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A LIMONOID FROM *XYLOCARPUS GRANATUM*

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Key Word Index—*Xylocarpus granatum*; Meliaceae; limonoid; X-ray crystallography.

Abstract—A new limonoid, xyloccensin K, has been isolated from the seeds of *Xylocarpus granatum*, along with mixtures of steroids and long chain fatty acids and alcohols. X-ray crystallography has shown that xyloccensin K is similar to a number of previously reported limonoids, but that it contains a tetrahydrofuran sub-unit with oxygen bridging from C-3 to C-8.

INTRODUCTION

Past investigations on the chemical constituents of the seeds of the mangrove, *Xylocarpus granatum* Koenig, have yielded several limonoids [1–4]. In general, the family Meliaceae is distinguished by the frequent occurrence of this class of triterpene derived metabolite, and a detailed appraisal of the limonoids which have been reported from this family has attempted to classify the diverse range of chemical structures in terms of cleavages of various rings in the basic 4,4,8-trimethyl-17-furanyl-steroidal skeleton [5]. We now report the isolation and structural characterization of a new limonoid from *X. granatum*. This compound, xyloccensin K (**1**), has a rare 3,8-epoxy linkage, which has been noted before in a structurally similar hemiacetal, formed by selenium dioxide oxidation of either carapin or mexicanolide [6].

RESULTS AND DISCUSSION

The gross structure of **1** (Fig. 1) compares well with that of a similar limonoid, swietenine (**2**), whose X-ray structure has been determined previously [7]. In both cases, ring A is in a twist boat conformation, ring C is a relatively undistorted chair, and ring D is a half-chair with C-13 and C-14 displaced from the mean plane of the other atoms. Ring B in both cases is a distorted chair, with the distortion being more pronounced in **1**, presumably as a direct result of the constraints of the C-3/C-8 linkage. The tetrahydrofuran ring of **1** is a slightly distorted β-envelope with the C-30 methylene grouping lying outside the approximate plane of the other four atoms.

Compound **1** relates closely in structure to the limonoids, which have been isolated previously from *X. granatum*. Its biosynthesis may well involve intramolecular cyclization of the as yet unreported 3β-hydroxy-8α,14α-epoxide (**3**). This conjecture is supported by the fact that an energy minimized structure for **3** shows a distance of 2.704 Å between the C-3 oxygen and C-8. Furthermore, an ester of **3**, xyloccensin H (**4**), has been isolated from *X. moluccensis* [8].

EXPERIMENTAL

Molecular modelling. Energy minimization was carried out by using PCMODEL for Windows™ (Serena Software, Bloomington, IN). This program uses the MMX force field.

NMR assignments. NMR assignments were deduced from a combination of COSY and HETCOR correlation experiments, aided by results of NOE experiments and reported data for compound **2** [9].

Isolation and extraction of plant material. The fruits of *X. granatum* Koenig were collected in Samuthsakorn province, Thailand, during November 1993. Voucher specimens (BKF 54419, 71031, 077705) have been lodged with the Herbarium of the Bangkok Forestry Department. The air-dried and ground fruits (8.5 kg) were extracted by soaking in CH_2Cl_2 for 5 days at room temp. This procedure was repeated 4×. After filtration, the combined CH_2Cl_2 extracts were concd to give crude material (150 g, 1.76% by wt of dried fruits).

Isolation of xyloccensin K (**1**). The crude extract (60 g) was chromatographed on silica gel with elution by hexane, hexane–CH_2Cl_2 mixts, CH_2Cl_2, and CH_2Cl_2–MeOH mixts. Frs included a mixt. of long chain alcohols, a mixt. of steroids, a mixt. of long chain fatty acids, and **1** (10.6 g, 0.31% by wt of dried fruits) (5%

