Testing the Chelating Properties of Coriander Lyophilisate (*Coriandrum sativum*) in Experimental Lead Poisoning in *Carassius gibelio* Bloch

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Abstract

Our study aimed to highlight the histological alterations of some tissue of Prussian carp's specimens, subjected to sub lethal Pb intoxication with and without coriander dietary supplementation. 90 Prussian carps, with weighing between 10 and 12 g were divided according to the following treatments for 21 days: C (without treatment), E1 (75 ppm Pb into water), E2 (75 ppm Pb into water+2% lyophilized coriander leaves in feed). Gill, intestine, liver and kidney were sampling and analyzed in light microscopy at the end of experiment. QuickPHOTO Micro 2.2 software has been used for the histological study. Our findings were: severe histological alterations in experimental Pb-poisoned group; coriander lyophilisate has been shown to be an excellent chelator on liver tissue and is largely able to attenuate the toxic effects of lead in the kidneys, intestine and gill.

Keywords: *Coriandrum sativum*, experimental lead intoxication, freshwater fish, histological alterations.

1. Introduction

Heavy metals are chemical elements that are naturally present in ecological systems [1], but with exploitation, they have become pollutants. All these exploitations led to the appearance of dangers in the aquatic environment, from anthropogenic sources that began to be much greater compared to inputs from natural sources [2].

Heavy metals are not created by biological or chemical processes but they are not destroyed either. Compared to organic pollutants, heavy metals are not biodegradable, they are less mobile, which is why they can persist much longer in the soil [2] and water ecosystems [3].

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Lead is a gray or blue heavy metal, whose presence is found on a large scale in the environment, having intensive and extensive utility in industry and human activity, producing environmental contamination and human and animal exposure.

In the aquatic environment, lead can be found in ionic form, in the form of organic complexes with dissolved humic materials, attached to colloidal particles or solid clay particles or remains of dead organisms [4].

Metallic lead toxicity in living cells follows the ionic and oxidative stress mechanism [5].

Freshwater fish exposure to sub lethal concentrations of lead was followed by significant accumulations of this metal in blood and tissues [6-10].

Synthetic chelating agents are the most commonly used in the in the treatment of harmful of heavy metals poisoning [11].

But, the use of bioactive compounds from medicinal herbs as oxygen free radical scavengers or as metal chelators has gained increased interest, especially due to their availability and efficiency, low cost and extremely low number of side effects [12].

Coriander (*Coriandrum sativum*) is considered a natural chelator, able to promote the liver antioxidant system [13], bind and immobilize cadmium chloride in the liver and kidneys [14-16] and reduce the toxic accumulation of cadmium in the tissues of the rainbow trout *Oncorhynchus mykiss* [14]. It also decreases lead uptake in bone tissue and inhibits delta-aminolevulinic acid dehydratase (ALAD) [17]. More recently, it has been found that it ensure an optimal growth and health regardless of whether rearing water is contaminated with heavy metals in Beluga fed a diet containing coriander [18, 19].

Fish are species that have attracted special attention in water pollution biomonitoring [20] due to their special biological characters, such as relatively large body size, long life cycle, easy to breed, etc. More importantly, fish species are at the top of the aquatic food chain and directly affect human health, hence the importance of biomonitoring using them as indicators [21].

The purpose of this study was to determine the histopathological effects of experimental lead poisoning of the *Carassius gibelio* Bloch species and highlighting if the freeze-dried coriander has chelating capacity on this toxicant at the tissue level.

2. Materials and methods

90 Prussian carps, with weighing between 10 and 12 g were divided according to the following treatments for 21 days: C (without treatment), E1 (75 ppm Pb into water), E2 (75 ppm Pb into water+2% lyophilized coriander leaves in feed). Gill, intestine, liver and kidney were sampling and analyzed in light microscopy at the end of experiment. QuickPHOTO Micro 2.2 software has been used for the histological study.

3. Results and discussion

In the present study, the microscopic analysis of the sections made on the gill tissue of the lead-intoxicated specimens, reveals the disorganization of the architecture of the gill lamellae: hypertrophic lamellar epithelium cells, with vacuolated cytoplasm; alteration of the connective structure in the lamellar axis; the fusion of the gill lamellae (Figure 1). Moreover, in figure 2, massive epithelial and connective degenerations appear, with the shortening to the point of destruction of the secondary gill lamellae; vascular congestion.

