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4-(2,6-Dichlorobenzylamino)-3-phenyl-5-*p*-tolyl-4*H*-1,2,4-triazole

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Key indicators

Single-crystal X-ray study
T = 293 K
Mean σ(C–C) = 0.006 Å
R factor = 0.052
wR factor = 0.094
Data-to-parameter ratio = 15.7

For details of how these key indicators were automatically derived from the article, see http://journals.iucr.org/e.

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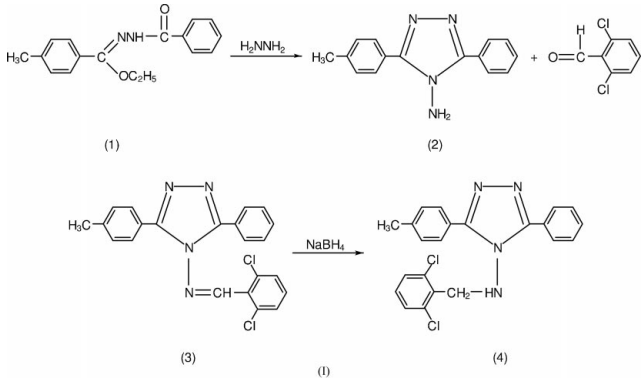
The title compound, $C_{22}H_{18}Cl_2N_4$, consists of four planar fragments. π–π interactions occur between the dichlorophenyl and tolyl groups. In the crystal structure, the molecules are organized into layers by a network of N—H···N hydrogen-bond interactions. The compound shows considerable peroxynitrite scavenging activity, although weaker than the standards used, and antimicrobial activity against Gram-positive bacteria such as *Staphylococcus aureus* ATCC 25923 and *Bacillus subtilis* ATCC 663.

Comment

In recent years, various 1,2,4-triazoles and 4,5-dihydro-1*H*-1,2,4-triazol-5-ones have been found to be associated with diverse pharmacological activities. In this connection, several articles have been devoted to the synthesis and biological activities of some 4-arylidenamino-4,5-dihydro-1*H*-1,2,4-triazol-5-ones (Bekircan, 2000; Kröger *et al.*, 1965; İkizler & Ün, 1979; Milcent & Redeuilh, 1979; Milcent & Vicart, 1983; Malbec *et al.*, 1984; İkizler *et al.*, 1991; İkizler, İkizler *et al.*, 1997; İkizler, Uçar *et al.*, 1997). Because of their structural resemblance, 4-arylidenamino-4*H*-1,2,4-triazoles may be important as potential biologically active compounds (Kahveci & İkizler, 2000; Grammaticakis & Champcticr, 1970). The current study was aimed at the determination of the chemical properties, crystal structure and *in vitro* biological activity, in terms of antioxidant, antibacterial and antifungal potentials, of the title compound, (4), to evaluate its nutritional and medicinal value.



The antioxidant activity of compound (4), according to the peroxynitrite scavenging assay of the sample, is lower than that of the reference standards. However, approximately 4 mg ml^{-1} inhibitory concentration of the sample against peroxynitrite oxidation of biological substrates makes it a moderate antioxidant, and this makes it worth investigating

analogous molecules with potentially higher antioxidant activity.

Eight different microorganisms were used to screen the possible antimicrobial activity of the title compound. Of the species used, *Staphylococcus aureus* is one of the most common Gram-positive bacteria, causing food poisoning and many infectious diseases. Gram-negative bacteria are represented by *Escherichia coli*, which belongs to the normal flora of humans. Candida is the yeast-like fungus responsible for most clinical yeast infections.

The antimicrobial activity of the title compound was also studied with the agar diffusion method using eight bacteria and yeasts. The title compound showed partial antimicrobial activity (8 mm in zone size) against Gram-positive bacteria *S. aureus* ATCC 25923 and antimicrobial activity (11 mm in zone size) against *B. subtilis* ATCC 6633. No antimicrobial activity was shown against the other microorganisms tested. Bacterial resistance against antibiotic treatment is becoming a problem in medicine. Such studies are assumed to be sufficient for the preliminary antimicrobial screening of chemical compounds.

