University of Benghazi

Faculty of Science

Department of Zoology

Estimation of the Cadmium, Chromium and Lead levels in the liver and kidney tissues of *Tilapia zillii* in Ain zayanah lagoon, Benghazi and manmade river reservoir, Ajdabia, Libya.

A thesis submitted in partial fulfillment of the requirements

for the degree of master of science in zoology

Presented By

Reima Khalil EL-Zwawi

(15125)

Supervisor

Prof. Abdalla I. Mohamed

(2013- 2014)

University of Benghazi

Faculty of Science

Department of Zoology

Estimation of the Cadmium, Chromium and Lead levels in the liver and kidney tissues of *Tilapia zillii* in Ain zayanah lagoon, Benghazi and manmade river reservoir, Ajdabia, Libya.

By

Reima Khalil EL-Zwawi

Approved by the examination committee on the 23th of February, 2014

Advisor:

Prof. Abdalla Ibrahim Mohamed ………………………

Internal examiner:

Dr. Houssein Mohamed El-baraasi ……………………...

External examiner:

Dr. Galal Ahmed EL-Sayed Mohamed ……………………..

Countersigned by:-

Dr. Galal Omar Bojwari — (Head, Zoology Department)

Dr. Ahmed Mammi — (Dean, Faculty of Science)

بسم الله الرحمن الرحيم

ظَهَرَ الْفَسَادُ فِي الْبَرِّ وَالْبَحْرِ بِمَا كَسَبَتْ أَيْدِي النَّاسِ لِيُذِيقَهُم بَعْضَ الَّذِي عَمِلُوا لَعَلَّهُمْ يَرْجِعُونَ}

صدق الله العظيم

سورة الروم الأيه (40)

الاهداء

إلي منارة العلم والعالمين إلي سيد الخلق وإمام المرسلين (سيدي وحبيبي رسول الله صلي الله عليه وسلم)

إليكم يا من علمتموني الحياة ثلاثا أن أكون في العلم جاد ولمكارم الأخلاق مثلا" عاليا وللواء الحق ناصرا إلي من كان ينتظرون هذه اللحظة بفارغ الصبر

(إلي أبي الغالي وأمي الحنونة)

إليك يا من سهرة لتشاركني فرحتي إليك يا من قدمت التهاني وحققت الأماني

(إلي زوجي العزيز)

إليكم يا ذرية والدي يا من شاركتموني فرحتي

(إلي أخوتي وأخواتي)

إلي من سطرت معها علي جدران الزمن أجمل الذكريات

صديقتي (سهيلة الحجازي)

الشكر والتقدير

الحمد لله رب العالمين, والصلاة والسلام علي سيدنا محمد الصادق الأمين أشكر الله وأحمده تعالي الذي منحني الاراده والعزيمة لانجاز هذه الدراسة.

وبأسمى آيات الود والعرفان وفائق الاحترام إلي من يعجز القلم عن كتابة الكلمات تعطيها حقها في كل قطرة جهد بذلت من أجلي طيلة مشواري في هذه الدراسة إلي الاستاذه الدكتورة فاطمة التومي (رحمة الله عليها) .

أتقدم بجزيل الشكر والتقدير للأستاذ الدكتور الفاضل عبدالله ابراهيم محمد, الذي تكرم بالإشراف علي هذه الدراسة, والذي كان لتوجيهاته وملاحظاته القيمة الفضل الكبير في إنجاح هذه الدراسة.

وأتقدم بالشكر والاحترام الي الدكتور حسين الجنجان الذي كان لتوجهاته الدائمة الأثر الكبير في أنجاح هذا العمل.

وأشكر الدكتور ماهر هيبه وحسين البرعصي والاستاذ عبد السلام السعيطي, عبد السلام فيلوغ, وليد عوقي والمهندس محمود الهوني في النهر الصناعي -أجدابيا والاستاذه سهيلة الحجازي, بثينة, أمينة, نسرين طلوبه وهبه وخديجة بقسم الكيمياء والاستاذه غاده الزواوي ومصعب التاورغي.

CONTENTS

List of Figures

List of Tables

1. Introduction

Pollution of rivers and streams with chemical contaminants has become one of the most crucial environmental problems within the 20 th century (Zowail *et al.*, 2010).

Pollution of streams and rivers flowing through agricultural areas such as insecticides, herbicides and fungicides, to pest control and industrial waste such as metal waste deposits, all these present varied and difficult problems due to drainage into our different water bodies (Akan *et al.*, 2009; Tekin-ozan and Aktan, 2012). Effluents discharged into river, may affect aquatic animals like fish, either directly or indirectly (Eletta *et al.*, 2003; Ekpo, *et al* .,2008). Pollutants able to accumulate along the aquatic food chain with severe risk for animal and human health (Kaoud and EL-Dahshan, 2010; Taweel *et al.*, 2011).

Fish is often at the top of the aquatic food chain and may concentrate large amounts of these metals from the surrounding waters (Olatunji and Osibanjo, 2012; Tekin-ozan and Aktan, 2012). Fish are able to uptake and retain heavy metals dissolved in water or passive processes. Toxic effects of metals occur after excretory, metabolic, storage and detoxification mechanisms are no longer able to match the uptake rates, but this capacity varies between different species and different metals (Kalay and Canli , 2000; Taweel *et al.*, 2011).

The variety of problems, particularly heavy metals which known to be toxic to human beings as well as to aquatic organisms , are enormous . Bioaccumulation of heavy metals in fish may critically influence both growth rate and quality of fish (Zaghloul, 2001; Zowail *et al* ., 2010).

Aquatic organisms such as fish and shell fish accumulate metals to concentration many times higher than present in water or sediment (Olaifa *et al.,* 2004; AL- Weher , 2008) . They can take up metals concentration at different levels in their different body organs and certain environmental conditions such as salinity, pH and water hardness can play an important factor in heavy metals accumulation in the living organisms up to toxic concentration and cause ecological damage (Guven *et al.,* 1999; AL- Weher , 2008) .

Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver and other vital organs. Long-term exposure may result in slowly progressing physical, muscular and neurological degenerative processes that mimic Alzheimer's disease, Parkinson's disease, muscular dystrophy, and multiple sclerosis. Allergies are not uncommon and repeated long-term contact with some metals or their compounds may even cause cancer (Busch, 1996; EL-turki, 2011).

Metal contaminations of aquatic ecosystem has long been recognized as a serious pollution problem. When fish are exposed to elevated levels of metals in a polluted aquatic ecosystem, they tend to take these metals up from their direct environment. Heavy metal contaminations may have devastating effects on the ecological balance of the recipient environment and a diversity of aquatic organisms (Farombi, 2007; Kaoud and EL-Dahshan, 2010).

Heavy metals having a density of 6 gr/cm^3 were present in the environment in minute concentrations until recent centuries ,where, industrialization brought in technological advances such as the use of metals in medicine and silver-mercury tooth amalgam (Kakulu *et al.,* 1987; Ekpo *et al.,* 2008) . Other sources through which human beings get contaminated include: lead based paint, leaded gasoline, air, water, mining, batteries, chemicals weathering of rocks and soils amongst others (Ekpo *et al* ., 2008; Taweel *et al.,* 2011).

Some heavy metals such as chromium, zinc , copper and cobalt are essential in trace amounts for normal growth and development, however, lead, cadmium and mercury have no biological importance (Kalay and Canli, 2000; Yilmaz , 2005). Levels in upper members of the food web like fish can reach values many times higher than those found in aquatic environment or in sediments (Yilmaz , 2005).

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. (Kalay and Canli, 2000; Taweel *et al.,* 2011).

Lead is naturally occurring toxic heavy metal which is ubiquitous in the environment as a pollution, and is not essential element for human. Lead present in food and feed may be the accidental result of technological operation, or of environmental origin (Timbrell, 2002; EL-turki, 2011). Lead can be present in food as a result of environmental pollution or unintentional contamination during food processing, handling and packaging (EL-turki, 2011). The metal of largest diffusion through the atmospheres and the contamination of environment with lead is increased by industrialization and emission from cars running on leaded gasoline (EL-turki, 2011).

Lead, the most toxic metal, is detectable in practically all phases of the inert environment and all biological systems, it is toxic to most living organisms at high exposure levels. Lead is non-essential element and it's a bone-seeking element, it is processed along with calcium because of its chemical resemblance to calcium. However, tissues other than bone are considered to be storage sites for lead in fish (Canli and Furness, 1993; AL-Nagaawy, 2008).

Lead enters the human body in many ways. It can be inhaled in dust from lead paints, or waste gases from leaded gasoline. It is found in trace amounts in various foods, notably fish, which are heavily subject to industrial pollution. Some old homes may have lead water pipes, which can then contaminate drinking water. Most of the lead we take in is removed from our bodies in urine; however, there is still risk of buildup, particularly in children. If lead buildup occurs, health problems including damage to the nervous system, mental retardation, and even death, can ensue (EL-turki, 2011).

Cadmium is natural element found in the earth's crust, combined with other element such as oxygen, chlorine, or sculpture. Cadmium is mostly present in nature as complex oxides, sulphides, and carbonates in zinc, lead, and copper ores (Taramelli *et al.,* 1991; Quarterman, 1987).

Cadmium is a non-essential trace element with no biological function and is implicated in numerous human deaths and delirious effects on fish and wildlife. In sufficient amounts cadmium is toxic to all forms of living organisms (Taramelli *et al.*, 1991; EL-turki, 2011).

Cadmium serves as an electrode component in alkaline batteries and is used in alloys, silver solders, and welding. Cadmium is also used for pigment and plastics manufacturing (Kegley and Andrews, 1998).

Cadmium pigments produce intense colorings such as yellow, orange and red, and are well known pigments in artists colors, plastics, glasses, ceramics and enamels (Kegley and Andrews, 1998; EL-turki, 2011).

Cadmium may promote skeletal demineralization and increase bone fragility and fracture risk. Also associated with alcoholism, alopecia, anemia, arthritis, bone disease ,pain in middle of bones, cancer, cardiovascular disease, cavities, cerebral, hemorrhage, cirrhosis, diabetes, digestive disturbances, emphysema, enlarged heart fiu-like symptoms, growth impairment, headaches, high cholesterol, hyperkinetic behavior, hypertension, hypoglycemia, impotence, inflammation, infertility, kidney disease, learning disorders, liver damage, lung disease, migraines nerve cell damage, osteoposis, prostate dysfunction, reproduction disorders, schizophrenia, and stroke (Taramelli *et al.,* 1991; Quarterman, 1987).

Cadmium is of even greater concern because of its harmful effects on plants, animals and man. Cadmium, is known to cause itai-itai disease; this disease is known to damage the joints, cause bones to soften and the body to shrink while the affected person dies a painful death (McKinney and Rogers, 1992; Ekpo *et al .,* 2008).

Chromium is a natural component of the earth crust .The most common oxidation states of chromium are divalent (II), trivalent (III) and hexavalent (VI), with III being the most stable . Chromium compounds of oxidation state VI are powerful oxidants. Trivalent chromium (III) is biologically essential and required in trace amounts for normal insulin and glucose metabolism in humans (Ferrara *et al.,* 1989) and for regulating carbohydrate metabolism in mammals (Vishop, 1983).

Trivalent chromium is considered to be a co-factor for insulin activity and part of an organic glucose tolerance in fish (Ferrara *et al.,* 1989) and have been shown to increases glucose utilization in tilapia. Hexavalent chromium (VI) is a non-essential element and considered to be toxic because of its powerful oxidative potential and its ability to cross cell membranes (Vishop, 1983).

Widely used as pigments, they also feature as tanning salts, oxidizing agents and catalysts. Other applications include the chromium plating of metal surfaces, photography and pyrotechnics (Conham, 2000).

All forms of chromium can be toxic at high levels, but Chromium (VI) is more toxic than chromium (III) . Acute toxic effects occur when breathing very high levels of chromium (VI) in air, that can damage and irritate nose, lungs, stomach, and intestines. People who are allergic to chromium may also have asthma attacks after breathing high levels of either chromium (VI) or (III). Long term exposures to high or moderate levels of chromium (VI) cause damage to the nose (bleeding, itching, sores) and lungs , and can increase the risk of non-cancer lung diseases . Ingesting very large amounts of chromium can cause stomach upsets and ulcers, convulsion, kidney and liver damage, and even death (Weiss, 1972; EL-turki, 2011).

