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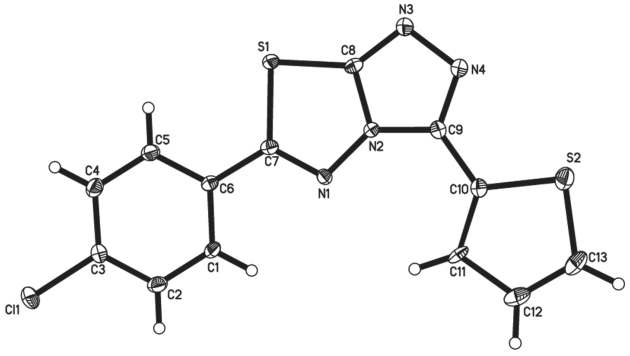
Crystal structure of 6-(4-chlorophenyl)-3-(thiophen-2-yl)-[1,2,4]triazolo[3,4-*b*][1,3,4]-thiadiazole, $C_{13}H_7ClN_4S_2$



DOI 10.1515/ncrs-2016-0010
Received January 5, 2016; accepted April 8, 2016; available online May 13, 2016

Abstract

$C_{13}H_7ClN_4S_2$, monoclinic, $P2_1/c$ (no. 14), $a = 10.2342(9)$ Å, $b = 11.9953(10)$ Å, $c = 12.0980(9)$ Å, $\beta = 116.283(6)°$, $V = 1331.6(2)$ Å^3, $Z = 4$, $R_{gt}(F) = 0.0573$, $wR_{ref}(F^2) = 0.1675$, $T = 100$ K.

CCDC no.: 1445311

Tables 1 and 2 contain details of the measurement method and a list of the atoms including atomic coordinates and displacement parameters.

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Table 1: Data collection and handling.

Crystal:	Colorless blocks size 0.34 × 0.30 × 0.28 mm
Wavelength: μ	Mo K_α radiation (0.71073 Å) 5.9 cm^{-1}
Diffractometer, scan mode:	Bruker Apex II, φ and ω
$2\theta_{max}$, completeness:	60.8°, >99%
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	3857, 3857
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\,\sigma(I_{obs})$, 2807
$N(param)_{refined}$:	290
Programs:	CrysAlis^{Pro} [16], SHELX [17]

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

Atom	*x*	*y*	*z*	U_{iso}*/U_{eq}
Cl1	−0.328078	−0.58567(6)	−0.37764(7)	0.01860(19)
S1	−0.08434(7)	−0.51774(6)	−0.83804(6)	0.01273(18)
S2	0.51224(8)	−0.78299(6)	−0.72424(7)	0.0193(2)
N1	0.0909(2)	−0.65736(19)	−0.6696(2)	0.0110(5)
N2	0.1404(2)	−0.63973(19)	−0.7567(2)	0.0107(5)
N3	0.1290(3)	−0.5601(2)	−0.9256(2)	0.0152(5)
N4	0.2539(3)	−0.6271(2)	−0.8725(2)	0.0145(5)
C1	−0.0618(3)	−0.6677(2)	−0.5241(3)	0.0149(6)
H1A	0.0141	−0.7176	−0.5074	0.018*
C2	−0.1305(3)	−0.6643(2)	−0.4486(3)	0.0164(6)
H2A	−0.1009	−0.7114	−0.3808	0.020*
C3	−0.2441(3)	−0.5901(2)	−0.4744(3)	0.0129(5)
C4	−0.2901(3)	−0.5189(2)	−0.5749(3)	0.0166(6)
H4A	−0.3663	−0.4693	−0.5912	0.020*
C5	−0.2208(3)	−0.5229(2)	−0.6508(3)	0.0155(6)
H5A	−0.2516	−0.4761	−0.7191	0.019*
C6	−0.1057(3)	−0.5963(2)	−0.6257(2)	0.0109(5)
C7	−0.0264(3)	−0.5976(2)	−0.7013(2)	0.0116(5)
C8	0.0648(3)	−0.5696(2)	−0.8531(2)	0.0120(5)
C9	0.2595(3)	−0.6735(2)	−0.7713(2)	0.0115(5)
C10	0.3733(3)	−0.7467(2)	−0.6883(2)	0.0121(5)
C11	0.3872(3)	−0.7935(2)	−0.5760(2)	0.0125(5)
H11A	0.3230	−0.7833	−0.5415	0.015*
C12	0.5190(3)	−0.8601(2)	−0.5245(3)	0.0203(7)
H12A	0.5503	−0.8981	−0.4501	0.024*
C13	0.5926(3)	−0.8622(3)	−0.5939(3)	0.0207(7)
H13A	0.6780	−0.9025	−0.5728	0.025*

