

Isopimaradiene Diterpenes from *Rzedowskia Tolantonguensis*

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We report the isolation of new diterpenes, 17-hydroxy-isopimara-8(14),15-dien-19-oic acid (1), isopimara-8(14),15-diene-17,19-diol (2), 17-hydroxy-19-norisopimara-4(18),8(14),15-trien-7-one (3), 19-norisopimara-4(18),8(14),15-triene-7 β ,17-diol (4), 19-norisopimara-4(18),8(14),15-triene-7 α -17-diol (6), 2 α ,17-dihydroxy-19-norisopimara-4(18),8(14),15-trien-7-one (7), and 19-norisopimara-4(18),8(14),15-triene-2 α ,7 β ,17-triol (8), from *Rzedowskia tolantouguensis*,¹⁰ the structure of (1) was confirmed by X-ray analysis.

The products can be grouped together as diterpenes and norditerpenes with an isopimarane skeleton. The structure of (1), C₂₀H₃₀O₃, was determined by a study of its spectral data. The ¹H n.m.r. spectrum showed an ABX vinylic system with the X proton as a double doublet centred at δ 5.74 (J_{BX} 10.7, J_{AX} 17.4 Hz) and the A and B protons as double doublets at δ 5.17 and 5.03 (J_{AB} 1.3 Hz) respectively. Another vinylic proton was observed as a broad singlet at δ 5.22,¹¹ with two hydrogens from a hydroxymethylene group¹² on a quaternary carbon as doublets (J 10.7 Hz) at δ 3.33 and 3.41 and two angular methyls at δ 0.67 and 1.22. The i.r. spectrum showed the presence of an acid grouping while the mass spectrum showed a fragment at m/z 273 attributable to the loss of CO₂, indicating a carboxy group.¹ An X-ray diffraction study, using direct-method solutions (MULTAN),²⁷ established the stereochemistry at C-4 and C-13, confirming the proposed structure.

The natural product (2) proved identical to the LiAlH₄-reduction product of (1) and its structure was thus assured.

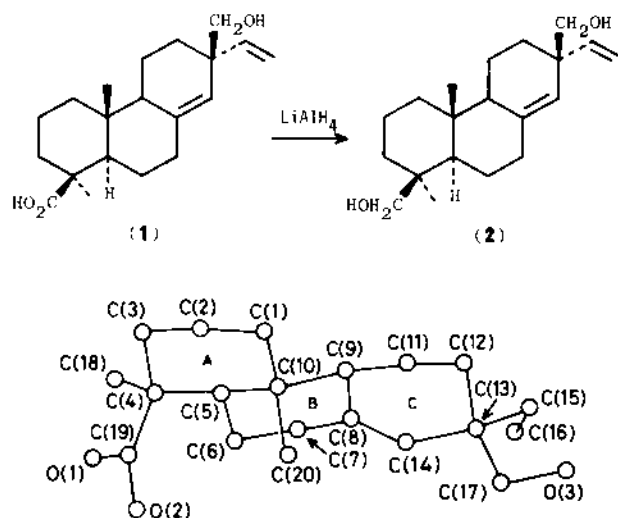
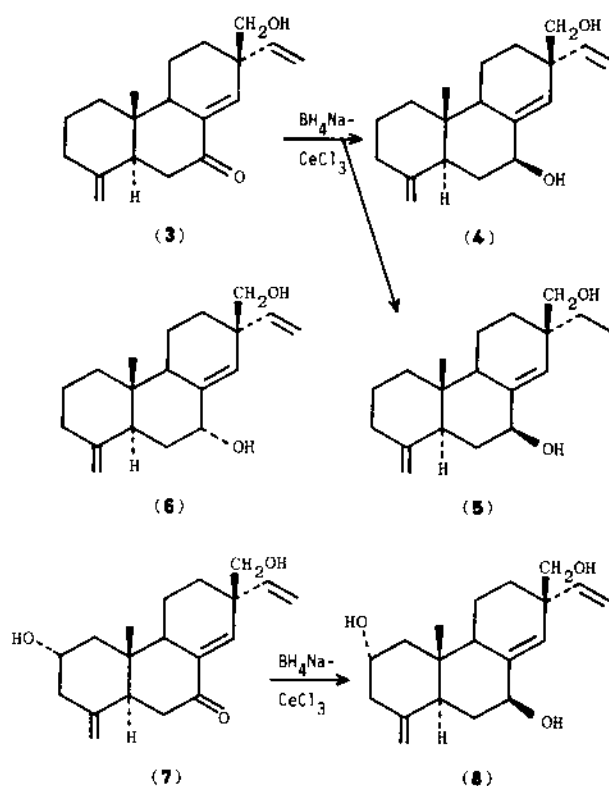