The objectives of this study:-

Comparative of lead, cadmium and chromium accumulation levels in liver and kidney tissue between *Tilapia zillii* from Ain zayanah lagoon and *Tilapia zillii* from the manmade river reservoir- Ajdabiay.

2. Review of Literature

2.1. Biology of *Tilapia zillii*.

Tilapia zillii is one of the most widely cultured fish in the world. They are easily cultured and highly adaptable to a wide range of environmental conditions-including factors such as salinity, dissolved oxygen, temperature, pH, and ammonia levels, their respiratory demands are slight so that they can accept low oxygen and high ammonia levels and tolerate a wide range of ecological conditions with a high reproduction rate (Akinwvmi, 2003; Taweel *et al.*, 2011).

Tilapia has become a popular seafood to American consumers, mainly because of its high nutritional value, mild taste, as well as their protein, phosphorus, potassium, selenium, niacin, vitamin B-12, and is low in fat and saturated fat, omega-3 fatty acids, calories, carbohydrates, and sodium (Akinwumi, 2003; Achionye-Nzeh *et al.*, 2005; Mjoun *et al.*, 2010).

2.1.1. Geographical distribution of *Tilapia zillii*.

Tilapia zillii is native to Africa, the Middle East, united states of America and Australia (Carpenter, 1992) and one of the most valued species in North Africa. It constitutes an important part of inland fish production especially in the brackish lagoons of Morocco, Senegal River, Egypt, Nigeria, Algeria and Libya (Achionye-Nzeh *et al.*, 2005; Mahomoud *et al.*, 2011) (Figure 1).

Figure 1. Distribution of *Tilapia zillii* (frose and pauly 2010)

2.1.2. Description of *Tilapia zillii*.

Tilapia zillii have deep laterally compressed body, which covered with scales and characterized by an interrupted double lateral lines .The head with a single nostril on each side (Carpenter, 1992; Achionye-Nzeh *et al.*, 2005).

The fish has a single dorsal fin with 8 to 19 spines and 10 to 16 soft rays, whereas, the anal fin with 3 spines and 7 to 12 soft rays and it has truncate caudal fin . The dorsal fin consist of spiny first half which is followed without a break by a second half having soft branch rays. Dorsal fin and upper half of caudal fin without small spots (Carpenter, 1992; Achionye-Nzeh *et al.,* 2005). *Tilapia zillii* is the most attractive species, the throat is red and the rest of the body is olive green (Achionye-Nzeh *et al.*, 2005).

2.1.3. Habitat and Feeding in *Tilapia zillii*.

Tilapia can be found in lakes, wetlands, water courses, estuaries, and marine environments, it lives in shallow and vegetative areas (Mahomoud *et al.*, 2011).

It also prefers the rocky outcrops and rocky shores, where ,it scrapes on epilithic algae. It also ingest gravel and sand particles, bearing algal or bacterial floras (Jembe *et al.,* 2006).

It prefers tropical environments with water temperatures in the 25-30 ºC range. Moreover, it can tolerate a wide range of salinity(EL-Sayed and Moharram, 2007; Mahomoud *et al.,* 2011).

Tilapia zillii is mainly herbivorous fish, and they have special adaptations to separate algae and other particulate matter from water for ingestion. The consumption of zooplankton, aquatic insects and other animals such as crustaceans, oligochaete, worms and diatoms is common to the fish (Jembe *et al.,* 2006 ; Meyer, 2001). Also it has small pre-maxillary and pharyngeal teeth to scrape algae (periphyton) from submerged surfaces, and to macerate food particles, respectively, prior to digestion (Meyer, 2001).

Tilapia zillii has long digestive tract but they lack a well- developed stomach. This means that tilapia cannot consume large amounts of food in a short time period, as do carnivorous fish species (Achionye-Nzeh *et al.,* 2005; Meyer, 2001).Tilapia have long intestines divided into anterior, middle and posterior sections for efficient digestion and assimilation of nutrients from plant tissues (Achionye-Nzeh *et al.,* 2005; Meyer, 2001).

2.1.4. Reproduction in *Tilapia zillii*.

Tilapia zillii called Substrate spawners. Males and females of the *T. zillii* build and defend the nest together. They aggressively protect the fertilized eggs and freshly hatched fry. Courtship can last to a week in some circumstances, but a couple of days is more common (Achionye-Nzeh *et al.,* 2005).

In the first step in the reproductive cycle for Mozambique tilapia, males excavate a nest into which a female can lay her eggs. After the eggs are laid, the male fertilizes them. Then the female stores the eggs in her mouth until the fry hatch; this act is called mouth brooding. One of the main reasons behind the aggressive actions of Mozambique tilapias is access to reproductive mates. The designation of Mozambique tilapias as an invasive species rests on their life-history traits: Tilapias exhibit high levels of parental care as well as the capacity to spawn multiple broods through an extended reproductive season, both contributing to their success in varying environments. In the system, males congregate and display themselves to attract females for mating. Thus, mating success is highly skewed towards dominant males, who tend to be larger, more aggressive, and more effective at defending territories. Dominant males also build larger nests for the spawn. During courtship rituals, acoustic communication is widely used by the males to attract females. Studies have shown that females are attracted to dominant males who produce lower peak frequencies as well as higher pulse rates. At the end of mating, males guard the nest while females take both the eggs and the sperm into their mouth. Due to this, Mozambique tilapias can occupy many niches during spawning since the young can be transported in the mouth. These proficient reproductive strategies may be the cause behind their invasive tendencies (Trewavas, 1982).

2.2. The studies of accumulation heavy metals of fishes:-

2.2.1. Effects of Cadmium on fishes.

The effects of Cd concentrations in muscle,bone, skin, scales and gills of different species of fishes have been studied in *Oreochromis aureus, Cyprinus carpio* and *Clarias lazera*, *Metacembelus Iconnbergii*, *Clarias lazera*, *Citarinus citharus* and *Erpetoichithy* (Ekpo *et al.*, 2008). On the other hand determination of cadmium concentration in the muscles and other organs of fish have been measured. For example, the concentration of cadmium in *Metacembelus Iconnbergii, Clarias lazera, Citarinus citharus* and *Erpetoichithy* were studied by Ekpo *et al.,* (2008) who revealed that the kidney had higher concentration of cadmium compared to the liver, which in turn had higher than that in the muscle.

Cadmium concentrations during wet season were slightly higher than that during dry season except in few occasions. Cadmium may promote skeletal demineralization and increase bone fragility and fracture risk (Taramelli *et al.,* 1991; EL-turki, 2011).

Cadmium can accumulate in the liver and kidneys, and can replace calcium in bones, leading to painful disorders in the second case, and even fatal in the former. Cadmium accumulates in living tissue, and increasing its presence in fish and other aquatic organisms, cadmium taken into the body usually remains there. Inhaled cadmium is more hazardous than ingested cadmium.

Effects of Cadmium on tilapia have been studied ,whereas, determination of the metal and its concentration distribution in the muscles and other organs of *Tilapia zillii*, have showed significant variations with respect to the muscles and other organs (Ekpo *et al.*,2008).Moreover, the kidney had higher concentration of cadmium compared to the liver, which in turn has higher than that in the muscle (Kakulu *et al.,* 1987; Ekpo *et al.,* 2008).

Tilapia zillii were exposed to cadmium for10 days so that the metal would accumulate in the liver, gill, brain and muscle tissues in Turkey (Kalay and Canli, 2000). Subsequently, the animals were transferred to uncontaminated water for a period of elimination ,where, cadmium was accumulated in all the tissues. The tissue concentrations increased many times compared to the levels of cadmium in the control fish. Also the brain accumulated cadmium to a high level. The accumulation of the cadmium was found to be considerably different when the tissues and the cadmium were compared with each other(Allen, 1994; Kalay and Canli, 2000).

The accumulation of cadmium in flesh, gills, liver and gonads of *Tilapia zillii* were studied by Zyadah, (1999) in Lake Manzalah, Egypt . The levels of cadmium is occasionally higher in females than in males, this could be attributed to the fact that females have a higher tendency to accumulate cadmium (Balogh *et al.,* 1989; Zyadah, 1999). While medium sizes fish (11-13 cm) showed more remarkable concentrations than the other sizes through both seasons and sites. The flesh accumulated low concentrations of cadmium in comparison with the other organs (Sumino *et al.,*1975; Zyadah, 1999).

Cadmium did not cause any health risks in human since the calculated probable amounts being ingested by an average adult (50 kg average weight) per day were lower than WHO maximum recommended value of intake which is equivalent to 2.0 mg/kg (Thorold *et al.,*1998; Bath *et al.,* 2000).

Determination levels of cadmium from bone, liver, stomach, gills and Kidney tissue in *Tilapia zillii* caught from Lake Chad in Doron Buhari were studied by Akan *et al.,*(2009) .The maximum concentration of cadmium studied was observed in the liver tissues, while bone tissues had the least concentration. High levels of cadmium was found in the liver tissues of *T. zillii* and cadmium effects are many, but it mainly affects the kidneys, the cardiovascular system. Cadmium is so toxic to the brain and the reproductive system (Walsh *et al.,* 1977; Akan *et al.,* 2009).

2.2.2. Effects of Chromium on fishes.

Chromium concentrations varied significantly depending on fish species and the type of the tissue (Barghigiani and Ranieri, 1992; Zyadah, 1999). Yilmaz, (2005) reported that chromium (Cr) contents were determined in muscle, skin and gonads of two fish species *Mugil cephalus* L. and *Sparus aurata* L.and found that, *Mugil cephalus* had higher levels of chromium concentrations in muscle and in gonads than *Sparus aurata*. The increasing of chromium concentration in tissues of *Mugil* could be related to the differences in aging, habits, fish species and type of tissues (Yilmaz, 2003; Yilmaz, 2005).

Taweel *et al.*,(2011) measured chromium (Cr) in the liver, gills and muscles *Oreochromis niloticus* and concluded that, the highest chromium concentrations were detected in the liver followed by the gills and the muscle. Furthermore, the chromium concentration in the tissues varied significantly depending upon the locations from where the fish was collected (Chi *et al.,* 2007; Taweel *et al.*, 2011).

Concentration levels of Chromium(Cr) was determined in fish fillets of some fresh water fish for example,*Oreochromis niloticus, Sarotherodon galileaus* and *Clariasan guillaris* (Turkmen *et al.*, 2004; Amoo *et al.*, 2005).

Concentrations of chromium could be also related with season. For example, during wet season chromium slightly higher than dry season (Chindah and Braide, 2003; Olowoyo, 2011). Chromium levels in water was the least in summer and winter ,whereas, chromium concentration in tissue of carp were increasing in summer , winter, and decreased in autumn and spring (Alam *et., al* 2002). Low-level exposure can irritate the skin and cause ulceration while Long-term exposure can cause kidney and liver damage, and circulatory and nerve tissue disruption.

Chromium often accumulates in aquatic life, adding to the danger of eating fish that may have been exposed to high levels.

Concentrations levels of chromium was determined in fish organs of *Tilapia zillii* from River Benue, North-Central Nigeria (Eneji *et al.*, 2011). The results indicated that *T. zilli* gills contained the highest concentration of chromium, followed by the intestine ,while the muscle tissues appeared to be the least preferred site for the bioaccumulation of chromium as the lowest chromium concentration were detected in this tissue.

Concentrations levels of Chromium(Cr) were also determined in *T. zillii* fillets in River Niger and River Osara in North Central Nigeria (Olatunji and Osibanjo, 2012).The levels of chromium was variable between River Nigeria and River Osara in *T. zillii* fillets, However, fillets concentration of chromium are low compared with the (FAO, 1983). The concentration of chromium in fillets of *T. zillii* evaluated was within the natural background levels.

2.2.3. Effects of Lead (Pb) on fishes.

Concentration of lead in the muscles, liver and kidney of some common species of fish including, *Metacembelus Iconnbergii*, *Clariaslazera*, *Citarinus citharus* and *Erpetoichithy* were determined (Ekpo *et al.*,2008). The concentration of lead in the kidney was higher than that in liver, which is in turn higher than that in the muscle (Kakulu *et al.*, 1987; Ekpo *et al.*, 2008). Moreover, lead concentrations was recorded in tissues of *Oreochromis niloticus* from Egyptian fish farms (Kaoud and EL- dahshan, 2010) and was found to be high in the liver and low in the kidney (Oladimeji and Offem1989; Kaoud and EL-dahshan 2010).

AL- Weher (2008) studied the accumulation and elimination of lead from *Oreochromis niloticus* fingerlings in Egypt and observed that, the accumulation was higher in the gills than in the muscles. Furthermore, accumulation rate increased with the increasing of exposure concentration or period.

