

(-)-HERBERTENEDIOL AND (-)-HERBERTENOLIDE, TWO NEW SESQUITERPENOIDS
OF THE ENT-HERBERTANE CLASS FROM THE LIVERWORT *HERBERTA ADUNCA*

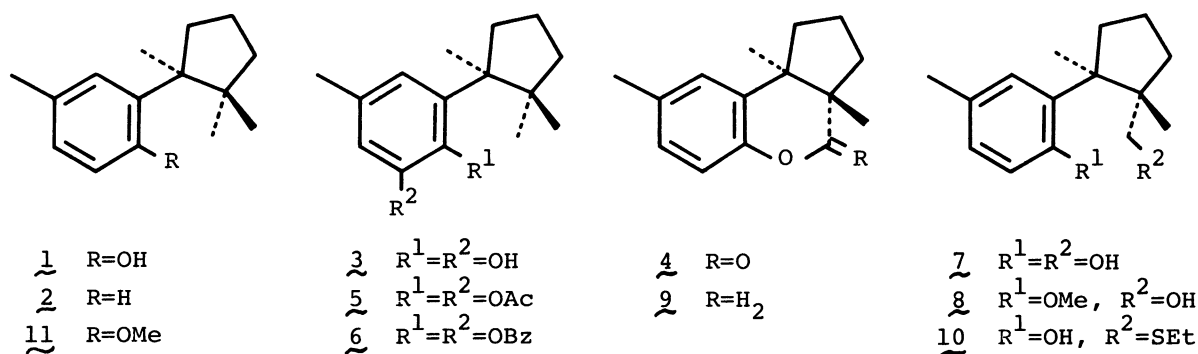
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The structures of (-)-herbertenediol and (-)-herbertenolide, the new aromatic sesquiterpenoids with the *ent*-herbertane skeleton isolated from the liverwort *Herberta adunca*, have been determined on the basis of the chemical and spectral evidence.

Previously, we isolated the sesquiterpene phenol (-)- α -herbertenol (1) together with the key hydrocarbon (-)-herbertene (2) and other phenolic derivatives from the liverwort *Herberta adunca* (Dicks.) S. Gray.^{1,2)} In continuing study on chemical constituents of the liverwort, we obtained two kinds of additional sesquiterpenoids named (-)-herbertenediol and (-)-herbertenolide and established their structures including the absolute configurations to be the formulae (3) and (4) having the same *ent*-herbertane framework, respectively. The present paper deals with the chemical and spectral evidence for the proposed structures.

The two new sesquiterpenoids, (3): C₁₅H₂₂O₂; mp 90.5-91.5 °C; [α]_D -46.5°, and (4): C₁₅H₁₈O₂; mp 95.5-96.5 °C; [α]_D -86.4°, were isolated from a polar fraction of the methanolic extract by a combination of column and thin layer chromatographies over silica gel in yields of 0.6 and 0.2 % to the extract, respectively.³⁾

The IR and NMR spectra of (-)-herbertenediol (3), which afforded a diacetate (5), C₁₉H₂₆O₄, suggested the presence of two hydroxy groups [ν 3630, 3570, and 3410 cm⁻¹; δ 5.28 (2H, br.s: exchangeable with D₂O)], a tetrasubstituted benzene nucleus with a methyl [ν 1600 and 1495 cm⁻¹; δ 2.18 (3H, s), 6.39 and 6.58 (each 1H, br.s)], and three tertiary methyl groups [ν 1380, 1370, and 1360 cm⁻¹; δ 0.75, 1.18, and 1.38 (each 3H, s)]. Substitution pattern of the two phenolic hydroxy groups was recognized as a catechol type since the UV spectrum underwent the bathochromic shift (9 nm) by addition of H₃BO₃ and NaOAc.⁴⁾ By the resemblance of the NMR spectrum, especially the chemical shifts of the tertiary methyls, to that of (-)- α -herbertenol (1), the structure of the diol was deduced to be a hydroxy derivative of α -herbertenol, that is, the structure (3). (-)- α -Herbertenol (1) was, therefore, submitted to benzoyloxylation with (PhCOO)₂/benzene to give a benzoyloxy-phenol mixture (1:1) of the positional isomers of the hydroxy and benzoyloxy groups. The mixture was then esterified with PhCOCl/pyridine to a single dibenzoate (6), C₂₉H₃₀O₄; mp 150-151 °C, treatment of which with LAH/ether produced a diol (3), C₁₅H₂₂O₂; mp 91-92 °C; [α]_D -51.1°. The optical rotation and the spectral data of (-)-herbertenediol (3) were in good agreement with those of the diol (3) derived from (-)- α -herbertenol (1) by the above



Chemical reactions. Accordingly, the structure, and the absolute configuration, of (-)-herbertenediol was represented by the formula (3).

(-)-Herbertenolide (4) was revealed by the spectroscopic properties as a tricyclic sesquiterpenoids containing a six-membered phenol lactone ring [ν 1770 cm^{-1}], a trisubstituted benzene ring with a methyl [ν 1490 cm^{-1} ; δ 2.33 (3H, s) and 6.7-7.1 (3H)], and two tertiary methyl groups [δ 0.90 and 1.11 (each 3H, s)]. Reduction of the δ -lactone (4) with LAH/ether gave a phenol (7), C₁₅H₂₂O₂; mp 139.5-140.5 °C, having a primary hydroxy group. When the diol (7) and its methyl ether (8), C₁₆H₂₄O, were, respectively, treated with (PhO)₃PCH₃I/HMPA,⁵ they did not give any alkyl iodides but formed a six-membered cyclic ether (9), C₁₅H₂₀O. The cyclic ether was transformed by a reaction with AlCl₃ and EtSH into a hydroxythioether (10), C₁₇H₂₆OS, which was, furthermore, reduced with Ra-Ni/EtOH to give a phenol (1), C₁₅H₂₂O; [α]_D -66.7°. The spectra and the optical rotation were identical with those of (-)- α -herbertenol (1).² Finally, determination of the carbon atom forming the lactone carbonyl was performed by examination of the chemical shifts of tertiary methyls in the diol (7) and the methyl ether (8): one methyl [δ 0.80 to (7) and 0.64 to (8)] resonated at the upper field, and the value was analogous to that of one methyl signal [δ 0.75 to (1) and 0.67 to (11)] of the three tertiary methyls in (-)- α -herbertenol (1) and its methoxy derivative (11).² The methyl group shielded by the anisotropic effect of benzene ring was assigned as β -configurational methyl holding a *cis*-relationship to benzene ring.^{6,7)}

References

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