Mercury Concentration in Muscle and Liver of Pike (*Esox lucius*) Collected from Anzali International Wetland, Iran

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ABSTRACT

Background: Mercury (Hg) is a major environmental contaminant due to its global ubiquity, tendency to bioaccumulate, and toxicity in wildlife. Mercury accumulation in wetlands threatens critical breeding and foraging habitats of many fish and wildlife species. In this study, mercury concentrations were detected in different tissues of pike.

Methods: To achieve these purposes, 58 pikes (*Esox lucius*) were hunted from Anzali wetland. Mercury concentration was analyzed by Advanced Mercury Analyzer (Leco, AMA 254). T-test was used to determine any significant differences between muscle and liver samples.

Results: The results revealed a significant difference ($t = 0.85$) in mercury concentrations between the tissues, whereas no significant differences were found in mercury concentrations between pikes of different sexes.

Conclusion: This study was conducted to evaluate the feasibility assessment to recognize bioindicatory index usage and to determine restricted standards to human consumption. Our data can contribute to the development of management programs for understanding the ecotoxicological status of Anzali wetland and can help determine restricted standards for human consumption.

Keywords: Anzali Wetland, Esox Lucius, Mercury.

INTRODUCTION

Mercury (Hg) is considered an important environmental contaminant due to its global ubiquity, tendency to bioaccumulate, and toxicity in wildlife, especially aquatic species (1). Mercury tends to accumulate in wetlands where it readily bioaccumulates and can biomagnify in aquatic food webs, especially as (mono) methylmercury (2,3). Mercury accumulation in wetlands threatens critical breeding and foraging habitats of many fish and wildlife species. The primary route of Hg exposure is through diet (4). Diets with environmentally realistic concentrations of Hg result in a wide range of toxic effects on fish and wildlife, including behavioral, developmental, neurological, hormonal, and reproductive changes (5). Mercury (Hg) is released and mobilized through natural processes and by anthropogenic activities (6). Anthropogenic sources, such as fossil fuels combustion, nonferrous metals production, and waste incineration, have been suggested to significantly contribute to Hg contamination (7). Wetlands, on the other hand, play an important role in the biogeochemical cycling of Hg. With abundant dissolved organic and humic acids, stable complex compounds are formed with Hg, and wetlands are the source of reactive Hg (8). Mercury has been recognized as a severe environmental pollutant. This can be due to its high toxicity, even at low concentrations, and its ability to enter into biological systems (9). It is well known that aquatic systems are highly vulnerable to Hg pollution and wetlands have been particularly mentioned as being very sensitive to this kind of pollution (10). The Caspian Sea area is the largest landlocked body of water on earth and home to numerous ecosystems. The coastal wetlands of the Caspian basin include many shallow and saline water pools which attract a variety of fish and support great biodiversity (11,12). The northern pike (known simply as pike in Britain and Ireland, jackfish in Canada, and *Esox lucius* in the United States of America) is a species of carnivorous fish of the

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genus Esox (the pikes) (Figure 1). They are typical of brackish and freshwaters of the northern hemisphere. *Esox lucius* is found in freshwater throughout the northern hemisphere, including Russia, Europe and North America (13). Anzali wetland is the most important habitat for *Esox lucius* in the Caspian Sea. The present study was carried out to evaluate feasibility assessment to recognize bioindicatory index usage and to determine restricted standards for human consumption.

Figure 1. Pike (*Esox lucius*) species collected from Anzali wetland, Iran

MATERIALS AND METHODS

Study area

Anzali wetland was chosen on the south Coast of Caspian Sea as the hot spot for mercury. The study area is known as a national and international wetland in world scales (Figure 2). Anzali wetland is located in 37°28' N, 49°25'E and has an average area of about 15000 hectares (11,14). Furthermore, this wetland represents an internationally important wildlife reserve and sanctuary which is listed under Ramsar Convention. During the last decades, this area has been threatened and destroyed by environmental pollution from seven identified sources, including rivers, cities, industries, commercials, mines, agriculture, and hospitals. Discharge of used oil from ships, illegal construction, drying the wetland, discharge of any wastewater from fish farms, and solid wastes disposal were the other reasons that have affected the wetland environment (15).

Figure 2. The sampling site for fish from Anzali wetland, south coast of the Caspian Sea

Sample preparation

On the whole, 56 fish consisting of 28 male and 28 female samples were obtained from Anzali wetland. The samples were transferred to laboratory right away and were immediately dissected. In general, to determine the concentration of mercury in tissues, samples were taken from liver and muscle tissues. The samples were then stored at -20 ° C in a cool room. After that, the samples were placed inside the freeze-drier for 48 hours. Mercury concentrations in the homogenized samples were determined by advanced mercury analyzer (LECO AMA 254, USA). In order to assess the analytical capability of the proposed methodology, accuracy of the total Hg analysis was checked by running three samples of standard reference materials (SRM), National Institute of Standard and Technology (NIST), (SRM 1633b, SRM 2709 and SRM 2711).

