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The crystal structure of 2-*p*-fluorophenyl-5-dihydroxymethyl-1,3,4-oxadiazole, C₉H₇FN₂O₃

Table 1: Data collection and handling.

Crystal:	Colorless block
Size:	0.22 × 0.20 × 0.18 mm
Wavelength:	Mo K α radiation (0.71073 Å)
μ :	0.13 mm ⁻¹
Diffractometer, scan mode:	SMART, φ and ω
$\theta_{\max}$, completeness:	25.6°, >99%
$N(hkl)_{\text{measured}}$, $N(hkl)_{\text{unique}}$, R_{int} :	5735, 1750, 0.036
Criterion for I_{obs} , $N(hkl)_{\text{gt}}$:	$I_{\text{obs}} > 2 \sigma(I_{\text{obs}})$, 1243
$N(\text{param})_{\text{refined}}$:	142
Programs:	Bruker [1], SHELX [2, 3]

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Abstract

C₉H₇FN₂O₃, triclinic, $P\bar{1}$ (no. 2), $a = 14.467(3)$ Å, $b = 7.4629(14)$ Å, $c = 8.9512(18)$ Å, $\alpha = 90^\circ$, $\beta = 104.759(4)^\circ$, $\gamma = 90^\circ$, $V = 934.5(3)$ Å³, $Z = 4$, $R_{\text{gt}}(F) = 0.0421$, $wR_{\text{ref}}(F^2) = 0.1173$, $T = 273$ K.

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The molecular structure is shown in the figure. Table 1 contains crystallographic data and Table 2 contains the list of the atoms including atomic coordinates and displacement parameters.

Source of material

All chemicals are of analytical grade and are commercially available. Preparation of 2-*p*-fluorophenyl-5-dihydroxymethyl-1,3,4-oxadiazole: a mixture of *p*-fluorobenzoic acid (30.0 g, 0.214 mol) and SOCl₂ (30.5 g, 0.257 mol) in EtOH (150 mL) was reacted for 30 min. We slowly added hydrazine hydrate in reflux with stirring for 1 h. The white solid was filtered and washed with water and dried

Table 2: Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å²).

Atom	<i>x</i>	<i>y</i>	<i>z</i>	$U_{\text{iso}}^*/U_{\text{eq}}$
C1	0.58771(16)	0.9348(4)	0.4053(3)	0.0609(7)
C2	0.60530(15)	0.7679(3)	0.4698(3)	0.0569(6)
H2	0.5718	0.6682	0.4220	0.068*
C3	0.67422(14)	0.7517(3)	0.6080(2)	0.0472(5)
H3	0.6885	0.6395	0.6532	0.057*
C4	0.72216(13)	0.9023(3)	0.6794(2)	0.0403(5)
C5	0.70209(16)	1.0690(3)	0.6103(3)	0.0540(6)
H5	0.7343	1.1700	0.6575	0.065*
C6	0.63378(18)	1.0845(3)	0.4707(3)	0.0657(7)
H6	0.6199	1.1954	0.4229	0.079*
C7	0.79354(13)	0.8830(2)	0.8267(2)	0.0365(4)
C8	0.88494(13)	0.9647(2)	1.0420(2)	0.0357(4)
C9	0.92178(14)	1.0911(2)	1.1747(2)	0.0401(5)
H9	0.9314	1.2096	1.1339	0.048*
F1	0.51945(11)	0.9488(3)	0.26892(17)	0.0924(6)
N1	0.83987(11)	0.7421(2)	0.88672(18)	0.0393(4)
N2	0.90022(11)	0.7958(2)	1.02942(18)	0.0391(4)
O1	0.81784(9)	1.02938(17)	0.91916(15)	0.0398(4)
O2	0.85449(11)	1.10509(18)	1.26279(18)	0.0487(4)
H10	0.8515(15)	1.003(2)	1.308(3)	0.058*
O3	1.00934(10)	1.02487(19)	1.25909(17)	0.0499(4)
H20	1.0328(15)	1.111(3)	1.320(2)	0.060*

