

Ethyl 5-hydroxy-3-(3-methoxybenzoyl)-1',5-dimethyl-2'-oxo-4,5-dihydro-1'H-spiro[furan-2(3H),3'(2'H)-indole]-4-carboxylate**D. Gayathri,^a D. Velmurugan,^{a*}
K. Ravikumar,^b G. Savitha^c and
P. T. Perumal^c**^aDepartment of Crystallography and Biophysics, University of Madras, Guindy Campus, Chennai 600 025, India, ^bLaboratory of X-ray Crystallography, Indian Institute of Chemical Technology, Hyderabad 500 007, India, and ^cOrganic Chemistry Division, Central Leather Research Institute, Adyar, Chennai 600 020, India

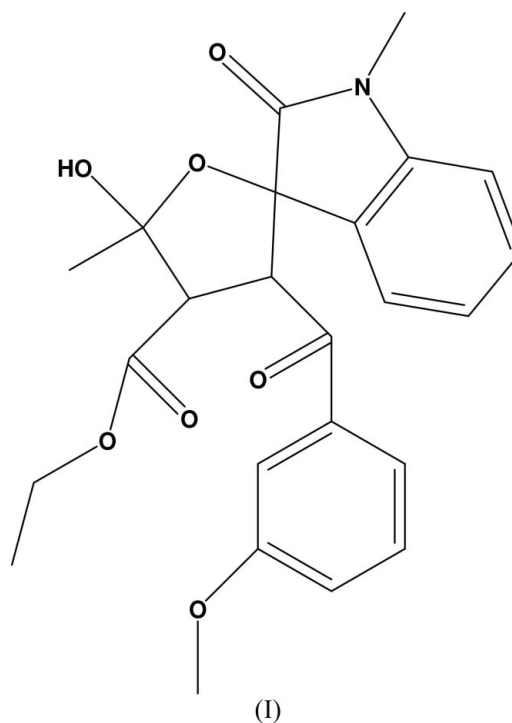
Correspondence e-mail: d_velu@yahoo.com

Key indicatorsSingle-crystal X-ray study
 $T = 293$ K
Mean $\sigma(C-C) = 0.002$ Å
 R factor = 0.056
 wR factor = 0.168
Data-to-parameter ratio = 17.4For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.

The furan ring in the title compound, $C_{24}H_{25}NO_7$, adopts a twisted conformation. The molecular structure is stabilized by an $O-H \cdots O$ intramolecular hydrogen bonding interaction which generates an $S(7)$ ring motif. The crystal packing is stabilized by $C-H \cdots O$ intermolecular interactions generating $C(10)$ and $C(6)$ chains and centrosymmetric $R_2^2(14)$ motifs.

Comment

2-Hydroxytetrahydrofuran derivatives have calpain-inhibiting activity and are used in the preparation of medicaments for the treatment of inflammatory and immunological diseases, cardiovascular and cerebro-vascular diseases, disorders of the central or peripheral nervous system, cachexia, osteoporosis, muscular dystrophy, proliferative diseases, cataracts, rejection reactions following organ transplants and auto-immune and viral diseases (Auvin *et al.*, 2005). In view of the high medicinal value, we have undertaken the X-ray crystal structure determination of the title compound, (I).



The bond lengths and angles in (I) are within normal ranges (Allen *et al.*, 1987), except those at the spiro junctions which reflect the presence of the bulky substituents. The sum of the bond angles around atom N1 (360°) indicates sp^2 -hybridiza-

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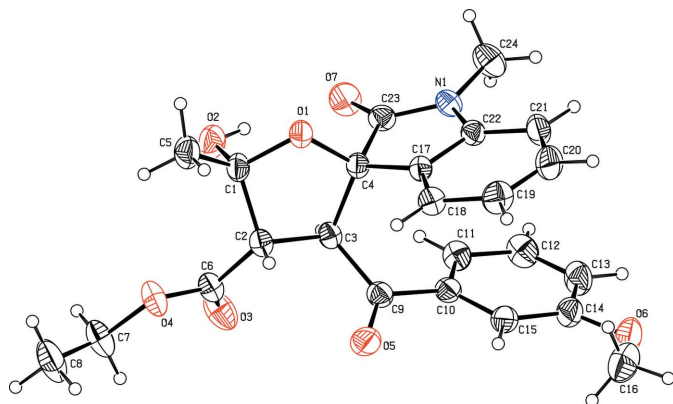


Figure 1
The molecular structure of the title compound, showing 30% probability displacement ellipsoids.

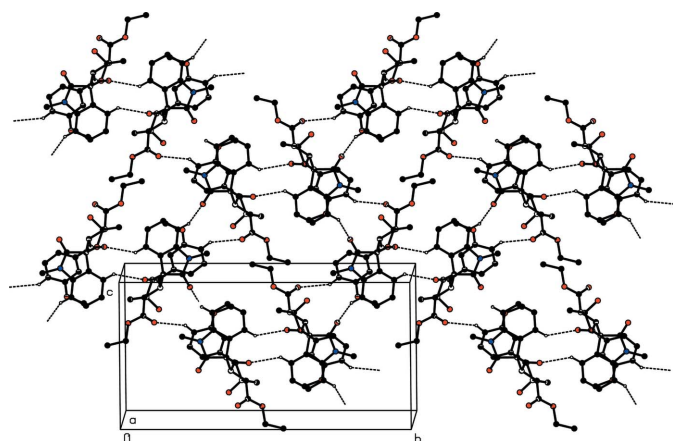


Figure 2
The packing of (I), viewed approximately down the *a* axis. Hydrogen bonds are shown as dashed lines. H atoms not involved in hydrogen bonding have been omitted.