Lead contents in fish tissues such as muscle, skin and gonads might be related with fish species and habitat. For example Yilmaz, (2005) found that, *Mugil cephalus* had higher levels of lead concentrations than *Sparus aurata* collected from the same station. Furthermore lead concentrations found to be the highest in *Mugil cephalus* in muscle and in gonads (Karadede and Unlu, 2000 and Yilmaz, 2005). In addition, effects of lead on fish and other water organisms could be related with time of exposure.

All clinical symptoms resulting from the toxic effects of Pb, were manifested mainly in the blood (anemia), nervous system (encephalopathy and neuropathy), and kidneys (renal dysfunction) ,which are the three major sites of Pb intoxication (EL-turki, 2011). Lead is known to cause the disease called plumbism . Furthermore, lead accumulated in aquatic biomass are concentrated and passed up the food chain to human consumers. Lead is also known to damage the brain, the central nervous system, kidneys, liver and the reproductive system (Mckinney and Rogers, 1992; Ekpo *et al* ., 2008) .

The distribution of lead in *Tilapia zillii* showed a significant variations with respect to the muscles and other organs (Ekpo *et al.,*2008). Moreover, the kidney had higher concentration of lead compared to the liver, which in turn has higher than that in the muscle (Kakulu *et al.,* 1987; Ekpo *et al.,* 2008).

Accumulation of lead in the gill, liver and muscle of *Tilapia zilii* and the effect on branchial Na,K-ATPase activity have been measured . For example, Ay *et al.*, (1999) found that, branchial Na,K-ATPase of *T. zillii* sensitive to lead exposure as its activity was significantly inhibited following *in vivo* exposure to lead. Additionally, these inhibitions were exposure dependent and enzyme activity showed negative relationships with lead.

The levels of lead is occasionally higher in females than in males (Zyadah, 1999), and this could be attributed to the fact that females have a higher tendency to accumulate lead (Balogh *et al.*,1989; Ramelow *et al.*, 1989).

The flesh accumulated low concentrations of lead in comparison with the other organs lead affects the body systems, especially the nervous system, bones ,teeth, kidney, cardiovascular, immune and reproductive system. kidney damage however, occurs with exposure to high levels of lead (Zyadah, 1999).

3. Materials and Methods

3.1.Ain Zayanah lagoon.

Ain zayanah lagoon (Figure 2) is a brackish body of water located approximately 12 Km north-east of Benghazi (32° 10'N, 20° 06'E), Libya. The total area is about 25 ha and 0.5 – 3m deep in the coastal area, increasing up to 5 – 6m in the centre. An outlet channel of the lagoon to the sea exists in the north, in addition to small freshwater channels which originate from the land and join the lagoon (AL Shareif, 2008).

The Ain Zayanah lagoon water has a salinity range between 14.5 to 15.8 ppt which is high as a result of seawater intrusion, the pH is 7.5 - 7.7 . And dissolved oxygen(DO) value is 11.2 ppm and wind speed ranging from 5-6 knots(AL shareif, 2008).

Figure 2. Location of Ain zayanah lagoon, Benghazi, Libya

3.2. Manmade river reservoir, Ajdabiay

The manmade river reservoir, Ajdabiay (Figure 3) is located southeast of Ajdabia city, 160 km west of Benghazi. It is a balance reservoir receiving and discharging water, its capacity is approximately 4.0 million m^3.

Figure 3. Location of Manmade river reservoir, Ajdabiay

3.3. Samples collection.

Forty samples of *Tilapia zillii* (Figure 4), mean Total 12.7cm, mean weight 44gr were collected from Ain zayanah lagoon in May and June 2012 from a depth of 3.5-5 meters by Fisherman using Fishing nets (2.5 cm diameter mesh size). Ten samples of *Tilapipa zillii* (mean Total 14.89 cm, mean weight 82gr) were collected in June from the manmade river reservoir, Ajdabiay. All samples were transferred directly to the Marine laboratory of the department of Zoology, Faculty of Science, University of Benghazi and kept in the deep freezer.

Figure 4. Sample of *Tilapia zillii* used in the experiment

3.4.Taxonomy of *Tilapia zillii*

Kingdom: Animalia

Phylum: Chordata

Class: Actinopterygii

Order: Perciformes

Family: Cichlidae

Genus: Tilapia

Species: zillii

Tilapia zillii (Gervais, 1848)

Redbelly tilapia (Figure 5)

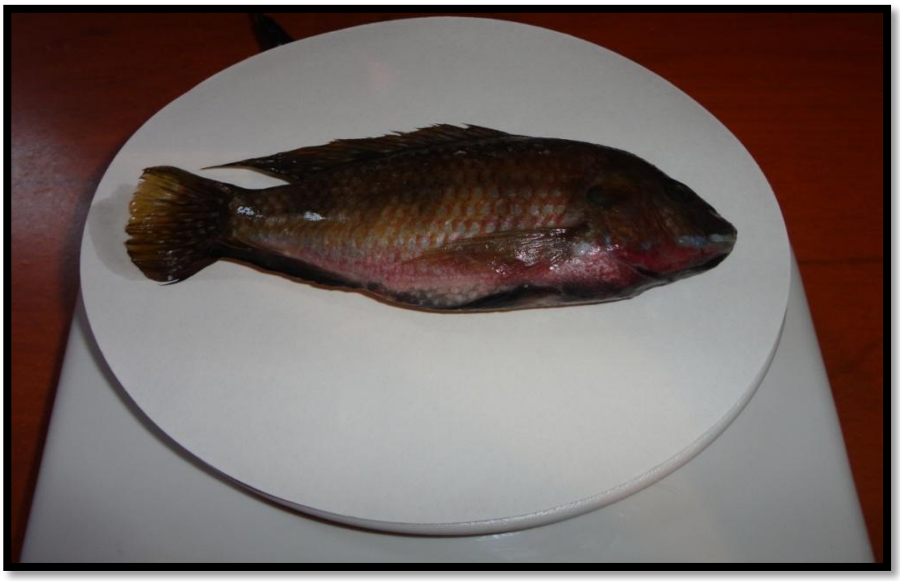

Figure 5. A photograph showing normal *Tilapia zillii*

3.5. Weight and Length.

Frozen fish were placed at room temperature, where, body length and weight of all fish were measured. Scales were removed from 3 areas (head, abdomen and tail) of fish external body and placed in normal saline. The age of each fish were estimated using ring growth of scales according to (Schneider *et al.*, 2000). Growth rings were measured under light microscopy at a magnification of 100X (Figures 6-7-8). *Tilapia zillii* in Ain zayanah lagoon ages from year to 2years, Manmade river reservoir, Ajdabiay ages from year to 5years.

Figure 6. Length measurement of *Tilapia zillii* (cm)

Figure 7. Weight measurment of *Tilapia zillii* (gr)

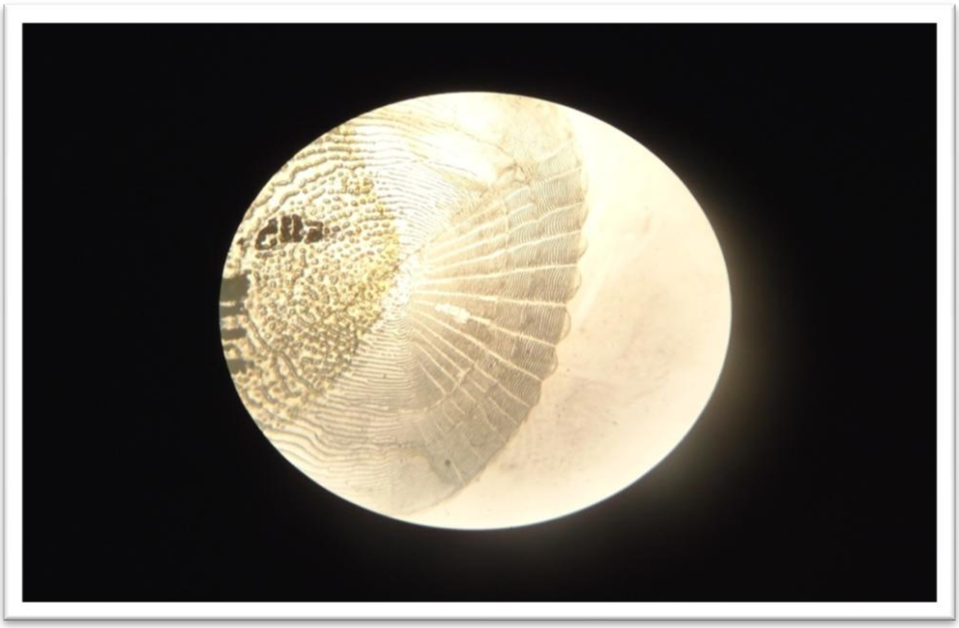

Figure 8. The age estimated according to scale measurement

3.6. Digestion of samples

The liver and kidney were removed and placed in 65% nitric acid (2.5 ml) for 24 hours at room temperature for digestion. Tissues were then placed on hot plate (70-80 C^0) for 10 minutes. A 2.5 ml of hydrogen peroxide was added and tissues were left to 2-4 hours for extra digestion. The solution was filtered in standard flask made up to 25 ml by adding distilled water and transferred into plastic tubes to determine the concentration of heavy metals (Daziel and Baker, 1983; Zyadah, 1999; Filogh, 2007) (Figures 9-13).

