Yi-Xin Chu*, Kai-Hao Li, Han-Huan Yang and Juan Yuan

Crystal structure of (*E*)-3',6'-bis(ethylamino)-2',7'-dimethyl-2-(2-((quinolin-2-ylmethylene)amino)ethyl)spiro[isoindoline-1,9'-xanthen]-3-one, C₃₈H₃₇N₅O₂

Table 1: Data collection and handling.

Crystal:	Yellow cube
Size:	0.30 × 0.20 × 0.10 mm
Wavelength:	Cu K α radiation (1.54184 Å)
μ :	0.65 mm ⁻¹
Diffractometer, scan mode:	SuperNova, ω
$\theta_{\max}$, completeness:	71.6°, >99%
$N(hkl)_{\text{measured}}$, $N(hkl)_{\text{unique}}$, R_{int} :	11880, 5759, 0.023
Criterion for I_{obs} , $N(hkl)_{\text{gt}}$:	$I_{\text{obs}} > 2 \sigma(I_{\text{obs}})$, 5054
$N(\text{param})_{\text{refined}}$:	414
Programs:	CrysAlis ^{PRO} [1], Olex2 [2], SHELX [3, 4]

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

Atom	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
O1	0.59614(7)	0.11687(6)	0.53780(7)	0.0331(2)
O2	0.41186(7)	0.45797(5)	0.58019(6)	0.0264(2)
N1	0.47335(9)	0.20742(7)	0.13535(8)	0.0288(3)
N2	0.61712(9)	0.26583(7)	0.35445(8)	0.0282(2)
N3	0.52523(7)	0.24299(6)	0.54671(7)	0.0199(2)
N4	0.57996(9)	0.48079(7)	0.90132(7)	0.0262(2)
H4	0.6090	0.4578	0.9530	0.031*
N5	0.23128(9)	0.46204(6)	0.26281(7)	0.0261(2)
H5	0.2098	0.4363	0.2104	0.031*
C1	0.47825(11)	0.16150(8)	0.05360(9)	0.0287(3)
C2	0.40078(12)	0.16887(9)	−0.02498(11)	0.0366(3)
H2	0.3451	0.2011	−0.0182	0.044*
C3	0.40725(14)	0.12901(10)	−0.11058(11)	0.0431(4)
H3	0.3559	0.1344	−0.1618	0.052*
C4	0.49045(14)	0.08003(10)	−0.12227(11)	0.0429(4)
H4A	0.4951	0.0546	−0.1818	0.051*
C5	0.56448(12)	0.06950(9)	−0.04686(11)	0.0383(4)
H5A	0.6183	0.0356	−0.0547	0.046*
C6	0.56065(11)	0.10949(8)	0.04333(10)	0.0304(3)
C7	0.63411(11)	0.10017(9)	0.12475(11)	0.0334(3)
H7	0.6878(13)	0.0623(11)	0.1201(12)	0.039(4)*
C8	0.62715(11)	0.14457(9)	0.20696(10)	0.0309(3)
H8	0.6741	0.1385	0.2617	0.037*
C9	0.54701(10)	0.20002(8)	0.20729(9)	0.0268(3)
C10	0.54393(10)	0.25788(8)	0.28808(9)	0.0271(3)
H10	0.4867	0.2894	0.2903	0.032*
C11	0.60798(10)	0.32734(8)	0.42799(9)	0.0270(3)
H11A	0.5443	0.3552	0.4136	0.032*

<https://doi.org/10.1515/ncrs-2020-0233>

Received May 16, 2020; accepted June 2, 2020; available online June 10, 2020

Abstract

C₃₈H₃₇N₅O₂, monoclinic, *P*₂₁/*n* (no. 14), *a* = 13.3575(2) Å, *b* = 16.6645(3) Å, *c* = 13.7678(2) Å, β = 96.4890(14)°, *Z* = 4, *V* = 3045.03(8) Å³, *R*_{gt}(*F*) = 0.0386, *wR*_{ref}(*F*²) = 0.1028, *T* = 116.2(4) K.

