Refinement

Refinement on F
$R = 0.072$
$wR = 0.067$
$S = 4.84$
1893 reflections
227 parameters
$w = 1/\sigma^2(F)$
$(\Delta/\sigma)_{\max} = 0.01$

$\Delta\rho_{\max} = 0.33$ e Å^{-3}
$\Delta\rho_{\min} = -0.46$ e Å^{-3}
Extinction correction: $F_c^* = F_c(1 - gF_c^2/\sin\omega)$
Extinction coefficient: $g = 0.0662$
Atomic scattering factors from *SHELXTL/PC* (Sheldrick, 1990)

Table 1. *Fractional atomic coordinates and equivalent isotropic displacement parameters* (Å^2)

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

	x	y	z	$U_{\rm eq}$
Cl	0.5265 (1)	0.6431 (2)	0.0978 (1)	0.092 (1)
O1	1.0741 (3)	0.9032 (3)	−0.3418 (3)	0.071 (1)
O2	0.9412 (3)	0.8881 (3)	0.1057 (3)	0.060 (1)
N1	1.0770 (3)	0.8639 (3)	−0.0335 (3)	0.048 (1)
N3	1.1966 (3)	0.8946 (3)	−0.1826 (3)	0.051 (1)
N4	1.2729 (3)	0.8834 (3)	0.0117 (3)	0.055 (1)
C2	1.1879 (3)	0.8794 (4)	−0.0598 (4)	0.049 (1)
C4	1.0923 (4)	0.8906 (4)	−0.2358 (4)	0.055 (1)
C5	1.0112 (4)	0.8652 (4)	−0.1406 (4)	0.050 (1)
C6	0.9055 (4)	0.8432 (4)	−0.1649 (4)	0.052 (1)
C7	1.0393 (4)	0.8782 (4)	0.0848 (4)	0.047 (1)
C8	1.1323 (4)	0.8783 (4)	0.1702 (4)	0.050 (1)
C9	1.1072 (4)	0.8823 (4)	0.2927 (4)	0.061 (1)
C10	1.1937 (5)	0.8818 (4)	0.3750 (4)	0.070 (2)
C11	1.3026 (5)	0.8763 (5)	0.3378 (5)	0.076 (2)
C12	1.3301 (4)	0.8752 (5)	0.2183 (4)	0.067 (1)
C13	1.2415 (4)	0.8763 (4)	0.1331 (4)	0.054 (1)
C14	1.3006 (4)	0.9200 (5)	−0.2425 (4)	0.065 (2)
C15	1.3261 (5)	1.0405 (6)	−0.2337 (5)	0.091 (2)
C16	0.8146 (3)	0.7961 (4)	−0.0952 (4)	0.048 (1)
C17	0.7059 (4)	0.8300 (4)	−0.1175 (4)	0.058 (1)
C18	0.6172 (4)	0.7848 (5)	−0.0558 (4)	0.063 (1)
C19	0.6375 (4)	0.7008 (5)	0.0228 (4)	0.057 (1)
C20	0.7438 (4)	0.6644 (4)	0.0435 (4)	0.059 (1)
C21	0.8325 (4)	0.7112 (4)	−0.0145 (4)	0.054 (1)

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

O1—C4	1.214 (6)	C4—C5	1.480 (7)
O2—C7	1.201 (6)	C5—C6	1.314 (7)
N1—C2	1.371 (5)	C7—C8	1.455 (7)
N1—C5	1.425 (6)	C8—C9	1.408 (6)
N1—C7	1.414 (6)	C8—C13	1.371 (7)
N3—C2	1.392 (6)	C9—C10	1.375 (7)
N3—C4	1.373 (6)	C10—C11	1.369 (8)
N3—C14	1.450 (6)	C11—C12	1.381 (7)
N4—C2	1.285 (5)	C12—C13	1.415 (7)
N4—C13	1.416 (6)		
C2—N1—C5	109.9 (4)	N1—C2—N3	108.3 (4)
C2—N1—C7	120.1 (4)	N1—C2—N4	128.8 (4)
C5—N1—C7	127.5 (4)	N3—C2—N4	122.9 (4)
C2—N4—C13	112.4 (4)		
N1—C5—C6—C16	−8.5 (9)		

Table 3. *Dihedral angles between mean planes* (°)

Plane *A*: N1, C2, N3, C4, C5. Plane *B*: N1, C2, N4, C13, C8, C7. Plane *C*: C8, C9, C10, C11, C12, C13.

