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MOLECULAR STRUCTURE AND STEREOCHEMISTRY OF CHRYSANDIOL, A NOVEL SESQUITERPENE DIOL FROM CHRYSANTHEMUM MORIFOLIUM

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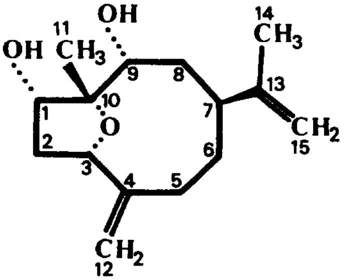
During the course of our search for rooting promoters in Chrysanthemum morifolium Ram. cv. 'Otomezakura', we have isolated chrysartemins A and B[1] and chlorochrymorin[2] as the active principles. Recently, we succeeded in isolating a novel sesquiterpene diol named chrysandiol, $C_{15}H_{24}O_3$, mp 177-180°C, $[\alpha]_D^{25}$ +12.3° (c 1.1, MeOH), from the same plant and assigned the structure 1 to this compound except for its stereochemistry.[3] To confirm the structure proposed and to establish the stereochemistry, we undertook an X-ray crystallographic analysis of 1.



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Recrystallization of 1 from n-hexane-acetone yielded well formed crystals: space group $P2_12_12_1$; a=13.172(3), b=17.284(2) and c=6.221(1)Å; four molecules per unit cell; crystallographic density, 1.19g/cm^3; density determined by flotation in cyclohexane-chloroform, 1.20g/cm^3.

Intensity data were collected on a Rigaku automatic four-circle diffractometer with Mokα radiation. A total of 1232 independent reflections with non-zero intensities ($I>3\sigma(I)$) were obtained. Corrections were made in the usual way for Lorentz and polarization factors, but not for absorption.

The symbolic addition method was applied.[4)] Three origin-defining and one enantiomer-defining reflections (6 0 1, E=2.73; 8 9 0, E=2.69; 7 8 0, E=2.99; 1 0 3, E=2.80) were selected and assigned phases of 90°, 0°, 90° and 90°, respectively. In addition, the following two symbols were given; 1 2 0 (A) E=2.53 and 10 4 1 (B) E=2.17. By use of equation $\phi_h=\phi_k+\phi_{h-k}$, 61 phases (E>1.5) including these symbols were obtained, and the symbol (B) was suggested to be +90° or -90°. Tangent refinement was made for each of possible four combinations of symbol phases, and an E map using 264 reflections with the phases in the most consistent set[5)] (R=0.445) revealed sixteen atoms. A structure factor calculation assuming that three of sixteen atoms would be oxygen gave a R factor of 0.431. The following Fourier synthesis disclosed the remaining two atoms, which were assigned as carbon atoms. Refinement of the structure was undertaken by a block-diagonal least-squares method. After four cycles of refinement, the R factor was reduced to 0.129. The bond distances of C(13)-C(14) and C(13)-C(15) were nearly the same (1.42(2) and 1.44(2)Å, respectively) and the temperature factors of C(14) and C(15) were found too large. These facts suggested that the isopropenyl group would be located in disordered orientations. Assuming the bond distance of C=C as 1.35Å and that of C-C as 1.51Å, the positions of C(14), C(15), C(14') and C(15') for the alternative orientations were obtained. Isotropic temperature factors and half-weights were applied to them, and anisotropic temperature factors to the other sixteen atoms. Four cycles of refinement reduced the R factor to 0.091. In Figs.1 and 2 are shown the bond lengths and angles in the present molecule, which are all reasonable. Thus, the molecular structure of chrysandiol should be 1 (Fig.3) or its mirror image. By the Hendrickson's biogenetic generalization[6)] that all sesquiterpenes attach C-7 substituents in β-orientation, it was concluded that the preferable structure of the diol is 1.

