Crystal structure of 1,2-bis(pyridin-1-ium-4-yl)ethylene bis(5-fluorouracil-1-acetate), $(C_{12}H_{12}N_2)[C_6H_4FN_2O_4]_2$

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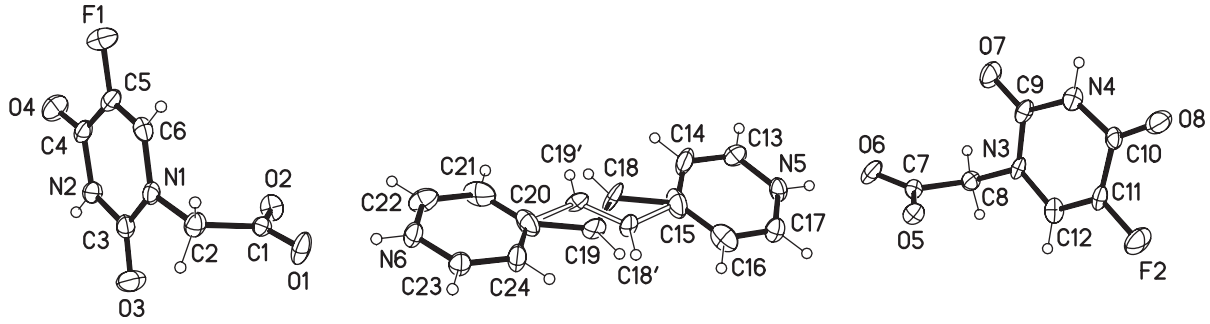
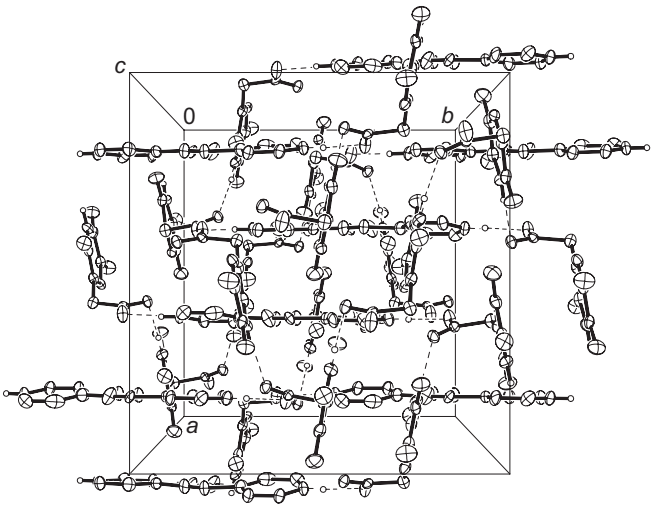
Received September 30, 2006, accepted and available on-line November 16, 2006; CCDC no. 1267/1904





Abstract

$C_{24}H_{20}F_2N_6O_8$, orthorhombic, *Pbca* (no. 61), a = 13.999(8) Å, b = 13.295(7) Å, c = 25.97(2) Å, V = 4833.5 Å^3, Z = 8, $R_{gt}(F)$ = 0.078, $wR_{ref}(F^2)$ = 0.193, T = 298 K.

Source of material

The 5-fluorouracil-1-acetic acid was prepared from 5-fluorouracil and bromoacetic acid following the method of the list [1]. An ethanol solution (10 mL) of 1,2-bis(pyridyl)ethylene (1.00 mmol, 0.18 g) was added dropwise to a stirred aqueous solution (10 mL) of 5-fluorouracil-1-acetic acid (2.00 mmol, 0.38 g) at 253 K. The reaction mixture was filtered and the filtrate was allowed to stand for approximately four weeks until colorless single crystals were formed.

Experimental details

The 1,2-bis(pyridin-1-ium-4-yl)ethylene is disordered over two positions, resulting in somewhat larger R values.

