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4-Acetyl-2,3,4,5-tetrahydro-1H-1,4-benzodiazepine

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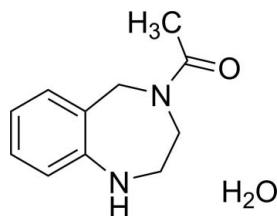
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Key indicators: single-crystal X-ray study; $T = 296$ K; mean $\sigma(\text{C}-\text{C}) = 0.004$ Å;
 R factor = 0.036; wR factor = 0.099; data-to-parameter ratio = 7.4.

The title compound, $\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}\cdot\text{H}_2\text{O}$, crystallizes with one formula unit in the asymmetric unit. The seven-membered ring has a chair conformation with the $\text{C}=\text{O}$ group turned away from the benzene ring. $\text{N}-\text{H}\cdots\text{O}$ and $\text{O}-\text{H}\cdots\text{O}$ hydrogen bonds are present in the crystal structure.

Related literature

For related literature, see: Allen *et al.* (1987); Ding *et al.* (1999); Grunewald *et al.* (1996); Kim (1976).



Experimental

Crystal data

$\text{C}_{11}\text{H}_{14}\text{N}_2\text{O}\cdot\text{H}_2\text{O}$
 $M_r = 208.26$
Tetragonal, $P4_3$
 $a = 10.8251$ (8) Å
 $c = 9.4569$ (14) Å
 $V = 1108.2$ (2) Å³

$Z = 4$
Mo $K\alpha$ radiation
 $\mu = 0.09$ mm⁻¹
 $T = 296$ (2) K
 $0.20 \times 0.20 \times 0.15$ mm

Data collection

Bruker APEXII CCD
diffractometer
Absorption correction: none
5758 measured reflections

1043 independent reflections
972 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.016$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.035$
 $wR(F^2) = 0.098$
 $S = 1.07$
1043 reflections
140 parameters
1 restraint

H atoms treated by a mixture of
independent and constrained
refinement
 $\Delta\rho_{\text{max}} = 0.21$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.20$ e Å⁻³

Table 1

Hydrogen-bond geometry (Å, °).

$D-\text{H}\cdots A$	$D-\text{H}$	$\text{H}\cdots A$	$D\cdots A$	$D-\text{H}\cdots A$
$\text{N1}-\text{H1}\cdots\text{O1W}^i$	0.88 (5)	2.33 (4)	3.163 (3)	158 (4)

Symmetry codes: (i) $y, -x + 1, z + \frac{1}{4}$; (ii) $-y + 1, x + 1, z + \frac{3}{4}$.

Data collection: *APEX2* (Bruker, 2000); cell refinement: *SAINT* (Bruker, 2000); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008); software used to prepare material for publication: *SHELXTL*.

Acknowledgement is made to the staff of Topharman Shanghai Co. Ltd for their active cooperation in this work. We also thank the Instrument Analysis and Research Center of Shanghai University for structural confirmation.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: OM2218).

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supplementary materials

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4-Acetyl-2,3,4,5-tetrahydro-1*H*-1,4-benzodiazepine

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Comment

The title molecule (Fig. 1) is an important intermediate used to synthesize a variety of pharmaceuticals, such as inhibitors of phenylethanolamine *N*-methyltransferase (Grunewald *et al.*, 1996) and inhibitors of Farnesyltransferase (Ding *et al.*, 1999). In our recent research for exploring new methods for synthesis of benzodiazepine derivatives, 4-acetyl-2,3,4,5-tetrahydro-1*H*-1,4-benzodiazepine is synthesized in 96% yield from 2,3,4,5-tetrahydro-1*H*-1,4-benzodiazepine (Ding *et al.*, 1999). We report here the crystal structure of the title compound, which crystallizes in the tetragonal space group P4(3) with one H₂O molecule in the asymmetric unit.

A view of the molecular structure of title compound is depicted in Fig.1. The central seven-membered ring has a chair conformation, which is consistent with reported *exo* conformational form with the C=O group turns away from benzene ring (Kim *et al.*, 1976). All bond lengths and angles are normal (Allen *et al.*, 1987). Molecules related by an *c*-axis translation are stacked over each other and stabilized by van de waals (Fig. 2). The stacked columns are linked together *via* an intermolecular hydrogen bond, in which the amine H1 act as a donor to H₂O O1w atom and H₂O H1A as a donor to H₂O O1w atom (Fig. 2 and Table 1).