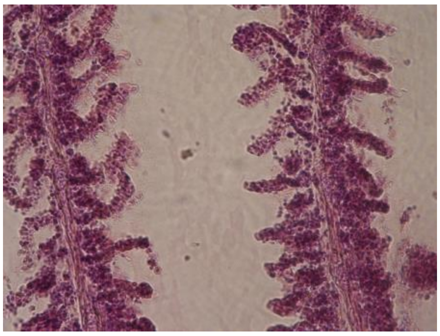

Figure 1. Gill-E1
hypertrophic lamellar epithelium**,**
vacuolated cytoplasm
(H-E, 10x)

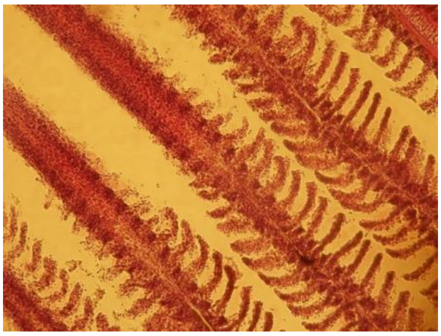

Figure 2. Gill-E1
epithelial and connective degenerations**;**
shortening and destruction of the secondary gill lamellae**;**
vascular congestion
(H-E, 10x)

In the individuals of the group that received additional lyophilized coriander in a proportion of 2%, the secondary gill lamellae, although thin, retain their uniform appearance (Figure 3 and Figure 4), being well individualized; slight epithelial hypertrophies are also present (Figure 5 and Figure 6). The morphological aspects observed in these specimens suggest the presence of a slightly affected respiratory barrier, a consequence of epithelial cell hyperplasia.

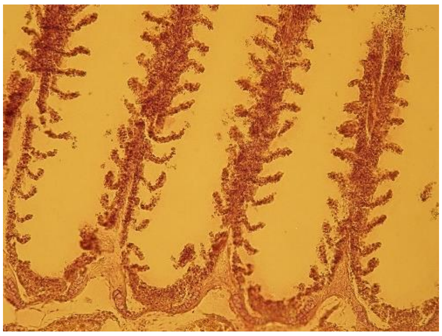

Figure 3. Gill-E2
well individualized secondary gill lamellae
(H-E, 10x)

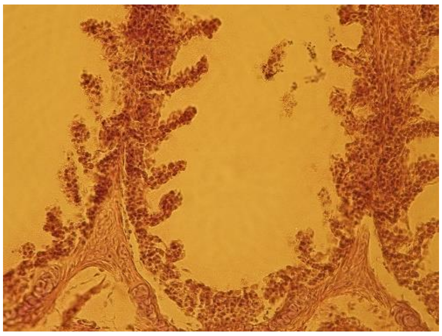

Figure 4. Gill-E2-detail
(H-E, 40x)

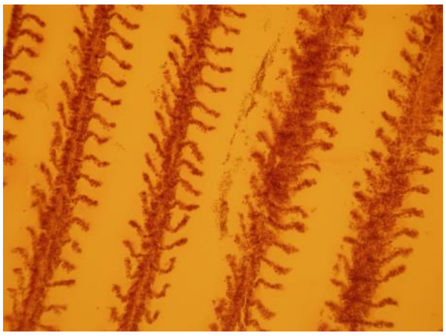

Figure 5. Gill-E2
slight epithelial hypertrophies
(H-E, 10x)

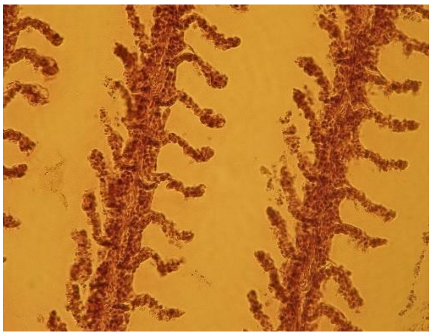

Figure 6. Gill-E2
slight epithelial hypertrophies
(H-E, 40x)

The intestinal mucosa of Pb-intoxicated individuals shows wide looking villi, reduced in height (Figure 7). Villous territories with altered epithelium are also evident, up to the disappearance of cells and microvilli. Leukocyte infiltrative cells are present in the chorion (Figure 8).

