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3,4-Di-*p*-tolyl-6,7-dihydroimidazo[2,1-*b*][1,3]thiazole

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Key indicators

Single-crystal X-ray study
T = 293 K
Mean σ(C–C) = 0.005 Å
R factor = 0.063
wR factor = 0.185
Data-to-parameter ratio = 15.2

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

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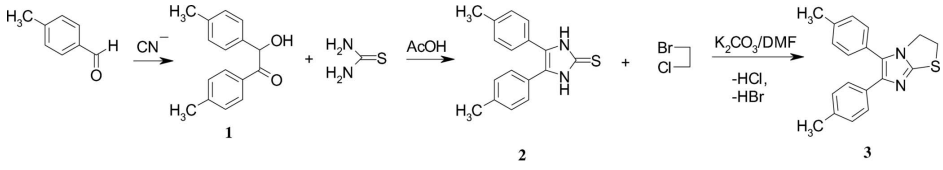
The title compound, $C_{19}H_{18}N_2S$, is a member of a new series of 2,3-dihydroimidazo[2,1-*b*][1,3]thiazoles and was obtained from 4,5-di-*p*-tolyl-1,3-dihydroimidazole-2-thione and 1-bromo-2-chloroethane. The thiazole ring adopts an envelope conformation; the plane through N, S and two C atoms makes a dihedral angle of 2.35 (3)° with the fused imidazole ring. The tolyl groups are essentially planar.

Comment

Fused azole compounds bearing bridgehead nitrogen represent an important class of substances characterized by highly pronounced biological properties, such as antitumour (Andreani *et al.*, 2005) and cytotoxic (Terasawa *et al.*, 2001), antifungal (Capan *et al.*, 1999), antimicrobial (Ur *et al.*, 2004; Ulusoy *et al.*, 2002), antitubercular (Ulusoy, 2002), cardiotonic (Andreani *et al.*, 1996), anti-inflammatory and analgesic activities (Palagiano *et al.*, 1995). Partially saturated imidazo[2,1-*b*]thiazoles, such as the title compound, (3), as well as unsaturated congeners, have demonstrated biological activities, including anthelmintic and immunostimulant, and as an adjuvant agent with 5-fluorouracil in the treatment of human colon cancer (*i.e.* levamisole and tetramisole) (Feil, 1996; Peterlin-Masic *et al.*, 2000).



The structure of compound (3) was suggested by IR, ^{1}H NMR and ^{13}C NMR spectroscopic analyses. In order to confirm the assigned structure, an X-ray crystallographic analysis was undertaken. The cytotoxic property of (3) is under investigation.

The molecular structure and atom-numbering scheme are shown in Fig. 1, and the arrangement of the molecules in the unit cell is shown in Fig. 2. Selected bond lengths and angles are listed in Table 1. The thiazole ring adopts an envelope conformation, with C2 as the flap atom, displaced from the C3/N4/C7/S1 mean plane by 0.402 (4) Å. The puckering parameters (Cremer & Pople, 1975) of this ring are q = 0.266 (3) Å and φ = 150.4 (7)°. The imidazole ring is planar and makes a dihedral angle of 2.35 (3)° with the C3/N4/C7/S1 mean plane of the thiazole ring. This value is close to those found for other structures including an imidazo–thiazole ring system [*e.g.* 1.38 (9)° (Akkurt *et al.*, 2005) and 0.38 (9)° (Öztürk Yıldırım *et al.*, 2005)]. The benzene rings are twisted out of the imidazole