A/B	9.8 (2)
A/C	12.1 (2)
B/C	4.5 (2)

The structure was refined by full-matrix least squares. The positions of all the H atoms were found from a $\Delta\rho$ map and refined using a riding model with fixed isotropic displacement parameters ($1.5U_{\rm eq}$ of the parent atom).

Structure solution: *SHELXTL/PC* (Sheldrick, 1990). Structure refinement: *SHELXTL/PC*. Molecular graphics: *SHELXTL/PC*. Preparation of material for publication: *SHELXTL/PC*.

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Lists of structure factors, anisotropic displacement parameters and H-atom coordinates have been deposited with the IUCr (Reference: KA1109). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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5-(2-Chlorobenzyl)-6-methyl-3(2*H*)-pyridazinone

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Abstract

The crystal and molecular structure of the title compound, $C_{12}H_{11}ClN_2O$, has been determined as part of an investigation into quantitative structure–activity

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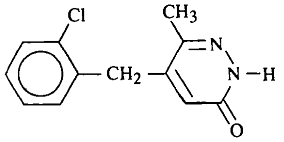
relationships in benzodiazepine ligands. The two planar rings (pyridazine and phenyl) are at an angle of *ca* 95°. Crystal cohesion is ensured by a dense network of van der Waals contacts.

Comment

The structure determination of 5-(2-chlorobenzyl)-6-methyl-3(2*H*)-pyridazinone was undertaken to confirm that 5-benzylpyridazine derivatives satisfy pharmacophore requirements (Villar *et al.*, 1989; Brandau, Bourguignon & Wermuth, 1991) of central benzodiazepine receptors, as suggested by previous molecular-modelling studies (Moreau *et al.*, 1994). The structure of the title compound determined by X-ray diffraction corroborates the aromatic structure of the pyridazine ring suggested by recent NMR spectroscopic data (Bebot, Coudert & Couquelet, unpublished work), contrary to former results (Rubat *et al.*, 1990) describing a dihydro skeleton with a 5-arylidene moiety. The lengths of the C═C [1.343 (3) Å], C═N [1.301 (4) Å], N—N [1.357 (3) Å] and C═O [1.255 (3) Å] bonds are comparable with published values for other pyridazinones [1.331–1.350, 1.301–1.316, 1.336–1.386 and 1.234–1.256 Å, respectively (Prout *et al.*, 1994)]. The angle between the phenyl ring and the pyridazine ring is 94.8 (1)°. Crystal cohesion is ensured by a three-dimensional network of van der Waals interactions (see Table 2). The carbonyl O atom O(16) and the N(2)—H(2) amino group form an intermolecular hydrogen bond, the details of which are given in Table 2.



The planar aromatic region of the pyridazine ring and the out-of-plane position of the phenyl nucleus suggest that 5-benzylpyridazine derivatives might possess agonistic properties at the central benzodiazepine receptor (Villar *et al.*, 1989; Brandau, Bourguignon & Wermuth, 1991) when they are substituted by an electron-rich group, such as an acetamido side chain at N(2) (Rubat *et al.*, 1990), or fused with a triazole ring (Moreau *et al.*, 1994).

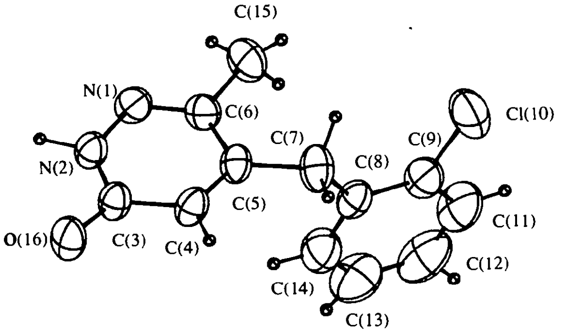


Fig. 1. *ORTEPII* (Johnson, 1976) view of the title molecule showing the labelling of non-H-atoms. Displacement ellipsoids are shown at 50% probability levels.

Experimental

The title compound was crystallized from ethanol after the reaction of levulinic acid with 2-chlorobenzaldehyde followed by condensation with hydrazine hydrate. The crystal density D_m was measured by flotation in xylene.