Figure 7. Intestine-E1 (cross section)
wide looking villi, reduced in height
(H-E, 10x)

The intestinal mucosa shoes high villi, with a rectangular and triangular appearance in individuals of the LE2 group. The intestinal epithelium is very little affected, observing the presence of slight epithelial detachments at the top of villi (Figure 9).

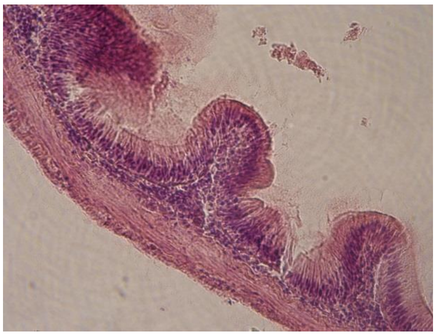

Figure 8. Intestine-E1- (cross section)
altered epithelium; no cells and microvilli**;**
leukocyte infiltrative cells
(H-E, 10x)

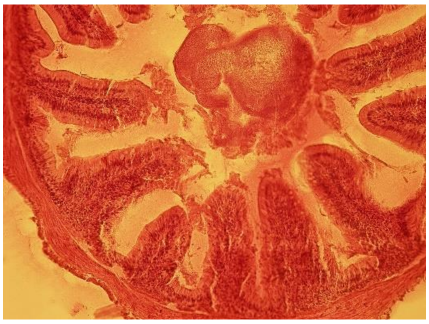

Figure 9. Intestine-E2-cross section
slight epithelial detachments
(H-E, 40x)

The liver of individuals subjected to chronic lead poisoning loses its normal architecture; the disorganized appearance of the hepatocyte cords can be observed on the sections made on this organ, the hepatocytes are hypertrophic, with clear, vacuolated cytoplasm (hepatocellular necrosis is considered a biomarker for the evaluation of chronic poisoning in fish) and a pyknotic nucleus (morphology characteristic of cell death); pericentrolobular necrosis with hypertrophies of the sinusoidal capillaries is frequently manifested in them (Figure 10). The disorganized appearance of the hepatocyte cords and hypertrophy of the centrolobular vein are evident in figure 11 and pericentrolobular hepatocytic necrosis with sinusoidal hypertrophies in figure 12.

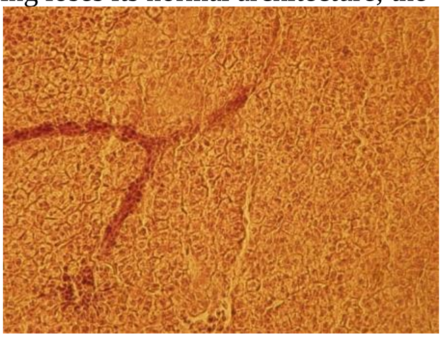

Figure 10. Liver–E1
hypertrophic hepatocytes
clear, vacuolated cytoplasm; pyknotic nucleus;
hypertrophied sinusoidal capillaries
(H-E, 10x)

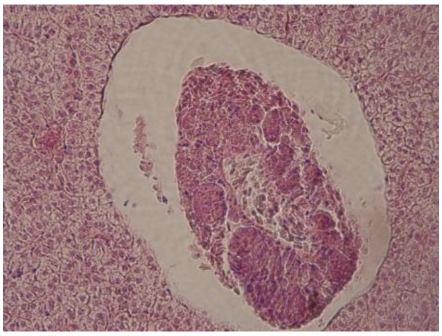

Figure 11. Liver–E1
hypertrophic centrolobular vein
(H-E, 40x)

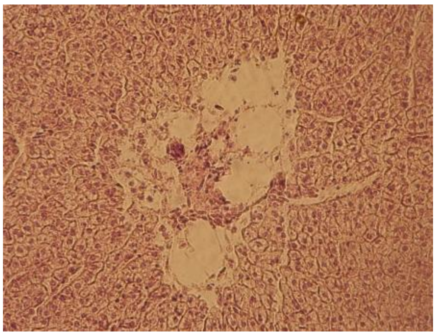

Figure 12. Liver–E1
pericentrolobular hepatocytic necrosis
sinusoidal hypertrophies
(H-E, 10x)

The histopathological changes recorded in Pb-intoxicated individuals are absent in the case of those who additionally received freeze-dried coriander in their daily diet. Ordered hepatocyte cords are observed in them (Figure 13). Normal-appearing sinusoidal capillaries lie between cords of hepatocytes.

