

3-(4-Chlorophenyl)-6-methyl-1,6-dihydro-1,2,4,5-tetrazine

Feng Xu, Wei-Xiao Hu,* Wei Zhou and Chun-Nian Xia

College of Pharmaceutical Science, Zhejiang University of Technology, Hangzhou 310014, People's Republic of China

Correspondence e-mail: huyang@mail.hz.zj.cn

Key indicators

Single-crystal X-ray study
 $T = 293\text{ K}$
Mean $\sigma(\text{C}-\text{C}) = 0.002\text{ \AA}$
 R factor = 0.045
 wR factor = 0.117
Data-to-parameter ratio = 16.1For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.

The title compound, $\text{C}_9\text{H}_9\text{ClN}_4$, was prepared from sodium borohydride and 3-(4-chlorophenyl)-6-methyl-1,2,4,5-tetrazine. The molecule can be considered to be homoaromatic. The tetrazine ring adopts an unsymmetrical boat conformation.

Received 3 June 2006

Accepted 13 June 2006

Comment

1,2,4,5-Tetrazine derivatives have high potential for biological activity, possessing a wide spectrum of antiviral and antitumor properties. They have been widely used in pesticides and herbicides (Sauer, 1996). Dihydro-1,2,4,5-tetrazine has four isomers, namely 1,2-, 1,4-, 1,6- and 3,6-dihydro-1,2,4,5-tetrazines. The 1,6-dihydro structure (Stam *et al.*, 1982) was found, by X-ray diffraction, to be homoaromatic. In continuation of our work on the structure–activity relationship of 1,2,4,5-tetrazine derivatives (Hu *et al.*, 2004, 2005), we have obtained yellow prismatic crystals of (I). The structural identity of (I) was confirmed using single-crystal X-ray diffraction. The molecular structure of (I) is illustrated in Fig. 1. Selected bond lengths and angles are listed in Table 1. In the tetrazine ring, atoms N1, N2, N4 and N5 are coplanar, while atoms C3 and C6 deviate from the plane by 0.320 (2) and 0.662 (3) Å, respectively. The N2/C3/N4 and N1/C6/N5 planes make dihedral angles of 27.2 (2) and 47.5 (2)°, respectively, with the N1/N2/N4/N5 plane, *i.e.* the tetrazine ring adopts an unsymmetrical boat conformation. Atom N1, which carries atom H1, is almost sp^2 -hybridized as the angles around it add up to 358.7°. In keeping with similar situations in 3-phenyl-6-ethyl-1,6-dihydro-1,2,4,5-tetrazine (Stam *et al.*, 1982), and 3-phenyl-6-methyl-1,6-dihydro-1,2,4,5-tetrazine (Counotte-Potman *et al.*, 1981), it can be considered that the molecule is homoaromatic.

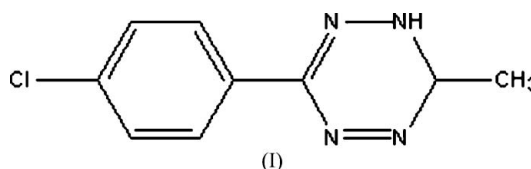


Fig. 2 shows that every molecule is involved in two hydrogen-bonding interactions (Table 2), which contribute to the formation of the crystal structure.

Experimental

The title compound was obtained by adding an 95% ethanol solution (4 ml) of sodium borohydride (38 mg) dropwise to 3-(4-chlorophenyl)-6-methyl-1,2,4,5-tetrazine (0.2 g, 1.0 mmol) in anhydrous (4 ml) at 263 K. After evaporation of the solvent, recrystallization from diethyl

ether–pentane (1:9) afforded the product (I) as yellow crystals. M.p. 393–394.5 K. IR (KBr, cm^{-1}): 3441 (*s*, NH), 1634 (C=N), 1394 (ring), 1089 (*s*, Ar–Cl). A solution of (I) in anhydrous ethanol was concentrated gradually at room temperature to afford crystals, which were suitable for X-ray diffraction.

Crystal data

$\text{C}_9\text{H}_9\text{ClN}_4$ $Z = 4$
 $M_r = 208.65$ $D_x = 1.416 \text{ Mg m}^{-3}$
 Monoclinic, $P2_1/c$ Mo $K\alpha$ radiation
 $a = 9.948 (3) \text{ \AA}$ $\mu = 0.35 \text{ mm}^{-1}$
 $b = 8.833 (3) \text{ \AA}$ $T = 293 (2) \text{ K}$
 $c = 11.420 (3) \text{ \AA}$ Prism, yellow
 $\beta = 102.682 (4)^\circ$ $0.20 \times 0.15 \times 0.10 \text{ mm}$
 $V = 979.0 (5) \text{ \AA}^3$

Data collection

Bruker SMART CCD area-detector 4749 measured reflections
 diffractometer 2142 independent reflections
 φ and ω scans 1580 reflections with $I > 2\sigma(I)$
 Absorption correction: multi-scan $R_{\text{int}} = 0.024$
 (ABSCOR; Higashi, 1995) $\theta_{\text{max}} = 27.2^\circ$
 $T_{\text{min}} = 0.933$, $T_{\text{max}} = 0.966$

Refinement

Refinement on F^2 $w = 1/[\sigma^2(F_o^2) + (0.0665P)^2]$
 $R[F^2 > 2\sigma(F^2)] = 0.045$ where $P = (F_o^2 + 2F_c^2)/3$
 $wR(F^2) = 0.117$ $(\Delta/\sigma)_{\text{max}} < 0.001$
 $S = 1.03$ $\Delta\rho_{\text{max}} = 0.31 \text{ e \AA}^{-3}$
 2142 reflections $\Delta\rho_{\text{min}} = -0.23 \text{ e \AA}^{-3}$
 133 parameters Extinction correction: SHELXL97
 H atoms treated by a mixture of independent and constrained refinement Extinction coefficient: 0.014 (4)

