# An Investigation of Mercury Bioaccumulation and its Relation with Selenium in the Muscle and Liver Tissues of Milk Shark (*Rhizoprionodon acutus*)

**Tarassoli, A.[1*], Esmaili Sari, A.[2], Vali nassab, T.[3]**

1-M.Sc. student, Department of Environment, Faculty of Natural Resources, Tarbiat Modares University, Tehran-Iran

2- Prof., Department of Environment, Faculty of Natural Resources, Tarbiat Modares University Tehran-Iran, esmaili@modares.ac.ir

3- Assoc. Prof., Department of Iranian Fisheries Research Organization, Tehran-Iran, t_valinassab@yahoo.com

Received: Oct., 2011 Accepted: Jan., 2012

## Introduction

Mercury (Hg) is a pollutant on a global scale; its emission spreads over long distances in the atmosphere and across the oceans. Mercury is released into the environment from a multitude of natural and anthropogenic sources. The presence and behavior of Hg in aquatic systems is of great interest and importance .Bacteria in lakes and ocean sediment can convert element and inorganic Hg into its organic compound (methyl), which may accumulate in algae, aquatic plants and fish and into the food chain. the poisoning characteristic of mercury causes many problems, including: neurological symptoms, reproductive disorders, circulatory diseases and digestive disorders. The presence of Hg in living organisms is undesirable and potentially hazardous.

Selenium (Se) is an essential micronutrient and antioxidant, and the interaction between these two elements has become one of the strongest and most general examples of interactions between a heavy metal and a micronutrient. Se: Hg molar ratio is an important factor that needs to be considered when assessing risks from Hg exposure. Molar concentrations were calculated with the following formula: Molar concentration (n mol/g wet wt) = concentration (μg/g wt) × [1000÷atomic weight g/mol]

Mercury contamination that might otherwise produce a toxic effect is often counteracted by Se, particularly when Se: Hg molar ratios approach or exceed 1. The mechanisms of this interaction between Hg and Se are not well understood. However, approximately two possible mechanisms for Se have been suggested: 1. Formation of an inert Hg-Se complex. 2. Hg and Se have similar binding capacities with respect to sulfhydryl groups (-SH), and this competitive inhabitation may prevent the binding of Hg to proteins on the gastrointestinal tract. This can also be described in terms of the integration of Se-specific nutritional benefits in relation to potential Hg-exposure risks presented by a given type of seafood, the proposed Selenium health benefit value (Se-HBV) is calculated as follows:

$$\text{Se-HBV} = [\text{molar ratio (Se/Hg)} \times \text{total Se}] - [\text{molar ratio (Hg/Se)} \times \text{total Hg}]$$

Several works have already reported information on the relationship between Se and Hg in marine mammals and birds, but information on this research in predatory fish is scarce. Sharks exhibit characteristics associated with being an apex predator, high longevity and low metabolic rate, which allows for maximum tolerance to Hg concentration according to standards set out. After the oil industry, fishing represents the second most important natural resource, and the most important renewable natural resource in the Persian Gulf region. Therefore, it is important to identify any potential risk from the consumption of marine products based on the molar ratio of Se: Hg and determination of Se-HBV on Hg toxicity in this aquatic system.



Corresponding author: Tel: 09379047478 atarassoli@gmail.com

## Materials and methods

Twenty-two milk sharks, (10 females and 12 males) were caught for this study by R/V Ferdows-1from the Persian Gulf (Bandar Abbas coastal) in January 2010 (Figure 1).



Tissue samples taken from the muscle and liver were kept frozen at -20 °C prior to analysis. The samples were freeze-dried and analyzed for Hg and Se.Hg concentration in each sample was determined by Advanced Mercury Analyzer –LECO AMA 254. Selenium was assessed using a Graphite Furnace Atomic Absorption Spectrophotometry (Perkin Elmer 3030) after digestion in a mixture of $HNO_3$ and $HClO_4$.

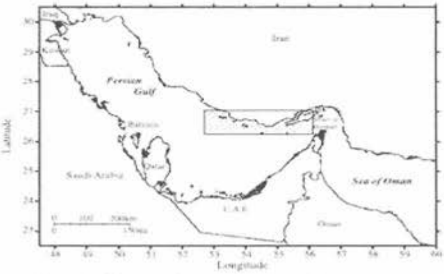


**Fig. 1: Location of sampling areas**

Statistical analysis of data was carried out using SPSS statistical package programs. Data for each individual milk shark was tested for normality by using the Kolomogorov-Smirnow test then analyzed by post test paired t test and Pearson's correlation coefficient test. Body size and gender of the milk shark, as well as the analytical results for Hg and Se in the muscle and liver samples are shown in Table 1.

**Table 1.Species and analytical result for Se and Hg (Average±S.D.)**

| Species | | milk shark (*Rhizoprionodon acutus*) | | |
|---|---|---|---|---|
| Gender | | Female | Male | Female+male |
| Weight (g)<br>Body length (Cm) | | 2544.57±1301.36<br>74.97±12.47 | 1889.68±1026.35<br>72.06±10.26 | 2187.36±1178.55<br>73.38±11.13 |
| T-Hg (µg/g wet wt) | muscle | 0.08±0.03 | 0.07±0.02 | 0.07±0.02 |
| | liver | 0.53±0.16 | 0.53±0.16 | 0.53±0.16 |
| Se (µg/g wet wt) | muscle | 0.01±0.02 | 0.09±0.02 | 0.09±0.02 |
| | liver | 0.31±0.06 | 0.30±0.04 | 0.31±0.05 |

## Discussion of Results

There was a significant positive correlation between total body length and weight ($p<0.05$). The Hg concentrations in the muscle and liver samples from the milk sharks increased proportionally with body length ($p<0.05$).This phenomenon has been previously observed in the muscle and liver of tuna and swordfish and sharks. Researchers have hypothesized that this phenomenon occurs due to an increasing Hg burden in aging predators. The result of this work shows that sex has no significant influence on the Hg concentrations in the tissue under analysis. No significant differences were found for Hg and Se concentrations between males and females or for body length between males and females ($p>0.05$).

