بسم الله الرحمن الرحيم

Comparative Study on the Impact of Heavy Metals and Chemical Composition Estimations of Fresh Water Fish (Oreochromis Niloticus and Bagrus Bayad) .

دراسة مقارنة تأثير المعادن الثقيلة وتقديرات التركيب الكيميائي لسمكتي البلطي النيلي والبياض.

A thesis Submitted in fulfillment of the Requirement of the Degree of Doctor of Philosophy in Fish science and technology

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DEDICATION

To my loving parents….

To my brothers and sisters….

To my Friends…

Mahdi

ACKNOWLEDGEMENTS

First of all my thanks and praise to Allah who gave me patience and will to accomplish this work. I am mast grateful to my Supervisor, Professor. Hassan Mohammed Adam for his guidance,continuousEncouragement and helps during all stages of this work. My deep thanks to all members of theFisheries production and technology Department , Friends and my colleagues .Finally deep and special thanks to my friend Dr. Adam Ismail Ahmed to help me.

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Abstract

The point of this study was to research the convergences of some overwhelming metals, Cadmium (Cd), Nickel (Ni),Lead(Pb), and chemical composition profile of two commercial critical fish species. *Oreochromis niloticus* and *Bagrus bayad* from Jabel Awlia Dam Reservoir and Lake Nubia fisheries of the Sudan, amid winter and summer season.

A specimen of 40 fish from every species was arbitrarily gathered via occasionally from two ranges Lake Nubia and Jabel Awlia Dam amid the time of May 2015 to January 2016. For every fish species absolute length, standard length, fork length, and aggregate weight were recorded. Various analytical tests were performed on fish tests. The tests incorporated some heavy metals (Cd, Ni and Pb) and proximate investigation for the protein, moisture, fat and fiery debris (ash).

The groupings of overwhelming metals in fish tests were most astounding distinctive criticalness ($P < 0.01$), level of Ni, Pb were essentially ($P < 0.01$) higher in all examples (fish, water) in summer collected in *Bagrus bayad* from Lake Nubia tests than the *Oreochromis niloticus*, in light of the fact that influenced via occasional component and contamination sources.Likewise level of Cd demonstrated the most highest value in winter in tilapia at Lake Nubia tests furthermore in water test. The acquired results proclaimed that groupings of major concentrated on metals (Pb, Ni and Cd ppm/l) in water tests and fish substance were not surpassing than the prescribed most extreme satisfactory levels proposed by the Joint FAO/WHO and EC Committees.The chemical composition tests included proximate examination for the rate of protein, moisture, fat, and ash. The protein

contents were most elevated in *Bagrus bayad* (winter) at Jabel Awlia and the slightest protein contents were most insignificant in *Oreochromis niloticus* appearing differently in relation to Lake Nubia tests,($P< 0.01$) . Moreover, the moisture contents were most high in *Bagrus bayad* (Summer)from Jabel Awlia Dam Reservoir than the *Oreochromis niloticus* from Lake Nubia tests (Winter).Significant contrasts ($P< 0.01$)were likewise acknowledged in the fat contents were most elevated in *Oreochromis niloticus* (Summer) at Jabel Awlia Dam Reservoir.

The mean values for ash content were Significant differences ($P\leq 0.01$), the highest in *Oreochromis niloticus* (winter) from Jabel Awlia Dam Reservoir samples.

The other phase of the study was determent of water quality parameters. Physic-chemical characteristic of the water, analytical tests were performed for the Temperature, Ph, Dissolved Oxygen(DO) ,Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD)There were significant differences between the mean values ($P\leq 0.01$).there was highest temperature in Jabel Awlia Dam (summer) and lowers in Lake Nubia at significant difference ($P\leq 0.05$). While there was no significant different In pH levels between the areas and seasons. Also there was high value in level of Do in Jabel Awlia Dam (winter) and lowers in Lake Nubia (summer) due to a affected by Bacteria activity.

There was no significant different in Body values between the season, while the high value showed in Lake nubia comparing to the Jabel Awlia Dam . Also the rustle showed that the high value of Cod in Lake Nubia (winter) and lowers in (summer) at Jabel Awlia Dam Reservoir.

