organic compounds

4-[(2,4-Difluorophenyl)hydrazinylidene]-3-methyl-5-oxo-4,5-dihydro-1H-pyrazole-1-carbothioamide

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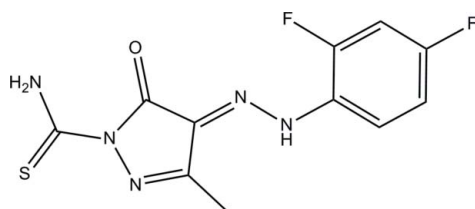Correspondence e-mail: hkfun@usm.my

In the title compound, $C_{11}H_9F_2N_5OS$, the pyrazole ring forms a dihedral angle of 16.42 (6)° with the benzene ring. Intramolecular N—H···O hydrogen bonds generate two $S(6)$ ring motifs. In the crystal, an $R_2^2(8)$ ring motif is formed by a pair of intermolecular N—H···S hydrogen bonds. Intermolecular C—H···F hydrogen bonds further link the molecules into a three-dimensional network.

Related literature

For the biological activity of pyrazole derivatives, see: Isloor et al. (2009); Rai et al. (2008); Bradbury & Pucci (2008); Girisha et al. (2010). For a related structure, see: Fun et al. (2011). For hydrogen-bond motifs, see: Bernstein et al. (1995). For stability of the temperature controller used in the data collection, see: Cosier & Glazer (1986).

Experimental

Crystal data

$C_{11}H_9F_2N_5OS$	$b = 8.2400$ (1) Å
$M_r = 297.29$	$c = 10.1378$ (1) Å
Triclinic, $P\bar{1}$	$\alpha = 103.409$ (1)°
$a = 7.9003$ (1) Å	$\beta = 99.864$ (1)°

$\gamma = 99.372$ (1)°	$\mu = 0.29$ mm^{-1}
$V = 618.18$ (1) Å^3	$T = 100$ K
$Z = 2$	$0.41 \times 0.23 \times 0.08$ mm
Mo $K\alpha$ radiation	

Data collection

Bruker SMART APEXII CCD area-detector diffractometer	15661 measured reflections
Absorption correction: multi-scan (SADABS; Bruker, 2009)	4211 independent reflections
$T_{min} = 0.890$, $T_{max} = 0.977$	3546 reflections with $I > 2\sigma(I)$
	$R_{int} = 0.024$

Refinement

$R[F^2 > 2\sigma(F^2)] = 0.033$	H atoms treated by a mixture of independent and constrained refinement
$wR(F^2) = 0.091$	
$S = 1.06$	
4211 reflections	$\Delta\rho_{max} = 0.46$ e Å^{-3}
194 parameters	$\Delta\rho_{min} = -0.27$ e Å^{-3}

Table 1
Hydrogen-bond geometry (Å, °).

D—H···A	D—H	H···A	D···A	D—H···A
N1—H1N1···O1	0.863 (17)	2.080 (17)	2.7605 (13)	135.2 (15)
N5—H1N5···S1^i	0.842 (17)	2.607 (17)	3.4279 (11)	165.5 (15)
N5—H2N5···O1	0.880 (17)	2.048 (17)	2.7208 (13)	132.5 (14)
C10—H10A···F1^{ii}	0.98	2.47	3.3016 (14)	143
C10—H10C···F1^{iii}	0.98	2.53	3.2775 (14)	133
C10—H10C···F2^{iv}	0.98	2.55	3.2145 (14)	125

Symmetry codes: (i) $-x, -y, -z + 1$; (ii) $x + 1, y, z + 1$; (iii) $-x, -y + 2, -z$; (iv) $-x, -y + 1, -z$.

Data collection: APEX2 (Bruker, 2009); cell refinement: SAINT (Bruker, 2009); data reduction: SAINT; program(s) used to solve structure: SHELXTL (Sheldrick, 2008); program(s) used to refine structure: SHELXTL; molecular graphics: SHELXTL; software used to prepare material for publication: SHELXTL and PLATON (Spek, 2009).

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: IS2796).

