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SYNTHESIS OF A COPPER GLYCINATE (II) COMPLEX MONOHYDRATE

ORIGINAL ARTICLE

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SUMMARY

The coordinating compounds are basically characterized by an ion of a D-block metal, called Lewis acid surrounded by ligants called Lewis bases, and usually their salts have intense coloration when in solution. Copper glycinate (II) monohydrate is a blue-green-colored solid, and has cis/trans isomer*ic forms*. The present work aims to report the process of synthesis and characterization at the qualitative level of this complex in the chemical laboratory of the Municipal school Governador Israel Pinheiro, João Monlevade, MG. The results of the experiment revealed characteristic color crystals of the intended compound and favorable percentage yield.

Keywords: chemical synthesis, copper glycinate, complex, coordination compound.

1. INTRODUCTION

Chemical synthesis allows us to obtain more complex products of interest to society starting from simpler substances. Most of the technological advances were possible thanks to these studies. Synthesis processes are present in the chemical and pharmaceutical industries, in the field of biology and biotechnology, among others. The

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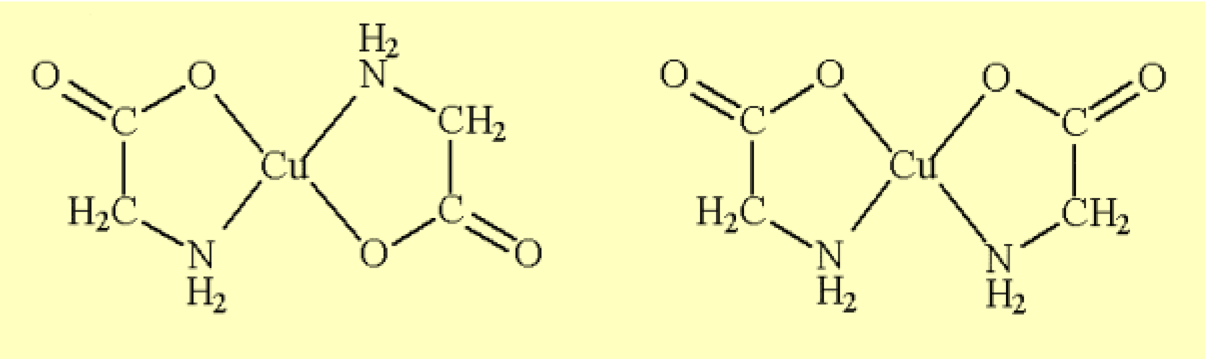
processes of chemical synthesis aim not only to create new substances, but to develop reactional methods of greater economic viability.

Isenmann (2013) *apud* Oliveira *et al* (2018) says that before thinking of synthesis planning, we should look for basic information, such as understanding the mechanisms of reactions, knowledge of classical reactions, notions of stoichiometry, methods of Purification and which compounds are readily available.

Among the thousands of compounds synthesized by man are the complexes. In Russell's definition (1994) a complex is constituted by a central or main atom, surrounded by and bound to one or more ligands, which can be atoms, ions or molecules. Atkins and Jones (2012) complement, saying that the binders are oriented to the metal by coordinated bonds.

It is common to have complex formation with elements of D and *f* blocks with orbitals available for new electrons. Copper Glycinate (II) –, is $[Cu(gly)_2]$a salt that has different routes to be synthesized, and the method and reagents influence when one wants to obtain distinctly the CIS and tr*ans* for*ms of* the compound. For Shriver and Atkins (2003), metal complexes have an important role in inorganic chemistry, especially those formed by D-Block metals.

Figure 01 **–** Trans-bis-a*nd ci*s-bis$[Cu(gly)_2]$-st*ruc*tures$[Cu(gly)_2]$.



Source: Cotton S., Uppingham Scholl, Rutland, 2010.

The metal complexes are interesting compounds, as they exhibit many peculiar properties in terms of: structures, colors, optical and magnetic properties, for example.

Another feature that can be mentioned refers to the fact that they form salts that do not release their ions in aqueous medium, maintaining their chemical integrity. The coordinating compounds are divided into two groups: the double salts, those that lose their identity, and the complexes, which are those that maintain the identity. (Hoehne e Dall'Oglio, 2013).