Limit of detection in AMA ranged from 5 µg/kg~5 mg/kg and recovery varied between 93.8% and 102.8%(Olsson, 1976).

Statistical Analysis

The statistical analyses were carried out using Excel 2007 and SPSS software version 17 licensed by Tarbiat Modares University.

RESULTS AND DISCUSSION

Biometry data are shown in Table 1. A significant relationship (r^2 = 0.83) was found between length and body weight of *E. lucius* (Figure 4). Many studies have shown that there is a significant relationship between length and bodyweight in this species (16). No significant correlation was found in mercury concentration between muscle and bodyweight and length of *E. lucius*. Other studies have also reported this issue (2,17). Mercury concentrations in the tested tissues of pike (*Esox lucius*) decreased in liver compared to muscle (Figures 3&4). T-test was used to determine the presence of any significant differences between muscle and liver. The results revealed a significant difference (t= 0.85) in mercury concentrations between the tissues, whereas no significant differences were found in mercury concentrations in different sexes (Figure 4).

Table 1. Biometry data of fish species collected from the Anzali wetland.

Species Name	Sex and Number	Weight	Length
Pike (*Esox lucius*)	Male (n= 28)	705.97	451.03
	Female (n = 28)	514.73	421.50

The EPA and FAO/WHO standards of mercury concentrations in the fish tissues were respectively detected 300 and 500 (ng/kg) compared with our data (18,19)(Figure 3). The tolerable maximum intake of mercury was calculated using following equation:

$$a = \frac{b \times c}{w}$$

a= EPA, FAO and WHO acceptable intake of mercury per week (µg/Kg)
b= Mercury concentrations in tissue (µg/Kg)
c= Maximum acceptable consumption per week (Kg)
w= Bodyweight (Kg)

Based on FAO/WHO standards, maximum consumption was calculated to be 86g per week of pike muscle for a 60Kg person. Regarding EPA standards, the maximum consumption of a person with 60kg of body weight could be 51 g/w (gram per week) of pike muscle.

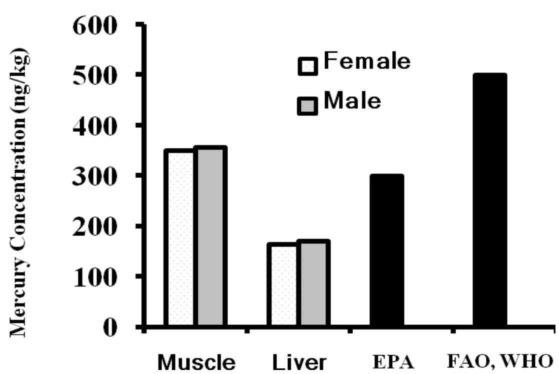

Figure 3. Mercury concentration in the different tissues of pike collected from Anzali wetland

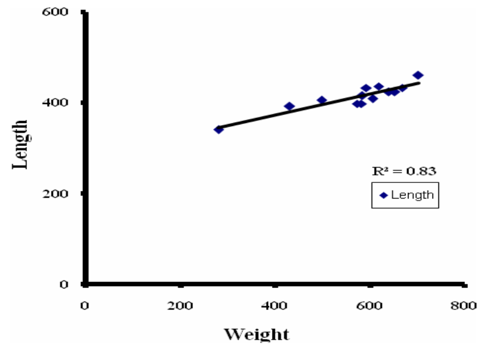

Figure 4. Regression between weight and length for pike collected from Anzali wetland

In addition, it is noteworthy that the young free-swimming pikes feed on small invertebrates starting with daphnia, and quickly moving on to bigger prey such as isopods like asellus or gammarus. When the body length is 4 to 8 cm, they start feeding on small fish. *Esox lucius*es are aggressive, solitary fish. They are typically lurkers, but are able to attack quickly. Their eyes are highly movable and are able to see in practically any direction (20). This is extremely important in tracking their prey. Considered "sprint predators", *E. lucius* hide in some type of cover, cocked in an "S" position, ready to strike. Mercury is a highly neurotoxic element that may accumulate in animal tissues, particularly liver. Methyl chloride has a high affinity to sulphydryl groups; therefore, it can be conveyed in food chain and mount up in tissues (21). Analyzing and monitoring of heavy metals including mercury in various tissues of assorted animals are of crucial importance in view of ecosystem management as well as human food health (22).

CONCLUSION

Based on FAO/WHO standards, maximum consumption was calculated as 86 g per week of pike muscle for a person of 60 Kg body weight. Regarding EPA standard, for a person with 60 kg body weight, the maximum consumption could be 51 g/w (gram per week) of pike muscle. Overall, the findings of the present study draw public attention to a serious hazard, especially for consumers of fish meat. Government authorities should take measures to manage ecological contamination of the Caspian Sea. This study was to evaluate feasibility assessment to recognize bioindicatory index usage.

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