

**EFFECT OF FEED CONTAMINATION ON
PRODUCTIVE PERFORMANCE AND
BODY COMPOSITION IN FISH**

By

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B. Sc. Agric. Sc. (Animal Production), Ain Shams University, 2002

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ABSTRACT

Dena Abbas Ahmed: Effect of Feed Contamination on the Productive Performance and Body Composition in Fish. Unpublished M.Sc.Thesis, Department of Animal Production, Faculty of Agriculture, Ain Shams University, 2010.

The experiment was carried out at the department of animal production, Faculty of Agriculture, Ain shams, University, Egypt. For a period of 12 weeks, using Nile tilapia (*Oreochromis niloticus*, 10 g average weight).

The objective of the present study is to determine the bioaccumulation of heavy metals in various organs of the fresh water fish exposed to heavy metal contaminated food system. The experimental fish was exposed to different concentrations of elements, mercury (Hg) and lead (Pb) for period of 70 days, Fish were divided into seven groups (treatments) each group was stocked into three aquaria and each contains 15 fish. The 1st treatment was fed diet without any element (control group), The 2nd treatment was feed diet contain with 0.5 mg/kg mercury, The 3rd treatment was Feed diet contain with 10 mg/kg mercury, The 4th treatment was feed diet contain with 15 mg/kg mercury, The 5th treatment was feed diet contain with 5 mg/kg lead, The 6th treatment was feed diet contain with 10 mg/kg lead, The last treatment was feed diet contain with 15 mg/kg lead. The diet contained 30% protein and 3848 kc /digestible energy.

Hg and Pb was assayed using atomic absorption spectrophotometer and the results were given as mg/g dry wt. The effects of different concentration of Hg and Pb on growth parameters of Nile tilapia were studied such as average daily gain, specific growth rate, protein efficiency ratio, feed conversion ratio, The levels of dietary mercury lead caused a negative growth rate, as the level of dietary mercury and lead increased. The best value was recorded for the control while the worst one was observed in treatment (4,7) for mercury and lead respectively. The protein efficiency ratio of tilapia clearly showed gradual decrease in protein efficiency ratio as the level of mercury, lead in the diet increased,

the control treatment had the best significant ($p < 0.01$) feed conversion. At the level of mercury, lead increased in the diet, as feed conversion values were obtained.

The histology study showed the effect of mercury and lead on some fish organs (gill-liver). The histological alterations in the gills of Nile tilapia fish was affected by mercury and lead showing dilation of the marginal channel, hyperplasia of the epithelial cells and lifting of the lamellar epithelium, epithelial lifting, hyperplasia and hypertrophy of the epithelial cells, besides partial fusion of some secondary lamellae. The main alterations found in the liver were irregular-shaped nuclei, nuclear hypertrophy, nuclear vacuolation and the presence of eosinophilic granules in the cytoplasm, cytoplasm and nuclear degeneration was also observed.

Key words: Toxicity, pollutants, mercury, lead, Nile tilapia and *Oreochromis niloticus*

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1. INTRODUCTION

There is an increasing awareness of the potential hazards that exist due to the contamination of freshwater impoundments by toxic metals associated with the mining industry (**Feather and Koen, 1975; Kelly, 1988; Quek et al., 1998 ; Du Preez et al., 2003**).

Over the last few decades, there has been growing interest in determining heavy metal levels in the marine environment and attention was drawn to the measurement of contamination levels in public food supplies, particularly fish (**Kalay, et al., 1999, Tariq, et al., 1993**)

The Food and Agriculture Organization and the World Health Organization both recommend that governments monitor the levels of pesticides and contaminants in food. This recommendation comes in response to increasing concern over the health effects of various contaminants, including metals, found in the food supply (**ANZFA, Australia New Zealand Food Authority, 1998**).

Fish is a commodity of potential public health concern as it can be contaminated with a range of chemicals such as metals, organ chlorine pesticides, organophosphate pesticides, herbicides, polyaromatic hydrocarbons, polychlorinated biphenyls and dioxins, some of which are environmentally persistent (**United States Environmental Protection Agency, 1996**).

