Acta Crystallographica Section E
Structure Reports Online
ISSN 1600-5368

Ethyl 5″-(2,6-dichlorophenyl)-1′-methyl-4-(1-naphthyl)-2,3″-dioxo-2,3,2″,3″-tetrahydro-1*H*-indole-3-spiro-2′-pyrrolidine-3′-spiro-2″-thiazolo[3″,2″-*a*]-pyrimidine-6″-carboxylate ethyl acetate hemisolvate

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Received 26 August 2003
Accepted 29 August 2003
Online 7 October 2003

Key indicators

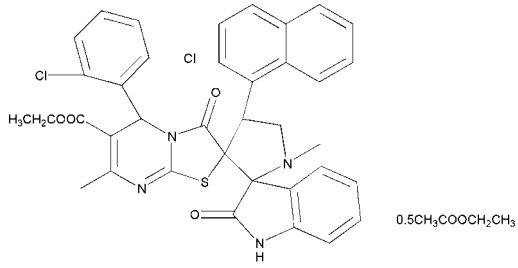
Single-crystal X-ray study
T = 293 K
Mean σ(C–C) = 0.007 Å
Disorder in main residue
R factor = 0.067
wR factor = 0.170
Data-to-parameter ratio = 14.7

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

The asymmetric unit of the title compound, $C_{37}H_{30}Cl_2N_4O_4S\cdot 0.5C_4H_8O_2$, contains two crystallographically independent spiro molecules and an ethyl acetate solvent molecule. In both spiro molecules, the pyrrolidine ring adopts an envelope conformation. The thiazolidine and oxindole moieties are slightly distorted from planarity. The molecular structure is stabilized by C—H···Cl and C—H···O interactions and the crystal structure is stabilized by N—H···N and C—H···O interactions.

Comment

Spiro compounds represent an important class of naturally occurring substances, which in many cases exhibit important biological properties (Kobayashi *et al.*, 1991; James *et al.*, 1991). 1,3-Dipolar cycloaddition reactions are widely used for the synthesis of spiro compounds (Caramella & Grunanger, 1984). In this paper, the structure of the title compound, (I), is reported. The compound was synthesized by the intermolecular [3+2] cycloaddition of azomethine ylide, derived from isatin and sarcosine by a decarboxylative route, and 5-(2,6-dichlorophenyl)-7-methyl-2-naphthalen-1-ylmethylene-3-oxo-2,3-dihydro-5*H*-thiazolo[3,2-*a*]pyrimidine-6-carboxylic acid ethyl ester (Tozkoparan *et al.*, 1999).



(I)

The asymmetric unit of (I) consists of two independent spiro molecules (Fig. 1) and an ethyl acetate solvent molecule. The molecule of (I) contains two spiro junctions involving a 2-oxindole ring, a pyrrolidine ring and a thiazolo[3,2-*a*]- molecules, the pyrrolidine ring adopts an envelope conformation. The thiazolidine ring is twisted about the S1—C1 bond [planar to within ±0.053 (1) Å] in one of the molecules, whereas in the other it is planar to within ±0.043 (4) Å. The oxindole rings are slightly distorted from planarity, with atoms C36 and C67 deviating from the corresponding mean planes by 0.052 (4) and 0.078 (4) Å, respectively. The dihedral angle between the indole and thiazolopyrimidine ring systems is 70.0 (1)° in one molecule and 69.82 (7)° in the other.

The structures of the two independent molecules in the asymmetric unit of (I) are stabilized by C—H···Cl and C—

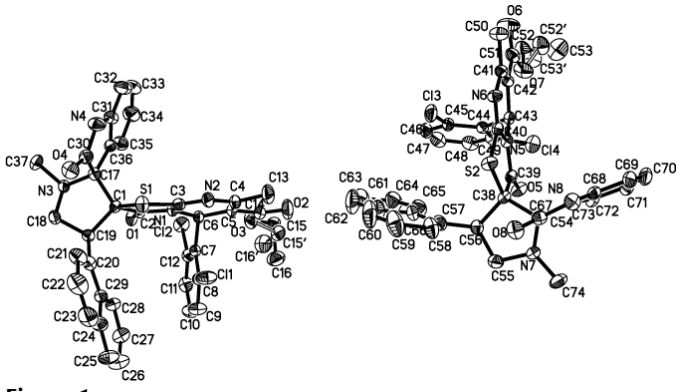


Figure 1
The structure of the asymmetric unit of (I), showing 30% probability displacement ellipsoids and the atom-numbering scheme. For clarity, the ethyl acetate solvent molecule and the H atoms have been omitted.

H···O interactions (Table 1). The crystal structure is stabilized by N—H···N and C—H···O interactions (Fig. 2). In addition to these interactions, a Cl4···Cl4($-x$, $1-y$, $1-z$) short contact of 3.183 (2) Å is observed in the structure.

