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Detection of silver ions by means of electrochemical sensors

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Due to many anthropogenic activities environment have been polluting by number of organic as well as inorganic compounds. The new procedures and technologies not only to monitor of levels of contamination but also to remediate the polluted environment have been still developing and suggesting. The heavy metals ions and their compounds are considered as one of the most toxic substances polluting all parts of environment. Due to competing equilibria and kinetics in water hydrated silver(I) ions may be also present in surface waters, which relates to the fact that Ag^{+} has been shown to be highly toxic to aquatic life. The aim of this work was to detect silver ions by using various electrochemical instruments. Carbon electrodes were tested as working electrodes the. The optimized procedures were utilized for determination of silver(I) at earthworms (*Eisenia fetida*) treated with the silver(I) ions.

Silver(I) ions gave the response at 200 mV at surface of carbon electrodes. The signal was well reproducible. We optimized the basic experimental parameters of the

high performance liquid chromatography with electrochemical detection (HPLC-ED) to determine silver(I) ions. It clearly follows from the obtained results that the most suitable parameters for the determination of silver ions were as follows – flow rate: 0.5 mL/min, guard cell potential: 0 mV, working electrode potential: 200 mV, current R: 1 μA, time filter: 2 s. The optimal mobile phase was 0.2 M acetate buffer (pH 4.0). After that we optimised all chromatographic parameters above mentioned, we studied dependence of silver ions peak height on its concentration (0 – 1,000 μmol/dm^3). The peak height is proportional to silver ions concentration, particularly, particularly; the height markedly increased up to 200 μmol/dm^3, and then increased more slightly. We obtained strictly linear calibration curve in the range of 0 – 31 μmol/dm^3 (y(peak height/nA) = 19.986x(silver concentration/μM) + 20.9, R^2 = 0.996. The detection limit (3 S/N) obtained were 20 nmol/dm^3, if we measured silver ions in the presence of ACS water (n = 3, R.S.D. 5 %). We applied the HPLC-ED technique to analyze waters of different purity (ACS water, Milli Q water – 18 MΩ, Distilled water – Aqua osmotic system 1 μS, Tap water from the city of Brno, Ponávka stream, Puddle from the city of Brno). We added different concentration of $AgNO_3$ to water samples and measured a current response of silver ions. We found the waters lowered signals of spiked silver(I) ions up to 80 % compared to the signal measured in the presence of ACS water. In the following experiments we aimed our attention on investigation of releasing of silver(I) ions from silver particles placed in various types of waters. We found that from 4^{th} week of the experiment, the silver(I) ions were released to all types of the waters. At the very end of the experiment (14^{th} week) the content of silver(I) ions were 5-8 μg/l. Further, we focused on determination of silver(I) ions in earthworms and soil, which was contaminated by silver(I) ions at concentrations (0, 50, 100 and 500 mg/kg). It was shown that silver(I) ions had high toxicity to the earthworms. At the end of the experiment the soil was analysed and silver(I) ions determined. We found that the concentrations determined were about 40 – 70 % lower compared to initial doses.

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