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Crystal structure and Hirshfeld surface analysis of *N*-(2,6-dimethylphenyl)-2-[3-hydroxy-2-oxo-3-(2-oxopropyl)indolin-1-yl]acetamide

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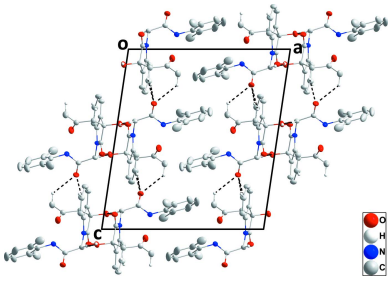
The cup-shaped conformation of the title molecule, $C_{21}H_{22}N_2O_4$, is largely determined by an intramolecular N—H···O hydrogen bond. In the crystal, double layers of molecules are formed by O—H···O and C—H···O hydrogen bonds. A Hirshfeld surface analysis was performed, which confirms the regions that are active for intermolecular interactions.

1. Chemical context

1*H*-Indole-2,3-dione, also known as isatin, represents a synthetically useful substrate that can be used to prepare a broad range of heterocyclic compounds, including examples of pharmacological significance (Bekircan & Bektas, 2008). Its derivates are biologically active and have significant importance in medicinal chemistry (Feng *et al.*, 2010). They show potent anticonvulsant activity at low concentrations (Mathur & Nain, 2014), as well as antibacterial (Hu *et al.*, 2017), anticancer (Ding *et al.*, 2020) and antitubercular (Nath *et al.*, 2020) activities. Arylacetamide-based compounds have attracted increasing attention because of their important pharmacological activities (Beccalli *et al.*, 2007; Valeur & Bradley, 2009; Allen & Williams, 2011; Missioui *et al.*, 2021, 2022*a*,*b*,*c*). As part of our interest in the identification of bioactive compounds, we report herein on the synthesis, crystal structure and Hirshfeld surface analysis of the title arylacetamide-based derivative containing an isatin moiety, namely *N*-(2,6-dimethylphenyl)-2-[3-hydroxy-2-oxo-3-(2-oxopropyl)indolin-1-yl]acetamide (Fig. 1)



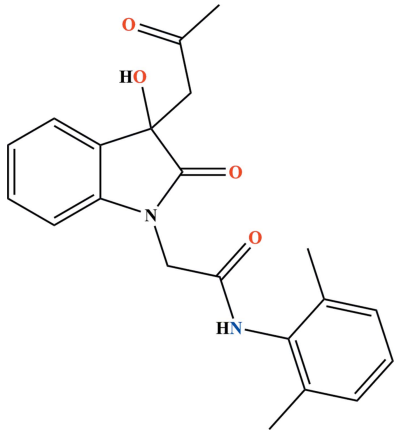


Table 1
Hydrogen-bond geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
O1—H1···O2^{i}	0.864 (15)	1.942 (15)	2.7829 (9)	164.1 (14)
N2—H2A···O3	0.874 (15)	2.154 (15)	3.0193 (10)	170.3 (13)
C3—H3···O4^{ii}	0.95	2.44	3.3280 (12)	155
C9—H9A···O4^{iii}	0.99	2.33	3.2537 (11)	154
C11—H11B···O4^{iii}	0.98	2.59	3.2988 (12)	129
C12—H12A···O1^{iv}	0.99	2.60	3.5835 (11)	173

Symmetry codes: (i) $-x, -y, -z+1$; (ii) $x, -y+\frac{3}{2}, z+\frac{1}{2}$; (iii) $x, -y+\frac{1}{2}, z+\frac{1}{2}$; (iv) $-x, -y+1, -z+1$.

2. Structural commentary

The molecule adopts a cup-shaped conformation (Fig. 1), which is largely determined by the intramolecular N2—H2A···O3 hydrogen bond (Table 1). As this places O3 directly over the five-membered ring [O3···centroid = 2.7062 (8) Å, C10···centroid = 2.9956 (9) Å, C10═O3···centroid = 99.56 (9)°], there is the possibility of an added C═O···π interaction reinforcing the observed conformation. The indole moiety is slightly non-planar as seen from the 1.89 (3)° dihedral angle between the mean planes of its constituent rings. The dihedral angle between the mean plane of the C1/C6/C7/C8/N1 ring and that of the C12/C13/N2/O4 unit is 82.83 (5)° while that between the latter plane and the mean plane of the C14–C19 ring is 72.24 (4)°. All bond distances and bond angles appear as expected for the given formulation.

3. Supramolecular features

In the crystal, centrosymmetric dimers are formed by self-complementary O1—H1···O2 hydrogen bonds (Table 1) and these units are assembled into corrugated layers parallel to the bc plane by C3—H3···O4 hydrogen bonds (Table 1 and Fig. 2). Although these layers clearly contain large pores, they are combined in pairs across centers of symmetry by C9—H9A···O4, C11—H11B···O4 and C12—H12A···O1 hydrogen bonds (Table 1) so that the pores in one layer are capped by molecules in the second and the resulting double layer has no significant pores (Fig. 3).

