DEVELOPMENT OF A SORPTION SPECTROSCOPIC METHOD FOR THE DETERMINATION OF CHROMIUM AND ZINC IONS IN ENVIRONMENTAL OBJECTS

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In the context of rapid industrialization and urbanization, ecosystem pollution with heavy metals has acquired the scale of a global environmental crisis. The growth of man-made waste leads to an uncontrolled accumulation of metal ions in soils and water bodies. However, the introduction of standard highly sensitive analysis methods such as atomic absorption spectrometry (AAS) or inductively coupled plasma mass spectrometry (ICP-MS) is limited for many laboratories due to the high cost of equipment, the complexity of sample preparation and the need to attract highly qualified personnel. Environmental pollution by heavy metals is one of the most pressing problems of modern analytical chemistry and ecology. Zinc and chromium ions are widely distributed in wastewater, industrial waste, and natural sites. [1-2].

Chromium(VI) and chromium(III) compounds with high toxicity and carcinogenic properties are particularly dangerous today. In this regard, there is a need to develop sensitive, selective and accessible methods for their determination, as well as to develop a sensitive sorption spectroscopic method for the

determination of Zn(II) and Cr(III) ions in environmental objects. The most promising are spectrophotometric methods using organic reagents, in particular azoreagents capable of forming stable colored complexes of metal ions. Silk fibroin fiber was used as a sorbent, pre–washed with distilled water and hydrochloric acid solution (0.01-0.05 M), followed by washing to a neutral pH value.. Standard solutions of Cr(III) and Zn(II) ions with a concentration of 1000 mg/l were prepared by dissolving $CrCl_3 \cdot 6H_2O$ and $znso_4 \cdot 7H_2O$ in distilled water, followed by bringing the volume to the mark in measuring flasks. Working solutions were obtained by sequential dilution.. A sample of sorbent weighing 0.2000 g was placed in a 50 ml glass. The sorption of metal ions was carried out under static conditions at optimal pH values of the medium (pH 5-6) and a contact time of 5-10 minutes. After sorption, colored complexes were formed using spectrophotometric reagents — methylthymol blue and alizarin red. The optical density was measured by the spectrophotometric method in the visible region of the spectrum at the appropriate wavelengths.. For quantitative analysis, calibration graphs of the dependence of optical density on concentration were constructed. The method is based on the formation of colored complexes of metal ions with azoreagents and obeys the Bouguer–Lambert–Beer law: $A = \varepsilon \cdot l \cdot C$ where: A is the optical density, ε is the molar absorption coefficient, l is the thickness of the cuvette, C is the concentration of the substance. [3–6].

Table

Conditions for the determination of Cr and Zn ions

Metal	**Cr(III)**	**Zn(II)**
Reagent	Alizarin Red-(S)	Methylthymol Blue

pH/Conditions	5–6	5–7
λmax, nm	520–580	600–630
Sorption time, t/min	5–10	5–10
Sorbent (carrier)	Natural Silk Fibroin Fiber	Natural Silk Fibroin Fiber

It is shown that the use of natural silk fibroin fiber as a sorbent (carrier) ensures effective extraction of chromium and zinc ions from solutions. The high sorption capacity is due to the presence of functional groups (–nh₂, –COOH) capable of interacting with metal ions. It is established that the sorption efficiency depends on the pH of the medium, the contact time and the nature of the reagent. Optimal sorption conditions are observed in a slightly acidic and neutral environment. The use of methylthymol blue allows the determination of both zinc and chromium ions, which makes this reagent universal. At the same time, the use of alizarin red-(C) provides a higher sensitivity in the determination of chromium. Comparative analysis has shown that the proposed sorption spectroscopic method is inferior in sensitivity to instrumental methods (ICP-MS, AAS), however, it has a number of advantages, including simplicity, accessibility and the possibility of use in rapid analysis. The method can be used for environmental monitoring of natural and wastewater, as well as for the analysis of man-made waste. Further research

may be aimed at modifying the sorbent and expanding the range of elements defined as toxic and heavy metals in environmental objects, including waste.

List of literature

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