Acta Crystallographica Section E
Structure Reports
Online
ISSN 1600-5368

3-(3-Hydroxypropyl)-6-(*p*-tolyl)-7*H*-1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazine dihydrate

Kai-Huang Zou,[a] Xiao-Qing Cai,[b] Jiu-Xi Chen,[b] Li-Xue Zhang,[b] An-Jiang Zhang[b] and Mao-Lin Hu[b]*

[a]Department of Biology and Chemistry, Fujian Education College, Fuzhou 350001, People's Republic of China, and [b]Department of Chemistry and Materials Science, Wenzhou Normal College, Wenzhou 325027, People's Republic of China

Correspondence e-mail: hu403cn@yahoo.com.cn

Key indicators

Single-crystal X-ray study
T = 298 K
Mean σ(C–C) = 0.005 Å
R factor = 0.072
wR factor = 0.157
Data-to-parameter ratio = 13.7

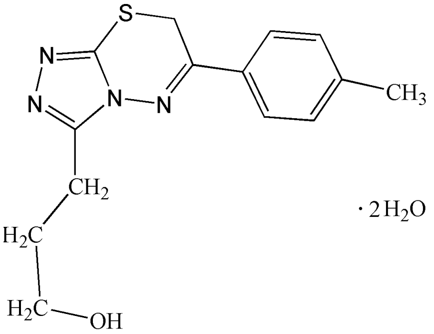
For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

Received 31 August 2004
Accepted 6 September 2004
Online 11 September 2004

In the title compound, $C_{14}H_{16}N_4OS{\cdot}2H_2O$, the five-membered triazole ring makes a dihedral angle of 13.2 (2)° with the six-membered thiadiazole ring. This latter ring is almost planar, with a maximum deviation from the mean plane of 0.357 (2) Å for the methylene C atom. The crystal packing is stabilized by intermolecular O—H···N and O—H···O hydrogen bonds involving the two solvent water molecules.

Comment

3,6-Disubstituted-7*H*-1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazines are among the various heterocycles that have received considerable attention over the last two decades as potential biologically active reagents, such as antimicrobial (Feng *et al.*, 1992), antibacterial, antifungal (Hui *et al.*, 2000), anti-inflammatory (Prasad *et al.*, 1989), diuretic (Mohan & Anjaneyulu, 1987), anthelmintic and analgesic (Turan *et al.*, 1999) compounds. They can also be used as plant-growth inhibitors (Feng *et al.*, 1991), photographic couplers, dyes for improved preservability and absorption characteristics, and inhibitors of malignant cellular proliferation. Attaching 3-hydroxypropyl and *p*-tolyl groups to 7*H*-1,2,4-triazolo[3,4-*b*][1,3,4]-thiadiazines can produce some new biological activities. In view of this, we report here the synthesis and crystal structure of the title compound, (I).



(I)

In (I) (Fig. 1), the five-membered triazole ring and the benzene ring are essentially planar, while the six-membered thiadiazole ring, composed of atoms N1, N2, C8, C9, C10 and S1, is somewhat distorted, with a maximum deviation from the mean plane of 0.357 (2) Å for atom C9 (Fig. 1). The thiadiazole and triazole rings make a dihedral angle of 13.20 (17)°, while the dihedral angle between the thiadiazole and benzene rings is 17.76 (16)°. The C—N bond lengths in the five-membered triazole ring [1.297 (4)–1.371 (3) Å] are longer than a typical C═N double bond (*ca* 1.269 Å) but shorter than a C—N single bond [*ca* 1.443 (4) Å] (Jin *et al.*, 2004), indicating electron delocalization in the ring (Table 1).

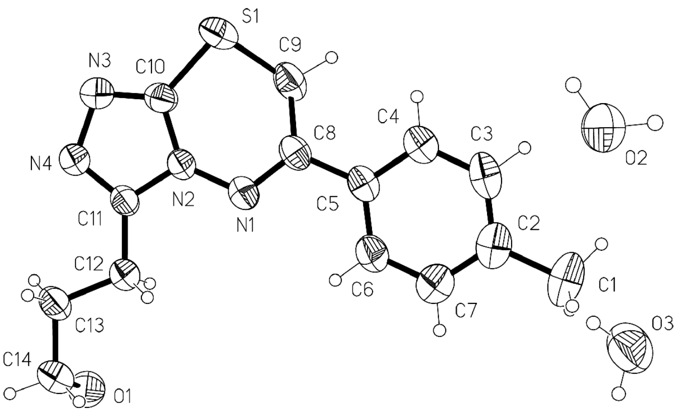


Figure 1
The asymmetric unit of (I), with the atom-numbering scheme. Displacement ellipsoids are drawn at the 50% probability level and H atoms are shown as small spheres of arbitrary radii.

The crystal packing in (I) (Fig. 2) is stabilized by intermolecular O—H···N and O—H···O hydrogen bonds (Table 2) involving the two lattice water molecules.

