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CHETTAPHANIN-II, A NOVEL FURANODITERPENOID

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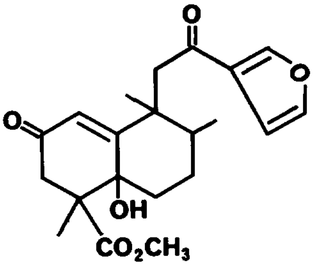
Investigation of chemical constituents of Adenochlaena siamensis Ridl. (Euphorbiaceae) led to the isolation of several novel diterpenoids. In the preceding paper[1)] the structure of chettaphanin-I, the most abundant component, was determined as 1 on the basis of chemical and spectral studies. We report here the structural elucidation of chettaphanin-II (2), the second component.



1

Chettaphanin-II, mp. 127-8°, $[\alpha]_D$ -592°(c=2.0, acetone), has the molecular formula of $C_{21}H_{24}O_4$ from elemental analysis and the mass spectrum with the parent peak at m/e 340, the base peak of which is at m/e 281 $[M-COOCH_3]^{+\cdot}$. In the nmr spectrum of 2, one secondary and two tertiary methyl groups appear at δ 0.98(3H, d, J=5.1 Hz) and at δ 1.00 and 1.39(3H, s, respectively). The signals appearing at δ 7.00, 7.44 and 8.68(each 1H, q) are characteristic of a β-monosubstituted furan[2)]. (The ir spectrum shows furan ring bands at 3125, 1570, 1497, 1010, and 871 cm^{-1} [2)].) The AB type quartet signals at δ 2.44 and 2.86(J=16 Hz) are assigned to the isolated geminal methylene hydrogens adjacent to a carbonyl group, because these signals shift upfield in the nmr spectrum of one (3a) of the epimeric alcohols obtained by lithium aluminium hydride reduction of 2. The three proton singlet at δ 3.59 is ascribed to a carbomethoxy group (the ester band at 1730 cm^{-1}), which is bonded with a quarternary carbon atom because the nmr signals at δ 4.13(2H, s) ($-C\underline{H}_2OCOCH_2Br$) of 3b do not show coupling with any other protons. Besides, the nmr spectrum shows a two proton singlet at δ 2.71, a two proton multiplet at δ 2.3 (both are assignable to allylic methylene groups) and a complex pattern of signals in the δ 1.4 to 1.8 region due to three protons. These nmr data account for all twenty-four protons, all four oxygens and seventeen of twenty-one carbons present in the chettaphanin-II molecule. The absence of an olefinic proton signal, in addition to the empirical formula of 2, indicates that chettaphanin-II has to contain two tetrasubstituted double bonds. The uv [λ_{max}^{EtOH} 236, 246, 262, and 356 mμ (ε 9,600, 9,600, 10,000, and 10,000)] and ir (ν^{nujol} 1686 cm^{-1}) spectra of 2 show cross conjugation of the ketone carbonyl, diene and furan ring and this is further supported by the uv [λ_{max}^{EtOH} 288, 296, and 310 mμ (ε 22,300, 22,900 and 14,200)] and ir (transparent in the carbonyl region) spectra of 3a. The base peak at m/e 281 in the mass spectrum of 2 is a highly stabilized dienic tertiary carbonium cation, and this again suggests the presence of the below partial formula.

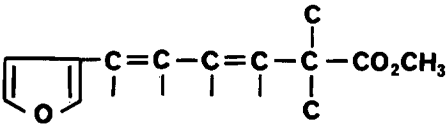
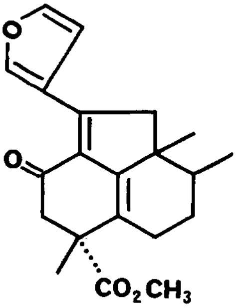


Fig. 1

Nuclear magnetic resonance results were of little utility in anticipating the structure of chettaphanin-II but the nmr spectra of 1 and 2 substantially resemble each other. Consequently, chettaphanin-I and II are closely related.



