Novel Tartratostannates with Complex 1,10-phenanthroline Cations of Fe(II), Co(II), Ni(II), Cu(II), Zn(II): Synthesis, Structure Features and Antimicrobial Activity

Eleonora Afanasenko, Inna Seifullina,

Odessa National Mechnikov University, department of inorganic chemistry and chemical education, Dvoryanskaya, 2, Odessa 65082 Ukraine

afanasenkoeleonora@gmail.com

1. Introduction

Nowadays, coordination compounds of biologically active metals and organic polydenatate ligands are considered as the most perspective for creation of new effective non-toxic drugs. The present study is focused on creation of supramolecular coordination compounds with biologically active structural units: p-(Sn(IV)) and d-metals M(II) (M=Fe, Co, Ni, Cu, Zn), two types of bioligands: ditopic polydentate tartaric acid and cyclic bidentate 1,10-phenantroline, combination of which leads to the intensification of individual properties and formation of perspective drugs on their basis.

2. Synthesis

The special new-developed “in situ” method of synthesis, that involves preparation of water-stable tartratogermanate acids as the intermediate products and their interaction with 1,10-phenantroline complexes of Fe^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, Zn^{2+} in ethanol.

Step I: $M(CH_3COO)_2 + 3phen \rightarrow [M(phen)_3](CH_3COO)_2$

Step II: $2SnCl_4 + 4H_4Tart \rightarrow H_4[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2] + 8HCl$

Step III: $H_4[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2] + 2[M(phen)_3](CH_3COO)_2 \rightarrow [M(phen)_3]_2[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2] + 4CH_3COOH$

Structural data of obtained complexes (**1**)–(**5**) are specified in the Cambridge Crystallographic Data Center (CCDC) under the numbers:

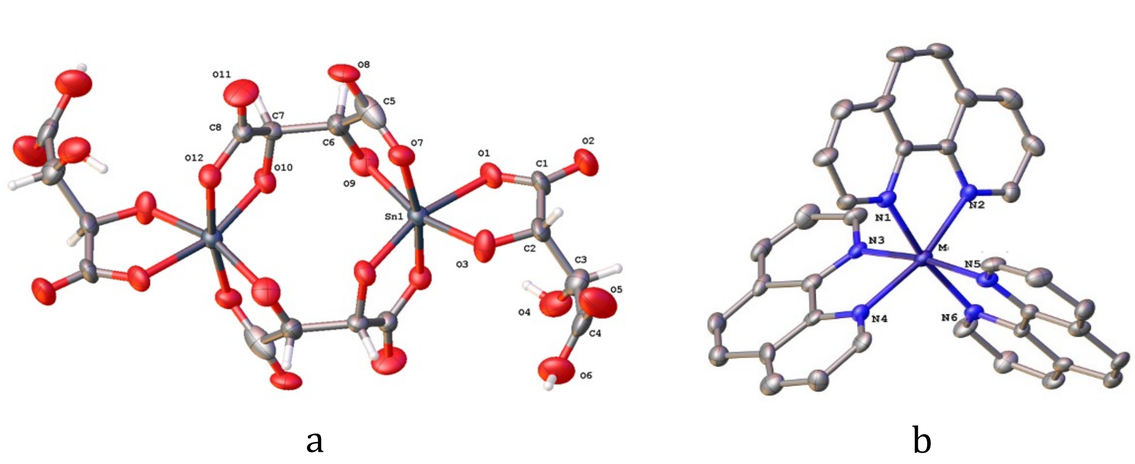
$[Fe(phen)_3]_2[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]\cdot 2H_2O$	1995154	(**1**)
$[Co(phen)_3]_2[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]\cdot 8H_2O$	1985185	(**2**)
$[Ni(phen)_3]_2[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]\cdot 2H_2O$	1985186	(**3**)
$[Cu(phen)_3]_2[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]\cdot 2H_2O$	1995153	(**4**)
$[Zn(phen)_3]_2[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]\cdot 6H_2O$	1985187	(**5**)

3. X-Ray studies

The studied complexes **1–5** are isostructural and represent cation-anionic compounds which exist as polyhydrates in the crystal phase.

In the complex anion $[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]^{4-}$, similar for all studied compounds (**1**)-(**5**), two Sn atoms are linked by two tetradentate chelate bridging ligands of tartaric acid with both deprotonated carboxylic and hydroxyl groups. Each Sn atom is coordinated additionally in bidentate manner by one terminal deprotonated tartaric acid with one deprotonated carboxylic and one deprotonated hydroxylic groups. The coordination polyhedrons are octahedrons.

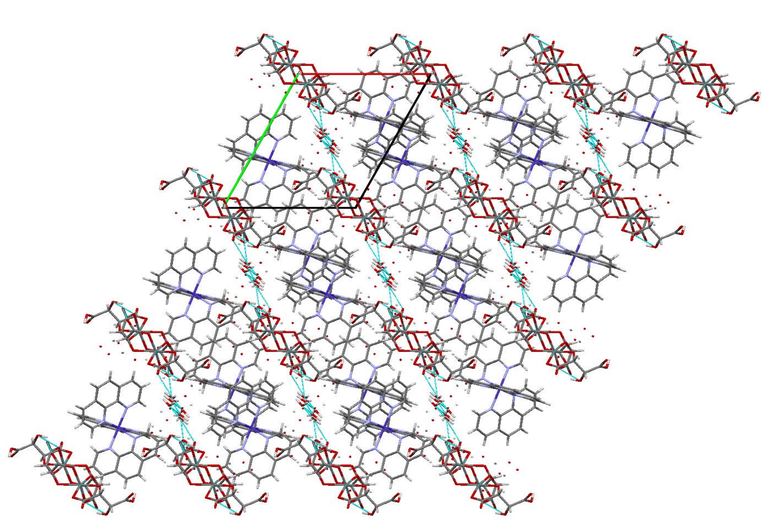
The one $[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]^{4-}$ anion is compensated by two $[M(phen)_3]^{2+}$ cations where M is Fe, Co, Ni, Cu, Zn respectively. The coordination polyhedron of metal is octahedron for all the cations.



a b

Structure of $[Sn_2(\mu\text{-}Tart)_2(H_2Tart)_2]^{4-}$ (a) and $[M(phen)_3]^{2+}$ (b)

The anions, cations and water molecules form alternating layers which are parallel to the (1-10) crystallographic planes in structures (**1**)–(**5**) . These layers can be divided into two types: 1) the layers containing anions; 2) the layers containing only cations. The anions and water molecules are linked by hydrogen bonds.



The crystalline structure of compounds (**1**)-(**5**)

4. Antimicrobial studies

The rapid twofold dilution method was used to determine minimal inhibitory concentrations of compounds against strains of microorganisms *Planococcus citreus*, *Micrococcus luteus*, *Bacillus cereus*, *Staphylococcus aureus*, *Streptococcus lactis*, *Escherichia coli*, *Agrobacterium tumefaciens*. All complexes showed themselves as strong antimicrobial agents in the minimal concentrations (μg/ml). Their complex nature leads to the diversity of their antimicrobial mechanisms of actions, excludes possibility of resistance and make them effective agents against multidrug-resistant organisms.

5. Conclusions

All complexes are isostructural. The formation of tartratostannate anions in the structures (**1**)-(**5**) has the regular pattern and does not depend on the d-metal in the structure of cation. However, despite the isostructural architecture of (**1**)-(**5**), compounds (**4**) and (**5**) turn out to be the most effective, while (**1**) works only in the high concentrations, which can be explained by the better competitive properties of Cu(II) and Zn(II) to bind the proteins.