Experimental

The key intermediate 3-(3-hydroxypropyl)-4-amino-5-mercapto-1,2,4-triazole was prepared from 1,4-butyrolactone and thiocarbohydrazide in pyridine solution, following the method of Xiong *et al.* (2002). The starting materials for the thiocarbohydrazide were carbon disulfide and hydrazine hydrate. To a solution of 3-(3-hydroxypropyl)-4-amino-5-mercapto-1,2,4-triazole (0.01 mol) in absolute ethanol (20 ml) was added 2-bromo-4′-methylacetophenone (0.01 mol). The mixture was refluxed for 7 h. The solid obtained on cooling was filtered, washed with cold water, dried and recrystallized from ethanol to give 3-(3-hydroxypropyl)-6-(*p*-tolyl)-7*H*-1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazine (yield 82%, m.p. 341–343 K). The purified product was dissolved in 95% ethanol and single crystals were obtained after 6 d. Spectroscopic analysis: IR (KBr, ν, cm^{-1}): 3424, 1596, 1530, 1475, 1399, 1256, 1060, 815, 669; ^{1}H NMR (chloroform-d_3, δ, p.p.m.): 7.90 (2H, Ar-H), 7.37 (2H, Ar-H), 4.35 (2H, *s*, SCH$_2$), 3.60 (1H, *s*, OH), 3.51 (2H, *t*, OCH$_2$), 2.91 (2H, *t*, N═C—CH$_2$), 2.40 (3H, *s*, C1H$_3$), 1.85–1.90 (2H, *m*, CH$_2$); ^{13}C NMR (chloroform-d_3, δ, p.p.m.): 154.65, 153.68, 142.17, 140.19, 130.94, 129.74, 127.50 (Aryl ring C), 60.07 (OCH$_2$), 29.75 (CH$_2$), 22.97 (SCH$_2$), 21.17 (CH$_2$), 21.02 (CH$_2$).

Crystal data

$C_{14}H_{16}N_4OS\cdot 2H_2O$
$M_r = 324.40$
Monoclinic, $P2_1/n$
$a = 12.7018$ (12) Å
$b = 7.3602$ (7) Å
$c = 17.3967$ (17) Å
$\beta = 92.612$ (2)°
$V = 1624.7$ (3) Å^3
$Z = 4$
$D_x = 1.326$ Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 1273 reflections
$\theta = 3.0$–21.6°
$\mu = 0.22$ mm^{-1}
$T = 298$ (2) K
Rod, colourless
0.48 × 0.16 × 0.15 mm

Data collection

Bruker APEX area-detector diffractometer
φ and ω scans
Absorption correction: multi-scan (*SADABS*; Bruker, 2002)
$T_{\min} = 0.903$, $T_{\max} = 0.958$
8314 measured reflections
2921 independent reflections
2208 reflections with $I > 2\sigma(I)$
$R_{\text{int}} = 0.037$
$\theta_{\max} = 25.2°$
$h = -15 \rightarrow 15$
$k = -8 \rightarrow 8$
$l = -14 \rightarrow 20$

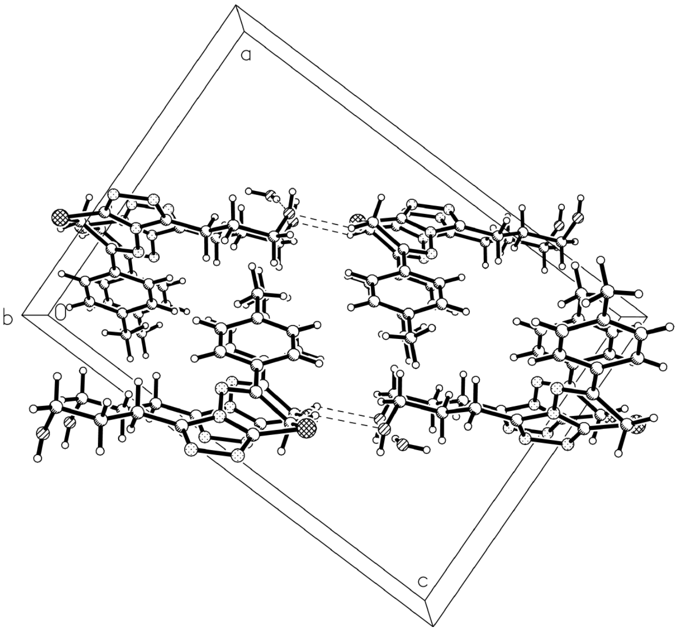


Figure 2
The crystal packing of (I), viewed along the *b* axis. Hydrogen bonds are indicated by dashed lines.

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)] = 0.072$
$wR(F^2) = 0.157$
$S = 1.15$
2921 reflections
213 parameters
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0565P)^2 + 0.7142P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{\max} < 0.001$
$\Delta\rho_{\max} = 0.27$ e Å^{-3}
$\Delta\rho_{\min} = -0.21$ e Å^{-3}

Table 1
Selected bond lengths (Å).