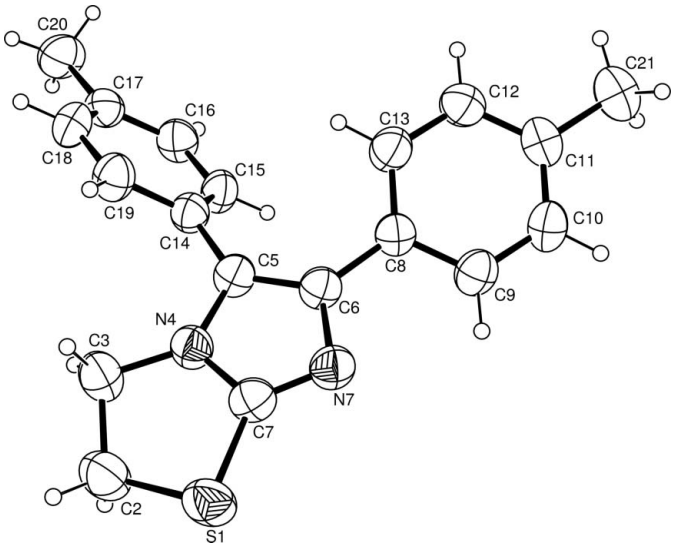


Figure 1
The molecular structure of (3). Displacement ellipsoids are drawn at the 50% probability level and H atoms are shown as small circles of arbitrary radii.

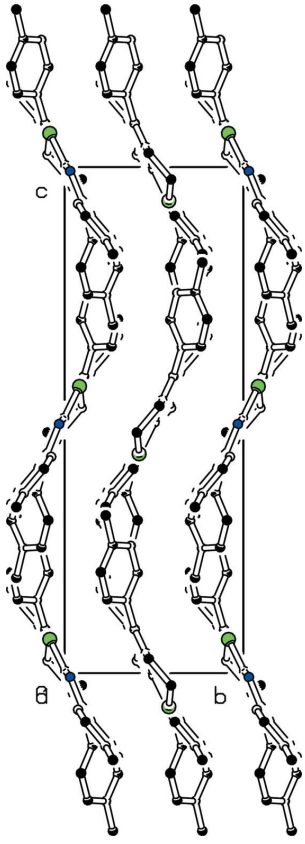


Figure 2
The crystal packing of (3), projected on to the *bc* plane. H atoms have been omitted.

ring plane and make dihedral angles of 20.5 (2) and 49.3 (2)° with the imidazole ring. The dihedral angle between the two benzene rings is 53.9 (2)°.

In the thiazole ring, the S1—C2 bond is longer than the S1—C7 bond. The difference between these bond lengths can be attributed to the different hybridization of the Csp^3 and Csp^2 atoms. The N4—C5 and N4—C7 distances are in good agreement, but the N7—C7 bond is slightly shorter and the N7—C6 bond is slightly longer than distances reported for similar structures (Akkurt *et al.*, 2005; Öztürk Yıldırım *et al.*, 2005).

There are no intra- or intermolecular hydrogen bonds in (3), but atom N7 of the imidazole ring is involved in a short intramolecular contact, forming a five-membered ring structure [C9···N7 = 2.850 (4) Å and C9—H14···N7 = 101°]. The structure is stabilized by van der Waals interactions.

Experimental

A mixture of 4,5-di-*p*-tolyl-1,3-dihydroimidazole-2-thione, (2) (2.5 mmol, 0.7 g) (Gregoire *et al.*, 1951; Yoshida *et al.*, 1951), and 1-bromo-2-chloroethane (2.5 mmol, 0.358 g, 0.225 ml) in dimethylformamide (35 ml) was heated at 403–408 K in the presence of K_2CO_3 (3.75 mmol, 0.518 g) (Bender, 1976; Bender *et al.*, 1985), until the starting material had disappeared, as evidenced by thin-layer chromatography (for 5 h). At the end of the reaction, the mixture was allowed to cool to room temperature, and then the contents of the reaction vessel were poured into ice–water and the pH adjusted to 11 using 10% aqueous NaOH solution. The solid thus obtained was filtered off, washed with water and dried. It was purified by column chromatography ($CHCl_3$–MeOH, 97:3; R_f 0.6). In order to remove unreacted 1-bromo-2-chloroethane, the product was washed with diethyl ether and dried (m.p. 446 K). Spectroscopic analysis: IR (KBr, ν, cm^{-1}): 1683–1456 (C═N and C═C), 727 (1,4-disubstituted-Ph ring-deformation band); no peaks at 3300–3100 (NH) and 1250–1020 (C═S); ^{1}H NMR ($CDCl_3$, δ, p.p.m.): 2.29 (3H, *s*, CH_3), 2.39 (3H, *s*, CH_3), 3.77 (2H, *t*, J = 6.9 Hz, CH_2S), 4.05 (2H, *t*, J = 6.9 Hz, CH_2N), 7.03 (2H, *d*, J = 8.1 Hz, C3-H and C5-H of Ph), 7.18 (2H, *d*, J = 8.4 Hz, C2-H and C6-H of Ph), 7.22 (2H, *d*, J = 8.4 Hz, C2-H and C6-H of Ph), 7.40 (2H, *d*, J = 8.1 Hz, C3-H and C5-H of Ph); ^{13}C NMR ($CDCl_3$, δ, p.p.m.): 21.13 (CH_3, C20 or C21), 21.28 (CH_3, C21 or C20), 34.62 (CH_2S, C2), 45.62 (CH_2N, C3), 126.64 (C6), 127.03 (C5), 127.93 (C9 and C13), 128.79 (C15 and C19), 128.95 (C10 and C12), 129.58 (C16 and C18), 131.81 (C8 or C14), 136.03 (C14 or C8), 137.93 (C11 or C17), 142.41 (C17 or C11), 148.47 (C7). A small quantity (20 mg) of (3) was dissolved in $CHCl_3$–MeOH (97:3, 2 ml); the solution was kept at room temperature for 2 d and natural evaporation afforded light brown single crystals of (3) suitable for X-ray analysis.