ملخص الاطروحة:

هدفت هذه الدراسة لمعرفة تراكم بعض العناصر الثقيلة وهي الكادميوم , النيكل والرصاص في الماء ولنوعين من الاسماك هي: البلطي النيلي والبياض , كذلك تقيم التركيب الكيميائي لجسمهما متمثل في : محتوي البروتين, الرطوبة, الدهن والرماد.

جمعت اربعين سمكة من كل نوع وبشكل عشوئي من منطقتين جبل أولياء و بحيرة النوبة في الفترة من شهري مايو/ 2015م ويناير /2016م. ثم بعد ذلك تم تسجيل الطول الكلي ,القياسي وطول الزعنفة لجميع الاسماك.

أوضحت الدراسة أن تراكم المعادن الثقيلة في عينات الماء والاسماك كانت ذات فروق معنوية , متأثر بعامل الموسم ومصادر التلوث حول منطقة الدراسة, فصل الصيف أظهر نسبة عالية من تراكم النيكل والرصاص في سمكة البياض مقارنة بسمكة البلطي شتاءا ,النسبة نفسها شوهدت في عينات الماء , اما النيكل سجل اعلي نسبة في سمكة البلطي في فصل الشتاء والتي جمعت من بحيرة النوبة وكذلك في عينات الماء.

أجريت تحاليل كيميائية لعينات الاسماك لمعرفة محتواها النسبي من البروتين , الرطوبة , الدهن و الرماد , فكانت الفروق معنوية بالنسبة للمحتويات المذكورة.

محتوي البروتين كان أعلي في أسماك البياض في فصل الشتاء واقل في أسماك البلطي في الصيف.

محتوي الرطوبة كان أعلي في أسماك البياض في فصل الصيف واقل نسبة كانت في اسماك البلطي النيلي في الشتاء.

نسبة الدهون كانت عالية في أسماك البلطي صيفا التي جمعت من منطقة جبل اولياء مقارنة بالتي جمعت من بحيرة النوبة , اما بالنسبة لمحتوي الرماد كان اعلي في أسماك البلطي في الشتاء.

أيضا اشتمل الجانب الاخر من الدراسة اختبارات لمكونات الماء شملت درجات الحرارة ,الأس الهيدروجيني , الأوكسجين المذاب والعضوي وأظهرت الدراسة فروقات معنوية بين متوسطات القيم ,فكانت أعلي درجة للحرارة سجلت في منطقة جبل أولياء في فصل الصيف مقارنة ببحيرة النوبة ,محتوي الأس الهيدروجيني كان متقارب في كل التجارب , اما الأوكسجين المذاب كان أعلي في منطقة جبل أولياء في الصيف مقارنة ببحيرة النوبة شتاءا.

الأوكسجين العضوي أعلي في فصل الصيف في بحيرة النوبة مقارنة بفصل الشتاء, اما بالنسبة لمحتوي الأوكسجين الحيوي فكان أعلي في بحيرة النوبة مقارنة بجبل أولياء ,ومتقارب في الفصول أي ليست هنالك فروق معنوية بين الفصول .

Chapter One

1.1.Introduction:

Fish is one of the most important sources of animal protein available, and has been widely accepted as a good source of protein and other elements for the fending off a healthy body (Arannilewa etal, 2005). As compared to red meat, fish meat is easily digestible because it contains long muscle fibers. In addition, fish is a good source of fluorine and iodine required for the development of strong teeth and prevention of goiter in man (Arannilewa, 2005). Moreover, the consumption of fish has been linked to health benefits such as reduced risk of coronary heart disease. A preventive and/or curative effect has also been reported for arterial hypertension (Millar and Waal-Manning, 1992), human breast cancer (Rose and Connoll, 1993), colon and prostate cancer (Marchioli, 2001 and 2002; URL, 2002), inflammatory diseases (Belluzi etal., 1993; James and Cleland, 1996), asthma (Dry and Vincent, 1991; Hodge *etal*., 1996) and disorders of the immune system (Kenneth, 1986; Levine and Labuza, 1990). In addition, fish oil helps to prevent brain aging and Alzheimer’s disease (Kyle, 1999).

