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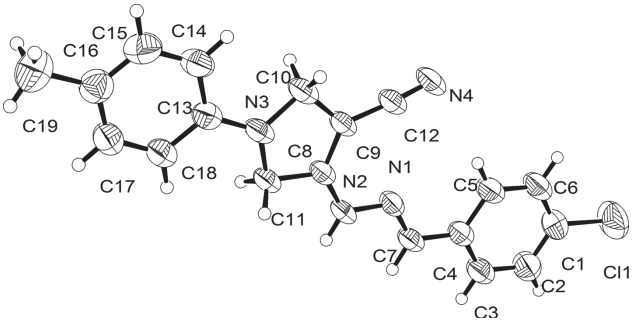
Gamal A. El-Hiti*, Bakr F. Abdel-Wahab, Mohammed Baashen, Amany S. Hegazy and Benson M. Kariuki

Crystal structure of (*Z*)-4-((*E*)-(4-chlorobenzylidene)hydrazono)-1-*p*-tolylpyrrolidine-3-carbonitrile, $C_{19}H_{17}ClN_4$



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Abstract

$C_{19}H_{17}ClN_4$, triclinic, $P\bar{1}$ (no. 2), $a = 6.9042(5)$ Å, $b = 7.1990(5)$ Å, $c = 18.2633(13)$ Å, $\alpha = 86.727(6)°$, $\beta = 79.214(6)°$, $\gamma = 69.876(7)°$, $V = 837.25(11)$ Å^3, $Z = 2$, $R_{gt}(F) = 0.0553$, $wR_{ref}(F^2) = 0.1406$, $T = 296(2)$ K.

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The 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.

Table 1: Data collection and handling.

Crystal:	Colourless plate
	Size 0.21 × 0.18 × 0.05 mm
Wavelength:	Mo *Kα* radiation (0.71073 Å)
μ:	2.4 cm^{-1}
Diffractometer, scan mode:	SuperNova, ω-scans
$2\theta_{max}$, completeness:	59.6°, >83%
$N(hkl)_{measured}$, $N(hkl)_{unique}$, R_{int}:	8852, 3988, 0.028
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 2319
$N(param)_{refined}$:	218
Programs:	CrysAlis^{PRO} [12], SHELX [13], WinGX [14]

Source of material

(*Z*)-4-((*E*)-(4-chlorobenzylidene)hydrazono)-1-*p*-tolylpyrrolidine-3-carbonitrile was synthesized from reaction of equimolar quantities of 4-hydrazono-1-*p*-tolylpyrrolidine-3-carbonitrile and 4-chorobenzaldehyde in ethanol in the presence of few drops of glacial acetic acid under reflux for 1 h. The solid produced was filtered, dried and recrystallized from dimethylformamide to give colourless crystals of the title compound (Mp 210–211 °C) [1].

Experimental details

All hydrogen atoms were placed in calculated positions and refined using a riding model. Methylene C—H bonds were fixed at 0.97 Å and methyl C—H bonds at 0.96 Å with $1.5U_{eq}$(C). Methyl groups were allowed to spin about the C—C bond. Aromatic C—H distances were set to 0.93 Å and N—H set to 0.86 Å with U_{iso} set to $1.2U_{eq}$ (N/C).

Discussion

The most efficient syntheses of pyrrolidines involve reactions of primary amines with diols in the presence of a metal complex catalyst [2, 3], of primary amines with dihaloalkanes in the presence of potassium carbonate under microwave conditions [4], of cyclization of amino alcohols in the presence of thionyl chloride [5] and of *N*-tosylhydrazones with vinyl iodides in the presence of a Pd-catalyst [6]. They can be

***Corresponding author: Gamal A. El-Hiti,** Cornea Research Chair, Department of Optometry, College of Applied Medical Sciences, King Saud University, P.O. Box 10219, Riyadh 11433, Saudi Arabia, e-mail: gelhiti@ksu.edu.sa
Bakr F. Abdel-Wahab: Department of Chemistry, College of Science and Humanities, Shaqra University, Duwadimi, Saudi Arabia; and Applied Organic Chemistry Department, National Research Centre, Dokki, Giza, Egypt
Mohammed Baashen: Department of Chemistry, College of Science and Humanities, Shaqra University, Duwadimi, Saudi Arabia
Amany S. Hegazy and Benson M. Kariuki: School of Chemistry, Cardiff University, Main Building, Park Place, Cardiff CF10 3AT, UK