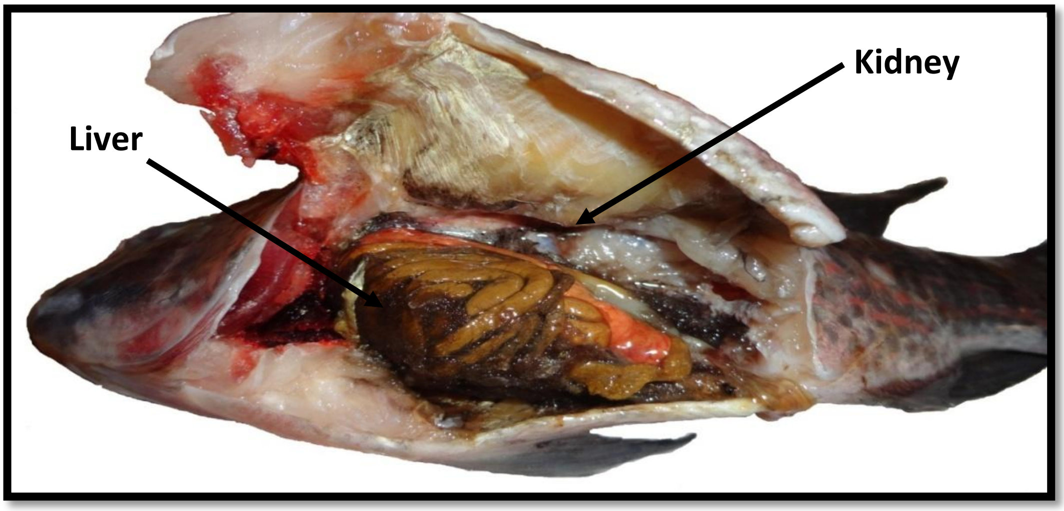

Figure 9. Dissected fish showing the location of liver and kidney

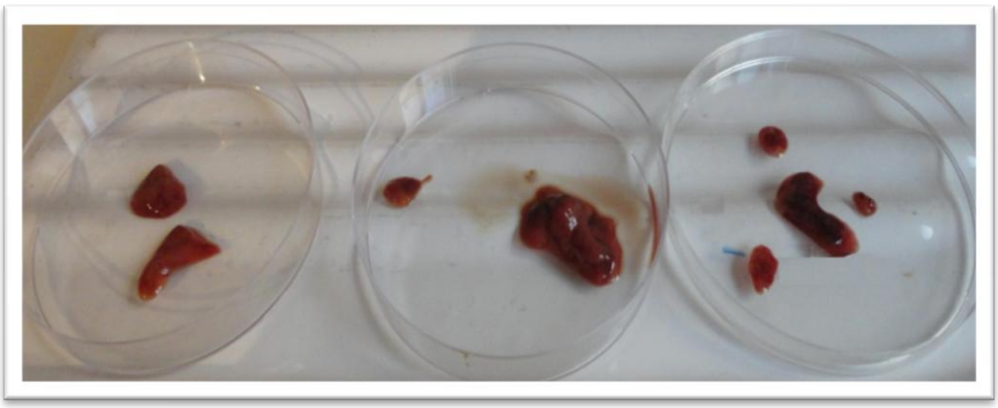

Figure 10. Liver and kidney tissues

Figure11. Tissues were then placed on hot plate

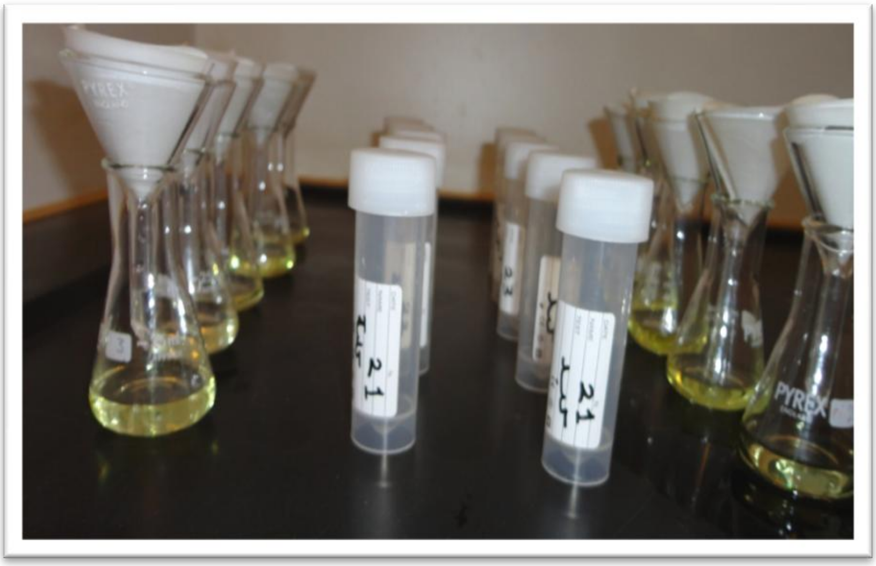

Figure 12. The solution was filtered in standard flask (25ml).

Figure 13. Adding distilled water and transferred into plastic tubes to determine the concentration of heavy metals

3.7. Measuring of heavy metals{lead (Pb), Cadmium (Cd) and Chromium (Cr)}.

Inductively coupled plasma- Mass spectrometry (ICP- MS) (Agilent 7500ce, Agilent Technologies, Japan) was used for the determination of heavy metals in samples solution . Elements were measured in He collision mode using octopole reaction system for reduction of polyatomic interferences from sample matrix. 200 ppb solution of internal standards (Ge, In, Bi) was used for correction of matrix effects and drift. The analysis was undertaken in Masaryk University ,Brno, Czech republic in 2013.

3.8. Statistical analysis.

All data were subjected to T-test to detect the relationship between the concentrations of Cadmium, Chromium and Lead in kidney and liver of *Tilapia zillii*.

4. Results

Liver and kidney of *Tilapia zillii* were chosen for cadmium, chromium and lead analysis. The metal contents were measured and compared in *T. zillii* from the two location, Ain Zayanah lagoon and manmade river reservoir, Ajdabiay.

4.1. *Tilapia zillii* in Ain zayanah lagoon.

4.1.1. Total length, Weight and heavy metals accumulation in liver and kidney.

The results revealed that the average length of *Tilapia zillii* of Ain zayanah lagoon was 12.23± 0.16 cm, whereas, the average weight was 44.01± 1.81 grams. On the other hand, the results show that cadmium was relatively low in both liver and kidney of *T. zillii* from Ain zayanah, where, the values were 4.27± 1.50 and 7.29± 2.97 mg/kg liver and kidney respectively. The same results was reported for the lead in liver and kidney, with values of 14.13± 3.01 and 10.69± 1.38 mg/kg liver and kidney respectively .On the other hand chromium has reported a higher concentrations in both the liver and kidney with values of 22.53± 0.61 and 21.53± 0.68 mg/kg for liver and kidney respectively (Table.1appendix and Figures 14,15).

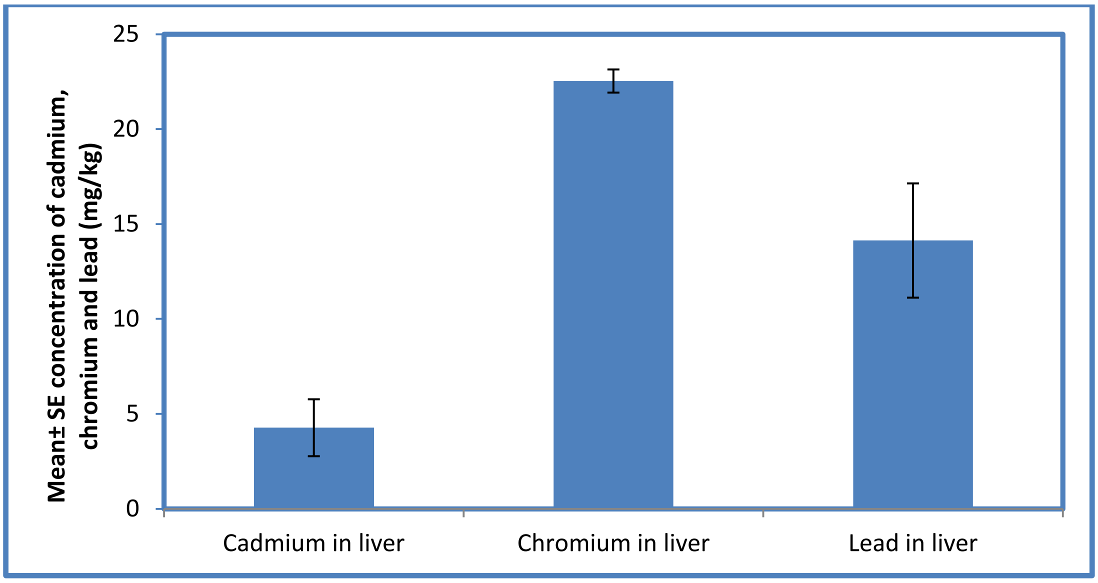

Figure 14. Shows the accumulated cadmium, chromium and lead (mg/kg) in the liver of *Tilapia zillii* from Ain zayanah lagoon

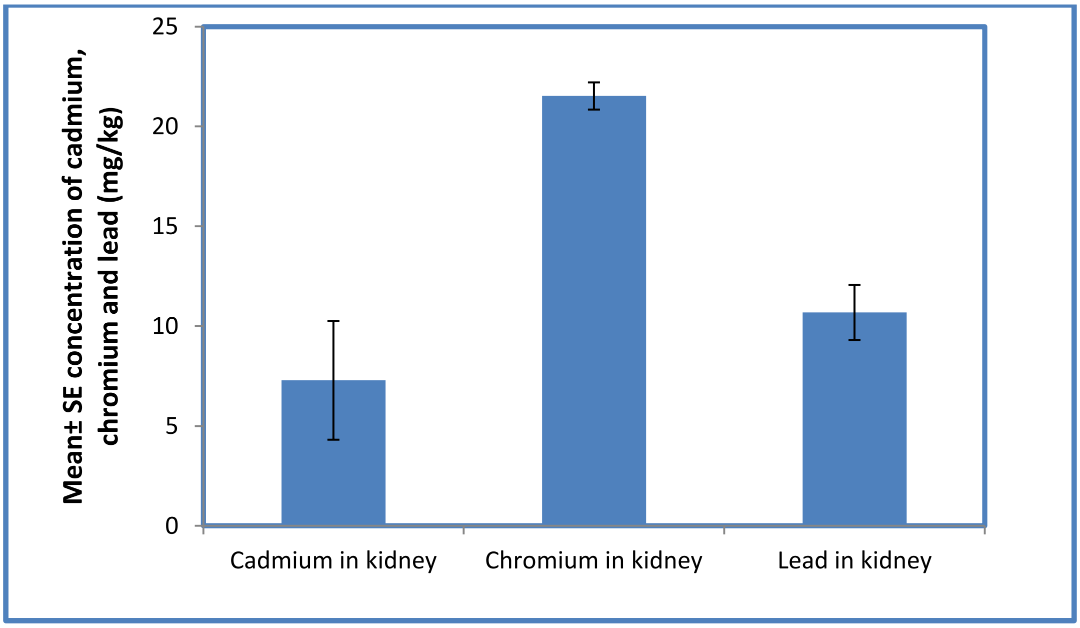

Figure 15. Shows the accumulated cadmium, chromium and lead (mg/kg) in the kidney of *Tilapia zillii* from Ain zayanah lagoon

4.1.2. Comparison between liver and kidney in heavy metal accumulations(mg/kg).

The mean ± SE of these metals came at 4.27± 1.50 mg/kg cadmium, 22.53± 0.6 mg/kg chromium at 14.13± 3.01 mg/kg lead. This results shown, a clear variation in metal accumulation in the liver. On the other the values of the same metals accumulated in the kidney of the same fish came relatively different from that in the liver. The concentration of these metals in the kidney were 7.29± 2.97 mg/kg, 21.53± 0.68 mg/kg and 10.69± 1.38 mg/kg for cadmium, chromium and lead respectively (Table.2 appendix).

4.2. *Tilapia zillii* in manmade river reservoir-Ajdabiay.

4.2.1. Total length, Weight and heavy metals accumulation in liver and kidney.

The results revealed greater length and weight of the fish of this location compared to that of Ain zayanah lagoon, whereas, the metal accumulations in both liver and kidney were variable. Cadmium concentrations in liver and kidney were 3.40± 1.82 mg/kg and 3.29± 1.53 mg/kg respectively, whereas chromium concentration in the same organs were 22.33± 0.96 and 22.61± 0.69 mg/kg respectively and lead concentrations were 5.78± 1.56 mg/kg liver and 4.78± 0.68 mg/kg kidney (Table.3appendix and Figures.16,17).

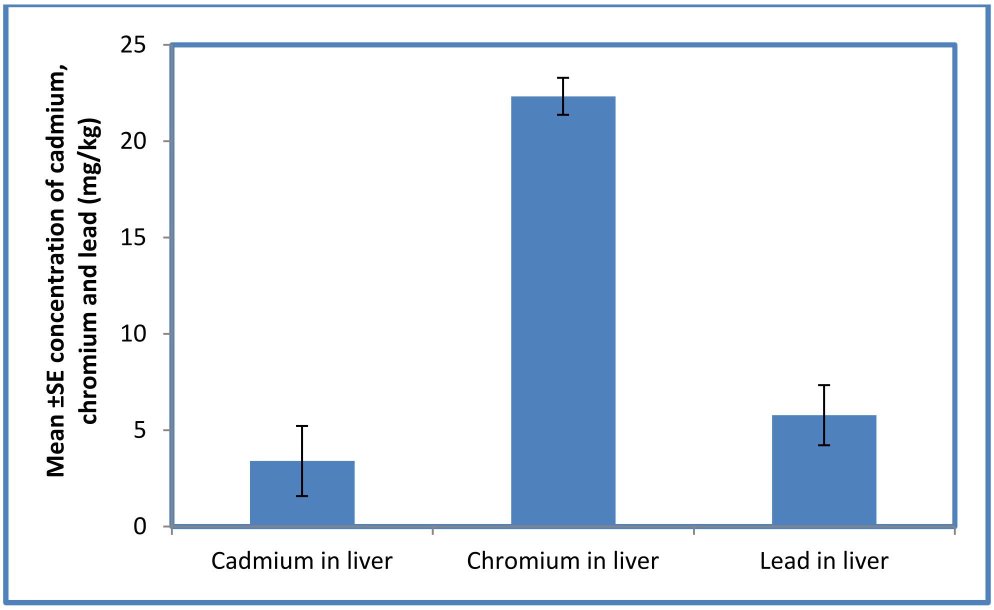

Figure 16. The metals cadmium, chromium and lead accumulation in the liver tissues of *Tilapia zillii* from manmade river reservoir- Ajdabiay.

