(Z)-2-(1-Benzyl-5-nitro-1H-indol-3-yl-methylene)-1-azabicyclo[2.2.2]-octan-3-one

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In the title compound, $C_{23}H_{21}N_3O_3$, the indole ring is planar and the phenyl ring of the benzyl group makes a dihedral angle with the best plane of the indole ring of 73.77 (4)°. The double bond connecting the azabicyclic and indole moieties has Z geometry.

Comment

In view of the biological activity associated with 1-azabicyclo[2.2.2]octan-3-ones, we have undertaken the synthesis and structural analysis of a series of 2-(substituted benzylidene/heteroaryl-3-ylmethylene)-1-azabicyclo[2.2.2]octan-3-ones (Sonar et al., 2003). In order to confirm the double-bond geometry of title compound, (I), and to obtain more detailed information on the structural conformation of the molecule that may be of value in structure–activity analysis, its X-ray structure determination has been carried out and the results are presented here.
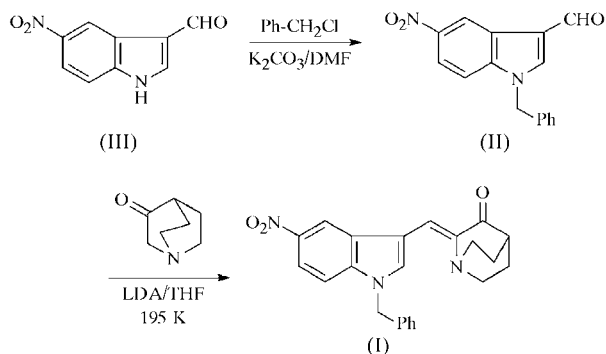
X-ray crystallography confirmed the molecular structure and atom connectivity for (I) as illustrated in Fig. 1, and selected geometric parameters are presented in Table 1. The indole ring is planar, with bond distances and angles comparable with those previously reported for other indole derivatives (Mason et al., 2003; Zarza et al., 1988). The benzene ring of the benzyl group linked to the N1 position of the indole ring is slightly twisted, making a dihedral angle of 73.77 (4)° with the plane of the indole ring system. There is an asymmetry of the exocyclic angles at C19 for (I).

The nitro group shows normal geometric parameters. The torsion angles (O2—N3—C6—C5 and O3—N3—C6—C7) indicate that there is not much deviation of the nitro-group plane from the indole moiety, facilitating conjugation. Furthermore, the observed length of the N3—C6 single bond is slightly shorter than the theoretical length for a C_{ar}—NO_2 bond of 1.47 Å (Glusker et al., 1994), which indicates the formation of a weak conjugated π-electron system along this bond.