Crystal data

$C_{19}H_{18}N_2S$
M_r = 306.41
Monoclinic, $C2/c$
a = 18.064 (4) Å
b = 7.901 (2) Å
c = 22.401 (7) Å
β = 91.76 (2)°
V = 3195.9 (15) Å^3
Z = 8
D_x = 1.274 Mg m^{-3}
Cu $K\alpha$ radiation
μ = 1.76 mm^{-1}
T = 293 (2) K
Prism, light brown
0.36 × 0.24 × 0.12 mm

Data collection

Enraf Nonius TurboCAD-4 diffractometer
Non–profiled ω scans
Absorption correction: ψ scan (North *et al.*, 1968)
T_{min} = 0.632, T_{max} = 0.810
3110 measured reflections
3018 independent reflections
2081 reflections with $I > 2\sigma(I)$
R_{int} = 0.034
θ_{max} = 74.2°
3 standard reflections
frequency: 120 min
intensity decay: none

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0984P)^2 + 2.0386P]$ where $P = (F_o^2 + 2F_c^2)/3$
$R[F^2 > 2\sigma(F^2)] = 0.063$	$(\Delta/\sigma)_{max} < 0.001$
$wR(F^2) = 0.185$	$\Delta\rho_{max} = 0.59$ e Å^{-3}
$S = 1.06$	$\Delta\rho_{min} = -0.42$ e Å^{-3}
3018 reflections	
199 parameters	
H-atom parameters constrained	

Table 1
Selected geometric parameters (Å, °).

C2—C3	1.530 (5)	C6—N7	1.399 (4)
C2—S1	1.818 (4)	C6—C8	1.472 (4)
C3—N4	1.461 (4)	C7—N7	1.307 (4)
C5—N4	1.390 (4)	C7—N4	1.345 (4)
C5—C6	1.394 (4)	C7—S1	1.747 (3)
C5—C14	1.465 (4)		
C3—C2—S1	108.8 (2)	N4—C7—S1	113.7 (2)
N4—C3—C2	104.5 (3)	C7—N4—C5	107.3 (3)
N4—C5—C6	104.3 (3)	C7—N4—C3	116.9 (3)
C5—C6—N7	110.3 (3)	C7—N7—C6	104.1 (3)
N7—C7—N4	113.9 (3)	C7—S1—C2	89.66 (16)
N7—C6—C8—C13	−158.8 (3)	N4—C5—C14—C15	−127.6 (3)

H atoms were placed in idealized positions and refined using a riding model, with U_{iso}(H) = 1.3U_{eq}(C), and with fixed distances of C—H = 0.93 (aromatic), 0.96 (methyl) and 0.97 Å (thiazole).

Data collection: *CAD-4 EXPRESS* (Enraf–Nonius, 1994); cell refinement: *CAD-4 EXPRESS*; data reduction: *XCAD4* (Harms & Wocadlo, 1995); 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: *WinGX* (Farrugia, 1999).

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