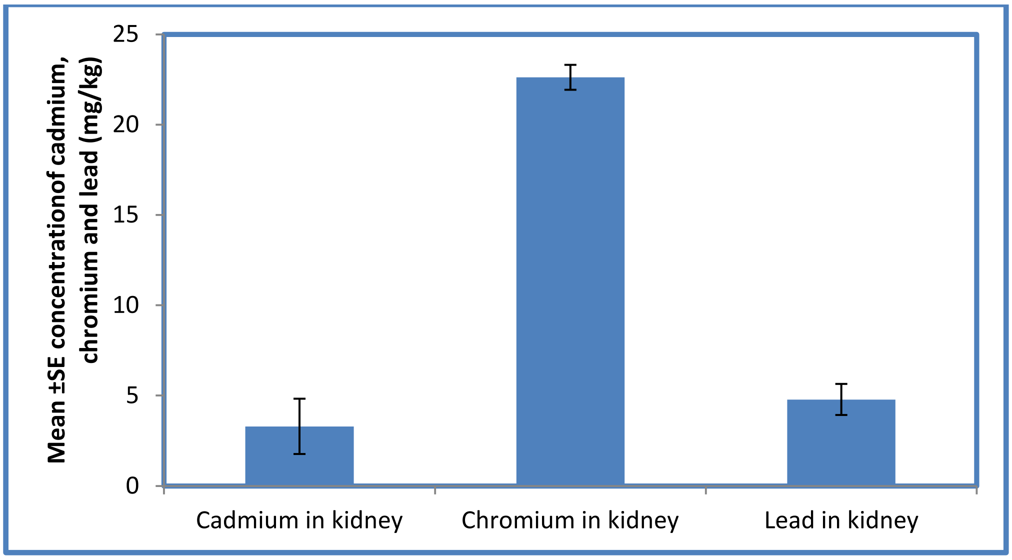

Figure 17. The metals, cadmium, chromium and lead accumulation in the kidney tissues of *Tilapia zillii* from manmade river reservoir- Ajdabiay.

4.2.2. Comparison between liver and kidney in heavy metals accumulations (mg/kg).

The results revealed more or less similar concentration of the three metals in both liver and kidney .The values of cadmium were 3.40± 1.82mg/kg in the liver compared to 3.29± 1.53mg/kg in the kidney, whereas, the values of chromium were 22.31± 0.96mg/kg in the liver compared to 22.61± 0.69 mg/kg in the kidney and the values of lead were 5.78± 1.56, 4.78± 0.68 mg/Kg of liver and kidney respectively (Table.4appendix).

4.3. Comparison between *Tilapi zillii* from Ain Zayanah lagoon and manmade river reservoir, Ajdabiay.

The results revealed that both the body length and the body weight were relatively different 12.23± 0.16 and 14.89± 0.65 cm for body length and 44.01± 1.81 and 82.56± 13.64 for body weight for the two location respectively.

The mean ± SE value for all variables in the Ain zayanah and manmade river reservoir fish groups have showed some differences. The two groups did not differ in cadmium and chromium contents in both liver and kidney, but fish of the Ain zayanah lagoon had significantly lighter in weight (p= 0.020) and shorter in length (p= 0.003).

In terms of heavy metal contents, the Ain zayznah fish group had significantly higher lead in liver (p= 0.018) and in kidney (p= 0.000) (Table.5appendix and Figures.18,19, 20).

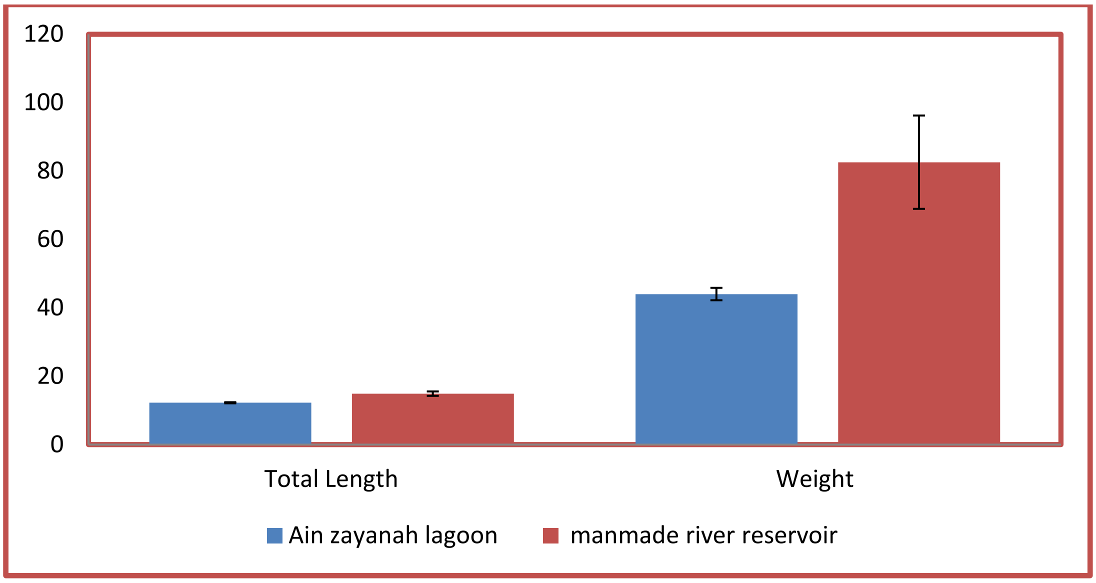

Figure 18. The average length (cm) left and weight (gr) right of *Tilapia zillii* from Ain zayanah and that from manmade river

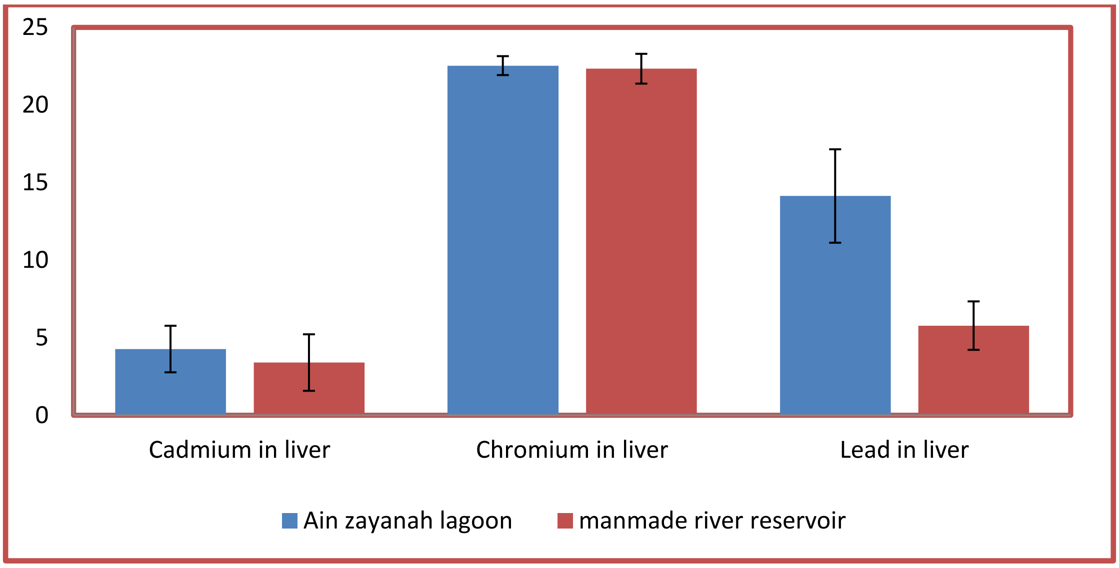

Figure 19. The mean ± SE of the heavy metals cadmium, chromium and lead (mg/kg) left to right in liver tissue of *Tilapia zillii* from Ain zayanah lagoon and manmade river reservoir

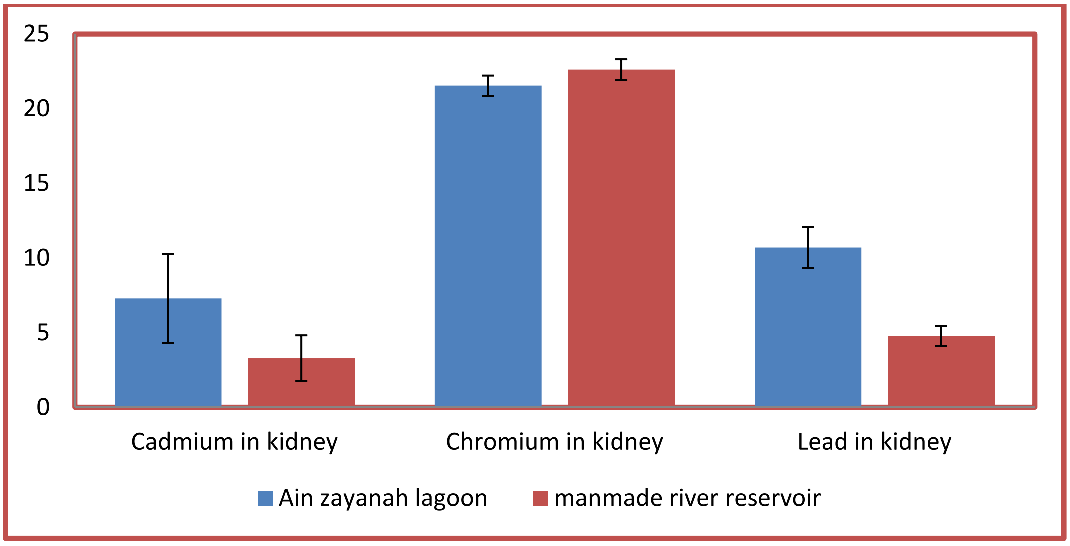

Figure 20. The mean ± SE of the heavy metals cadmium, chromium and lead (mg/kg) left to right in kidney tissue of *Tilapia zillii* from Ain zayanah lagoon and manmade river reservoir

4.4. Comparison between surface and deep water samples collected from Ain Zayanah lagoon and manmade river reservoir-Ajdabiay.

The analysis of both surface and deep water revealed zero cadmium in Ain zayanah surface and deep water, however, no cadmium was detected in manmade river surface water and 0.0213 mg/l in the reservoir deep water. On the other hand chromium concentrations were 1.48 mg/l and 0.016 mg/l in the surface water of Ain zayanah lagoon and manmade river whereas, 1.39 mg/l and 0.00 in the deep water of Ain zayanah and manmade river.

The metal lead was found only in the Ain zayanah surface and deep water at 1.39 mg/l and 1.16 mg/l. whereas, it was absent from both surface and deep water of the manmade river reservoir- Ajdabiay (Table.6,7appendix).

5. Discussion

Ain zayanah lagoon and Manmade river reservoir ,Ajdabia metals values were within the permissible values set by (USEPA) 2008, (EU)1998and (WHO) 2008.However, due to the expected bioaccumulation of these metals in fish, consequently a harm effect most likely, will results in human consuming these fishes.

Though the average length and weight of Ain zayanah lagoon was found smaller than that of manmade river, this however does not necessarily reflect age differences, since both samples were collected randomly from their locations. On the other hand the Ain zayanah samples in fact are much older time wise in this location compared to manmade river which most likely introduced to this location intentionally or unintentionally during early 1990, consequently metal concentrations detected in the two location samples cannot be attributed to age factor, however, age factor can be considered only within each location sample.

Heavy metals are very toxic, as ions or in compound forms, because they are soluble in water and may be readily absorbed into living organisms. After absorption, these metals can bind to vital cellular components such as structural proteins, enzymes, and nucleic acids, and interfere with their functioning (Landis, 2004).

Consequently, the international organizations including World Health Organization (WHO) and the European Commission (EC), all have set standard limits that should not be exceeded in food, feed, water and even in soil intended for cultivation, regardless whether the metal is essential or non essential.

In the present study, no toxic symptoms were observed since all fish samples brought were dead. However, metal (including those under study) toxicity can happen in any life forms including fish, through their forming complexes or ligants with organic compounds.

These modified biological molecules lose their ability to function properly and result in malfunction or death of the affected cells. Among the involved groups in ligant formation are oxygen, sulfur and nitrogen. Once these groups are bound to the metal they may inactivate important enzymes system and / or affect protein structure.

In the present study cadmium, chromium and lead were all detected in liver and kidney of the two fish group. Their values were higher than the maximum acceptable limits in fish set by EC, (2005) and WHO (1985) . In addition , cadmium levels (4.27 and 3.40 mg/kg in liver) and chromium (21.53 and 22.61 mg/kg in kidney) recorded in fish from Ain zayanah and manmade river were high, when compared to WHO (1985) maximum recommended limits of 2.0 mg/kg in fish food. The levels of all heavy metals recorded in the present study were also high in comparison to the 0.576-1.257 mg/kg recorded in fishes of Olomoro water bodies (Idodo-Umeh, 2002) and 0.270 mg/kg fishes of the River Niger (Okoronkwo, 1992).

Chromium and lead but not cadmium had higher concentrations in Ain zayanah lagoon than manmade river at both surface and deep water.