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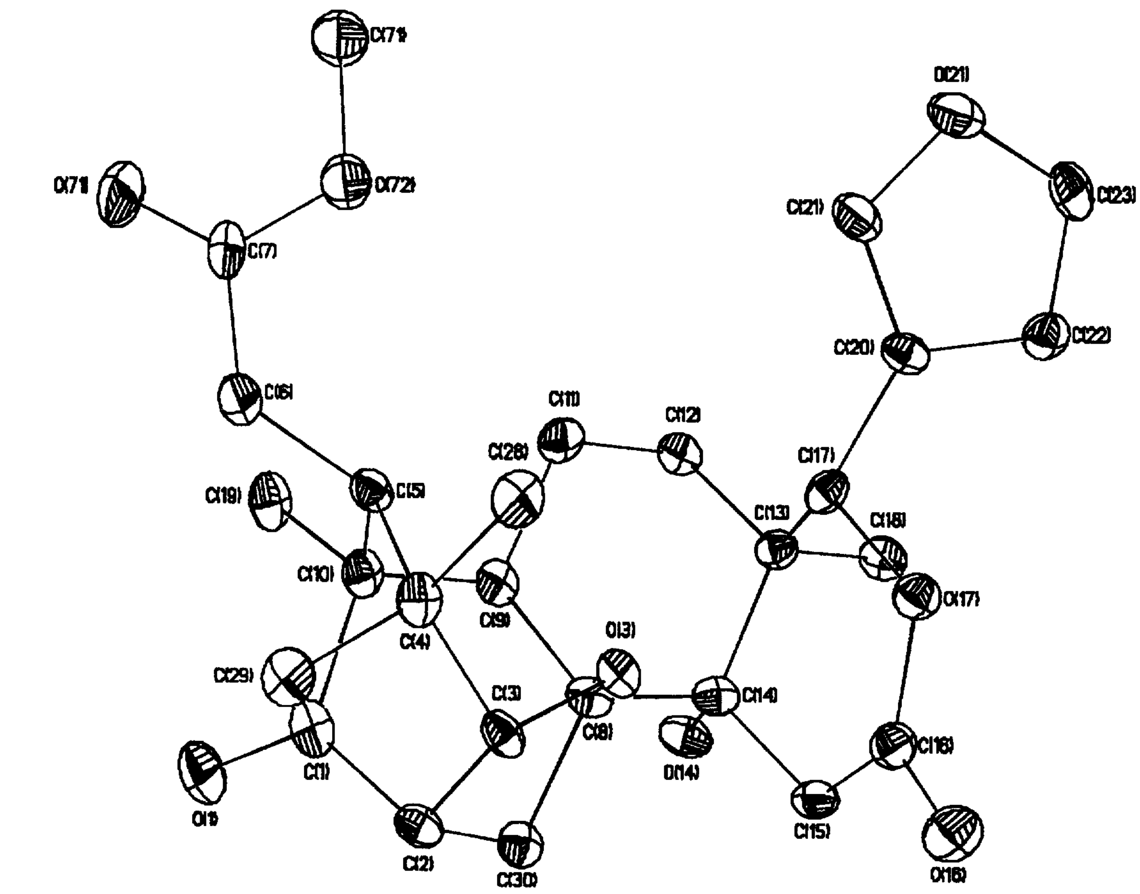
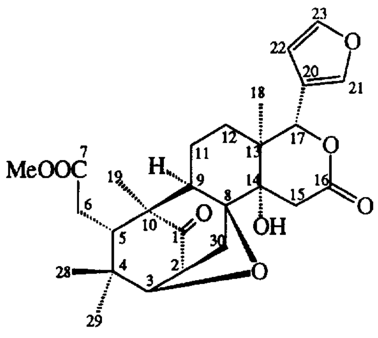


Fig. 1. Structure of xyloccensin K (1).