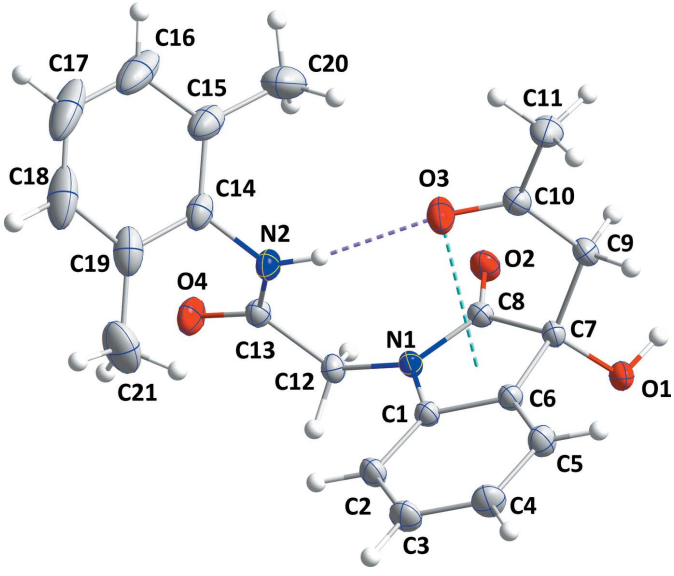


Figure 1
The title molecule with labeling scheme and 50% probability ellipsoids. The intramolecular N—H···O hydrogen bond and C═O···ring interaction are depicted, respectively by violet and light-blue dashed lines.

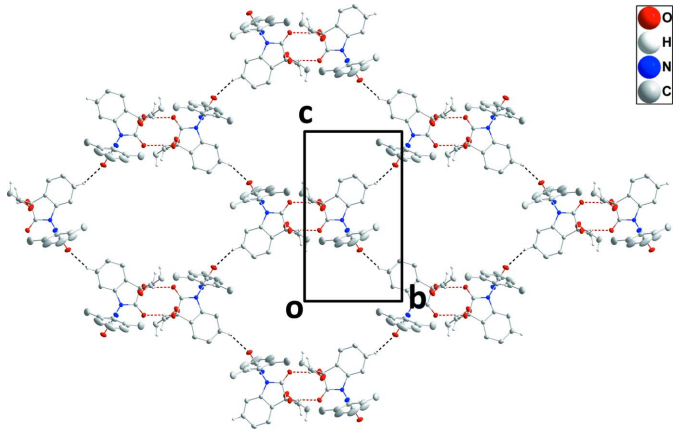


Figure 2
A plan view of a portion of one layer viewed along the a-axis direction. O—H···O and C—H···O hydrogen bonds are depicted, respectively, by red and black dashed lines while intramolecular interactions and non-interacting hydrogen atoms are omitted for clarity.

4. Database survey

A search of the Cambridge Structural Database (CSD version 5.43 updated to March 2022; Groom *et al.*, 2016) with the fragment A provided 28 hits, most of which contained a benzyl group attached to the ring nitrogen atom. Of these, seven [DEVVUY (Liu *et al.*, 2018), DIDVAO (Makaev *et al.*, 2006),

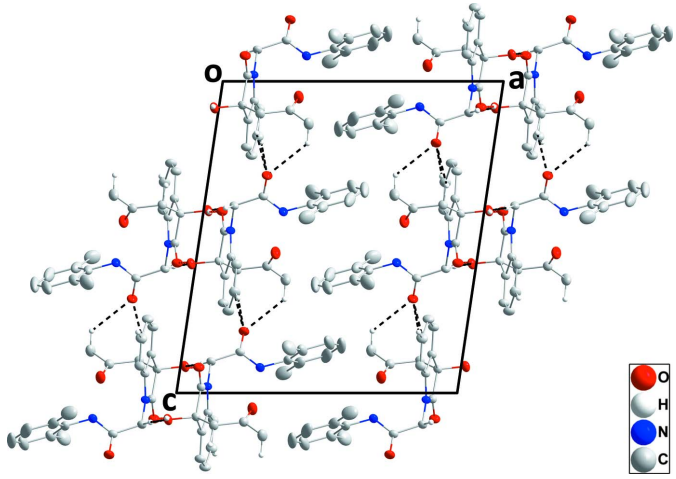
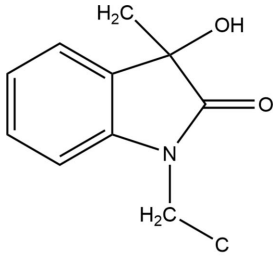


Figure 3
Packing viewed along the b-axis direction with O—H···O and C—H···O hydrogen bonds depicted, respectively, by red and black dashed lines. Intramolecular interactions and non-interacting hydrogen atoms are omitted for clarity.