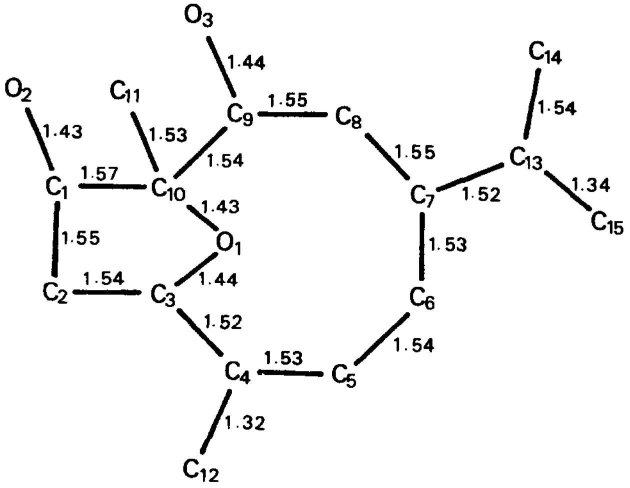

Fig.1. Bond lengths (Å) in chrysandiol: C(14') and C(15') are omitted to avoid confusion; 1.59Å (C(13)-C(14')) and 1.26Å (C(13)-C(15')).

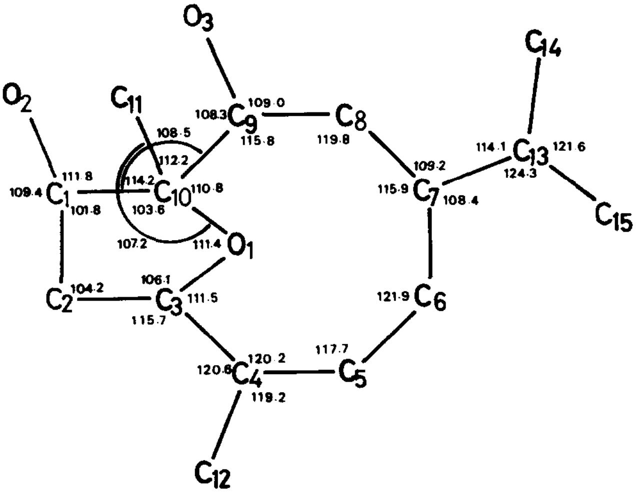

Fig.2. Bond angles (°) in chrysandiol: C(14') and C(15') are omitted to avoid confusion; 116.7° (C(7)-C(13)-C(14')), 124.5° (C(7)-C(13)-C(15')) and 118.7° (C(14')-C(13)-C(15')).

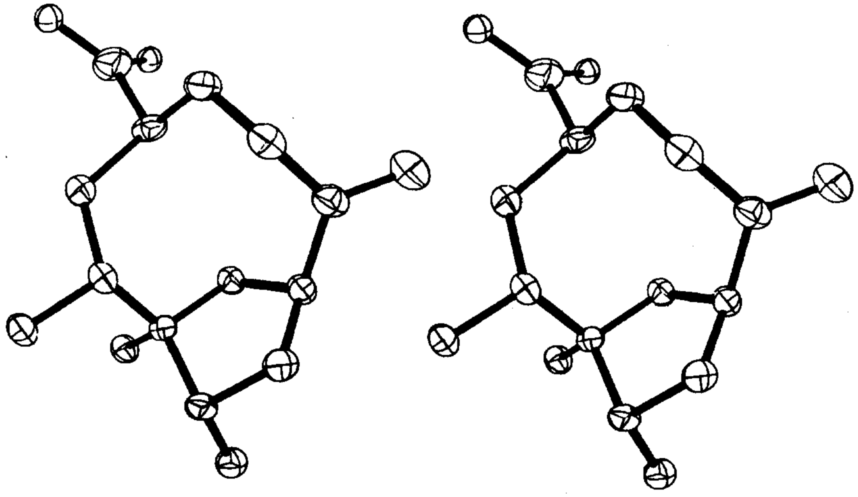

Fig.3. Stereoscopic view of chrysandiol showing elipsoids of thermal motion at 30% probability.

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