Table 1

Hydrogen-bond geometry (\AA , $^\circ$).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
$\text{N1-H1}\cdots\text{N4}^i$	0.900 (14)	2.802 (15)	3.658 (2)	159.3 (15)
$\text{N1-H1}\cdots\text{N5}^i$	0.900 (14)	2.025 (15)	2.922 (2)	174.6 (16)
$\text{C7-H7C}\cdots\text{N4}^{ii}$	0.96	2.70	3.594 (3)	156
$\text{C10-H10}\cdots\text{N2}^{iii}$	0.93	2.80	3.671 (2)	156

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

The N1-bound H atom was found in a difference Fourier map and refined freely; $\text{N1-H1} = 0.900 (14) \text{ \AA}$. The other H atoms were placed in calculated positions and refined using a riding model, with $U_{\text{iso}}(\text{H})$ values of 1.2 (or 1.5 for methyl H atoms) times U_{eq} of their parent atoms, and C–H distances set at 0.93 \AA for the aromatic H atoms, 0.98 \AA for the methylene H atom and 0.96 \AA for those of the methyl group.

Data collection: SMART (Bruker, 1997); cell refinement: SMART; data reduction: SAINT and SHELXTL (Bruker, 1997); program(s) used to solve structure: SHELXS97 (Sheldrick, 1997); program(s) used to refine structure: SHELXL97 (Sheldrick, 1997); molecular graphics: ORTEP-3 for Windows, (Farrugia, 1997); software used to prepare material for publication: SHELXL97.

We are very grateful to the National Natural and Scientific Foundation (grant No. 20272053) for financial support.

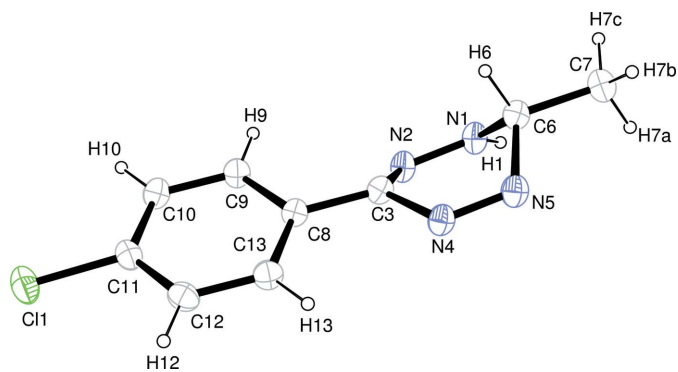


Figure 1 The structure of (I), shown with 30% probability displacement ellipsoids.

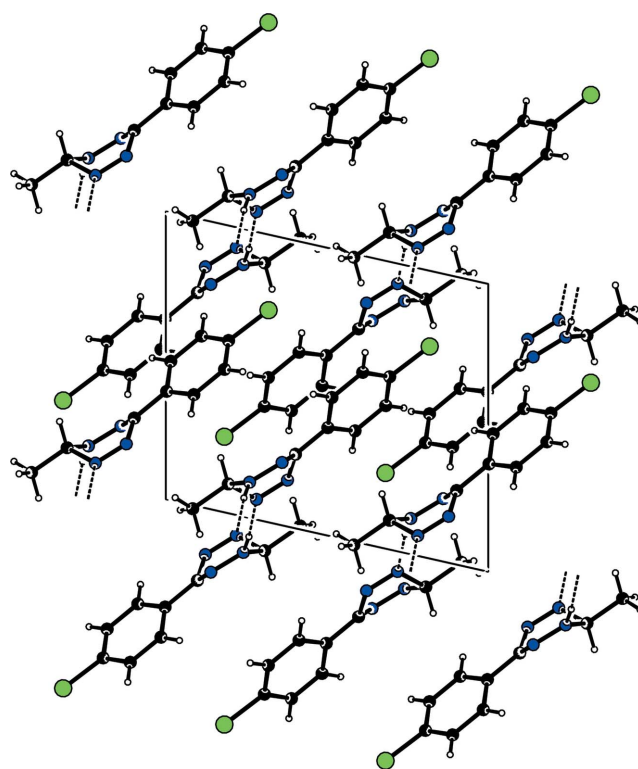


Figure 2 A view of the molecular packing, showing two N–H...N type hydrogen bonding interactions (dashed lines).

References

Bruker (1997). SMART, SAINT and SHELXTL. Bruker AXS Inc., Madison, Wisconsin, USA.
 Counotte-Potman, A., Van der Plas, H. C. & Van Veldhuizen, A. (1981). *J. Org. Chem.* **46**, 2138–2141.
 Farrugia, L. J. (1997). *J. Appl. Cryst.* **30**, 565.
 Higashi, T. (1995). ABSCOR. Rigaku Corporation, Tokyo, Japan.
 Hu, W. X., Rao, G. W. & Sun, Y. Q. (2004). *Bioorg. Med. Chem. Lett.* **14**, 1177–1181.
 Hu, W. X., Shi, H. B., Yuan, Q. & Sun, Y. Q. (2005). *J. Chem. Res.* **2**, 91–93.
 Sauer, J. (1996). *Comprehensive Heterocyclic Chemistry*, 2nd ed., edited by A. J. Boulton, Vol. 6, pp. 901–955. Oxford, England: Elsevier.
 Sheldrick, G. M. (1997). SHELXL97 and SHELXS97. University of Göttingen, Germany.
 Stam, C. H., Counotte-Potman, A. D. & Van der Plas, H. C. (1982). *J. Org. Chem.* **47**, 2856–2858.