Huanhuan Yang, Fanyu Shi, Qingqing Xu, Jinghai Wang and Ai-Ping Xing*

Crystal structure of (*E*)-2-((2-(pyrimidin-2-yl)hydrazono)methyl)quinolin-1-ium perchlorate – methanol (1/1), C₁₅H₁₆N₅O₅Cl

Table 1: Data collection and handling.

Crystal:	Yellow cube
Size:	0.20 × 0.10 × 0.10 mm
Wavelength:	Cu K α radiation (1.54184 Å)
μ :	2.39 mm ⁻¹
Diffractometer, scan mode:	SuperNova, ω
$\theta_{\max}$, completeness:	74.8°, >99%
$N(hkl)_{\text{measured}}$, $N(hkl)_{\text{unique}}$, R_{int} :	6479, 3313, 0.018
Criterion for I_{obs} , $N(hkl)_{\text{gt}}$:	$I_{\text{obs}} > 2 \sigma(I_{\text{obs}})$, 3022
$N(\text{param})_{\text{refined}}$:	241
Programs:	CrysAlis ^{PRO} [1], Olex2 [2], SHELX [3, 4]

<https://doi.org/10.1515/ncrs-2019-0873>

Received November 29, 2019; accepted January 13, 2020; available online March 25, 2020

Abstract

C₁₅H₁₆N₅O₅Cl, monoclinic, $P2_1/n$ (no. 14), $a = 7.37210(10)$ Å, $b = 13.30639(19)$ Å, $c = 17.1682(2)$ Å, $\beta = 97.2301(12)^\circ$, $Z = 4$, $V = 1670.74(4)$ Å³, $R_{\text{gt}}(F) = 0.0357$, $wR_{\text{ref}}(F^2) = 0.1023$, $T = 173(1)$ K.

CCDC no.: 1977198

The asymmetric unit of the title crystal structure is shown in the figure. Tables 1 and 2 contain details of the measurement method and a list of the atoms including atomic coordinates and displacement parameters.

Source of material

All chemicals were of reagent grade and used without further purification. The title compound was synthesized according to the relevant literature [5].

The synthesis of the intermediate 2-hydrazinopyrimidine: 2-chloropyrimidine (20 mmol, 2.29 g) was dissolved in

Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²).

Atom	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
Cl1	0.57731(5)	0.53745(3)	0.84240(2)	0.02563(13)
O1	0.6532(2)	0.47832(11)	0.90768(8)	0.0467(4)
O2	0.52243(19)	0.47407(10)	0.77588(7)	0.0424(3)
O3	0.42113(18)	0.59200(10)	0.86131(9)	0.0456(3)
O4	0.71333(17)	0.60872(10)	0.82253(7)	0.0364(3)
O5	0.59300(17)	0.64623(9)	0.43948(6)	0.0330(3)
H5B	0.5737	0.6835	0.4756	0.049*
C15	0.5755(3)	0.70157(14)	0.36811(9)	0.0355(4)
H15A	0.6251	0.6631	0.3285	0.053*
H15B	0.6408	0.7639	0.3762	0.053*
H15C	0.4486	0.7151	0.3515	0.053*
N1	0.51510(17)	0.78806(10)	0.55241(7)	0.0258(3)
N2	0.51253(19)	0.84204(11)	0.68570(8)	0.0297(3)
N3	0.63795(17)	0.69064(10)	0.65879(7)	0.0257(3)
H3	0.6661	0.6823	0.7085	0.031*
N4	0.67750(16)	0.61947(10)	0.60863(7)	0.0234(3)
N5	0.76895(16)	0.47665(9)	0.50539(7)	0.0209(3)
C1	0.4247(2)	0.87224(12)	0.52842(9)	0.0290(3)
H1	0.3954	0.8830	0.4748	0.035*
C2	0.3733(2)	0.94339(13)	0.57962(10)	0.0317(4)
H2	0.3087	1.0008	0.5621	0.038*
C3	0.4233(2)	0.92465(13)	0.65863(10)	0.0325(4)
H3A	0.3932	0.9720	0.6947	0.039*
C4	0.5517(2)	0.77768(12)	0.63038(9)	0.0242(3)
C5	0.7544(2)	0.53839(12)	0.63682(9)	0.0252(3)
H5A	0.7777	0.5287	0.6908	0.030*
C6	0.80431(19)	0.46239(11)	0.58312(9)	0.0231(3)

*Corresponding author: Ai-Ping Xing, Henan University of Chinese Medicine, Zhengzhou 450046, P.R. China, e-mail: hnxap@hactcm.edu.cn. <https://orcid.org/0000-0002-3173-7430>

