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SYNTHESIS AND CHARACTERIZATION OF PALLADIUM (II)–2-(AZIDOMETHYL)CYCLOPROPANE-1,1-DICARBOXYLIC ACID COMPLEX

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Abstract:

The discovery that palladium complexes possess a wide range of biological activities (from antitumor, -viral, -malarial, -fungal to antimicrobial activities) encourages further research in this scientific field. Herein we describe the synthesis and characterization of a novel palladium (II) complex, using [Pd(dien)Cl]Cl and 2-(azidomethyl)cyclopropane-1,1-dicarboxylic acid (**azmcpda**) as a ligand. [Pd(dien)Cl]Cl was selected as a starting material taking into consideration its importance as a model for the investigation of the substitution reactions in coordination chemistry and a deeper understanding of the biological activities of some structurally similar compounds. The ligand compound was synthesized by the procedure described in the literature. It is noteworthy to mention that 2-(azidomethyl)cyclopropane-1,1-dicarboxylic acid presents the precursor for the synthesis of 2-(aminomethyl)cyclopropane-1,1-dicarboxylic acid, as an example of the constrained γ-amino dicarboxylic acids. The synthesis was achieved by the conversion of the ligand compound into the corresponding sodium dicarboxylate salt and subsequent treatment with [Pd(dien)Cl]Cl (pH maintained between 6-7). The IR and NMR spectra, as well as elemental analysis have confirmed that the Na[Pd(dien)(azmcpda)]· H_2O species was formed and that coordination of the ligand compound to the metal ion was established through carboxylate oxygen donor atom.

Keywords: palladium, cyclopropane, azide, dicarboxylic acid

1. Introduction

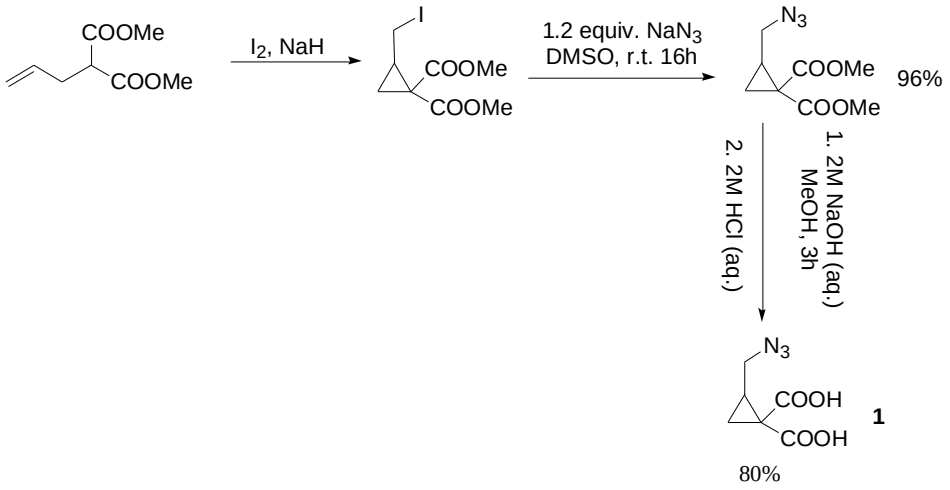
The discovery of the *cis*-platinum has prompted scientific efforts toward the design and synthesis of other metal-based chemotherapeutic agents that have ability to interact with DNA [1]. The structural similarity of platinum and palladium, as well as the fact that palladium complexes could enable complementary modes of the biological behavior, places them into the focus of the recent scientific studies. To acquire the desired chemical and biological properties of the metal complexes, the proper choice of the organic ligand is the crucial step.

Derivatives of γ-amino acid and analogues have demonstrated huge potential to serve as drugs (such as GABA), as well as to be implemented into small peptides. Due to their significant pharmacological importance, it could be of interest to explore their potential as ligands for the coordination to transition metal ions.

Herein we describe the synthesis and characterization of the palladium(II)-2-(azidomethyl)cyclopropane-1,1-dicarboxylic acid complex.

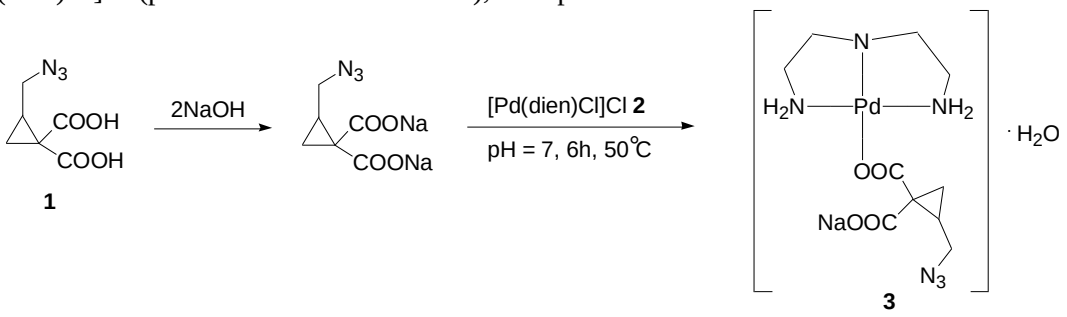
2. Instructions

The ligand compound **1** (2-(azidomethyl)cyclopropane-1,1-dicarboxylic acid) was prepared according to the our previously published procedure (Scheme 1) [2].



