Crystal structure of 5-((4-chloropyridin-3-ylamino)methylene)-2,2-dimethyl-1,3-dioxane-4,6-dione, $C_{12}H_{11}ClN_2O_4$

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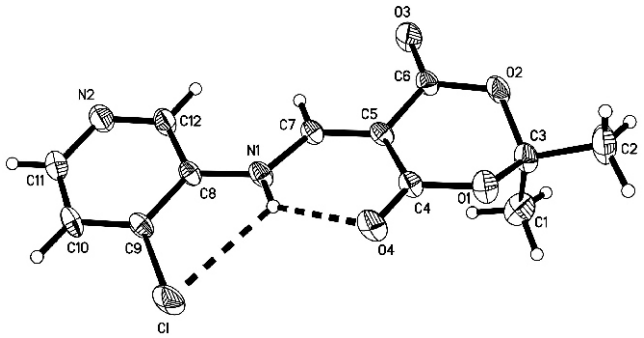

Abstract

$C_{12}H_{11}ClN_2O_4$, monoclinic, $P2_1/n$ (no. 14), a = 5.157(1) Å, b = 22.850(5) Å, c = 10.786(2) Å, β = 98.59(3)°, V = 1256.7 Å^3, Z = 4, $R_{gt}(F)$ = 0.064, $wR_{ref}(F^2)$ = 0.183, T = 295 K.

Source of material

A mixture of 2,2-dimethyl-1,3-dioxane-4,6-dione (1.72 g, 12.0 mmol) and triethyl orthoformate (14.45 g, 45.0 mmol) was refluxed for 3 h. Then 3-amino-4-chloropyridine (1.29 g, 10 mmol) was added and the mixture was heated at reflux under nitrogen for 4 h. The reaction proceeded by changing color from yellow to wine red accompanying the formation of yellow precipitate. After cooling to room temperature, the excess liquid triethyl orthoformate was removed by vacuum distillation. The resulting solid was purified by flash column chromatography (silica gel, ethyl acetate/dichloromethane: 1/1). After recrystallization from ethyl acetate, the product was obtained as colorless crystals.

Experimental details

All H atoms on C were placed in idealized positions and refined as riding atoms on their parent atoms with d(C—H) = 0.93 - 0.96 Å, U_{iso}(H) = 1.2 U_{eq}(C) and U_{iso}(H) = 1.5 U_{eq}(C_{methyl}). The H atom bonded to N1 was placed in a calculated position with d(N—H) = 0.86 Å, U_{iso}(H) = 1.2 U_{eq}(N).

Discussion

The title compound is an intermediate between phenoxyquinolines and naphthyridines known as inhibitors of kinases involved in angiogenesis [1,2].

In the title crystal structure, d(C5—C7) = 1.355(5) Å is in the range of a typical double bond (1.32 - 1.38 Å), d(C4—O4) = 1.220(4) Å and d(C6—O3) = 1.202(4) Å are in the range of a typical double bond (1.19 - 1.23 Å). The distances d(C6—O2) = 1.365(5) Å and d(C4—O1) = 1.339(4) Å are shorter than the standard C—O single bond (1.41 - 1.44 Å), but longer than a C=O double bond (1.19 -1.23 Å). This indicates that an sp^3 orbital of C4 is conjugated with the molecular orbital of the C5=C7 double bond, which was supported by the small torsion angles (–1.6(6)°) of C4–C5–C7–N1. The 1,3-dioxane moiety forms a dihedral angle of 10.67(6)° with the 3-amino-4-chloropyridine group.

Two independent hydrogen bonds generate a two-dimensional layer of edge-fused centrosymmetric rings running parallel to (100), with $R_2^2(8)$ rings built from pairs of C–H···N hydrogen bonds, and with $R_4^4(44)$ rings built from pairs of C–H···N and C–H···O hydrogen bonds. The resulting layer has a zigzag pattern along the [001] direction. The three-dimensional network is formed through intermolecular weak C–H···O, C–H···N hydrogen bonds which interlink molecules and stabilize the structure.

Table 1. Data collection and handling.

