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7′-(4-Methoxyphenyl)chroman-3-spiro-6′-hexahydro-1*H*-pyrrolo[1,2-*c*]thiazole-5′-spiro-3″-1″*H*-indole-4,2″(3″*H*)-dione

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Key indicators

Single-crystal X-ray study
T = 273 K
Mean σ(C–C) = 0.002 Å
R factor = 0.047
wR factor = 0.126
Data-to-parameter ratio = 16.2

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

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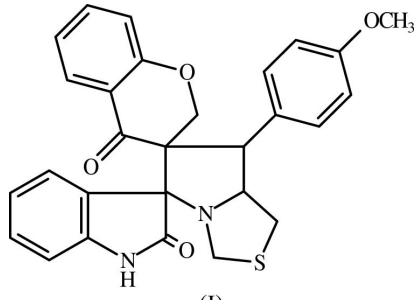
In the title compound, $C_{28}H_{24}N_2O_4S$, the indole ring system is planar, but the pyrrolidine and thiazole rings adopt an envelope and a twist conformation, respectively. The indole system makes a dihedral angle of 55.7 (1)° with the methoxyphenyl ring. The molecular packing in the crystal structure is stabilized by C—H···O and N—H···O hydrogen bonds.

Comment

Thiazolidine derivatives possess antidiabetic and adipogenic properties (Norisada *et al.*, 2004) and antitussive activity (Gandolfi *et al.*, 1995). These derivatives induce insulin resistance *via* the normalization of protein-tyrosine phosphatase activities (Maegawa *et al.*, 1995). Chromanone derivatives possess antiviral (Xu *et al.*, 1998), antifungal (Emami *et al.*, 2004; Yang *et al.*, 2002) and anti-inflammatory (Konieczny *et al.*, 1976) activities. The indole ring system is present in a number of natural products (Nigović *et al.*, 2000), many of which are found to possess psychotropic (Grinev *et al.*, 1978) and antidepressant (Grinev *et al.*, 1984) properties. In view of its medicinal importance, the crystal structure and molecular structure determination of the title compound, (I), was carried out by X-ray diffraction.



(I)

A displacement ellipsoid plot of (I) is shown in Fig. 1. The C—S bond lengths are comparable to the reported mean value of 1.819 (19) Å (Allen *et al.*, 1987). The geometry of the chromanone group is also close to those found in related structures (Abdul Ajees *et al.*, 2001; Usha *et al.*, 2003).

The sum of the angles at atom N1 of the pyrrolidine ring, 339.1°, is in accordance with sp^3 hybridization. The exocyclic angles around C10 show considerable asymmetry, with O1—C10—C11 [124.9 (2)°] being wider than O1—C10—C9 [115.6 (2)°]. This difference is due to the steric repulsion between the benzyl ring and its attached methyl group.

The torsion angles C13—O1—C10—C9 [−179.4 (2)°] and C13—O1—C10—C11 [1.3 (3)°] indicate that the methoxy group does not deviate significantly from coplanarity with its

benzene ring. The indole moiety is planar and the dihedral angle between the planes of the heterocyclic and benzene ring system is 3.5 (1)°. The methoxyphenyl ring and the oxindole group are oriented at an angle of 55.7 (1)° with respect to each other. The dihedral angle between the methoxyphenyl ring and the benzene ring in the chromanone system is 77.7 (1)°.

The pyran ring in the chromanone system has a half-chair conformation with the lowest asymmetry parameters of ΔC_2(C14—C2) = 0.018 (1) (Nardelli, 1983). The pyrrolidine ring (N1/C1–C4) adopts an envelope conformation, with puckering parameters q_2 = 0.438 (1) Å and φ = 150.6 (2)° (Cremer & Pople, 1975). Atom C4 deviates by 0.666 (2) Å from the least-squares plane through the remaining four atoms. The thiazole ring (N1/C4/C6/S1/C5) adopts a twist conformation, with puckering parameters q_2 = 0.814 (3) Å and φ = 16.8 (1)°.

In addition to van der Waals interactions, the crystal structure is stabilized by intermolecular N—H···O hydrogen bonds and C—H···O interactions. The N—H···O hydrogen bond forms an $R_2^2(8)$ graph-set dimer (Fig. 2).

Experimental

A mixture of 3-*p*-methoxybenzylidene-4-chromanone (0.5 mmol), isatin (0.5 mmol) and thiazolidine-4-carboxylic acid (0.5 mmol) was refluxed in methanol until the disappearance of the starting material. After the completion of the reaction, the solvent was removed *in vacuo* and the residue was chromatographed on silica gel using a hexane and ethyl acetate mixture as eluant to give the title compound. The compound was recrystallized using ethyl acetate and hexane (1:1) by slow evaporation to obtain good diffraction-quality crystals.