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supplementary materials

4-[(2,4-Difluorophenyl)hydrazinylidene]-3-methyl-5-oxo-4,5-dihydro-1*H*-pyrazole-1-carbothioamide

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Comment

The pyrazole ring is a prominent structural moiety found in numerous pharmaceutically active compounds. This is mainly due to the easy preparation and the important pharmacological activity. Therefore, the synthesis and selective functionalization of pyrazoles have been focus of active research area over the years (Isloor *et al.*, 2009). Pyrazoles have been reported to possess antibacterial activity (Rai *et al.*, 2008), and found to posses inhibitor activity against DNA gyrase and topoisomerase IV at their respective ATP-binding sites (Bradbury & Pucci, 2008). Moreover, pyrazole-containing compounds have received considerable attention owing to their diverse chemotherapeutic potentials including versatile anti-inflammatory and antimicrobial activities (Girisha *et al.*, 2010). The synthetic route followed for obtaining the title compound (I) involves the diazotization of substituted anilines to give the diazonium salts followed by coupling with ethyl acetoacetate in the presence of sodium acetate to give the corresponding oxobutanoate which on further reaction with thiosemicarbazide in acetic acid gave the required thioamides.

In the title compound of (I), (Fig. 1), the pyrazole (N3/N4/C7–C9) ring is essentially planar, with a maximum deviation of 0.007 (1) Å for atom C9 and makes a dihedral angle of 16.42 (6)° with the benzene (C1–C6) ring. The intramolecular N1—H1N1···O1 and N5—H2N5···O1 hydrogen bonds generate two S(6) ring motifs (Bernstein *et al.*, 1995). The geometric parameters are consistent to those observed in a closely related structure (Fun *et al.*, 2011).

In the crystal structure, (Fig. 2), an $R_2^2(8)$ ring motif is formed by intermolecular N5—H1N5···S1 hydrogen bonds (Table 1). Intermolecular C10—H10A···F1, C10—H10C···F1 and C10—H10C···F2 (Table 1) hydrogen bonds further link the molecules into a three- dimensional network.

Experimental

To a solution of ethyl-2-[(2,4-difluorophenyl)hydrazono]-3-oxobutanoate (0.01 mol) dissolved in glacial acetic acid (15 ml), a solution of thiosemicarbazide (0.02 mol) in glacial acetic acid (15 ml) was added and the mixture was refluxed for 4 h. It is cooled and allowed to stand overnight. The solid product that separated out was filtered and dried. It was then recrystallized from ethanol. Crystals suitable for X-ray analysis were obtained from 1:2 mixture of DMF and ethanol by slow evaporation.

Refinement

Atoms H1N1, H1N5 and H2N5 were located in a difference Fourier map and refined freely [N—H = 0.866 (17), 0.840 (18) and 0.878 (17) Å]. The remaining H atoms were positioned geometrically (C—H = 0.95 and 0.98 Å) and refined riding on their carrier atoms. The U_{iso}(H) values were constrained to be $1.5U_{eq}$ of the carrier atoms for methyl H atoms and $1.2U_{eq}$ for the remaining H atoms. A rotating group model was used for the methyl group.
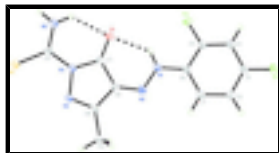
supplementary materials

Figures

Fig. 1. The structure of the title compound, showing 50% probability displacement ellipsoids. Hydrogen atoms are shown as spheres of arbitrary radius.
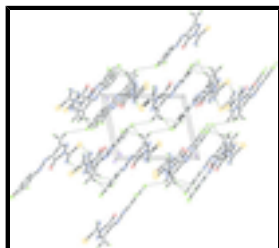

Fig. 2. The crystal packing, viewed along the *b*-axis, showing the molecules formed a into three-dimensional network. Hydrogen atoms that not involved in hydrogen bonding (dashed lines) are omitted for clarity.

