The Crystal Structure of Khusimol *p*-Bromobenzoate

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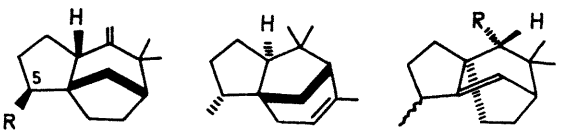
Summary. The structure and stereochemistry of the sesquiterpene alcohol khusimol have been determined by *X*-ray crystallographic analysis of the *p*-bromobenzoate.

THE new carbon skeleton (I) has been assigned to a small group of tricyclic sesquiterpenes occurring in vetiver oil on the basis of degradative and spectroscopic evidence.[1,2] While the gross structure can be biogenetically related to the well-known sesquiterpene cedrene (II),[1] the recently suggested stereochemistry (I) precludes such a relationship.[3] To investigate the structure and stereochemistry of this group of sesquiterpenes we have undertaken an *X*-ray crystallographic study on a derivative of khusimol (Ia).[1,2,4]

Zizanoic acid (khusenic acid) (Ib) was isolated from Haitian vetiver oil and converted into khusimol by lithium aluminium hydride reduction of the corresponding methyl ester.[1,2] The *p*-bromobenzoate (Ic), m.p. 77—79°, afforded needle-like crystals from ethyl acetate which proved adequate for *X*-ray analysis.

Crystal data: khusimol *p*-bromobenzoate, $C_{22}H_{27}O_2Br$, $M = 403{\cdot}4$, monoclinic, $a = 14{\cdot}82(3)$, $b = 10{\cdot}23(4)$, $c = 13{\cdot}27(4)$ Å, and $\beta = 98°\ 15'(20')$, $V = 1991 \times 10^{-24}$ cm.^{3}, $Z = 4$, $D_c = 1{\cdot}35$ g.cm.$^{-3}$. Systematic absences, $0k0$ when $k = 2n + 1$, and the optical activity of the molecule determine the space group as $P2_1$; there are, therefore, two crystallographically independent molecules of khusimol *p*-bromobenzoate.



(I) (II) (III)

a, R = CH_2OH
b, R = CO_2H
c, R = $CH_2O_2C{\cdot}C_6H_4{\cdot}Br$-*p*-

Visual estimates of photographic data (Cu-K_α) gave a total of 1375 independent structure amplitudes. The

crystal structure has been refined to an R-value of 0·14 and a stereoscopic view of the contents of a unit-cell is shown in the Figure.†

The structure and stereochemistry of khusimol are in agreement with the conclusions derived from the chemical studies.[1–3] The sesquiterpenes based upon structure (I) as well as the C-5 epimers[5] are not stereochemically related to cedrene (II) and therefore presumably require different biosynthetic pathways. The stereochemistry of (I), or its C-5 epimer, does, however, correspond to the diterpene eremolactone (III).[2a,6]

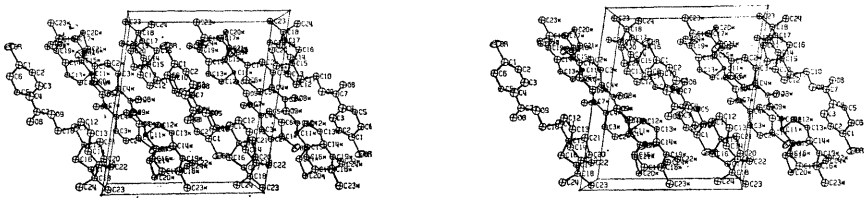


FIGURE. *Stereoscopic pair of the crystal structure looking along the* b-*axis. Chemically equivalent atoms in the molecule which is crystallographically independent of that with regular numbering are given the same numbers with asterisks. (Atom numbering does not correspond to any particular convention.)*

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† Refinement of the two enantiomorphs favoured the absolute configuration shown in (Ic) and in the Figure.

[1] F. Kido, H. Uda, and A. Yoshikoshi, *Tetrahedron Letters*, 1967, 2815.
[2] (a) I. C. Nigam, H. Komae, G. A. Neville, C. Radecka, and S. K. Paknikar, *Tetrahedron Letters*, 1968, 2497; (b) H. Komae and I. C. Nigam, *J. Org. Chem.*, 1968, **33**, 1771.
[3] F. Kido, H. Uda, and A. Yoshikoshi, *Tetrahedron Letters*, 1968, 1247.
[4] D. C. Umarani, K. G. Gore, and K. K. Chakravarti, *Tetrahedron Letters*, 1966, 1255.
[5] N. Hanayama, F. Kido, R. Sakuma, H. Uda, and A. Yoshikoshi, *Tetrahedron Letters*, 1968, 6099.
[6] Y. L. Oh and E. N. Maslen, *Acta Cryst.*, 1968, **B24**, 883.