Summary of the Aleksandra Maria Tesmar PhD thesis entitled:

"Structure, physicochemical and biological properties of aminopolycarboxylate complexes of some d-block metal ions"

The aminopolycarboxylate anions can serve as flexible organic ligands capable to form fairly stable complexes with most of the metal ions. For this reason they have a variety of applications in analytical chemistry, medicine as well as environmental protection. The presence of two flexible chelating arms containing carboxylic acid groups and a central N-donor atom in their structures enables the design of new materials with complex architecture and diverse topology, displaying the desired magnetic, electrical, photochemical and also catalytic properties that are increasingly used in various industries.

At the stage of starting this research (2013), there were few reports on the biological activity of the polycarboxylate metal ion complexes. Especially, much attention has been devoted to their insulin-mimetic and anticancer activities. It has been proven that their biological action depends on the type of a ligand presented in the coordination sphere of the oxidovanadium(IV) ion. Slightly less attention was devoted on their antioxidant properties as well as the cytoprotective activity. Despite the fact that the anticancer, antidiabetic and cytoprotective mechanism of action of the oxidovanadium(IV) compounds still remains to be elucidated, high hopes are placed on the use of vanadium complexes to treat diseases of various etiology and to protect healthy tissues during therapy.

Due to the growing interest in carboxylate complexes and the possibility of their use in technology and materials chemistry as well as in the area of life science I decided to test this group of compounds in the widest possible range of research methods. The main goal of this doctoral project was to investigate the structures, physicochemical and biological properties of selected aminopolycarboxylate transition metal (ion) complexes.

As a part of my doctoral thesis, I developed synthesis methods and, consequently I isolated 14 complexes from the solution, 13 of which are new compounds not described earlier in the chemical literature. The selection of appropriate synthesis conditions enabled to obtain monocrystals of 11 compounds.

Their crystal structures were described based on the X-ray measurements. I utilized a number of complementary measurement techniques (IR, TG-FTIR, magnetic susceptibility as well as EPR) to describe the physicochemical properties of the complexes under study in the solid phase.

The thermodynamic parameters for complexation reactions of the Co^{2+}, Ni^{2+} and Zn^{2+} ions with some aminopolycarboxylate ligands I investigated using the isothermal titration calorimetry (ITC) technique supported by potentiometric titration data. The quantification of the metal-buffer interactions and their incorporation into the ITC data analysis enabled to obtain the pH-independent and buffer-independent thermodynamic parameters (K, ΔG, ΔH and ΔS) for the reactions under study. On the basis of the calculated thermodynamic parameters, I determined the structural features of the ligands and metal ions, which determine the stability of the resulting complexes in solutions.

Another aspect of my studies was the determination of the antioxidant activity of the examined complexes towards the stable organic radical, namely the 2,2′-azinobis(3-ethylbenzothiazoline-6 sulfonic acid) cation radical ($ABTS^{+\bullet}$). Based on the obtained results I drew conclusions about the influence of the type of the aminopolycarboxylate ligand (primary ligand) as well as auxiliary ligands (imidazole, 2-amino-3-hydroxypyridine) presented in the coordination sphere of the oxidovanadium(IV) ion on the antioxidant activity of the complexes.

In the last stage of these studies I focused my attention on the characteristics of the biological activity of the investigated compounds. I examined their cytoprotective activity against the oxidative damage generated exogenously by using hydrogen peroxide in the Hippocampal neuronal cell line HT22. Furthermore, I described the antitumor activity of the synthesized complexes towards human osteosarcoma cell lines (MG-63 and HOS) as well as their cytotoxic effect on the untransformed human osteoblast cell line (hFOB 1.19).

The results of the structural, physicochemical and biological studies enabled to define the features of the complexes that are worth to consider when searching for new synthetic compounds and testing their cytoprotective and antitumor mechanisms of the action.