Scheme 1. The synthesis of the ligand **1**

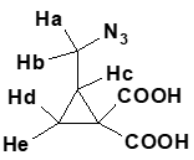
It is noteworthy to mention that it presents the precursor for the synthesis of 2-(aminomethyl) cyclopropane-1,1-dicarboxylic acid, as an example of the constrained γ-amino dicarboxylic acids. For the coordination, the [Pd(dien)Cl]Cl **2** was selected as a starting material taking into consideration its importance as a model for the investigation of the substitution reactions in coordination chemistry and a deeper understanding of the biological activities of some structurally similar compounds. Considering the nature of the donor atoms in ligand **1**, the coordination with metal ion could be established through oxygen from carboxylic groups or through the nitrogen from azido group. The coordination through N_3 group is less likely due to the labile bonds that azido group forms with metal centers and consequent nitrogen loosing, so the synthesis of complex compound was performed by the conversion of the ligand compound into the corresponding sodium dicarboxylate salt and subsequent treatment with [Pd(dien)Cl]Cl (pH maintained between 6-7), as depicted in the Scheme 2.



Scheme 2. The synthesis of the complex compound **3**

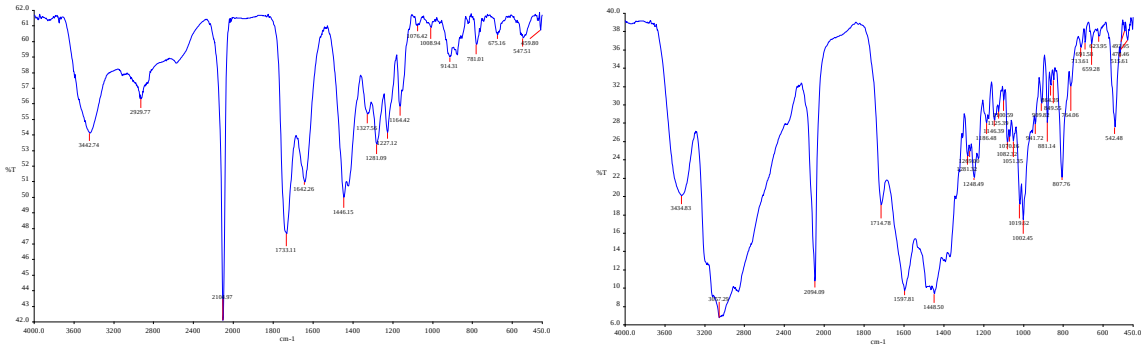
The characterization of the obtained complex compound was achieved by the comparation of the ^{1}H NMR and IR spectra of the ligand compound and obtained complex compound, as well as by elemental analysis. The Table 1 consist of the ^{1}H NMR chemical shifts for the protons from the ligand and complex compounds, as well as IR peaks for these two compounds.

Table 1. ^{1}H NMR chemical shifts for the ligand protons and protons in complex-compounds in D_2O

Ligand structure	Chemical shifts from ligand compound	Chemical shifts from complex compound
	δ = 1.35-1.4 and 1.45-1.53 (two dd from Hd and He)	δ = 1.65 (dd, J = 10Hz); δ = 1.73 (dd, J = 10Hz) Hd and He

	δ = 1.92-2.10 (m from Hc)	δ = 2.1-2.3 (m from Hc)
	δ = 3.30-3.60 (two dd from Ha and Hb)	δ = 3.52 (dd, J = 12Hz); δ = 3.74 (dd, J = 12Hz) Ha and Hb δ = 3.04 (t, J = 8Hz); δ = 3.17 (dd, J = 8Hz) (protons from Pd-dien part of the complex)

As it can be seen from the data given in Table 1, the NMR chemical shift for the protons that are near the carboxylic groups are much more shifted than the protons near azido group. Also, the IR spectra of the complex compound (Figure 1, b) have confirmed that azido group has maintained the structural integrity and position as in starting ligand compounds (Figure 1, a) (as a confirmation that coordination was established through carboxylic oxygen). The existence of the water molecule in the complex formula was confirmed from the elemental analysis, as well as by the comparison of the IR spectra of ligand and complex compounds where the presence of strong OH vibration stretch at 3434 cm^{-1} undoubtedly confirms its presence in the complex (Figure 1, b).



a) b)

Fig. 1. IR spectra of the ligand (a) and complex compound (b)

3. Conclusions

In this paper we described the synthesis of the novel palladium complexes with 2-(azidomethyl)cyclopropane-1,1-dicarboxylic acid as a ligand. The used ligand represents the precursor for the synthesis of 2-(aminomethyl) cyclopropane-1,1-dicarboxylic acid, as an example of the constrained γ-amino dicarboxylic acids, and its incorporation into complex compounds could enable some interesting new features. Taking into consideration the huge potential of the palladium complexes as pharmaceutical agents, this study represents small contribution toward their synthesis and characterization with vision for their further biological screening.

References

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