vinyl hydrogen and the vinyl methyl hydrogens, indicate the presence of the part structure A. From the finding that the methylene hydrogens (3.10, 3.14 ppm) are long range coupled to the vinyl methyl hydrogens (1.72, 1.74 ppm), the presence of the part structure B is suggested. The methine hydrogen signal upon saturation of the methyl doublet (0.99 ppm) appeared as a doublet of doublets at 2.83 ppm, showing the presence of the part structure C or C′.

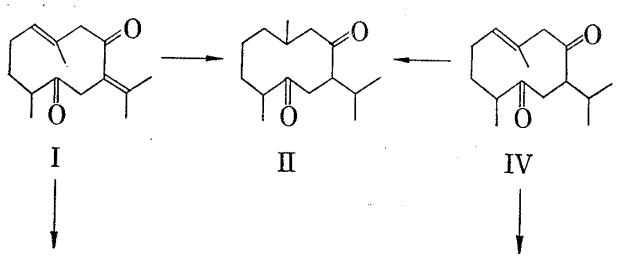
The accumulated data indicate that dehydrocurdione is a monocarbocyclic doubly unsaturated diketone. This deduction, coupled with biogenetic consideration, leads to the assumption that dehydrocurdione possesses the structure I.



A B C C′

■ denotes a quaternary carbon

1) This paper is Part XLIII in the series on Sesquiterpenoids. Preceding paper, Part XLII: H. Hikino, Y. Hikino, H. Kato, Y. Takeshita, and T. Takemoto, *Yakugaku Zasshi*, **91**, 766 (1971).
2) Location: *Aoba-yama, Sendai.*
3) *cf.*, H. Hikino, C. Konno, and T. Takemoto, *Chem. Pharm. Bull.* (Tokyo), **19**, 93 (1971).

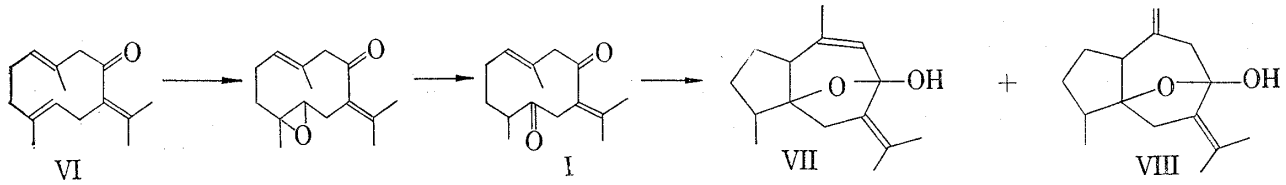


III: a stereoisomer of II V: a stereoisomer of II

In order to confirm this assumption, catalytic hydrogenation of dehydrocurdione over platinum in methanol was carried out and, after the consumption of two moles of hydrogen, two hydrogenation products (II and III) were obtained. The properties of the one (II) including the optical rotation, were identified as those of one of the two hydrogenation products (II and V), prepared from curdione (IV)[4] under similar conditions.

Hence, it has been established that dehydrocurdione is represented by formula I.

Dehydrocurdione may be an intermediate in the sesquiterpenoid biosynthesis from germacrone (VI) to curcumenol (VII)[5] and isocurcumenol (VIII)[6] in the plant, *Curcuma zedoaria*.



Experimental[7]

Isolation of Dehydrocurdione——The fresh rhizomes (1 kg) of *Curcuma zedoaria* Roscoe were extracted with light petroleum. The light petroleum solution was concentrated under reduced pressure to give the residue (27.3 g). The residue (7.0 g) was subjected to repeated chromatography over silica gel affording dehydrocurdione (I) as colorless oil (325 mg). $[\alpha]_D$ +67.9° (c=0.51, $CHCl_3$), CD (c=0.093, MeOH): $[\theta]_{346}$ −760, $[\theta]_{294}$ +1030. Mass Spectrum m/e: 234 (M^+). UV λ_{max}^{MeOH} nm (log ε): 224 inf (3.63), 253 inf (3.46), 305 inf (2.56). IR $\nu_{max}^{CCl_4}$ cm^{-1}: 1710 (cyclodecanone), 1687 (cyclodecenone). NMR ppm (CCl_4, 100 MHz): 0.99 (3H d, J=6, C<u>H</u>$_3$-CH〈), 1.60 (3H d, J=1.5, -CH=C-C<u>H</u>$_3$), 1.72, 1.74 (3H s, each, (C<u>H</u>$_3$)$_2$-C=C〈), 2.94, 3.14 (1H d, each, J=11, -C<u>H</u>$_2$-), 3.10, 3.14 (1H d, each, J=18, -C<u>H</u>$_2$-), 5.08 (1H dd, J=7.5, 7.5, -CH$_2$-C<u>H</u>=C-CH$_3$), NMR ppm (C_6H_6): 0.75 (3H d, J=6, C<u>H</u>$_3$-CH〈), 1.48 (3H s, C<u>H</u>$_3$-C=CH-), 1.60, 1.66 (3H s, each, (C<u>H</u>$_3$)$_2$-C=C〈), 2.90, 3.11 (1H d, each, J=11, -C<u>H</u>$_2$-), 2.97 (2H s, -C<u>H</u>$_2$-), 5.00 (1H dd, J=7.5, 7.5, -CH$_2$-C<u>H</u>=C-CH$_3$).

