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STUDY ON THE COORDINATION CAPABILITY OF KOJIC ACID DERIVATIVES TOWARDS OXOVANADIUM(IV)

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Oxovanadium(IV) complexes exhibit insulin-mimetic activity and may be good candidates for the treatment of type II diabetes mellitus [1]. In particular, the complexes of maltol, in which the cation is coordinated by two 3-hydroxy-4-pyrone units, have undergone extensive pre-clinical testing [2].

Kojic acid (5-hydroxy-2-(hydroxymethyl)-4-pyrone, KA) shows a hydroxyl-pyronic structure and the coordination of KA, or its derivatives, with oxovanadium(IV) was previously studied. Yuen et al. [3] compared the glucose-lowering properties of BMOV (bis(maltolato)oxovanadium(IV)) and bis(kojiate)oxovanadium(IV) complexes, Sanna et al. [4] studied the chemical equilibria of KA-vanadyl complexes in blood serum and Wei et al. [5, 6] developed and tested a series of complexes based on the KA structure for the glucose control in blood. These studies showed a glucose-lowering activity of bis(kojiate)oxovanadium(IV) complexes.

In this work the complexation capability of four KA derivatives towards oxovanadium(IV) was studied. The newly synthesized ligands (namely S2, S3, S4 and SC, Figure 1) have two or three kojic acid units linked through diamines or tris(2-aminoethyl)amine chains, respectively. The synthesis and the characterization of the four ligands considered were previously presented, as well as their coordination capability towards Fe³⁺, Al³⁺, Cu²⁺ and Zn²⁺ cations [7, 8].

The chemical systems were studied by potentiometry and UV-visible spectrophotometry at 25°C and ionic strength 0.1 mol L⁻¹, KCl. EPR spectra were recorded both at room (RT) and low (LT) temperature, as a function of pH. For all systems a chemical model was hypothesized analyzing the experimental data by a thermodynamic approach and by chemometric methods.

The formation constants of the complexes and the pure UV-vis and EPR spectra were determined.

In all systems the coordination of the oxovanadium(IV) starts already under acidic conditions and the metal complex remains stable even at pH 8. Ligands S2, S3 and S4 form two complex species with two kojate units inserted in the coordination shell successively.

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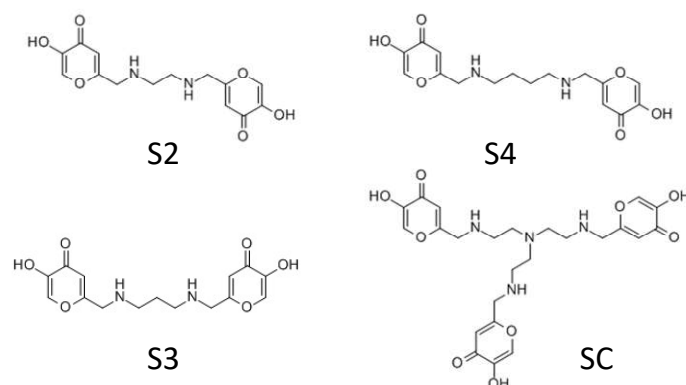


Figure 1. Molecular structure of the kojic acid derivatives studied: S2: [ethane-1,2-diylbis(iminomethanediy)]bis(5-hydroxy-4H-pyran-4-one), S3: [propane-1,3-diylbis(iminomethanediy)]bis(5-hydroxy-4H-pyran-4-one); S4: [butane-1,4-diylbis(iminomethanediy)]bis(5-hydroxy-4H-pyran-4-one); SC: 6,6',6''-(((nitrilotris(ethane-2,1-diyl))tris(azanediy))tris(methylene))tris(3-hydroxy-4H-pyran-4-one).

The shifts of the UV-vis absorption bands as well as of the magnetic parameters reveal that four ligand oxygen atoms replace the water molecules in the equatorial coordination plane leading to the formation of a dominant complex species with stoichiometry $[\text{VOLH}_2]$ in the 4–8 pH range. Despite the presence of a third KA unit in the SC ligand, only two of them participate to the coordination process.

The sequestering capability of the four ligands towards oxovanadium(IV) is very similar and it is higher than that of maltol and KA.

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