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GRAPHITE FURNACE ANALYSIS OF A SERIES OF METALS (Cu, Mn, Pb, Zn AND Cd) IN OX KIDNEY.

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ABSTRACT

The aim of this study was to create a methodology for animal tissue analysis, with the use of flame atomic absorption spectrophotometry techniques and graphite furnace analysis to determining metal concentrations in ox kidney. The organ of this animal can be considered a great nutritional food, due to the high protein and micronutrient content beyond the ability to absorb and concentrate important metals such as Zn, Fe, Mn and Se. On the other hand, there is a risk when eating this food owing to the capacity to accumulate toxic metals such as Pb and Cd. In accordance with the laboratorial analysis, Zn can be analyzed by flame atomic absorption spectrophotometry, but other metals such as Cu, Mn, Pb and Cd, could only be detected by graphite furnace analysis. The results showed that there is more Zn and Cu than other metals. Such metals follows an order reported by the literature (Zn > Cu > Cd > Pb > Mn). The results showed that kidney is actually a rich source of Zn and Cu. The Cd levels in the ox kidney didn't exceed the values which cause toxic effects. The adequacy of the results indicates that the proposed methodology can be used for animal tissue analysis.

1. INTRODUCTION

Ox kidney can be considered a food of high nutritional value, due to a high protein and micronutrient contents and also by the ability to absorb and concentrate important metals such as Zn, Fe, Mn and Se. On the other hand, there is a risk when eating this food owing to capacity to accumulate toxic metals such as Pb and Cd. If there is an inadequate ability to regulate the metal concentrations in the tissues and organs, probably, is due to the available number of metal-binding sites in organs, which may result in possible hepatic and/or renal damage [1].

In a general way, the presence of elements called essential is required in plant and animal metabolism. These elements can be minerals (as N, P, K, Ca, Mg, S, B, Cl, Fe, Mn, Zn and Cu) and not minerals (such as H, O and C). Some are classified as macronutrients (nitrogen, phosphorus, potassium, calcium, magnesium and sulfur) that make part of organic compounds, as proteins and nucleic acids, or acting as osmotic components in the organisms, because they are required in relatively high proportions. Other elements are classified as

micronutrients (copper, iron, zinc, manganese, molybdenum, chlorine and boron); because they are required in small proportions; these elements are enzymatic constituents or act as activators of enzymatic in organisms [2-3].

Copper, zinc and manganese are essential elements for the growth and development of the living beings, although being toxic at high concentrations [4]. There are also elements that are considered useful (or beneficial) such as sodium, cobalt, nickel, silicon, aluminum and selenium; these elements do not have their essentiality comproved, however Co is a vitamin B12 component, but in excess it can cause a reduction in appetite and slow rate of growth. Generally, lead, cadmium, mercury, chromium, fluoride, bromine and iodine are reported as toxic for animals and plants [5].

Numerous investigations indicate that the accumulation of a metal in a tissue depends on the trophic level in organism, in connection with diet [6-8]. Normally, the diet is the major source of metal intake [8].

Aspartate, serine, threonine, and alanine were found in fairly large amounts in ox kidney. Some cysteine conjugates, which have been found in urine were found in liver and kidney by Tsukasa Azumi (2007) [9]. Besides, kidney is a rich source of protein, niacin, iron, zinc, copper, selenium, vitamins A, B1, B2, B12, and folate. It is also a good source of vitamin B6 and, vitamin C and a source of iodine. The aim of this study was to create a methodology for animal tissue analysis for determining Cu, Mn, Pb, Zn and Cd concentrations in ox kidney, with the use of standard flame atomic absorption spectrophotometry techniques and graphite furnace analysis. The adequacy of the results can indicate if the proposed methodology can or not be used for animal tissue analyses.

2. METHODS

At the laboratory, samples of ox kidney, were lyophilized, crushed and separated in a sieve. The kidney samples (0.1 g) were transferred to fluorocarbon tubes equipped with a cap and pressure relief valve belonging to a microwave (MS 5, CEM Corporation, Mattehews, NC, USA) where they underwent acid digestion (2 mL H_2O e 5 mL HNO_3) in the conditions according the Table 1:

Table 1: Adequate conditions to acid digestion in ox kidney.

Adequate conditionals to acid digestion	
Temperature	210°C
Power	1200W
Pressure	175 psi
Processing time	20 minutes

A Graphite Furnace (GTA 110, VARIAN) was used to determine the trace metals (Cu, Mn, Pb and Cd, with a dilution factor of 70 or more) except for zinc (with a dilution factor of 200 a 4000) that was determined by atomic absorption spectrometry (FS-220A, VARIAN). The results obtained were comparing with samples coming from Quebec, as a standard.

3. RESULTS

The values showed in Table 2 are the means obtained from replicates for each investigated element, calculated by an average of 10 measures. The Atomic Absorption Spectrometer software automatically performed blank subtraction, calibration, drift control and calculation of elemental concentrations of the standards and unknown samples. Comparing the results obtained with samples coming from Quebec, as a standard (Table 2) we could provide adequate validation for the methods used.

Table 2: The results for trace elements in ox kidney samples compared with samples from Quebec related values.

Elements (μg/g)	Samples of ox kidney	Samples from Quebec related values
Zn	124.60 ± 10.00%	125.7
Cu	31.01 ± 6.80%	34.35
Cd	26.74 ± 4.67%	25.60
Pb	6.556 ± 8.53%	6.510
Mn	4.187 ± 4.65%	4.180

4. DISCUSSION

The results indicated that accumulation of the analyzed metals in the kidney tissues followed the order: Zn > Cu > Cd > Pb > Mn. For Zn and Cu these results agree with the values found in the work done by Ashraf (2005) [10]. In this work, the ox kidney Cd levels did not exceed 27 μg/g d.w. However, in the work performed by Scheuhammer (1987) [11], the Cd levels found in kidney (5.4 μg/g d.w.) exceeded 2 – 5 times of liver Cd levels, and he said that toxic effects of Cd only occur in humans and other mammals when kidney Cd levels were about 100 μg/g w.w.

Stock et al. (1989) [12] found that cadmium concentrations in kidney and liver tissues were strongly, linearly correlated (positively). Similar results were reported by Blomqvist et al. (1987) [13] in their work, showing significant linear correlations between renal and hepatic concentrations of cadmium, copper, magnesium, and manganese.

These results showed that the values in ox kidney analyzed in the laboratory and in samples coming from Quebec (standards) were very similar, because performing paired statistical analysis between samples and standards, the results showed no significant difference (student's t test, $p < 0.05$). Normally, when there are metal-processing industries in the area,

where people live, Cd, Ni and Cu appears in high concentrations in human and animals liver and kidney [8].

5. CONCLUSIONS

The results showed that kidney is, actually a rich source of Zn and Cu because, there is more Zn and Cu than other metals (Zn > Cu > Cd > Pb > Mn). The ox kidney Cd levels did not exceed the values which cause toxic effects. The adequacy of the results indicates that the proposed methodology can be used for animal tissue analyses.

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