Experimental

Acetyl chloride (6 ml) was added dropwise to CH₂Cl₂ solution (80 ml) containing 2,3,4,5-tetrahydro-1*H*-1,4-benzodiazepine (14.8 g, 0.1 mol) at ice-water bath. After addition, the reaction temperature was raised to room temperature. The resulting mixture was crashed to ice-water bath after stirring for 5 hrs. The organic layer was separated and dried over MgSO₄. After filtration, the filtrate was evaporated to give an oil which can be crystallized from acetone to give title compound in 96% yield. Single crystals suitable for X-ray analysis (m.p. 358 K) were obtained by slow evaporation of a ethyl acetate/n-hexane/H₂O solution at 298 K.

Refinement

The water H atoms and imine H atom were located from Fourier difference maps and refined subject to an O—H restraint of 0.85 Å and N—H 0.88 Å. Other H atoms were introduced at calculated positions (C—H = 0.93–0.97 Å) and refined using a riding model. The isotropic displacement parameters of all H atoms were set to 1.2 times U_{eq} of the parent atoms.

Figures

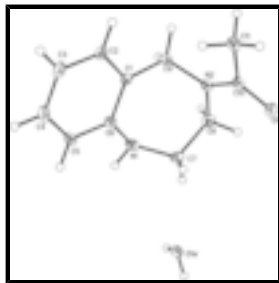


Fig. 1. View of the molecule of (I) showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 30% probability level and H atoms are shown as small spheres of arbitrary radii.

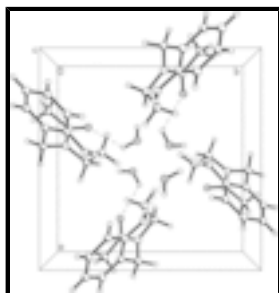


Fig. 2. The crystal packing of (I), viewed along the *c*-axis. Hydrogen bonds are shown as dashed lines.

(I)

Crystal data

$C_{11}H_{14}N_2O \cdot H_2O$

$M_r = 208.26$

Tetragonal, $P4(3)$

$a = 10.8251$ (8) Å

$b = 10.8251$ (8) Å

$c = 9.4569$ (14) Å

$\alpha = 90^\circ$

$\beta = 90^\circ$

$\gamma = 90^\circ$

$V = 1108.2$ (2) Å³

$Z = 4$

$F_{000} = 448$

$D_x = 1.248$ Mg m⁻³

Melting point: 358 K

Mo $K\alpha$ radiation

$\lambda = 0.71073$ Å

Cell parameters from 3047 reflections

$\theta = 2.7\text{--}26.0^\circ$

$\mu = 0.09$ mm⁻¹

$T = 296$ (2) K

Block, colourless

$0.20 \times 0.20 \times 0.15$ mm

Data collection

Bruker SMART CCD
diffractometer

Radiation source: fine-focus sealed tube

Monochromator: graphite

$T = 296$ (2) K

ϕ and ω scans

Absorption correction: none

5758 measured reflections

1043 independent reflections

972 reflections with $I > 2\sigma(I)$

$R_{int} = 0.016$

$\theta_{max} = 25.0^\circ$

$\theta_{min} = 2.7^\circ$

$h = -12 \rightarrow 8$

$k = -12 \rightarrow 12$

$l = -9 \rightarrow 11$

Refinement

Refinement on F^2	Hydrogen site location: inferred from neighbouring sites
Least-squares matrix: full	H atoms treated by a mixture of independent and constrained refinement
$R[F^2 > 2\sigma(F^2)] = 0.035$	$w = 1/[\sigma^2(F_o^2) + (0.0638P)^2 + 0.1073P]$ where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.098$	$(\Delta/\sigma)_{\max} < 0.001$
$S = 1.07$	$\Delta\rho_{\max} = 0.21 \text{ e } \text{\AA}^{-3}$
1043 reflections	$\Delta\rho_{\min} = -0.19 \text{ e } \text{\AA}^{-3}$
140 parameters	Extinction correction: none
1 restraint	Absolute structure: Flack (1983)
Primary atom site location: structure-invariant direct methods	Flack parameter: $-10 (10)$
Secondary atom site location: difference Fourier map	

Special details

Geometry. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s 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 $F^2 > \sigma(F^2)$ 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.