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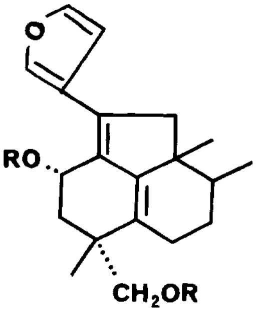


3a R = H

b R = $COCH_2Br$

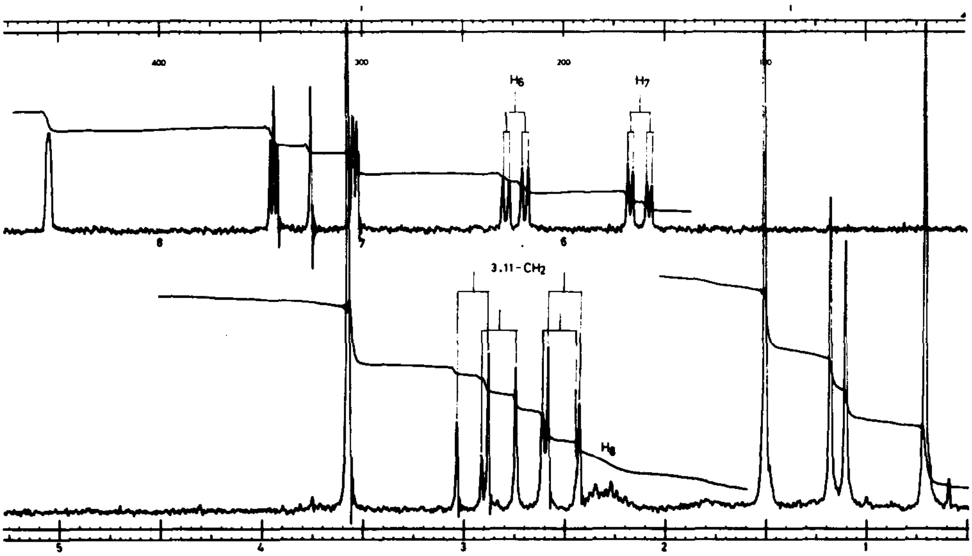
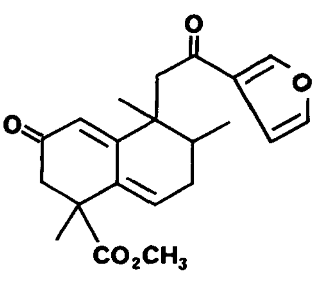


Fig. 2 Nmr spectrum of dehydrochettaphanin-II (5)

The fact that chettaphanin-II was derived from 1 by treatment with zinc-acetic acid, leads to the conclusion that the structure of chettaphanin-II could be tentatively represented as 2.

Convincing evidence for the structure of 2 was readily obtained. Treatment of anhydrochettaphanin-I (4)[1] with sodium methoxide in methanol afforded 5, $C_{21}H_{22}O_4$, mp. 114-6°; M^+ m/e 338; λ_{max}^{EtOH} 306, 319, 334, and 387 mμ (ε 10,100, 10,900, 8,800, and 7,900); ν^{nujol} 1730, 1692, and 1640 cm^{-1}. The nmr spectrum of 5 shows signals of an ABX pattern δ 6.24 (1H, q, J=3.0 and 9.5 Hz), 5.67(1H,



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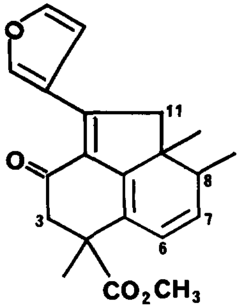

5

q, J=2.5 and 9.5 Hz) and 2.3(1H, m) assigned to -CH=CH-CH< moiety. The $J_{6,8}$ value for the long-range coupling is large enough to show that the hydrogen at C_8 is axial[3]. From the above spectral data, it is clear that this reaction proceeded by an intramolecular aldol condensation to give 5 having a hydroacenaphthene skeleton. Catalytic reduction of 5 on Pd-$CaCO_3$ furnished chettaphanin-II.

The assignment of cis-orientation of C_9 methyl group to the C_8 methyl group is based on biogenetic considerations[4] which would require a back side attack for a Wagner-Meerwein rearrangement.

The stereochemistry of chettaphanin-II was established by X-ray analysis[5]. Treatment of 3a with bromoacetic anhydride in dioxane containing few drops of pyridine gave the bis-bromoacetate (3b), which was crystallized from methanol in the monoclinic system, with the space group $P2_1$, a=12.95, b=15.69, c=5.82 Å; β=100°.

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5) These experiments were carried out in collaboration with Dr. C. Tamura and other stuffs in Crystallographic Section of this Laboratories.