ODUWIV (Duan *et al.*, 2013), PUZBAQ (Becerra *et al.*, 2020), PUZBEU (Becerra *et al.*, 2020), PUZBIY (Becerra *et al.*, 2020) and PUZBOE (Becerra *et al.*, 2020)] are most similar to the title molecule having a β-carbonyl group in the substituent attached to the saturated carbon of the five-membered ring. As in the title compound, all of these form dimers through complementary O— H···O hydrogen bonds between the hydroxy and keto groups and these units are also further assembled into chains and/or layers by hydrogen-bonding interactions.



A

5. Hirshfeld surface analysis

The analysis was performed with *CrystalExplorer 21.5* (Spackman *et al.*, 2021) with the details of the pictorial output described in a recent publication (Tan *et al.*, 2019). Fig. 4 shows the d_{norm} surface for the asymmetric unit plotted over the limits −0.6060 to 1.5193 a.u. together with three adjacent molecules that are hydrogen-bonded to it. The one on the lower left, adjacent to the pair of intense red spots, is the second half of one inversion dimer with these red spots indicating the strong O1—H1···O2 hydrogen bonds (*cf.* Fig. 2). The molecules above and below the surface are members of two adjacent layers of molecules (*cf.* Fig. 3), which are linked by the C9—H9*A*···O4 hydrogen bonds (lighter red spots). Fig. 5*a* presents a fingerprint plot of all intermolecular interactions while Fig. 5*b* shows the 55.2% of these attributable to H···H interactions. Fig. 5*c* and 5*d* delineate the O···H/H···O (24.1%) and C···H/H···C (17.8%) interactions, respectively.

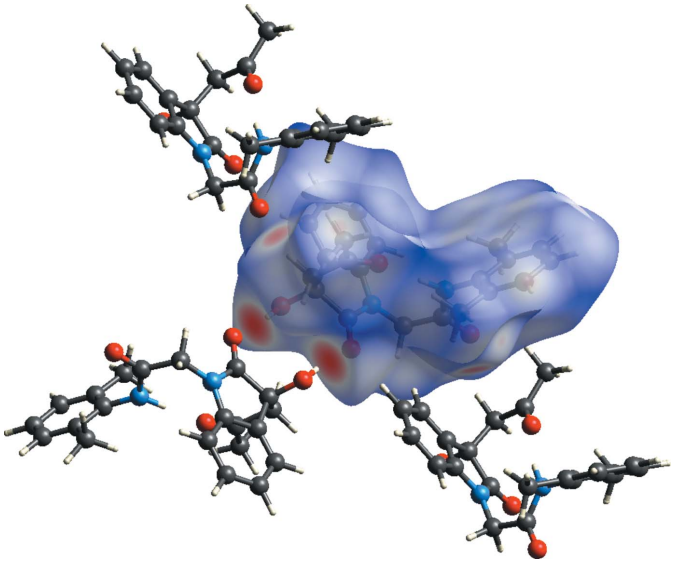


Figure 4
The Hirshfeld surface for the title molecule with three close neighbors added.

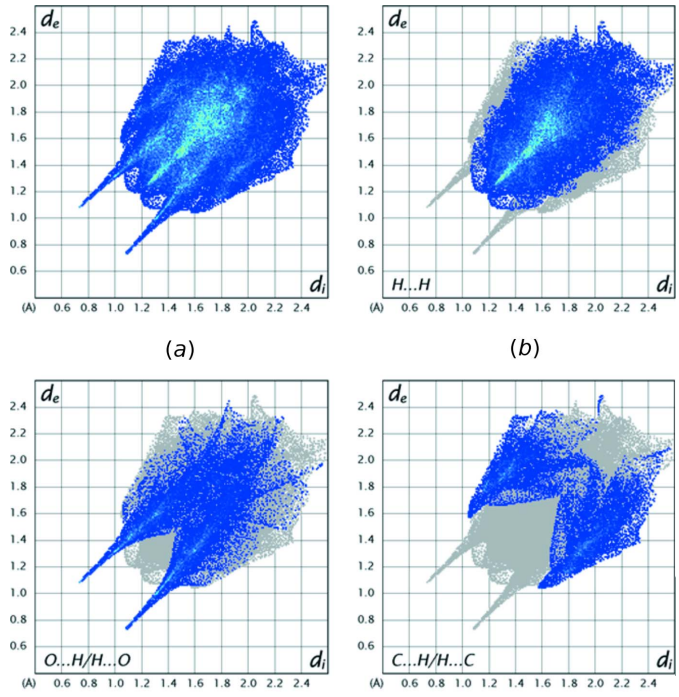


Figure 5
Fingerprint plots for the title molecule: (*a*) all contacts, (*b*) H···H contacts, (*c*) O···H/H···O contacts and (*d*) C···H/H···C contacts.

