Crystal structure of dichloro[1-(*p*-chlorophenyl)-5-isopropylbiguanide]-palladium(II), $C_{11}H_{16}Cl_3N_5Pd$

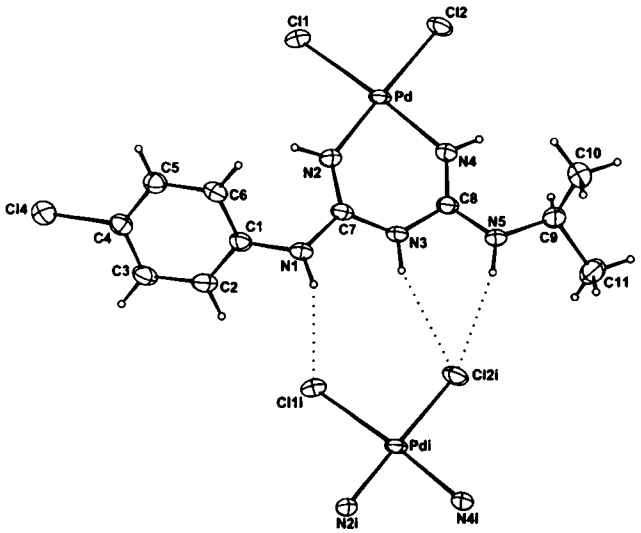
F. Bentefrit[I], A. Tomas*[II], G. Morgant[I], D. Nguyen-Huy[I], P. Lemoine[II] and B. Viossat[II, III]

[I] Université de Paris XI, Faculté de Pharmacie, Laboratoire de Cristallochimie Bioinorganique, 5, rue J. B. Clément, F-92296 Châtenay-Malabry Cedex, France

[II] Université de Paris V, Faculté des Sciences Pharmaceutiques et Biologiques, Laboratoire de Cristallographie et RMN Biologiques, UMR 8015 CNRS, 4, avenue de l'Observatoire, F-75270 Paris Cedex 06, France

[III] Laboratoire de Chimie Générale, Faculté de Médecine et de Pharmacie, 34, rue du Jardin des Plantes, BP199, F-86005 Poitiers Cedex, France

Received May 14, 2002, accepted and available on-line September 4, 2002; CCDC-No. 1267/867



Abstract

$C_{11}H_{16}Cl_3N_5Pd$, triclinic, $P\bar{1}$ (No. 2), a = 8.198(1) Å, b = 8.614(2) Å, c = 11.882(4) Å, α = 78.27(2)°, β = 70.85(2)°, γ = 84.53(2)°, V = 775.7 Å^3, Z = 2, ρ_m = 1.80(2) g·cm^{-3}, $R_{gt}(F)$ = 0.028, $wR_{ref}(F^2)$ = 0.072, T = 293 K.

Source of material

The title compound was obtained by dissolving proguanil hydrochloride ($4 \cdot 10^{-4}$ mol) in hot water (10 mL, 343 K) and adding potassium tetrachloropalladate(II) ($2 \cdot 10^{-4}$ mol) in water (1 mL, room temperature). An immediate beige precipitate was formed, and stirred during 30 mn at 343 K. The crystalline product was filtered off, washed with water, methanol and diethylether (yield: 58%). Analysis: calc. for $C_{11}H_{16}Cl_3N_5Pd$: C, 30.65%; H, 3.74%; Cl, 24.67%; N, 16.25%; Pd, 24.68%; found: C, 30.30%; H, 3.97%; Cl, 24.41%; N, 16.11%; Pd, 23.60%. The title compound was recrystallised from DMF.

