AMOUNTS OF HEAVY METALS IN BALTIC COD MEAT

Viktoras Liorancas*, Jelena Andriejauskiene

Klaipeda's State College, Klaipeda, LT- 91223, Lithuania
**e-mail: viktoras@lva.lt*
Work was done at the Klaipeda's State Veterinary and Food Department Laboratory

Abstract
The aim of the study was to analyze the amount of heavy metals in Baltic cod meat. Three year averages of Pb, Cd and Hg in cod muscle are reported (the study was conducted in 2008–2010) and data compared with the acts of the Republic of Lithuania and the European Union. The information and research material (data on the amount of heavy metals) were received from the National Laboratory of Veterinary. During the monitoring period amount of heavy metals Pb, Cd and Hg in cod meat corresponded to the allowable standards and are close to Lithuanian Hygiene Norms MAL. The results of this work obligate to control the amounts of heavy metals in fish muscles regularly.

Key words: heavy metals, fish, cod, contamination

Introduction
Mankind, without let-up through the land resources and promoting the development of civilization does not always ensure the protection of the natural environment of various chemical or biological contaminants. Some heavy metals − lead (Pb), cadmium (Cd) and mercury (Hg) emissions of its toxic properties within the human body and can cause serious problems to the marine environment and human's health. The heavy metals content of fishery products need to be well established as fishery products are widely consumed by humans (Volbekas, 1990; Turan et al., 2009; Staniškienė et al., 2007).

Since fish is the last link in the aquatic food chain, the heavy metal concentrations in many fish species have been determined in relation to the metal content of the aquatic environment (Kargin, 1998). Heavy metals like copper, zinc and iron are essential for fish metabolism while some others such as mercury, cadmium and lead have no known role in biological systems. For the normal metabolism of fish, the essential metals must be taken up from water, food or sediment. However, similar to essential metals, non-essential ones are also taken up by fish and accumulated in their tissues (Turan et al., 2009).

Industrialization has improved general technology as well as quality of life but has also resulted in an increase in metal concentrations in water. These metals can be classified as potentially toxic (aluminium, arsenic, cadmium, lead, mercury, etc.), probably essential (nickel, vanadium, cobalt) and essential (copper, zinc, selenium) (Munoz-Olivas and Ca´mara, 2001). Toxic elements can be very harmful even at low concentration when ingested over a long time period. Other elements, which are also present in seafood, are essential for human life at low concentration; however, they can also be toxic at high concentrations (Ray, 1994). In our study we investigated lead (Pb), cadmium (Cd) and mercury (Hg) in Baltic cod meat. Mercury gets into water mainly with industrial effluents and atmospheric precipitation and very quickly passes into the bottom sediments. It accumulates there, usually in sulphite form. Elementary mercury and its organic and inorganic compounds are liable to methylation. The toxic products of this methylation (methyl mercury) enter the food chains and accumulate in the aquatic organisms. In the aquatic medium, lead accumulates mainly in the bottom sediments where its level is usually four orders higher than in the water. Like mercury, lead is able, through the action of some micro-organisms, to produce organic methyl derivatives which accumulate in the aquatic organisms. However, as distinct from mercury, lead was not observed to accumulate in fish. In waters, cadmium is accompanied by zinc; it is also contained in industrial effluents. Waters that wash phosphate fertilizers from farm land are also a significant source of cadmium contamination. Like lead, cadmium was not found to significantly accumulate in aquatic organisms (Svobodová, 1991).

Among Baltic fish, the following species have been studied for heavy metal levels: cod (*Gadus morhua*), herring (*Clupea harengus*), sprat (*Sprattus sprattus*), flounder (*Platichthys flesus*), sea trout (*Salmo trutta*) and perch (*Perca fluviatilis*) (Brzezinska et al., 1984; Kannan and Falandysz, 1997; Szefer and Falandysz, 1985; Vuorinen et al., 1998; Vuorinen et al., 1994). There are reports on heavy metals in cod from Baltic waters (Polak-Juszczak, 2009); however no data are available for cod heavy metal content reported from the coastal waters of the western Baltic sea of the Lithuania.

The aim of the paper was to study the distribution of Pb, Cd and Hg in muscle and liver of edible fish, i.e. cod (*Gadus morhua*), economic zone of the Baltic Sea.

Materials and Methods

Data of heavy metals concentrations in Baltic cod was taken from the Lithuanian State Food and Veterinary Service of the National Veterinary Laboratory annual reports (2008–2010).

Fish samples were collected from fishing cutters operating in the Lithuanian coastal zone of the Baltic. Cruises were undertaken in the winter-spring (February–March), summer (August), and fall (October–November) seasons. Fish at the fishing vessels were sealed in plastic bags, frozen on board the vessels, and then transferred to the freezer at the laboratory (-18 °C).

Heavy metal content in tissues was assessed by atomic absorption spectrometry. Cold vapour atomic fluorescence spectroscopy was used for Hg assessment and graphite furnace atomic absorption – for Cd and Pb.

Statistical analyses of results are performed using SPSS statistical software.

Results and Discussion

Restricted levels of heavy metals in the fish are determined not only by the World Health Organization guidelines, but also by the actual situation of the country, so in different countries it is different. For example, the Lithuanian Hygiene Norm 54: 2001 indicates maximum concentration of lead in fish flesh from 0.2 to 0.4 mg kg^{-1} and the European Union − 0.2 mg kg^{-1} (EC, 2000). The evaluation of the average annual content of the various elements based on the data from several years confirmed that the dominating element in all the fish was Hg (Table 1).