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

Atom	*x*	*y*	*z*	U_{iso}*/U_{eq}
C1	0.2692(4)	0.4285(4)	0.36369(14)	0.0644(7)
C2	0.0725(4)	0.4147(4)	0.37520(14)	0.0674(7)
H2	−0.0093	0.4324	0.4226	0.081*
C3	−0.0015(4)	0.3742(4)	0.31516(13)	0.0609(6)
H3	−0.1349	0.3650	0.3225	0.073*
C4	0.1176(3)	0.3468(3)	0.24428(12)	0.0488(5)
C5	0.3180(3)	0.3591(4)	0.23488(13)	0.0598(6)
H5	0.4019	0.3394	0.1878	0.072*
C6	0.3924(4)	0.4002(4)	0.29443(14)	0.0693(7)
H6	0.5260	0.4087	0.2877	0.083*
C7	0.0339(3)	0.3141(3)	0.18069(12)	0.0495(5)
H7	−0.1020	0.3116	0.1874	0.059*
C8	0.1742(3)	0.2465(3)	−0.01152(12)	0.0429(5)
C9	0.3736(3)	0.2436(3)	−0.03389(12)	0.0464(5)
C10	0.4383(3)	0.2147(4)	−0.11651(13)	0.0543(6)
H10A	0.4883	0.3187	−0.1393	0.065*
H10B	0.5469	0.0874	−0.1290	0.065*
C11	0.0826(3)	0.2213(3)	−0.07661(11)	0.0460(5)
H11A	0.0568	0.0967	−0.0742	0.055*
H11B	−0.0476	0.3288	−0.0791	0.055*
C12	0.5147(3)	0.2577(3)	0.01114(13)	0.0498(5)
C13	0.2382(3)	0.1710(3)	−0.21074(12)	0.0498(5)
C14	0.4040(4)	0.1529(4)	−0.26947(14)	0.0620(6)
H14	0.5249	0.1710	−0.2608	0.074*
C15	0.3916(4)	0.1082(4)	−0.34065(15)	0.0723(7)
H15	0.5052	0.0965	−0.3788	0.087*
C16	0.2154(4)	0.0804(4)	−0.35716(14)	0.0654(7)
C17	0.0522(4)	0.0980(3)	−0.29824(13)	0.0604(6)
H17	−0.0681	0.0794	−0.3072	0.072*
C18	0.0604(4)	0.1418(3)	−0.22680(13)	0.0543(6)
H18	−0.0533	0.1522	−0.1888	0.065*
C19	0.1986(5)	0.0364(5)	−0.43580(15)	0.0952(10)
H19A	0.2842	−0.0978	−0.4490	0.143*
H19B	0.2457	0.1245	−0.4701	0.143*
H19C	0.0553	0.0549	−0.4379	0.143*
N1	0.1460(3)	0.2890(3)	0.11594(10)	0.0474(4)
N2	0.0582(3)	0.2650(3)	0.05747(10)	0.0500(5)
H2A	−0.0673	0.2619	0.0645	0.060*
N3	0.2442(3)	0.2245(3)	−0.13973(10)	0.0552(5)
N4	0.6383(3)	0.2673(3)	0.04327(12)	0.0617(5)
Cl1	0.36114(14)	0.48795(15)	0.43835(4)	0.1048(3)

used as inhibitors for thrombin, and as antiarrhythmic and antihypertensive drugs [7–11].

The asymmetric unit comprises one molecule. The molecule is almost planar as the angle between the chlorobenzene and tolylpyrrolidine-carbonitrile groups is 7.52(6)° and between the latter group and the toluene group is 7.33(8)°. In the crystal, the molecules are linked by N—H···N hydrogen bonds to form chains aligned to [010]. For the hydrogen bond, the N2···N4 distance is 2.953(2) Å and the N2—H2a···N4 angle is 161.0°. A short Cl···Cl contact of 3.27 Å is observed in the structure.

