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Exposure Assessment of Cadmium via Consumption of Fish Sold in the City of Yerevan

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ABSTRACT

The purpose of this research was to study residual cadmium in trout and to assess effects of daily and weekly exposure of this heavy metal on consumers' organism. The results obtained have indicated that residual cadmium in the studied fish samples vary between 6,00E-05 and 3,00E-03 mg/kg, whereas the estimated daily and weekly intake of this element does not exceed international standards.

Introduction

Fish and fish products are known to be healthy food which, as a source of proteins, fats and fat soluble vitamins having high biological value, is essential for improving the diet quality (FAO, 2014). Fish quality indices are negatively influenced by heavy metals, a constituent of water in natural water reservoirs, the levels of which largely vary depending on geochemical conditions (Yi, et.al., 2017). Heavy metals have a harmful impact on the environment (Ekpo, 2008) as well as living organisms and human health triggering allergic reactions, disorders in digestive and central nervous systems and so on (Renieri, et.al., 2014). Of all heavy metals, one of the primary water contaminants is cadmium (Cd), a rare but dispersed element (Burke, 2016). This element enters a fish body via feed and water and builds up mainly in gills (respiratory ways), stomach (gastro-intestinal tract), skin and mussels (Miri, et.al., 2017). It is well documented that after penetrating into a human organism, cadmium accumulates during a relatively long period (20-30 years), and that high Cd levels provoke

respiratory disorders and bone diseases (Renieri, et.al., 2014); so the long-term effect brings to teratogenicity, gene mutations and cancirogenesis (Yuan, et.al., 2016). In recent years, residual cadmium in fish has increased becoming a priority health issue (Storelli, et. al., 2005).

Cadmium belongs to the elements of the 1st class toxicity, so it is important to monitor residual Cd in *Salmo Ischchan* – a basic fish species in the diet of local consumers.

The purpose of this research was to study cadmium contents in fish meat sold in Yerevan and to estimate the daily intake of cadmium through fish consumption.

Materials and methods

Fish sampling was done in 2016 in the frame of a state monitoring program (Decision N 1142-N) from large food markets and supermarkets in Yerevan. A total of 5 composite samples of trout (*Salmo Ischchan*) within 3 subsamples were

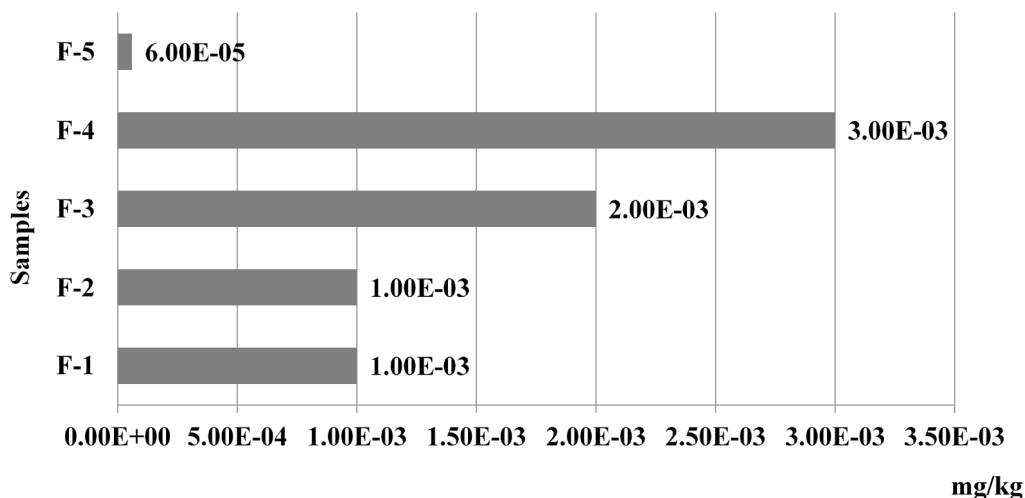


Figure. Concentration of Cd in *Salmo ischchan* samples (mg/kg) sold in Yerevan markets (composed by the authors).

collected from the 5 supermarkets and fisheries, which are the main source for fish retail. The samples were placed into appropriately tagged plastic bags and transported at 4°C to the Republican Veterinary-Sanitary and Phytosanitary Laboratory Services Center SNCO (RVSPCLS SNCO). The analysis was done through the atomic adsorption spectrophotometry method in compliance with EN 14083-2003 (EN 14083-2003 Foodstuffs) and using the Thermo ISE 3000 (Thermo Fisher Scientific Inc., USA) atomic adsorption spectrophotometer. The detected “Cd” residues were then compared with maximum residue limits (MRLs) of “Cd” in fish set by the Eurasian Economic Commission (EEC) and Commission of the European Communities (EC) 2.00E-01 mg/kg and 5.00E-02 mg/kg, respectively (Technical Regulations of Eurasian Economic Commission, 2011; Commission Regulation (EC) No 1881/2006, Renieri, et.al., 2014).

Estimated daily intake (EDI)

Estimation of daily intake of cadmium was done based on metal concentration in fish meat, the quantity of consumed fish and human body weight. Data on the quantity of trout consumed by Armenia’s population were obtained from the database of Statistical Committee (SC) of the Republic of Armenia (ARMSTAT, 2016), which were then recalculated for daily intake since SC provides data on monthly intake of fish. The estimated daily intake was calculated by the following equation (Yi, et.al., 2017):

$$EDI = C \times Ccons / BW, \quad (1)$$

where C is the concentration of “Cd” in fish (mg/kg wet weight), Ccons (kg/day) is the average daily consumption of fish by population of Armenia (ARMSTAT, 2016) and BW is

the average body weight for adults (65 kg).

Besides EDI (mg/kg BW per day), we also calculated estimated weekly intake (EWI) of “Cd” and the percentage of provisional tolerable weekly intake PTWI (in percent). The PTWI is the reference dose set by Food and Agriculture Organization (FAO) and World Health Organization (WHO) (Joint, 2011, Renieri, et.al., 2014) which represents a safe weekly intake of heavy metals (Miri, et.al., 2017).

$$PTWI\% = EWI/PTWI * 100, \quad (2)$$

where EWI (mg/kg BW per week) is the estimated weekly intake of “Cd” and PTWI is provisional tolerable weekly intake of Cd (7.00E-03 mg/kg of BW per week (Joint, 2011)).

Results and discussions

Data obtained from the analysis have indicated that “Cd” was present in all the five fish samples within the range of 6.00E-05 to 3.00E-03 mg/kg (Fig.). However, they did not exceed Maximum Residue Limits (MRLs) set by EEC (2.00E-01 mg/kg) and EC (5.00E-02 mg/kg). The calculated daily intake of Cd via consumption of fish was 7.32E-08 mg/kg of BW per day, whereas EWI (5.49E-07 mg/kg of BW per week) did not exceed the permissible level of PTWI (Joint, 2011) set by FAO/WHO for Cd.

One should stress that despite the absence of normative excesses, the ability of cadmium to cause chronic intoxication in humans even at minimal concentrations should not be disregarded (Ekpo, et. al., 2008). It should also be stressed that this metal can build up to toxic levels in fish and then enter food chains (Sarkar, et.al., 2016).

Conclusion

The main conclusion derived from this fish research was that residual cadmium detected in *Salmo Ischchan* samples does not exceed MRL set by EEC and EU and that EDI and EWI of this heavy metal meet the international standards set by joint FAO/WHO and EU.

Due to its toxicity cadmium belongs to the elements of the 1st class hazard, so a recommendation is made to continue monitoring on residual cadmium in *Salmo Ischchan* which is among the basic fish species in the diet of local consumers.

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