Huanhuan Yang, Fanyu Shi, Qingqing Xu and Jinghai Wang: Henan University of Chinese Medicine, Zhengzhou 450046, P.R. China

Table 2 (continued)

Atom	<i>x</i>	<i>y</i>	<i>z</i>	<i>U</i> _{iso} [*] / <i>U</i> _{eq}
C7	0.8932(2)	0.37398(12)	0.61188(9)	0.0274(3)
H7	0.9169	0.3631	0.6657	0.033*
C8	0.9446(2)	0.30409(12)	0.56066(10)	0.0286(3)
H8	1.0043	0.2459	0.5799	0.034*
C9	0.90804(19)	0.31946(11)	0.47871(9)	0.0251(3)
C10	0.9560(2)	0.24869(12)	0.42337(10)	0.0309(3)
H10	1.0182	0.1903	0.4403	0.037*
C11	0.9109(2)	0.26629(13)	0.34499(10)	0.0336(4)
H11	0.9420	0.2195	0.3087	0.040*
C12	0.8175(2)	0.35476(13)	0.31860(9)	0.0316(4)
H12	0.7874	0.3653	0.2650	0.038*
C13	0.7702(2)	0.42562(12)	0.37040(9)	0.0267(3)
H13	0.7097	0.4841	0.3524	0.032*
C14	0.81479(19)	0.40814(11)	0.45139(9)	0.0221(3)
H5	0.718(3)	0.5315(16)	0.4874(13)	0.041(6)*

absolute ethanol (30 mL). Then, excess hydrazine hydrate (8 mL, 80%) was added to the solution under stirring; a pale yellow solution formed immediately, accompanied with the release of heat. About 2 h later, colorless needle crystals appeared. The crystals were filtered and purified by recrystallization in ethanol. Yield: ca. 80%.

The synthesis of the target compound: 2-hydrazinopyrimidine (10 mmol, 1.10 g) was dissolved in absolute ethanol, furthermore 2-quinolinecarboxaldehyde (10 mmol, 1.57 g) and 2-hydrazinopyrimidine (10 mmol, 1.10 g) were dissolved in ethanol, respectively. And then, both solutions were mixed and reacted by reflux for 6 h to form a bright yellow solution. The pale yellow powder appeared by vacuum distillation and filtration. Yield: ca. 65%. The yellow powder (0.1 mmol, 24.9 mg) was dissolved in methanol to form a solution, and then a drop of perchloric acid was added. This solution was filtered and evaporated slowly at room temperature. A few days later, pale yellow crystals appeared. Yield: ca. 70%.

Experimental details

The H atoms were added geometrically using riding models and refined isotropically. Their *U*_{iso} values were set to 1.2*U*_{eq} of the parent C and N atoms, and 1.5*U*_{eq} of the parent O atoms.

Comment

As far as we know, pyrimidine derivatives have biological activities, such as anti-tumor, bactericidal, insecticidal and plant growth promotion. They are important pharmaceutical intermediates [6–9]. Quinoline derivatives have also attracted great interest for the variety of biological activities such as antibacterial and anticancer activities [10, 11]. Moreover, the nitrogen atoms of the quinoline and pyrimidine derivatives

have strong coordination ability to transition metals and rare-earth metals [12, 13].

The asymmetric unit of the title compound contains one organic cation, one perchlorate anion and one methanol molecule (see the figure). The C=N bond length of the title compound is 1.285(2) Å, which proved that the synthesis of title compound was successful. All geometric parameters are in the expected ranges [14, 15]. The nitrogen atom of quinoline section got a proton from perchloric acid in solution and formed a cationic structure. The dihedral angle between the quinoline plane and the pyrimidine plane is 1.33°. Abundant hydrogen bonds are formed between adjacent molecules through perchlorate anions and solvent methanol molecules as well.