Hydrogenation of Dehydrocurdione over Adams' Catalyst in Methanol——Dehydrocurdione (I) (78 mg) in MeOH (4 ml) was hydrogenated over PtO_2 (20 mg). After isolation in the usual manner, the product (74 mg) was chromatographed over silica gel (5 g).

Elution with benzene gave a crystalline mass (23 mg) which on crystallization from AcOEt afforded the tetrahydrodehydrocurdione (II) as colorless needles. mp 46—47°. $[\alpha]_D$ −19.2° (c=0.55, $CHCl_3$). Mass Spectrum m/e: 238 (M^+). IR ν_{max}^{KBr} cm^{-1}: 1688 (cyclodecanone). NMR ppm (CCl_4): 0.85 (6H d, J=6, (C<u>H</u>$_3$)$_2$CH〈), 0.94 (3H d, J=5, C<u>H</u>$_3$-CH〈), 0.96 (3H d, J=6, CH$_3$-CH〈). This substance was identified as the tetrahydrodehydrocurdione (II), obtained from curdione (IV) (*vide infra*), by mixed melting point determination, and comparison of IR and NMR spectra.

Further elution with the same solvent furnished a crystalline mass (29 mg) which was crystallized from AcOEt to give the tetrahydrodehydrocurdione (III) as colorless needles. mp 67.5—68.5°. IR ν_{max}^{KBr} cm^{-1}: 1690 (cyclodecanone). NMR ppm (CCl_4): 0.92 (3H d, J=6, C<u>H</u>$_3$-CH〈), 0.94 (3H d, J=5, C<u>H</u>$_3$-CH〈), 0.95 (3H d, J=6, C<u>H</u>$_3$-CH〈), 1.02 (3H d, J=6, C<u>H</u>$_3$-CH〈).

4) H. Hikino, Y. Sakurai, S. Takahashi, and T. Takemoto, *Chem. Pharm. Bull.* (Tokyo), **14**, 1310 (1966); **15**, 1390 (1967).
5) H. Hikino, Y. Sakurai, S. Numabe, and T. Takemoto, *Chem. Pharm. Bull.* (Tokyo), **16**, 39 (1968).
6) H. Hikino, K. Agatsuma, and T. Takemoto, *Chem. Pharm. Bull.* (Tokyo), **17**, 959 (1969).
7) Melting points are uncorrected. NMR spectra were recorded at 60 MHz unless otherwise indicated. Chemical shifts are expressed in ppm downfield from Me_4Si as internal reference and coupling constants (J) in Hz. Abbreviations: s=siglet, d=doublet, and dd=doublet of doublets.

Hydrogenation of Curdione over Adams' Catalyst in Methanol——Curdione (IV) (92 mg) in MeOH (4 ml) was hydrogenated over PtO_2 (20 mg). Upon isolation, the product (95 mg) was chromatographed over silica gel (5 g).

Elution with benzene gave a crystalline mass (32 mg) which on crystallization from AcOEt yielded the dihydrocurdione as colorless needles. mp 46—47°. $[\alpha]_D$ −18.4° (c=0.75, $CHCl_3$). IR ν_{max}^{KBr} cm^{-1}: 1688 (cyclodecanone). NMR ppm (CCl_4): 0.85 (6H d, J=6, $(C\underline{H}_3)_2$-CH⟨), 0.94 (3H d, J=5, $C\underline{H}_3$-CH⟨), 0.96 (3H d, J=6, $C\underline{H}_3$-CH⟨).

Successive elution with the same solvent gave a crystalline mass (46 mg) which was submitted to recrystallization from AcOEt affording the dihydrocurdione (V) as colorless needles. mp 97.5—98.5°. IR ν_{max}^{KBr} cm^{-1}: 1704 (cyclodecanone). NMR ppm (CCl_4): 0.86 (3H d, J=6, $C\underline{H}_3$-CH⟨), 0.94 (3H d, J=6, $C\underline{H}_3$-CH⟨), 0.96 (3H d, J=6, $C\underline{H}_3$-CH⟨), 1.05 (3H d, J=6, $C\underline{H}_3$-CH⟨).

Acknowledgement Thanks are due to Mr. M. Takagi, National Institute of Hygienic Sciences, for the rhizomes, to Analytical Laboratory, Department of Chemistry, this University, for NMR measurements, and to Analytical Laboratories, this Institute, for mass and NMR measurements.