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Bioaccumulation of Lead Nitrate in Freshwater Crayfish (*Astacus leptodactylus*) Tissues Under Aquaculture Conditions

N. Naghshbandi, S. Zare, R. Heidari and S. Soleimani Palcheglu
Department of Biology, Faculty of Sciences, Urmia University, Urmia, Iran

Abstract: The aim of this research was to evaluate the amount of lead in the tissue of *Astacus leptodactylus* especially in their muscle which the consumed part of their body. In this study the crayfish was exposed to intermediate concentration of lead nitrate (500 μg L^{-1}) for periods up to 3 weeks. In the first, second and third weeks bioaccumulation in various tissues was under investigation. The data of toxicological analysis obtained by the method of atomic absorption revealed that the levels of bioaccumulation of metal are different in various tissues of this crayfish. The accumulation of the lead in gills was the highest and in muscles was lowest degree. The amount of heavy metals in the tissues of crayfish was as follow. Gills>exoskeleton>hepatopancreas (digestive glands)>digestive tract>green gland>testis and ovary>muscles.

Key words: Crayfish, *Astacus leptodactylus*, lead, bioaccumulation

INTRODUCTION

Contamination of our environment with heavy metals from agriculture, industrial and household sources has become a significant issue with respect to our ecosystems as well as human health. A primary consideration is the bioaccumulation of metals such as lead, cadmium, zinc and copper etc in to tissues of plants and animal's which result in toxic effects (Landrigan, 1990).

Heavy metals can enter food chain and as a result of bioaccumulation, cause serious health problems to human's. These metals have long biological half-life in animal tissues, which in the case of lead is 10-30 years in bone tissue. Lead can produce a wide rang of pathologies associated with hemoglobin synthesis, renal function nervous system function and reproduction (ATSDR, 2005). Lead continuously accumulates in the bone of humans over the course of exposure which subsequently provides a pool of lead for its slow release over an extended period of years (Long *et al*., 1990). Lead exposure and accumulation in children are especially serious in that lead is incorporated into the matrix of rapidly growing bone (Committee on Environmental Health, 2005). Consequently, upon long term, low level release, there may be sustained biological effects such as neurological damage. The introduction of lead into the food chain can thus provide a potential pathway for complete exposure to this metal. Exposure to lead can occur through food, water and air. Aquatic species such as fish and crayfish are part of the food chain which has previously been studied for bioaccumulation of lead from the environment some recent work has focused on the effect of environmental toxins on crayfish species (IP *et al*., 2005; Mackeviciene, 2002). Freshwater crayfish species are considered to be biological indicators of clean water because of their relatively lower locomotors activity in comparison with fish (Viikinkoski *et al*., 1995). If crayfish from a contaminated area are consumed in large quantities they could case adverse health consequences. It is important to have knowledge ones level in the tissues of crayfish used for food. The aim of the present work was to investigate the accumulation level of lead in the organism of crayfish *Astacus leptodactylus* and to assess their nutritive under value under semi natural conditions according to the parameters of ecological cleanness. The accumulation of lead in *Astacus lleptodactylus* tissue under aquaculture conditions were not examined.

MATERIALS AND METHODS

Experimental animals: Freshwater crayfish *Astacus leptodactylus* (wt. rang 35-45) obtained from Aras. They were kept in aquaria with continues aeration and acclimatized to laboratory conditions for one week under constant pH (7-7.2) and temperature (15±2°C). During this period the crayfishes were fed fish only intermolte (stage C4), intact crayfish used in present study.

Metals analyses: For estimating the heavy metals content, firstly different tissues such as gills, Hepatopancreas, exoskeleton and muscle were excised from the experimental crayfishes and the tissues were placed in separate Petri dishes to dry at 105°C for 48 h in oven until the dried completely up. The dry tissues were

Corresponding Author: N. Naghshbandi, Department of Biology, Faculty of Sciences, Urmia University, Urmia, Iran

homogenized with a ceramic mortar and were pest led. 0.5 g of the dried tissue was placed in separate digestion flasks and nitric-perchloric acid (2:1) mixture was added. The digestion Flasks were gradually brought to and kept at 120°C in an oven for 3 h unit all materials were dissolved and the digests were diluted with 0.4% of nitric acid. All the dissection instrument and glassware were acid washed and rinsed 0.4% nitric acid. Metal concentrations in samples were measured using atomic absorption spectrophotometer flame Emission Shimadzu (AA-670 Shimadza) the figures read was based on ppm (Riyahi, 2000).