6. Synthesis and crystallization

Indoline-2,3-dione (0.1g, 0.0679 mmol) was taken up in 10 mL of acetone under stirring. Solid potassium carbonate (0.11 g, 0.815 mmol) was added in one portion. Then, the dark-colored suspension was raised to room temperature and stirred for a further 1 h. The appropriate 2-chloro-*N*-(2,6-dimethylphenyl)acetamide (0.119 g, 0.0679 mmol) and potassium iodide (0.05 g, 0.301 mmol) were added. Then, the reaction mixture was stirred at 353.15–373 K for 2 h until the reaction was complete, which was confirmed using TLC (ethyl acetate:hexane, 40:60). The resulting solid was filtered and recrystallized from ethanol to give title compound as colorless crystals. Yield: 64%; m.p. 527.15–529.15 K. FT–IR (ATR, υ, cm^{-1}) 3292 υ (N—H amide), 1021 υ (N—C amide), 1675 υ (C═O amide), 1708 υ (C═O lactam), 1615 υ (C═O ketone), 3073 υ(C—H_{arom}), 1175 υ(C—N), 2952 υ(C—H, CH_3), 3348 (O—H). ^{1}H NMR (DMSO–d_6) δ ppm: 9.086 (*s*, 1H, NH); 7.011–7.338 (*m*, 7H, H_{arom}); 6.134 (*s*, 1H, OH); 3.16-4.52 (2d, 2H, CH_2); 2.03 (*s*, 6H, 2 CH_3) 1.97 (*s*, 3H, CH_3). ^{13}C NMR (DMSO–d_6) δ ppm: 207.448 (C═O), 177.126 (C═O_{lactam}), 166.770 (C═O_{amide}), 143.329; 135.794; 134.718; 131.196;

Table 2
Experimental details.

Crystal data	
Chemical formula	$C_{21}H_{22}N_2O_4$
M_r	366.40
Crystal system, space group	Monoclinic, $P2_1/c$
Temperature (K)	150
a, b, c (Å)	13.8608 (5), 8.8352 (3), 15.5411 (6)
β (°)	98.468 (1)
V (Å^3)	1882.46 (12)
Z	4
Radiation type	Mo $K\alpha$
μ (mm^{-1})	0.09
Crystal size (mm)	0.46 × 0.37 × 0.26
Data collection	
Diffractometer	Bruker D8 QUEST PHOTON 3
Absorption correction	Numerical (*SADABS*; Krause *et al.*, 2015)
T_{min}, T_{max}	0.95, 0.98
No. of measured, independent and observed [$I > 2\sigma(I)$] reflections	101980, 6815, 5846
R_{int}	0.035
(sin $\theta/\lambda)_{max}$ (Å^{-1})	0.759
Refinement	
$R[F^2 > 2\sigma(F^2)]$, $wR(F^2)$, S	0.045, 0.129, 1.07
No. of reflections	6815
No. of parameters	254
H-atom treatment	H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{max}$, $\Delta\rho_{min}$ (e Å^{-3})	0.42, −0.31

Computer programs: *APEX4* and *SAINT* (Bruker, 2021), *SHELXT* (Sheldrick, 2015*a*), *SHELXL2018/1* (Sheldrick, 2015*b*), *DIAMOND* (Brandenburg & Putz, 2012) and *SHELXTL* (Sheldrick, 2008).

129.746; 128.268; 127.327; 124.150; 123.094; 109.196 (12CH_{arom}), 72.740 (Cq), 51.075 (CH_2—N), 40.200 (CH_2—$COCH_3$), 31.024 (CH_3), 18.498 (2 CH_3). Its mass spectrum showed a molecular ion peak (MH$^+$, m/z = 367.15799 and MNa$^+$, m/z = 389.13943) that conforms to its molecular formula $C_{21}H_{22}N_2O_4$

7. Refinement

Crystal data, data collection and structure refinement details are summarized in Table 2. Hydrogen atoms attached to carbon were included as riding contributions in idealized positions (C—H = 0.95–0.99 Å) with isotropic displacement parameters tied to those of the attached atoms [U_{iso}(H) = 1.2–1.5U_{eq}(C)]. Those attached to nitrogen and to oxygen were placed in locations derived from a difference map and refined with DFIX 0.91 0.01 and DFIX 0.84 0.01 instructions, respectively.

Acknowledgements

Author contributions are as follows. Conceptualization, YR and AA; methodology, YR; investigation, IN; theoretical calculations, JTM; writing (original draft), JMT and YR; writing (review and editing of the manuscript), YR; formal analysis, AA and YR; supervision, YR; crystal-structure determination and validation, JTM.

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Computing details

Data collection: *APEX4* (Bruker, 2021); cell refinement: *SAINT* (Bruker, 2021); data reduction: *SAINT* (Bruker, 2021); program(s) used to solve structure: *SHELXT* (Sheldrick, 2015*a*); program(s) used to refine structure: *SHELXL2018/1* (Sheldrick, 2015*b*); molecular graphics: *DIAMOND* (Brandenburg & Putz, 2012); software used to prepare material for publication: *SHELXTL* (Sheldrick, 2008).

