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1-(2,5-Dichlorophenyl)-3-methyl-5-phenyl-1*H*-pyrazole

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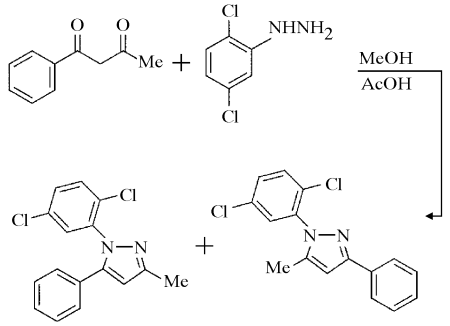
The title compound, $C_{16}H_{12}Cl_2N_2$, crystallizes in the centrosymmetric space group $P2_1/c$. Two independent but chemically identical molecules comprise the asymmetric unit and in each of these the pyrazole ring is planar.

Comment

Pyrazoles are one of the important classes of biologically active compounds. Pyrazole derivatives exhibit parasiticidal properties (Bristol–Meyers, 1973) and have been studied as potential antimicrobial agents (Novinson *et al.*, 1976). Pyrazolo[3,4-*b*]quinolines are known to exhibit bactericidal activity (Fraghaly *et al.*, 1989). The present work was undertaken to explore the possible application of pyrazole analogues as antitubercular agents. In this respect, we have synthesized a series of pyrazoles and evaluated them for antitubercular activity against *Mycobacterium tuberculosis* $H37R_v$. The title compound, (I), was prepared by condensation of 2,5-dichlorophenylhydrazine with benzoylacetone in



(I)

methanol in the presence of a catalytic amount of acetic acid. The structure of the product was confirmed by NMR spectroscopy. To confirm further the position of attachment of the methyl and phenyl groups on the pyrazole ring and to obtain more detailed structural information on the conformation of the molecule in the crystalline state, the X-ray structure determination of (I) has been carried out and the results are presented here.

The crystal structure of (I) contains two molecules (*A* and *B*) in the asymmetric unit; Fig. 1 shows labelled displacement ellipsoid plots of these two molecules, and selected geometric parameters are presented in Table 1. A pairwise comparison between the two molecules shows no significant differences in bond lengths or angles. Pairwise comparisons of torsion angles, however, do show some differences between the molecules: C9*A*—N1*A*—C1*A*—C2*A* and N1*A*—C9*A*—C10*A*—C15*A* are −67.9 (2) and −45.2 (2)°, respectively, while C9*B*—N1*B*—C1*B*—C2*B* and N1*B*—C9*B*—C10*B*—C15*B* are −79.6 (2) and −37.6 (3)°, respectively.

The pyrazole moiety in both molecules is nearly planar, with overall root-mean-square deviations (r.m.s.d.) for the ring atoms of 0.005 (1) Å for either molecule. It has been reported (Krishna *et al.*, 1999) that the N—N bond length in the pyrazoline ring varies over a wide range, from 1.234 (8) to 1.385 (4) Å, where the length depends on the substituents

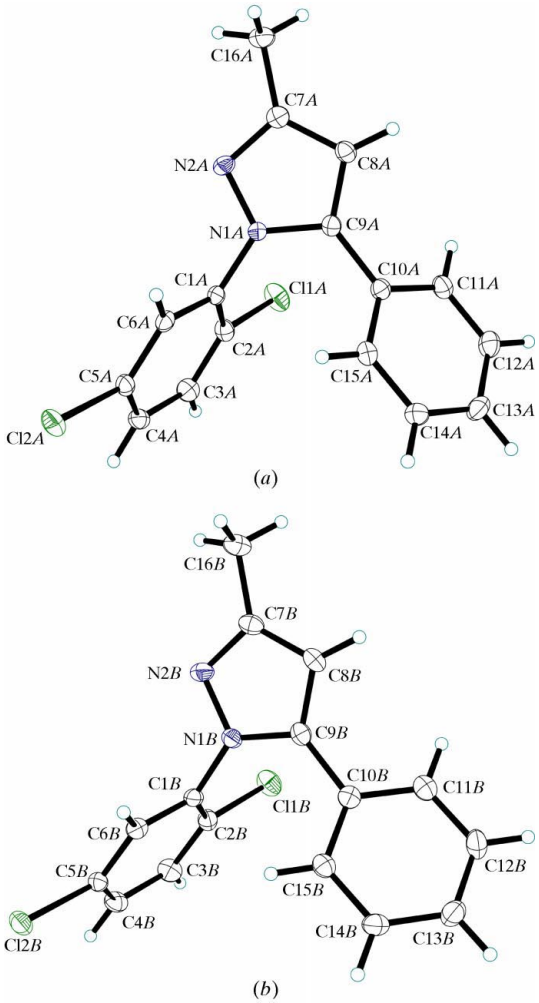


Figure 1
A view of the two independent molecules, *A* and *B*, of the asymmetric unit of (I), showing the atom-numbering schemes. Displacement ellipsoids are drawn at the 50% probability level and H atoms are shown as small spheres of arbitrary radii.