S1—C10	1.732 (3)	C2—C3	1.367 (5)
S1—C9	1.811 (4)	C2—C7	1.389 (5)
O1—C14	1.418 (4)	C3—C4	1.380 (5)
N1—C8	1.290 (4)	C4—C5	1.383 (4)
N1—N2	1.389 (3)	C5—C6	1.387 (4)
N2—C10	1.365 (4)	C5—C8	1.482 (4)
N2—C11	1.371 (3)	C6—C7	1.369 (5)
N3—C10	1.297 (4)	C8—C9	1.498 (5)
N3—N4	1.402 (4)	C11—C12	1.486 (4)
N4—C11	1.297 (4)	C12—C13	1.507 (4)
C1—C2	1.525 (5)	C13—C14	1.507 (4)

Table 2
Hydrogen-bonding geometry (Å, °).

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O3—H3*B*···O2$^{\text{i}}$	0.832 (17)	1.93 (2)	2.730 (4)	160 (4)
O3—H3*A*···O1$^{\text{ii}}$	0.838 (17)	2.006 (18)	2.840 (4)	174 (4)
O2—H2*B*···N3$^{\text{iii}}$	0.832 (17)	2.027 (17)	2.858 (4)	176 (4)
O2—H2*A*···N4$^{\text{iv}}$	0.826 (17)	2.074 (18)	2.899 (4)	177 (3)
O1—H1···O3$^{\text{v}}$	0.82	1.93	2.743 (4)	175

Symmetry codes: (i) $\frac{1}{2} - x, \frac{1}{2} + y, \frac{3}{2} - z$; (ii) $\frac{3}{2} - x, \frac{1}{2} + y, \frac{3}{2} - z$; (iii) $1 - x, -y, 1 - z$; (iv) $x - 1, 1 + y, z$; (v) $1 + x, y - 1, z$.

The H atoms of the water molecules were located in Fourier difference electron-density maps and refined with O—H and H···H

Acta Cryst. (2004). E**60**, m1736–m1738 Kai-Huang Zou *et al.* • $C_{14}H_{16}N_4OS\cdot 2H_2O$ **o1737**

distances restrained to 0.82 (2) Å and 1.39 (1) Å, respectively, and with $U_{\rm iso} = 1.2U_{\rm eq}$(O). The other H atoms were positioned geometrically and allowed to ride on their parent atoms at distances of Csp^2—H = 0.93 Å with $U_{\rm iso} = 1.2U_{\rm eq}$(C), C$sp^3$—H = 0.96 or 0.97 Å with $U_{\rm iso} = 1.5U_{\rm eq}$(C), and 0.82 Å (O—H) with $U_{\rm iso} = 1.2U_{\rm eq}$(O).

Data collection: *SMART* (Bruker, 2002); cell refinement: *SAINT* (Bruker, 2002); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS*97 (Sheldrick, 1997); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics: *XP* (Bruker, 2002); software used to prepare material for publication: *SHELXL*97.

The authors acknowledge financial support from the Zhejiang Provincial Technology Project Foundation of China (grant No. 2004 C32088) and the Zhejiang Provincial Natural Science Foundation of China (grant No. M 203149).

References

Bruker (2002). *SADABS* (Version 2.03), *SAINT* (Version 6.02), *SMART* (Version 5.62) and *XP*. Bruker AXS Inc., Madison, Wisconsin, USA.

Feng, X. M., Chen, R. & Yang, W. D. (1992). *Chem. J. Chin. Univ.* **13**, 187–194.

Feng, X. M., Chen, R. & Zang, Z. Y. (1991). *Chem. J. Chin. Univ.* **12**, 1326–1332.

Hui, X. P., Zhang, L. M. & Zhang, Z. Y. (2000). *J. Chin. Chem. Soc.* **47**, 535–541.

Jin, Z. M., Li, L., Li, M. C., Hu, M. L. & Shen, L. (2004). *Acta Cryst.* C**60**, o642–o643.

Mohan, J. & Anjaneyulu, G. S. R. (1987). *Pol. J. Chem.* **61**, 547–551.

Prasad, A. P., Ramalingam, T. & Rao, A. B. (1989). *J. Med. Chem.* **24**, 199–214.

Sheldrick, G. M. (1997). *SHELXS*97 and *SHELXL*97. University of Göttingen, Germany.

Turan, Z. G., Kaplancikli, Z. A. & Erol, K. (1999). *Farmaco*, **54**, 218–223.

Xiong, Y., Zhang, L. X., Zhang, A. J. & Xu, D. J. (2002). *Synth. Commun.* **32**, 3455–3459.

o1738 Kai-Huang Zou *et al.* • $C_{14}H_{16}N_4OS{\cdot}2H_2O$ *Acta Cryst.* (2004). E**60**, m1736–m1738