Figure X-Ray molecular model of (1)

The natural products (3), (4), (6), (7), and (8) were all norditerpenes with an exocyclic methylene and no acid group at C-4 and are probably the result of oxidative decarboxylation, as is the case in other compounds with a similar skeleton.¹⁷



In its u.v. spectrum, the product (3) proved to have an unsaturated $\alpha\beta$ carbonyl system, with a band at 250 nm;¹⁶ since the ¹H n.m.r. spectrum showed the isolated vinylic proton [at δ 5.22 in (1)] to have moved to δ 6.74 in (3), the carbonyl group must be sited at C-7; two protons of an exocyclic methylene were observed as singlets at δ 4.51 and 4.87.

The natural product (4) proved to be the same as the LiAlH₄-reduction product of (3), and the hydroxy group was established as β -equatorial in view of the coupling constant and the chemical shift of the geminal proton. The reduction of (3) also yielded (5), which may be explained by the hydroxymethylene group assisting in the reduction process.

The product (6) was an epimer of (4) at C-7²⁰⁻²³ (¹H n.m.r. spectrum); the coupling constant and chemical shift of the proton geminal to the secondary alcohol group determined its C-7 α -axial configuration.

The product (7) had one hydroxy group more than (3),

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located at C-2 by the ^1H n.m.r. chemical shift (δ 3.78). The multiplicity of its geminal proton signal clearly indicated its 2α -configuration.²⁴⁻²⁶

Compound (8) proved identical to the LiAlH_4 -reduction product of (7) and its structure was thus established.

^{13}C N.m.r. analysis confirmed these findings.¹⁷⁻¹⁹

Crystallographic Data for (1). — $\text{C}_{20}\text{H}_{30}\text{O}_3$, orthorhombic, space group $P2_12_12_1$, $a = 17.1301(5)$, $b = 13.8109(7)$, $c = 7.2307(3)$ Å, $V = 1710.68(12)$ Å³, $Z = 4$, $D_x = 1.236$ g cm⁻³. A crystal of approximate dimensions of $0.20 \times 0.15 \times 0.25$ mm was used to measure the intensities of 1964 independent Friedel pairs. The data were collected on an automatic four-circle diffractometer using graphite-monochromated $\text{Cu-K}\alpha$ radiation ($\lambda = 1.5418$ Å) and a ω - 2θ scan at ca. 2° min^{-1} ($\theta = 65^\circ$). No evidence of crystal decomposition was observed during the experiment and no absorption correction was made ($\mu = 6.036$ cm⁻¹). The structure was solved by direct methods²⁷ (MULTAN), and refined by least-squares techniques using the 1507 observed Bijvoet pairs with $I > 2\sigma(I)$. The non-hydrogen atoms were refined using anisotropic temperature factors.²⁸ All hydrogen atoms were found from a difference map. A weighting scheme, to prevent bias in $\langle w\Delta^2 F_0 \rangle$ vs. $\langle F_0 \rangle$ and vs. $\langle \sin\alpha/\lambda \rangle$, was applied, and a final weighted anisotropic refinement (fixed isotropic contributors for H atoms), with both hkl and $\bar{h}\bar{k}l$ reflections, gave $R = 0.044$ and $R_w = 0.053$. The absolute configuration was determined using the more relevant 78 Bijvoet pairs,^{29,30} with $F_0 < 10\sigma(F_0)$, and $\Delta F_0 > 0.08$. The average Bijvoet difference was 1.018 for the right enantiomer vs. 1.025 for the wrong one. The average $\text{C}(sp^3)\text{—C}(sp^3)$ bond length is $1.532(25)$ Å and the average C—C—C angle is $110.81(13)^\circ$.

Techniques used: I.r., ^1H and ^{13}C n.m.r., mass spec., X-ray diffraction

References: 30

Table 1: Torsion angles for the ring system and conformational and configurational angles for the ring substituents of (1)

Table 2: ^1H N.m.r. data for (1)–(4) and (6)–(15)

Table 3: ^{13}C N.m.r. data for (3), (7), (8), and (10)

Appendix: Atomic co-ordinates and thermal parameters of (1)

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