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STEREOSTRUCTURE OF CURLONE, A SESQUITERPENOID OF *CURCUMA LONGA* RHIZOMES*

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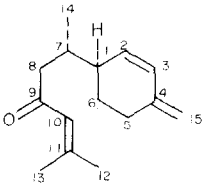
Key Word Index—*Curcuma longa*; Zingiberaceae; sesquiterpenoid; bisabolane skeleton; curlone; (6*S*)-2-methyl-6-[(1*S*)-4-methylene-2-cyclohexen-1-yl]-2-hepten-4-one.

Abstract—From the crude drug 'ukon' (turmeric) (obtained from the rhizomes of *Curcuma longa*) a new sesquiterpenoid, curlone, has been isolated and shown as (6*S*)-2-methyl-6-[(1*S*)-4-methylene-2-cyclohexen-1-yl]-2-hepten-4-one on the basis of its spectral properties and its chemical conversion to the known (+)-*ar*-turmerone.

The crude drug 'ukon' (turmeric), prepared from the rhizomes of *Curcuma longa* Linné, has been used as a remedy for hepatitis in Oriental medicine. It has been reported to contain a number of monoterpenoids, sesquiterpenoids and curcuminoids. As part of our investigation on the constituents of this drug, we have now isolated a novel sesquiterpenoid (curlone) having the bisabolane skeleton.

Curlone had the molecular formula $C_{15}H_{22}O$ (MS: *m/z* 218 $[M]^+$). The IR spectrum showed strong bands at 1680 and 870 cm^{-1} associated with an α,β-unsaturated ketone and a vinylidene, respectively. The ^1H NMR spectrum revealed the presence of a secondary methyl group (δ 0.88), two vinyl methyl groups (δ 1.88 and 2.14) and five olefinic hydrogens [δ 4.76 (2H, *br s*), 5.67 (1H, *br d*, J = 10 Hz), 6.07 (1H, *m*) and 6.17 (1H, *dd*, J = 10, 2 Hz)]. Further, the splitting patterns of the ^{13}C NMR signals assignable to olefinic carbons (δ 110.3 *t*, 124.1 *d*, 130.0 *d*, 133.7 *d*, 143.3 *s* and 154.9 *s*), together with the parameters of the ^1H NMR signals due to the olefinic hydrogens, confirmed the presence of a terminal methylene group, a disubstituted double bond and a trisubstituted double bond. The above spectral data, coupled with the double bond equivalence of the molecule, showed curlone to be monocyclic.

Dehydrogenation of curlone with 5% palladium-on-charcoal yielded (+)-*ar*-turmerone [1], demonstrating that curlone had the bisabolane skeleton. It was consequently revealed that the carbonyl group was situated at C-9 and the trisubstituted double bond located at C-10–C-11. Further, the disubstituted double bond could be situated only at C-2–C-3. The location of the vinylidene at C-4–C-15 was deduced by the following: (1) the intensity of the UV absorption at 235.5 nm (ε 21100) was indicative of the presence of a conjugated diene as well as an α,β-unsaturated ketone; (2) in the ^1H NMR spectrum, the signals due to the hydrogens at C-2 and C-3 were long range coupled with those at C-15; (3) the parameters of the ^1H NMR signals due to the hydrogens at C-2, C-3 and C-15 were in good accord with those in (−)-β-sesquiphellandrene [2]; and (4) if the vinylidene was located at C-7–C-14, the ^1H NMR signals due to the methylene hydrogens at C-8, should appear at *ca* δ 3.2, but no signals were observed below *ca* δ2.5. These data established that the gross structure of curlone was represented by formula **1** (stereochemistry not implied).



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The fact that curlone was dehydrogenated to give (+)-*ar*-turmerone was not only useful in the determination of the carbon skeleton of curlone, but also indicative that the absolute configuration at C-7 was *S*. In the ^1H NMR spectrum, an intramolecular NOE was observed between the secondary methyl hydrogens at C-14 and the olefinic hydrogen at C-2, showing that these hydrogens were situated in a spatially close relationship. Provided that the hydrogens at C-1 and C-7 adopted the thermodynamically most stable *anti*-arrangement, the above observation of the NOE allowed the absolute configuration at C-1 to be *S*. The combined evidence pointed to the stereostructure **1** for curlone.

EXPERIMENTAL

Isolation of curlone. The crude drug 'ukon' (2.0 kg) was extracted with EtOH–H_2O (1:1) (3 l. × 4) for 5 days (each extraction) at room temp. The EtOH–H_2O (1:1) soln was concd to give an extract (212 g) which on extraction with EtOAc (1 l.) gave an EtOAc-soluble fraction (76 g), a portion (10 g) of which was chromatographed over Si gel (200 g) with $CHCl_3$, followed by $CHCl_3$–MeOH and then MeOH. The $CHCl_3$ fraction (3.5 g) was rechromatographed on Si gel (100 g). Elution with hexane–EtOAc (97:3) furnished curlone (240 mg) as a colourless

*Part 59 in the series "Sesquiterpenoids". For Part 58 see Oshima, Y., Iwakawa, T. and Hikino, H. (1983) *Phytochemistry* **22**, 183.

