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ORIGINAL ARTICLE

Tween 80 coated alumina: An alternative support for solid phase extraction of copper, nickel, cobalt and cadmium prior to flame atomic absorption spectrometric determination

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Abstract The potential of coated alumina as a sorbent for the simultaneous separation and preconcentration of copper, nickel, cobalt and cadmium ions has been investigated. Copper, nickel, cobalt and cadmium were adsorbed quantitatively on coated alumina in the pH of 6. The main factors such as pH, amount sorbent, sample and eluent flow rate, type and volume of elution solution and interfering ions on the sorption of metal ions have been investigated in detail. Under the optimum experimental conditions, the detection limits ($3S_b$) of this method for Cu(II), Ni(II), Co(II) and Cd(II) ions were 0.4, 1.0, 1.2 and 0.2 ng mL^{-1} in the original solution, respectively. Seven replicate determinations of a mixture of 5.0 μg of Cu(II), Ni(II), Co(II) and 1.0 μg of Cd(II) ions in the original solution gave a mean absorbance of 0.093, 0.071, 0.066 and 0.049 with relative standard deviations 1.9%, 2.3%, 2.6% and 2.1%, respectively. The method has been applied for the deter-

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mination of trace amounts of Cu(II), Ni(II), Co(II) and Cd(II) ions in tobacco, brewed tea and water samples with satisfactory results.

1. Introduction

Copper, cobalt and nickel are essential trace elements, having an important role in many body functions. These elements are required in small amounts; while they are toxic in large amounts (Mohammadi et al., 2009a, 2010; Hu et al., 2006). Chronic ingestion of cobalt in daily diet can cause some toxicological effects (Felipe-Sotelo et al., 2004). Also, cadmium is well recognized to be a highly toxic and hazardous element to human health (Valerie, 2003). Therefore, sensitive and accurate determination of the levels of heavy metals in the environmental samples has been continuously carried out on the analytical and environmental laboratories around the world (Tuzen et al., 2008).

Spectrophotometry (Taher and Mohammadi Mobarakeh, 2005), electrothermal and/or flame atomic absorption spectrometry (Salih et al., 2007; Sabermahani et al., 2011), inductively coupled plasma atomic emission spectrometry (Bezerra et al., 2007), inductively coupled mass spectrometry (Liu et al., 2007), voltammetry (Ghiaci et al., 2007) are the main instrumental techniques for the determination of traces of heavy metal ions.

The common availability of the instrumentation, simplicity of the procedure, speed, precision and accuracy of the technique still make flame atomic absorption method an attractive alternative (Afzali et al., 2005; Ghaedi et al., 2009a; Soylak et al., 2003; Mohammadi et al., 2009b). However, flame atomic absorption spectrometry (FAAS), suffers from insufficient sensitivity for the direct determination of metal ions in environmental samples and the interfering effects sourced from the matrix of the real samples (Afzali et al., 2005; Ghaedi et al., 2009a; Soylak et al., 2003; Mohammadi et al., 2009b). In order to overcome these difficulties, various methods including, cloud point extraction (Ghaedi et al., 2009a; Mohammadi et al., 2011), coprecipitation (Soylak and Tuzen, 2008a), liquid–liquid extraction (Pena-Pereira et al., 2009), and solid-phase extraction (SPE) (Shamspur and Mostafavi, 2009) have been commonly used for the sample pre-treatment.

Solid-phase extraction of heavy metal ions for preconcentration is preferred to other techniques due to simplicity, consumption of small volumes of organic solvent, and ability to achieve a higher enrichment factor (Pena-Pereira et al., 2009). It is commonly acknowledged that the adsorption materials play a very important role in SPE, because adsorption materials determine the analytical sensitivity, precision and selectivity in SPE techniques. The current researches in SPE are mainly focused on the development of new sorbents.

The design of stable and selective solid phase sorbents for separation and preconcentration of target metal ions depends on different factors such as the nature of solid support, its surface area and activity (Ghaedi et al., 2009b). Among the various solid phases, alumina is one of the most widely used adsorbents, as it does not swell and has good mechanical strength, small solubility and stability in a broad pH range (Chibowski et al., 2005). Chemical activation of the alumina with functional groups containing N, S, O, and P atoms is highly efficient for the sorption of several metal ions. Immobilization of organic compounds on the surface of the solid support is usually aimed at modifying the surface with certain target functional groups for a higher selectivity of the extraction. The selectivity of the modified solid phases toward certain metal ions is attributed to several well-known factors, such as the size of the organic compound used to modify the sorbent, the activity of the loaded surface groups and the type of the interaction of functional group (Tewari and Singh, 2000).

In this work, the analytical potential of alumina coated with Tween 80 (Fig. 1) was examined for simultaneous separation and preconcentration trace amounts of copper, nickel, cobalt and cadmium ions in tobacco, brewed tea and water samples. The analytical conditions for the preconcentration of analytes were investigated.

2. Experimental

2.1. Instrumentation

A SensAA GBC atomic absorption spectrometer (Dandenong, Australia) equipped with deuterium background correction and air–acetylene burner was used for absorbance measurements. Copper, nickel, cobalt and cadmium hollow cathode lamps were used as light sources at wavelengths of 324.8, 232.0, 240.7 and 228.8 nm, respectively. The operating parameters of elements were set according to the manufacturer recommendations. The acetylene flow rate and burner height were adjusted in order to obtain the maximum absorbance signal, while aspirating the analyte solutions. A Metrohm 692 pH meter (Herisau, Switzerland) was used for pH measurements.

2.2. Reagents and solutions

Deionized water was used throughout the experimental work. Standard solutions of the analyte ions were prepared by diluting stock solutions of 1000.0 mgL^{-1} supplied by Merck (Darmstadt, Germany). Working standard solutions were obtained by appropriate dilution of the stock standard solutions by serial dilution with deionized water. Al_2O_3 (0.063–0.2 mm) (Merck) was used for the preparation of sorbent. Buffer solution was prepared, from 0.1 mol L^{-1} acetic acid and the addition of NaOH solution. Before use, all of the glasswares were washed with deionized water and dried. The solutions of alkali

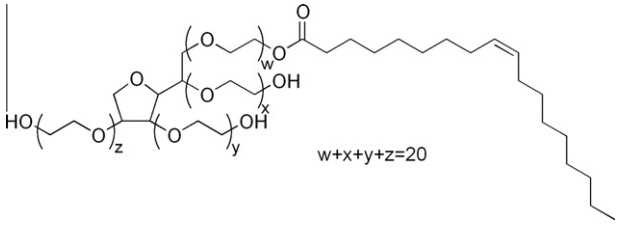

Figure 1 Tween 80.

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