The high level of chromium and lead at Ain zayanah lagoon (surface and deep could be attributed to local sources such as metal waste and other pollutants that drifted to the lagoon (Tekin-ozan and Aktan, 2012). Many data show that the amount of metals in the labile fraction, and the share of various metals ions strongly depend on environmental conditions. Water temperature may cause the differences in metal deposition in water (Gaber, 2007).

The increase of heavy metal concentration in the Ain zayanah might be related to the increase of total dissolved heavy metal consequently, leading to the increasing of the free chromium and lead concentration and thereby lead to an increase in metal uptake by fish (this could explain why fish from Ain zayanah had higher concentration of lead in liver than that of fish collected from manmade river).

Tilapia zillii were selected because they are the most commonly fish in aquaculture. The levels of heavy metals were determined in the liver and kidney because of their importance in metabolism and excretion.

This study was undertaken to investigate the heavy metal concentrations in the two groups of fish, and detect whether their levels are potentially harmful for human health if included in the diet.

It is well known, the difficulty to compare the metal concentrations even between the same tissue in different groups because of the differences in many factors such as, the aquatic environments, the type and the level of water pollution and the type of food.

Kamaruzzaman, *et al*., (2010) have indicated that there were a relation between metal concentration and age of fish. Taking all these factors of fish such as size, genetic composition and age of fish, it was very difficult to compare metal concentrations between the two group of fish in the present study, because of the expected differences in the environmental medium and behavior, so the emphasis here was directed toward metals levels in fish liver and kidney regardless of fish environment.

This study showed that the two fish group contained different concentration of heavy metal in their liver and kidney, that is because the liver plays an important role in accumulation and detoxification of heavy metals (Yousafzai, 2004). Exposure of fish to an elevated levels of heavy metals induces the synthesis of metallothioneine proteins (MT), which serve as metal binding proteins and defense mechanism for the fish (Phillips and Rainbow, 1989).

Fishes are known to posses the metallothioneine proteins. Metallothioneine proteins have high affinities for heavy metals and in doing so, concentrate and regulate these metals in the liver (Phillips and Rainbow, 1989). Metallothioneine protein bind and detoxify the metal ion. This well support the present study , where liver of *T. zillii* accumulated more concentrations of the metals when compared to other organs.

The liver of *T. zillii* from Ain zayanah lagoon contained higher concentrations of heavy metals except cadmium, whereas, the liver of *T. zillii* from the manmade river had more concentration of chromium. Both the liver and kidney are the primary sites for storage and detoxification of heavy metals (Bagatto and khan, 1987). The differences of the heavy metals detected in the liver and kidney of the two fish groups in this study came in agreement with the finding of Kalay *et al*., (1999) who found that different fish species and fish group accumulate metals in their tissue in significantly different values. This study further confirm that the levels of heavy metals in fish vary in various groups and species as well as different aquatic environment (Phillips and Rainbow, 1989; Canli and Atli, 2003).

The present study has detected very high concentrations of lead in the liver and kidney of *T. zillii* from Ain zayanah lagoon compared to that from manmade river, this could be attributed to the accumulated lead in the lagoon environment itself, which may, receive more pollutants in water, sediment and diet. Similar result were reported by Norrgren *et al*., (2000) who confirmed that caged three-spot tilpia (*Oreochromis andersonii*) exposed to Kafue River water accumulated higher lead concentrations (liver: 9700 ± 810 mg/kg dry-wt) probably due to extrinsic pollutants.

Generally, concentration of heavy metals in different organs of fishes is directly influenced by contamination in aquatic environment, uptake, regulation and elimination inside the fish body (Romeo *et al*., 1999 and Kamaruzzaman *et al*., 2010). Liver either stores or excretes heavy metals through bile. Other routes of heavy metal regulation are the kidneys and other minor organs (Kamaruzzaman *et al*., 2010).

The accumulation of metals in various organs depends upon the route of exposure such as through diet or their elevated level in the surrounding environment (Phillips and Rainbow, 1989; Norrgren *et al*., 2000).

In addition Romeo *et al*., (1999) explained that the capability of fish to accumulate heavy metals depends on ecological needs, metabolism, degree of pollution in sediment, water and food, furthermore salinity and temperature of water (Phillips and Rainbow, 1989; Heath, 1991). Moreover, Kotze *et al*., (1999) reported that physiological differences among tissues and organs influence the bioaccumulation of a particular metal.

6. Conclusion

The study was based on the comparison between *Tilapia zillii* samples collected from Ain zayanah lagoon and manmade river reservoir.

The results revealed that the average length and weight of a total of 10 samples from manmade river reservoir had both greater length and weight as compared to that of Ain zayanah lagoon (40 samples).

The results have also shown that chromium was found in both liver and kidney of *Tilapia zillii* of both location in a greater concentration, followed by lead, whereas, cadmium was the least.

The analysis have also revealed that the order of concentrations were Cr> Pb> Cd.

The water analyses from surface and deep water of both Ain zayanah and manmade river have shown that cadmium was absent from Ain zayanah , and only in the deep water of manmade river, whereas, chromium was found in both locations and lead only in Ain zayanah.

7. Summary

Pollution of rivers and streams with chemical contamination has become one of the most crucial environmental problems within the 20 th century (Zowail *et al.,* 2010).

Pollution of streams and rivers flowing through agricultural areas where insecticides, herbicides and fungicides, may have been applied for pest control, and industrial districts which may contain metal waste deposits, all these present varied and difficult problems due to drainage into different water bodies (Akan *et al.,* 2009; Tekin-ozan and Aktan, 2012). Effluents discharged into water, which affect aquatic animals like fish, may do so either directly or indirectly (Eletta *et al.,* 2003; Ekpo, *et al* .,2008). Pollutants able to accumulate along the aquatic food chain with severe risks for animal and human health (Kaoud and EL-Dahshan, 2010; Taweel *et al.,* 2011).

Fish is often at the top of the aquatic food chain and they may concentrate large amount of these metals from the surrounding waters (Tekin-ozan and Aktan, 2012; Olatunji and Osibanjo, 2012). Fish are able to uptake and retain heavy metals dissolved in water via active or passive processes. Toxic effects of metals occur after excretory, metabolic, storage and detoxification mechanisms are no longer able to match the uptake rates, but this capacity varies between different species and different metals (Kalay and Canli , 2000; Taweel *et al.,* 2011).

Heavy metal toxicity can result in damaged or reduced mental and central nervous function, lower energy levels, and damage to blood composition, lungs, kidneys, liver and other vital organs functions (Busch, 1996; EL-turki, 2011).

In this study, the accumulation of cadmium, chromium and lead metals were estimated in the liver and kidney of two groups of *Tilapia*

zillii fish from Ain zayanah lagoon- Benghazi (12 km north-east of Benghazi) and manmade river reservoir-Ajdabia (160km west of Benghazi).

Forty sample of *Tilapia zillii* (average length 12.7cm, average weight 44grams) were collected from Ain zayanah lagoon in May and June 2012 , and ten (average length 14.89 cm, average weight 82 grams) were collected in June from manmade river reservoir, Ajdabiay.

The liver and kidney tissues were digested and the percentage of metals chromium , lead, and cadmium were measured by Inductively coupled plasma- Mass spectrometry (ICP- MS) (Agilent 7500ce, Agilent Technologies, Japan) was used for determination of heavy metals in solution.

Liver tissue has higher chromium metal in Ain zayanah lagoon and river 22.53, 22.33 respectively and lead was high in the lagoon compared to River 14.13, 5.78 respectively ,whereas, cadmium in the lagoon was higher than the river 4.27, 3.4 respectively.

Kidney tissue has higher chromium metal in manmade river reservoir than Ain zayanah lagoon 22.61, 21.53 respectively ,whereas, lead was higher in the lagoon than river 10.69, 4.78 respectively and cadmium was higher in the lagoon than the river 7.29, 3.29 respectively.

The study showed that the order of metals in the liver and kidney of *Tilapia zillii* as follows Cr>Pb>Cd and the same order of their metals were reported in the two locations with higher values in Ain zayanah compared to manmade river.

It is also worthy to emphasize that the metals accumulation detected in liver and kidney of *T. zillii* of both location, does not reflect the total accumulation values since other organs of the fish such as skin ,flesh, muscles, lung, gonads, bones and body fluid were not analyzed.

Water samples were collected from the surface and deep of Ain zayanah lagoon and manmade river reservoir and the proportion of metals cadmium ,chromium and lead were measured. cadmium does not existed in the surface water of both lagoon and the river, but chromium and lead were within the allowable limits in lagoon and absent in river. In the deep water, cadmium was absent in the lagoon and within the allowable limits in the river .The chromium and lead were within the allowable limits in lagoon and in the river were absent.

Recommendations:

Sewage and industrial wastes should not be discharged into sea or water bodies before their treatments.

Bio-indicators including fish and other animals can be used to monitor both heavy metals and other organic pollutants for the safety of the environment.

This study involved only the liver and kidney, the author suggest further studies dealing with these metals and others in the other *T. zillii* organs such as muscle, bone, skin, gonads and gills to have a total picture for the total metal accumulation in the fish as whole.

Since these metals can bioaccumulate in the fish organs, then, the fish from Ain zayanah and similar habitat are not recommended for food, unless the extern sic pollutants sources are controlled.

8. Appendix

Table (1) Total length (cm), weight (gm) and accumulation heavy metals (mg/kg) in liver and kidney of *Tilapia zillii* in Ain Zayanah lagoon (Number of samples= 40 fish).

Variable	Mean ± Std. Error
Total length	**12.23 ± 0.16**
Weight	**44.01 ± 1.81**
Cadmium in liver	**1.50 ± 4.27**
Cadmium in kidney	**2.97 ± 7.29**
Chromium in liver	**0.61 ± 22.53**
Chromium in kidney	**0.68 ± 21.53**
Lead in liver	**14.13 ± 3.01**
Lead in kidney	**10.69 ± 1.38**

Table (2) Shows comparison between liver and kidney contents of heavy metal accumulation of *Tilapia zillii* from the Ain zayanah lagoon (mg/kg).

Organs	Cadmium Mean ± Std. Error	Chromium Mean ± Std. Error	Lead Mean ± Std. Error
Liver	**4.27 ± 1.50**	**22.53 ± 0.61**	**14.13 ± 3.01**
Kidney	**7.29 ± 2.97**	**21.53 ± 0.68**	**10.69 ± 1.38**

Table (3) Total length, weight and heavy metals accumulation in liver and kidney of *Tilapia zillii* in manmade river reservoir-Ajdabia (Number of samples= 10 fish).

Variable	Mean ± Std. Error
Total Length (cm)	**14.89 ± 0.65**
Weight (g)	**82.56 ± 13.64**
Cadmium in Liver	**3.40 ± 1.82**
Cadmium in Kidney	**3.29 ± 1.53**
Chromium in Liver	**22.33 ± 0.96**
Chromium in Kidney	**22.61 ± 0.69**
Lead in Liver	**5.78 ± 1.56**
Lead in Kidney	**4.78 ± 0.68**

Table (4) Shows comparison between liver and kidney contents of heavy metals accumulation of *Tilapia zillii* from the Manmade river reservoir-Ajdabiay (mg/kg).

Organs	Cadmium Mean ± Std. Error	Chromium Mean ± Std. Error	Lead Mean ± Std. Error
Liver	**3.40 ± 1.82**	**22.33 ± 0.96**	**5.78 ± 1.56**
Kidney	**3.29 ± 1.53**	**22.61 ± 0.69**	**4.78 ± 0.68**

Table.5 Showing comparison body length, body weight and cadmium, chromium and lead in liver and kidney of *Tilapia zillii* from Ain zayanah and manmade river.

Variable	***Tilapia zillii* in Ain zayanah lagoon**	***Tilapia zillii* in manmade river reservoir, Ajdabia**	**t-Value**	**P-Value**
	Mean ± Std. Error	**Mean ± Std. Error**		
Total Length (cm)	**a 0.16±12.23**	**a 0.65 ±14.89**	**-3.955**	**0.003**
Weight (g)	**b 1.81±44.01**	**b 13.64±82.56**	**-2.801**	**0.020**
Cadmium in Liver	**1.50±4.27**	**1.82±3.40**	**0.369**	**0.715**
Cadmium in Kidney	**c 2.97±7.29**	**c 1.53±3.29**	**1.195**	**0.238**
Chromium in Liver	**0.61±22.53**	**0.96±22.33**	**0.178**	**0.861**
Chromium in Kidney	**0.68±21.53**	**0.69±22.61**	**-1.104**	**0.279**
Lead in Liver	**d 3.01 ±14.13**	**d 1.56±5.78**	**2.458**	**0.018**
Lead in Kidney	**e 1.38 ±10.69**	**e 0.68±4.78**	**3.825**	**0.000**

Means followed by the same letter are significantly difference (t-test).