Discussion

Proguanil[1-(*p*-chlorophenyl)-5-isopropylbiguanide], an antimalarial drug used worldwide, is characterized by different tautomer forms, one of which is stabilized upon complexation. The presence of the two imine groups in *cis* position thus acting as a bidentate ligand chelating the nickel(II) [1], prompted us to synthesize and characterize new complexes of Pd(II) or Pt(II) in view to modulate the pharmacological properties of the free ligand. The asymetric unit of the title compound consists of one monomeric molecule with Pd(II) cation surrounded by one proguanil ligand and two Cl^- anions. The Pd(II) atom exhibits a slightly distorted square-planar coordination built up from one bidentate chelating proguanil ligand via N2 and N4 atoms from the biguanide moiety of the molecule. The values of the bond angles at the Pd atom are in the range 86.99(8) ° – 93.93(4)°. The Pd—Cl bond lengths are equivalent [average value: 2.311(1) Å]. The Pd—N bond lengths are significantly different with average value of 1.966(2) Å. The Pd atom is displaced out of plane P1 (Cl1/Cl2/N2/N4)) by –0.018(1) Å. The N2–C7–N3–C8–N4 contour is nearly planar (mean plane P2), allowing delocalization of the π electron system along it. Pd(II) is displaced by 0.042(4) Å out of the plane P2. The dihedral angle between plane P2 and its attached phenyl ring (C1···C6) via N1 is 50.9(1)°; C7 atom is displaced out of plane P3 (N1/N2/N3) by –0.005(3)° and C8 atom is displaced out of plane P4 (N3/N4/N5) by –0.001(3)°. The dihedral angle between planes P3 and P4 is 5.3(2)°. Thus, the biguanide moiety in the proguanil ligand is almost plane. In contrast, the corresponding dihedral angle between the homologous nitrogen atoms in the crystal structure of 1-(*p*-chlorophenyl)-5-isopropylbiguanide hydrochloride) is 58.9°, a value which is characteristic of a non-planar molecule [2]. The crystal packing is characterized by several intra- and intermolecular hydrogen bonds [N4–H4···Cl2: 3.061(3) Å, 98°; N2–H2···Cl1: 2.947(3) Å, 100°; N1–H1···Cl1^i: 3.147(3) Å, 153°; N3–H3···Cl2^i: 3.483(3) Å, 152°; N5–H5···Cl2^i: 3.289(3) Å, 154°; symmetry code: *i*: 1–*x*, –*y*, –*z*]. In addition, the crystalline cohesion is likewise ensured by many van der Waals contacts.

Table 1. Data collection and handling.

Crystal:	yellow parallelepiped, size 0.12 × 0.17 × 0.22 mm
Wavelength:	Mo K_α radiation (0.71073 Å)
μ:	17.09 cm^{-1}
Diffractometer, scan mode:	Enraf-Nonius CAD4, $\omega/2\theta$
$2\theta_{max}$:	51.94°
$N(hkl)_{measured}$, $N(hkl)_{unique}$:	3030, 3030
Criterion for I_{obs}, $N(hkl)_{gt}$:	$I_{obs} > 2\,\sigma(I_{obs})$, 2695
$N(param)_{refined}$:	181
Programs:	SIR92 [3], SHELXL-97 [4], WinGX [5]

* Correspondence author (e-mail: tomas@pharmacie.univ-paris5.fr)

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

Atom	Site	x	y	z	U_{iso}
H(1)	2*i*	0.4191	0.0087	0.6800	0.052
H(2)	2*i*	0.0116	−0.0025	0.7062	0.048
H(3)	2*i*	0.4300	0.1868	0.5264	0.047
H(4)	2*i*	0.0924	0.3739	0.3880	0.050
H(5)	2*i*	0.5046	0.3427	0.3595	0.049
H(20)	2*i*	0.3398	0.0204	0.9101	0.052
H(30)	2*i*	0.2161	−0.1269	1.0997	0.054
H(50)	2*i*	−0.0490	−0.3627	0.9614	0.050

Table 2. Continued.

Atom	Site	x	y	z	U_{iso}
	2*i*	0.0938	−0.2295	0.7682	0.050
H(9)	2*i*	0.2795	0.5446	0.2790	0.051
H(10A)	2*i*	0.2566	0.3296	0.1927	0.080
H(10B)	2*i*	0.4566	0.3269	0.1275	0.080
H(10C)	2*i*	0.3415	0.4710	0.0900	0.080
H(11A)	2*i*	0.5496	0.6304	0.2612	0.087
H(11B)	2*i*	0.5247	0.6596	0.1332	0.087
H(11C)	2*i*	0.6401	0.5156	0.1705	0.087

