MERCURY, LEAD, CADMIUM AND CHROME CONCENTRATION LEVELS IN FISH FOR PUBLIC CONSUMPTION

ENKELEDA OZUNI [1*], LULJETA DHASKALI[1], DORIANA BEQIRAJ[1] JETMIRA 1ABESHI[1], FATGZIM LATIFI[2] MUHAMED ZOGAJ[2], IMER HAZIRI [2]

1. Faculty of Veterinary Medicine, Agricultural University of Tirana, Tirana, ALBANIA

2. Faculty of Agriculture and Veterinary, Prishtina, KOSOVO

E-mail address: enkeledaozuni@hotmail.com

Abstract:

A total of seventy cultured fish from the local market of Tirana were sampled and the concentration level of mercury, lead, cadmium and chrome was evaluated. Their concentration always resulted below the maximum permitted level for human consumption set by EC (Hg- 1.0 mg/kg, Pb – 0.30 mg/kg, Cd – 0.05 mg/kg and Cr -8 mg/kg). Heavy metal concentration varied among the muscle tissue of different fish species. The concentration level of mercury, lead, cadmium and chrome ranged between 0.002-0.21 mg/kg (Hg); 0.01-0.16 mg/kg (Pb); nd - 0.002 (Cd), and 0.01-0.03 (Cr) mg/kg wet weight. The results collected from this monitoring process revealed that these groups of cultivated fish species show low levels of contaminants, such as mercury (Hg), lead (Pb), cadmium (Cd) and chrome (Cr). This monitoring process is very important to safeguard the health of Tirana consumers.

Keywords: fish; commercially; heavy metal; consumer.

1. Introduction

Water pollution is the consequence of natural and anthropogenic activities. Small quantities of chemical substances like mercury (Hg), lead (Pb), cadmium (Cd), and arsenic (As) enter the aquatic environment and cause damage and disease to aquatic animals. We know that the heavy metals have the capacity to remain within aquatic animals for a very long time. Because of several chemical reactions, metals have the ability to be transformed and bound to fish proteins, afterwards they are accumulated into the internal organs and the muscle tissues of the aquatic animals. The efficiency of metal uptake may differ in relation to the ecological needs, metabolisms, and contamination gradient of water, food, and sediment as well as other factors like salinity and temperature [5]. These heavy metals pass through the food chain from the fish to the consumers. Metals contribute to a variety of negative effects on human's health because of the capacity of accumulation in the muscle tissue and their bioaccessibility. In some cases metal toxicity involves brain and kidney and some of them are even capable of causing cancer [2].

Fish meat is very rich in proteins, fatty acids and minerals, which make it specifically valuable food for consumers all over the world. Because of the great importance of fish and fishery production we are monitoring the concentration levels of some heavy metals in edible part of some important fish species of Tirana local market.

2. Material and Methods

2.1. Collection and preparation of fish samples

All fish species were collected from January to December 2010 in the local market of Tirana. The chosen species are important and serve as commercial products, thus having a significant interest as food used by Tirana consumers. The study included cultured benthic fish species with different origins: **Albanian production**: (*Sparus aurata, Oncorhynchus mykiss*) and **Imported production**: (*Dicentrarchus labrax, Sparus aurata*). The fish samples were divided in two groups according to their weight: small fish size (body weight of 180 g) and medium fish size (body weight 275 g). The fish species collected at the market were first, identified; weighed, catalogued and

conserved at - 18°C before they were sent to the laboratory of the Department of Toxicology, at the Institute of Veterinary and Food Safety, Tirana, Albania.

There are taken 10 fish sample for each species including small and medium fish size. We made an exception in the case of *Oncorhynchus mykiss* (10 samples only for medium fish size, because of species characteristics and the commercial form).

2.2. Analyses and determination of chemical contaminants

A total of 70 frozen samples of muscle tissue were evaluated for the concentration of mercury, cadmium, lead and chrome by using an Atomic Absorption Spectrophotometer (AAS). The muscle tissue of the fish samples was homogenized in a blender; they were dried at 100 ºC. One g of sample was weighed and then treated with 10 ml of HNO_3 and 5 ml of concentrated H_2SO_4 and let in overnight. The next day they were dried at 150º C for at least, 30 minutes and 50 ml of it were put into a normal flask, and filled with tap water. The heavy metals were measured by ICP-OES, Optima 2100 Dv produced by Perkin Elmer.