Source of material

A mixture of 4-amino-5-(thiophen-2-yl)-4*H*-1,2,4-triazole-3-thiol (1.98 g, 0.01 mol), 4-chlorobenzoic acid (1.57 g, 0.01 mol) and phosphorous (V) oxychloride (10 mL) was heated under reflux for four hours and then distilled off *in vacuo*. The obtained residue was washed with saturated sodium hydrogen carbonate solution, with water, then dried and crystallized from ethanol to yield 2.61 g (82%) of the title compound. M.p. 495–497 K. Colourless block-shaped crystals were obtained by slow evaporation of chloroform-ethanol solution (1:1, 10 mL) at room temperature. ^{1}H NMR ($CDCl_3$, 500.13 MHz): δ 7.22 (t, 1H, thiophene-H, $J = 4.5$ Hz), 7.30 (d, 2H, Ar—H, $J = 7.5$ Hz), 7.45 (d, 2H, Ar—H, $J = 7.5$ Hz), 7.62 (d, 1H, thiophene-H, $J = 4.5$ Hz), 7.70 (d, 1H, thiophene-H, $J = 4.5$ Hz). ^{13}C NMR ($CDCl_3$, 125.76 MHz): δ 123.16, 126.66, 127.0, 128.02, 128.88, 129.28, 131.78, 142.96, 159.28, 161.06, 165.88.

Discussion

1,2,4-Triazoles and their condensed heterocyclic derivatives are known for their diverse biological activities [1–6]. Several 3,6-disubstituted-1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazoles were reported to exhibit significant antibacterial [7–10], pesticidal [11], anticancer [12], anti-inflammatory, analgesic and anti-oxidant [13] activities. In continuation to a previous interest in the chemical synthesis of 1,2,4-triazolo[3,4-*b*][1,3,4] thiadiazole [14, 15], we report herein the synthesis and X-ray characteristics of the title compound as potential bioactive agent.

The central [1,2,4]triazolo[3,4-*b*][1,3,4]thiadiazole ring (S1/C7-C9/N1-N4) is nearly planar and shows dihedral angles to the chlorophenyl (C1—C6) and thiophenyl (S2/C10—C13) ring of 8.05° and 2.61°, respectively.

Acknowledgements: This research project was supported by a grant from the Research Center of the Female Scientific and Medical Colleges, Deanship of Scientific Research, King Saud University.

