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جامعة القاهرة
كلية الطب البيطري
قسم الرقابة الصحية على الأغذية

Heavy Metal Residues of Public Health Significance in Farmed Freshwater Fish in Kafr-El Sheikh and Menofia Governorates

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Abstract:

(Key words: heavy metals, fresh water, atomic absorption, farmed fish**).**

The main objective of the current study was to estimate the levels of mercury, lead, cadmium and arsenic residues in the flesh of farmed freshwater fish and fresh water samples collected from different localities. Fifty random fresh fish samples (20 cultured, Oreochromis niloticus, 20 cultured African catfish and 10 cultured Mugil cephalus) and 30 fresh water samples were collected from Kafr-El Sheikh governorate Moreover, forty fish samples (20, cultured Oreochromis niloticus and 20 cultured African catfish) and 20 water samples were collected from Menofia governorate. The fish samples were collected from the same sites and at the same times where water samples were collected throughout two successive years (2013-2014). Collected cultured fresh fish and water samples were analyzed for heavy metal residues using Atomic Absorption Spectrophotometer (AAS). The results indicated that the concentration of Mercury, Lead, Cadmium and Arsenic residues in fresh water were higher than their levels in fish flesh samples under the study. Also the results indicated that the concentration of Mercury, Lead, Cadmium and Arsenic residues in both fresh water and fish flesh samples in Menofia were higher than their levels in Kafr- El Sheikh. Moreover, the results revealed that the concentration of Mercury, Lead, Cadmuim and Arsenic residues in the flesh of cultred African catfish were higher than the permissible limits recommended by ***E.O.S.Q.C (2010) and FAO/WHO (1992)*** in both governorates under the study and the least concentration of such heavy metals residues was found in flesh of cultured Oreochromis niloticus followed by cultured Mugil cephalus.

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Dedication

To

My wife

My lovely daughter and sons

My family

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List of Abbreviations

FAO	**Food and Agriculture Organization**
WHO	**World Health Organization**
PL	**Permissible Limit**
Hg	**Mercury**
Cd	**Cadmium**
Pb	**Lead**
As	**Arsenic**
AAS	**Atomic Absorption Spectrophotometer**
E.O.S.Q.C	**Egyptian Organization of Standards and Quality Control**
MHS	**Mercury Hydride System**
CNS	**Central Nervous System**

INTRODUCTION

Fish and fish products are considered as one of the main sources of animal proteins of high biological value and easily digestible with high nutritional constituent due to their generous supply of minerals and vitamins.

Consumption of fish provides both benefits (lean protein, omega-3 fatty acids and essential nutrients) and risks (main source of mercury (Hg) exposure for humans) ***(Petre et al., 2012).***

The consumption of fish contaminated by lead, mercury, and cadmium can seriously deplete the body stores of iron, vitamin-c and other essential nutrients leading to decreased immunological defenses, intra uterine growth retardation, impaired psycho-social faculties and disabilities associated with malnutrition ***(Iyengar and Nair, 2000)***.

Fish considered one of the main sources of the national income that Egypt depends on, stimulating local market economics, and important source of foreign exchange ***(Sadek, 2000).***

The world aquaculture production in major species groups showed that freshwater fishes continued to dominate with a production of 28.8 million tonnes (54.7 percent) valued at US$40.5 billion (41.2 percent), followed by mollusks (13.1 million tonnes), crustaceans (5 million tonnes), diadromous fishes (3.3 million tonnes), marine fishes (1.8 million tonnes) and other aquatic animals (0.62 million tonnes) ***(FAO, 2014).***

The main sources of fish production in Egypt include marine fisheries, inland fisheries and aquaculture. Total production levels increased by more than 50% over the period 2000 to 2014 from 724,300 ton in 2000 to 1.48 million ton in 2014. The rise in production is due to the significant increases in aquaculture that constituted up to 77% of the fish production in 2014 ***(Mehanna, 2015)***.

In recent years pollution and industrial practice result in concentration of metals and other environmental agents that are related to environmental toxicity (***Novelli et al., 1998).***

Fresh water fish are more sensitive to heavy metals than marine species especially lead (Pb), cadmium (Cd) and mercury (Hg) which are among the most dangerous of these metals ***(Sorensen, 1991).***

Heavy metals are conservative or persistent type of pollutants and can not be broken down or destroyed over long time of heat treatment therefore, they become permanent additives to aquatic environment and their persistence enhances their potential to reach and affect human beings ***(Levensen and Barnard, 1988).***

Heavy metals have special problems because they usually accumulate in living organisms at successive trophic levels and may reach high concentration as great as in water, a process called "biological magnification" for example mercury may be accumulated in fish to levels that are dangerous to human health ***(Royce, 1984).***From public health point of view non-essential metals including mercury, lead, cadmium and arsenic are of our primary concern because they have no biological role, are toxic even in traces for human being and their presence in high concentrations in wastes disposed in water of rivers and lakes ***(Abd El-Kader, 1993)***. To the best of our knowledge, there is a limited data on the level of contamination of farmed fish with heavy metals in Kafr-El-sheikh and Menofia farms. Therefore, the main objective of the current study was:

1- To estimate the levels of Mercury, Lead, Cadmium and Arsenic residues in the fresh water in Kafr-Elsheikh and Menofia fish farms.

