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DETERMINATION OF ESSENTIAL AND TOXIC ELEMENTS IN SHRIMP CONSUMED IN SÃO PAULO CITY

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ABSTRACT

Shrimps are consumed across the world and are a major source of protein, calcium and iodine. However, both the shrimp overfishing in the wild and the production of farmed shrimp are potential causes of environmental impact. The aim of this study was to contribute to the knowledge of the levels of essential elements Mg and Cl, toxic elements and potentially toxic elements such as V and Br in shrimp consumed at São Paulo city using the Instrumental Neutron Activation technique. The analyzed shrimp species were gray shrimp *(Litopenaeus vannamei)* produced in captivity and pink shrimp *(Farfantepenaeus subtilis)* from sea fishery.

1. INTRODUCTION

Despite political and social problems, it can be affirmed that there has been, since the mid-twentieth century, significant increase in quality of life and access to food almost everywhere in the world, with significant environmental impact due to improper exploitation of natural resources, particularly at the marine environment.

The activity of shrimp fishing for human consumption is of great economic, social and cultural importance, being held globally on a large scale.

According to the Food and Agriculture Organization (FAO), the world catch of shrimp reached 3.4 million tons in 2012 [1]. Thus, commercial fishing has shown signs of exhaustion, because shrimp banks in coastal areas need to renew from the intense fishing and boats must then go further and further to pursue the shrimp and costs increases [2].

The obvious solution to the problem would be the replacement of wild shrimp by shrimp farming. However, many studies have shown that shrimp, or shrimp farming should follow the principles of quality assurance and regulation to be sustainable from the social and economic viewpoints, but mainly from an environmental perspective, since it can cause serious damage to estuaries used for shrimp cultivation [1, 3].

In Brazil, particularly in the Northeast, the cultivation of saltwater shrimp has been developing in recent years and, in some locations, it has become the main economic activity. The concern about the negative impacts of this activity is due to discharge without any treatment, of the effluent from farms directly into the marine environment, in estuaries or mangroves. These effluents have dissolved and particulate organic matter, ammonia, nitrite, nitrate, phosphate, suspended solid particles and other substances that may be considered potential contaminants [4]. Thus, after very rapid growth, the national export shrimp collapsed from 2009 as a result of both inadequate industrial planning and public policies [5].

There are several studies related to the environmental impact on the marine environment related to human activities involving shrimp. Because it has high tolerance to toxins in polluted areas, shrimp can increase the level of toxins in its predators and thus is used in biomonitoring studies [6]. With regard to element mass fraction determination by Instrumental Neutron Activation Instrumental (INAA), only one study on speciation of as was found in the literature [7], indicating the importance of the development of INAA applications for the determination of elements in shrimp.

In this study, samples from two shrimp species were obtained at the Central Warehouse Company of the State of São Paulo (CEAGESP): gray shrimp (*Litopenaeus vannamei*) and pink shrimp (*Farfantepenaeus subtilis*).

The objective of this study was to determine the mass fraction of essential elements such as Cl and Mg, and toxic or potentially toxic as Br and V in shrimp samples by the INAA comparative method using short irradiations in the different species.

For the investigated samples, mass fractions were determined in different compartments of the animals such as in fresh sample (the whole animals), clean sample (animals without head and tail), and isolated muscle and shells.

2 EXPERIMENTAL

2.1 Preparation of element standards

Standards of the elements of interest were prepared by pipetting Spex standard solutions into Whatmann filter paper sheets using Eppendorf pipettes with varying volumes. For some elements dilutions of the original solutions were made in calibrated volumetric flasks before pipetting. After drying, filter papers were folded and sealed in polyethylene, with the same geometry as for samples.

2.2 Sample preparation

Shrimp samples were obtained from the warehouses at the Central Warehouse Company of the State of São Paulo (CEAGESP). Then the two species - gray shrimp (*Litopenaeus vannamei*) and pink shrimp (*Farfantepenaeus subtilis*) were fractionated into their compartments (organs "guts", shells, muscle and muscle with shell), and each sample compartment were analyzed. All samples were processed in a blender with titanium blades to homogenize the batch of every sample and then freeze-dried, ground in a blender, sieved and weighed on an analytical balance (AEL-40SM Analytical Balance) in the form of powder with 150 mg of sample each in polyethylene bag with the same geometry of the standards.

2.3 Irradiation and determining the concentration of elements / sample

The samples were irradiated simultaneously with standards of Cl, Mg, Br and V, in the pneumatic station of the IEA-R1 reactor of IPEN - CNEN/SP, for 20 seconds under a thermal neutrons flux of 10^{12} cm^2 s^{-1}. Immediately after irradiation, the standards and sample were measured at a high-purity Ge detector (CANBERRA). They were measured for 300 s, always at the same distance sample-detector (shelf 1). Obtained activation values were transformed into mass fraction through a Microsoft Excel spreadsheet.

3. RESULTS AND DISCUSSION

Table 1 presents the obtained experimental results for the mass fractions of Cl, Mg and Br in the two species of shrimp obtained by INAA. The presence of V was also investigated in the shrimp samples, but it was below the detection limit of the used method.