References

1. Rigaku Oxford Diffraction. *CrysAlis Pro* Software system, version 1.171.38.43f. Rigaku Oxford Diffraction (2015).
2. Dolomanov, O. V.; Bourhis, L. J.; Gildea, R. J.; Howard, J. A. K.; Puschmann, H.: OLEX2: a complete structure solution, refinement and analysis program. *J. Appl. Crystallogr.* **42** (2009) 339–341.
3. Sheldrick, G. M.: Crystal structure refinement with SHELXL. *Acta Crystallogr.* **C71** (2015) 3–8.
4. Sheldrick, G. M.: SHELXT-integrated space-group and crystal-structure determination. *Acta Crystallogr.* **A71** (2015) 3–8.
5. Yuan, J.; Chu, Y.-X.; Kou, H.-Z.: Synthesis, crystal structures, and magnetic properties of methoxido-bridged dinuclear MnIII complexes derived from tri-dentate chelating ligands. *J. Coord. Chem.* **69** (2016) 1218–1225.
6. Dehnhardt, C. M.; Venkatesan, A. M.; Santos, E. D.; Chen, Z.; Santos, O.; Ayril-Kaloustian, S.; Brooijmans, N.; Mallon, R.; Hollander, I.; Feldberg, L.; Lucas, J.; Chaudhary, I.; Yu, K.; Gibbons, J.; Abraham, R.; Mansour, T. S.: Lead optimization of *N*-3-substituted 7-morpholinotriazolopyrimidines as dual phosphoinositide 3-kinase/mammalian target of rapamycin inhibitors: discovery of PKI-402. *J. Med. Chem.* **53** (2010) 798–810.
7. Li, Z. H.; Liu, X. Q.; Geng, P. F.; Suo, F. Z.; Ma, J. L.: Discovery of [1,2,3]triazolo[4,5-*d*]pyrimidine derivatives as novel LSD1 inhibitors. *ACS Med. Chem. Lett.* **8** (2017) 384–389.
8. Yu, W.; Goddard, C.; Clearfield, E.; Mills, C.; Xiao, T.; Guo, H.; Morrey, J. D.; Motter, N. E.; Zhao, K.; Block, T. M.; Cuconati, A.; Xu, X.: Design, synthesis, and biological evaluation of triazolo-pyrimidine derivatives as novel inhibitors of hepatitis B virus surface antigen (HBsAg) secretion. *J. Med. Chem.* **54** (2011) 5660–5670.
9. Baraldi, P. G.; Cacciari, B.; Moro, S.; Spalluto, G.; Pastorin, G.; Ros, T. D.; Klotz, K.-N.; Varani, K.; Gessi, S.; Borea, P. A.: Synthesis, biological activity, and molecular modeling investigation of new pyrazolo[4,3-*e*]-1,2,4-triazolo[1,5-*c*]pyrimidine derivatives as human A₃ adenosine receptor antagonists. *J. Med. Chem.* **45** (2002) 770–780.

10. Ding, W. Q.; Liu, B.; Vaught, J. L.; Yamauchi, H.; Lind, S. E.: Anticancer activity of the antibiotic clioquinol. *Cancer Res.* **65** (2005) 3389–3395.
11. Jiang, H.; Taggart, J. E.; Zhang, X.; Benbrook, D. M.; Lind, S. E.; Ding, W.-Q.: Nitroxoline (8-hydroxy-5-nitroquinoline) is more a potent anti-cancer agent than clioquinol(5-chloro-7-iodo-8-quinoline). *Cancer Lett.* **312** (2011) 11–17.
12. Tardito, S.; Barilli, A.; Bassanetti, I.; Tegoni, M.; Bussolati, O.; Franchi-Gazzola, R.; Mucchino, C.; Marchio, L.: Copper-dependent cytotoxicity of 8-hydroxyquinoline derivatives correlates with their hydrophobicity and does not require caspase activation. *J. Med. Chem.* **55** (2012) 10448–10459.
13. Qin, Q.-P.; Chen, Z.-F.; Qin, J.-L.; He, X.-J.; Li, Y.-L.; Liu, Y.-C.; Huang, K.-B.; Liang, H.: Studies on antitumor mechanism of two planar platinum(II) complexes with 8-hydroxyquinoline: synthesis, characterization, cytotoxicity, cell cycle and apoptosis. *Eur. J. Med. Chem.* **92** (2015) 302–313.
14. Buvaylo, E. A.; Kokozay, V. N.; Yu. Vassilyeva, O.; Skelton, B. W.; Nesterova, O. V.; Pombeiro, A. J. L.: Copper(II) complex of the 2-pyridinecarbaldehyde aminoguanidine Schiff base: crystal structure and catalytic behaviour in mild oxidation of alkanes. *Inorg. Chem. Commun.* **78** (2017) 85–90.
15. Valdes-Martinez, J.; Alstrum-Acevedo, J. H.; Toscano, R. A.; Espinosa-Perez, G.; Helfrich, B. A.; West, D. X.: Bis(2-pyridiniomethyleneaminoguanidinium) *trans*-tetraaquadichloronickel(II) dichloride tetrahydrate. *Acta Crystallogr.* **E57** (2001) m137–m139.