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

	x	y	z	$U_{\text{iso}}^*/U_{\text{eq}}$
O1W	0.40813 (19)	0.43417 (18)	0.4076 (2)	0.0676 (6)
H1A	0.4427	0.3641	0.3986	0.081*
H1B	0.3401	0.4358	0.4525	0.081*
C1	0.6424 (2)	0.9826 (2)	0.3856 (3)	0.0460 (5)
C2	0.7330 (3)	1.0679 (2)	0.4220 (3)	0.0580 (7)
H2	0.7462	1.1362	0.3642	0.070*
C3	0.8037 (3)	1.0533 (3)	0.5422 (3)	0.0701 (8)
H3	0.8639	1.1112	0.5653	0.084*
C4	0.7843 (3)	0.9525 (3)	0.6272 (3)	0.0735 (9)
H4	0.8310	0.9425	0.7090	0.088*
C5	0.6966 (3)	0.8663 (3)	0.5923 (3)	0.0638 (8)
H5	0.6853	0.7980	0.6505	0.077*
C6	0.6240 (2)	0.8789 (2)	0.4716 (3)	0.0490 (6)
C7	0.5295 (3)	0.7284 (2)	0.3073 (4)	0.0613 (7)
H7A	0.4792	0.6547	0.3164	0.074*

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H7B	0.6133	0.7023	0.2867	0.074*
C8	0.4817 (2)	0.8038 (3)	0.1833 (3)	0.0604 (7)
H8A	0.4760	0.7516	0.1002	0.072*
H8B	0.3996	0.8343	0.2047	0.072*
C9	0.5604 (2)	1.0065 (2)	0.2601 (3)	0.0514 (6)
H9A	0.4761	1.0164	0.2928	0.062*
H9B	0.5853	1.0835	0.2160	0.062*
C10	0.6485 (2)	0.8995 (2)	0.0517 (3)	0.0513 (6)
C11	0.7359 (3)	1.0053 (3)	0.0322 (3)	0.0689 (8)
H11A	0.7950	0.9850	-0.0398	0.103*
H11B	0.7783	1.0213	0.1195	0.103*
H11C	0.6906	1.0776	0.0044	0.103*
N1	0.5291 (2)	0.7936 (2)	0.4415 (3)	0.0596 (6)
N2	0.56359 (19)	0.90814 (18)	0.1536 (2)	0.0500 (5)
O1	0.6565 (2)	0.80907 (18)	-0.0269 (2)	0.0685 (6)
H1	0.519 (3)	0.747 (4)	0.517 (5)	0.082*

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
O1W	0.0770 (13)	0.0662 (11)	0.0596 (12)	0.0001 (9)	-0.0051 (10)	0.0138 (10)
C1	0.0511 (12)	0.0457 (12)	0.0412 (12)	0.0081 (10)	0.0042 (10)	-0.0016 (10)
C2	0.0669 (16)	0.0523 (13)	0.0547 (16)	0.0004 (12)	0.0037 (13)	-0.0129 (12)
C3	0.0711 (18)	0.0773 (19)	0.0620 (19)	0.0076 (15)	-0.0121 (15)	-0.0284 (16)
C4	0.0722 (19)	0.101 (2)	0.0476 (16)	0.0341 (18)	-0.0147 (14)	-0.0216 (17)
C5	0.0764 (18)	0.0692 (17)	0.0457 (15)	0.0306 (15)	0.0060 (14)	0.0082 (13)
C6	0.0502 (13)	0.0513 (13)	0.0455 (13)	0.0126 (10)	0.0072 (11)	0.0053 (11)
C7	0.0599 (15)	0.0437 (13)	0.080 (2)	-0.0070 (11)	0.0064 (14)	0.0074 (14)
C8	0.0514 (13)	0.0617 (15)	0.0682 (19)	-0.0105 (11)	-0.0053 (13)	-0.0020 (14)
C9	0.0596 (14)	0.0441 (12)	0.0507 (15)	0.0070 (11)	-0.0044 (12)	0.0048 (11)
C10	0.0640 (15)	0.0508 (13)	0.0392 (12)	-0.0015 (11)	-0.0085 (12)	0.0050 (11)
C11	0.087 (2)	0.0663 (17)	0.0529 (17)	-0.0163 (15)	0.0089 (15)	0.0064 (14)
N1	0.0602 (13)	0.0577 (13)	0.0610 (15)	0.0020 (10)	0.0131 (12)	0.0183 (12)
N2	0.0582 (12)	0.0469 (11)	0.0449 (11)	-0.0001 (9)	-0.0078 (10)	0.0040 (9)
O1	0.0907 (14)	0.0624 (11)	0.0525 (11)	-0.0061 (10)	0.0010 (11)	-0.0097 (10)