4-[(2,4-Difluorophenyl)hydrazinylidene]-3-methyl-5-oxo-4,5-dihydro- 1*H*-pyrazole-1-carbothioamide

Crystal data

$C_{11}H_9F_2N_5OS$	$Z = 2$
$M_r = 297.29$	$F(000) = 304$
Triclinic, $P\bar{1}$	$D_x = 1.597$ Mg m^{-3}
Hall symbol: -P 1	Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
$a = 7.9003$ (1) Å	Cell parameters from 7383 reflections
$b = 8.2400$ (1) Å	$\theta = 2.6–31.9°$
$c = 10.1378$ (1) Å	$\mu = 0.29$ mm^{-1}
$\alpha = 103.409$ (1)°	$T = 100$ K
$\beta = 99.864$ (1)°	Block, green
$\gamma = 99.372$ (1)°	$0.41 \times 0.23 \times 0.08$ mm
$V = 618.18$ (1) Å^3	

Data collection

Bruker SMART APEXII CCD area-detector diffractometer	4211 independent reflections
Radiation source: fine-focus sealed tube	3546 reflections with $I > 2\sigma(I)$
graphite	$R_{int} = 0.024$
φ and ω scans	$\theta_{max} = 31.9°$, $\theta_{min} = 2.1°$
Absorption correction: multi-scan (*SADABS*; Bruker, 2009)	$h = -11 \rightarrow 11$
$T_{min} = 0.890$, $T_{max} = 0.977$	$k = -12 \rightarrow 12$
15661 measured reflections	$l = -15 \rightarrow 15$

Refinement

Refinement on F^2	Primary atom site location: structure-invariant direct methods
Least-squares matrix: full	Secondary atom site location: difference Fourier map

$R[F^2 > 2\sigma(F^2)] = 0.033$

$wR(F^2) = 0.091$

$S = 1.06$

4211 reflections

194 parameters

0 restraints

Hydrogen site location: inferred from neighbouring sites

H atoms treated by a mixture of independent and constrained refinement

$w = 1/[\sigma^2(F_o^2) + (0.0469P)^2 + 0.1483P]$
where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{max} = 0.001$

$\Delta\rho_{max} = 0.46$ e Å^{-3}

$\Delta\rho_{min} = -0.27$ e Å^{-3}

Special details

Experimental. The crystal was placed in the cold stream of an Oxford Cryosystems Cobra open-flow nitrogen cryostat (Cosier & Glazer, 1986) operating at 100.0 (1) K.

Geometry. All esds (except the esd in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell esds are taken into account individually in the estimation of esds in distances, angles and torsion angles; correlations between esds in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell esds is used for estimating esds involving l.s. planes.

Refinement. Refinement of F^2 against ALL reflections. The weighted R-factor wR and goodness of fit S are based on F^2, conventional R-factors R are based on F, with F set to zero for negative F^2. The threshold expression of $F^2 > 2\text{sigma}(F^2)$ is used only for calculating R-factors(gt) etc. and is not relevant to the choice of reflections for refinement. R-factors based on F^2 are statistically about twice as large as those based on F, and R- factors based on ALL data will be even larger.

Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²)

	x	*y*	*z*	$U_{iso}*/U_{eq}$
S1	0.21061 (4)	0.24608 (3)	0.56219 (3)	0.01893 (8)
F1	−0.53111 (10)	0.91062 (10)	−0.26133 (8)	0.02844 (17)
F2	−0.43017 (9)	0.41257 (8)	−0.13817 (7)	0.02208 (15)
O1	−0.14398 (10)	0.30354 (10)	0.16468 (8)	0.01952 (16)
N1	−0.15277 (12)	0.58736 (12)	0.06501 (10)	0.01746 (17)
N2	−0.00803 (12)	0.66676 (12)	0.15852 (9)	0.01665 (17)
N3	0.08671 (12)	0.38926 (11)	0.36455 (9)	0.01611 (17)
N4	0.22017 (12)	0.53670 (11)	0.43282 (10)	0.01660 (17)
N5	−0.06153 (13)	0.11880 (12)	0.34770 (11)	0.02077 (19)
C1	−0.19357 (15)	0.85108 (14)	0.00178 (12)	0.0202 (2)
H1A	−0.0949	0.9165	0.0722	0.024*
C2	−0.29073 (16)	0.93080 (15)	−0.08133 (13)	0.0229 (2)
H2A	−0.2603	1.0507	−0.0681	0.027*
C3	−0.43254 (15)	0.83195 (15)	−0.18365 (12)	0.0208 (2)
C4	−0.48169 (14)	0.65643 (14)	−0.21030 (12)	0.0190 (2)
H4A	−0.5768	0.5907	−0.2839	0.023*
C5	−0.38454 (14)	0.58275 (13)	−0.12371 (11)	0.01665 (19)
C6	−0.24060 (14)	0.67551 (13)	−0.01797 (11)	0.01630 (19)
C7	−0.01793 (13)	0.40835 (13)	0.24639 (11)	0.01574 (19)
C8	0.05592 (13)	0.58088 (13)	0.24210 (11)	0.01541 (18)
C9	0.20256 (14)	0.64684 (13)	0.36007 (11)	0.01583 (19)