N-(2,6-dimethylphenyl)-2-[3-hydroxy-2-oxo-3-(2-oxopropyl)indolin-\ 1-yl]acetamide

Crystal data

$C_{21}H_{22}N_2O_4$
M_r = 366.40
Monoclinic, $P2_1/c$
a = 13.8608 (5) Å
b = 8.8352 (3) Å
c = 15.5411 (6) Å
β = 98.468 (1)°
V = 1882.46 (12) Å^3
Z = 4
$F(000)$ = 776
D_x = 1.293 Mg m^{-3}
Mo $K\alpha$ radiation, λ = 0.71073 Å
Cell parameters from 9714 reflections
θ = 3.0–32.6°
μ = 0.09 mm^{-1}
T = 150 K
Block, colourless
0.46 × 0.37 × 0.26 mm

Data collection

Bruker D8 QUEST PHOTON 3 diffractometer
Radiation source: fine-focus sealed tube
Graphite monochromator
Detector resolution: 7.3910 pixels mm^{-1}
φ and ω scans
Absorption correction: numerical (*SADABS*; Krause *et al.*, 2015)
T_{min} = 0.95, T_{max} = 0.98
101980 measured reflections
6815 independent reflections
5846 reflections with $I > 2\sigma(I)$
R_{int} = 0.035
θ_{max} = 32.6°, θ_{min} = 3.0°
h = −21→21
k = −13→13
l = −23→23

Refinement

Refinement on F^2
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.045
$wR(F^2)$ = 0.129
S = 1.07
6815 reflections
254 parameters
0 restraints
Primary atom site location: dual
Secondary atom site location: difference Fourier map
Hydrogen site location: mixed
H atoms treated by a mixture of independent and constrained refinement
$w = 1/[\sigma^2(F_o^2) + (0.0697P)^2 + 0.4122P]$ where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{max}$ = 0.001
$\Delta\rho_{max}$ = 0.42 e Å^{-3}
$\Delta\rho_{min}$ = −0.31 e Å^{-3}

Special details

Experimental. The diffraction data were obtained from 9 sets of frames, each of width 0.5° in ω or φ, collected with scan parameters determined by the "strategy" routine in *APEX3*. The scan time was 5 sec/frame.

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R-factor wR and goodness of fit S are based on F^2, conventional R-factors R are based on F, with F set to zero for negative F^2. The threshold expression of $F^2 > 2\text{sigma}(F^2)$ is used only for calculating R-factors(gt) etc. and is not relevant to the choice of reflections for refinement. R-factors based on F^2 are statistically about twice as large as those based on F, and R- factors based on ALL data will be even larger. H-atoms attached to carbon were placed in calculated positions (C—H = 0.95 - 0.99 Å) and were included as riding contributions with isotropic displacement parameters 1.2 - 1.5 times those of the attached atoms. Those attached to nitrogen and to oxygen were placed in locations derived from a difference map and refined with DFIX 0.91 0.01 and DFIX 0.84 0.01 instructions, respectively.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å^2)

	x	*y*	*z*	U_{iso}*/U_{eq}
O1	−0.01619 (5)	0.15240 (7)	0.58519 (4)	0.02331 (13)
H1	−0.0211 (11)	0.0551 (17)	0.5810 (10)	0.035*
O2	0.06628 (5)	0.15275 (7)	0.41710 (4)	0.02433 (13)
O3	0.27892 (5)	0.18850 (8)	0.55047 (5)	0.03248 (16)
O4	0.20771 (5)	0.56774 (9)	0.30204 (4)	0.02884 (15)
N1	0.10667 (5)	0.38567 (7)	0.47826 (4)	0.01780 (13)
N2	0.28454 (5)	0.43751 (9)	0.41823 (5)	0.02231 (14)
H2A	0.2780 (10)	0.3724 (17)	0.4593 (10)	0.035 (3)*
C1	0.12285 (6)	0.44754 (8)	0.56329 (5)	0.01798 (14)
C2	0.14520 (7)	0.59580 (9)	0.58717 (6)	0.02279 (16)
H2	0.154105	0.670797	0.545243	0.027*
C3	0.15409 (7)	0.63026 (10)	0.67608 (6)	0.02693 (17)
H3	0.169109	0.730952	0.694915	0.032*
C4	0.14134 (7)	0.51983 (11)	0.73723 (6)	0.02757 (18)
H4	0.147813	0.545934	0.797102	0.033*
C5	0.11902 (7)	0.37041 (10)	0.71126 (5)	0.02376 (16)
H5	0.110095	0.294882	0.752878	0.029*
C6	0.11028 (6)	0.33536 (9)	0.62380 (5)	0.01846 (14)
C7	0.08199 (6)	0.18914 (8)	0.57660 (5)	0.01790 (14)
C8	0.08473 (6)	0.23521 (9)	0.48075 (5)	0.01807 (14)
C9	0.15003 (6)	0.05606 (9)	0.60396 (5)	0.02081 (15)
H9A	0.147274	0.032787	0.665866	0.025*
H9B	0.125732	−0.033851	0.569376	0.025*
C10	0.25502 (6)	0.08274 (10)	0.59283 (6)	0.02231 (15)
C11	0.32861 (7)	−0.02778 (12)	0.63580 (7)	0.0316 (2)
H11A	0.307193	−0.131044	0.619844	0.047*
H11B	0.335063	−0.015875	0.699085	0.047*
H11C	0.391777	−0.008787	0.616620	0.047*

