Abstract

The aim of this dissertation was to investigate the complexation process in systems containing sugar derivatives of uridine-5'-diphosphate with biologically relevant d-block metal ions, as well as to conduct a thermodynamic and spectroscopic characterization of the identified complex forms. In addition, the biological activity of selected complex species was examined.

The first stage of the study included determining the protonation constants of the analyzed ligands: uridine-5'-diphosphoglucuronic acid, uridine-5'-diphospho-N-acetylglucosamine, and uridine-5'-diphosphoglucose, using potentiometric analysis under strictly defined conditions: constant ionic strength (0.1 mol/dm³), temperature (20±1°C), and an inert gas atmosphere. For each of the obtained forms, protonation constants (logβ) and equilibrium constants of the formation reaction (logKe) were determined. Distribution curves were plotted to assess the percentage contribution of each ligand to the formation of a given species. Subsequently, potentiometric measurements were conducted for the Cu(II)/UDP-GluA, Cu(II)/UDP-GlcNAc, Co(II)/UDP-GlcNAc, Ni(II)/UDP-GlcNAc, Cu(II)/UDP-Glc, Co(II)/UDP-Glc, and Ni(II)/UDP-Glc systems at metal-to-ligand molar ratios of 1:1 and 1:2. Based on the obtained data, the types of complex species present in the studied systems were identified, and their thermodynamic characteristics were established. For each complex species, overall stability constants (logβ) and equilibrium constants of the formation reaction (logKe) were calculated, and the corresponding formation reactions were proposed. Distribution curves were plotted to determine the pH ranges in which the analyzed complexes dominate, as well as the percentage content of metal ions within their structures.

The next stage of the research included spectroscopic analysis and biological activity assays of the selected complex compounds. UV-Vis, EPR, NMR, and CD spectroscopic studies were carried out at the pH values where each form predominates. The results allowed for the determination of the composition of the inner coordination sphere and identification of the chromophore types present in the analyzed systems. NMR spectroscopy was conducted in collaboration with the Institute of Bioorganic Chemistry of the Polish Academy of Sciences in Poznań. Preliminary biological activity studies were carried out in collaboration with the Collegium Medicum of the Nicolaus Copernicus University in Bydgoszcz on selected complexes containing copper(II) ions. Lines A549 (lung cancer cells), T2H (bladder cancer cells), and SV HUC-1 (normal urothelial bladder epithelial cells) were used for the study. Cells were incubated with the analyzed complex compounds and ligands for 24 and 72 hours. On the basis of the results obtained, the cytotoxic properties of the complexes obtained against free ligands were determined.

The performed measurements will extend the knowledge of complex compounds of sugar uridine-5'-diphosphate derivatives and their spectroscopic and biological properties.