CCDC no.: 2007137

The asymmetric unit of the molecular structure is shown in the figure. Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

Source of material

All reagents and starting materials were commercially available and used as received. The title compound was

*Corresponding author: Yi-Xin Chu, Henan University of Chinese Medicine, Zhengzhou 450046, P.R. China, e-mail: cyxmz2011@126.com. <https://orcid.org/0000-0002-3872-4405>

Kai-Hao Li, Han-Huan Yang and Juan Yuan: 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}
H11B	0.6618	0.3662	0.4266	0.032*
C12	0.61351(9)	0.28921(8)	0.52919(9)	0.0239(3)
H12A	0.6720	0.2543	0.5380	0.029*
H12B	0.6234	0.3313	0.5779	0.029*
C13	0.52623(9)	0.16105(8)	0.55297(9)	0.0230(3)
C14	0.42819(9)	0.13739(7)	0.58508(8)	0.0223(3)
C15	0.38985(10)	0.06102(8)	0.59813(9)	0.0282(3)
H15	0.4255	0.0153	0.5841	0.034*
C16	0.29671(11)	0.05547(8)	0.63279(10)	0.0309(3)
H16	0.2693	0.0053	0.6428	0.037*
C17	0.24373(10)	0.12434(9)	0.65275(10)	0.0302(3)
H17	0.1816	0.1194	0.6766	0.036*
C18	0.28196(10)	0.20052(8)	0.63763(9)	0.0257(3)
H18	0.2459	0.2464	0.6503	0.031*
C19	0.37501(9)	0.20605(7)	0.60335(8)	0.0200(2)
C20	0.43277(9)	0.28105(7)	0.57964(8)	0.0192(2)
C21	0.46151(9)	0.33441(7)	0.66727(8)	0.0194(2)
C22	0.50652(9)	0.30226(7)	0.75580(8)	0.0198(2)
H22	0.5102	0.2467	0.7620	0.024*
C23	0.54560(9)	0.34837(7)	0.83398(8)	0.0202(2)
C24	0.53838(9)	0.43341(7)	0.82541(8)	0.0205(2)
C25	0.49035(9)	0.46671(7)	0.73975(9)	0.0225(3)
H25	0.4824	0.5220	0.7345	0.027*
C26	0.45421(9)	0.41735(7)	0.66202(8)	0.0212(2)
C27	0.37174(9)	0.41307(7)	0.50106(8)	0.0210(2)
C28	0.32571(9)	0.45790(8)	0.42324(9)	0.0230(3)
H28	0.3245	0.5136	0.4274	0.028*
C29	0.28136(9)	0.41976(7)	0.33887(8)	0.0208(2)
C30	0.28619(9)	0.33459(7)	0.33325(8)	0.0207(2)
C31	0.33254(9)	0.29329(7)	0.41238(8)	0.0204(2)
H31	0.3348	0.2376	0.4086	0.024*
C32	0.37660(9)	0.33006(7)	0.49832(8)	0.0195(2)
C33	0.59719(10)	0.31104(8)	0.92559(9)	0.0244(3)
H33A	0.5604	0.3236	0.9796	0.037*
H33B	0.6645	0.3317	0.9381	0.037*
H33C	0.5997	0.2539	0.9176	0.037*
C34	0.57705(9)	0.56747(8)	0.89810(9)	0.0235(3)
H34A	0.5080	0.5857	0.8975	0.028*
H34B	0.6021	0.5861	0.8386	0.028*
C35	0.64094(10)	0.60239(8)	0.98604(10)	0.0285(3)
H35A	0.7100	0.5871	0.9842	0.043*
H35B	0.6177	0.5823	1.0449	0.043*
H35C	0.6356	0.6598	0.9847	0.043*
C36	0.24188(10)	0.29165(8)	0.24233(9)	0.0251(3)
H36A	0.2798	0.3047	0.1893	0.038*
H36B	0.1731	0.3080	0.2262	0.038*
H36C	0.2444	0.2348	0.2535	0.038*
C37	0.21261(10)	0.54752(8)	0.26584(9)	0.0246(3)
H37A	0.2755	0.5764	0.2649	0.030*
H37B	0.1848	0.5610	0.3259	0.030*
C38	0.13987(12)	0.57220(9)	0.17922(11)	0.0361(3)
H38A	0.1691	0.5615	0.1200	0.054*
H38B	0.1257	0.6285	0.1833	0.054*
H38C	0.0784	0.5423	0.1792	0.054*

synthesized from rhodmine 6G by a simple two-step Schiff base condensation reaction according to the literature [5, 6]. In first step, the intermediate rhodmine 6G amide was prepared by Schiff base condensation reaction between rhodmine 6G and ethylenediamine. The title compound was got by mixing an equimolar 2-quinolinecarbaldehyde and rhodmine 6G amide obtained in the first step.