Table 1: Element mass fraction in mg kg^{-1} (dry weight) in shrimp species obtained by INAA

Shrimp Sample	Mean value ± Standard Deviation (*n* = 2)		
	Cl	Mg	Br
Fresh Pink Shrimp	22.7 ± 5.7	3.52 ± 0.10	0.17 ± 0.03
Fresh Gray Shrimp	4.95 ± 0.93	2.54 ± 0.23	0.13 ± 0.01
Pink Shrimp Muscle	24.46 ± 0.94	1.58 ± 0.11	0.08 ± 0.01
Pink Shrimp Muscle in Shell	19.97 ± 0.44	2.53 ± 0.38	0.09 ± 0.01
Pink Shrimp Guts	22.22 ± 0.36	4.76 ± 0.20	0.30 ± 0.02

Mass fraction differences between species are presented in Figure 1 while the comparison for different compartments for pink shrimp is presented in Figure 2.

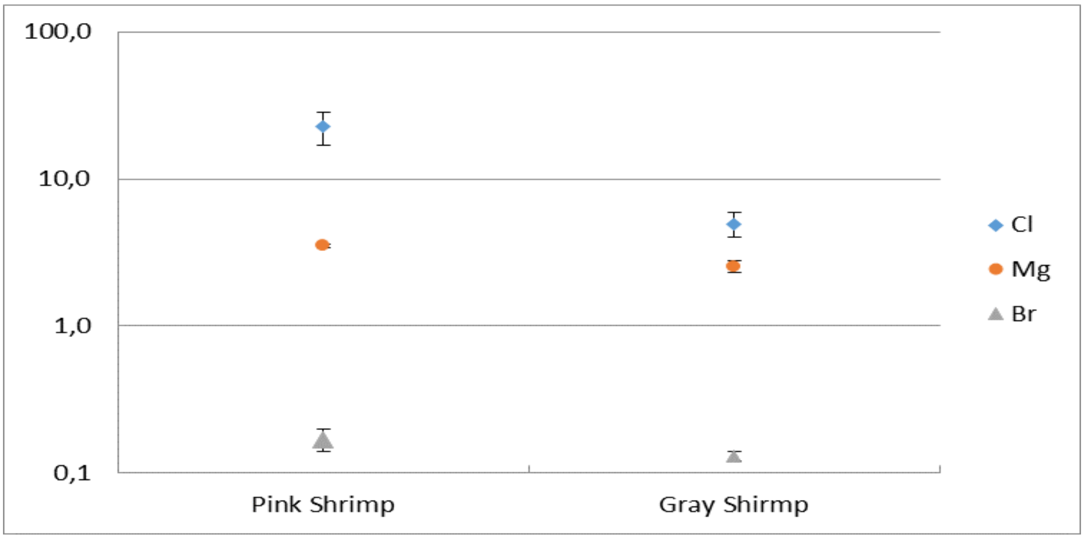

Figure 1: Comparison of element mass fraction in mg kg^{-1} (dry weight) in shrimp species obtained by INAA

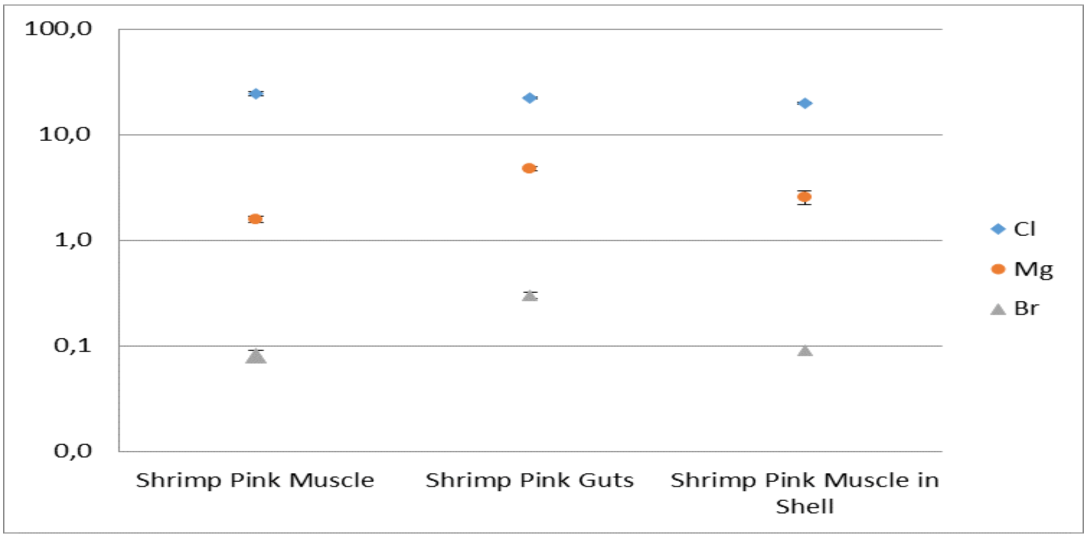

Figure 2: Comparison of element mass fraction in mg kg^{-1} (dry weight) in compartments of pink shrimp obtained by INAA

It was observed in Figure 1 that for the three quantified elements, pink shrimp presented higher mass fraction values. This difference may be related to differences in the origin of the animals and/or differences physiological differences between the two species.

In Figure 2, the influence of pink shrimp compartments on element mass fraction was examined. It was observed that Mg and Br are present in larger quantities in the guts while for Cl differences are less pronounced. In next steps of this study more samples will be analyzed for species comparison as well as organs and the influence of sample preparation in obtained results.

4. CONCLUSIONS

In this preliminary study, short irradiation INAA was successfully applied in samples of two species of shrimp consumed at São Paulo city. It was observed that Mg, Br and Cl mass fractions were higher in pink shrimp if compared to gray shrimp. Also element mass fractions are different for a particular species if different organs were taken into account.

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