Tilapia is a good fish for warm water aquaculture. They are easily spawned, use a wide variety of natural foods as well as artificial feeds, tolerate poor water quality, and grow rapidly at warm temperatures. Tilapia is the most widely cultured freshwater fish in tropical and subtropical countries.

The metallic elements can be categorized into two groups. The heavy metals are those having densities five times greater than water such as iron, lead, and copper and the light metals, those having lesser

densities such as sodium, magnesium, and potassium. Humans consume metallic elements through both water and food. Some metals such as sodium, potassium, magnesium, calcium, and iron are found in living tissues. They are essential to human life-biological anomalies arise when they are depleted or removed. Probably less well known is that currently no less than six other heavy metals including molybdenum, manganese, cobalt, copper, and zinc, have been linked to human growth, development, achievement, and reproduction **(Friberg et al., 1979; Vahrenkamp, 1979)**.

Even these metals, however, can become toxic or aesthetically undesirable when their concentrations are too great. Several heavy metals, like cadmium, lead, and mercury, are highly toxic at relatively low concentrations, and can accumulate in body tissues over long periods of time; they are nonessential for human health.

Toxicological and environmental studies have prompted interest in the determination of toxic elements in food. The ingestion of food is an obvious means of exposure to metals, not only because many metals are natural components of foodstuffs but also because of environmental contamination and contamination during processing **(Steve Hall, 1995; Yousuf, and El-Shahawi, 1999)**.

This study should raise a red flag when considering spraying communities with chemical pesticides for mosquitoes since wildlife also receives significant exposure as their entire habitats and food sources are covered with chemicals well documented for weakening immune function

Toxic neutrals causing death, disease, cancer, genetic mutations, or physical deformations in any organism or its offspring upon exposure, ingestion, inhalation, or assimilation.

Heavy metals represent a common type of chemical pollution in water. They can be found naturally in bedrock and sediment or they may be introduced into water from industrial sources and household

chemicals. Heavy metals harm humans through direct ingestion of contaminated water or through accumulation in the tissues of other organisms that are eaten by humans.

Mercury and lead are selected in the present study because they are known to accumulate in the environment and in fish, and are known to cause serious adverse .Health effects if consumed in sufficient quantities.

Mercury (Hg): Enters the environment through the leaching of soil due to acid rain, coal burning, or industrial, household, and mining wastes. It causes damage to nervous system, kidneys, and vision.

Lead (Pb): sources include paint, mining wastes, incinerator ash, water from lead pipes and solder, and automobile exhaust. Causes damage to kidneys, nervous system, learning ability, ability to synthesize protein, and nerve and red blood cells.

2. REVIEW OF LITERATURE

2.1. Aquaculture world production

Cichlidae species such as *Oreochromis aureus*, *Oreochromis niloticus*, *Tilapia zillii* and *Oreochromis gallili* are the most popular and highly economic fishes in most lakes in Egypt and they play the essential role in the Lake Manzalah fisheries (El-Ghobashi, 1990).

The tilapia species have become important in fish culture, especially in warmer climates. According to data of FAO (2003), the annual world aquaculture production of tilapias and other cichlids in 2003 was about 1677751 MT. The most important species in terms of percentage production by weight (80.46%) is undoubtedly *Oreochromis niloticus* (1349954 MT.)

Tilapia, are considered as the best species for culture because of their high tolerance to adverse environmental conditions, ease of reproduction, their fast growth and potential for domestication (El-Sayed, 1999)

2.2. Contamination defines:

There are many definition of contamination and the Following are some define to contamination:

Contaminants are defined as any substance not intentionally added to food that is present in such food as a result of the production, manufacture, processing, preparation, treatment, packing, packaging, or transport or as a result of environmental contamination.

Another definition of contamination:

Contaminants chemicals whose adventitious presence in food has the potential to cause toxicological harm to consumers. (Fishmeal information network March, 2006).