This work aims to describe the method used in obtaining one of the copper glycinate isomers (II) starting from the aminoacetic acid and copper acetate (II) monohydrate, carried out in the laboratory of a technical school of João Monlevade, MG, and make a Simple qualitative analysis of the compound formed.

2. METHOD

Using a 50 mL bequer dissolved 2.0 g of copper acetate (II) Monohydrate in 25 mL of heated deionized water, proceeding to subsequent progressive warming using the Bunsen-mounted apparatus. A previously heated 25 mL of ethanol P.A. was added to this solution. It continued to keep the mixture under heating. In another bequer, 1.5 g of aminoacetic acid was dissolved in 25 mL of hot deionized water. Both babies were kept under heating until they reached 70°C (a thermometer was used to monitor the temperature). The solution of aminoacetic acid was added to the mixture of copper acetate (II) monohydrate. The mixture was left at rest until it reached room temperature. Then the bequer was immersed in the ice bath. After a few minutes, the content of the Bequer was filtered using the previously determined qualitative mass filter paper. The contents of the funnel were washed with ethanol. After the complete filtration, the filter paper was removed from the funnel, which was opened on the countertop until complete evaporation of the alcohol. The mass of the content on the filter paper was measured and the reaction yield was calculated.

3. RESULTS AND DISCUSSIONS

We measured the masses of aminoacetic acid and copper acetate (II) Monohydrate, whose values were respectively 1.5009g and 2.0036g. After that, the mass of the qualitative filter paper was measured and the value of 1.1609g was found. It was observed inaccuracy of mass measurement in the fourth decimal place for aminoacetic acid and for the qualitative filter paper and in the third and fourth decimal places for copper acetate (II) monohydrate.

Copper acetate is a blue-green-colored salt while aminoacetic acid is colorless organic acid. During the heating phase there were no notable alterations in the contents of the Bedouin, and they clearly presented the colors of the respective reagents used.

Figure 02 – Heating phase of the reagents.

Source: the author.

The notorious change occurred when the solution of aminoacetic acid was placed in the bequer containing the mixture of copper acetate (II) monohydrate and ethanol. It revealed a blue color. The bequer was removed from the heating apparatus and placed on the countertop until it reached room temperature.

Figure 03 – Mixture resulting from the mixture between the reagents.

Source: the author.

The observed staining is due to the copper ion CU2 $^{+}$ hydrated, metal responsible for the formation of several complexes of scientific interest, among them, the copper glycinate (II) monohydrate, which aroused the greater interest of the students by revealing their intense Coloring. Many elements of the D bloc*k* form solutions with characteristic colors in water (ATKINS and JONES, 2012). Other characteristics, such as conductivity, color, compounds with the same molecular composition, but different color and dipole moment were observed in this new class of compounds (COELHO, 2010).

The color that a substance displays corresponding, therefore, to the fraction of the visible light that it does not absorb. The absorption of ultraviolet radiations below 400 is not detected by the human eye, and we perceive infrared radiation as heat (SOUZA, S.D.).

In chemistry the variety of colors enchants everyone and, in fact, color change is an indication of chemical reaction. Colors are important as they can reveal more details about a composite in analysis. Based on copper glycinate (II) monohydrate, salt revealed characteristic staining of the complex ion. According to Atkins and Jones (2012), if the complex is blue it is because it is absorbing the orange light (580-620 nm). Orange and blue are complementary colors.

Figures 0**4 –** Chromatic circle.

Source: Elgin, 2017.

For a compound to have color, it must absorb visible light. A compound will absorb visible radiation when that radiation has the energy needed to move an electron from its lower (fundamental) energy state to an excited state (BROWN, 2003).

After the beaker mixture reached room temperature, measured with a thermometer, the bequer was immersed in the ice bath. Crystals too bright of a blue coloration, slightly less intense, were shown to be larger and more defined. The salt crystals showed little solubility in aqueous medium when subjected to low temperature.