Rhodmine 6G (5 mmol, 2.395 g) was dissolved in ethanol (60 mL). An excess of ethylenediamine (3.0 mL) was then added dropwise under vigorous stirring at room temperature. After addition, the stirred mixture was heated to reflux for 6 h, during which the white precipitate appeared. The resulting precipitate was filtered and washed several times with ethanol-water (1:1, v/v) to obtain a white powder of the intermediate rhodamine 6G amide. Yield: ca. 80%.

The intermediate rhodmine 6G amide was condensed with equimolar 2-quinolinecarbaldehyde in boiling ethanol and refluxed for 6 h, during which a yellow powder appeared. The yellow powder was filtered off, washed with ethanol-water (1:1, v/v) to obtain the crude product of the title compound, which was purified by recrystallization. Yield: ca. 85%. Single crystals of the title compound were grown from a CH₂Cl₂/CH₃OH (1:1, v/v) solution by slow evaporation at room temperature. About one week later, light yellow cube crystals were obtained. Yield: ca. 60%.

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

It is well known that quinoline skeleton and its derivatives are important units existing widely in alkaloids. Quinoline derivatives have attracted much attention due to their potential functions in molecular probes, protein binding activities and anticancer activities etc. [7–10].

The title compound is probably the potential fluorescent probe, anticancer active substance or valuable ligand for transition metals. The asymmetric unit contains a neutral molecule in a ring-closed form. The amide C=O bond distance is 1.2255(16) Å, indicative of the keto form of the amide. The dihedral angle between the least-square plane of the benzamide and quinoline is 81.68°, which indicates that it is difficult for title compound to form chelate complexes in this ring-closed structure. The bond length of C10–N2 is 1.2675(17) Å, which shows the existence of the Schiff base C=N moiety. The hydrogen bond between adjacent molecules is very weak. Bond lengths are all in the expected ranges [11]. There are also no obvious pi-pi contacts.

References

1. Rigaku: 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. Yang, H.; Xu, Q.; Feng, H.; Yuan, J.: Crystal structure of (*E*)-*N'*-(1,8-dihydropyren-1-yl)-methylene)picolinohydrazide, $C_{23}H_{15}N_3O$. *Z. Kristallogr. NCS* **234** (2019) 1103–1104.
6. Yu, F.; Zhang, W.; Li, P.; Xing, Y.; Tong, L.; Ma, J.; Tang, B.: Cu^{2+} -selective naked-eye and fluorescent probe: its crystal structure and application in bioimaging. *Analyst* **134** (2009) 1826–1833.
7. Nolan, E. M.; Jaworski, J.; Okamoto, K.-I.; Hayashi, Y.; Sheng, M.; Lippard, S. J.: QZ1 and QZ2: rapid, reversible quinoline-derivatized fluoresceins for sensing biological Zn(II). *J. Am. Chem. Soc.* **127** (2005) 16812–16823.
8. Lu, J.; Li, J.-L.; Sun, Q.; Jiang, L.; Gu, W.; Liu, X.; Tian, J.-L.; Yan, S.-P.: Synthesis, characterization, and biological activities of two Cu(II) and Zn(II) complexes with one polyquinoline ligand. *Spectrochim. Acta, Part A* **130** (2014) 390–396.
9. Volynets, G. P.; Chekanov, M. O.; Synyugin, A. R.; Golub, A. G.; Kukharensko, O. P.; Bdzhola, V. G.; Yarmoluk, S. M.: Identification of 3*H*-naphtho[1,2,3-*de*]quinoline-2,7-diones as inhibitors of apoptosis signal-regulating kinase 1 (ASK1). *J. Med. Chem.* **54** (2011) 2680–2686.
10. El-Halim, H. F. A.; Mohamed, G. G.; Anwar, M. N.: Antimicrobial and anticancer activities of Schiff base ligand and its transition metal mixed ligand complexes with heterocyclic base. *Appl. Organometal Chem.* **32** (2018) 3899–3910.
11. Yuan, J.: Crystal structure of (*E*)-2-(3,6-bis(ethylamino)-2,7-dimethyl-9*H*-xanthen-9-yl)-*N'*-((6-methylpyridin-2-yl)methylene) benzohydrazide – methanol (1/1), $C_{34}H_{37}N_5O_3$. *Z. Kristallogr. NCS* **234** (2019) 1091–1093.