

SINTESIS VERDE DE UNA NUEVA BASE DE SCHIFF QUIRAL Y SU COMPLEJO CON PD(II)

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Abstract: In this research a new complex with Pd(II) was synthesized from a Schiff base which was obtained with 2-thiophenecarboxaldehyde and the halogenated aromatic chiral primary amine (R)-(+)-1-(4-fluorophenyl) ethylamine, the method used for the synthesis was Solvent-free which is part of Green Chemistry which consists of the design, development and implementation of products and processes that reduce or eliminate the use and generation of hazardous substances for human health and the environment. One of the greatest challenges for chemists today is the development of non-conventional synthetic methods that are less polluting, designing clean chemical transformations. That is why this research work turns out to be interesting and topical. The composition of the products was verified by spectroscopic methods and the structures were confirmed by X-ray diffraction.

Keywords: Green Chemistry, complexes, palladium.

INTRODUCTION

One of the principles of Green Chemistry proposes the use of benign solvents, which are not flammable, toxic and do not produce emissions of volatile organic compounds derived from their use as a reaction medium in the chemical and pharmaceutical industries, with the aim of minimizing production of contaminants and by-products. To provide a solution, the development of a compound synthesis technique known as "Solvent Free" was planned. This technique drastically reduces the production of wastewater and atmospheric contamination; in addition to the fact that this methodology also has other advantages such as greater reactivity, a maximum concentration of reagents, washing and extraction processes are also simplified, or eventually avoided. (Anastas and Warner 2000).

An important objective of green chemistry must be to maximize the efficiency of the use of raw materials to minimize the creation of waste. (Trost, 2002)

The reactions in medium dry in many cases occur more selectively and efficiently than the reactions in solution, since in these, the molecules in a crystal, are arranged in a compact and regular way. In addition, the reactions in medium dry conditions have many advantages: reduced contamination, low cost, simplicity in processes and handling. (Tanaka, 2006)

The advances in the synthesis where the Solvent-free technique is used, in particular reactions between metallic salts and organic ligands to obtain coordination complexes has result to be very efficient. (Lazuen et al., 2007)

The Schiff base ligands are considered "privileged ligands" because they are easily prepared by means of condensation between aldehydes and amines. The stereogenic centers or other chiral elements (planes, shafts) can be introduced into the synthetic design. Schiff base ligands are capable of coordinating many different metals and stabilizing them in different oxidation states. (Cozzi PG 2004)

The great interest of Pd(II) complexes is mainly due to their structural diversity and applications as catalysts in organic synthesis and antitumoral drugs. (Gutiérrez et al., 2015)

The models of the reactions that involve the species of Palladium have found great applications in chemistry in the last two decades it has allowed to obtain previous knowledge in various stoichiometric and catalytic reactions. (Derat and Maestri, 2013).

The use of platinum-derived complexes as pharmaceuticals has acquired great importance since Rosenberg reported the synthesis and biological activity of the cis-dichlorodiaminoplatinum compound. These compounds have been used universally in various types of cancer but, unfortunately,

induce harmful side effects. On the other hand, many patients do not tolerate the treatment with inorganic drugs at the level of the doses required to be effective. This way, since the detection of the antitumoral activity of Cisplatin, a large number of analogous compounds with the general formula ML₂X₂ have been synthesized, (where M corresponds to Pt or Pd, L corresponds to an organic ligand and X corresponds to a halogen) and it has been observed that this activity varies with the metal and the ligands used. Due to the great importance that these complexes represent in the field of medicine, one of our main objectives has been focused on the synthesis of palladium complexes using chiral ligands of the imine type. (Rosenberg, 1965)

The metals, in particular, the transition metals offer potential advantages over the most common organic medicines, there is also much interest in the study of derivatives of palladium (II) as possible drugs against cancer. (Zhang J. et al. 2010)

The Palladium offers several applications in the field of chemical products, as one of the most widely used catalytic metals, due to its high activity and selectivity, there are many possibilities for the formation of carbon-carbon bonds in organic synthesis. (Sedighipoor M. et al., 2018)

DEVELOPMENT

The synthesis of a new chiral imine is reported, the reaction was carried out by reacting 2-thiofencarboxaldehyde (204.8 mg. 1.35 mmol) and the primary halogenated chiral amine (R)-(+)-1-(4-fluorophenyl) ethylamine (151.8 mg. 1.35 mmoles) in 1:1 molar amounts using a Green Chemistry technique: Solvent-free “reactions in dry medium” a medium free of solvent, starting from this with PdCl₂, the complex is obtained (Figure 1).

