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Comparison of mineral and trace element concentrations in two molluscs from the Strait of Magellan (Chile)

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Abstract

Concentrations of Na, K, Ca, Mg, Fe, Cu, Zn, Mn, Se and Cd were determined in 58 specimens of molluscs belonging to two species: *Mytilus chilensis* ($n = 29$) and *Perunytitus purpuratus* ($n = 29$), collected on the coast of San Juan in the Strait of Magellan (Chile). *Perunytitus purpuratus* presented higher concentrations for all the minerals and trace elements except K, with significant differences for Mg, Fe, Cu, Se and Cd. A 100 g serving of these molluscs was shown to provide a high contribution of these minerals and trace elements to the daily dietary intake; especially noteworthy were Fe, Zn, Mg and Se in the case of *P. purpuratus*. In addition, the consumption of these molluscs makes a large contribution to daily Cd intake. Significant differences were observed among the mean concentrations for most of the metals studied, according to the date that the samples were collected. The application of linear discriminant analysis (LDA) to the minerals and trace elements studied makes it possible to differentiate reasonably between these two mollusc species. For specimens belonging to each mollusc species, the application of LDA made the differentiation of the specimens according to their weight range possible.

Keywords: *Mytilus chilensis*; *Perunytitus purpuratus*; Strait of Magellan; Essential and toxic elements; Dietary intake; Food safety; Mineral concentrations in molluscs; Trace element concentration in molluscs; Metal contamination in foods; Metal accumulation in foods; Metal contamination in marine organisms

1. Introduction

Marine organisms, especially molluscs, are a good source of nutrients. The consumption of marine mussels provides an inexpensive source of protein with high biological value for human consumption. In addition, this food group contributes to the intake of essential minerals and trace metals and certain vitamins (Cheong and Lee, 1984; Mataix Verdú and Urbano Valero, 2002).

On the other hand, toxicological effects in humans could result from the consumption of these organisms when they contain high accumulations of metals. Toxic metals (which are the same as essential metals, after a determined concentration has been attained) have the capacity to accumulate in organisms from the environment in which they live. Many papers (Cantillo, 1998; Kaimoussi et al., 2001; Ke and Wang, 2001; Chou et al., 2003; Roméo et al., 2005) have already shown why molluscs may be used to biomonitor heavy metals in the environment. Mussel watch programs have been used to assess coastal environmental pollution since they were proposed in the 1970s by Goldberg et al. (1978). Nevertheless, no data are available on the pollutant content in mussels for some parts of the world, and therefore research on toxic metal concentrations in organisms in their tissues remains necessary basic work (Roméo et al., 2005).

Mollusc production plays an important role in the economy of the Strait of Magellan, representing about 1.5% of Chile's total exports. In the next few decades an increase in the production of molluscs from the Strait of Magellan will probably be observed. Thus, it is important to find out the levels of the minerals and trace elements in the mollusc species from this coastal region, in order to

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report information of interest from the point of view of both nutrition and contamination.

In previous papers, we determined the essential metals Na, K, Ca, Mg, Fe, Cu and Zn (Astorga España et al., 2004) and other trace elements such as Mn, Ni, Se and Cd (Astorga España et al., 2005) in specimens of mollusc belonging to five different species from the Strait of Magellan. In this paper we have determined the concentrations of several essential or toxic minerals and trace elements in two species of molluscs collected in the Strait of Magellan. The influence of the weight or length of the specimen and sampling date on the metal concentration was evaluated. In addition, the contribution of these metals to the dietary daily intake through consumption of one 100 g serving of these molluscs was also estimated. Linear discriminant analysis was applied on the mineral and trace elements analysed to differentiate the mollusc samples according to species and, within each species, according to the weight of the specimens.