2- To estimate the levels of Mercury, Lead, Cadmium and Arsenic residues in the flesh of Cultured Oreochromis niloticus, African catfish and Mugil cephalus harvested from Kafr-Elsheikh and Menofia fish farms.

REVIEW OF LITERATURE

Incidence and sources of contamination in fresh water and fish:

Lewis (1966) stated that the average daily intake of lead by adults in north America is about 0.33mg from this quantity 0.01-0.03 mg/ day -were derived from water used for cooking and drinking.

Plunkett (1966) stated that consumption of fish contaminated with alkyl mercury may be a cause of disastrous due to the alkyl mercury compounds were present in concentrations 10- 100 times more toxic than the inorganic mercury forms and usually absorbed by the intestinal tract, while inorganic compounds were less absorbed.

Lofroth (1970) revealed that fish in non-polluted areas had mercury content of 0.01-0.1 mg/kg wet weight and the highest concentration legally admitted for human health is 1.0 ppm in Sweden, 0.5 ppm in united states and 0**.7** ppm in Italy. The continous ingestion of fish contained mercury above 1-2 ppm is potentially dangerous and this vary according to the type of food consumed by human being.

Wershaw (1970) stated that the natural content of mercury in non-polluted surface water was generally less than 0.1 ug/l.

Taylor (1971) revealed that level of cadmium was up to 6 mg/kg in various fish products. The majority of the products contained less than l-2 mg/kg and the highest levels were recorded in fish pastes due to the presence of viscera. Fish meal may be a source of heavy metal contamination in farmed fish.

Bella and Mccauley (1972) attributed the pollution of water with the heavy metals to industrial and municipal discharges into rivers, it is also related to dredging and spoil disposal.

Cameron and Jonassen (1972) mentioned that high mercury content in rocks in some regions may be responsible for high mercury levels in organisms and found that the average of mercury level was 0.513 ppm, which they indicated to be a high near the head waters of the La. Grande.

Hem (1972) suggested that sources of pollution and atmospheric rain out may be the most important contributors of cadmium to river water.

Eustace (1974) failed to reveal signifcant differences between the cadmium levels in fish from polluted and non polluted areas.

Nordberg (1976) concluded that prolonged exposure to cadmium at low level through food and water for occupationally unexposed populations produce manifestation of chronic toxicity.

U.S. Environmental protection Agency (1976) suggested that the run off phosphate fertilizers which may contain from 0.5g to 30 ppm cadmium, from agricultural areas to water lead to substantial concentration with cadmium to the aquatic environment.

Larry and Dorn (1977) mentioned that more than person suffered from severe central nervous system of illness and 12 individuals died after eating fish contaminated with mercury caught in Minimata Bay between 1953 and 1956. Chemical analysis of the fish showed 40 ppm of pure organic methyl mercury which is much more toxic than inorganic mercury.

Commision of the European communities (1978) concluded that surface water that contain more than few micro grams of cadmium per litre have propably been contaminated by discharges of industrial wastes.

Roberts (1978) suggested that the commonest causes of metal poisoning in fish were the heavy metals such as copper, lead, mercury, cadmium, iron and zinc. Furthermore, the industrial discharges, seepage from industrial and mining wastes were the commonest sources of heavy metals in the aquatic environment and when fish caught from areas with industrial pollution, various quantities of heavy metals like lead, mercury and cadmium were accumulated in their tissues.

Raie et **al. (1981)** claimed that heavy metals could not be eliminated from water and persisted in sediments, from which they were slowly released into water and posed serious hazards to aquatic organisms including fish, in contrast to herbicides and pesticides which could be easily brokendown.

Royce (1984) stated that heavy metals constituted special problems because they usually accumulated in living organisms at successive trophic levels and may reach high concentrations of more thousands of times as great as in the water, a process called biological magnification. Mercury from pollution or even from entirely natural sources could accumulate in fish to levels that were dangerous to human health.

WHO (1984) stated that there is significant correlation between the concentration of detected heavy metals in fish and their concentrations in water.

EL-Nabawi et al. (1987) proved that industrial and agricultural discharges were the primary sources of lead poisoning in fish in Egypt and also found that cadmium concentration in skeletal muscle of fish was 0.018+ 0.005pmm.