C10	0.32130 (15)	0.81794 (13)	0.39924 (12)	0.0200 (2)
H10A	0.4110	0.8292	0.4825	0.030*
H10B	0.2529	0.9064	0.4184	0.030*
H10C	0.3783	0.8311	0.3227	0.030*
C11	0.07145 (14)	0.24765 (13)	0.41963 (11)	0.01608 (19)
H1N1	−0.198 (2)	0.482 (2)	0.0569 (18)	0.036 (5)*
H1N5	−0.078 (2)	0.032 (2)	0.3780 (19)	0.036 (4)*
H2N5	−0.138 (2)	0.126 (2)	0.2763 (18)	0.030 (4)*

Atomic displacement parameters ($Å^2$)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
S1	0.01932 (13)	0.01622 (12)	0.01939 (14)	0.00185 (9)	−0.00104 (10)	0.00627 (10)
F1	0.0254 (4)	0.0287 (4)	0.0295 (4)	0.0030 (3)	−0.0064 (3)	0.0154 (3)
F2	0.0226 (3)	0.0156 (3)	0.0241 (3)	−0.0004 (2)	0.0008 (3)	0.0039 (3)
O1	0.0175 (4)	0.0184 (4)	0.0183 (4)	−0.0008 (3)	−0.0013 (3)	0.0032 (3)
N1	0.0172 (4)	0.0165 (4)	0.0164 (4)	0.0018 (3)	−0.0009 (3)	0.0044 (3)
N2	0.0170 (4)	0.0175 (4)	0.0143 (4)	0.0034 (3)	0.0018 (3)	0.0032 (3)
N3	0.0164 (4)	0.0135 (4)	0.0161 (4)	0.0005 (3)	−0.0002 (3)	0.0041 (3)
N4	0.0164 (4)	0.0134 (4)	0.0170 (4)	0.0000 (3)	0.0003 (3)	0.0027 (3)
N5	0.0211 (5)	0.0163 (4)	0.0216 (5)	−0.0015 (3)	−0.0015 (4)	0.0068 (4)
C1	0.0194 (5)	0.0186 (5)	0.0185 (5)	0.0011 (4)	−0.0028 (4)	0.0038 (4)
C2	0.0238 (5)	0.0183 (5)	0.0236 (6)	0.0020 (4)	−0.0022 (4)	0.0067 (4)
C3	0.0195 (5)	0.0231 (5)	0.0193 (5)	0.0038 (4)	−0.0010 (4)	0.0089 (4)
C4	0.0159 (5)	0.0220 (5)	0.0164 (5)	0.0005 (4)	0.0002 (4)	0.0046 (4)
C5	0.0166 (5)	0.0160 (4)	0.0157 (5)	0.0009 (4)	0.0030 (4)	0.0031 (4)
C6	0.0165 (4)	0.0176 (4)	0.0146 (4)	0.0036 (4)	0.0023 (4)	0.0046 (4)
C7	0.0152 (4)	0.0163 (4)	0.0147 (4)	0.0028 (3)	0.0022 (4)	0.0033 (4)
C8	0.0156 (4)	0.0146 (4)	0.0146 (4)	0.0018 (3)	0.0018 (4)	0.0030 (4)
C9	0.0164 (4)	0.0146 (4)	0.0152 (4)	0.0025 (3)	0.0022 (4)	0.0030 (4)
C10	0.0219 (5)	0.0148 (4)	0.0197 (5)	−0.0006 (4)	0.0005 (4)	0.0037 (4)
C11	0.0164 (4)	0.0143 (4)	0.0170 (5)	0.0030 (3)	0.0029 (4)	0.0041 (4)

