Notes: (I) this compound; (II) Takeda compound (Kubo *et al.*, 1993); (III) 5,8-dihydro-2,4-dimethyl-8-{[2′-(1*H*-tetrazol-5-yl)biphenyl-4-yl]-methyl}pyrido[2,3-*d*]pyrimidin-7(6*H*)-one (Ellingboe *et al.*, 1994); (IV) 2-ethyl-5,6,7,8-tetrahydro-4-{[2′-(1*H*-tetrazol-5-yl)biphenyl-4-yl]methoxyl}quinolone (Bradbury *et al.*, 1993); all the crystal structures are in centrosymmetric space groups.

X-ray data were collected using standard techniques. Diffraction from the crystals was generally very weak and only 38% of the reflections were observed with $I > 2\sigma(I)$. Crystals of better quality were not available. H atoms were generated geometrically and refined using the *AFIX* option of *SHELXL*93 (Sheldrick, 1993), except for the methyl H atoms which were found from a difference Fourier map and refined using the *AFIX* 137 option. The isotropic displacement parameters of all H atoms were fixed as 1.2 times the isotropic equivalents of their bonded atoms.

Data collection: local program (Yoon, Kim & Shin, 1994). Cell refinement: local program. Data reduction: local program. Program(s) used to solve structure: *SHELXS*86 (Sheldrick, 1985). Program(s) used to refine structure: *SHELXL*93. Molecular graphics: *ORTEP*II (Johnson, 1976). Software used to prepare material for publication: *SHELXL*93.

This work was supported by the Ministry of Science and Technology, Korea.

Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and complete geometry have been deposited with the IUCr (Reference: KH1056). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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Ipriflavone, an Antiostheophorotic Agent

ZSOLT BÖCSKEI, KÁLMÁN SIMON, MÁRTON VARGA AND ISTVÁN HERMECZ

Department of Chemical Research, Chinoin Pharmaceuticals, POB 110, 1325 Budapest, Hungary. E-mail: h2959boc@huella.bitnet

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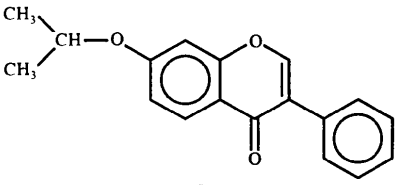
Abstract

The antiostheophorotic agent ipriflavone [7-(1-methylethoxy)-3-phenyl-4*H*-1-benzopyran-4-one, $C_{18}H_{16}O_3$] is an important member of the isoflavone family. The structure of the molecule is dominated by the dihedral angle (50°) between the planes of the phenyl and benzopyran moieties. A structural comparison with other related published structures is represented.

Comment

Isoflavone derivatives are widely known to be biologically active compounds. A number of publications report crystal structures of isoflavone derivatives (Shoja, 1992*a*,*b*; Acharya, Puranik, Tavale & Guru Row, 1986; Breton, Precigoux, Courseille & Hospital, 1975) including naturally occurring molecules. Licoricone (Kaneda, Iitaka & Shibata, 1973) from the root of licorice, for example, is used in the treatment of stomach ulcers. Aformosine (Caballero & Smith, 1986) is an isoflavone partly responsible for the insect resistance of a soybean species.

Ipriflavone, (I) (Feuer, Nógrádi, Gottsegen, Vermes, Streliszky, Wolfner, Farkas, Antus, Kovács, 1971; Lányi, Nógrádi, Ecsery-Puskás & Hermecz, 1995; Varga, Bátori, Hermecz, 1995), has been registered 19 years after its synthesis and launched as an effective ostheophorotic agent, first in Japan in 1988 (registered names: Osteochin in Hungary, Osten in Japan, Osteofix in Italy). A crystal structure analysis of (I) has been carried out in order to contribute to a wider structural characterization of the active substance of the drug.



(I)

The molecule consists of a planar phenyl ring and a planar 7-isopropoxy-substituted benzopyran moiety. The two planar moieties form an angle of 50.0°. Considering

the values of corresponding angles in other isoflavone derivatives, ipriflavone displays a fairly average structure. One of the known extremes is licoricone which has a corresponding dihedral angle of 75°. This is due to disubstitution in the 2 and 6 positions on the phenyl ring of the isoflavone moiety. On the other hand, in 4′,6,7-trimethoxyisoflavone (Shoja, 1992*b*) the corresponding value is −42.8°. Other known examples lie between these two extremes.

Another parameter of the isoflavone structures that is usually of interest is the bond length between the benzopyran and phenyl ring. In the present case, the corresponding C3—C9 bond length is 1.476 (7) Å, which agrees well with values observed in most of the other compounds studied thus far. The only significant exception, as expected, is licoricone, where the decreased delocalization between the two rings due to their almost perpendicular orientation is also manifested by an increased C3—C9 bond lengths (1.51 Å in licoricone).