References

1. El-Emam, A. A.; Ibrahim, T. M.: Synthesis, anti-inflammatory and analgesic activity of certain 3-(1-adamantyl)-4-substituted-5-mercapto-1,2,4-triazole derivatives. Arzneim.-Forsch./Drug Res. **41** (1991) 1260–1264.
2. Aboelmagd, A.; Ali, I. A. I.; Salem, E. M. S.; Abdel-Razik, M.: Synthesis and antifungal activity of some *s*-mercaptotriazolo benzothiazolyl amino acid derivatives. Eur. J. Med. Chem. **60** (2013) 503–511.
3. Chai, X.; Zhang, J.; Yu, S.; Hu, H.; Zou, Y.; Zhao, Q.; Dan, Z.; Zhang, D.; Wu, Q.: Design, synthesis, and biological evaluation of novel 1-(1*H*-1,2,4-triazole-1-yl)-2-(2,4-difluorophenyl)-3-substituted benzylamino-2-propanols. Bioorg. Med. Chem. Lett. **19** (2009) 1811–1814.
4. El-Emam, A. A.; Al-Tamimi, A. -M. S.; Al-Omar, M. A.; Al-Rashood, K. A.; Habib, E. E.: Synthesis and antimicrobial activity of novel 5-(1-adamantyl)-2-aminomethyl-4-substituted-1,2,4-triazoline-3-thiones. Eur. J. Med. Chem. **68** (2013) 96–102.
5. Luo, Y.; Zhang, S.; Liu, Z. -J.; Chen, W.; Fu, J.; Zeng, Q. -F.: Synthesis and antimicrobical evaluation of a novel class of 1,3,4-thiadiazole: Derivatives bearing 1,2,4-triazolo[1,5-*a*]pyrimidine moiety. Eur. J. Med. Chem. **64** (2013) 54–61.
6. Plech, T.; Wujec, M.; Kosikowska, U.; Malm, A.; Kaproń, B.: Studies on the synthesis and antibacterial activity of 3,6-disubstituted 1,2,4-triazolo[3,4-*b*]1,3,4-thiadiazoles. Eur. J. Med. Chem. **47** (2012) 580–584.
7. Kotaiah, Y.; Nagaraju, K.; Harikrishna, N.; Rao, C. V.; Yamini, L.; Vijjulatha, M.: Synthesis, docking and evaluation of antioxidant and antimicrobial activities of novel 1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazol-6-yl)selenopheno[2,3-*d*] pyrimidines. Eur. J. Med. Chem. **75** (2014) 195–202.
8. Eweiss, N. F.; Bahajaj, A. A.: Synthesis of heterocycles. Part VII. Synthesis and antimicrobial activity of some 7*H*-*s*-triazolo[3,4-*b*][1,3,4]thiadiazine and *s*-triazolo[3,4-*b*][1,3,4]thiadiazole derivatives. J. Heterocycl. Chem. **24** (1987) 1173–1181.
9. Swamy, S. N.; Basappa; Priya, B. S.; Prabhuswamy, B.; Doreswamy, B. H.; Shahidhara, J. S.; Rangappa, K. S.: Synthesis of pharmaceutically important condensed heterocyclic 4,6-disubstituted-1,2,4-triazolo-1,3,4-thiadiazole derivatives as antimicrobials. Eur. J. Med. Chem. **41** (2006) 531–538.
10. Mathew, V.; Keshavayya, J.; Vaidya, V. P.: Heterocyclic system containing bridged nitrogen atom: Synthesis and pharmacological activities of some substituted 1,2,4-triazolo[3,4-*b*]-1,3,4-thiadiazoles. Eur. J. Med. Chem. **41** (2006) 1048–1058.
11. Chaturvedi, B.; Tiwari, N.; Nirupama, N.: A convenient synthesis of 1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazoles as potential pesticides. Agri. Biol. Chem. **52** (1988) 1229–1232.
12. Khan, I.; Zaib, S.; Ibrar, A.; Rama, N. S.; Simpson, J.; Iqbal, J.: Synthesis, crystal structure and biological evaluation of some novel 1,2,4-triazolo[3,4-*b*]-1,3,4-thiadiazoles and 1,2,4-triazolo[3,4-*b*]-1,3,4-thiadiazines. Eur. J. Med. Chem. **78** (2014) 167–177.
13. Chidananda, N.; Poojary, B.; Sumangala, V.; Kumari, N. S.; Shetty, P.; Arulmoli, T.: Facile synthesis, characterization and pharmacological activities of 3,6-disubstituted 1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazoles and 5,6-dihydro-3,6-disubstituted-1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazoles. Eur. J. Med. Chem. **51** (2012) 124–136.
14. Al-Abdullah, E. S.; Shehata, I. A.; Al-Deeb, O. A.; El-Emam, A. A.: Microwave-assisted dehydrosulphurization: An efficient, solvent-free synthesis of 5-(1-adamantyl)-2-arylamino-1,2,4-triazolo[3,4-*b*][1,3,4]thiadiazoles. Heterocycles **71** (2007) 379–388.
15. El-Emam, A. A.; Moustafa, M. A.; El-Subbagh, H. I.; El-Ashmawy, M. B.: Triazoles and fused triazoles III: Facile and efficient synthesis of 2,4-disubstituted-*s*-triazolo[3,4-*b*]-1,3,4-thiadiazoles. Monatsh. Chem. **121** (1990) 221–225.
16. Agilent (2014) CrysAlis^{PRO}. Agilent Technologies UK Ltd, Yarnton, England.
17. Sheldrick, G. M.: A short history of SHELX. Acta Crystallogr. **A64** (2008) 112–122.