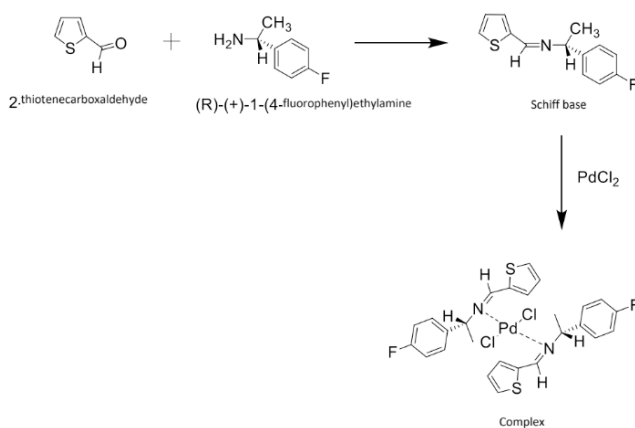


Figure 1. Reaction of the synthesis of the imine and its complex with Pd(II).

The coordination reaction of a palladium salt with an N-donating ligand involves the n orbital of the nitrogen and the d₈ orbital of the palladium. This type of coordination is unique of its kind in coordination chemistry. The synthesis of these complexes does not require special conditions, control of variables, special equipment, photolysis and has an advantage in the short reaction time, the use of polluting solvents is also minimized.

The palladium complexes are studied with routine spectroscopic techniques and depending on whether crystals are obtained, the X-ray diffraction of the single crystal is used.

The IR spectra were recorded on the Perkin Elmer Spectrum One FT-IR spectrometer Universal ATR equipment. The ¹H NMR and ¹³C NMR spectra were carried out on the Bruker-500 equipment (500 MHz); The chemical shifts are expressed in ppm towards low fields taking tetramethylsilane (TMS) as a reference (δ=00). The mass spectra were carried out using the electron impact (IE) technique, were recorded with a JEOL JMS-SX 102a spectrometer operated in positive ion mode at 70 eV, the data are expressed in mass/charge units (m/z). The optical rotation was measured on a Perkin-Elmer 241 polarimeter.

RESULTS AND DISCUSSIONS

The Schiff base obtained is a white solid with a melting point of 69-70° and a yield of 98% an excellent yield of the Schiff base, with $a = -153.7$ ($c=1$ CHCl₃). $[\alpha]_D^{25}$

For the Schiff base the spectroscopic results are the following:

FT-IR ν_{max} (KBr): 1631 (C=N). ¹H NMR (500 MHz, CDCl₃/TMS): δ =8.42 (s, 1H; HC=N), 7.395 (d, 1H; Ar-H), 7.37-7.33 (m, 2H; Ar-H), 7.30- 7.29 (m, 1H; Ar-H), 7.07-7.05 (m, 1H; Ar-H), 7.04-6.99 (m, 2H; Ar-H), 4.495 (q, 1H; CHCH₃), 1.55 (d, 3H; CH₃); ¹³C NMR (500 MHz, CDCl₃/TMS): δ =152.87 (HC=N), 161.8 (d, JF-C=242.5 Hz), 142.59, 140.71 (d, JF-C=3.75 Hz), 130.57, 128.99, 128.15 (d, JF-C=7.5 Hz), 127.37, 115.18 (d, JF-C=21.25 Hz) (C-Ar), 68.51 (CHCH₃), 24.88 (CHCH₃) ppm.

MS-EI: $m/z = 233$ confirms the proposed molecular formula C₁₃H₁₂FNS. The structure of this new Schiff base was confirmed by single crystal X-ray diffraction (Figure 2).

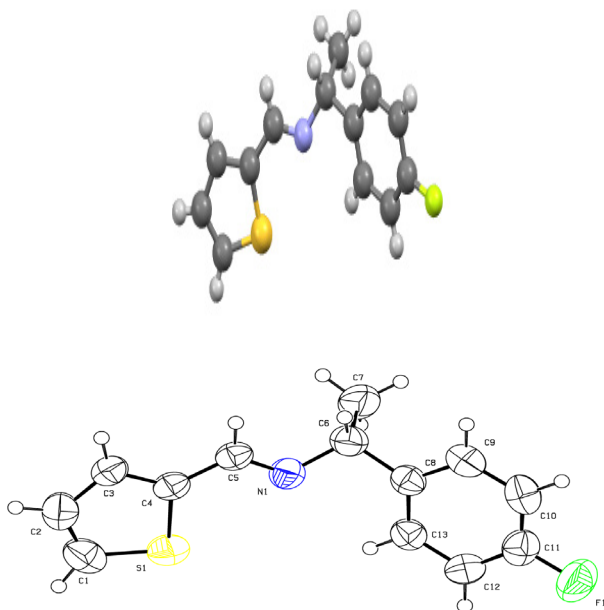


Figure 2. X-ray structure of the new Schiff Base.

