Crystal structure of (6*E*)-2-[(*ortho*-hydroxy)benzylidene]-1-[4,5-dihydro-5-(*ortho*-hydroxy-phenyl)-1,3,4-thiadiazo-2-yl-4-isoproylidenonium]-hydrazine chloride, $C_{18}H_{19}ClN_4O_2S$

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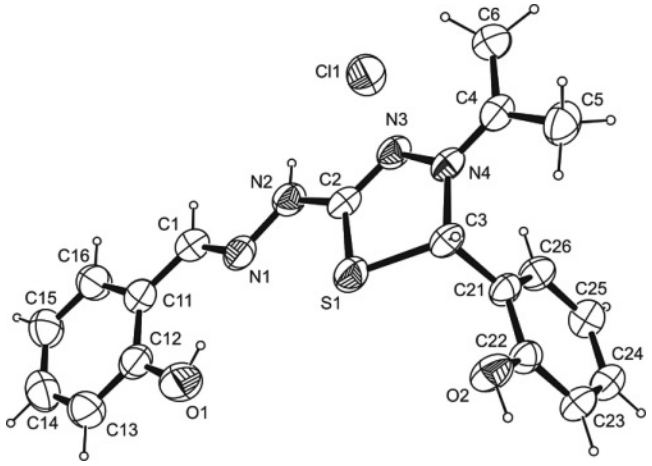

Abstract

$C_{18}H_{19}ClN_4O_2S$, monoclinic, *I*2/*a* (no. 15), a = 15.771(4) Å, b = 11.101(3) Å, c = 22.072(6) Å, β = 101.986(9)°, V = 3780.0 Å^3, Z = 8, $R_{gt}(F)$ = 0.0551, $wR_{ref}(F^2)$ = 0.1538, T = 200 K.

Table 1. Data collection and handling.

Crystal:	black blocks, size 0.157×0.379×0.546 mm
Wavelength:	Mo K_α radiation (0.71073 Å)
μ:	3.33 cm^{-1}
Diffractometer, scan mode:	Bruker APEX-II CCD, φ and ω
$2\theta_{max}$:	56.56°
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	16893, 4661
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\ \sigma(I_{obs})$, 3498
$N(param)_{refined}$:	243
Programs:	SHELX, WinGX, MERCURY, PLATON [9–12]

Source of material

The compound was obtained upon the attempted coordination reaction between $ReOCl_3(PPh_3)_2$ and (1*E*,5*E*)-1,5-di(*ortho*-hydroxy-benzylidene)thiocarbonohydrazide in a mixture of acetone and dichloromethane. Crystals suitable for the diffraction study were obtained directly from reaction product obtained.

Experimental details

Carbon-bound H atoms were placed in calculated positions (C–H 0.95 Å for aromatic carbon atoms and the formyl group and C–H 1.00 Å for the methine group) and were included in the refinement in the riding model approximation, with U_{iso}(H) set to 1.2U_{eq}(C). The H atoms of the methyl groups were allowed to rotate with a fixed angle around the C–C bond to best fit the experimental electron density (HFIX 137 in the SHELX program suite [9]), with U_{iso}(H) set to 1.5U_{eq}(C). The H atoms of the hydroxyl groups were allowed to rotate with a fixed angle around the C–O bond to fit the experimental electron density (HFIX 147 in the SHELX program suite [9]), with U_{iso}(H) set to 1.5U_{eq}(O). The nitrogen-bound H atom was located on a difference Fourier map and refined freely.

Discussion

Next to cardiovascular diseases, cancer has become one of the main fatal diseases in industrialized countries. Apart from classical surgery, chemo- and radiotherapeutic treatments have entered the arsenal of possible cures for certain types of cancer. All methods, however, suffer from their own set of problematic side-effects and, as a consequence, the development of radiopharmaceuticals – combining the advantages of chemotherapy as well as radiation methods while at the same time avoiding their unique respective undesired side-effects – has been a topic of research [1, 2]. Tailoring and fine-tuning of the envisioned radiopharmaceuticals' properties such as lipophilicity and, in particular, inertness is of paramount importance with respect to possible future *in vivo* applications in contemporary medicine and requires sound knowledge about structural parameters of the ligands applied if a more heuristic approach in the synthesis is to triumph over pure trial-and-error as it is encountered in this specific field of coordination chemistry up to the present day. In continuation of our interest in rhenium-based coordination compounds, the coordination between a thionohydrazide-derived ligand and a rhenium(V) starting compound was attempted. A structural study of the isolated crystals showed the formation of a surprising reaction product instead of the desired compound. The compound is the chloride salt of a heterocyclic quarternary ammonium cation. The positive charge is located on the nitrogen atom bearing the isopropyl group as isopropenyl group. Extensive resonance spanning from the cationic moiety to the (*ortho*-hydroxy)benzylidene moiety bonded to the hydrazine chain causes planarization of this part of the molecule (r.m.s of all fitted non-hydrogen atoms = 0.0954 Å) with the phenyl-bearing carbon atom of the heterocycle deviating most from this least-squares plane by 0.1876(22) Å. The latter least-squares plane intersects with the least-squares plane defined by the non-hydrogen atoms of the aromatic moiety that is bonded directly to the heterocycle at an angle of 78.18(5)°. A puckering analysis of the five-membered heterocycle according to Cremer & Pople [3] shows it to adopt an E_5 conformation [4] with the carbon atom bearing the (*ortho*-hydroxy)-phenyl group as the flap atom. The exocyclic N–N bond length was found at 1.376(3) Å which is in good agreement with values apparent for other compounds derived from