Table 1

Heavy metal concentrations in cod (*Gadus morhua*) from the Lithuanian coastal zone of the Baltic in the 2008–2010 period (mg kg^{-1}, wet weight)

Year	n	*Cd*	Pb	*Hg
2008	24	0.0023±0.0023	0.0420±0.0350	0.0920±0.0510
2009	23	0.0021±0.0022	0.0250±0.0300	0.0370±0.0400
2010	25	0.0022±0.2500	0.0320±0.3200	0.0470±0.4300

The toxic elements of Cd and Pb occurred at low levels in the fish studied. In cod, these elements were often at the levels of detection (Cd below 0.002 mg kg^{-1}, Pb below 0.013 mg kg^{-1}).

The concentration of Hg in 2010 was approximately two times lower than in 2008. The differences in average concentrations of Cd and Pb in 2008 and 2010 were much less pronounced; however, this stable level was not noted throughout the studied period. Differences in average concentrations of Hg in cod meat were much more dispersed. This agrees with previously done studies (Polak-Juszczak, 2009). There Polak-Juszczak found the concentration of Hg and Pb in 2003 was approximately fourfold lower than in 1994, while concentrations of Cd were more than twofold lower in sprat, herring and cod from Baltic Sea. Casini et al. (2004) reported that many factors impact the accumulation of metals by fish, including diet. If trace elements associated with plankton are absorbed into the alimentary track of consumers, this is the predominant route of exposure (Harms, 1996). This nutritional chain can be applied to herring and sprat. These fishes feed mainly on plankton, in contrast to cod which feed mainly on small herring and benthic animals. This means that the respective variations in the concentrations of trace metals in the water and, thus, plankton, are not reflected directly in heavy metals concentrations in cod (HELCOM, 2002).

Conclusions

1. Baltic cod fillets are a good source of many major and essential elements. In addition, the levels of non-essential elements, such as Cd, Pb and Hg are typically low.
2. Accumulating of heavy metals in fish muscle may be considered as an important warning signal for fish health and human consumption.
3. The present study shows that precautions need to be taken in order to prevent future heavy metal pollution. Otherwise, these pollutions can be dangerous for fish and human health.

References

1. Brzezinska, A., Trzosinska, A., Zmijewska, W., Wodkiewicz, L. (1984) Trace metals in some organisms from the southern Baltic. *Oceanologia*, 18, pp. 79–94.
2. Casini, M., Cardinale, M., Arrhenius, F. (2004) Feeding preferences of herring (Clupea harengus) and sprat (Sprattus sprattus) in the southern Baltic Sea. ICES J. *Mar. Sci.*, 61, pp. 1267–1277.
3. Harms, U. (1996) Biota. Third periodic assessment of the state of the marine environment of the Baltic Sea 1983–93. In: *Background Document Baltic Sea Environment Proceedings*, vol. 4B, pp. 149–153.
4. HELCOM, 2002. Environment of the Baltic Sea area 1994–1998. In: *Baltic Sea Environment Proceedings*, vol. 82B, pp. 153.
5. Kannan, K., Falandysz, J. (1997) Butyltin residues in sediment, fish, fish-eating birds, harbour porpoise and human tissues from the Polish coast of the Baltic Sea. *Marine Pollution Bulletin*, 34, pp. 203–207.
6. Kargin, F. (1998) Metal Concentrations in Tissues of the Freshwater Fish Capoeta barroisi from the Seyhan River (Turkey). *Bulletin of Environmental Contamination and Toxicology*, Volume 60, Number 5, pp. 822-828.
7. Munoz-Olivas, R., Camara, C. (2001) Trace element speciation for environment, food and health. *The Royal Society of Chemistry*, pp. 331–353.
8. Polak-Juszczak, L. (2009) Temporal trends in the bioaccumulation of trace metals in herring, sprat, and cod from the southern Baltic Sea in the 1994–2003 period. *Chemosphere*, 76, pp.1334–1339.
9. Ray, S. (1994) Analysis of contaminants in edible aquatic resources. *VCH Publishers*, pp. 91–113.
10. Staniškienė, B., Matusevičius, P., Budreckienė, R., Sinkevičienė, I. (2007) Sunkiųjų metalų kiekio meduje ir žuvienoje nustatymas ICP masių spektrometru. *Veterinarija ir zootechnika*, T. 39 (61).
11. Svobodová Z., Vykusová B. // Diagnostics, prevention and therapy of fish diseases and intoxications. 1991. Source: http://www.fao.org/docrep/field/003/ac160e/AC160E08.htm #ch5. Resource used on 28.03.2011.
12. Szefer, P., Falandysz, J. (1985) Trace metals in muscle tissue of fish taken from the southern Baltic. *Zeitschrift fuØr Lebensmittel-Untersuchung und-Forschung*, 181, pp. 217–220.
13. Turan, C., Dural, M., Oksuz, A., Ozturk, B. (2009) Levels of Heavy Metals in Some Commercial Fish Species Captured from the Black Sea and Mediterranean Coast of Turkey. *Bull Environ Contam Toxicol*, 82, pp. 601–604.
14. Volbekas V., Grinevičius K., Gutmanas A., Mickis A. *Sveikata ir sunkieji metalai*. Kaunas, 1990, pp. 7.
15. Vuorinen, P.J., Haahti, H., Leivuori, M., Miettinen, V. (1998) Comparison and temporal trends of organochlorines and heavy metals in fish from the Gulf of Bothnia. *Marine Pollution Bulletin*, 36, pp. 236–240.
16. Vuorinen, P.J., Rantio, T., Witick, A., Vuorinen, M. (1994) Organochlorines and heavy metals in sea trout (Salmo trutta m. trutta) in the Gulf of Bothnia off the coast of Finland. *Aqua Fennica*, 24, pp. 29–35.