From nutritional point of view fish composite of very high nutritional quality it is rich in most of vitamins , proteins , minerals , fats and essential amino – acid and a nutritious part of human diet an idea which had been justified by some biological experiments that it is nutritionally equivalent to those of meat , milk, and eggs . This properly placed fish in an especially important category of food. The study of chemical composition of fish is an important aspect of fish flesh quality since it influences both keeping quality and the technological characteristics of the fish (Huss, 1988).To compare the chemical analytic composition of farmed fish with their natural counterparts is complex, study should be emphasized with more specialized geographical influence with diet playing an important role (R. Malcolm lea, 1968- 1977).

The chemical composition of water is very variable, depending on season, time of day, place, and depth , Of all the chemical substances in natural waters, oxygen is one of the most significant (Golterman 1975).

The pollution and contamination of the soil, water, and air has become inevitable as a result of anthropogenic activities. Environmental pollution by toxic metals has increased steadily since the industrial revolution, thereby causing serious ecological problems (Osma *et al*. 2012). The pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms (MacFarlane and Burchett 2000). Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems (Censi et al. 2006). Heavy metals can be classified as potentially toxic (cadmium and lead), probably essential (nickel), and essential (copper, zinc, and selenium). The essential metals can also produce toxic effects when the metal intake is excessively elevated (Munoz-Olivas and Camara, 2001, Tuzen 2003). Heavy metals are natural trace components of the aquatic environment, but their levels have increased due to industrial, agricultural and mining activities. As a result, aquatic animals are exposed to elevated levels of heavy metals.

The levels of metals in upper members of the food web like fish can reach values many times higher than those found in aquatic environment or in sediments. Thus contamination in the region is an important issue regarding the health of the aquatic animals and in turn, health of the seafood consumers (Yilmaz, 2005).

a. General objectives:

1. The main objective of this study is geared towards determining the presence and distribution of some heavy metals in different fish species collected from different places of River Nile (Jebal Aulia dam) and Lake Nubia.

2. With the aim of assessing and establishing a baseline data on the current pollution status and using of set of molecular biology measurements in pollution monitoring programmers of Nile River environment and identify the interactions that have taken place between contaminants and the organism.

b. Specific objectives of this study are:

1. To determine the concentrations of nickel, lead and cadmium in commercial fish species and water samples around Jebal Aulia dam and Lake Nubia , by using atomic absorption spectroscopy (AAS)

2. To determine proximate composition contents in different fish species.

Chapter Two

2.Literature review:

Fish are generally defined as cold blooded aquatic vertebrates, breathing by gills and moving by swimming, most of fish are more or less streamlined inform (Thurman and Webber, 1984). Five vertebrate classes have order, suborder, and species, which could be called fish, but only two these groups bony and the cartilaginous fish are generally important and widely distributed in the aquatic environment. The classification of fish into bony and cartilaginous is important from a practical viewpoint, since these groups of fish spoil differently and vary with regard to chemical composition. The use of common or local names often creates confusion since the same species may have different names in different regions or, conversely, the same name is ascribed to several different species, sometimes with different technological properties

(ICES, 1966; OECD, 1990).

2.1. Fish environments:

Fish are the most numerous of the vertebrates, with at least 24000known species and more than half (58%) are found in the marine environment. They are most common in the warm and temperate waters of the continental shelves (some 8000species).In the cold polar waters, about 1100 species are found. In the oceanic pelagic environment well away from the effect of land, there are only some 225 species. Surprisingly, in the deeper mesopelagic zone of the pelagic environment (between 100 and 1000 m depth) the number of species increases. There are some 1000Species of so- called mid- water fish (Thurman and Webber, 1984).

2.2. World fish production:

Unlike most of our dietary choices, consumption of seafood has direct implications on global biodiversity. Across the globe, marine populations are under siege as harvest pressures decimate stocks, degrade ecosystems and ensnare communities and businesses in a spiral of extraction and depletion. In the majority of cases, management systems have failed to stem this decline and one of the only areas of consensus in that existing systems must be improved if biodiversity is to be maintained and sustainable use achieved (FAO, 2000).

The world fish production (catches of wild fish plus production in aquaculture) has increased steadily to approximately 120 million tons in recent years. World fishery production reached 126.2 million tons in 1999, an increase of 7.2% above the 1998 level. The value of world total fish production grew by 7% which amounts to 125 billion USS. In 2001, total fishery production was equivalent to 130.2 million tons (FAO, 2000, 2001, 2003). Estimates in the early 1970 predicted the potential for traditionally exploited marine species was about 100 million tons per year (FAO 1997a).