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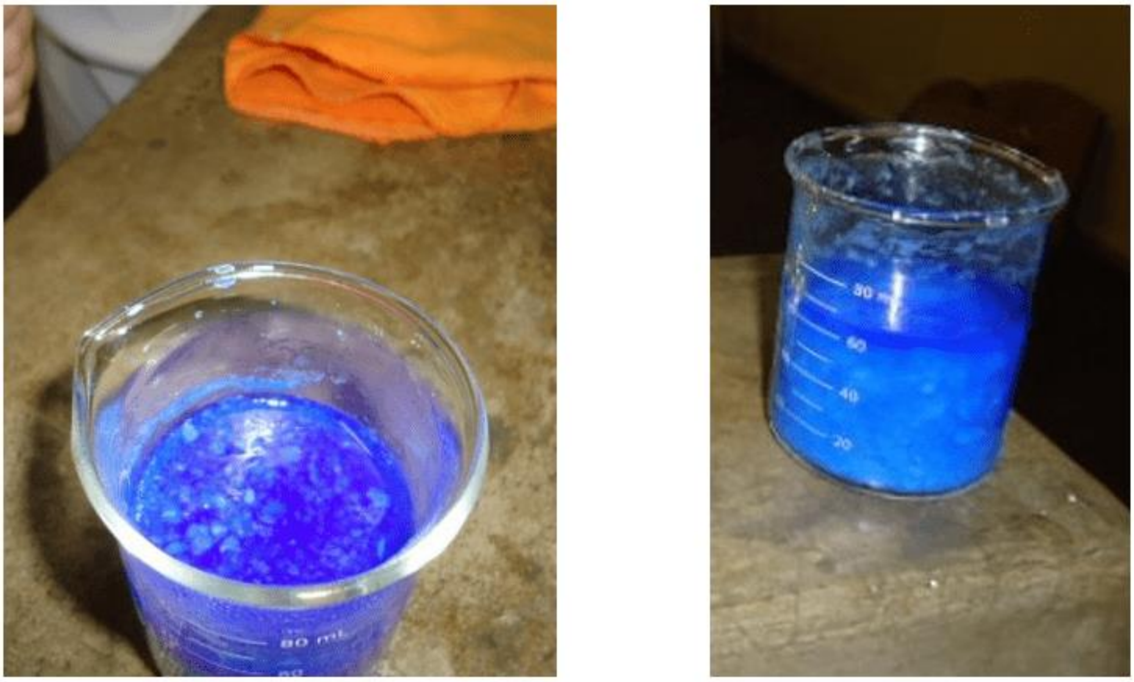
Figures 05/06-copper glycinate crystals (II).



Source: the author.

Figure 07 – Filtration apparatus.

Source: the author.

After a few minutes, the filtration apparatus was assembled in order to retain the solid part that was formed as the temperature was decreasing. As the volume of the filtrate increased in the chalice, due to continuous washing with ethanol, we could see the crystals of copper Glycinus (II), very united, apparently macerated, of intense blue coloration. The color of the complex depends on the metal, but also the ligand, which means that changes in substitutions can cause changes in color. After filtering, the filter paper was removed and opened on the countertop, so that it would pass over an air stream.

The reaction that occurred for the formation of the coordination compound is given by the equation

$Cu\ (CH_3COO)_2 + 2\ NH_2CH_2COOH + H_2O\ [Cu\ (NH_2CH_2COO)_2].\ H_2O + 2\ CH_3COOH$

After the complete evaporation of the ethanol that dampened the filter paper, only the crystals were left. The mass of the crystals with the filter paper was 2.9385 g. Therefore, the mass of the isolated crystals corresponds to 1.7776 g.