2.3. Effects of pollution by heavy metals:

The pollution of aquatic ecosystems by heavy metals is an important environmental problem (**Rayms-Keller et al., 1998**), as heavy metals constitute some of the most hazardous substances that can bioaccumulate (**Tarifeno-Silva et al., 1982**). Bioaccumulation is a process in which a chemical pollutant enters into the body of an organism and is not excreted, but rather collected in the organism's tissues (**Zweig et al., 1999**).

Metals that are deposited in the aquatic environment may accumulate in the food chain and cause ecological damage and a threat to human health (**Grimanis et al. 1978; Adams et al., 1992; Ermoesele et al., 1995**). Trace elements occur in minute concentration in biological systems. They may exert beneficial or harmful effects on plant, animal, and human life depending upon the concentration (**Forstner and Wittman, 1981**). The effects of heavy metal toxicity can be very dangerous to our health. Some effects of heavy metal toxicity on our bodies: are asthma, autism, tremors, epilepsy, certain cancers, memory problems, shyness, irritability, depression, high blood pressure, lung, respiratory illness and damage to the nervous system (**Zweig et al., 1999**). The United State (U.S) Environmental Protection Agency conducted a national study of accumulated toxins documenting this concern (**USEPA, 1992**).

The contamination of fresh waters with a wide range of pollutants has become a matter of concern over the last few decades (**Canli et al., 1998; Voegborlo et al., 1999; Dirilgen, 2001; Vutukuru, 2005**). The reason is the world demand for minerals, which has intensified the exploitation of natural resources. The water and tailings waste from mining and milling operations are discharged into settlement and treatment dams or tailings ponds. Eroded or disused tailings dams may contain considerable concentrations of toxic metals, usually dissolved

in water at pH values as low as 1.7 (**Wittmann and Förstner, 1977a**) that may be released into the environment.

The role of heavy metals in aquatic organisms has been drawn attention. There are at least 100 or so of these substances on lists of 'chemicals causing concern' and currently the UK Food Standards Agency is taking an interest in about 30 contaminants in terms of actual or suspected acute or chronic toxic effects to human beings. The Fish information network(FIN) Contaminant Safety Monitor, introduced in 2004, is a regular alert to contamination issue and regulations and focuses on contaminants that are, or are likely to, impact on fishmeal, fish oil, wild finfish and farmed fish. These elements are introduced into the environment through various routes, such as smelting processes, fuel combustion and industrialization (**Forstner and Wittman, 1981**)

Contaminants get their way into aquatic systems, rivers, lakes or oceans through atmospheric fallout, dumping wastes, accidental leaks, runoff of terrestrial systems (industrial and domestic effluents) and geological weathering (**Eisler, 1981**). The majority of these contaminants is already the subject of EU legislation and identified in either Directive 2002/32/EC on undesirable substances in animal feed and/or Commission Regulation (European Commission (EC)) No 466/2001 which sets maximum levels for certain contaminants in foodstuffs.

Many analytical studies of fish and shellfish have been carried out from an environmental perspective (**Park and et al., 1997; Rowe et al., 1998; Kress et al., 1998; Cronin et al., 1998; Muller et al., 1998; Castro et al. 1999; Kucuksezgin et al., 2001; Bervoets et al. 2001; Gaspic et al. 2002; Beiras et al., 2002; Storelli et al., 2003a, b; Juresa and et al., 2003; Sepe et al., 2003**).

Toxic compounds, like mercury and lead, poison organ systems and can lead to brain damage and death. Fish consumption advisories

have been imposed in parts of the country where lakes and waterways have been contaminated with mercury from electric power plants. Other pollutants, like ozone and particulate matter, cause respiratory and other health problems, particularly in children and the elderly.

If the heavy metal concentration at the source of supply is too high, the homeostatic mechanisms cease to function and the essential heavy metals act in either acutely or chronically toxic manner (**Phillips et al., 1982**). Thus in the event of a resulting extended bioaccumulation of heavy metals the organism may be damaged (**Young et al., 1981; Balkas et al., 1982**). Any pollution, either physical or chemical, cause changes to the quality of the receiving waters (**Noble et al., 1971; Wittmann and Förstner, 1977b; Sanders, 1997**). The fish species are the inhabitants that cannot escape from the detrimental effects of these pollutants (**Clarkson, 1998; Dickman and Leung, 1998; Olaifa et al., 2004**).