C12	0.10666 (6)	0.47028 (9)	0.39869 (5)	0.01999 (14)
H12A	0.077300	0.570684	0.406183	0.024*
H12B	0.063673	0.417265	0.351674	0.024*
C13	0.20497 (6)	0.49478 (9)	0.36878 (5)	0.01973 (14)
C14	0.37969 (6)	0.45788 (11)	0.39438 (6)	0.02663 (18)
C15	0.42552 (8)	0.33352 (14)	0.36257 (7)	0.0365 (2)
C16	0.51776 (9)	0.3568 (2)	0.33836 (10)	0.0557 (4)
H16	0.550264	0.275060	0.315182	0.067*
C17	0.56220 (9)	0.4971 (2)	0.34769 (11)	0.0664 (5)
H17	0.625396	0.510315	0.332070	0.080*
C18	0.51564 (10)	0.6172 (2)	0.37936 (10)	0.0579 (4)
H18	0.547197	0.712839	0.385442	0.069*
C19	0.42263 (8)	0.60162 (14)	0.40288 (7)	0.0381 (2)
C20	0.37803 (12)	0.18097 (16)	0.35535 (11)	0.0515 (3)
H20A	0.315758	0.187197	0.316412	0.077*
H20B	0.366401	0.147447	0.413048	0.077*
H20C	0.420847	0.108401	0.331858	0.077*
C21	0.37171 (12)	0.73438 (15)	0.43604 (10)	0.0528 (3)
H21A	0.322214	0.772932	0.389673	0.079*
H21B	0.419331	0.814269	0.454501	0.079*
H21C	0.340299	0.702735	0.485625	0.079*

Atomic displacement parameters (Å²)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1	0.0214 (3)	0.0181 (3)	0.0320 (3)	−0.0025 (2)	0.0089 (2)	0.0019 (2)
O2	0.0324 (3)	0.0196 (3)	0.0212 (3)	−0.0036 (2)	0.0045 (2)	−0.0041 (2)
O3	0.0261 (3)	0.0303 (3)	0.0419 (4)	−0.0001 (3)	0.0079 (3)	0.0139 (3)
O4	0.0303 (3)	0.0361 (4)	0.0206 (3)	0.0004 (3)	0.0053 (2)	0.0107 (2)
N1	0.0230 (3)	0.0147 (3)	0.0162 (3)	−0.0012 (2)	0.0045 (2)	0.0007 (2)
N2	0.0221 (3)	0.0242 (3)	0.0213 (3)	0.0006 (2)	0.0051 (2)	0.0069 (2)
C1	0.0214 (3)	0.0153 (3)	0.0178 (3)	−0.0010 (2)	0.0045 (2)	−0.0007 (2)
C2	0.0296 (4)	0.0157 (3)	0.0237 (3)	−0.0032 (3)	0.0062 (3)	−0.0013 (3)
C3	0.0348 (4)	0.0198 (4)	0.0266 (4)	−0.0037 (3)	0.0057 (3)	−0.0062 (3)
C4	0.0356 (5)	0.0269 (4)	0.0203 (3)	−0.0020 (3)	0.0044 (3)	−0.0053 (3)
C5	0.0311 (4)	0.0226 (4)	0.0179 (3)	−0.0012 (3)	0.0049 (3)	0.0008 (3)
C6	0.0226 (3)	0.0153 (3)	0.0179 (3)	−0.0010 (2)	0.0044 (2)	−0.0002 (2)
C7	0.0206 (3)	0.0145 (3)	0.0193 (3)	−0.0019 (2)	0.0050 (2)	0.0012 (2)
C8	0.0196 (3)	0.0155 (3)	0.0193 (3)	−0.0005 (2)	0.0037 (2)	−0.0005 (2)
C9	0.0235 (3)	0.0157 (3)	0.0236 (3)	0.0004 (3)	0.0045 (3)	0.0029 (3)
C10	0.0236 (3)	0.0200 (3)	0.0236 (3)	0.0015 (3)	0.0044 (3)	0.0010 (3)
C11	0.0271 (4)	0.0310 (4)	0.0374 (5)	0.0081 (3)	0.0072 (3)	0.0093 (4)
C12	0.0228 (3)	0.0196 (3)	0.0180 (3)	0.0010 (3)	0.0043 (3)	0.0041 (2)
C13	0.0237 (3)	0.0186 (3)	0.0173 (3)	−0.0003 (3)	0.0044 (3)	0.0011 (2)
C14	0.0215 (3)	0.0354 (5)	0.0230 (4)	−0.0008 (3)	0.0034 (3)	0.0095 (3)
C15	0.0299 (4)	0.0478 (6)	0.0334 (5)	0.0128 (4)	0.0102 (4)	0.0136 (4)
C16	0.0342 (5)	0.0853 (11)	0.0517 (7)	0.0270 (6)	0.0199 (5)	0.0313 (7)
C17	0.0237 (5)	0.1103 (14)	0.0668 (9)	0.0030 (7)	0.0118 (5)	0.0503 (10)