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thionodihydrazide whose structural parameters have been deposited with the Cambridge Structural Database [5]. The C=N double bond is (*E*)-configured. In the crystal, classical hydrogen bonds of the O–H···N, O–H···Cl and N–H···Cl type are observed next to C–H···O and C–H···Cl contatcs whose range invariably falls below the sum of van-der-Waals radii of the atoms participating in them [6]. The O–H···N contacts are intramolecular with the acceptor atom being part of the Schiff base moiety. The intermolecular C–H···O contacts are supported by the hydrogen atom of the intracyclic asymmetric CH group of the heterocycle as donor and the hydroxyl group of the (*ortho*-hydroxy)-phenyl group bonded to this asymmetric carbon atom as acceptor. The C–H···Cl contact stems from the hydrogen atom in *para* position to the hydrazide chain giving rise to the Schiff base functionality. In terms of graph-set analysis [7, 8], the descriptor for the classical hydrogen bonds is *DDS*(6) on the unary level while the C–H···O contacts necessitate a $R^2_2(10)$ descriptor on the same level. For a C–H···Cl contacts, a *D* descriptor is needed on the unary level. In total, the entities of the title compound are connected to layers perpendicular to the crystallographic *a* axis.

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

Atom	Site	*x*	*y*	*z*	U_{iso}
H(81)	8*f*	0.3659	–0.0311	0.0444	0.097
H(2)	8*f*	0.3756	0.1852	0.3145	0.071
H(72)	8*f*	0.362(3)	0.311(4)	–0.019(2)	0.09(1)
H(1)	8*f*	0.3800	0.1519	–0.0798	0.054
H(3)	8*f*	0.2861	0.3417	0.1955	0.047
H(5A)	8*f*	0.2200	0.6128	0.1960	0.081
H(5B)	8*f*	0.3198	0.6490	0.2183	0.081
H(5C)	8*f*	0.2892	0.5141	0.2276	0.081
H(6A)	8*f*	0.3383	0.6545	0.0747	0.079
H(6B)	8*f*	0.2674	0.7207	0.1053	0.079
H(6C)	8*f*	0.2382	0.6182	0.0543	0.079
H(13)	8*f*	0.4306	–0.2984	0.0037	0.069
H(14)	8*f*	0.4493	–0.3472	–0.0955	0.072
H(15)	8*f*	0.4326	–0.2021	–0.1726	0.069
H(16)	8*f*	0.4034	–0.0034	–0.1494	0.065
H(23)	8*f*	0.5151	0.2562	0.3544	0.052
H(24)	8*f*	0.6247	0.3831	0.3368	0.055
H(25)	8*f*	0.6069	0.4959	0.2461	0.056
H(26)	8*f*	0.4789	0.4800	0.1719	0.052

