FISH LIVER SIZE AND CAT ACTIVITY: ARE THEY RELATED TO METALS BIOACCUMULATION?

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Abstract:

The uptake of metals by a wild mullet (*Liza saliens*) from a polluted coastal lagoon, Portugal, was related with liver catalase activity (CAT) and relative liver size (HSI). Lagoon mullets showed higher CAT activity in liver, as well as higher HSI, than mullets collected in the sea.
The positive relationship between CAT activity and Cu levels found in liver suggests that a metabolic increase was induced to cope with Cu oxidative stress. Besides, the observed positive relationship between CAT activity and HSI indicates that CAT induction, under oxidative stress conditions, could contribute to the relative liver enlargement.

Introduction:

Several studies revealed that fish exposure to heavy metals could trigger oxidative stress [1, 2], by reactive oxygen species (ROS) generation [3, 4]. ROS can be detoxified by an enzymatic defence system, that include catalase (CAT) [5, 6]. The hepato-somatic index (HSI) reflects the status of liver, as energy store and metabolic centre, and its variation may be associated to contaminant exposure [7].

The Esmoriz-Paramos coastal lagoon on the Northwest of Portugal, is contaminated by heavy metals [8]. The dominant fish in the lagoon is the mullet *Liza saliens* that showed bioaccumulation of Cu in liver over age [9].

In this study CAT liver activity and relative liver size (HSI) were investigated in relation to metal bioaccumulation in liver.

Materials & Methods:

- Mullets, from the lagoon and from the sea (14 Km northwards), were captured in post-spawning period by gill net and anaesthetised. Livers were weighed to obtain hepato-somatic index (HSI = liver weight (g)/ body weight (g) x 100).
- Liver samples were frozen in liquid nitrogen, in the field, and taken to the laboratory where they were homogenised in ice-cold sodium phosphate buffer 50 mM, Na_2EDTA 0.1 mM, pH 7.8. Mitochondrial fractions were obtained after centrifugation at 15 000 X g (20 min, 4ºC). CAT activity was determined spectrophotometrically (240 nm) by the consumption of H_2O_2 [12]. The reaction volume was according to [13].
- Copper and zinc concentrations in liver of lagoon fish were analysed elsewhere [9].
- Comparisons between HSI of the two fish populations were made with t test, and the differences of enzymatic activities were tested with Mann-Whitney U-Test. The relationships among the different parameters were tested with Spearman´s correlations. A 5% significance level was employed throughout.

Results & Discussions:

Livers from lagoon fish showed higher Cu concentrations (378.9 ± 122.5 mg.Kg-1), ranging from 125 to 547 mg.Kg-1, than Zn (99.9 ± 30.9 mg.Kg-1) ranging from 61 to 190 mg.Kg-1.

HSI was significantly higher in mullet from the lagoon than mullet from the sea (ranging from 1.76-4.38 % and 0.36-2.21 %, respectively), when compared within the same size class. Higher HSI in fish (*Myoxocephalus scorpius*) from polluted areas can be indicative of increased activity of xenobiotic biotransformation enzymes [10].

CAT-liver activity in mullet from the lagoon was significantly higher than in mullet from the sea (Tab. 1) suggesting that a metabolic increase was induced to cope with Cu oxidative stress [11]. It is recognised that ROS production is associated with exposure to several metals and *Liza saliens* seems to have developed an adaptive response to metal-induced stress by increasing CAT activity in liver. In fact, CAT-liver activity was positively related with Cu levels in liver and with HSI (Figure 1). This may mean that CAT induction, under conditions of oxidative stress, could contribute to relative liver enlargement.

Tab. 1 – CAT liver activity and HSI in mullets from the lagoon and from the sea (mean ± standard deviation).

Parameters	*Lagoon*	*Sea*
	N = 13	**N = 7**
CAT (mmol/min/mg prot)	39.2 ± 16.6* (HSI=2.3 ± 0.4 **)	21.6 ± 5.3 (HSI=1.2 ± 0.2)
	N = 30	**N = 32**
Lenght (cm)	28.63 ± 2.21	28.05 ± 3.20
HSI (%)	2.56 ± 0.65 **	1.26 ± 0.41

HSI, hepato-somatic index=liver weight (g)/body weight (g)x100
$^{**}p<0.01$; $^{*}p<0.05$

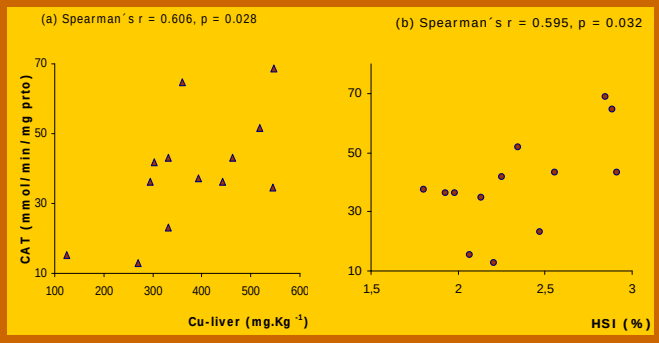

Fig.1 – Relationships between Cu-liver content and CAT activity (a) and between HSI and CAT (b) in mullet from Esmoriz-Paramos lagoon.

Conclusions:

- High Cu levels in liver of *Liza saliens* may have led to some loss of homeostatic capacity and induction of CAT activity in order to reduce oxidative stress. On the other hand, hepatic Zn is apparently under regulation (Fernandes *et al.* 2007) [9]
- Increase of HSI can be due to induction of biotransformation enzymes in response to chronic exposure to heavy metals.
- *Liza saliens* seems to have developed an adaptive response to metal-induced stress by increasing CAT activity in liver.

References

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