Table (6) Shows the background metals, cadmium, chromium and lead concentrations mg/l of water from surface and deep water of both Ain zayanah lagoon and manmade river reservoir- Ajdabiay.

Variable	Ain Zayanah Lagoon of surface	Manmade river of surface	Ain Zayanah Lagoon of depth	manmade river of depth
Cadmium	**0.000**	**0.000**	**0.000**	**0.02131**
Chromium	**1.48**	**0.01601**	**1.39**	**0.000**
Lead	**1.39**	**0.000**	**1.16**	**0.000**

Table 7. Drinking water contaminants and maximum admissible limit set by and international organizations.

International organizations	Cadmium	Chromium	Lead
USEPA,2008	**5**	**100**	**15**
EU,1998	**5**	**50**	**10**
WHO,2008	**3**	**50**	**10**

9. References

Achionye-Nzeh, C; Obaroh, I and Adeniyi, V. (2005) Lipase activity the liver and digestive tract of some cichlids (pisces: Cichlidea). African journal of applied zoology and environmental biology, 7: 136-139.

Akan, J; Abdulrahman, F; Sodipo, O and Akandu, P. (2009) Bioaccumulation of some heavy metals of six fresh water fishes caught from Lake chad in doron buhari, Maiduguri, Borno state, Nigeria. Journal of applied sciences in environmental anitation, 4(2): 103-114.

Akinwumi, F. (2003) Food and feeding habits of *Tilapia zillii* pisces: (Cichlidae) in ondo state University fish farm. Fisheries Society of Nigeria 4-9: 195-198.

AL shareif, S. (2008) Seasonal variation of zooplankton abundance and their relation to physic-chemical factors of Ain zayanah lagoon Benghazi, Libya. Master thesis, Science Biology Department, University of Garyounis.

Alam, M; Tanaka, A; Allinson, G; Laurenson, I and Stagnitti, F. (2002) Acomparison of trace element concentrations in culture and wild carp (*Cyprinus carpio*) of Lake Kasumigaura, Japan. Ecotoxicology environmental safety, 53: 348-354.

Allen, P. (1994) Accumulation profiles of lead and the influence of cadmium and mercury in *Oreochromis auereus* (Steindachner) during chronic exposure. Toxicology Environmental of chemistry, 44: 101-112.

AL-Nagaawy,A. (2008) Accumulation elimination of copper and lead from *Oreochromis niloticus* fingerlings and consequent influence on their tissue residues and some biochemical parameters. International symposium on Tilapia in aquaculture, Pp 431-445.

AL-Weher, S. (2008) Levels of heavy metal Cd, Cu and Zn in three fish species collected from the Northern Jordan Valley, Jordan. Jordan journal of biological sciences, 1(1): 41-46.

Amoo, I; Adebayo, O and Lateef, A. (2005) Evaluation of heavy metals in fishes, water and sediments of Lake kainji, Nigeria. Journal of food, Agriculture and Environment, 3(1): 209-212.

AY, O; Kalay, M; Tamer, L and Canli, M. (1999) Copper and lead accumulation in tissues of a freshwater fish *Tilapia zillii* and its effects on the branchial Na, K-ATPase activity. Environmental contamination and toxicology, 62: 160-168.

Bagatto, G and Khan, M. (1987) Copper, cadmium and nickel accumulation in crayfish population near copper- nickel smelters at Sudbury, Ontario, Canada. bullets Environmental Contamination and Toxicology, 38:540- 545.

Balogh, V; Salanki, J and Varanka, I. (1989) Heavy metals in fresh water organisms in the catchment area of Lake Balaton. symposium Biology Hungarian, 38: 281-289.

Barghigiani, C and Ranieri de, S. (1992) Mercury content in different size of important edible species of the northern Tyrrhenian sea. Marine pollution of bullets 24: 114-116.

Bath, G; Thorold, S; Campana, S; Mclaren, J and Lam, J. (2000) Strontium and barium uptake in aragonitic otoliths of marine fish. Geochimica et Cosmochimica Acta, 64: 1705-1714.

Busch, K. (1996) US Agency for toxic substance and disease registry. Lead. Toxicological profikes.

Canli, M and Atli, G. (2003) The relationships between heavy metal (Cd, Cr, Cu, Fe, Pb, Zn) levels and the size of six Mediterranean fish species. Environmental pollution, 121: 129-136.

Canli, M and Furness, R. (1993) Toxicity of heavy metals dissolved in sea water and in fluencies of sex and size on metal accumulation and tissue distribution in the Norway lobster *Nephrops norvegicus*. Marine Environmental Research, 36: 217-236.

Carpenter, K. (1992) Suborder Labroidei Cichlidae. Old Dominion University, Virginia, USA, Pp (1690-1693).

Chi, Q; Zhu, G and Langdon, A. (2007) Bioaccumulation of heavy metals in fishes from Taihu Lake, China. Journal Environmental Sciences, 19(12); 1500-1504.

Chindah, A and Braide, S. (2003) Cadmium and lead concentrations in fish species of a brackish wetland/upper bonny Estuary. Niger Delta. Journal Nigeria Environmental Society, 1: 399-405.

Conham, G. (2000) Descriptive in organic chemistry. New York: W.H. Freeman & Company.

Daziel, J and Baker, C. (1983) Analytical methods for measuring metals by atomic absorption spectrometry. FAO. Fisheries Technology, 212: 14-21.

Ekpo, K; Asia, I ; Amayo, K and jegede, D. (2008) Determination of lead, cadmium and mercury in surrounding water and organs of some species of fish from Ikpoba river in Benin city, Nigeria. International journal of physical sciences, 3(11): 289-292.

Eletta, O. A; Adekola, F.A and Omotosho, J. S. (2003) Determination of heavy metals in two common fish species from ASA River, Ilorin, Nigeria. Toxicological and environmental chemistry, 85(1-3): 7-12.

EL-Sayed, H and Moharram, S. (2007) Reproductive biology of *Tilapia zillii* (Gerv, 1848) from ABU QIR BAY, Egypt. Egyptian journal of aquatic research, 33(1): 379-394.

EL-turki, K. (2011) Determination of some heavy metals in seagrass "poisdonia oceanic" (L.) Delile of Eastern Libyan coast "Mediterranean". MSc. Thesis, Faculty of science, Benghazi university.

Eneji, I; Ato, R and Annune, P. (2011) Bioaccumulation of heavy metals in fish (*Tilapia zillii* and *Clarias Gariepinus*) organs from River Benue, North-Central Nigeria. Pakistan Journal analytical environmental chemistry, 12(1-2): 25-31.

European Commission. Commission Regulation (EC) No 78/2005, amending Regulation (EC) No 466/2001 as regards heavy metals L 16/43.45.2005 cited; Available from: http://europa. eu/LexUriServ/LexUriServ.do ?uri=OJ:L:2005:016:0043:0045:EN:PDF.

Farombi, E; Adelowo, O and Ajimoko, Y. (2007) Biomarkers of oxidative stress and heavy metal levels as indicator of environmental pollution in African catfish (*Clarias gariepinus*) from Nigeria Ogun River. International journal of environmental research and public health, 4: 158-165.

Ferrara, R; Maserti, B; Paterno, P. (1989) Mercury distribution in maritime sediment and its correlation with the posidonia oceanic prairie in a coastal area affected by a chlor-alkali complex. Toxicological and Environmental chemistry, 22: 131-134.

Filogh , A. (2007) determination of levels of some heavy metals (Fe,Cu,Zn) in tissue of grey mullet *mugil cephalus* muscles, Liver, kidney, gills) from Juliana lagoon – Benghazi and Relation to body weight and sex . MSc. Thesis, Academe of graduate Studies, Benghazi.

Food and Agriculture organization. (1983) Compilation of legal limits for hazardous substances in fish and fishery products. Fisheries circular, 764.FAO,Rome.

Froese, R. and Pauly, D. (2010). Fish base, http:// www.Fish base. Org, accessed November 16, 2010.

Gaber, H. (2007) Impact of certain metals on the gill and liver of the Nill Tilapia (*Oreochromis niloticus*). Egyptian Journal Aquaculture Biology and fisheries,11(2): 79-100.

Guven, K; Ozbay, C; Unlu, E and Satar, A. (1999) Acute lethal toxicity and accumulation of copper in Gammarus pulex (Amphipods).Turkey Journal Biology, 23: 513-521.

Heath, A. (1991) Effect of water-borne on physiological responses of bluegill (*Lepomis macrochirus*) to acute hypoxic stress and subsequent recovery. Company Biochemistry Physiology, 100(C): 559-564.

Idodo- Umeh, G. (2002) Pollution assessments of Olomoro water bodies using physical and biological indices. PHD Thesis, University of Benin City, Nigeria, Pp387.

Jembe, B; Boera, P and Okeyo Owuor, J. (2006) Distribution and association of Tilapia unit stocks in the Lake Victoria catchment (Kenya). Conference paper-published, 2: 210-216.

Kakulu, S; Osibanjo, O; Ajayi, S. (1987) Trace metal content of fish and shellfishes of the River Niger Delta Areas of Nigeria. Environmental international, 13: 247-251.

Kalay, M and Canli, M. (2000) Elimination of essential (Cu, Zn) and non-essential (Cd, Pb) metals from tissues of a freshwater fish *Tilapia zillii*. Turkey journal of zoological, 24: 429-436.

Kalay, M; Aly, O and Canil, M. (1999) Heavy metal concentration in fish tissues from the Northeast Mediterranean sea. bullets Environmental Contamination Toxicology, 63: 673-681.

Kamaruzzaman, Y; Ong, C and Rina, Z. (2010) Concentration of Zn, Cu and Pb in some selected marine fishes of the Pahang coastal water, malaysiay. American journal of applied sciences, 7(3): 309-314.

Kaoud, H. and EL-Dahshan, A. (2010) Bioaccumulation and histopathological alterations of the heavy metals in *oreochromis niloticus*. Nature and science, 8(4): 147-156.

Karadede, H and Unlu, E. (2000) Concentrations of some heavy metals in water, sediment and fish species from the Ataturk dam lake (Euphrates). Turkey chemosphere, 41: 1371-1376.

Kegley, S and Andrews, J. (1998) The chemistry of water. California; University Science Book.

Kotze, P; Preez, H and Van vuren, J. (1999) Bioaccumulation of copper and zinc *Oreochromis mossambicus* and *Clarias gariepinus* from the olifants river, Mpumalanga, south Africa. Water SA, 25: 99-100.

Landis, W. (2004) Environmental toxicology. CRC press LLC, U.S.A. 3rd ed., Pp(219-227).

Mahomoud, W; Amin, A; Elboray, K; Ramadan, A and EL-Halfawy, M. (2011) Reproductive biology and some observation on the age, growth, and management of *Tilapia zillii* (Gerv, 1848) from Lake Timsah, Egypt. International journal of fisheries and aquaculture, 3(2): 16-26.

Mckinney, J and Rogers, R. (1992) Metal bioavailability. Environmental science and technology, 26; 1298-1299.

Mebrahtu, G and Zerabruk, S. (2011) Concentration of heavy metals in drinking water from Urban Areas of the Tigray Region, Northern Ethiopia. Mekeelle University, Ethiopia, 3(1): 105-121.

Meyer, D. (2001) Nutrition and feeding of tilapia. Panamerican Agriculture school Zamorano, Honduras, Pp (61-66).

Mjoun, K; Rosentrater, K and Brown, M. (2010) Tilapia; profile and economic importance. South Dakota State University, Pp(1-4).

Norrgren, L; Pettersson, U; Oms, S and Bergqvist, P. (2000) Environmental monitoring of the Kafue River, Zambia using caged three spot tilapia (*Oreochromis andersonii*). Archives of Environmental Contamination and Toxicology, 38:334-341.

Okoronkwo, p. (1992) Heavy metals content in water and fish of river Niger at yelwa. MSc. Thesis, University of Benin, Benin City, Nigeria, p88.

Oladimeji, A and Offem, B. (1989) Toxicity of lead to *Clarias lazera, Oreochromis niloticus, Chironomus tantans* and *Benacus* sp. Water, Air and Soil pollution, 44: 191-201.