Crystal data

$C_{28}H_{24}N_2O_4S$
M_r = 484.55
Monoclinic, $P2_1/c$
a = 9.5561 (6) Å
b = 16.1035 (11) Å
c = 15.2631 (10) Å
β = 91.213 (10)°
V = 2348.3 (3) Å^3
Z = 4
D_x = 1.371 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 6089 reflections
θ = 2.5–27.8°
μ = 0.18 mm^{-1}
T = 273 (2) K
Block, colourless
0.26 × 0.24 × 0.18 mm

Data collection

Bruker SMART APEX CCD area-detector diffractometer
ω scans
14 171 measured reflections
5134 independent reflections
4396 reflections with $I > 2\sigma(I)$
R_{int} = 0.018
θ_{max} = 28.0°
$h = -10 \rightarrow 11$
$k = -20 \rightarrow 21$
$l = -19 \rightarrow 20$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.047
$wR(F^2)$ = 0.126
S = 1.02
5134 reflections
317 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0726P)^2 + 0.5516P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ <0.001
$\Delta\rho_{max}$ = 0.38 e Å^{-3}
$\Delta\rho_{min}$ = −0.21 e Å^{-3}

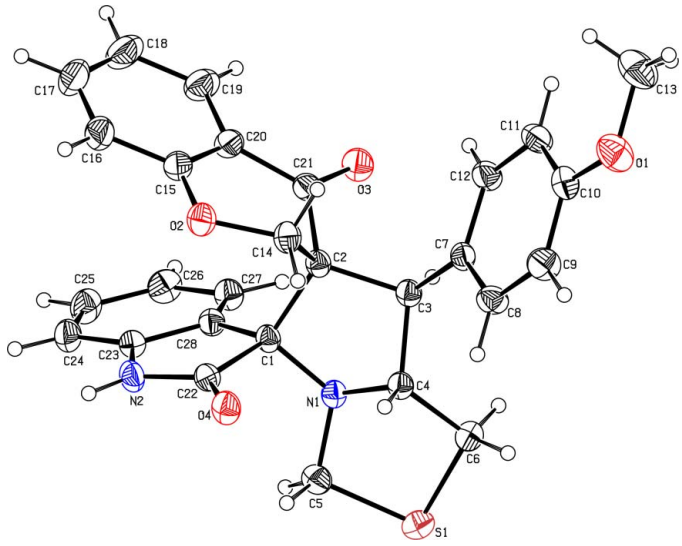


Figure 1
The molecular configuration and atom-numbering scheme for (I). Displacement ellipsoids are drawn at the 30% probability level and H atoms are shown as small spheres of arbitrary radii.

Table 1
Selected geometric parameters (Å, °).

S1—C5	1.824 (2)	O2—C15	1.359 (2)
S1—C6	1.829 (2)	O2—C14	1.435 (2)
C5—N1—C1	120.0 (1)	O1—C10—C11	124.9 (2)
C5—N1—C4	110.1 (1)	O1—C10—C9	115.6 (2)
C1—N1—C4	109.0 (1)		
C13—O1—C10—C11	1.3 (3)	C13—O1—C10—C9	−179.4 (2)

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

D—H···A	D—H	H···A	D···A	D—H···A
N2—H2···O4^{i}	0.86	2.13	2.949 (2)	160
C9—H9···O3^{ii}	0.93	2.42	3.312 (2)	160

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

The H atoms were positioned geometrically and were treated as riding on their parent atoms with an N—H distance of 0.86 Å and C—H distances of 0.93–0.98 Å, and with U_{iso}= 1.5U_{eq}(C) for methyl H and 1.2U_{eq}(N or C) for other H.

Data collection: *SMART* (Bruker, 2001); cell refinement: *SAINT* (Bruker, 2001); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *ORTEP-3* (Farrugia, 1997) and *PLATON* (Spek, 2003); software used to prepare material for publication: *SHELXL97* and *PARST* (Nardelli, 1995).

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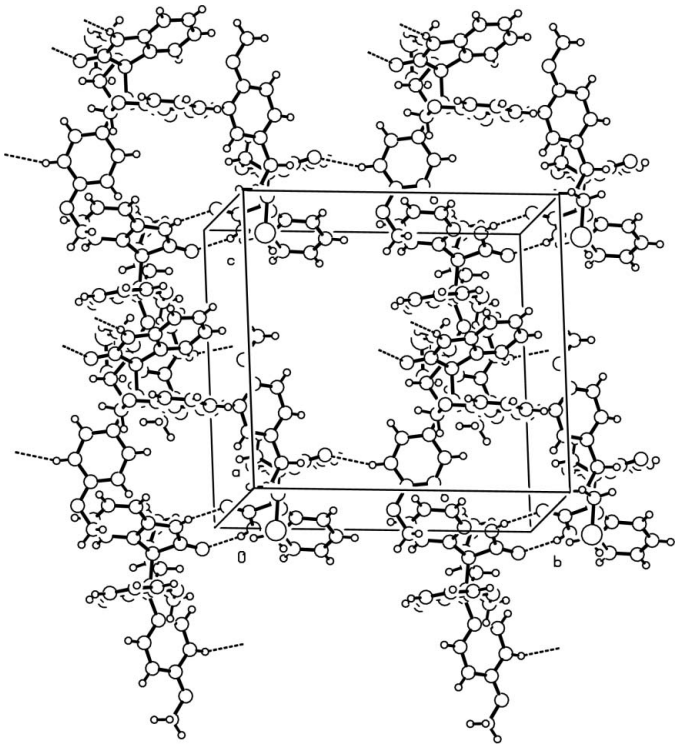

Figure 2
The molecular packing of (I), viewed approximately down the *a* axis. Dashed lines indicate hydrogen bonds.

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