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Discussion

5-Fluorouracil (5FU) is an antimetabolite with a broad spectrum of activity against solid tumors. It is also known to be an effective anti-tumor compound against breast, colorectal, and gastric cancers [2,3]. However, it causes toxic side effects and disorders of bone marrow or the epithelium of the gastrointestinal tract. Thus, many derivatives of 5FU have been developed to minimize toxic side effects and delivery problems [1,4,5]. 5-Fluorouracil-1-acetic acid, a derivative of 5FU, is an excellent candidate for the development of supramolecular motifs in crystals, as it possesses not only acceptor atoms (carboxylate O and carbonyl O), but also donor atom (the uracil N). 1,2-Bis(pyridyl)ethylene is a basic amine spacer which readily forms monocation or dication, where the N—H bonds are generally active in hydrogen-bond formation. In order to investigate proton transfer and hydrogen-bond motifs between molecules of the two compounds, the title compound was synthesized and its crystal structure was determined.

The formula unit of the title crystal structure comprises one 1,2-bis(pyridin-1-ium-4-yl)ethylene cation and two 5-fluorouracil-1-acetate anions (figure, top). The 1,2-bis(pyridyl)ethylene molecule acts as a proton receptor in the title charge transfer complex. The conjugation in the cation is confirmed by the distances of N4—C9, C9—C10, C10—C11, C11—C12, C12—C13 and C13—N4, which are intermediate between single bond and double bonds [6]. In the crystal structure, intermolecular N–H···O hydrogen bonds connect cations and anions into the three dimensional network (figure, bottom).

Table 1. Data collection and handling.

Crystal:	colorless block, size 0.09 × 0.15 × 0.22 mm
Wavelength:	Mo K_α radiation (0.71073 Å)
μ:	1.27 cm^{-1}
Diffractometer, scan mode:	Bruker SMART APEX CCD, φ/ω
$2\theta_{max}$:	50.04°
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	24065, 4264
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\,\sigma(I_{obs})$, 3606
$N(param)_{refined}$:	380
Programs:	SHELXS-97 [7], SHELXL-97 [8]

Table 2. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	Occ.	*x*	*y*	*z*	U_{iso}
H(2)	8*c*		0.2946	–0.5426	0.1982	0.044
H(2A)	8*c*		0.1799	–0.5584	0.3584	0.051
H(2B)	8*c*		0.0711	–0.5340	0.3514	0.051
H(6A)	8*c*		0.0074	–0.4965	0.2688	0.046
H(4)	8*c*		–0.2011	0.7968	0.6989	0.048
H(8A)	8*c*		0.1526	0.7707	0.6676	0.048
H(8B)	8*c*		0.0790	0.7984	0.6244	0.048
H(12)	8*c*		0.0962	0.7347	0.7536	0.048
H(5)	8*c*		0.1326	0.5109	0.5646	0.050
H(6)	8*c*		0.1342	–0.2742	0.4299	0.052
H(13)	8*c*		0.1070	0.4822	0.4814	0.064
H(14)	8*c*		0.1080	0.3187	0.4534	0.086
H(16)	8*c*		0.1588	0.2290	0.5970	0.070
H(17)	8*c*		0.1549	0.3925	0.6230	0.053
H(18)	8*c*	0.54	0.1337	0.1665	0.4517	0.065
H(19)	8*c*	0.54	0.1360	0.0702	0.5468	0.048
H(21)	8*c*		0.1382	0.0121	0.4010	0.079
H(22)	8*c*		0.1403	–0.1508	0.3724	0.066
H(23)	8*c*		0.1266	–0.2490	0.5146	0.050
H(24)	8*c*		0.1272	–0.0892	0.5449	0.063
H(18′)	8*c*	0.46	0.1435	0.1020	0.5518	0.041
H(19′)	8*c*	0.46	0.1306	0.1309	0.4460	0.040

Table 3. Atomic coordinates and displacement parameters (in Å^2).

