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Crystal structure of 6,6*a*,7,8,9,10-hexahydro-5*H*-pyrazino [2,3-*e*]pyrido[1,2-*a*]pyrazine, $C_{10}H_{14}N_4$

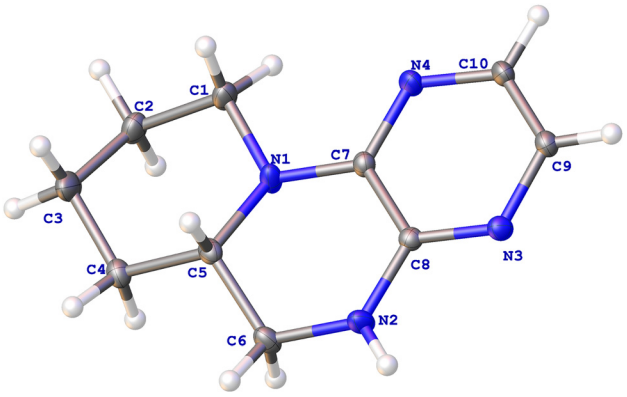

Table 1: Data collection and handling.

Crystal:	Colorless block
Size:	0.14 × 0.13 × 0.10 mm
Wavelength:	Cu *K*α radiation (1.54184 Å)
μ:	0.65 mm^{-1}
Diffractometer, scan mode:	SuperNova, ω
θ_{max}, completeness:	66.6°, >99 %
$N(hkl)_{measured}$, $N(hkl)_{unique}$, R_{int}:	8924, 3455, 0.087
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 3149
$N(param)_{refined}$:	281
Programs:	CrysAlis^{PRO} [1], Olex2 [2], SHELX [3], WinGX/ORTEP [4]

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Abstract

$C_{10}H_{14}N_4$, orthorhombic, *Pbca* (no. 61), a = 15.5356(2) Å, b = 9.8551(2) Å, c = 25.5551(4) Å, V = 3912.61(11) Å^3, Z = 16, $R_{gt}(F)$ = 0.0873, $wR_{ref}(F^2)$ = 0.2481, T = 150 K.

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Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

1 Source of materials

2–Piperidylmethylamine (20 g, 175 mmol), K_2CO_3 (28.75 g, 202 mmol) were added into a round bottom flask. 2,3–Dichloropyrazine (39 g, 261 mmol) was added after the solid dissolved in 250 ml DMF. The mixture was stirred at 120 °C in nitrogen atmosphere for 8 h. After cooling to room temperature, the solution was poured into 500 ml water and stirred. The organic phase was extracted three times with ethyl acetate (EA), and 20 % HCL solution was added. After mixing, the aqueous phase was kept, and the pH was adjusted to alkaline by adding NaOH solution, then extracted three times with EA, dried with Na_2SO_4 and concentrated under reduced pressure. After separation and purification, 14.3 g pink solid was obtained (yield 43 %). Crystals were grown by slow crystallization in EA solution of the product.

2 Experimental details

Using Olex2, the structure was solved with SHELXT program and refined with the SHELXT refinement package [2, 3]. The crystal structure of title compound was visualized using Ortep3 software [4]. All hydrogen atoms were placed in their geometrically idealized positions.

3 Comment

Tetrazanbigen (TNBG) is a novel non-cytotoxic antitumor drug with innovative compound, which has good *in vitro* and *in vivo* anti-tumor activity [5]. Based on SAR, our research team has reported a series of derivatives with improved physical properties and biological effect comparing to TNBG [6, 7]. TNBG is a compound composed of quinoxaline and tetrahydroisoquinoline as the core and five rings closely connected. In order to reduce the molecular weight and structural rigidity, attempts were made to improve the pharmacological effects of TNBG by removing two benzene rings [8]. Therefore, the synthesized title compound has excellent water solubility and convenient synthetic route, and has excellent antitumor activity, and it is also a new