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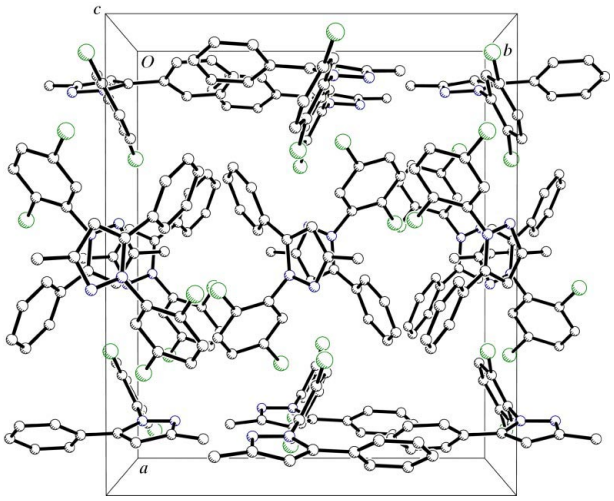

Figure 2
The crystal packing of (I), viewed along the *c* axis. H atoms have been omitted for clarity.

bonded to the N atoms. Accordingly, the length of the adjacent C=N bond ranges from 1.288 (4) to 1.461 (8) Å. These differences are caused by a varying degree of conjugation in the π-electron portion of the pyrazoline ring, which is sensitive to the nature of the substituent(s) bonded to the atoms of the π system. The N1—N2 bond length of 1.3674 (19) Å found in (I) further extends this range, approximating the length of a pure single bond (1.41 Å; Burke-Laing & Laing, 1976). There is an extended conjugation between the π-electron system of the pyrazole ring and the 5-phenyl group, which is evident from the bond lengths N2=C7, C7—C8, C8=C9 and C9—C10.

The mode of packing of (I) along the *c* direction is illustrated in Fig. 2. In addition to weak C—H···π interactions, van der Waals forces contribute to the stabilization of the crystal structure.

Experimental

A mixture of 2,5-dichlorophenylhydrazine (0.354 g, 2 mmol) and benzoylacetone (0.324 g, 2 mmol) was dissolved in methanol (10 ml). To this reaction mixture were added 2 drops of acetic acid and the solution was refluxed for 5 h. After completion of the reaction, the solvent was removed, and the resultant solid was crystallized from methanol to afford colourless crystals of (I) suitable for X-ray analysis. Spectroscopic analysis, ^{1}H NMR ($CDCl_3$, p.p.m.): 2.39 (*s*, 3H), 6.36 (*s*, 1H), 7.17–7.20 (*m*, 2H), 7.26–7.29 (*m*, 3H), 7.32 (*t*, 2H), 7.49 (*q*, 1H); ^{13}C NMR ($CDCl_3$, p.p.m.): 14.0, 106.7, 127.8, 128.5, 128.6, 130.1,130.2, 130.3, 130.7, 131.2, 133.1, 139.2, 145.8, 150.5.

Crystal data

$C_{16}H_{12}Cl_2N_2$
M_r = 303.18
Monoclinic, $P2_1/c$
a = 17.3805 (3) Å
b = 14.8094 (2) Å
c = 11.0596 (2) Å
β = 90.7798 (6)°
V = 2846.42 (8) Å^3
Z = 8
D_x = 1.415 Mg m^{-3}
Mo $K\alpha$ radiation
Cell parameters from 6703 reflections
θ = 1.0–27.5°
μ = 0.45 mm^{-1}
T = 90.0 (2) K
Block, colourless
0.35 × 0.30 × 0.20 mm

Data collection

Nonius KappaCCD area-detector diffractometer
ω scans at fixed χ = 55°
Absorption correction: multi-scan (*SCALEPACK*; Otwinowski & Minor, 1997)
T_{min} = 0.860, T_{max} = 0.916
12 695 measured reflections
6525 independent reflections
5003 reflections with $I > 2\sigma(I)$
R_{int} = 0.030
θ_{max} = 27.5°
$h = -22 \rightarrow 22$
$k = -19 \rightarrow 19$
$l = -14 \rightarrow 14$

Refinement

Refinement on F^2
$R[F^2 > 2\sigma(F^2)]$ = 0.035
$wR(F^2)$ = 0.089
S = 1.06
6525 reflections
363 parameters
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.0405P)^2 + 0.7814P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.023
$\Delta\rho_{max}$ = 0.36 e Å^{-3}
$\Delta\rho_{min}$ = −0.37 e Å^{-3}

Table 1
Selected geometric parameters (Å, °).