tion. The five- (C4/C17/C22/N1/C23) and six-membered (C17–C22) rings in the indole group are planar, with a dihedral angle of 1.8 (1)° between them. Atoms C24 and O7 deviate by 0.004 (3) and 0.055 (2) Å, respectively, from the C4/C17/C22/N1/C23 plane. The dihedral angle between the two benzene rings (C10–C15 and C17–C22) is 22.5 (1)°. The methoxy group at C14 is twisted slightly away from the C10–C15 benzene ring [torsion angle C15–C14–O6–C16 = –8.7 (3)°]

The furan ring in the structure adopts a twisted conformation with a pseudo-twofold axis passing through C4 and the C1–C2 bond. The puckering parameters (Cremer & Pople, 1975) and the smallest displacement asymmetry parameters (Nardelli, 1983) for the furan ring are $q_2 = 0.392$ (2) Å, $\varphi = 234.6$ (2)° and $\Delta_2(C4) = 2.7$ (2)°.

The molecule of (I) is stabilized by an O–H...O intramolecular hydrogen bond, which generates an *S*(7) ring motif. The crystal structure is stabilized by C–H...O intermolecular interactions (Table 2). Atoms C13 and C21 at (*x*, *y*, *z*) act as donors to atoms O3 and O7 at ($\frac{1}{2} + x$, $\frac{1}{2} - y$, $\frac{1}{2} + z$), generating

C(10) and C(6) chains, respectively. Also, atom C18 acts as a donor to O5 at ($2 - x$, $-y$, $2 - z$), generating a centrosymmetric dimer of $R_2^2(14)$ motif (Fig. 2)

Experimental

To a solution of 3-[(3-methoxyphenyl)-2-oxoethylidene]-1-methyl-oxindole (1.02 mmol, 0.3 g, 1 equivalent), ethyl acetoacetate (1.02 mmol, 0.133 g, 1 equivalent) and NaHCO₃ (3.07 mmol, 0.258 g, 3 equivalents) in acetonitrile (10 ml), ceric ammonium nitrate (2.56 mmol, 1.4 g, 2.5 equivalents) dissolved in acetonitrile (5 ml) was added dropwise at 273 K under an N₂ atmosphere. The reaction mixture was stirred until the reaction was complete, as monitored by thin-layer chromatography. Water was added to the mixture and the product was extracted into ethyl acetate (2 × 20 ml); it was then dried over anhydrous Na₂SO₄. Removal of the solvent under reduced pressure gave a crude product, which was further purified by column chromatography on silica gel, with ethyl acetate–hexane (4:6) as eluent, to afford the pure product (0.322 g, 72%) as a white crystalline solid. Single crystals of the product were obtained by recrystallization from ethyl acetate.

Crystal data

C₂₄H₂₅NO₇
M_r = 439.45
Monoclinic, *P*2₁/*n*
a = 8.4860 (12) Å
b = 22.446 (3) Å
c = 11.5348 (16) Å
 β = 90.305 (2)°
V = 2197.1 (5) Å³

Z = 4
D_x = 1.329 Mg m^{−3}
Mo *K*α radiation
 μ = 0.10 mm^{−1}
T = 293 (2) K
Block, white
0.24 × 0.23 × 0.21 mm

Data collection

Bruker SMART APEX CCD area-detector diffractometer
 ω scans
Absorption correction: none
18459 measured reflections

5057 independent reflections
3819 reflections with $I > 2\sigma(I)$
*R*_{int} = 0.031
 θ_{\max} = 28.1°

Refinement

Refinement on *F*²
 $R[F^2 > 2\sigma(F^2)] = 0.056$
 $wR(F^2) = 0.168$
S = 1.03
5057 reflections
290 parameters
H-atom parameters constrained

$w = 1/[\sigma^2(F_o^2) + (0.1007P)^2 + 0.2499P]$
where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta\sigma)_{\max} = 0.001$
 $\Delta\rho_{\max} = 0.33 \text{ e } \text{Å}^{-3}$
 $\Delta\rho_{\min} = -0.26 \text{ e } \text{Å}^{-3}$

Table 1

Selected geometric parameters (Å, °).

C1–O2	1.411 (2)	C6–O3	1.198 (2)
C1–O1	1.429 (2)	C6–O4	1.334 (2)
C1–C5	1.501 (3)	C7–O4	1.456 (2)
C1–C2	1.545 (2)	C9–O5	1.208 (2)
C2–C6	1.509 (2)	C14–O6	1.370 (2)
C2–C3	1.521 (2)	C16–O6	1.407 (3)
C3–C9	1.521 (2)	C22–N1	1.409 (2)
C3–C4	1.563 (2)	C23–O7	1.217 (2)
C4–O1	1.435 (2)	C23–N1	1.348 (2)
C4–C17	1.504 (2)	C24–N1	1.452 (2)
C4–C23	1.552 (2)		
C23–N1–C22	111.1 (1)	C22–N1–C24	125.0 (2)
C23–N1–C24	123.9 (2)		

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

<i>D</i> —H··· <i>A</i>	<i>D</i> —H	H··· <i>A</i>	<i>D</i> ··· <i>A</i>	<i>D</i> —H··· <i>A</i>
O2—H2A···O7	0.82	2.17	2.959 (2)	163
C13—H13···O3 ⁱ	0.93	2.53	3.359 (3)	149
C18—H18···O5 ⁱⁱ	0.93	2.55	3.319 (2)	141
C21—H21···O7 ⁱ	0.93	2.60	3.230 (2)	126

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

H atoms were positioned geometrically and were treated as riding on their parent C atoms, with C—H = 0.93–0.98 Å, and $U_{\text{iso}}(\text{H}) = 1.5U_{\text{eq}}(\text{C})$ for methyl and $1.2U_{\text{eq}}(\text{C})$ for other H atoms.

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

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