Experimental

A mixture of 5-(2,6-dichloro-phenyl)-7-methyl-2-naphthalen-1-yl-methylene-3-oxo-2,3-dihydro-5*H*-thiazolo[3,2-*a*]pyrimidine-6-carboxylic acid ethyl ester (1 mmol), isatin (1 mmol) and sarcosine (1 mmol) were refluxed in methanol (60 ml) until the disappearance of the starting materials, as evidenced by thin-layer chromatography. On completion of the reaction, the solvent was removed *in vacuo* and the residue was separated by column chromatography (silica gel, petroleum ether–ethyl acetate 5:1) to give the title compound, (I) (m.p. 512 K). IR (KBr, ν, cm^{-1}): 3351.1 (–NH), 1744.4, 1723.9, 1685.6 (C═O); ^{1}H NMR ($CHCl_3$, δ, p.p.m.): 1.05 (*m*, 3H, $-CH_3$), 2.09 (*s*, 3H, $-CH_3$), 2.25 (*s*, 3H, N$-CH_3$), 3.52 (*m*, 1H, $-CH_2$), 3.95 (*m*, 1H, $-CH_2$), 4.29 (*m*, 2H, $-CH_2$), 5.16 (*m*, 1H, –CH), 5.63 (*s*, 1H, –CH), 6.59–8.00 (*m*, 14H, ArH), 7.77 (*bs*, 1H, –NH). A small amount of (I) (20 mg) was dissolved in dioxane–ethyl acetate mixed solvent (15 ml; 2:1) and the solution was kept at room temperature for 15 d to give colourless single crystals of (I) by slow evaporation.

Crystal data

$C_{37}H_{30}Cl_2N_4O_4S\cdot0.5C_4H_8O_2$
M_r = 741.66
Monoclinic, $P2_1/c$
a = 21.879 (8) Å
b = 31.062 (12) Å
c = 11.129 (5) Å
β = 104.415 (7)°
V = 7326 (5) Å^3
Z = 8
D_x = 1.345 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 990 reflections
θ = 2.4–21.6°
μ = 0.28 mm^{-1}
T = 293 (2) K
Block, colourless
0.36 × 0.18 × 0.12 mm

Data collection

Bruker SMART CCD area-detector diffractometer
φ and ω scans
Absorption correction: multi-scan (*SADABS*; Bruker, 1997)
T_{min} = 0.940, T_{max} = 0.966
30 794 measured reflections
14 902 independent reflections
6894 reflections with $I > 2\sigma(I)$
R_{int} = 0.072
θ_{max} = 26.4°
$h = -27 \rightarrow 27$
$k = -38 \rightarrow 38$
$l = -13 \rightarrow 4$

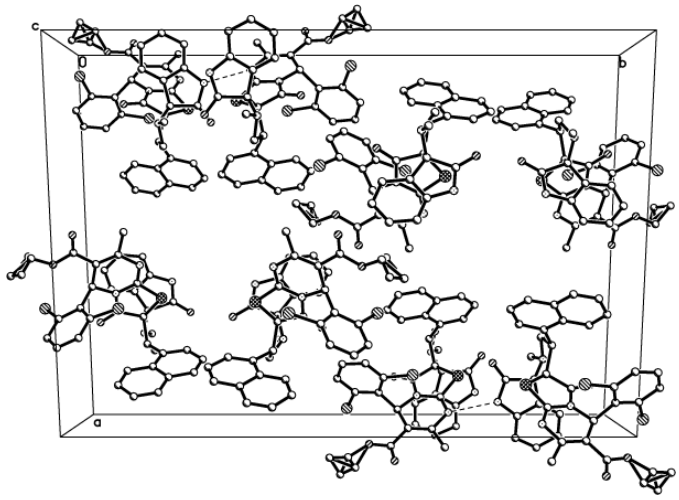


Figure 2
The crystal structure of (I), viewed along the *c* axis.

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.067
$wR(F^2)$ = 0.170
S = 0.98
14 902 reflections
1016 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.084P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.001
$\Delta\rho_{max}$ = 0.29 e Å^{-3}
$\Delta\rho_{min}$ = −0.27 e Å^{-3}

Table 1
Hydrogen-bonding geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N8—H8···N6^{i}	0.86	2.03	2.854 (5)	161
C6—H6···Cl2	0.98	2.53	3.108 (4)	117
C10—H10···O5^{ii}	0.93	2.38	3.106 (6)	135
C18—H18*B*···O4	0.97	2.44	3.016 (5)	117
C19—H19···O1	0.98	2.40	2.909 (5)	112
C21—H21···O4	0.93	2.48	3.335 (6)	152
C35—H35···O1	0.93	2.49	3.135 (6)	127
C43—H43···Cl4	0.98	2.52	3.103 (4)	118
C47—H47···O1^{iii}	0.93	2.59	3.349 (6)	139
C50—H50*C*···O6	0.96	2.09	2.829 (6)	132
C55—H55*A*···O8	0.97	2.44	3.031 (6)	119
C56—H56···O5	0.98	2.48	2.960 (5)	110
C58—H58···O8	0.93	2.48	3.320 (6)	150
C72—H72···O5	0.93	2.51	3.099 (5)	121

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

H atoms were placed in calculated positions and allowed to ride on their parent atoms, with an N—H distance of 0.86 Å and C—H distances in the range 0.93–0.98 Å; the U_{iso}(H) values were set to $1.5U_{eq}$(parent atom) for the methyl H atoms and $1.2U_{eq}$(parent atom) for the remaining H atoms. A rotating-group model was used for the methyl groups attached to the pyrrolidine and pyrimidine rings. In both molecules in the asymmetric unit, the side-chain ethyl group was found to be disordered. The occupancies of the disordered positions C15, C16, C15′, C16′, C52, C53, C52′ and C53′ were refined, and the populations of the major components were 62% in one molecule and 74% in the other. The ethyl acetate solvate was also disordered over two positions, with occupancies of 0.61 (1) and 0.39 (1). The bond lengths and angles involving the disordered atoms were suitably restrained and U_{ij} restraints were also applied.

Data collection: *SMART* (Bruker, 1997); cell refinement: *SMART*; data reduction: *SAINT* (Bruker, 1997); program(s) used to solve

structure: *SHELXS*97 (Sheldrick, 1997); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics: *SHELXTL* (Bruker, 1997); software used to prepare material for publication: *SHELXTL*.

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