Crystal data

$C_{12}H_{11}ClN_2O$
$M_r = 234.69$
Monoclinic
$P2_1$
$a = 7.270\,(1)$ Å
$b = 7.076\,(4)$ Å
$c = 11.227\,(1)$ Å
$\beta = 100.57\,(1)°$
$V = 567.8$ Å^3
$Z = 2$
$D_x = 1.373$ Mg m^{-3}
$D_m = 1.2$ Mg m^{-3}

Mo $K\alpha$ radiation
$\lambda = 0.71069$ Å
Cell parameters from 25 reflections
$\theta = 8–15°$
$\mu = 0.31$ mm^{-1}
$T = 293$ K
Prism
0.42 × 0.21 × 0.12 mm
White

Data collection

Enraf–Nonius CAD-4 diffractometer
$\theta–2\theta$ scans
Absorption correction: none
2650 measured reflections
2650 independent reflections
1468 observed reflections $[I > 1.5\sigma(I)]$

$\theta_{\max} = 35°$
$h = 0 \rightarrow 11$
$k = 0 \rightarrow 11$
$l = -18 \rightarrow 18$
3 standard reflections frequency: 60 min intensity decay: 1%

Refinement

Refinement on F
$R = 0.051$
$wR = 0.054$
$S = 1.67$
1468 reflections
189 parameters
All H-atom parameters refined
$w = 1/\sigma^2(F)$
$(\Delta/\sigma)_{\max} = 0.01$

$\Delta\rho_{\max} = 0.33$ e Å^{-3}
$\Delta\rho_{\min} = -0.36$ e Å^{-3}
Extinction correction: $F_c = |F_o|(1 + gI_c)$ (Stout & Jensen, 1968)
Extinction coefficient: $g = 1.683 \times 10^{-6}$
Atomic scattering factors from *International Tables for X-ray Crystallography* (1974, Vol. IV)

Table 1. *Fractional atomic coordinates and equivalent isotropic displacement parameters* (Å^2)

$$B_{eq} = (4/3)\Sigma_i\Sigma_j\beta_{ij}\mathbf{a}_i.\mathbf{a}_j.$$

	x	y	z	B_{eq}
N(1)	0.3978 (3)	−0.1953 (4)	0.1338 (2)	3.69 (4)
N(2)	0.2197 (3)	−0.1456 (3)	0.0846 (2)	3.38 (4)
C(3)	0.1511 (3)	0.0300 (4)	0.0621 (2)	3.34 (4)
C(4)	0.2839 (3)	0.1781 (4)	0.0966 (2)	3.52 (5)

C(5)	0.4618 (3)	0.1389 (4)	0.1475 (2)	3.32 (5)
C(6)	0.5146 (3)	−0.0568 (5)	0.1646 (2)	3.47 (5)
C(7)	0.6038 (3)	0.2923 (5)	0.1827 (2)	4.26 (6)
C(8)	0.6662 (3)	0.3149 (4)	0.3194 (2)	3.70 (5)
C(9)	0.8447 (4)	0.3774 (5)	0.3679 (3)	4.32 (6)
Cl(10)	1.0040 (1)	0.427	0.2739 (1)	6.96 (2)
C(11)	0.9041 (4)	0.4052 (6)	0.4909 (3)	6.14 (8)
C(12)	0.7805 (5)	0.3627 (7)	0.5684 (3)	6.9 (1)
C(13)	0.6067 (5)	0.2992 (7)	0.5235 (3)	6.70 (9)
C(14)	0.5477 (4)	0.2782 (6)	0.3987 (3)	5.26 (7)
C(15)	0.7113 (3)	−0.1161 (5)	0.2179 (3)	4.90 (7)
O(16)	−0.0182 (3)	0.0503 (3)	0.0150 (2)	4.51 (4)