The bonds to O1 are asymmetric in length and strength. C2—O1 and the corresponding bonds in other isoflavones are always slightly shorter (usually by about 0.02 Å) than those corresponding to C8a—O1.

The C15 atom of the isopropoxy group is also in the plane of the isoflavone ring. The conformation of the isopropoxy group in relation to the benzopyran moiety is determined by the need to avoid close contacts with atoms H6 and H8 of the isoflavone moiety.

A more widespread study on the structures of several of the derivatives, metabolites and followers of ipriflavone is in preparation.

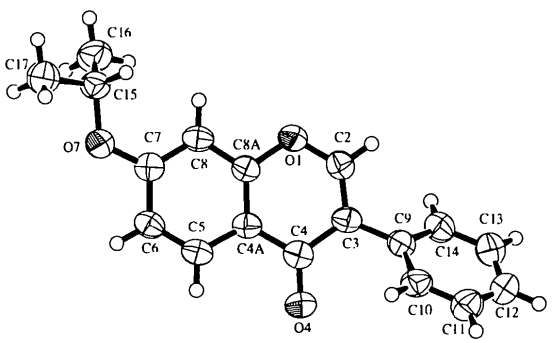


Fig. 1. Molecular structure and atomic numbering for ipriflavone. Displacement ellipsoids are plotted at the 50% probability level.

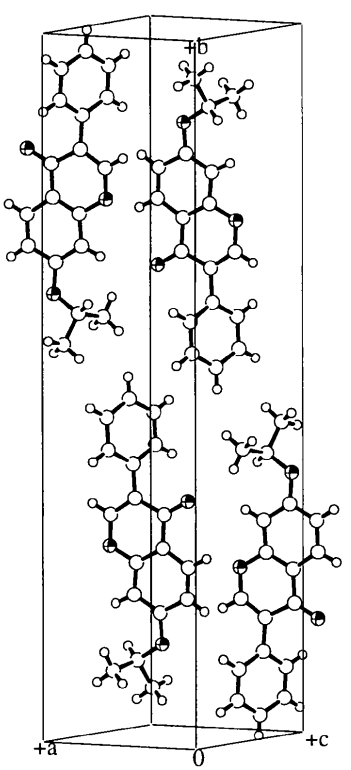


Fig. 2. Packing diagram of ipriflavone.

Experimental

The title compound, (I) (m.p. 391–392 K), was produced using the method of Feuer *et al.* (1971).

Crystal data

$C_{18}H_{16}O_3$
M_r = 280.31
Monoclinic
$P2_1/n$
a = 7.000 (4) Å
b = 30.605 (5) Å
c = 7.151 (3) Å
β = 110.32 (4)°
V = 1436.5 (11) Å^3
Z = 4
D_x = 1.296 Mg m^{-3}
D_m not measured
Cu $K\alpha$ radiation
λ = 1.5418 Å
Cell parameters from 20 reflections
θ = 41.25–87.98°
μ = 0.707 mm^{-1}
T = 293 (2) K
Plate
0.4 × 0.2 × 0.1 mm
Transparent

Data collection

AFC-6*S* diffractometer
$\omega/2\theta$ scans
Absorption correction: none
3038 measured reflections
2828 independent reflections
1118 observed reflections [$I > 2\sigma(I)$]
R_{int} = 0.0607
θ_{max} = 75.15°
$h = -6 \rightarrow 8$
$k = 0 \rightarrow 38$
$l = 0 \rightarrow 8$
3 standard reflections monitored every 150 reflections
intensity decay: none

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.0741
$wR(F^2)$ = 0.3279
S = 1.033
2819 reflections
194 parameters
Only H-atom U's refined
$w = 1/[\sigma^2(F_o^2) + (0.1552P)^2 + 0.7485P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = −0.003
$\Delta\rho_{max}$ = 0.300 e Å^{-3}
$\Delta\rho_{min}$ = −0.325 e Å^{-3}
Extinction correction: *SHELXL*93 (Sheldrick, 1993)
Extinction coefficient: 0.0077 (16)
Atomic scattering factors from *International Tables for Crystallography* (1992, Vol. C, Tables 4.2.6.8 and 6.1.1.4)

Table 1. *Fractional atomic coordinates and equivalent isotropic displacement parameters (Å²)*

$U_{eq} = (1/3)\Sigma_i\Sigma_j U_{ij} a_i^* a_j^* \mathbf{a}_i.\mathbf{a}_j$.