2.3 Statistical Analysis

Statistical analysis of data was carried out. Means and standard deviations, Minimum and Maximum values were determined for the heavy metals level. Differences in mean values were accepted as being statistically significant if $P < 0.05$.

3. Results and Discussion

3.1. Heavy metal levels

The concentration levels of heavy metals (Hg, Pb, Cd, Cr) in the muscle tissue of fish species are given in Table 1, mean and deviation standard for each species, as well. As we can see from statistical comparison the average concentration levels of mercury (Hg), lead (Pb), cadmium (Cd) and chrome (Cr) vary significantly among the muscle tissues of different species (Tab. 1, 2, 3, 4 and figs. 1, 2, 3).

The total concentration level of mercury (Hg), lead (Pb), cadmium (Cd) and chrome (Cr) of different fish species taken from Tirana market have been given in Table 1. The levels of Hg (mg/kg wet weight) in different fish muscle tissues always resulted below the maximum permitted level for human consumption (Hg – 1.0 mg/kg) set by EC and the Albanian legislation [3, 6]. Mercury is a considerably toxic chemical compound that occurs from both naturally and anthropogenic activities in the aquatic environment. Mercury in the aquatic environment is transformed into methyl mercury. In the marine environment, methyl mercury enters the food chain first via the filter feeding organisms and gradually

Table 1. Mercury, lead, cadmium and chrome concentration (mg/kg) level in the muscle tissue of different cultured fish species of the local market of Tirana

	HEAVY METALS							
Fish species	**Hg**		**Pb**		**Cd**		**Cr**	
	S	**M**	**S**	**M**	**S**	**M**	**S**	**M**
D. labrax	0.21±0.02*	0.12±0.14	0.16±0.24*	0.02±0.03	nd	nd	nd	nd
S.aurata (imported prod)	Nd	0.008±0.002	nd	0.02±0.003***	nd	nd	nd	0.03±0.008***
S.aurata (own prod)	0.16±0.21	0.03±0.02**	0.04±0.05*	nd	nd	nd	nd	nd
O. mykiss	-	0.002±0.002	-	0.01±0.02	-	0.002±0.002	-	0.01±0.02
A±SD	**0.185±0.134**	**0.04±0.066**	**0.1±0.134**	**0.016±0.013**	**nd**	**0.002±0.002**	**nd**	**0.02±0.0084**

S - Group of fish small weight of mean 160 g.
M - Group of fish medium weight of mean 255 g.
Nd - Not detected
Significant differences of average between groups
***** P < 0.001; ** P < 0.01; * P<0.05**

gets concentrated higher up the food chain [7]. The highest level of mercury (0.21 mg/kg) was found in the fish sample of *Dicentrarchus labrax* (small fish size), while the lowest concentration was found in *Oncorhynchus mykiss* (0.002 mg/kg). *D. labrax* and *O. mykiss* are two different fish species that also live in different aquatic environments. Referring to table 1 the concentration level of mercury shows differences in the muscle tissue of *D. labrax* ($p < 0.05$) and *S. aurata* ($p < 0.01$) (own production). The mercury concentration varies among fish species in range *D. labrax > S.aurata (own) > S.aurata (imported) > O. mykiss.*

Lead is a highly toxic chemical compound for both aquatic animals and humans. Aquatic animals are exposed to lead from the polluted aquatic environment. Lead is accumulated in their bodies' tissue in different amounts, depending on the size and age of the fish [1, 9]. The maximum concentration level of lead was found in *Dicentrarchus labrax* (0.16 mg/kg wet weight: small fish size), while the minimum concentration level was found in *Oncorhynchus mykiss* (0.01 mg/kg: medium fish size). Referring to table 1 the concentration level of lead shows differences in the muscle tissue of *D. labraxs*, *S.aurata* ($p < 0.05$) (own production) and *S.aurata* ($p < 0.001$) (imported production). The concentration level of lead (Pb) in all the sampled tissues of fish (small and medium fish size) species considered in our study always resulted below the maximum permitted level for human consumption set by EC legislation (0.30 mg/kg wet weight), as we can see in the following figures (Figures. 1, 2, 3).