Atom	Site	Occ.	*x*	*y*	*z*	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
F(1)	8*c*		–0.0003(5)	–0.4856(5)	0.1725(3)	0.055(4)	0.076(5)	0.057(4)	–0.004(3)	–0.020(3)	0.009(3)
O(1)	8*c*		0.1333(6)	–0.3982(5)	0.4095(3)	0.101(6)	0.044(4)	0.024(4)	–0.013(4)	0.004(4)	–0.008(3)
O(2)	8*c*		0.1786(5)	–0.3397(5)	0.3327(3)	0.046(4)	0.036(4)	0.047(4)	–0.008(3)	0.012(3)	0.005(3)
O(3)	8*c*		0.3053(5)	–0.5519(7)	0.2914(3)	0.050(5)	0.088(6)	0.044(4)	0.011(4)	–0.011(4)	0.001(4)
O(4)	8*c*		0.1792(6)	–0.5108(6)	0.1311(3)	0.072(6)	0.074(6)	0.034(4)	–0.002(4)	–0.002(4)	–0.002(4)
N(1)	8*c*		0.1460(6)	–0.5214(6)	0.2854(3)	0.044(5)	0.034(4)	0.029(4)	0.003(3)	0.002(3)	–0.009(3)
N(2)	8*c*		0.2395(6)	–0.5322(6)	0.2117(3)	0.039(4)	0.045(5)	0.026(4)	0.006(4)	0.004(3)	–0.005(3)
C(1)	8*c*		0.1523(6)	–0.4061(6)	0.3618(3)	0.031(5)	0.028(5)	0.035(5)	–0.001(4)	–0.004(4)	–0.001(4)
C(2)	8*c*		0.1351(8)	–0.5130(8)	0.3419(4)	0.054(6)	0.042(6)	0.031(5)	–0.002(5)	0.002(4)	–0.001(4)
C(3)	8*c*		0.2359(8)	–0.5356(7)	0.2650(4)	0.053(6)	0.029(5)	0.036(5)	0.003(4)	0.001(5)	–0.002(4)
C(4)	8*c*		0.1660(7)	–0.5143(7)	0.1777(3)	0.056(6)	0.033(5)	0.025(5)	–0.004(4)	–0.006(4)	–0.003(4)
C(5)	8*c*		0.0766(7)	–0.5003(7)	0.2030(4)	0.050(6)	0.037(5)	0.032(5)	–0.008(4)	–0.009(4)	–0.003(4)
C(6)	8*c*		0.0674(7)	–0.5047(7)	0.2540(4)	0.033(5)	0.029(5)	0.052(6)	–0.001(4)	0.009(4)	–0.005(4)
F(2)	8*c*		–0.0195(5)	0.7440(6)	0.8278(2)	0.067(5)	0.109(6)	0.029(3)	–0.005(4)	0.005(3)	0.006(3)
O(5)	8*c*		0.0888(5)	0.5727(5)	0.6591(2)	0.047(4)	0.032(3)	0.034(4)	–0.007(3)	–0.001(3)	0.006(3)
O(6)	8*c*		0.1251(6)	0.6398(5)	0.5828(2)	0.092(6)	0.035(4)	0.028(4)	–0.006(4)	–0.019(4)	–0.001(3)
O(7)	8*c*		–0.0936(6)	0.7755(6)	0.6265(3)	0.068(5)	0.074(5)	0.029(4)	–0.001(4)	0.008(4)	–0.002(4)
O(8)	8*c*		–0.1999(6)	0.7886(7)	0.7922(3)	0.053(5)	0.081(6)	0.045(5)	–0.004(4)	–0.012(4)	–0.006(4)
N(3)	8*c*		0.0167(5)	0.7591(5)	0.6908(3)	0.046(5)	0.032(4)	0.020(4)	–0.007(3)	0.002(3)	–0.007(3)
N(4)	8*c*		–0.1443(6)	0.7840(6)	0.7096(3)	0.040(4)	0.042(5)	0.037(5)	–0.011(4)	0.006(3)	–0.004(4)
C(7)	8*c*		0.1019(6)	0.6449(6)	0.6295(3)	0.027(4)	0.032(5)	0.029(5)	–0.005(3)	0.005(4)	0.000(4)
C(8)	8*c*		0.0923(7)	0.7515(7)	0.6521(4)	0.049(6)	0.037(5)	0.035(5)	0.005(4)	–0.005(4)	–0.002(4)