Geometric parameters (\AA , $^\circ$)

O1W—H1A	0.8500	C7—H7A	0.9700
O1W—H1B	0.8499	C7—H7B	0.9700
C1—C2	1.390 (4)	C8—N2	1.463 (3)
C1—C6	1.401 (4)	C8—H8A	0.9700
C1—C9	1.505 (3)	C8—H8B	0.9700
C2—C3	1.379 (4)	C9—N2	1.466 (3)
C2—H2	0.9300	C9—H9A	0.9700
C3—C4	1.372 (5)	C9—H9B	0.9700
C3—H3	0.9300	C10—O1	1.233 (3)
C4—C5	1.372 (5)	C10—N2	1.334 (3)
C4—H4	0.9300	C10—C11	1.497 (4)

C5—C6	1.392 (4)	C11—H11A	0.9600
C5—H5	0.9300	C11—H11B	0.9600
C6—N1	1.411 (4)	C11—H11C	0.9600
C7—N1	1.452 (4)	N1—H1	0.88 (4)
C7—C8	1.519 (4)		
H1A—O1W—H1B	116.8	N2—C8—H8A	109.5
C2—C1—C6	119.3 (3)	C7—C8—H8A	109.5
C2—C1—C9	119.9 (2)	N2—C8—H8B	109.5
C6—C1—C9	120.8 (2)	C7—C8—H8B	109.5
C3—C2—C1	121.3 (3)	H8A—C8—H8B	108.0
C3—C2—H2	119.4	N2—C9—C1	113.81 (19)
C1—C2—H2	119.4	N2—C9—H9A	108.8
C4—C3—C2	119.3 (3)	C1—C9—H9A	108.8
C4—C3—H3	120.3	N2—C9—H9B	108.8
C2—C3—H3	120.3	C1—C9—H9B	108.8
C5—C4—C3	120.4 (3)	H9A—C9—H9B	107.7
C5—C4—H4	119.8	O1—C10—N2	122.7 (2)
C3—C4—H4	119.8	O1—C10—C11	119.2 (3)
C4—C5—C6	121.4 (3)	N2—C10—C11	118.1 (2)
C4—C5—H5	119.3	C10—C11—H11A	109.5
C6—C5—H5	119.3	C10—C11—H11B	109.5
C5—C6—C1	118.3 (3)	H11A—C11—H11B	109.5
C5—C6—N1	120.8 (2)	C10—C11—H11C	109.5
C1—C6—N1	120.7 (2)	H11A—C11—H11C	109.5
N1—C7—C8	114.4 (2)	H11B—C11—H11C	109.5
N1—C7—H7A	108.7	C6—N1—C7	119.5 (2)
C8—C7—H7A	108.7	C6—N1—H1	107 (3)
N1—C7—H7B	108.7	C7—N1—H1	116 (3)
C8—C7—H7B	108.7	C10—N2—C8	120.1 (2)
H7A—C7—H7B	107.6	C10—N2—C9	124.3 (2)
N2—C8—C7	110.9 (2)	C8—N2—C9	114.5 (2)
C6—C1—C2—C3	-1.0 (4)	C6—C1—C9—N2	-60.6 (3)
C9—C1—C2—C3	175.2 (2)	C5—C6—N1—C7	-123.7 (3)
C1—C2—C3—C4	0.1 (4)	C1—C6—N1—C7	60.3 (3)
C2—C3—C4—C5	0.7 (4)	C8—C7—N1—C6	-79.0 (3)
C3—C4—C5—C6	-0.8 (4)	O1—C10—N2—C8	5.0 (4)
C4—C5—C6—C1	-0.1 (4)	C11—C10—N2—C8	-175.7 (3)
C4—C5—C6—N1	-176.2 (3)	O1—C10—N2—C9	172.1 (2)
C2—C1—C6—C5	0.9 (3)	C11—C10—N2—C9	-8.6 (4)
C9—C1—C6—C5	-175.3 (2)	C7—C8—N2—C10	97.6 (3)
C2—C1—C6—N1	177.0 (2)	C7—C8—N2—C9	-70.8 (3)
C9—C1—C6—N1	0.8 (3)	C1—C9—N2—C10	-84.2 (3)
N1—C7—C8—N2	65.5 (3)	C1—C9—N2—C8	83.6 (3)
C2—C1—C9—N2	123.2 (3)		