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oil. $[\alpha]_D$ −0.03° ($CHCl_3$; *c* 2.16); MS *m/z*: 218 $[M]^+$, 120, 83, 55; UV λ_{max}^{MeOH} nm (ε): 235.5 (21 100); IR ν_{max}^{film} cm^{-1}: 1680, 1615, 870; ^1H NMR ($CDCl_3$, 270 MHz): δ 0.88 (3H, *d*, *J* = 6.5 Hz, H-14), 1.88 and 2.14 (each 3H, *d*, *J* = 1.5 Hz, H-12 and H-13), 4.76 (2H, *br s*, H-15), 5.67 (1H, *br d*, *J* ≈ 10 Hz, H-2), 6.07 (1H, *m*, H-10), 6.17 (1H, *dd*, *J* = 10, 2 Hz, H-3); ^{13}C NMR ($CDCl_3$, 25 MHz): δ 16.5 (*q*), 20.7 (*q*), 25.0 (*t*), 27.7 (*q*), 30.1 (*t*), 33.3 (*d*), 40.5 (*d*), 48.6 (*t*), 110.3 (*t*), 124.1 (*d*), 130.0 (*d*), 133.7 (*d*), 143.3 (*s*), 154.9 (*s*), 200.7 (*s*).

Dehydrogenation of curlone. Curlone (20 mg) and Pd–C (5%, 20 mg) were heated at 320–340° for 3 min. The product in $CHCl_3$ was chromatographed on Si gel (20 g) to give (+)-*ar*-turmerone (8 mg) as a colourless oil. $[\alpha]_D$ + 54.0° ($CHCl_3$; *c* 0.25); MS *m/z*: 216 $[M]^+$, 201, 119, 83, 55; ^1H NMR ($CDCl_3$, 100 MHz): δ 1.24 (3H, *d*, *J* = 7 Hz), 1.84 (3H, *d*, *J* = 1 Hz), 2.10 (3H, *d*, *J* = 1 Hz), 2.29 (3H, *s*), 2.66 (2H, *m*), 3.29 (1H, *m*), 6.01 (1H, *m*), 7.07 (4H, *s*). Its identity was confirmed by the usual criteria.

Acknowledgement—We are grateful to JEOL Ltd. for the 270 MHz ^1H NMR data.

REFERENCES

1. Honwad, V. K. and Rao, A. S. (1964) *Tetrahedron* **20**, 2921.
2. Connell, D. W. and Sutherland, M. D. (1966) *Aust. J. Chem.* **19**, 283.

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A FURANOEREMOPHILANE FROM *VITEX NEGUNDO**

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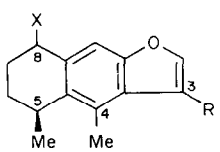
Key Word Index—*Vitex negundo*; Verbenaceae; roots; sesquiterpene; furanoeremophilane; 3-formyl-4,5-dimethyl-8-oxo-5*H*-6,7-dihydronaphtho(2,3-*b*)furan; acetyl oleanolic acid; sitosterol.

Abstract—Acetyl oleanolic acid, sitosterol and a new furanoeremophilane characterized as 3-formyl-4,5-dimethyl-8-oxo-5*H*-6,7-dihydronaphtho(2,3-*b*)furan have been isolated from the roots of *Vitex negundo*.

Vitex negundo, which is known for its antiarthritic activity in the indigenous system of medicine [1], has been extensively examined in the past to yield various constituents, such as, hydrocarbons [2], flavonoids [3], anthocyanins [4] and iridoids [5, 6]. As a continuation of our phytochemical investigations of medicinal plants, the benzene-soluble fraction of the ethanol extractives of *V. negundo* was examined to afford acetyl oleanolic acid, sitosterol and a new sesquiterpene, mp 145°, $[\alpha]_D^{20°}$ + 6.4° ($CHCl_3$; *c* 1.07%). The IR spectrum of the sesquiterpene exhibited the presence of PhCO and CHO functionalities (ν_{max}^{KBr} cm^{-1}: 1685 and 1700, respectively) together with bands characteristic of aromatic and furanoid moieties. The molecular composition, $C_{15}H_{14}O_3$, as determined by accurate mass measurements (M^+ at *m/z* 242.0935), indicated it to be a tricyclic sesquiterpene derivative. Further insight into its structure was gained by the study of its ^1H NMR spectrum which revealed the presence of 14 protons in agreement with the molecular composition. The low-field transitions consisted of three one-proton singlets identifiable as: (1) a formyl function (δ10.17); (2) C_2-H of a 3-formylbenzofuran moiety (δ8.40) [7]; and (3) the lone aromatic proton (δ8.10) situated peri to a C=O group [8]. A singlet which resonated at δ2.77 accounted for one aromatic methyl group while a second singlet at δ1.22 was identified as a secondary methyl group coupled with a benzylic methine (δ3.47) and confirmed by double resonance experiments. The remaining four protons were located at δ2.76 and 2.18 as multiplets pertaining to two CH_2 groups situated α- and β- to the carbonyl function, respectively. The preceding observations in conjunction with biogenetic concepts led to the characterization of this sesquiterpene as 3-formyl-4,5-dimethyl-8-oxo-5*H*-6,7-dihydronaphtho(2,3-*b*)furan (**1**). Reduction of **1** with sodium borohydride yielded a diol, $C_{15}H_{18}O_3$, M^+ at *m/z* 246. The carbonyl absorption bands of **1** were replaced by primary and secondary alcoholic functions in the IR spectrum of the diol. Besides the molecular ion, the rest of the electron impact mass spectral pattern was compatible with structure **2** for this diol.



	R	X
1	CHO	=O
2	CH_2OH	H, OH
3	Me	=O

*CDRI communication No. 3157. Part VIII in the series, "Studies in Medicinal Plants". For Part VII see, Rizvi, S. H., Shoeb, A., Kapil, R. S. and Popli, S. P. (1979) *Indian J. Pharm. Sci.* **41**, 205.