For the Pd(II) complex, the NMR results

are as follows:

¹H NMR (500 MHz, CDCl₃/TMS): δ =7.71 (s, 1H; HC=N), 7.825 (d, 1H; Ar-H), 7.67-7.64 (m, 2H; Ar-H), 7.45- 7.44 (m, 1H; Ar-H), 7.17-7.16 (m, 1H; Ar-H), 7.12-7.07 (m, 2H; Ar-H), 6.185 (q, 1H; CHCH₃), 2.085 (d, 3H; CH₃); ¹³C NMR (500 MHz, CDCl₃/TMS): δ =162.09 (HC=N), 162.62 (d, JF-C=246.25 Hz), 138.91, 136.59, 135.20 (d, JF-C=3.75 Hz), 134.62, 130.5 (d, JF-C=7.5 Hz), 127.34, 115.77 (d, JF-C=25 Hz) (C-Ar), 68.56 (CHCH₃), 20.02 (CHCH₃) ppm.

In the NMR results we can observe that in the complex the signals are displaced due to the presence of Pd, the structure of the Pd(II) complex was confirmed by X-ray diffraction of the single crystal and which I present an orthorhombic structure with a formula molecular condensed C₂₆H₂₄Cl₂F₂N₂PdS₂ and a molecular weight of 643.89, we can also observe that the Pd coordinated with the pairs of electrons of the nitrogen and in addition were two molecules of the ligand that coordinated with the palladium (Figure 3)

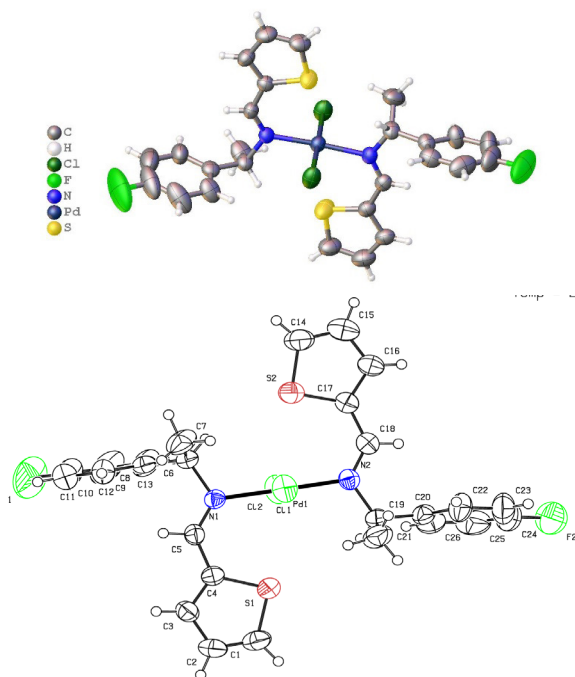


Figure 3. X-ray structure of the complex.

CONCLUSIONS

I confirm that the method of Solvent-free Green Chemistry actually turns out to be very efficient for the synthesis of the Schiff bases, due to the fact that contamination and energy consumption are greatly reduced. If the complex of Pd(II) is obtained, complexes of this type have been reported in the literature

with possible anticancer activity. The structure of the compounds was established by spectroscopic analysis and in addition the crystalline structure of the Schiff Base and the complex was fully confirmed by X-ray diffraction studies, from which we can observe that the pair of electrons from the nitrogen was coordinated with the Paladio.

REFERENCES

- Anastas, P. T., Warner, J. C. (2000). *Green Chemistry: Theory and Practice*. Ed. Oxford University Press, p. 30-36.
- Cozzi P. G. (2004) **Metal-Salen Schiff base complexes in catalysis: practical aspects**. *Chem. Soc. Rev.* 33: 410-421.
- Derat E., Maestri G. (2013) **Understanding palladium complexes structures and reactivities: beyond classical point of view**. *WIREs Comput Mol Sci.* 3: 529-541.
- Gutiérrez D. et al. (2015) **New chiral α -ketoimine-Pd(II) complexes and their anticancer activity**. *Journal of Coordination Chemistry*, 21: 3805-3813.
- Lazuen G.A. et al. (2007). **Solvent-free synthesis of metal complexes**. *Chem. Soc. Rev.*, 36: 846-855.
- Rosenberg B. (1965) *Nature*, 205: 698.
- Sedighipoor M. et al. (2018) **Unsymmetrical palladium (II) N,N,O,O-Schiff base complexes: Efficient catalysts for Suzuki coupling reactions**. *Inorgánica Chimica Acta*. 476: 20-26.
- Tanaka K. (2006) **Solvent-free Organic Synthesis**. Ed. Wiley-VCH, p-270-27.
- Trost Barry M. (2002) **On Inventing Reactions for Atom Economy**. *American Chemical Society*. 35: 695-705.
- Zhang J. et al. (2010) **Synthesis, Characterization and cytotoxicity of mixed-ligand complexes of palladium(II) with aromatic diimine and 4-toluenesulfonyl -L-amino acid dianion**. *European Journal of Medicinal Chemistry*. 45: 5337-5344.