Geometric parameters (Å, °)

S1—C11	1.6633 (11)	C1—C2	1.3893 (15)
F1—C3	1.3557 (12)	C1—C6	1.3914 (15)
F2—C5	1.3564 (12)	C1—H1A	0.9500
O1—C7	1.2366 (13)	C2—C3	1.3810 (16)
N1—N2	1.3159 (13)	C2—H2A	0.9500
N1—C6	1.4016 (13)	C3—C4	1.3840 (16)
N1—H1N1	0.866 (17)	C4—C5	1.3772 (15)
N2—C8	1.3122 (13)	C4—H4A	0.9500
N3—C7	1.3905 (13)	C5—C6	1.3949 (15)
N3—C11	1.4026 (13)	C7—C8	1.4597 (14)
N3—N4	1.4176 (12)	C8—C9	1.4445 (14)
N4—C9	1.3051 (13)	C9—C10	1.4858 (14)
N5—C11	1.3334 (14)	C10—H10A	0.9800
N5—H1N5	0.840 (18)	C10—H10B	0.9800

N5—H2N5	0.878 (17)	C10—H10C	0.9800
N2—N1—C6	120.34 (9)	F2—C5—C6	117.21 (9)
N2—N1—H1N1	120.6 (12)	C4—C5—C6	123.13 (10)
C6—N1—H1N1	119.0 (12)	C1—C6—C5	118.51 (10)
C8—N2—N1	116.66 (9)	C1—C6—N1	123.27 (10)
C7—N3—C11	127.86 (9)	C5—C6—N1	118.20 (9)
C7—N3—N4	112.25 (8)	O1—C7—N3	127.95 (10)
C11—N3—N4	119.89 (9)	O1—C7—C8	128.37 (10)
C9—N4—N3	106.61 (8)	N3—C7—C8	103.68 (9)
C11—N5—H1N5	117.8 (12)	N2—C8—C9	126.25 (9)
C11—N5—H2N5	122.4 (11)	N2—C8—C7	127.47 (10)
H1N5—N5—H2N5	119.5 (16)	C9—C8—C7	105.88 (9)
C2—C1—C6	120.11 (10)	N4—C9—C8	111.56 (9)
C2—C1—H1A	119.9	N4—C9—C10	122.26 (10)
C6—C1—H1A	119.9	C8—C9—C10	126.18 (9)
C3—C2—C1	118.57 (10)	C9—C10—H10A	109.5
C3—C2—H2A	120.7	C9—C10—H10B	109.5
C1—C2—H2A	120.7	H10A—C10—H10B	109.5
F1—C3—C2	118.52 (10)	C9—C10—H10C	109.5
F1—C3—C4	117.86 (10)	H10A—C10—H10C	109.5
C2—C3—C4	123.62 (10)	H10B—C10—H10C	109.5
C5—C4—C3	116.00 (10)	N5—C11—N3	114.10 (9)
C5—C4—H4A	122.0	N5—C11—S1	124.50 (8)
C3—C4—H4A	122.0	N3—C11—S1	121.40 (8)
F2—C5—C4	119.65 (10)		
C6—N1—N2—C8	172.87 (9)	N4—N3—C7—O1	179.75 (10)
C7—N3—N4—C9	−0.44 (12)	C11—N3—C7—C8	178.66 (10)
C11—N3—N4—C9	−179.57 (9)	N4—N3—C7—C8	−0.38 (11)
C6—C1—C2—C3	−0.58 (18)	N1—N2—C8—C9	−173.72 (10)
C1—C2—C3—F1	177.63 (10)	N1—N2—C8—C7	−2.03 (16)
C1—C2—C3—C4	−1.39 (19)	O1—C7—C8—N2	7.81 (18)
F1—C3—C4—C5	−176.26 (10)	N3—C7—C8—N2	−172.05 (10)
C2—C3—C4—C5	2.77 (17)	O1—C7—C8—C9	−179.15 (10)
C3—C4—C5—F2	176.48 (10)	N3—C7—C8—C9	0.98 (11)
C3—C4—C5—C6	−2.30 (16)	N3—N4—C9—C8	1.11 (12)
C2—C1—C6—C5	1.00 (17)	N3—N4—C9—C10	−179.47 (9)
C2—C1—C6—N1	−177.62 (10)	N2—C8—C9—N4	171.79 (10)
F2—C5—C6—C1	−178.30 (10)	C7—C8—C9—N4	−1.35 (12)
C4—C5—C6—C1	0.50 (16)	N2—C8—C9—C10	−7.61 (17)
F2—C5—C6—N1	0.39 (14)	C7—C8—C9—C10	179.24 (10)
C4—C5—C6—N1	179.20 (10)	C7—N3—C11—N5	−0.44 (16)
N2—N1—C6—C1	−6.89 (16)	N4—N3—C11—N5	178.53 (9)
N2—N1—C6—C5	174.49 (9)	C7—N3—C11—S1	179.35 (8)
C11—N3—C7—O1	−1.21 (18)	N4—N3—C11—S1	−1.67 (13)