Despite development of non- traditional species, marine fishery production by 1994 reached only 90 million tones with capture fisheries accounting for 84 million tones. In 1994, the world's 200 major fishery resources accounted for 77% of marine fish production and about 35% of these resources were showing declining yields, about 25% are leveled at high exploitation rates, 40% were still developing and non remain at the undeveloped level (FAO,2006).

Seventy percent of the world's catch of fish and fishery products is consumed as food. Fish and shellfish products represent 15.6 percent of animal protein supply and 5.6 percent of total protein supply on a worldwide basis. Developing countries account for almost 50 percent of global fish exports. Seafood- borne disease or illness outbreaks affect consumers both physically and financially, and create regulatory problems for both importing and exporting countries (Cato, 1998).

The artisanal fisheries contribute significantly to socio-economic conditions in fishing communities and to food security in Africa (Diei-Ouadi and Mensah, 2005). Various efforts have been made to establish trade agreements among North African countries, but so far such agreements have been political rather than economical and commercial (Malvarosa, 2002).

2.3. Fish and fisheries in Sudan:

Fish as an important food, world preliminary production in 1989 was about one hundred million (i.e. 100,000,000Mt, FAO1995b) in which fifty five percent (55%) of this production was championed by the developing world. Sudan as one of the developing nations has no exception to the problem of malnutrition and malnourishment, although endowed with numerous rivers and the Red Sea Coast. The river Nile with its tributaries (Blue and White Niles) extending inland, transverses the country from the Ugandan and Ethiopian boarders up to the Mediterranean Sea, covering an area of about two million hectares (Medani, 1973), in which the fresh water fishery resources are distributed in an area of about 100,000km.While the Red Sea which represents the

Marine Fisheries has a coast line of more than seven hundred kilometers approximately (Abdellathf, 1991).

These water bodies constitute a rich source of numerous species of fresh and Marine Fish for many people. Seventy nine Fish families inhabit these water bodies of the Sudan (Abu Gideiri, 1984). The river Niles alone has about two hundred species of Fish from these families, which have high degree of adaptability to diverse geographical and physic-chemical conditions. Fish from important source of human food, the production of its flesh under different natural and artificial conditions is of global commercial interest.

Yet Sudan with its large fisheries resources, fish is not well utilized for the human benefit. Thus, the importance of fish in the diet in the Sudan, in fact follows a markedly regional pattern (Abu Gideiri, 1972). Many dams have been constructed across the river Nile and its tributaries resulting in the creation of seasonal and permanent reservoirs that increased the fisheries resources. Of a particular interest is Lake Nubia which represents a permanent reservoir in the river Nile system. Situated in the extreme north of the Northern state of the Sudan.

The objective of this dam reservoir is the long term water storage for irrigation which helps the increase of fisheries resources. The length of the lake is about 180kms and its maximum area is about 1000km, with 10km mean width and 25km mean depth at a maximum level (180MASL).At present the Lake is undergoing a continuous change from loacustrine condition in the Middle and Northern part, affecting the fish potentiality(Abu Gideiri and Ali,1975).

2.3.1. Fresh water fish:

Estimates indicate that about 95% of the fish captured in Sudan are from fresh water fisheries, of which 55% is form Blue Nile, White Nile, Atbara river and Lake Nubia (Carleton and Pena, 1982).The production figures from the south, however, remain doubtful as data collection is hampered by remoteness Carleton and Pena (1982) surveyed the situation in the premises in the (Sudd) and estimated yields ranging from 6000 to 43000 tons /yr.

Fresh water fish culture started in Sudan in 1953, with the establishment of the Experimental, Demonstration Fish farm within the premises of the fisheries research Centre Khartoum. Experimental trial and subsequent applications were primarily concerned with the pond –based culture of Nile Tilapia using asemi –intensive system. Apart from Oreochromis niloticus, other indigenous species such as Labio sp, Lates niloticus and Clarias sp were also experimented with in combination with the former species. Grass carp was interdicted for the eradication of aquatic weeds using controlled experimentation. Common carp was also tested in combination with Tilapia. Private and public sector fish farms were established around the capital, Khartoum and other cities. Production from these farms has been extremely low, with a maximum of 1000 tons / year. Fresh water fish culture has not developed, due to serious handicaps including limited skilled personnel, inadequate research. extension and infrastructure facilities and limited operational funds. (FAO, 2002).