A view of the title compound, with the atom-labelling scheme, is shown in Fig. 1. The crystal structure of (4) can be described as being built from essentially planar fragments, *viz*. a triazole ring (ring *D* = N1/N2/C1/N3/C2), a dichlorophenyl group (Cl1/Cl2/C3–C8) linked to the triazole ring by an aminomethylene bridge (N3/N4/C9/C3), and a tolyl group (C10–C16) and a phenyl ring (ring *C* = C17–C22) substituted at atoms C2 and C1 of the triazole ring, respectively. The triazole ring is planar to within 0.007 (4) Å. However, the aminomethylene bridge is not planar, the N3—N4—C9—C3 torsion angle being −59.6 (4)°.

As seen in Fig. 1, the planes of ring *A* (C3–C8) and ring *B* (C10–C15) are almost parallel, with a dihedral angle of 7.07 (19)°. The bond lengths and angles found for the triazole ring are close to those reported in the literature (Özdemir *et al.*, 2003). In the title structure, an intramolecular C—H···Cl interaction forms a five-membered Cl2/C8/C3/C9/H9*B* closed ring, which is fused with ring A. The molecules pack in layers (Fig. 2). A two-dimensional network is formed by the N—H···N interaction between atom N4 of the four-atom bridge and atom N2 of the triazole ring (Table 2). This arrangement results in the formation of chains extending along the *a* axis. These interactions, as well as the van der Waals interactions, stabilize the molecular structure and packing.

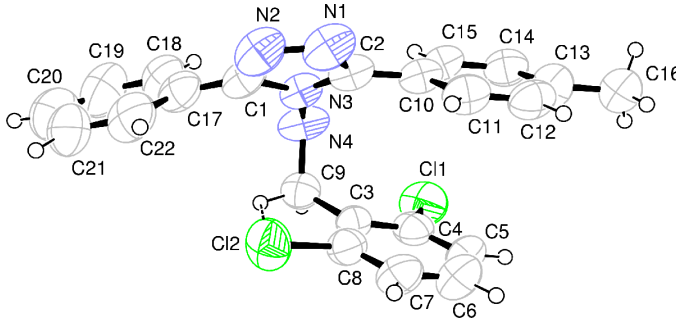


Figure 1
An *ORTEP*III (Farrugia, 1997) view of (4), with the atomic numbering scheme. Displacement ellipsoids of non-H atoms are drawn at the 50% probability level.

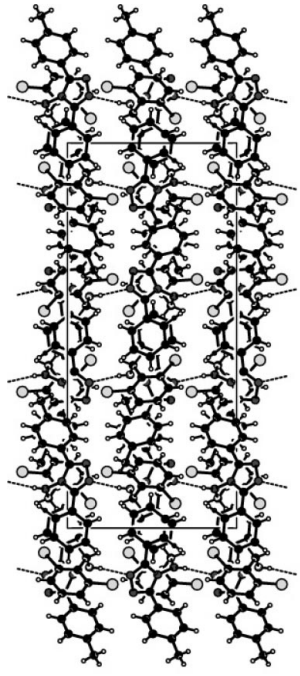


Figure 2
The crystal packing of (4), viewed along the *c* axis. The horizontal short axis is the *a* axis.

Experimental

Compound (3) (0.005 mol) (Bekircan, 2000) was dissolved in dried methanol (50 ml), and $NaBH_4$ (0.005 mol) was added in small portions to this solution. The mixture was refluxed for 20 min and then allowed to cool. After evaporation at 298–303 K under reduced pressure, the solid residue was washed with cold water. After drying *in vacuo*, the solid product was recrystallized from ethyl acetate to afford the desired compound (m.p. 482–483 K, yield 94%). IR (KBr): 3277, 1618, 827, 777, 764, 729, 691; ^{1}H NMR (DMSO-d_6): δ 2.42(*s*, 3H, CH_3), 4.10 (*d*, 2H, CH_2), 5.98 (*t*, 1H, NH), 6.94 (*s*, 2H, Ar-H), 7.24 (*d*, 3H, Ar-H), 7.42 (*m*, 3H, Ar-H), 7.72 (*m*, 4H, Ar-H); ^{13}C NMR ($CDCl_3$): δ 153.59, 153.50, 139.94, 136.15 (2C), 130.55, 129.90, 129.67, 129.36 (2C), 128.57 (2C), 128.01 (2C), 127.94 (2C), 127.37 (2C), 126.45, 123.56, 51.75, 21.45; UV: λ_{max}, nm ($\varepsilon \times 10^{-3}$): 261 (23.1), 210 (30.6). Analysis Calculated for $C_{22}H_{18}N_4Cl_2$: C 64.56, H 4.43, N 13.69%; found: C 64.48, H 4.22, N 14.27%.