Crystal:	colorless block, size 0.20 × 0.20 × 0.30 mm
Wavelength:	Mo K_α radiation (0.71073 Å)
μ:	3.16 cm^{-1}
Diffractometer, scan mode:	Nonius CAD4, $\omega/2\theta$
$2\theta_{max}$:	50.52°
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	2539, 2276
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 1592
$N(param)_{refined}$:	172
Programs:	SHELXS-97, SHELXL-97, SHELXTL [3]

Table 2. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	x	y	z	U_{iso}
H(1A)	4*e*	0.6808	0.1241	0.5018	0.043
H(1B)	4*e*	0.5470	0.2350	0.8152	0.089
H(1C)	4*e*	0.7623	0.2815	0.8634	0.089
H(1D)	4*e*	0.5812	0.2562	0.9550	0.089
H(2B)	4*e*	1.1560	0.2480	1.0192	0.108
H(2C)	4*e*	1.1939	0.1808	1.0449	0.108
H(2D)	4*e*	0.9853	0.2158	1.1068	0.108
H(7A)	4*e*	0.3629	0.0782	0.6511	0.038
H(10A)	4*e*	0.3354	0.0678	0.1090	0.060
H(11A)	4*e*	0.0109	0.0019	0.1461	0.063
H(12A)	4*e*	0.1673	0.0278	0.5031	0.053

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Table 3. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	x	y	z	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
Cl	4*e*	0.6845(2)	0.13940(5)	0.2687(1)	0.0606(7)	0.0790(8)	0.0412(6)	–0.0158(6)	0.0285(5)	0.0061(5)
O(1)	4*e*	1.0091(5)	0.1885(1)	0.8184(2)	0.026(1)	0.069(2)	0.038(2)	–0.011(1)	0.014(1)	–0.008(1)
N(1)	4*e*	0.5485(6)	0.1036(1)	0.5159(3)	0.031(2)	0.052(2)	0.026(2)	–0.004(1)	0.010(1)	0.002(1)
C(1)	4*e*	0.6714(9)	0.2473(2)	0.8856(5)	0.060(3)	0.059(3)	0.066(3)	–0.004(2)	0.034(2)	–0.016(2)
O(2)	4*e*	0.7371(6)	0.1462(1)	0.9523(2)	0.057(2)	0.065(2)	0.024(1)	–0.019(2)	0.010(1)	0.003(1)
N(2)	4*e*	0.0587(7)	0.0091(2)	0.3276(3)	0.059(2)	0.059(2)	0.037(2)	–0.013(2)	0.005(2)	–0.001(2)
C(2)	4*e*	1.068(1)	0.2121(3)	1.0332(4)	0.071(3)	0.107(4)	0.039(2)	–0.041(3)	0.006(2)	–0.014(3)
O(3)	4*e*	0.4304(6)	0.0814(1)	0.8848(3)	0.073(2)	0.073(2)	0.036(2)	–0.032(2)	0.027(2)	–0.002(1)
C(3)	4*e*	0.8651(8)	0.1990(2)	0.9221(3)	0.039(2)	0.065(3)	0.027(2)	–0.015(2)	0.017(2)	–0.006(2)
O(4)	4*e*	0.9758(5)	0.1643(1)	0.6194(2)	0.033(1)	0.072(2)	0.034(1)	–0.006(1)	0.022(1)	0.002(1)
C(4)	4*e*	0.8855(6)	0.1607(2)	0.7174(3)	0.021(2)	0.048(2)	0.027(2)	–0.001(2)	0.009(1)	0.001(2)
C(5)	4*e*	0.6541(7)	0.1265(2)	0.7335(3)	0.029(2)	0.043(2)	0.025(2)	0.001(2)	0.013(1)	0.003(2)
C(6)	4*e*	0.5904(7)	0.1156(2)	0.8581(3)	0.038(2)	0.046(2)	0.026(2)	–0.002(2)	0.012(2)	0.000(2)
C(7)	4*e*	0.5056(7)	0.1002(2)	0.6348(3)	0.028(2)	0.042(2)	0.028(2)	0.002(2)	0.013(1)	0.000(2)
C(8)	4*e*	0.3991(7)	0.0769(2)	0.4118(3)	0.035(2)	0.045(2)	0.024(2)	0.001(2)	0.011(1)	0.001(2)
C(9)	4*e*	0.4487(7)	0.0886(2)	0.2915(3)	0.039(2)	0.049(2)	0.027(2)	0.002(2)	0.015(2)	0.002(2)
C(10)	4*e*	0.3043(9)	0.0606(2)	0.1904(4)	0.062(3)	0.066(3)	0.024(2)	0.002(2)	0.016(2)	–0.006(2)
C(11)	4*e*	0.1089(9)	0.0208(2)	0.2138(4)	0.065(3)	0.057(3)	0.034(2)	–0.005(2)	0.006(2)	–0.008(2)
C(12)	4*e*	0.2015(8)	0.0364(2)	0.4228(4)	0.047(2)	0.057(3)	0.029(2)	–0.013(2)	0.008(2)	–0.003(2)

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