2.4. Heavy metals:

Heavy elements are natural trace components of the aquatic environment, but their levels have increased due to industrial wastes, agricultural, geochemical structure and mining activities (Singh, R. K. *et al.*, 2006; Sprocati *et al.*, 2006).These sources of pollution affect the physiochemical characteristics of the water, sediment and biological components, and thus the quality and quantity of fish stocks (Al-Rawi, 2005; Mantovi et al., 2005; Singh, *et al.*, 2006).

Fish is generally appreciated as one of the healthiest and cheapest source of protein and it has amino acid compositions that are higher in cysteine than most other source of protein. Some of heavy metals are essential for fish metabolism while some others such as cadmium, nickel and lead have no known role in biological systems (SallamKh *et al.*, 1999; Schmitt *et al.*, 2005; Has-Schon *et al.*, 2007). Lead (Pb) and cadmium (Cd) are industrial pollutants which have strong negative effect on human and animal health. Cadmium is a very toxic metal. All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Cadmium has many uses, including batteries, pigments, metal coatings, and plastics. It is used extensively in electroplating; these metals are, accumulated in the organism, mainly in the liver and kidneys. The exposure to toxic elements could be minimized by regular control of food and feed and setting maximum levels for heavy metals in these products [Johnson, 1998]. Lead and lead compounds can be found in all parts of our environment. This includes air, soil, and water. Lead exerts its effect, physiologically and biochemically as a mimetic agent substituting for essential elements participating in metabolism such as calcium, iron and zinc. For instance, it directly interferes with zinc and iron in the biosynthesis of heme, in the function sulfhy dryl group rich-protein enzymes and in protein synthesis in general either directly or indirectly [Corpas, I., M.J. Bentio, D. Marquina, M. Castillo,N. Lopez and M.T. Antonio, *etal* 2002].

Lead exerts adverse effects on the resistance of the body to disease. It also suppresses the immune system, particularly the humoral response in animals. This suppression often occurs at very low sub-clinical dosages and, therefore, may be detrimental to the health of animals and perhaps of man by mechanisms other than the typical well-documented toxicity which occurs at larger dosages. Severe contamination with Pb leads to brain damage, anemia, liver, and kidney diseases (Rippe and Berry, 1973; Goyer and Mushak, 1977).

Nickel acetate depresses circulating antibody titers to T-phages and inhibits the interferon response of metal treated cells (Treagan and Furst, 1970). Nickel also inhibits the phagocytic ability and other properties of macrophages (Graham et al, 1975). Delayed hypersensitivity reactions occur in guinea pigs that are exposed to nickel (Parker and Turk, 1978).

2.4.1. Sources of Heavy Metals Pollution:

The sources of heavy metals were reported by The FAO (1996). as follows; mining effluents, industrial effluents, domestic effluents, urban storm-water, leaching of metals from garbage and solid wastes dump, metal inputs from rural areas, batteries, pigments, paints, glass, fertilizers, textiles, dental and cosmetics, atmospheric sources and petroleum

Industrial activities. Moreover, heavy metal pollution can arise from many sources as smelting of copper, preparation of nuclear fuels,

electroplating with chromium and cadmium. Cadmium, lead and zinc are released into tiny particles as dust from rubber tires on road surface. These small size particles allow these toxic metals to rise on the wind to be inhaled, or transported onto top soil or edible plants. Cadmium compounds are used as stabilizers in PVC products, color pigments, several alloys and now most commonly in rechargeable nickel-cadmium batteries Metallic cadmium mostly used as an anticorrosion agent. Cadmium is present also as a pollutant in phosphate fertilizers. The anthropogenic sources of cadmium, including industrial emission and application of fertilizers, sewage sludge to farmland, may lead to contamination of soils to increase cadmium uptake by crops and vegetables grown for human consumption. Cigarette smoking is a major source of cadmium exposure. Food is the most important source of cadmium exposure in the general non-smoking population (WHO, 1992).

General population is exposed primarily to mercury via food, fish being a major source of methyl mercury exposure and, dental amalgam. A major use of mercury is in the color-alkali industry, in the electrochemical process of manufacturing chlorine, where mercury is used as an electrode. Organic mercury exists as methyl mercury, which is very stable and accumulates in food chain. Methyl mercury was commonly used for control of fungi on grain seeds (WHO, 1990).

