Matrix Interferences in the Analysis of Digested Biological Tissues with Inductively Coupled Plasma-Mass Spectrometry

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ABSTRACT

To investigate the physiological roles or toxicity of trace or toxic elements, multielement analysis of limited quantities of samples in the biological tissues is required. Inductively coupled plasma mass spectrometry (ICP-MS) suits this requirement, but spectral and nonspectral interferences are inevitable. We examined correction methods for the nonspectral interferences by analyzing signals of 21 elements in various concentrations of HNO₃ as well as five major elements (Na, K, P, Ca, and Cl). Using internal standards, the interferences caused by the major elements were corrected, but the interferences caused by HNO₃ were impossible to correct for elements with high ionization potentials. The analytical results using the standard addition method on 14 elements in standard reference materials and fresh brain tissues confirmed the accuracy of this method. Thus, we concluded that the standard addition method is useful to correct for the nonspectral interferences.

Index Entries: Element analysis; wet digestion; nonspectral interferences; inductively coupled plasma mass spectrometry.

INTRODUCTION

To investigate the physiological roles or toxicity of trace or toxic elements, quantification of many elements in biological samples is required, preferably by a method that requires small amounts. Although

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several multielement quantification methods have been used, they have produced little information about trace elements in biological tissues because of their low sensitivity or inaccessibility. Inductively coupled plasma mass spectrometry (ICP-MS) is a highly sensitive multielement analytical method and has been becoming accessible for many laboratories. ICP-MS has been increasingly applied to biological samples, and regional (1) or subcellular (2) distribution of many elements in biological tissues has been reported. However, ICP-MS is seriously affected by matrix interferences, such as spectral overlapping (spectral interferences) and matrix-induced signal intensity changes (nonspectral interferences). Nonspectral interferences are usually corrected by the internal standard method or by the standard addition method. Internal standardization is used more often, because it requires less time and sample amounts than does the standard addition method. Usually, one selects an internal standard whose mass number is near the elements to be determined. However, the interference is difficult to predict, so it does not always make the appropriate correction (3). Therefore, before using an internal standard, we should determine whether it corrects for the interferences appropriately. When internal standardization is not applicable, the standard addition method, which is considered to be more accurate and reliable, is used (4,5).

As reviewed by Vandecasteele et al. (6), internal standardization is appropriate for correcting for the nonspectral interferences in the analysis of serum. However, for the analysis of digested tissues, correction methods for these interferences have not been fully investigated. In the present study, we evaluated the influence of nonspectral interferences on a multielement analysis of wet-digested tissue, because wet digestion is commonly applied to biological samples.

The main causes of nonspectral interference in the analysis of wet-digested biological tissues are considered to be the major elements (Na, K, P, Ca, and Cl), which are naturally abundant in tissues, and nitric acid, which is recommended for use in wet digestion for ICP-MS analysis because it has lower spectral interferences than other acids (7). Therefore, we investigated the effects of nonspectral interferences caused by various concentrations of HNO₃ and the major elements. Then, because we found that the internal standardization was not appropriate, we analyzed HNO₃-digested biological tissues using the standard addition method to confirm the reliability of this method. The samples we analyzed were certified reference materials and fresh brain tissues. The reason we analyzed brain tissues was that the multielement analysis using small amount of samples was considered to be useful, especially for the brain tissues, because their elaborated anatomical structures and functions will require knowledge about element concentrations in a small region.