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

Atom	*x*	*y*	*z*	U_{iso}*/U_{eq}
N1	0.62135 (18)	0.2746 (2)	0.07777 (10)	0.0402 (7)
N2	0.63282 (19)	0.1625 (3)	0.17768 (9)	0.0423 (7)
H2	0.641202	0.126181	0.208721	0.051*
N3	0.59840 (16)	−0.0487 (2)	0.14472 (9)	0.0342 (6)
N4	0.58823 (17)	0.0604 (3)	0.04440 (9)	0.0391 (6)
C1	0.6236 (2)	0.3235 (3)	0.02374 (12)	0.0428 (8)
H1AA[a]	0.575927	0.281556	0.003748	0.051*
H1AB[a]	0.678474	0.295826	0.007232	0.051*
H1BC[b]	0.646314	0.249066	0.001722	0.051*
H1BD[b]	0.563362	0.339483	0.012645	0.051*
C2[a]	0.6151 (4)	0.4786 (5)	0.02138 (18)	0.0464 (13)
H2A[a]	0.625685	0.508961	−0.014982	0.056*
H2B[a]	0.555401	0.504102	0.030690	0.056*
C3	0.6732 (3)	0.5480 (3)	0.05555 (14)	0.0595 (11)
H3AA[a]	0.661669	0.646710	0.054036	0.071*
H3AB[a]	0.733072	0.532651	0.043587	0.071*
H3BC[b]	0.728193	0.598451	0.052978	0.071*
H3BD[b]	0.626399	0.613811	0.048797	0.071*
C4	0.6641 (2)	0.4996(3)	0.11112 (12)	0.0375 (7)
H4AA[a]	0.608141	0.531637	0.124884	0.045*
H4AB[a]	0.709942	0.542273	0.132434	0.045*
H4BC[b]	0.629098	0.566260	0.130771	0.045*
H4BD[b]	0.721916	0.496975	0.127422	0.045*
C5[a]	0.6690 (4)	0.3482 (4)	0.11838 (16)	0.0314 (10)
H5[a]	0.730947	0.322071	0.114763	0.038*
C6	0.6411 (2)	0.3053 (3)	0.17126 (11)	0.0385 (7)
H6AA[a]	0.683157	0.339504	0.197189	0.046*
H6AB[a]	0.584902	0.348159	0.179039	0.046*
H6BC[b]	0.700399	0.331442	0.181195	0.046*
H6BD[b]	0.601415	0.350208	0.196135	0.046*
C7	0.60742 (17)	0.1382 (3)	0.08476 (10)	0.0293 (6)
C8	0.61208 (16)	0.0812 (3)	0.13641 (10)	0.0278 (6)
C9	0.57916 (18)	−0.1266 (3)	0.10235 (11)	0.0338 (7)
H9	0.569008	−0.220861	0.107003	0.041*
C10	0.5741 (2)	−0.0728 (3)	0.05370 (12)	0.0378 (7)
H10	0.560266	−0.130566	0.025164	0.045*
C22[b]	0.6230 (11)	0.3609 (13)	0.1166 (5)	0.027 (3)
H22[b]	0.560745	0.385500	0.119544	0.033*
C23[b]	0.6718 (13)	0.4434 (14)	0.0115 (5)	0.044 (4)
H23A[b]	0.646819	0.485934	−0.020139	0.053*
H23B[b]	0.731729	0.417046	0.003153	0.053*
N5	0.40075 (15)	0.4588 (2)	0.11606 (9)	0.0327 (6)
N6	0.42043 (18)	0.5495 (2)	0.21880 (10)	0.0399 (6)
N7	0.3930 (2)	0.3325 (3)	0.24857 (10)	0.0588 (9)
H7	0.408904	0.357010	0.280232	0.071*
N8	0.36675 (15)	0.2422(2)	0.14650 (9)	0.0326 (6)
C11	0.42026 (18)	0.5888 (3)	0.12749 (11)	0.0340 (6)
H11	0.427727	0.651320	0.099544	0.041*
C12	0.4296 (2)	0.6338 (3)	0.17715 (11)	0.0365 (7)
H12	0.442972	0.726579	0.183042	0.044*
C13	0.40054 (19)	0.4217 (3)	0.20854 (11)	0.0340 (7)
C14	0.39010 (16)	0.3738 (3)	0.15569 (10)	0.0268 (6)
C15	0.3597(2)	0.2000(3)	0.24031(12)	0.0413(8)
H15A	0.296879	0.201660	0.246788	0.050*
H15B	0.385784	0.137992	0.266345	0.050*
C16	0.3752 (3)	0.1437 (3)	0.18705 (14)	0.0611 (11)
H16	0.437750	0.119882	0.186940	0.073*
C17	0.3309 (2)	0.0131 (3)	0.17791 (13)	0.0430 (8)
H17A	0.269779	0.023339	0.188148	0.052*
H17B	0.356712	−0.056049	0.201236	0.052*
C18	0.3342 (3)	−0.0395 (3)	0.12249 (14)	0.0489 (8)
H18A[a]	0.391795	−0.078637	0.115782	0.059*
H18B[a]	0.291234	−0.113016	0.118445	0.059*
H18C[b]	0.364357	−0.127955	0.122685	0.059*
H18D[b]	0.274432	−0.056266	0.110618	0.059*
C19[a]	0.3164 (3)	0.0686 (4)	0.08285 (16)	0.0393 (12)
H19A[a]	0.254355	0.091108	0.083662	0.047*
H19B[a]	0.329944	0.032915	0.047580	0.047*
C20	0.36741 (19)	0.1954 (3)	0.09190 (11)	0.0356 (7)
H20A[a]	0.427735	0.179058	0.081118	0.043*
H20B[a]	0.344030	0.268305	0.069358	0.043*
H20C[b]	0.416846	0.237296	0.073556	0.043*
H20D[b]	0.314138	0.226812	0.074433	0.043*
C21[b]	0.3736 (10)	0.0428 (13)	0.0867 (5)	0.037 (3)
H21A[b]	0.350521	0.018502	0.051801	0.044*
H21B[b]	0.435470	0.019023	0.086531	0.044*

[a]Occupancy: 0.756(8), [b]Occupancy: 0.244(8).

compound that has not been reported. The single crystal structure verifies that all bond lengths and angles are within the expected range [9].

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