Hydrogen-bond geometry (Å, °)

D—H...A	D—H	H...A	D...A	D—H...A
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supplementary materials

$N1-H1\cdots O1W^i$ 0.88 (5) 2.33 (4) 3.163 (3) 158 (4)
Symmetry codes: (i) $y, -x+1, z+1/4$.

Fig. 1

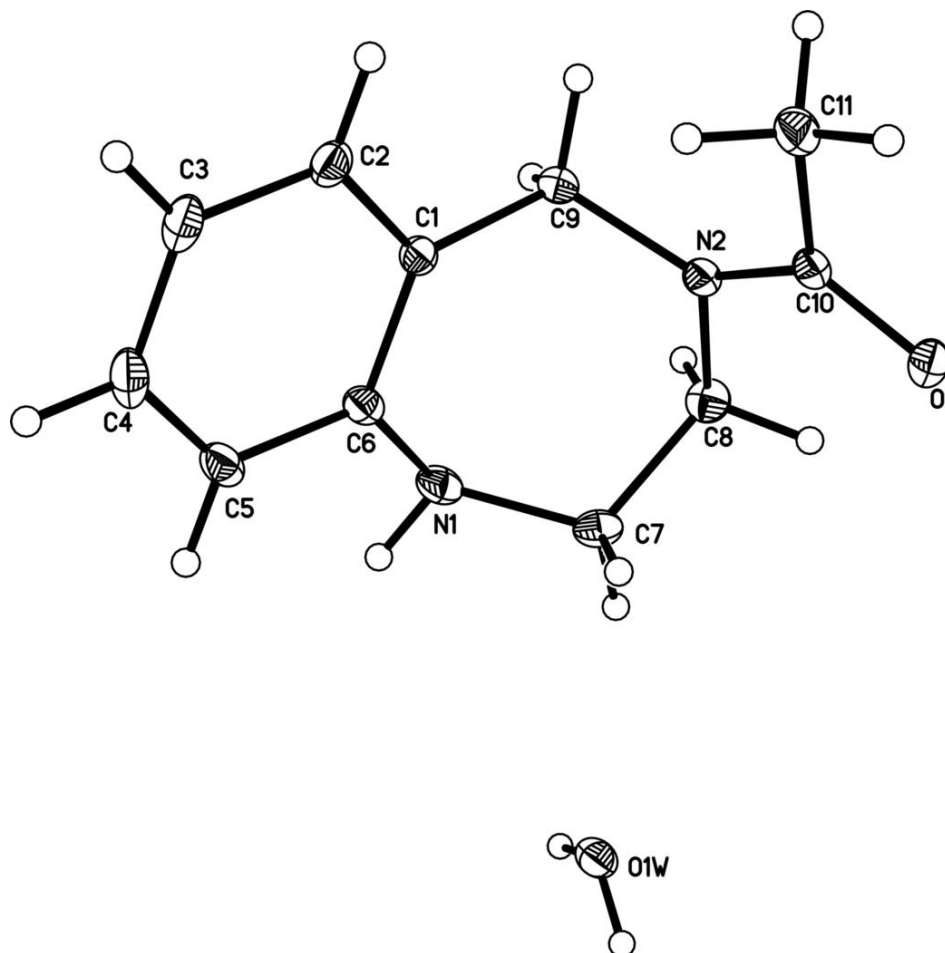


Fig. 2