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under vacuum to give the compound 4-fluorobenzohydrazide (32.3 g, yield 98%). To a mixture of 4-fluorobenzoyl hydrazide (30.0 g, 0.194 mol) and chloroacetic acid (18.3 mL, 0.194 mol) in xylene (200 mL), phosphorus oxychloride (20.08 mL) was dropped on the condition of ice bath, and stirred to reflux for 4 h. After cooling and evaporating the solvent under reduced pressure, saturated sodium bicarbonate solution

was slowly added to the residue in ice bath. The product was filtered, and washed with water to neutrality to get the 2-(chloromethyl)-5-(4-fluorophenyl)-1,3,4-oxadiazole (37.9 g, yield 92%). 2-(Chloromethyl)-5-(4-fluorophenyl)-1,3,4-oxadiazole (35.0 g, 0.164 mol) and sodium acetate (16.1 g, 0.197 mol) were stirred in *N,N*-dimethylformamide (150 mL) at ambient temperature for 24 h before partitioning between dichloromethane and water. The aqueous phase was extracted with dichloromethane, the combined organics washed with sat. dried (Na₂SO₄), and concentrated *in vacuo* to get the (5-(4-fluorophenyl)-1,3,4-oxadiazol-2-yl)methyl acetate (34.4 g, yield 89%). The product was used in the next reaction without purification. A mixture of (5-(4-fluorophenyl)-1,3,4-oxadiazol-2-yl)methyl acetate (30.0 g, 0.127 mol) and sodium hydroxide (14.2, 0.254 mol) in H₂O:THF (1:1) at ambient temperature for 24 h. The mixture was concentrated *in vacuo*, followed by purification of the residue (24.6 g, yield 84%) by silica gel flash chromatography (gradient from *n*-hexane to *n*-hexane:ethyl acetate 1:1). The product was used in the next reaction without purification. A mixture of 2-*p*-fluorophenyl-5-dihydroxymethyl-1,3,4-oxadiazole (24.0 g, 0.137 mol) and MnO₂ (10.8 g, 0.123 mol) in THF (9 mL) was stirred for 16 h. The reaction mixture was filtered through a pad of celite and the filtrate was evaporated to get the title compound (18.8 g, yield 80%). ¹H NMR (400 MHz, DMSO) δ [ppm] 8.08 (t, 2H), 7.46 (d, *J* = 5.1 Hz, 2H), 7.29 (d, *J* = 6.4 Hz, 2H), 6.01 (t, 1H). Crystals were grown in hexane at room temperature.

Experimental details

All hydrogen atoms were placed in geometrically calculated positions.

Comment

1,3,4-Oxadiazoles have shown broad biological activities [4, 5]. Antifungal activities against rice sheath blight (RSB) and sorghum anthracnose (SA) [6] are two examples. Some oxadiazole compounds are also good photosensitive materials and monomers for polymer liquid crystals and polymers [7]. The 1,3,4-oxadiazole ring is introduced into a different compound structure, and a series of compounds having a broad spectrum of biological activity and an electroluminescent material can be produced by structural modification [8]. Therefore, the synthesis of 1,3,4-oxadiazole derivatives has also become a hot spot of research. Oxadiazole derivatives, having been important intermediates in the fields of medicine and organic chemical industry [9, 10].

The structure of the title compound was elucidated by spectroscopic method and X-ray diffraction. The crystal structure shows that the 1,3,4-oxadiazole is linked to *p*-fluorophenyl via C7, and C8 is linked to dihydroxymethyl.

All bond lengths and angles in the crystal structure are within the normal ranges [11]. The crystal structure indicates that the molecule shows intermolecular O3—H20 ⋯ N2 hydrogen bonds (distance = 2.00 Å), and O2—H10 ⋯ N1 hydrogen bonds (distance = 1.98 Å).

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