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

N(1)—N(2)	1.357 (3)	C(7)—C(8)	1.527 (3)
N(1)—C(6)	1.301 (4)	C(8)—C(9)	1.384 (3)
N(2)—C(3)	1.346 (4)	C(8)—C(14)	1.373 (4)
C(3)—C(4)	1.430 (4)	C(9)—Cl(10)	1.739 (3)
C(3)—O(16)	1.255 (3)	C(9)—C(11)	1.384 (4)
C(4)—C(5)	1.343 (3)	C(11)—C(12)	1.393 (5)
C(5)—C(6)	1.440 (4)	C(12)—C(13)	1.348 (5)
C(5)—C(7)	1.500 (4)	C(13)—C(14)	1.396 (4)
C(6)—C(15)	1.505 (3)		
C(4)···O(16^{i})	3.369 (3)	O(16)···O(16^{iii})	3.568 (3)
Cl(10)···O(16^{ii})	3.379 (3)	O(16)···O(16^{i})	3.568 (3)
N(1)···O(16^{iii})	3.458 (3)	C(3)···O(16^{iii})	3.592 (4)
C(15)···O(16^{iv})	3.477 (4)	N(2)···C(3^{iii})	3.690 (3)
N(2)···C(7^{v})	3.501 (3)	N(1)···C(5^{v})	3.684 (3)
N(1)···C(7^{v})	3.551 (3)	C(13)···C(14^{vii})	3.725 (6)
C(4)···Cl(10^{vi})	3.562 (3)		
N(2)—N(1)—C(6)	116.1 (2)	C(5)—C(7)—C(8)	113.8 (2)
N(1)—N(2)—C(3)	127.5 (2)	C(7)—C(8)—C(9)	120.9 (2)
N(2)—C(3)—C(4)	114.7 (2)	C(7)—C(8)—C(14)	121.7 (2)
N(2)—C(3)—O(16)	119.1 (2)	C(9)—C(8)—C(14)	117.4 (2)
C(4)—C(3)—O(16)	126.3 (3)	C(8)—C(9)—Cl(10)	120.4 (2)
C(3)—C(4)—C(5)	120.9 (3)	C(8)—C(9)—C(11)	122.4 (3)
C(4)—C(5)—C(6)	117.9 (2)	Cl(10)—C(9)—C(11)	117.2 (2)
C(4)—C(5)—C(7)	121.6 (3)	C(9)—C(11)—C(12)	118.3 (3)
C(6)—C(5)—C(7)	120.4 (2)	C(11)—C(12)—C(13)	120.4 (4)
N(1)—C(6)—C(5)	122.9 (3)	C(12)—C(13)—C(14)	120.3 (3)
N(1)—C(6)—C(15)	115.0 (3)	C(8)—C(14)—C(13)	121.1 (3)
C(5)—C(6)—C(15)	122.1 (2)		
C(4)—C(5)—C(7)—C(8)	111.0 (3)	C(5)—C(7)—C(8)—C(9)	149.7 (3)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
N(2)—H(2)···O(16^{iii})	0.78 (3)	1.96 (3)	2.725 (3)	170 (3)

Symmetry codes: (i) $-x, \frac{1}{2}+y, -z$; (ii) $1-x, \frac{1}{2}+y, -z$; (iii) $-x, y-\frac{1}{2}, -z$; (iv) $1+x, y, z$; (v) $1-x, y-\frac{1}{2}, -z$; (vi) $-x, y, z$; (vii) $1-x, \frac{1}{2}+y, 1-z$.

Data reduction and other calculations were performed using *MolEN* (Fair, 1990). Lorentz and polarization corrections were applied to the data. The non-H atoms were located by direct methods using *MULTAN*11/82 (Main *et al.*, 1982). Molecular graphics were produced using *ORTEP*II (Johnson, 1976).

Lists of structure factors, anisotropic displacement parameters, H-atom coordinates and bond distances and angles involving H atoms have been deposited with the IUCr (Reference: JZ1037). Copies may be obtained through The Managing Editor, International Union of Crystallography, 5 Abbey Square, Chester CH1 2HU, England.

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cyclo-*N*-Acetyl-L-alanyl-*N*-methyl-L-alanyl (*cyclo*-*N*-Ac-L-Ala-*N*-Me-L-Ala)

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Abstract

The title compound, $C_9H_{14}N_2O_3$ (alternative name: 1-acetyl-3,4,6-trimethyl-2,5-piperazinedione), assumes a boat conformation with both methyl substituents in pseudo-axial orientations. The degree of folding of the diketopiperazine ring, defined by the angle between the planes containing the two endocyclic amide bonds, was found to be −29.1°.

Comment

The conformations of a number of diketopiperazines have been studied by X-ray diffraction (for examples and leading references, see Karle, 1981). In an attempt

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