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}
Pd(1)	2*i*	−0.09109(2)	0.18937(3)	0.56011(2)	0.0198(1)	0.0465(1)	0.0366(1)	−0.00064(8)	−0.01409(9)	−0.01143(9)
Cl(1)	2*i*	−0.31509(9)	0.0471(1)	0.70483(8)	0.0267(4)	0.0680(5)	0.0554(5)	−0.0112(3)	−0.0146(3)	−0.0039(4)
Cl(2)	2*i*	−0.2680(1)	0.3359(1)	0.45790(7)	0.0346(4)	0.0738(5)	0.0513(4)	0.0046(4)	−0.0270(3)	−0.0083(4)
Cl(4)	2*i*	−0.0330(1)	−0.3638(1)	1.19189(7)	0.0495(5)	0.0642(5)	0.0427(4)	−0.0056(4)	−0.0159(3)	−0.0065(3)
N(1)	2*i*	0.3083(3)	0.0043(3)	0.7042(2)	0.026(1)	0.058(2)	0.048(1)	−0.002(1)	−0.019(1)	−0.000(1)
N(2)	2*i*	0.0609(3)	0.0708(3)	0.6469(2)	0.027(1)	0.049(1)	0.044(1)	−0.005(1)	−0.015(1)	0.000(1)
N(3)	2*i*	0.3227(3)	0.1856(3)	0.5323(2)	0.023(1)	0.057(2)	0.040(1)	−0.004(1)	−0.016(1)	−0.004(1)
N(4)	2*i*	0.1126(3)	0.3031(3)	0.4447(2)	0.028(1)	0.056(2)	0.042(1)	−0.003(1)	−0.017(1)	−0.001(1)
N(5)	2*i*	0.4022(3)	0.3624(3)	0.3545(2)	0.023(1)	0.057(2)	0.042(1)	−0.005(1)	−0.014(1)	−0.001(1)
C(1)	2*i*	0.2272(4)	−0.0868(4)	0.8199(3)	0.027(1)	0.047(2)	0.040(2)	0.004(1)	−0.015(1)	−0.007(1)
C(2)	2*i*	0.2634(4)	−0.0583(4)	0.9201(3)	0.034(2)	0.052(2)	0.051(2)	−0.004(1)	−0.020(1)	−0.012(1)
C(3)	2*i*	0.1882(4)	−0.1443(4)	1.0336(3)	0.041(2)	0.062(2)	0.043(2)	−0.001(1)	−0.021(1)	−0.019(1)
C(4)	2*i*	0.0703(4)	−0.2572(4)	1.0480(3)	0.037(2)	0.044(2)	0.042(2)	0.006(1)	−0.017(1)	−0.011(1)
C(5)	2*i*	0.0318(4)	−0.2875(3)	0.9502(3)	0.045(2)	0.038(1)	0.049(2)	−0.003(1)	−0.022(1)	−0.007(1)
C(6)	2*i*	0.1141(4)	−0.2054(3)	0.8352(3)	0.045(2)	0.044(2)	0.045(2)	0.001(1)	−0.025(1)	−0.010(1)
C(7)	2*i*	0.2227(3)	0.0846(3)	0.6295(3)	0.027(1)	0.044(2)	0.039(1)	0.000(1)	−0.017(1)	−0.011(1)
C(8)	2*i*	0.2720(4)	0.2863(3)	0.4421(3)	0.027(1)	0.047(2)	0.037(1)	−0.002(1)	−0.014(1)	−0.011(1)
C(9)	2*i*	0.3821(4)	0.4770(4)	0.2506(3)	0.031(2)	0.048(2)	0.045(2)	0.001(1)	−0.012(1)	−0.005(1)
C(10)	2*i*	0.3569(5)	0.3934(4)	0.1565(3)	0.056(2)	0.060(2)	0.045(2)	−0.003(2)	−0.019(2)	−0.005(2)
C(11)	2*i*	0.5384(5)	0.5801(4)	0.1992(4)	0.045(2)	0.056(2)	0.066(2)	−0.012(2)	−0.012(2)	−0.000(2)

References

1. Bentefrit, F. ; Nguyen-Huy, D.; Viossat, B. ; Lemoine, P; Morgant, G.: Crystal structure of bis[1-(*p*-chlorophenyl)-5-isopropylbiguanide] nickel(II) dichloride dimethylformamide solvate, $[Ni(C_{11}H_{16}N_5Cl)_2Cl_2] \cdot (C_3H_7NO)$. Acta Crystallogr. C**58** (2002), submitted.
2. Brown, C. J.: The crystal structure of 1-(*p*-chlorophenyl)-5-isopropylbiguanide hydrochloride. J. Chem. Soc. A (1967) 60-65.
3. Altomare, A.; Cascarano, G.; Giacovazzo, G; Guagliardi, A.; Burla, M. C.; Polidori, G.; Camalli, M.: SIR92 - a program for automatic solution of crystal structures by direct methods. J. Appl. Crystallogr. **27** (1994) 435.
4. Sheldrick, G. M.: SHELXL-97. A computer program for refinement of crystal structures. University of Göttingen, Germany 1997.
5. Farrugia, L. J.: WinGX - Version 1.63.02. An integrated System of Windows Programs for the Solution, Refinement and Analysis of Single Crystals X-Ray Diffraction Data. J. Appl. Crystallogr. **32** (1999) 837-838.