2. Materials and methods

2.1. Sampling and preparation

Fifty-eight samples of molluscs (*Perunytitus purpuratus*, $n = 29$; *Mytilus chilensis*, $n = 29$) were collected on the coast of San Juan (Chile) in the Strait of Magellan (Fig. 1), between October 2000 and February 2001. The sampling stations were selected on the basis of their production; sampling took place to the south of Punta Arenas, considered to be the cleanest zone with a Pacific Ocean influence. Samples were collected, taking care to maintain uniform sets and comparable mussel size. The organisms were handpicked in the tidal zones and washed with seawater and stored in plastic bags in a freezer at −20 °C until analysis. Once the samples were defrosted and classified, the soft tissues were separated and weighed. The length of the shell was also recorded. Each sample was analysed individually. For statistical analysis, the samples were also classified according to the weight of the specimens, as follows: (1) *M. chilensis*: very small (<0.5 g), small (0.5–1 g) and medium (>1 g); and (2) *P. purpuratus*: very small (<1 g), small (1–3 g) and medium (>3 g).

2.2. Analytical methods and quality control

Metal contents were determined using a Varian Spectra (Varian Iberica S. L., Madrid, Spain) AA-10 Plus atomic absorption spectrometer equipped with a D_2 lamp background correction system. Each sample was placed in digestion tubes, and between 8 and 20 ml of HNO_3 Suprapur (Merck) was added depending on the weight of the mollusc. Afterwards the procedure we previously described (Astorga España et al., 2004, 2005) was applied.

The mean recovery percentages (eight replicates) were: Na (101.2±1.5%), K (96.5±3.2%), Ca (95.0±5.2%) and Mg (104.2±5.3%) using the reference material NBS-SRM 1566a; Fe (101.3±3.8%), Cu (97.9±2.3%), Zn (100.7±3.6%), Mn (84.9±2.0%) and Se (89.3±3.8%) using DORM-2; and Cd, (95.4±2.3%) using DOLT-2. Coefficients of variation ranged from 2.4% to 5.3%. Detection limits were: Na (1 μg/100 g), K (5 μg/100 g), Ca (40 μg/100 g), Mg (14 μg/100 g), Fe (2 μg/100 g), Cu (1 μg/100 g), Zn (5 μg/100 g), Mn (1 μg/100 g), Se (0.1 μg/100 g) and Cd (1 μg/100 g).

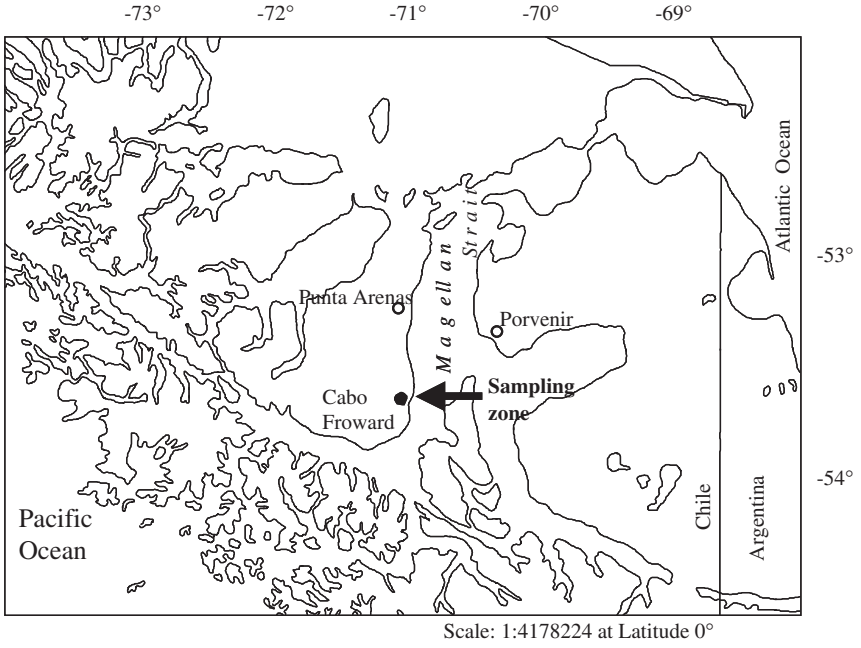

Fig. 1. Geographical location of sampling site (coast of San Juan, Chile) in the Strait of Magellan.