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Selective Separation and Preconcentration of trace Amounts of Gallium in Water and Rice Samples using Cloud Point Extraction and Determination by Inductively Coupled Plasma-Atomic Emission Spectrometry

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ABSTRACT

In the present study a cloud-point extraction process using non-ionic surfactant Triton X-114 for selective extraction of gallium from aqueous solutions was developed. The method is based on the complex formation of Ga (III) with N, N′ -bis (salycilidene)-1, 2-phenylenediamine (salophen) as a chelating agent in buffer media of pH 5. After phase separation and dilution of the surfactant-rich phase with 0.2 mL of a (80-20) propanol-water mixture containing 0.02 mL HNO_3, the enriched analyte was determined by inductively coupled plasma-atomic emission spectrometry (ICP-AES). The variables affecting the complexation and extraction steps were optimized. Under the optimum conditions (i.e. 7.5×10^{-5} mol L^{-1} salophen, 0.5% (v/v) Triton X-114, 45ºC equilibrium temperature, incubation time 15 min) the calibration graph was linear in the range of 20–120 ng mL^{-1} with detection limit of 1.5 ng mL^{-1}. The precision (R.S.D. %) for

five replicate determinations at 60 ng mL^{-1} of Ga (III) was better than 4%. In this manner, the preconcentration factor was 22.2. Under the presence of foreign ions, no significant interference was observed. Finally, the proposed method was utilized successfully for the determination of gallium in water and rice samples.

Keywords: Cloud point extraction; Gallium; Inductively coupled plasma atomic emission spectrometry; Salophen; Rice

Introduction

Although, some of the inorganic cations (such as calcium) act as vital micronutrients in the body and their deficiency can lead to various sicknesses [1] there are cations that not only have no nutritional value for human but also are highly toxic and dangerous. Because of their un-degradability and accumulation in the human body, they can eventuate too many diseases, such as cancer, kidney and liver damage, hair loss, hearing loss and very severe toxic effects [2]. Gallium is ideal example for this type of cations. The supply and demand of gallium products has gradually increased during the past decade. Gallium salts are used in medicine as tumor-scanning [3] and antitumoral agents [4]. Important application of Ga is in the semiconductor industry [5-7]. In recent years, it has been employed in many applications, such as microwave transceivers, laser diodes in compact discs and other electronics [8]. From an environmental point of view, the increasing importance and use of compounds such as gallium arsenide in the semiconductor industry, has posed the question of its toxicity and potential hazard when it is suspended in the industrial atmosphere [6, 9-12]. These are reasons for developing sensitive analytical methods for the determination of gallium. In recent years, several techniques have been reported for the determination of gallium in different types of matrices including, spectrophotometry [13], derivative spectrophotometry [14], AAS [15,16], ICP-AES [17,18], ICP-MS [19], X-ray fluorescence spectrometry [20], electro analytical techniques such as voltammetry [21,22], polarography [23], chronopotentiometry [24,25], ion-selective electrode [26], coulometric [27] and PVC-membrane bulk optode [28]. In almost all these methods,