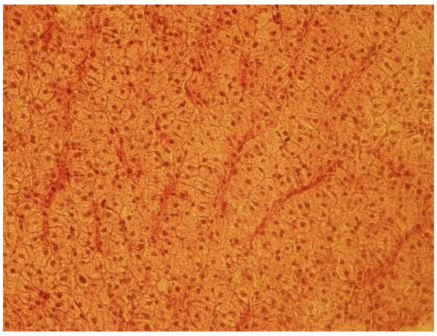

Figure 13. Liver–E2
(H-E, 10x)

The morphomicroscopic study of the sections made on the kidneys of experimentally contaminated individuals, highlights a series of changes at the level of the renal parenchyma, but also at the level of the stroma: the renal corpuscle is hypertrophic, with lesions at the glomerular capillaries and enlarged capsular space; peritubular edema (Figure 14), nephrocytic and interstitial necrosis (Figure 15).

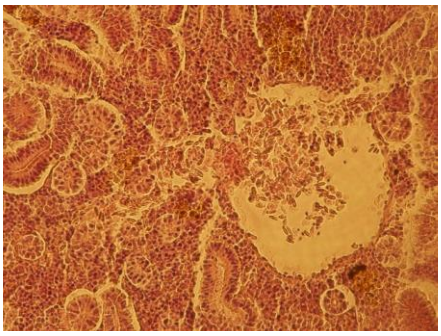

Figure 14. Kidney-E1
hypertrophic corpuscle**;**
glomerular capillaries lesions**;**
enlarged capsular space**;**
peritubular edema (H-E, 10x)

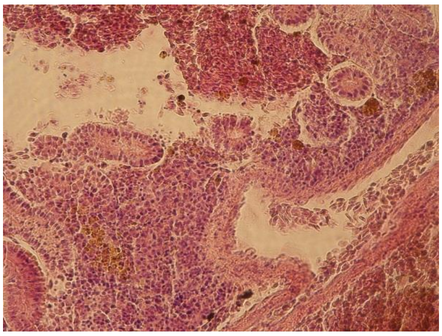

Figure 15. Kidney- E1
peritubular edema;
vascular hypertrophies;
nephrocytic and interstitial necrosis
(H-E, 10x)

The lyophilized coriander succeeds through its active principles to greatly mitigate the toxic effects of the contaminant in the individuals of the LE2 experimental group.

The histological preparation obtained from these specimens are showing only slight peritubular edema, capillary hypertrophies (Figure 16).

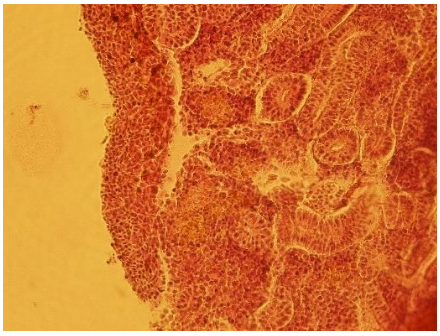

Figure 3.29. Kidney- E2
slight peritubular edema,
capillary hypertrophies
(H-E, 10x)

In addition to the known toxic effects associated with lead poisoning [22, 23], recent studies place particular emphasis on chronic lead exposures even at extremely low levels, which produce a series of disturbances in the physiological processes in the body, through an imbalance of the oxidant/antioxidant balance and of the enzymatic apparatus involved. It is known today that lead is a toxic element that generates oxidative stress. Reactive oxygen species are called free radicals, having negative effects on the biological structures with which they come into contact [24]. Antioxidants are part of the body's defense arsenal against these reactive oxygen species [25].

Coriander's anti-oxidant properties is precisely due to the presence in its leaves, seeds or root of flavonoids - quercetin, kaempferol and acacetin, which have been shown to be free radical scavengers [26-28]. Coriander is also reported to be a chelating agent and reported to be effective as pharmaceutical agents in removing heavy metals 29]. On the other hand, there are authors who stated that cilantro prevented placement of lead in bone tissue, but not in soft tissues in mice [30].

4. Conclusions

1. The results of the histopathological examination highlight structural and architectural changes in fish tissues exposed to lead contamination;
2. coriander has proven to be an excellent chelator in liver tissue in lead intoxicated fish;
3. coriander is largely able to attenuate the toxic effects of lead in kidneys, intestine and gill;
4. coriander can be administered in addition to classic chemical compounds as the potential heavy metals chelating agents

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