Crystal data

$C_{22}H_{18}Cl_2N_4$
M_r = 409.30
Orthorhombic, *Pbca*
a = 12.0008 (11) Å
b = 27.4501 (16) Å
c = 12.068 (3) Å
V = 3975.4 (10) Å^3
Z = 8
D_x = 1.368 Mg m^{-3}
Mo *K*α radiation
Cell parameters from 8102 reflections
θ = 1.5–24.1°
μ = 0.34 mm^{-1}
T = 293 (2) K
Plate, colourless
0.50 × 0.35 × 0.04 mm

Data collection

Stoe IPDS-II diffractometer
ω scans
Absorption correction: by integration (X-RED; Stoe & Cie, 2002)
T_{min} = 0.866, T_{max} = 0.986
26 654 measured reflections
3901 independent reflections
1304 reflections with $I > 2\sigma(I)$
R_{int} = 0.137
θ_{max} = 26.0°
$h = -14 \rightarrow 14$
$k = -30 \rightarrow 33$
$l = -14 \rightarrow 14$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.052
$wR(F^2)$ = 0.094
S = 1.01
3901 reflections
248 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0112P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max} < 0.001$
$\Delta\rho_{max}$ = 0.34 e Å^{-3}
$\Delta\rho_{min}$ = −0.42 e Å^{-3}
Extinction correction: *SHELXL*97
Extinction coefficient: 0.00079 (10)

Table 1
Selected geometric parameters (Å, °).

Cl1—C4	1.739 (4)	N3—C1	1.378 (4)
Cl2—C8	1.743 (4)	N3—N4	1.395 (3)
N1—C2	1.319 (4)	N4—C9	1.434 (4)
N1—N2	1.370 (4)	C1—C17	1.436 (5)
N2—C1	1.330 (4)	C2—C10	1.464 (5)
N3—C2	1.355 (4)	C3—C9	1.514 (4)
C2—N1—N2	106.5 (4)	N1—C2—N3	110.2 (4)
C1—N2—N1	109.6 (3)	N1—C2—C10	122.6 (4)
C2—N3—C1	106.6 (3)	N3—C2—C10	127.1 (3)
C2—N3—N4	128.9 (3)	C3—C4—Cl1	119.3 (3)
C1—N3—N4	124.0 (4)	C5—C4—Cl1	118.5 (4)
N3—N4—C9	114.6 (2)	C3—C8—Cl2	119.8 (3)
N2—C1—N3	107.1 (4)	C7—C8—Cl2	117.8 (3)
N2—C1—C17	126.7 (4)	N4—C9—C3	115.1 (3)
N3—C1—C17	126.2 (4)		

Table 2
Hydrogen-bonding geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N4—H4···N2^{i}	0.86	2.20	3.030 (4)	162
C9—H9B···Cl2	0.97	2.57	3.082 (3)	113

Symmetry code: (i) $x - \frac{1}{2}, y, -\frac{1}{2} - z$.

H atoms were positioned geometrically and treated using a riding model, with an N—H distance of 0.86 Å for atom N4, and C—H distances of 0.93 Å for the phenyl atoms, 0.96 Å for the methyl group and 0.97 Å for atom C9. The displacement parameters of the H atoms were included as U_{iso}(H) = 1.2U_{eq}(carrier atom) [1.5U_{eq}(C) for methyl atoms]. The reflections were very weak due to the thinness of the crystal. No further precaution was available to increase the intensities.

Data collection: *X-AREA* (Stoe & Cie, 2002); cell refinement: *X-AREA*; data reduction: *X-RED*32 (Stoe & Cie, 2002); program(s) used to solve structure: *SHELXS*97 (Sheldrick, 1997); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics: *ORTEP*-3 *for Windows* (Farrugia, 1997) and *PLATON* (Spek, 1997); software used to prepare material for publication: *WinGX* (Farrugia, 1999).

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