The total concentration level of cadmium (Cd) and chrome (Cr) in the muscle tissues of different cultivated fish species have been given also in Table 1. The maximum concentration level of cadmium was found in the muscle tissue of *Oncorhynchus mykiss* (0.002 mg/kg wet weight), while it always resulted below the detection level (nd) in the other fish species. The low concentration level of cadmium in the muscle tissue of the cultured fish may be a result of fish species characteristics like: age, concentration level

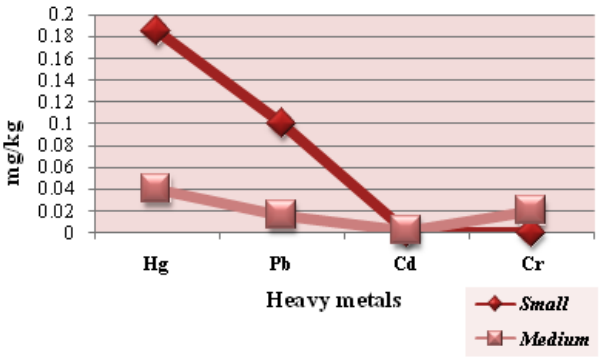

Fig. 1. Average value of heavy metals concentration in different fish size (Small and medium fish size) (mg/kg wet weight)

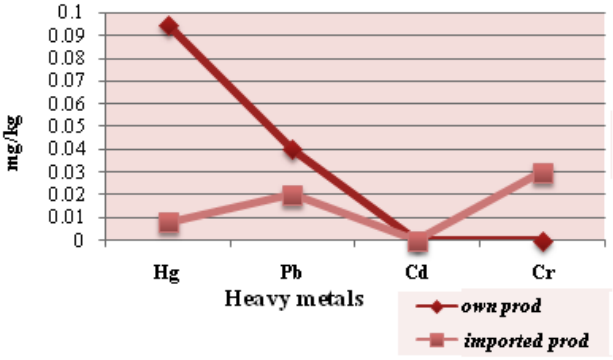

Fig. 2. Average mean of heavy metals concentration in *Sparus aurata* from different origins (Albanian and Imported production) (mg/kg wet weight)

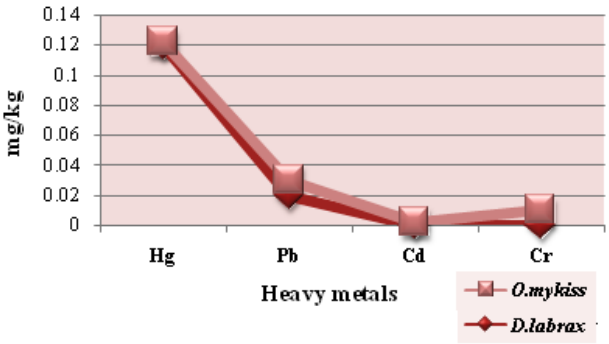

Fig. 3. Average mean of heavy metal concentration two different fish species (mg/kg wet weight)

in the aquatic environment, way of living, eating habits etc. It is reported that 50% of the total of cadmium in the aquatic environment is originated from the anthropogenic activities [8]. Cadmium has a

high potential for bioconcentration in fish and it is accumulated in multiple organs [10]. It is very dangerous for the health of humans and causes several negative effects in the renal system, nervous system and in some cases it also acts as teratogenic and mutagenic [4]. The highest level of chrome was found in *Sparus aurata* (own production) (0.03 mg/kg) and the lowest level in *Oncorhynchus mykiss* (0.01mg/kg wet weight), while in the other samples of tissues of the fish species it resulted below the detection level (nd). Chrome is an essential chemical compound and plays a very important role in different systems of the body. Several times when it is taken in higher doses it can cause negative health effects to the human body.

According to table 3 and fig. 1 the average value of mercury (Hg), lead (Pb) cadmium (Cd) and chrome (Cr) concentrations resulted lower in both cases of small and medium fish size groups than the maximum permitted levels for human consumption set by EC legislation [3].

As we can see from table 4 and fig. 2 the average value of Hg, Pb, Cd and Cr in the muscle tissue of *Sparus aurata* from different origins (Albanian and Imported production) always resulted below the maximum limit levels set by EC and the Albanian legislation in the case of cultivated fish species. *Sparus aurata* is a benthic, carnivore fish species commonly cultured in the Adriatic and the Ionian Sea.