C(9)	8*c*		–0.0748(8)	0.7729(7)	0.6723(3)	0.061(7)	0.031(5)	0.022(5)	–0.007(4)	0.002(4)	0.004(4)
C(10)	8*c*		–0.1330(7)	0.7768(7)	0.7622(4)	0.047(6)	0.027(5)	0.037(5)	0.002(4)	0.000(4)	–0.011(4)
C(11)	8*c*		–0.0360(7)	0.7553(7)	0.7766(3)	0.057(6)	0.033(5)	0.022(5)	–0.003(4)	0.008(4)	–0.005(4)
C(12)	8*c*		0.0343(7)	0.7478(7)	0.7424(4)	0.044(5)	0.035(5)	0.042(6)	–0.010(4)	0.012(4)	–0.004(4)
N(5)	8*c*		0.1322(6)	0.4494(6)	0.5543(3)	0.056(5)	0.027(4)	0.041(5)	0.004(3)	0.006(4)	–0.003(4)
N(6)	8*c*		0.1338(6)	–0.2132(6)	0.4410(3)	0.058(5)	0.033(5)	0.037(5)	–0.006(4)	–0.003(4)	–0.008(4)
C(13)	8*c*		0.1176(8)	0.430(1)	0.5045(4)	0.064(7)	0.066(8)	0.030(6)	0.010(6)	–0.005(5)	0.004(5)
C(14)	8*c*		0.1182(9)	0.333(1)	0.4881(5)	0.054(7)	0.10(1)	0.055(8)	0.004(7)	–0.005(6)	–0.051(8)
C(15)	8*c*		0.1337(9)	0.254(1)	0.5219(6)	0.052(7)	0.050(7)	0.11(1)	0.001(5)	–0.001(7)	–0.039(8)
C(16)	8*c*		0.1479(8)	0.2794(8)	0.5728(5)	0.058(7)	0.034(6)	0.082(9)	–0.004(5)	0.009(6)	0.012(6)
C(17)	8*c*		0.1462(8)	0.3767(7)	0.5884(4)	0.059(7)	0.036(6)	0.037(5)	–0.005(5)	0.002(5)	–0.003(4)
C(18)	8*c*	0.54(3)	0.134(2)	0.162(1)	0.4874(6)	0.09(2)	0.06(2)	0.02(1)	–0.03(1)	–0.003(9)	–0.01(1)
C(19)	8*c*	0.54	0.135(1)	0.075(1)	0.5110(6)	0.07(1)	0.04(1)	0.02(1)	0.00(1)	–0.006(8)	0.018(9)
C(20)	8*c*		0.1333(8)	–0.0199(8)	0.4772(6)	0.041(6)	0.033(6)	0.11(1)	0.003(4)	–0.009(6)	–0.020(7)
C(21)	8*c*		0.1366(9)	–0.0405(8)	0.4246(6)	0.067(8)	0.033(6)	0.10(1)	–0.011(5)	–0.020(7)	0.028(6)
C(22)	8*c*		0.1373(8)	–0.1375(9)	0.4075(4)	0.065(8)	0.059(7)	0.042(6)	–0.016(6)	–0.011(5)	0.019(5)
C(23)	8*c*		0.1296(7)	–0.1955(8)	0.4916(4)	0.058(6)	0.036(5)	0.032(5)	0.002(4)	0.000(4)	0.004(4)
C(24)	8*c*		0.1297(8)	–0.1002(9)	0.5096(4)	0.059(7)	0.049(7)	0.050(6)	0.003(5)	0.001(5)	–0.022(6)
C(18′)	8*c*	0.46	0.138(2)	0.139(1)	0.5215(7)	0.06(1)	0.03(1)	0.01(1)	0.00(1)	0.003(9)	0.007(9)
C(19′)	8*c*	0.46	0.134(1)	0.095(1)	0.4765(7)	0.05(1)	0.03(1)	0.02(1)	–0.014(9)	–0.008(9)	0.01(1)

Acknowledgments. We acknowledge financial support by the Zhejiang Provincial Natural Science Foundation of China (grant no. Y405078) and the National Natural Science Foundation of China (grant no. 20571057).

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