MeOH–CH_2Cl_2); mp 235–237° (EtOAc); ^{1}H NMR (500.0 MHz, $CDCl_3$): δ 0.67 (3H, *s*, H-18), 0.94 (3H, *s*, H-19), 0.98 (3H, *s*, H-29), 1.03 (3H, *s*, H-28), 1.46 (1H, *m*, H-11), 1.50 (1H, *ddd*, J = 1.5, 1.5, 14 Hz, H-12), 1.70 (1H, *ddd*, J = 4, 14, 14 Hz, H-12), 1.97 (1H, *dd*, J = 5, 12.5 Hz, H-9), 2.04 (1H, *d*, J = 12 Hz, H-30), 2.10 (1H, *m*, H-11), 2.14 (1H, *dd*, J = 2, 17 Hz, H-6), 2.24 (1H, *dd*, J = 11, 17 Hz, H-6), 2.52 (1H, *dd*, J = 7, 12 Hz, H-30), 2.54 (1H, *d*, J = 17 Hz, H-15), 2.96 (1H, *dd*, J = 6, 6 Hz, H-2), 3.08 (1H, *dd*, J = 2, 11 Hz, H-5), 3.13 (1H, *d*, J = 17 Hz, H-15), 3.70 (3H, *s*, OMe), 4.22 (1H, *d*, J = 6 Hz, H-3), 6.28 (1H, *br s*, H-17), 6.49 (1H, *br d*, J = 2 Hz, H-22), 7.45 (1H, *dd*, J = 2, 2 Hz, H-21); 7.56 (1H, *br s*, H-23); ^{13}C NMR (125.7 MHz, $CDCl_3$): δ 16.03 (*q*, C-29), 16.78 (*q*, C-19), 17.81 (*t*, C11), 19.97 (*q*, C-18), 27.94 (*q*, C-28), 28.58 (*t*, C-12), 32.52 (*t*, C6), 36.76 (*t*, C-15), 37.05 (*s*, C-13), 39.90 (*s*, C-4), 42.44 (*t*, C-30), 42.90 (*d*, C-5), 48.91 (*d*, C-2), 50.97 (*s*, C-10), 51.81 (*q*, OMe), 51.98 (*d*, C-9), 74.07 (*s*, C-14 or C-8), 76.66 (*s*, C-8 or C-14), 85.41 (*d*, C-17), 91.27 (*d*, C-3), 109.87 (*d*, C-22) 120.60 (*s*, C-20), 140.70 (*d*, C-23), 142.89 (*d*, C-21), 170.71 (*s*, C-16), 174.19 (*s*, C-7), 215.21 (*s*, C-1); MS *m/z* 486 $[M]^+$, 349, 348, 330, 209, 208, 149, 135, 121, 105.

X-ray structure determination. Crystal data for **1**: $C_{27}H_{34}O_8$; M 486.54 g mol^{-1}; orthorhombic $P2_12_12_1$ (No. 19) [10]; a 9.549(2) Å; b 11.279(2) Å; c 22.330(4) Å; V 2405.0(8) Å^3; D_x 1.344 g cm^{-1}; Z 4; F(000) 1040; λ 0.71069 Å; μ(Mo-$K\alpha$) 0.098 mm^{-1}; T 130(2) K. 1814 measured reflections were employed in the refinement, $\theta_{max} = 22.5°$, $R(\Sigma|F_o| - |F_c|/\Sigma|F_o|) = 0.0300$ ($I > 2\sigma I$, 1623 reflections), and $wR2 = [\Sigma w(F_o^2 - F_c^2)^2/\Sigma w F_o^4]^{\frac{1}{2}} = 0.0741$ (all data), $S = 0.931$, $w^{-1} = \sigma^2(F_o^2) = (0.0609P)$ [11, 12], and $P = (F_o^2 + 2F_c^2)/3$. Residual electron density max. = 0.22, min. = $-$ 0.22 eÅ^{-3}. Data were collected on a Nicolet R3 diffractometer using graphite monochromated Mo-Kα radiation. The structure was solved by direct methods using SHELXS-86 [11, 12]. All non-H atoms were located in the chosen E-map and were refined anisotropically by full matrix least squares based on F^2, with SHELXL-93 [13]. H atoms were input in calculated positions, with isotropic thermal parameters related to the equivalent isotropic displacement parameters of the C or O atoms to which they were bound. The data showed evidence for secondary extinction, and an empirical extinction parameter was refined by least squares to give an extinction coefficient 0.039(2). Atomic coordinates, bond lengths and angles and thermal parameters have been deposited at the Cambridge Crystallographic Data Centre. See Notice to Authors, issue No 1.



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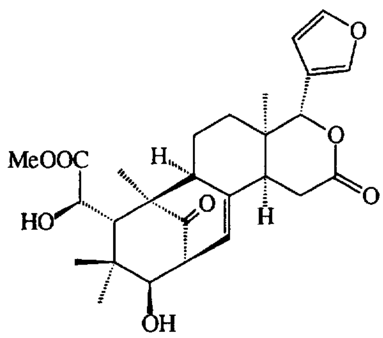

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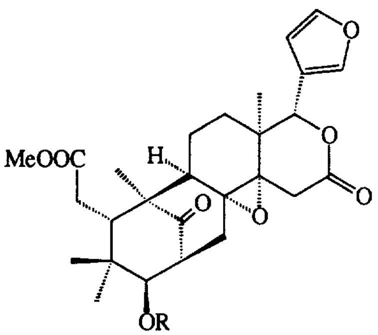

R
3 OH
4 $COCH(Me)_2$

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