According to table 5 and fig. 3 the average concentration level of the heavy metals (Hg, Pb, Cd and Cr) in *Oncorhynchus mykiss* and *Dicentrarchus labrax* resulted as in the above mentioned cases, below the maximum permitted limits set by EC. *O. mykiss* and *D. labrax* are both benthic, carnivore species, but they differ from each other from their living conditions (*O.mykiss* lives in fresh water and *D.labrax* in sea water) [2, 5].

Seventy cultured fish samples taken from the local market of Tirana were studied in this monitoring process. The concentration level of mercury, lead, cadmium and chrome (Tabs. 1, 2, 3, 4 and figs. 1, 2, 3) always resulted below the maximum permitted level for human consumption set by EC (Hg- 1.0 mg/kg, Pb – 0.30 mg/kg, Cd – 0.050 mg/kg and Cr -8 mg/kg). Mercury, lead, cadmium and chrome concentration levels ranged between 0.002-0.21 mg/kg (Hg): 0.01-0.16 mg/kg (Pb), nd - 0.002 (Cd), 0.01-0.03 mg/kg wet weight. All the fish species shown in the above tables are typically carnivore, benthic fish species. The concentration level of heavy metals varies among them, primarily depending on age and eating habits (the short cycle of life, the orientated way of feeding) [2, 5]. The results collected from this monitoring process revealed that these groups of cultivated fish species have low levels of contaminants, such as mercury (Hg), lead (Pb), cadmium (Cd) and chrome (Cr).

As conclusion, the monitoring process provides important results on the chemical contamination of some commercially cultured fish species taken from the local market of Tirana. According to the results the concentration level of mercury, lead, cadmium and chrome found in the muscle tissue of the fish samples they were below the maximum permitted level for human consumption set by EC as well as the Albanian legislation. This monitoring process is very important to safeguard the health of Tirana consumers.

4. Acknowledgments

Our team group expresses her gratitude to Ivana Dervishi, member of the Institute of Veterinary and Food Safety for helping us in performing of this study.

5. References

1. Burger K F, Gaines C, Boring W L, Stephens J S, and Dixon C: **Metals levels in fish from the Savannah River: Potential hazards to fish and other receptors.** *Environ. Res.* 2002, **89:** 85-97.
2. Dural M, Gokksu M Z L, Ozak A A L: **Investigation of heavy metal levels in**

economically important fish species captured from Tuzla Lagoon, *Food Chem*. 2007, **102**: 415-421

3. Europian Commission Regulation (EC) No. 1881/2006 of 19 December 2006. ***Setting maximum levels for certain contaminants in foodstuffs,*** OJ L. 2006, **364**: 1-26.
4. Friberg L, Elinder C G, Kjellstorm T, Nordberg GF: **Cadmium and health; a toxicological and epidemiological appraisal.** *CRC Press. Inc.* Boca Rato, Florida 1986.
5. Pagenkopf G K:. **Gill surface interaction model for trace metal toxicity of fish. Role of complexation, ph, water hardness**. *Environ. Sci. Technol*., 1983, **17** (6): 342-347.
6. Regullore182 MBMUK . **Për vendosjen e niveleve maksimale të lejuara për disa kontaminues në artikuj ushqimorë.** Republika e Shqipërisë, Tiranë 2007.
7. Reilly C: **Metal contamination of food, 2nd Edition.** *Elsevier Applied sience*, 1991: 131-147.
8. Russo S, Rosario L: **La contaminazione da metalli pesanti nei prodotti della pesca**. *Il pesce nr.3* " La pagina scentifica" 2007.
9. Tuzen M, Soylak M: **Determination of trace elements in canned fish marketed in Turkey**. *Food Chem.* 2007, **10**: 1378-1382.
10. Yilmaz F: **The comparison of heavy metal concentrations (Cd, Cu, Pb and Zn) in tissues of three economically important fish (*Anguilla anguilla, Mugil cephalus* and *Ooreochromis niloticus* inhabiting Koycegiz Lake- Mugla (Turkey).** *Turk. Jour. Sci. and Tech.*2009, **4** (1): 7-15.