Hydrogen-bond geometry (Å, °)

D—H···A	D—H	H···A	D···A	D—H···A
N1—H1N1···O1	0.863 (17)	2.080 (17)	2.7605 (13)	135.2 (15)

N5—H1N5···S1[i]	0.842 (17)	2.607 (17)	3.4279 (11)	165.5 (15)
N5—H2N5···O1	0.880 (17)	2.048 (17)	2.7208 (13)	132.5 (14)
C10—H10A···F1[ii]	0.98	2.47	3.3016 (14)	143.
C10—H10C···F1[iii]	0.98	2.53	3.2775 (14)	133.
C10—H10C···F2[iv]	0.98	2.55	3.2145 (14)	125.

Symmetry codes: (i) $-x$, $-y$, $-z+1$; (ii) $x+1$, y, $z+1$; (iii) $-x$, $-y+2$, $-z$; (iv) $-x$, $-y+1$, $-z$.
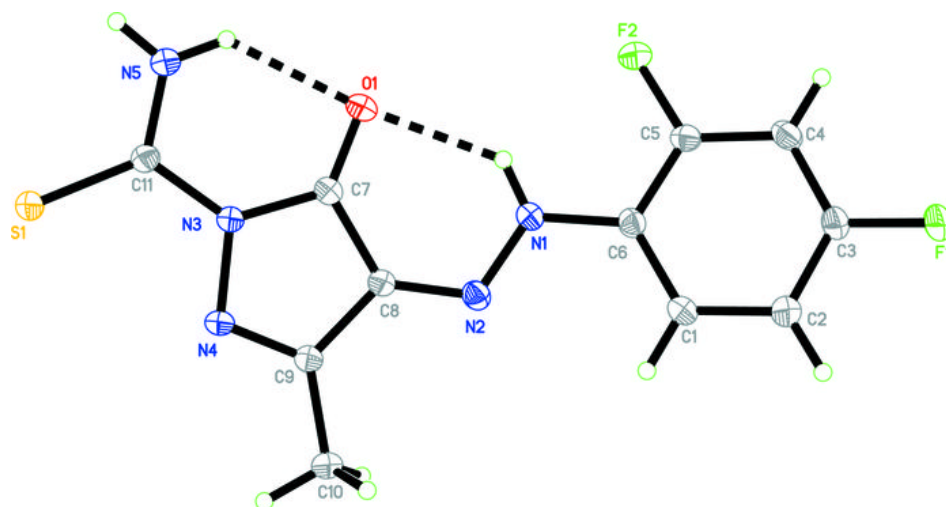
Fig. 1

Fig. 2