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References

1. Abdalla, M. M.; Abdel-Wahab, B. F.; Amr, A. -G. E.: Synthesis and serotonin antagonist and antianexity activities of pyrrolidine derivatives from 4-hydrazinyl-1-*p*-substituted phenyl-2,5-dihydro-1*H*-pyrrole-3-carbonitriles. Monatsh. Chem. **140** (2009) 129–137.
2. Fujita, K.-I.; Fujii, T.; Yamaguchi, R.: Cp*Ir complex-catalyzed *N*-heterocyclization of primary amines with diols: a new catalytic system for environmentally benign synthesis of cyclic amines. Org. Lett. **6** (2004) 3525–3528.
3. Hamid, M. H. S. A.; Allen, C. L.; Lamb, G. W.; Maxwell, A. C.; Maytum, H. C.; Watson, A. J. A.; Williams, J. M. J.: Ruthenium-catalyzed *N*-alkylation of amines and sulfonamides using borrowing hydrogen methodology. J. Am. Chem. Soc. **131** (2009) 1766–1774.
4. Ju, Y.; Varma, R. S.: Aqueous *N*-heterocyclization of primary amines and hydrazines with dihalides: microwave-assisted syntheses of *N*-azacycloalkanes, isoindole, pyrazole, pyrazolidine, and phthalazine derivatives. J. Org. Chem. **71** (2006) 135–141.
5. Xu, F.; Simmons, B.; Reamer, R. A.; Corley, E.; Murry, J.; Tschaen, D.: Chlorination/cyclodehydration of amino alcohols with $SOCl_2$: an old Reaction revisited. J. Org. Chem. **73** (2008) 312–315.
6. Khanna, A.; Maung, C.; Johnson, K. R.; Luong, T. T.; Van Vranken, D. L.: Carbenylative amination with *N*-tosylhydrazones. Org. Lett. **14** (2012) 3233–3235.
7. Mack, H.; Pfeiffer, T.; Hornberger, W.; Böhm, H. J.; Höffken, H. W.: Design, synthesis and biological activity of novel rigid amidinophenylalanine derivatives as inhibitors of thrombin. J. Enzyme Inhib. **9** (1995) 73–86.
8. Adam, W.; Zhang, A.: High π-facial selectivity through chelation of magnesium ions in the DMD epoxidation of α,β-unsaturated imides with chiral pyrrolidinone auxiliaries. Eur. J. Org. Chem. **1** (2004) 147–152.
9. Amer, F. A.-K.; Hammouda, M.; El-Ahl, A.-A. S.; Abdel-Wahab, B. F.: Synthesis and reactions of 3-pyrrolidinones. J. Heterocycl. Chem. **45** (2008) 1549–1569.
10. Ha, Y. M; Kim, J.-A.; Park, Y. J.; Choi, Y. J.; Kim, J. M.; Chung, K. W.; Han, Y. K.; Park, J. Y.; Lee, J. Y.; Moon, H. R.; Chung, H. Y.: Synthesis and biological activity of hydroxy-benzylidenyl pyrrolidine-2,5-dione derivatives as new potent inhibitors of tyrosinase. Med. Chem. Commun. **2** (2011) 542–549.
11. Bini, D.; Cardona, F.; Forcella, M.; Parmeggiani, C.; Parenti, P.;Nicotra, F.; Cipolla, L.: Synthesis and biological evaluation of nojirimycinand pyrrolidine-based trehalase inhibitors. Beilstein J. Org. Chem. **8** (2012) 514–521.
12. Agilent. CrysAlis^{PRO}. Agilent Technologies, Yarnton, England, (2014).
13. Sheldrick, G. M.: A short history of SHELX. Acta Crystallogr. **A64** (2008) 112–122.
14. Farrugia, L. J.: WinGX and ORTEP for Windows: an update. J. Appl. Crystallogr. **45** (2012) 849–854.