Olaifa, F; Olaifa, A; Adelaja, A and Oowolabi, A. (2004) Heavy metal contamination of *Clarias garpinus* from a lake and fish farm in Ibadan, Nigeria. African Journal Biomedical Research, 7:145-148.

Olatunji, O and Osibanjo,O. (2012) Comparative assessment of some heavy metals in some inland fresh water fish species from River Niger and River Osara in North Central Nigeria. International journal of environmental sciences, 2(3): 1842-1851.

Olowoyo, D. (2011) Heavy metal concentrations in Periwinkle (*Litorina Littorea*) and tilapia (*Tilapia zillii*) from the coastal water of warri, Nigeria. American journal of food and nutrition, 1(3): 102-108.

Phillips, D and Rainbow, P. (1989) Strategies of trace metal sequestration in Aquatic organisms. Marine environmental research, 28: 1-4.

Quarterman, J. (1987) Lead in (Ed. Mertz, W) Trace elements in human and animal nutrition press, Inc., San Diego, Calif., 2: 281-317.

Ramelow, G; Webre, C; Muller, C; Beck, J and Lanley, M. (1989) Variations of heavy metals and arsenic in fish and other organisms from the Calcasiey River and Lake Louisiana. Archives Environmental Contamination Toxicology, 18: 804-818.

Romeo, M; Siaub, Y; Sidoumoub, Z and Gnassia-Barellia, M. (1999) Heavy metal distribution in different fish species from the Mauritania coast. The science of total environment, 232(3): 169-175.

Schneider, J; Laarman, P and Gowing, H. (2000) Age and growth methods and state averages. Manual of fisheries survey methods, Pp (1- 4).

Sumino, K; Hayakawa, A; Shibata, T and Kitamoura, S. (1975) Heavy metals in normal Japanese tissues. Archives Environmental Healthy, 30: 487-494.

Taramelli, E; Costantini, S; Giordano, R; Olivieri, N and Perdicaro, R. (1991) Cadmium in water, sediments and benthic organisms from a stretch of coast facing the thermoelectric power plant at torvaldiga (Civitavecchia, Rome). In: UNEP/FAO (Ed), Final reports on research projects dealing with bioaccumulation and toxicity of chemical pollutants (MAP) Technical reports series No.52). UNEP/FAO PUB, Athens, Pp15-31.

Taweel, A; Shuhaimi-Othman, M; and mad, A. (2011) Heavy metals concentration in different organs of tilapia fish (*Oreochromis niloticus*) from selected areas of Bangi, Selangor, Malaysia. African journal of biotechnology, 10(55): 11562-11566.

Tekin-Ozan, S and Aktan, N. (2012) Relationship of heavy metals in water, sediment and tissues with total length, weight and seasons of *Cyprinus carpio* L., 1758 from Isikli Lake (Turkey). Pakistan journal of zoological, 44(5): 1405-1416.

Thorold, S; Jones, C; Campana, S; Mclaren, J and Lam, J. (1998) Trace element signatures in otoliths record natal river of juvenile American shad. Limmology and oceanograghy, 43:1826-1835.

Timbrell, J. (2002) Introduction to toxicology. New York: CRC press.

Trewavas, G. (1982) Grouping of Tilapia used in Aquaculture. Brief ref note Aquaculture 27:79-81.

Turkmen, A; Turkmen, M; Tepe, Y and Akyurt, I. (2004) Heavy metals in three commercially valuable fish species from Iskenderum Bay, North East Mediterranean sea, Turkey. Pakistan journal of science and industrial research, 27(1): 102-110.

United State Environmental Protection Agency, office of water Management (4204m), 1200 Pennsylvania Avenue, N.W., Washington, D.C. 20460.

Vishop, L. (1983) Marine pollution and its control., Pp(357).

Walsh, D; Berger, B and Bean, J. (1977) Mercury, arsenic, lead. Cadmium and selenium residues in fish. Pesticide Monitoring Journal, 11: 5-134.

Weiss, M. (1972) Lead. In F.d. Shell& L.S. Etle (Eds), Encyclopedia of Inter science New York: preason prentice Hell.

WHO (World Health Organization). (1985) Guidelines for During Water Quality. Vol 1. Recommendation who: Geneva, p130.

WHO 1998, European standard for drinking water, World Health Organization, Geneva.

WHO 2008, Guidelines for drinking water quality. World Health Organization, Geneva.

Yilmaz, A. (2003) Levels of heavy metals (Fe, Cu, Ni, Cr, Pb and Zn) in tissue of *Mugil cephalus* and *Trachurus mediterraneus* from Iskenderun bay. Turkey of environmental research, 92: 277-281.

Yilmaz, A. (2005) Comparison of heavy metal levels of Grey Mullet (*Mugil cephalus* L.) and sea Bream (*Sparus aurata* L.) caught in Iskenderun Bay (Turkey). Turkey journal vertebrate animals sciences, 29: 257-262.

Yousafzai, A. (2004) Toxicological effects of industrial effluents dumped in River Kabul on mahaseer, Tor putitora at Aman Garh industrial Area Nowshera, Peshawar, Pakistan. Ph.D. Thesis, University of the Punjab, Lahore.

Zaghloul, K. (2001) Usage of zinc and cadmium in inhibiting the toxic effect of copper on the african catfish (*Clarias garie pinus*). Journal of Egyptian Germinal for Science of Zoology, 33(C): 99-120.

Zowail, M; Elezaby, M; Abdel-kareim, A; Yousef, G and Mahmoud, A. (2010) Cytogenetic effect of industrial and agricultural wastes on *Tilapia zillii* fish. Acadmical journal of biological sciences, 2(1): 9-16.

Zyadah, M. (1999) Accumulation of some heavy metals in *Tilapia zillii* organs from Lake manzalah, Egypt. Turkey of journal zoological, 23: 365-372.

10. الملخص العربي

تحديد مستويات الكادميوم، الكروم والرصاص في أنسجة الكبد وكلي البلطي الزيلي من بحيرة عين زيانة, بنغازي وخزان النهر الصناعي, أجدابيا , ليبيا

أصبح التلوث الكيميائي للأنهار والجداول واحد من أكثر المشاكل البيئية أهمية في القرن 20 (Zowail *et al.*, 2010).

تلوث الجداول والأنهار المتدفق من المناطق الزراعية حيث المبيدات الحشرية ومبيدات الإعشاب والفطريات ومن المناطق الصناعية كرواسب النفايات المعدنية , وجميع هذه المشاكل المتنوعة والصعبة في الوقت الحاضر بسبب الصرف في المياه (Eletta *et al.*, 2003).

النفايات السائلة التي تصرف في الأنهار , قد تؤثر علي الحيوانات المائية مثل الأسماك , بشكل مباشر أو غير مباشر. الملوثات لها قدرة التراكم نتيجة الدفق المتواصل للنفايات السائلة بمياه الصرف (Kaoud and EL-Dahshan, 2010).

وقد تتراكم كميات كبيرة من المعادن في المياه المحيطة بالأسماك, فالأسماك غالبا" ما تكون في أعلي السلسلة المائية.

الأسماك قادرة علي الامتصاص والاحتفاظ بالمعادن الثقيلة الذائبة في الماء عن طريق العمليات النشطة أو السلبية. تحدث التأثيرات السامة للمعادن بعد آليات الطرح, التمثيل الغذائي والتخزين وإزالة السموم, إلا إن هذه العمليات غير قادرة علي مواكبة معدلات الامتصاص مع الأخذ في الاعتبار إن هذه القدرة تتباين مابين الأنواع المختلفة والمعادن المختلفة.

سمية المعادن الثقيلة قد تؤدي إلي تلف في وظيفة الجهاز العصبي المركزي, انخفاض مستويات الطاقة وضرر في تكوين الدم والرئتين والكلي والكبد والأعضاء الحيوية الاخري.

عينات البلطي الأخضر (متوسط طولها 12.7سم) جمعت 40 عينة من بحيرة عين زيانة في شهر 5-6 2012 ف, واخري (متوسط طولها 14.89سم) جمعت 10عينات من النهر الصناعي خزان أجدابيا في شهر 6 .

رغم ان متوسط الطول ومتوسط الوزن لعينات بحيرة عين زيانة كانت أصغر منها في عينات النهر الصناعي ألا أن ذلك لا يعكس الاختلاف في العمر نظرا" لان (1) العينات في الموقعين تم تجميعها عشوائيا" (2) اسماك البلطي ببحيرة عين زيانة أقدم كثيرا" مما هي عليه في خزان

أجدابيا التي لم يتعدي وجودها بداية 1990 لحداثة الخزان لذا فأن العمر لا يمكن اعتباره فارق في تركيز المعادن بين اسماك الموقعين في هذه الدراسة ومع ذلك لا يمكن نفي أن العمر يعد عامل في عينات كل موقع علي حده.

تم هضم عينات الكبد والكلية وتم قياس مستوي المعادن (الكروم, الرصاص والكادميوم) بواسطة جهاز الامتصاص الذري لتحديد نسبة المعادن الثقيلة في العينات المهضومة.

النتائج أوضحت وجود علاقة قوية بين الطول والوزن في عينات كل من البحيرة والنهر.

أوضح التحليل معدلات عالية للكروم في كل من بحيرة عين زيانة والنهر الصناعي 22.53 , 22.33ملجم/كجم علي التوالي أما الرصاص فكان عالي في البحيرة مقارنة مع النهر 14.13, 5.78ملجم/كجم علي التوالي فيما جاء الكادميوم اعلي في البحيرة من النهر 4.27, 3.4ملجم/كجم علي التوالي.

أما تحاليل الكلي أوضح أن معدن الكروم في النهر الصناعي والبحيرة كان متقاربا" وبحدود 21.53,22.61ملجم/كجم علي التوالي فيما كان الرصاص عالي في البحيرة مقارنة بالنهر 10.69, 4.78ملجم/كجم علي التوالي وجاء معدن الكادميوم نسبيا" عاليا" في البحيرة مقارنة مع النهر 7.29, 3.29ملجم/كجم علي التوالي.

أظهرت الدراسة ترتيب المعادن في الكبد والكلية للبلطي الأخضر كالأتي الكروم ثم الرصاص وأخيرا" الكادميوم.

تركيزات المعادن كل من المياه السطحية والعمق لكل من البحيرة والنهر كانت كالتالي عند السطح كان الكادميوم غير موجود في البحيرة والنهر ولكن الكروم كان قليل جدا" بالنسبة للبحيرة والنهر في الحدود المسموح بها , بينما الرصاص كان قليل جدا" في البحيرة وفي النهر غير موجود.

أما بالنسبة للأعماق كان الكادميوم في البحيرة غير موجود والنهر في الحد المسموح به , الكروم كان قليل جدا" في البحيرة وفي النهر غير موجود وكذلك الرصاص كان قليل جدا" في البحيرة وفي النهر غير موجود.

ويمكن أن نستنتج من هذه الدراسة أن هناك ضرورة لمعالجة مياه الصرف الصحي وعدم التخلص من النفايات ومخلفات المصانع بالمياه بشكل مباشر وقبل معالجتها.

كما نثوه إلي ضرورة المتابعة المستمرة لوجود وتركيز المعادن السامة والمركبات الهيدروكربونية بالمياه المفتوحة بما في ذلك الأنهار والجداول والشواطئ. ويمكن إن يتم ذلك بالاعتماد علي المؤشرات الحيوانية كالأسماك وغيرها.

وأخيرا" حيث أن هذه المعادن وغيرها عادة ما تتراكم حيويا" في الأعضاء الحيوانية بما في ذلك أعضاء الأسماك عليه فان استهلاكها قد يشكل خطورة علي الصحة لذا ننصح بضرورة الحد من وصول الملوثات إلي البحيرة حتى يمكن استغلالها كمصدر للثروة السمكية.

جامعة بنغازي

كلية العلوم

قسم علم الحيوان

تحديد مستوي الكادميوم, الكروم والرصاص في أنسجة الكبد وكلي البلطي الزيلي من بحيرة عين زيانة, بنغازي وخزان النهر الصناعي, أجدابيا , ليبيا

دراسة مقدمة لغرض استكمال متطلبات الحصول علي درجة الإجازة العليا الماجستير

في العلوم في قسم علم الحيوان

مقدمة من قبل

ريما خليل الزواوي

(15125)

أشراف الدكتور

عبد الله إبراهيم محمد

(2014-2013)