	x	y	z	U_{eq}
O1	0.3655 (5)	0.23117 (11)	−0.0704 (5)	0.0534 (10)
O4	−0.1304 (5)	0.16407 (12)	−0.0474 (6)	0.0634 (11)
O7	0.0520 (5)	0.36750 (11)	−0.0305 (6)	0.0576 (10)
C2	0.3586 (8)	0.1870 (2)	−0.0723 (7)	0.0479 (12)
C3	0.2020 (7)	0.1624 (2)	−0.0675 (7)	0.0477 (12)
C4	0.0184 (8)	0.1842 (2)	−0.0567 (7)	0.0474 (12)
C4a	0.0269 (7)	0.2319 (2)	−0.0577 (7)	0.0446 (12)
C5	−0.1351 (7)	0.2577 (2)	−0.0514 (8)	0.0504 (13)
C6	−0.1240 (8)	0.3020 (2)	−0.0470 (8)	0.0517 (13)
C7	0.0550 (8)	0.3232 (2)	−0.0452 (7)	0.0480 (12)
C8	0.2163 (7)	0.2988 (2)	−0.0576 (7)	0.0496 (13)
C8a	0.1989 (7)	0.2536 (2)	−0.0612 (7)	0.0436 (12)
C9	0.2165 (7)	0.1143 (2)	−0.0643 (8)	0.0504 (13)
C10	0.1701 (8)	0.0900 (2)	0.0787 (9)	0.061 (2)
C11	0.1867 (10)	0.0455 (2)	0.0865 (11)	0.074 (2)
C12	0.2501 (10)	0.0234 (2)	−0.0489 (12)	0.082 (2)
C13	0.2970 (10)	0.0468 (2)	−0.1941 (11)	0.077 (2)
C14	0.2811 (9)	0.0917 (2)	−0.2017 (9)	0.064 (2)
C15	0.2343 (8)	0.3925 (2)	−0.0038 (9)	0.0551 (14)
C16	0.2521 (10)	0.4022 (2)	−0.2030 (10)	0.074 (2)
C17	0.2118 (10)	0.4337 (2)	0.1032 (10)	0.078 (2)

Table 2. *Selected geometric parameters (Å, °)*

O1—C2	1.351 (6)	C2—C3	1.341 (6)
O1—C8a	1.373 (5)	C3—C4	1.473 (7)
O4—C4	1.232 (6)	C3—C9	1.476 (7)
O7—C7	1.361 (6)	C4—C4a	1.461 (7)
O7—C15	1.443 (6)		
C2—O1—C8a	118.1 (4)	C3—C2—O1	126.1 (5)
C7—O7—C15	120.2 (4)		
C2—C3—C9—C10	128.5 (5)	C7—O7—C15—C16	86.1 (6)
C2—C3—C9—C14	−50.2 (7)	C7—O7—C15—C17	−153.1 (5)

Data collection: *MSC/AFC Diffractometer Control Software* (Molecular Structure Corporation, 1988). Cell refinement: *MSC/AFC Diffractometer Control Software*. Data reduction: *PROCESS* in *TEXSAN* (Molecular Structure Corporation, 1992). Program(s) used to solve structure: *SHELXS*86 (Sheldrick, 1990). Program(s) used to refine structure: *SHELXL*93 (Sheldrick, 1993). Software used to prepare material for publication: *FINISH* in *TEXSAN*.

Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and complete geometry have been deposited with the IUCr (Reference: KA1158). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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A New Crystalline Form of 1-Phenyl-1,2-dicarba-*closo*-dodecaborane(12)

RHODRI LL. THOMAS, GEORGINA M. ROSAIR AND ALAN J. WELCH

Department of Chemistry, Heriot-Watt University, Riccarton, Edinburgh EH14 4AS, Scotland. E-mail: cherlt@caledonia.hw.ac.uk

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Abstract

A new polymorph of the title compound, $C_8H_{16}B_{10}$, is reported. The carborane icosahedron is relatively undistorted, with the phenyl substituent twisted out of the C2—C1—C_{ring} plane by 18.3 (2)°, which is in good agreement with the conformation predicted by molecular-orbital calculations.

Comment

1-Ph-1,2-*closo*-$C_2B_{10}H_{11}$ has been known since 1963 (Heyling *et al.*, 1963) and many derivatives of it have been structurally characterized (Clegg *et al.*, 1993; McGrath & Welch, 1995*a*,*b*,*c*,*d*). Surprisingly, it is only recently that a structural determination of the parent molecule has been reported (Brain *et al.*, 1996). This previous crystal form, which will be denoted as the α form, contained two crystallographically independent molecules, only one of which was sufficiently ordered for all cage atoms to be identified. In the other molecule, the position of atom C2 could not be determined unambiguously. In the new crystalline modification described herein, which will be referred to as the β form, there is only one molecule in the asymmetric unit and the cage C atom bearing the H atom is easily identified. All reference to the molecular parameters of the α form are to those of the ordered molecule. The determination of the β form, (I), proved to be more precise than that of the α form, with typical e.s.d.'s being one third of the values reported previously, presumably due in part to the greater order found in the present determination.