Cl1*A*—C2*A*	1.7303 (17)	Cl1*B*—C2*B*	1.7295 (17)
Cl2*A*—C5*A*	1.7394 (17)	Cl2*B*—C5*B*	1.7413 (17)
N1*A*—N2*A*	1.3674 (19)	N1*B*—C9*B*	1.369 (2)
N1*A*—C9*A*	1.369 (2)	N1*B*—N2*B*	1.3716 (19)
N1*A*—C1*A*	1.426 (2)	N1*B*—C1*B*	1.432 (2)
N2*A*—C7*A*	1.336 (2)	N2*B*—C7*B*	1.332 (2)
C7*A*—C8*A*	1.404 (2)	C7*B*—C8*B*	1.403 (2)
C8*A*—C9*A*	1.375 (2)	C8*B*—C9*B*	1.376 (2)
C9*A*—C10*A*	1.472 (2)	C9*B*—C10*B*	1.471 (2)
N2*A*—N1*A*—C9*A*	112.51 (13)	C9*B*—N1*B*—N2*B*	112.06 (13)
N2*A*—N1*A*—C1*A*	119.34 (13)	N2*B*—N1*B*—C1*B*	117.06 (13)
C9*A*—N1*A*—C1*A*	127.81 (14)	C9*B*—N1*B*—C1*B*	130.47 (14)
N1*A*—C9*A*—C10*A*	123.30 (14)	N1*B*—C9*B*—C10*B*	125.74 (15)
C8*A*—C9*A*—C10*A*	131.18 (15)	C8*B*—C9*B*—C10*B*	128.71 (15)
C9*A*—N1*A*—N2*A*—C7*A*	−1.36 (17)	C9*B*—N1*B*—N2*B*—C7*B*	−1.10 (18)
N1*A*—N2*A*—C7*A*—C8*A*	0.74 (18)	N1*B*—N2*B*—C7*B*—C8*B*	0.42 (18)
N2*A*—C7*A*—C8*A*—C9*A*	0.10 (19)	N2*B*—C7*B*—C8*B*—C9*B*	0.4 (2)
C1*A*—N1*A*—C9*A*—C10*A*	−5.4 (3)	C1*B*—N1*B*—C9*B*—C10*B*	−8.6 (3)
C7*A*—C8*A*—C9*A*—N1*A*	−0.90 (18)	C7*B*—C8*B*—C9*B*—N1*B*	−1.01 (18)

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

*Cg*1 is the centroid of the N1*A*/N2*A*/C7*A*–C9*A* ring and *Cg*2 is the centroid of the C10*B*–C15*B* ring.

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
C3*A*—H3*A*···N2*B*	0.95	2.56	3.251 (2)	130
C13*A*—H13*A*···Cl2*A*^{i}	0.95	2.97	3.9219 (18)	176
C15*A*—H15*A*···*Cg*1^{ii}	0.95	2.84	3.5387 (17)	132
C3*B*—H3*B*···Cl2*B*^{iii}	0.95	2.95	3.8228 (18)	154
C4*B*—H4*B*···N2*A*^{iv}	0.95	2.62	3.420 (2)	142
C6*B*—H6*B*···*Cg*2^{v}	0.95	2.90	3.8110 (17)	160
C8*B*—H8*B*···Cl1*A*^{vi}	0.95	2.94	3.6625 (18)	134
C16*B*—H16*F*···Cl1*B*^{vii}	0.98	2.88	3.7199 (19)	144

Symmetry codes: (i) $x, \frac{3}{2}-y, \frac{1}{2}+z$; (ii) $2-x, 1-y, 2-z$; (iii) $x, \frac{1}{2}-y, \frac{1}{2}+z$; (iv) $x, \frac{1}{2}-y, z-\frac{1}{2}$; (v) $1-x, 1-y, 1-z$; (vi) $1-x, 1-y, 2-z$; (vii) $1-x, \frac{1}{2}+y, \frac{3}{2}-z$.

Data collection: *COLLECT* (Nonius, 1999); cell refinement: *SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *DENZO–SMN* (Otwinowski & Minor, 1997); program(s) used to solve structure: *SHELXS*97 (Sheldrick, 1997); program(s) used to refine structure: *SHELXL*97 (Sheldrick, 1997); molecular graphics:

XP in *SHELXTL*/*PC* (Sheldrick, 1995); software used to prepare material for publication: *SHELX*97 and local procedures.

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: NA1669). Services for accessing these data are described at the back of the journal.

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