Compound (I) is the Z isomer, with the C11—C17 bond in a trans disposition with respect to the C3—C10 bond. The double bond has a nearly planar arrangement, since the r.m.s. deviation from the best plane passing through atoms N2/C11/C17/C10/C3 is 0.0147 (7) Å. Deviations from ideal geometry are observed in the angles around atoms C3, C10 and C11. The C10=C11—C17 angle is close to the ideal value of 120°, whereas the C2=C3—C10, C3—C10=C11 and N2—C11—C17 angles are more distorted. These bond-angle deformations, which require little energy, are needed to release the intramolecular interactions between non-bonded atoms. The azabicyclic system presents very small distortions around atoms N2, C13, C14, C15, C16 and C17. The value of the C2=C3—C10=C11 torsion angle [−9.2 (2)°] indicates the deviation of the indole ring from the plane of the double bond connected to the azabicyclic ring. However, the C3—C10 bond length [1.4428 (17) Å], when compared with the standard value for a single bond connecting a C_{ar} atom to a Csp^2 atom
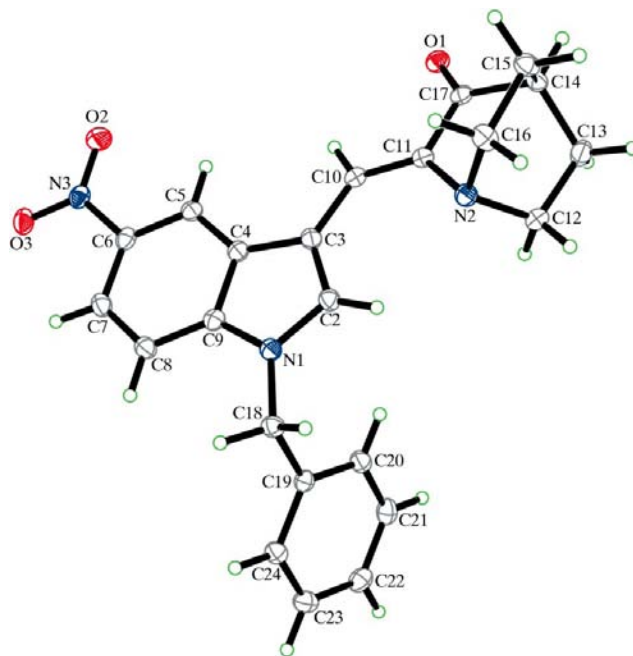
Figure 1
A view of the molecule of (I), showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 50% probability level and H atoms are shown as small spheres of arbitrary radii.

organic compounds

[1.470 (15) Å; Wilson, 1992], suggests extensive conjugation, beginning at atom O1 and extending through to the aromatic ring. Within the azabicyclic group, the bond angles at atoms C13, C14 and C15 are, on average, smaller than the ideal tetrahedral value of 109.5°, while those at atoms C12 and C16 are, on average, slightly larger than the tetrahedral value.

Experimental

1-Benzyl-5-nitroindole-3-carbaldehyde, (II), was prepared by the reaction of 5-nitroindole-3-carbaldehyde, (III), with benzyl chloride in the presence of potassium carbonate and dimethylformamide under reflux, according to a previously reported procedure (Sonar *et al.*, 2006). The title compound was prepared by aldol condensation of 1-benzyl-5-nitroindole-3-carbaldehyde with 1-azabicyclo[2.2.2]octan-3-one to afford (*Z*)-2-(1-benzyl-5-nitro-1*H*-indol-3-ylmethylene)-1-azabicyclo[2.2.2]octan-3-one, (I), as a single geometric isomer, according to the previously reported procedure of Sonar *et al.* (2003). Crystallization from ethyl acetate afforded (I) as a yellow crystalline product suitable for X-ray analysis. ^{1}H NMR (CDCl$_3$): δ 2.01–2.07 (*m*, 4H), 2.65 (*p*, 1H), 2.94–3.04 (*m*, 2H), 3.13–3.23 (*m*, 2H), 5.42 (*s*, 2H), 7.10–7.13 (*m*, 2H), 7.25–7.37 (*m*, 5H), 8.06–8.10 (*dd*, 1H), 8.41 (*s*, 1H), 8.96 (*d*, 1H); ^{13}C NMR (CDCl$_3$): δ 26.48, 40.63, 47.77, 51.37, 110.46, 112.78, 116.35, 117.28, 118.34, 126.68, 128.06, 128.41, 129.21, 135.59, 136.93, 138.99, 142.38, 142.65, 205.14.

Crystal data

C$_{23}$H$_{21}$N$_3$O$_3$	$V = 907.99$ (2) Å^3
$M_r = 387.43$	$Z = 2$
Triclinic, $P\bar{1}$	$D_x = 1.417$ Mg m^{-3}
$a = 9.3560$ (1) Å	Mo $K\alpha$ radiation
$b = 9.4049$ (1) Å	$\mu = 0.10$ mm^{-1}
$c = 11.1174$ (2) Å	$T = 90.0$ (2) K
$\alpha = 90.1103$ (5)°	Block, yellow
$\beta = 104.3081$ (5)°	$0.25 \times 0.18 \times 0.10$ mm
$\gamma = 106.1250$ (6)°	

