# TRACE METALS IN SOFT TISSUE OF MARINE BIVALVE NOAH'S ARK (*ARCA NOAE*) FROM BIZERTE LAGOON (NORTHERN TUNISIA)

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## Abstract
This study aimed to monitor the bioaccumulation of 5 trace elements (TEs: Zn, Fe, Cu, Cd, and Pb) in the soft tissue of the Ark shell (*Arca noae*), seasonally sampled in Bizerte lagoon, northern Tunisia, in order to assess the nutritional quality of this bivalve and to promote its consumption as marine resource in Tunisia. The levels of all trace metals analyzed in *Arca noae* are below maximum admissible level which makes this species a healthy and safe food for human consumption.

*Keywords: Bio-accumulation, Trace elements, North-Eastern Mediterranean*

**Introduction**
Bizerte lagoon is one of the most studied coastal areas in Tunisia, and is used for shellfish production since 1964. It is permanently connected to the Mediterranean Sea by a straight channel of 8.5 km long and communicates also with the Ichkeul Lake (110 $km^2$) through the Tinja channel (Fig.1). The Bizerte lagoon inhabit a wide diversity of marine invertebrates, among them the valuable shellfish Noah's ark. But like any benthic invertebrates, that mollusk may accumulate trace elements whether essential or not, which cause toxic effects above threshold levels. The number of papers studying the accumulation of trace metals in *Arca noae* worldwide is limited [1] [2].

**Materials and Methods**
Ten specimens of Ark shell of commercial size (46.23-65.08 mm) were collected monthly from Bizerte lagoon (Fig. 1) at 3 meter depth by scuba diving from October 2013 to September 2014. The sampling site was located far from urban and industrial sources of pollution, but remained influenced by agricultural inputs. TE concentrations were measured in the mollusk flesh by inductively coupled plasma mass spectrometry (ICP-MS). TE concentrations were averaged by seasons and significant seasonal differences between mean TE levels were highlighted through non-parametric analysis of variance (Kruskal–Wallis test) followed by Dunn pairwise comparison test of means ($p < 0.05$). Statistical analysis were performed using STATISTICA 8 (StatSoft Inc.).

**Results & Discussions**
Mean seasonal TE levels in *A. noae* flesh (mean ± SD, in mg $kg_{ww}^{-1}$) are given in Table 1. TE concentrations decreased in the following order: Zn > Fe > Cu > Pb > Cd. Essential (e.g. Zn) TEs were accumulated at higher levels than non-essential toxic ones (e.g. Pb, Cd). Significant differences ($p < 0.05$) were observed between mean seasonal TE concentrations in *A. noae* flesh, the highest values of all trace elements being recorded during summer 2014 and autumn 2014 (warmer compared to autumn 2013) and the lowest ones during winter 2014 (Table. 1). The winter period in Bizerte lagoon being characterized by the increase of provision in rainwaters washing out the agricultural bordering lands and enriching the lagoon on various pollutants (pesticides and heavy metals) [3] [4], higher TE levels were expected in ark flesh for that season. But since results showed the opposite trend, we assume that the strong surface water currents specific to Bizerte lagoon rapidly diluted and exported TEs brought through water runoff and river discharge that were consequently not bioaccumulated at higher levels in *A. noae* flesh. Food safety standards have been set for metals in bivalves by Food and Agricultural Organization (FAO) of United Nations. The food standards for bivalves set by the FAO [5] are 10.0-30.0, 40.0-100.0, 2.0 and 1.0-6.0 mg $kg_{ww}^{-1}$for Cu, Zn, Cd and Pb, respectively. The derived wet weight based-concentrations of all metals in *Arca noae* from the present study were well below their respective food standards. This result is very encouraging from an economic point of view to enable future commercial exploitation of *A. noae* in our country.

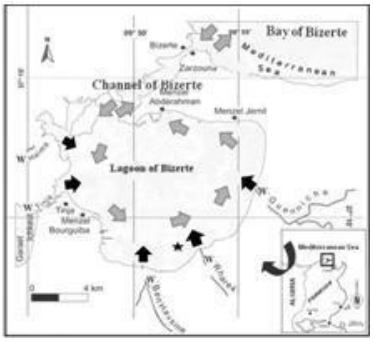


Fig. 1. Map of Bizerte lagoon (Northern Tunisia). The black full star in the Southern part of the lagoon shows the sampling site location.

Tab. 1. Seasonal mean Trace element (TEs) concentrations (mean ± SD, in mg $kg_{ww}^{-1}$) in *A. noae* flesh(n=40) (Letters indicate significant differences ($p < 0.05$) between seasons).

| | Autumn 2013 | Winter 2014 | Spring 2014 | Summer 2014 | Autumn 2014 |
|---|---|---|---|---|---|
| Zn | $37,44^{a}\pm4.52$ | $42,02^{a}\pm5.32$ | $42,23^{b}\pm4.61$ | $42,41^{b}\pm3.79$ | $75,02^{c}\pm20.12$ |
| Fe | $36,81^{b}\pm8.688$ | $33,20^{b}\pm5.819$ | $30,06^{b}\pm2.504$ | $45,73^{c}\pm17.48$ | $46,94^{c}\pm0.00$ |
| Cu | $1,06^{b}\pm0.19$ | $0,97^{a}\pm0.08$ | $1,26^{c}\pm0.17$ | $1,56^{c}\pm0.14$ | $1,12^{b}\pm1.16$ |
| Cd | $0,14^{a}\pm0.00$ | $0,20^{b}\pm0.03$ | $0,21^{b}\pm0.03$ | $0,23^{b}\pm0.05$ | $0,31^{c}\pm0.42$ |
| Pb | $0,29^{b}\pm0.17$ | $0,13^{a}\pm0.01$ | $0,28^{b}\pm0.26$ | $0,48^{c}\pm0.43$ | $0,40^{c}\pm0.44$ |

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