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Correlations between arsenolipids, organic and inorganic forms of arsenic, mercury and selenium in muscles and cephalothoraxes of *Aristaeomorpha foliacea* shrimp

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Abstract

A Mediterranean species of shrimps, *Aristaeomorpha foliacea* (giant red shrimp) from the deep waters of the Ionian Sea, was studied in terms of its content of organic and inorganic arsenic, mercury and selenium in muscles and cephalothoraxes. Generally, total arsenic (As) concentration ranges from 1 to 100 mg/kg w.w in marine organisms. Arsenic is found in marine organisms as inorganic (the most toxic form of As, typically found in low concentrations) and as organic (considered as less- or non-toxic, and typically found in high levels). Arsenolipids, a group of lipophilic of arsenic-containing compounds, has been reported in concentrations from 1 to 50 mg/kg in marine oils. Mercury, a well-known toxic element, is typically determined in low levels in crustaceans. Selenium is believed to have an antagonistic protective effect against the toxicity of mercury and hence the ratio of these two elements is interesting to study in marine organisms. The aim of the present study was to determine the levels of organic and inorganic arsenic, as well as the levels of mercury and selenium in order to evaluate the food safety of this type of shrimp.

ICP-MS, HPLC-ICPMS and CVAFS were used for the analysis. The total arsenic in muscles was 16.3 mg/kg w.w., while in the cephalothorax tissue much higher concentrations (32.7 mg/kg w.w.) were observed. The inorganic form of arsenic in the shrimp was detected only in cephalothoraxes at very low levels (0.9 iAs $\mu\text{g}/\text{kg}$ w.w.) and not at all in the edible muscle tissue. Arsenolipids comprised only 0.4% of the total organic As in the muscles and only 1.9% of the organic arsenic in the cephalothorax. Analysis of cephalothorax extract showed the existence of several arsenolipids in this type of shrimp. The rest of the organic As included water-soluble compounds, mainly arsenobetaine, which typically is the predominant arsenic compound in marine organisms and was calculated. As far as Hg is concerned according to the European Legislation for heavy metals in foods, mercury has a maximum level of 0.5 mg/Kg w.t. in seafood. Noticeably, the studied samples had lower concentration than the maximum level. The concentration of selenium in the whole shrimp (sum of both tissues) was three times higher than Hg concentration. Remarkably, selenium content in cephalothoraxes was one folder higher. The correlation coefficient between these two metals had the highest value (-1.00). In conclusion, even though the levels of As were quite high, the largest proportion of total As was in organic form (primarily non-toxic) and the levels of Hg was lower than the permissible maximum level.

Keywords: Shrimp; Mediterranean Sea; arsenolipids; mercury; selenium.