The mean concentrations of Hg and Se in the liver were higher than those in the muscle (Figure 2).

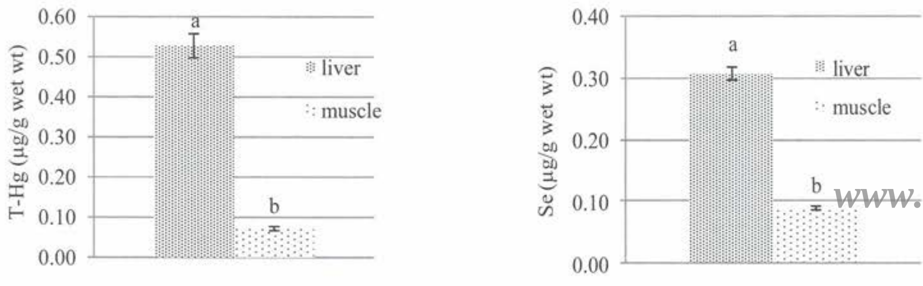




**Fig 2: Comparison of Hg and Se concentrations in muscle and Liver (Average±SE)**

The average Hg concentration in the liver ranged from 0.31 to 0.84 μg/g wet wt. approximately 45% of the liver samples showed levels above the limit established by WHO and FAO(0.5 μg/g wet wt). Liver tissue is highly active in the uptake and storage of heavy metals. It is well known that a large amount of metallothionein induction occurs in the liver tissue of fish. Essential elements are able to induce metallothionein synthesis, which probably acts to detoxify heavy metals by the formation of a heavy metal–MT complex. In the present study, a significant positive correlation was found between Hg concentration to Se concentration in the muscle and liver of milk shark ($p<0.01$) (Figure 3).It could be a reflection of a direct association between these two elements in the muscle and liver, explained by the essential role of Sea, apart from its detoxification function on Hg through formation of inert Se:Hg complexes or the indirect action of Se in preventing oxidative damage by Hg through the increase of glutathione peroxidase activity.



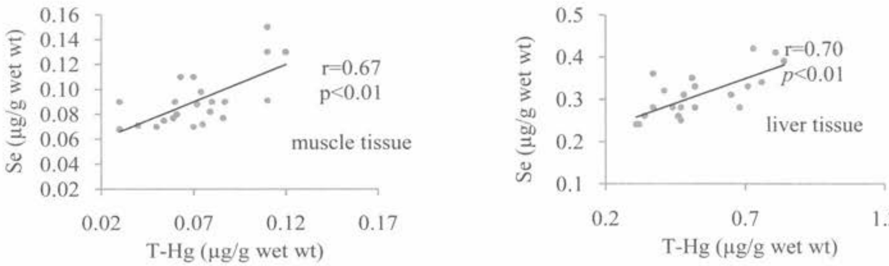


**Fig 3: Correlation between Hg and Se in muscle and liver**.

The mean Se: Hg molar ratio in the muscle and liver of milk shark was 1.58±0.42 and 3.53±0.16 respectively. Hg concentrations in the muscle and liver of milk shark were lower than sharks in other parts of the world. But, in contrast, the Se: Hg molar ratio was lower in the present study (Table 2). Se deficiency in milk shark could be due to several reasons: 1. Se may be attributed to biological interactions with Ag and Cd as well as with Hg. Se is known to reduce the toxicity of various transition metals. 2. Se deficiency may reflect low concentrations of this metal in aquatic ecosystems and food chains, because the uptake of Se by species can be from water or from dietary sources. In this study, the mean Se-HBV in muscles is positive; therefore Se concentration is sufficient for detoxification of Hg. In this index, 27% of the liver samples were negative. When Se-HBV is a negative, it is recommended to avoid the consumption of the product.

**Table 2: Comparison of average molar ratio of Se: Hg in sharks in different regions of the word**

| Reference | Species | Locality | | tissue | Molar ratio (Se:Hg) |
|---|---|---|---|---|---|
| Paul et al. (2003) | *Sphyrna zygaena* | Australian Cost | | muscle<br>liver | 0.5±0.13<br>17±4.1 |
| Branco et al. (2007) | *Prionace glauca* | Atlantic Ocean | Equatorial region<br>Azores | liver | 63±48<br>20±14 |
| McMeans et al. (2007) | *Somniosus pacificus*<br>*Somniosus microcephalus* | Arctic waters | Prince William Sound<br>Cumberland Sound | liver | 12.36±5.46<br>3.26±1.45 |
| In the present study | *Rh. acutus* | Persian Gulf (Bandar Abbas coastal) | | muscle<br>liver | 3.5±0.16<br>1.57±0.42 |

## Conclusion

The results of this study show that highly significant correlations between Hg and Se in the muscle and liver suggest a detoxifying mechanism of Hg in *Rh. acutus* through Se-Hg complex.



**Key words**
Mercury, Selenium, Milk shark, Persian Gulf