The contaminants change water quality and may cause many problems to fish, such as diseases and structural alterations (**Chang et al., 1998**). These changes may include raising of dissolved nutrients which may result in eutrophication, changes in stream temperatures and bottom characteristics which lead to habitat destruction and alteration of species diversity, and the addition of toxic substances which can have either acute or chronic effects on aquatic organisms (**Gaufin, 1973; Sanders, 1997**).

Heavy metal contamination may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organisms (**Ashraj, 2005; Vosyliene and Jankaite, 2006; Farombi, et al., 2007**). Excessive levels of essential heavy metals such as include copper (Cu), iron (Fe), manganese (Mn), nickel (Ni) and zinc (Zn) can however be detrimental to the organism. Non-essential heavy metals of particular concern to surface water systems

are cadmium (Cd), chromium (Cr), mercury (Hg), lead (Pb), arsenic (As), and antimony (Sb) (**Kennish, 1992**).

The chemical characteristics of heavy metals are responsible for the fact that all heavy metals can ultimately become toxic (**Wittmann, 1979; Rainbow, 1985**). A heavy metal becomes toxic when a level is reached where it damages the life functions of an organism (**Albergoni and Piccinni, 1983**).

Heavy metals is toxic when present in elevated concentrations in the environment (**Bryan, 1971; Du Preez and Van Vuren, 1994; Sanders, 1997**). Various environmental factors like temperature, pH, water hardness, dissolved oxygen, light, salinity and organic matter can influence the toxicity of metals in solution.

Heavy metals accumulate in the tissues of aquatic animals and may become toxic when accumulation reaches a substantially high level. Accumulation levels vary considerably among metals and species (**Heath, 1987**).

Pollution of aquatic environment by inorganic chemicals has been considered a major threat to the aquatic organisms including fishes.

2.4. Heavy metal pollutions and aquatic environments:

Fish are widely used to evaluate the health of aquatic ecosystems because pollutants build up in the food chain and are responsible for adverse effects and death in the aquatic systems (**Yousuf and El-Shahawi, 1999; Farkas et al., 2002**).

The toxic effects of heavy metals have been reviewed, including bioaccumulation (**Aucoin et al., 1999; Rainy, 2000; Rasmussen and Anderson, 2000; Adami et al., 2002; Waqar, 2006**).

The aquatic environment is constantly exposed to various pollutants, and the group of heavy metals has been the focus of many studies with deep concern.

Freshwater ecosystems exhibit a high natural variability in their physical and chemical properties due to local differences in geology and climate. They are therefore more susceptible to anthropogenic influences than the more consistent and stable marine environments **(Rainbow and Dallinger, 1993)**.

According to **Mason, (1991)**, heavy metal pollution is one of the five major types of toxic pollutants commonly present in surface waters.

The important environmental pollutants are those that tend to accumulate in organisms, those which are persistent because of their chemical stability or poor biodegradability, and those which are readily

soluble and therefore environmentally mobile **(Hellawell, 1986; Sanders, 1997)**. Some are essential elements that are required for the normal metabolism of organisms, while others are non-essential and play no significant biological role **(Prosi, 1979; Cross and Sunda, 1985; Rainbow, 1985; Rainbow and White, 1989; Sanders, 1997)**.

Essential heavy metals are generally considered to be less toxic than nonessential metals **(Batley, 1983)**.

Some metals such as Manganese, Zinc, Copper, Iron, and Nickel, when present in trace concentrations are important for the physiological functions of living tissue and regulate many biochemical processes **(Rainbow and White, 1989; Sanders, 1997)**.

Accumulation of pollutants in marine organisms offers a tool to monitor the degree of anthropogenic impact. Living organisms do however require trace amounts of some heavy metals. Non essential metals often exert their action through their chemical similarity to essential elements for example cadmium with copper or zinc **(George, 1982)**.

Heavy metals like copper, zinc and iron are essential for fish metabolism while some others such as cadmium, and mercury and