RESULTS

The results of this study demonstrate a time-dependant bioaccumulation of lead in most of the tissues evaluated. Animals exposed to lead the order of magnitude of tissue concentration of lead is gills>carapace>Hepatopancreas>digestive tract>kidney> muscle, for 1, 2 and 3 weeks exposer (Fig. 1).

All tissues reveal a significant increase in tissue concentration of lead. The most dramatic bioaccumulation of lead is absorbed in the gills (255 μg g^{-1}). The other tissues demonstrate the following accumulation of lead: Exoskeleton>Hepatopancreas>digestive tract>green gland and muscle (6.32 μg g^{-1}) (Table 1). Measurement of

Table 1: Lead concentrations (μg g^{-1}) dry mass

Tissue	1 week	2 week	3 week
Intestine	17.99±1.12	66.30±1.12	77.99±1.23*
Green gland	246.60±12.5	292.60±12.5	356.60±12.5*
Gill	33.26±3.6	109.90±3.6	255.40±3.6*
Exoskeleton	47.00±1.4	61.16±1.4	77.30±1.4*
Testis	123.30±4.3	142.90±4.3	139.90±4.3*
Ovary	136.50±1.8	154.90±1.8	183.30±1.8*
Hepatopancreas	138.20±5.8	33.90±5.8	41.40±5.8*
Muscles	0.57±0.1	3.80±0.1	6.30±0.2*

*Concentration are significantly different ($p \leq 0.05$) from their corresponding 3 week exposure

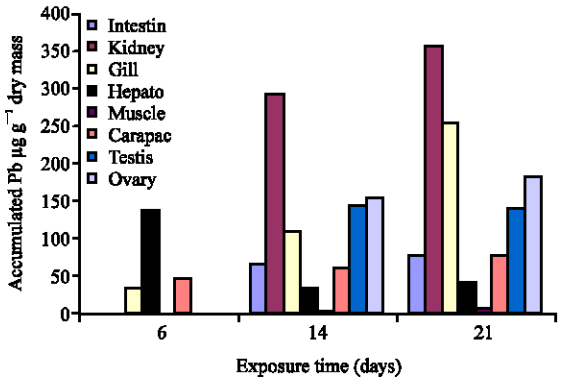

Fig. 1: The accumulation of Pb in selected tissues (μg g^{-1} dry tissue) of *Astacus leptodactylus* after 6, 14 and 21 days exposure to 0.5 mg L^{-1}

lead water concentration over a 24 h period. Lead concentrations were measured in water of the lead expose before and after a 24 h exposed period. The lead concentration decreased approximately 57% in a 24 h interval. For this reason tank solutions changed daily to maintain exposure concentration.

DISCUSSION

This study represents one of very few reports available on the bioaccumulation of lead in crustaceans. In a report by Morris *et al*. (2005) acute expose (3 weeks) in doses of 500 μg g^{-1} was conducted for determination of accumulation rates various tissues of *Cherax destructor*, including the gills, exoskeleton, midget gland, muscle and heamolymph. In this research we obtained same results. The present study focuses in bioaccumulation of lead in all tissues (soft tissue and exoskeleton) of *Astacus leptodactylus*. The result presented here in is agreement with those reported by other researchers (Anderson *et al*., 1997; Mackeviciene, 2002) showing a time dependency among soft tissues and the highest level of lead accumulated in gills. Gills contained the highest concentration of Pb which may be attributed to the presence of adsorbed matter on the gills rather than to active biological uptake of metals (Szefer *et al*., 1990). And also the gills involved in the exchange of gases and control ion fluxes as a result they are responsible for making necessary adjustments in their function to meet the changes in their aqueous environment (Taylor and Taylor, 1992). The first reason for the presence substantial concentration of Pb in the exoskeleton and Hepatopancreas might indicate that these tissues were involved in the excretion of this metals (Mackeviciene, 2002) the second reason for the highest accumulation of Pb in Hepatopancreas was probably deuto the storage of the metabolizable elements in the digestive gland (Nessim and Raid, 2003). The highest accumulation level of Pb in the digestive system of *Astacus leptodactylus* reflected the storage capacity for heavy metals (Mackeviciene, 2002). While the lead levels in muscles are considered as being low relative to the other tissues, accumulation is still significant as lead content exceeds the FDA safe limits for human consumption (0.3 μg pb/g tissue).

This study on lead nitrate clearly demonstrates that crayfish are excellent species for evaluating the lead contamination of our wetland environments. Lead accumulation in crayfish is time dependant which may be reflective of the levels of lead present in contaminated wetlands. This accumulation may be of concern for human health and the ecosystem in that crayfish can survive in

a lead contaminated environment and through the food chain could impact on the health of both humans and animals.

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