To calculate the yield of the synthesis reaction of copper glycinate it was necessary to determine the molar masses of the reagents involved, being

$Cu\ (CH_3COO)_2$ = 181,62982 $g.mol^{-1}$, NH_2CH_2COOH = 75,42662 $g.mol^{-1}$ e

$[Cu\ (NH_2CH_2COO)_2].\ H_2O$ = 229,67450 $g.mol^{-1}$. The calculations performed follow below, using all the decimal places for the purpose of leaving the result more accurate:

1 mol NH_2CH_2COOH __________ 75,42662 g

2 mol NH_2CH_2COOH __________ m_1 = 150,85324 g

Verification was made to verify if there was excess reagent, the calculation of which follows:

1 mol $Cu\ (CH_3COO)_2$ __________ 2 mol NH_2CH_2COOH

181,62982 g __________ 150,85324 g

2,0036 g __________ m_2 = 1,6640965215 g NH_2CH_2COOH

181,62982 g __________ 150,85324 g

m_3 __________ 1,5009 g m_3 = 1,8071086629 g Cu $(CH_3COO)_2$

It was noticed, through the calculations, that the excess reagent is Cu (CH3COO) 2, soon departed from the limiting reagent, NH2CH2COOH, to perform the calculation of the yield.

2 mol NH_2CH_2COOH __________ 1 mol [Cu $(NH_2CH_2COO)_2$]. H_2O

150,85324 g __________ 229,6745 g

1,5009 g __________ m_4 = 2,2851246486 g

2,2851246486 g __________ 100%

1,7776 g __________ R = 77,790067211%

The calculations showed that the reaction yield was approximately 77.8%. We can consider how favorable the reactional yields > 60%.

There is great interest among professionals in the structures, properties and uses of the complexes, according to Atkins and Jones (2012), partly because they participate in many biological reactions.

The colors of the coordinating compounds are usually determined by the central atoms, although they may also be due to other chromophores (or pigments) that are part of their composition. Transition metal complexes are fascinating by the varieties of colors they exhibit. For a particular metal, this color change can also be observed as a function of the ligand (SOUZA, S.D.).

Group D metals complexes are often magnetic and brightly coloured and are used in chemistry for analysis, ion dissolution, metal electrodeposition and catalysis. They are also objects of research in the conservation of solar energy, in the fixation of atmospheric nitrogen and new drugs (ATKINS and JONES, 2012).

Many complexes are important to our lives, and their lack in our organism can cause serious diseases. According to Brown (2003) elements such as V, Cr, Mn, Fe, Co, Ni, Cu, Zn, Mo and Cd form complexes with a variety of donor groups present in biological systems such as enzymes. Copper Glycinate (II) is also widely used for parenteral supplementation in animals, being a source of copper replacement.

There are also complexes that are used in paint pigments, color production in glass and precious stones. Examples of other important complexes for the maintenance of life are hemoglobin, responsible for transporting oxygen in the blood, whose central atom is Fe2 + ^{an}d chlorophyll, responsible for photosynthesis, whose central atom is Mg2 $^{+}$.

There are many metals that form complexes indispensable to several biological functions of living beings, contributing to the maintenance of basic cellular needs. These compounds are able to interact with many receptor sites, which represents a potential gain in the formulation of selective therapeutic agents.

The activities performed by metal ions in biological media have stimulated the research and development of inorganic compounds as therapeutic agents. The involvement of these compounds in medicine, especially those containing transition metals, was very limited until 1965, when there was a classical demonstration of the antitumor activity of the complex called cisplatin, [PtCl2(NH3)2](COHEN, 2007 apud GUERRA et al, 2011).

4. CONCLUSION

The proposed synthesis of the intended compound was successfully fulfilled. The use of strategies such as experimentation contributes greatly to the formation of students, besides being able to be used as an initial milestone for the introduction of a content. It is believed that analytical errors and equipment without proper calibration may have contributed to the loss of the reactional yield. It is not possible to determine only qualitatively which isomeric form was synthesized or if there is possibility of a racemic mixture. For this, more selective instrumental analytical methods, capable of determining the structure of the compounds, would be necessary. The formation of cis-bis-was *sp*ecul[Cu(gly)$_2$]at$_e$d. H2O based on information from other experiments, saying that through the glycine mixture to the remaining filtrate it is possible to obtain the trans *form* of the complex of interest. The study of chemical synthesis is relatively complex, but important for the development of new products and active principles of interest not only in the academic environment, but in different areas of knowledge, such as the pharmaceutical and agroveterinary sectors, for Example.

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