C18	0.0323 (5)	0.0797 (10)	0.0591 (8)	−0.0212 (6)	−0.0020 (5)	0.0332 (8)
C19	0.0328 (5)	0.0454 (6)	0.0342 (5)	−0.0131 (4)	−0.0010 (4)	0.0135 (4)
C20	0.0586 (8)	0.0398 (6)	0.0598 (8)	0.0159 (6)	0.0215 (7)	−0.0014 (6)
C21	0.0691 (9)	0.0350 (6)	0.0522 (7)	−0.0196 (6)	0.0019 (6)	−0.0015 (5)

Geometric parameters (Å, º)

O1—C7	1.4242 (10)	C9—H9B	0.9900
O1—H1	0.864 (15)	C10—C11	1.4965 (13)
O2—C8	1.2248 (9)	C11—H11A	0.9800
O3—C10	1.2167 (11)	C11—H11B	0.9800
O4—C13	1.2266 (10)	C11—H11C	0.9800
N1—C8	1.3655 (10)	C12—C13	1.5187 (11)
N1—C1	1.4170 (10)	C12—H12A	0.9900
N1—C12	1.4450 (10)	C12—H12B	0.9900
N2—C13	1.3467 (11)	C14—C15	1.3956 (15)
N2—C14	1.4329 (11)	C14—C19	1.4005 (15)
N2—H2A	0.874 (15)	C15—C16	1.4002 (16)
C1—C2	1.3840 (11)	C15—C20	1.497 (2)
C1—C6	1.3948 (11)	C16—C17	1.382 (3)
C2—C3	1.4026 (12)	C16—H16	0.9500
C2—H2	0.9500	C17—C18	1.370 (3)
C3—C4	1.3913 (13)	C17—H17	0.9500
C3—H3	0.9500	C18—C19	1.3976 (17)
C4—C5	1.4017 (13)	C18—H18	0.9500
C4—H4	0.9500	C19—C21	1.499 (2)
C5—C6	1.3818 (11)	C20—H20A	0.9800
C5—H5	0.9500	C20—H20B	0.9800
C6—C7	1.5087 (11)	C20—H20C	0.9800
C7—C9	1.5279 (11)	C21—H21A	0.9800
C7—C8	1.5501 (11)	C21—H21B	0.9800
C9—C10	1.5091 (12)	C21—H21C	0.9800
C9—H9A	0.9900		

C7—O1—H1	106.6 (10)	C10—C11—H11B	109.5
C8—N1—C1	110.76 (6)	H11A—C11—H11B	109.5
C8—N1—C12	123.77 (7)	C10—C11—H11C	109.5
C1—N1—C12	125.35 (6)	H11A—C11—H11C	109.5
C13—N2—C14	120.85 (7)	H11B—C11—H11C	109.5
C13—N2—H2A	120.0 (9)	N1—C12—C13	116.66 (7)
C14—N2—H2A	118.0 (9)	N1—C12—H12A	108.1
C2—C1—C6	122.48 (7)	C13—C12—H12A	108.1
C2—C1—N1	127.85 (7)	N1—C12—H12B	108.1
C6—C1—N1	109.65 (6)	C13—C12—H12B	108.1
C1—C2—C3	116.96 (8)	H12A—C12—H12B	107.3
C1—C2—H2	121.5	O4—C13—N2	123.73 (8)
C3—C2—H2	121.5	O4—C13—C12	118.34 (7)
C4—C3—C2	121.27 (8)	N2—C13—C12	117.91 (7)

C4—C3—H3	119.4	C15—C14—C19	122.55 (10)
C2—C3—H3	119.4	C15—C14—N2	118.49 (9)
C3—C4—C5	120.58 (8)	C19—C14—N2	118.96 (9)
C3—C4—H4	119.7	C14—C15—C16	117.43 (13)
C5—C4—H4	119.7	C14—C15—C20	121.16 (10)
C6—C5—C4	118.55 (8)	C16—C15—C20	121.41 (12)
C6—C5—H5	120.7	C17—C16—C15	120.95 (14)
C4—C5—H5	120.7	C17—C16—H16	119.5
C5—C6—C1	120.16 (7)	C15—C16—H16	119.5
C5—C6—C7	130.47 (7)	C18—C17—C16	120.38 (11)
C1—C6—C7	109.27 (7)	C18—C17—H17	119.8
O1—C7—C6	109.46 (6)	C16—C17—H17	119.8
O1—C7—C9	110.96 (6)	C17—C18—C19	121.27 (14)
C6—C7—C9	114.71 (7)	C17—C18—H18	119.4
O1—C7—C8	107.99 (6)	C19—C18—H18	119.4
C6—C7—C8	101.59 (6)	C18—C19—C14	117.39 (13)
C9—C7—C8	111.59 (6)	C18—C19—C21	120.81 (13)
O2—C8—N1	125.24 (7)	C14—C19—C21	121.80 (10)
O2—C8—C7	126.03 (7)	C15—C20—H20A	109.5
N1—C8—C7	108.66 (6)	C15—C20—H20B	109.5
C10—C9—C7	114.46 (6)	H20A—C20—H20B	109.5
C10—C9—H9A	108.6	C15—C20—H20C	109.5
C7—C9—H9A	108.6	H20A—C20—H20C	109.5
C10—C9—H9B	108.6	H20B—C20—H20C	109.5
C7—C9—H9B	108.6	C19—C21—H21A	109.5
H9A—C9—H9B	107.6	C19—C21—H21B	109.5
O3—C10—C11	121.37 (8)	H21A—C21—H21B	109.5
O3—C10—C9	121.73 (8)	C19—C21—H21C	109.5
C11—C10—C9	116.90 (7)	H21A—C21—H21C	109.5
C10—C11—H11A	109.5	H21B—C21—H21C	109.5

