Evaluation of a fast extraction procedure using diluted hydrochloric acid solution for determination of metals in animal and plant tissues

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Abstract

Extraction is an attractive approach for sample preparation and sometimes it can be easily applied for inorganic analysis. It was shown here that simple extractions can be applied to quantitative determination of Ca and Zn in bovine muscle and Ca in sugarcane leaves. However, harsh conditions should be applied to quantify Fe and Cu in these samples and Zn in sugarcane leaves.

Introduction

Sample preparation is an important step for metal analysis because most spectroanalytical techniques are applied for analysis of solutions. Some elements can be easily extracted from plant tissues using diluted acid[1]. However, there is no systematic study evaluating the extraction of some metals in animal and plant tissues using short extraction times.

Results and Discussion

In this study it was evaluated the extraction of Ca, Cu, Fe, and Zn in bovine muscle and sugarcane leaves using diluted hydrochloric acid solutions. The contents of Ca, Cu, Fe and Zn are 135.4, 1.8, 51.5 and 118.6 mg/kg in bovine muscle and 3691, 4.5, 159.5, 15.8 mg/kg in sugarcane leaves.

Initially, the acid concentration (1, 2, 4, 6, 8 and 10 % v/v) was optimized with 50 mg of sample mixed with 10 mL extractor solution at 200 rpm for 5 min using a laboratory shaker. The suspensions were filtered and stored until performing measurements using an inductively coupled plasma optical emission spectrometer (ICP OES, iCAP 6000, Dual view, Thermo Scientific). Afterwards, the effect of time (2.5, 5.0, and 7.5 min) and temperature (25, 40 and 60 °C) on elements extraction were evaluated using the best conditions previously obtained.

The increase in the acid concentration improves the extraction efficiency in plant tissues, but an opposite effect was observed for animal tissues (Figure 1). For solutions containing higher acid concentration there is more available protons which improve ion exchange in sugarcane leaves, but decreases bovine muscle dispersion in solution due its high fat content. The best acid concentration was 1 and 8% v/v HCl for animal and plant tissues, respectively.

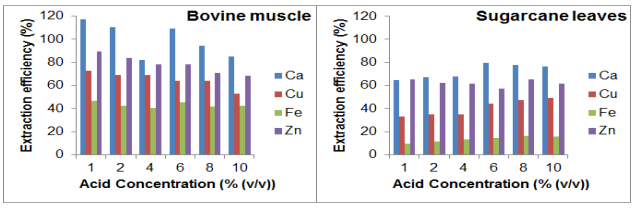

Figure 1. Effect of acid concentration in the extraction efficiency.

The increase of extraction time caused just a slight improvement in the extraction efficiency (Figure 2). So, 2.5 and 5.0 min were the best conditions for plant and animal tissues, respectively. Increase of temperature did not improve extraction efficiency.

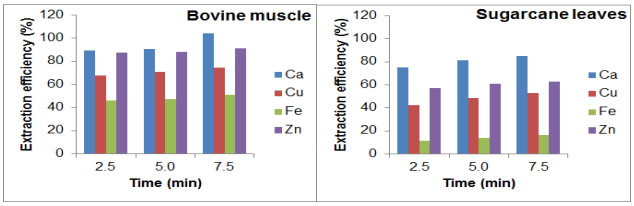

Figure 2. Effect of time in the extraction efficiency.

Iron was not successfully extracted in both samples, because it might be strongly linked to sample matrix. Concentrations of Cu in both samples and Zn in plant tissues are near the limit of detection and this might justify the low recoveries. Calcium in both samples and Zn in bovine muscle can be determined by a fast extraction (≤ 5 min) using diluted hydrochloric acid.

Conclusion

Despite semi-quantitative recoveries for Fe and Cu in all samples and Zn in sugarcane leaves, it is feasible to quantitatively extract Ca and Zn in these samples at room temperature. Consequently, extractions using 1% v/v HCl during only 2.5 min can be applied to determine Ca and Zn in bovine muscle. Quantitative extraction of Ca in sugarcane leaves required 8% v/v HCl solution and 5.0 min of extraction probably because this analyte is linked to silicate matrix.

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