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

Atom	Site	*x*	*y*	*z*	U_{11}	U_{22}	U_{33}	U_{12}	U_{13}	U_{23}
S(1)	8*f*	0.33382(5)	0.20843(6)	0.12487(3)	0.0550(4)	0.0472(4)	0.0326(3)	–0.0056(3)	0.0014(3)	0.0034(3)
O(1)	8*f*	0.3922(2)	–0.0968(2)	0.0442(1)	0.087(2)	0.063(1)	0.044(1)	0.000(1)	0.014(1)	0.010(1)
O(2)	8*f*	0.3626(1)	0.2223(2)	0.28065(8)	0.044(1)	0.060(1)	0.0359(9)	–0.0073(9)	0.0041(7)	0.0132(8)
N(1)	8*f*	0.3662(1)	0.1322(2)	0.0056(1)	0.042(1)	0.053(1)	0.037(1)	0.001(1)	–0.0007(9)	–0.0028(9)
N(2)	8*f*	0.3560(1)	0.2547(2)	0.0102(1)	0.047(1)	0.049(1)	0.032(1)	0.006(1)	0.0055(9)	–0.0012(9)
N(3)	8*f*	0.3370(1)	0.4181(2)	0.06901(9)	0.045(1)	0.051(1)	0.0251(9)	0.0036(9)	0.0065(8)	0.0021(8)
N(4)	8*f*	0.3206(1)	0.4447(2)	0.12704(8)	0.039(1)	0.049(1)	0.0243(9)	0.0006(9)	0.0034(8)	0.0031(8)
C(1)	8*f*	0.3800(2)	0.0949(3)	–0.0477(1)	0.044(1)	0.050(2)	0.039(1)	0.002(1)	0.003(1)	0.003(1)
C(2)	8*f*	0.3437(2)	0.3017(2)	0.0634(1)	0.033(1)	0.051(1)	0.028(1)	0.003(1)	0.0007(9)	0.003(1)
C(3)	8*f*	0.3350(2)	0.3448(2)	0.1730(1)	0.042(1)	0.049(1)	0.025(1)	–0.001(1)	0.0046(9)	0.0044(9)
C(4)	8*f*	0.2959(2)	0.5515(3)	0.1385(1)	0.038(1)	0.053(2)	0.034(1)	0.000(1)	0.0028(9)	–0.002(1)
C(5)	8*f*	0.2798(2)	0.5847(3)	0.2004(1)	0.055(2)	0.067(2)	0.040(1)	0.004(1)	0.009(1)	–0.009(1)
C(6)	8*f*	0.2840(2)	0.6441(3)	0.0890(1)	0.058(2)	0.053(2)	0.043(1)	0.007(1)	0.004(1)	0.004(1)
C(11)	8*f*	0.3952(2)	–0.0302(3)	–0.0591(1)	0.042(1)	0.050(2)	0.040(1)	–0.003(1)	0.004(1)	–0.001(1)
C(12)	8*f*	0.4027(2)	–0.1208(3)	–0.0138(1)	0.047(1)	0.052(2)	0.041(1)	–0.008(1)	0.001(1)	0.004(1)
C(13)	8*f*	0.4238(2)	–0.2380(3)	–0.0274(2)	0.057(2)	0.050(2)	0.063(2)	–0.006(1)	0.009(1)	0.006(1)
C(14)	8*f*	0.4352(2)	–0.2668(3)	–0.0866(2)	0.054(2)	0.051(2)	0.076(2)	–0.006(1)	0.012(2)	–0.011(2)
C(15)	8*f*	0.4262(2)	–0.1812(3)	–0.1320(2)	0.065(2)	0.055(2)	0.053(2)	0.000(1)	0.013(1)	–0.009(1)
C(16)	8*f*	0.4077(2)	–0.0633(3)	–0.1182(1)	0.069(2)	0.050(2)	0.044(1)	0.002(1)	0.013(1)	–0.001(1)
C(21)	8*f*	0.4195(2)	0.3595(2)	0.2185(1)	0.040(1)	0.043(1)	0.0227(9)	0.002(1)	0.0068(8)	0.0008(9)
C(22)	8*f*	0.4306(2)	0.2921(2)	0.2733(1)	0.041(1)	0.041(1)	0.028(1)	0.002(1)	0.0085(9)	0.0014(9)
C(23)	8*f*	0.5074(2)	0.3016(2)	0.3172(1)	0.047(1)	0.052(2)	0.029(1)	0.000(1)	0.004(1)	0.005(1)
C(24)	8*f*	0.5722(2)	0.3770(3)	0.3067(1)	0.042(1)	0.057(2)	0.036(1)	0.001(1)	0.001(1)	–0.000(1)
C(25)	8*f*	0.5619(2)	0.4439(3)	0.2529(1)	0.043(1)	0.054(2)	0.044(1)	–0.006(1)	0.011(1)	0.001(1)
C(26)	8*f*	0.4859(2)	0.4345(2)	0.2090(1)	0.047(1)	0.051(2)	0.033(1)	–0.000(1)	0.011(1)	0.007(1)
Cl(1)	8*f*	0.10610(5)	0.40893(6)	0.09990(3)	0.0638(4)	0.0432(3)	0.0337(3)	–0.0024(3)	0.0140(3)	0.0034(2)

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