C8—N1—C1—C2	−178.96 (8)	C6—C7—C8—N1	−2.55 (8)
C12—N1—C1—C2	−2.79 (13)	C9—C7—C8—N1	−125.24 (7)
C8—N1—C1—C6	−0.65 (9)	O1—C7—C9—C10	177.23 (7)
C12—N1—C1—C6	175.53 (7)	C6—C7—C9—C10	−58.09 (9)
C6—C1—C2—C3	−0.55 (13)	C8—C7—C9—C10	56.75 (9)
N1—C1—C2—C3	177.57 (8)	C7—C9—C10—O3	−13.37 (12)
C1—C2—C3—C4	0.25 (14)	C7—C9—C10—C11	167.08 (8)
C2—C3—C4—C5	−0.08 (15)	C8—N1—C12—C13	−98.64 (9)
C3—C4—C5—C6	0.18 (14)	C1—N1—C12—C13	85.66 (9)
C4—C5—C6—C1	−0.47 (13)	C14—N2—C13—O4	−0.69 (13)
C4—C5—C6—C7	−176.29 (8)	C14—N2—C13—C12	−179.30 (8)
C2—C1—C6—C5	0.68 (13)	N1—C12—C13—O4	−179.12 (8)
N1—C1—C6—C5	−177.74 (7)	N1—C12—C13—N2	−0.44 (11)
C2—C1—C6—C7	177.32 (7)	C13—N2—C14—C15	−107.45 (10)
N1—C1—C6—C7	−1.11 (9)	C13—N2—C14—C19	71.84 (12)
C5—C6—C7—O1	64.33 (11)	C19—C14—C15—C16	−0.29 (15)
C1—C6—C7—O1	−111.85 (7)	N2—C14—C15—C16	178.98 (9)

C5—C6—C7—C9	−61.13 (12)	C19—C14—C15—C20	179.24 (11)
C1—C6—C7—C9	122.69 (7)	N2—C14—C15—C20	−1.49 (15)
C5—C6—C7—C8	178.34 (9)	C14—C15—C16—C17	1.46 (18)
C1—C6—C7—C8	2.16 (8)	C20—C15—C16—C17	−178.06 (13)
C1—N1—C8—O2	179.22 (8)	C15—C16—C17—C18	−1.3 (2)
C12—N1—C8—O2	2.97 (12)	C16—C17—C18—C19	−0.1 (2)
C1—N1—C8—C7	2.07 (9)	C17—C18—C19—C14	1.18 (18)
C12—N1—C8—C7	−174.18 (7)	C17—C18—C19—C21	−178.97 (13)
O1—C7—C8—O2	−64.57 (10)	C15—C14—C19—C18	−1.01 (15)
C6—C7—C8—O2	−179.67 (8)	N2—C14—C19—C18	179.73 (10)
C9—C7—C8—O2	57.64 (10)	C15—C14—C19—C21	179.15 (11)
O1—C7—C8—N1	112.55 (7)	N2—C14—C19—C21	−0.12 (15)

Hydrogen-bond geometry (Å, º)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O1—H1···O2^{i}	0.864 (15)	1.942 (15)	2.7829 (9)	164.1 (14)
N2—H2*A*···O3	0.874 (15)	2.154 (15)	3.0193 (10)	170.3 (13)
C3—H3···O4^{ii}	0.95	2.44	3.3280 (12)	155
C9—H9*A*···O4^{iii}	0.99	2.33	3.2537 (11)	154
C11—H11*B*···O4^{iii}	0.98	2.59	3.2988 (12)	129
C12—H12*A*···O1^{iv}	0.99	2.60	3.5835 (11)	173

Symmetry codes: (i) −*x*, −*y*, −*z*+1; (ii) *x*, −*y*+3/2, *z*+1/2; (iii) *x*, −*y*+1/2, *z*+1/2; (iv) −*x*, −*y*+1, −*z*+1.