Data collection

Nonius KappaCCD area-detector diffractometer	8270 measured reflections
ω scans at fixed $\chi = 55°$	4162 independent reflections
Absorption correction: multi-scan (*SCALEPACK*; Otwinowski & Minor, 1997)	3404 reflections with $I > 2\sigma(I)$
	$R_{int} = 0.024$
	$\theta_{max} = 27.5°$
$T_{min} = 0.977$, $T_{max} = 0.991$	

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0517P)^2 + 0.3204P]$
$R[F^2 > 2\sigma(F^2)] = 0.040$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.107$	$(\Delta/\sigma)_{max} < 0.001$
$S = 1.04$	$\Delta\rho_{max} = 0.25$ e Å^{-3}
4162 reflections	$\Delta\rho_{min} = -0.26$ e Å^{-3}
262 parameters	
H-atom parameters constrained	

Table 1
Selected geometric parameters (Å, °).

N2—C11	1.4429 (15)	C10—C11	1.3374 (17)
N3—C6	1.4643 (16)	C11—C17	1.4863 (17)
C2—C3—C10	129.41 (11)	N2—C11—C17	113.92 (10)
C11—C10—C3	128.65 (12)	C24—C19—C18	118.58 (11)
C10—C11—C17	122.04 (11)	C20—C19—C18	122.23 (11)
O2—N3—C6—C5	−3.33 (17)	C10—C11—C17—O1	−4.64 (19)
O3—N3—C6—C7	−3.81 (17)	N2—C11—C17—O1	176.22 (11)

H atoms were found in difference Fourier maps and subsequently placed in idealized positions with constrained C—H distances of 1.00 (R_3CH), 0.99 (R_2CH$_2$) and 0.95 Å (Csp^2), and with U_{iso}(H) values set at 1.2U_{eq} of the attached C atom.

Data collection: *COLLECT* (Nonius, 1999); cell refinement: *SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *DENZO-SMN* (Otwinowski & Minor, 1997); program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *XP* in *SHELXTL* (Sheldrick, 1995); software used to prepare material for publication: *SHELXL97* and local procedures.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: SK3086). Services for accessing these data are described at the back of the journal.

References

Glusker, J. P., Lewis, M. & Rossi, M. (1994). *Crystal Structure Analysis for Chemists and Biologists*, p. 854. New York: VCH Publishers.

Mason, M. R., Barnard, T. S., Segla, M. F., Xie, B. & Kirschbaum, K. (2003). *J. Chem. Crystallogr.* **33**, 531–540.

Nonius (1999). *COLLECT*. Nonius, BV, Delft, The Netherlands.

Otwinowski, Z. & Minor, W. (1997). *Methods in Enzymology*, Vol. 276, *Macromolecular Crystallography*, Part A, edited by C. W. Carter Jr & R. M. Sweet, pp. 307–326. New York: Academic Press.

Sheldrick (1995). *XP in SHELXTL/PC*. Siemens Analytical X-ray Instruments Inc., Madison, Wisconsin, USA.

Sheldrick, G. M. (1997). *SHELXS97* and *SHELXL97*. University of Göttingen, Germany.

Sonar, V. N., Parkin, S. & Crooks, P. A. (2003). *Acta Cryst.* E**59**, o1478–o1480.

Sonar, V. N., Parkin, S. & Crooks, P. A. (2006). *Acta Cryst.* E**62**, o3231–o3232.

Wilson, A. J. C. (1992). Editor. *International Tables for Crystallography*, Vol. C, Table 9.5.1.1. Dordrecht: Kluwer Academic Publishers.

Zarza, P. M., Gill, P., Díaz Gonzáles, M. C., Martin Reyes, M. G., Arrieta, J. M., Nastopoulos, V., Germain, G. & Debaerdemaeker, T. (1988). *Acta Cryst.* C**44**, 678–681.