2.4.2. Hazards of Heavy Metals:

Lead (Pb) and cadmium (Cd) are industrial pollutants which have strong negative effect on human and animal health. These metals are accumulated in the organism, mainly in the liver and kidneys.

The exposure to toxic elements could be minimized by regular control of food and feed and setting maximum levels for heavy metals in these products (Johnson.,1998).Lead exerts its effect, physiologically and biochemically as a mimetic agent substituting for essential elements participating in metabolism such as calcium, and zinc. For instance, it directly interferes with zinc and iron in the biosynthesis of heme, in the sulfhy dryl group rich-protein enzymes and in protein synthesis in general either directly or indirectly (Corpas, *etal* 2002).

Lead binds to different kinds of transport proteins including, metallothionein, transferring, calmodulin and calcium-ATP ASE.

The maximum Cd and Pb levels permitted for sea fish are 0.1 and 0.4 mg/g, respectively. The levels of Cd and Pb in the underground water were reported as 0.003 and 0.01 mg/L, respectively [Anonymous, 2002]. WHO/FAO, 1989] reported that Cd in surface water is usually found together with zinc at much lower concentrations. The Cd present in surface water may be either dissolved or insoluble. Of the dissolved for those which may be poisonous to fish include the simple and various inorganic and organic complex ions. Its acute toxic action damage to central nervous system and parenchymatous organs, very small concentrations of Cd may produce specific effects after a long exposure period [FDA, 1993].

The acute lethal concentration of Cd for different species of fish ranges from 2-20 mg/L [WHO, 1989]. The Cd is deposited in soft tissues of the body with 50-70% accumulation in both kidneys and liver. In whole blood, Cd is bound to the erythrocytes [Piotrowski and Coleman1980]. The Cd-induced renal damage in human beings is represented by protein urea, renal tubular cell damage, decreased proximal tubular reabsorption and increased creatinin levels. Suggested that cadmium may be a risk factor for cardiovascular diseases. Cadmium is highly toxic metal that was the cause of death, serious illness, rheumatoid arthritis (RA), full skeletal deformities, depressed growth, hypertension and fetal deformity. The International Agency Research on Cancer (IARC) has classified cadmium as human carcinogen (group I). It was found to be associated with prostate cancer and renal cell carcinoma [Piotrowski and Coleman 1980].

2.5. Water:

Water like food is a vehicle for the transmission of many agents of disease and continues to cause significant outbreaks of disease in developed and developing countries world – wide (Kirby *etal*., 2003).

Water is exposed to innumerous natural and/or anthropogenic influences in the form of for example, sulfides; sodium chloride; metals e.g. iron and toxic metals e.g. lead, cadmium and chromium; carbon components; pathogens, such as bacteria and viruses (Ali, 1999).

These could be harmful to the human when high concentrations are found. The sources of water pollution is determined where human activities continue to influence the environment, which include farming, harvesting trees, constructing building and roadways, mining and disposing of liquids (Ali, 1999).

It is important to understand that pollution can be defined in many ways, and the specific definition used in specific case can be important. For example, if an industry spewing forth contaminates to water can convince the public and the regular agencies that by their definition they are not polluting. Pressure to force them to clean up might never materialize, even though the results of inadequate waste disposal are obvious (Aarne, and Jeffery 1983). Aarne, and Jeffery (1983) stated that "Citizen has an inherent right to the enjoyment of pure and uncontaminated air and water and soil; that this right should be regarded as belong to the whole community and that no one should be allowed to trespass upon it by ignorance carelessness or his avarice.

2.5.1. Water pollution and contamination:

The pollution and contamination of the soil, water, and air has become inevitable as a result of anthropogenic activities. Environmental pollution by toxic metals has increased steadily since the industrial revolution, thereby causing serious ecological problems (Osma *et al.* 2012).The Pollution of the aquatic environment with heavy metals has become a worldwide problem during recent years, because they are indestructible and most of them have toxic effects on organisms (MacFarlane and Burchett 2000). Among environmental pollutants, metals are of particular concern, due to their potential toxic effect and ability to bioaccumulate in aquatic ecosystems (Censi *et al.* 2006). Heavy metals can be classified as potentially toxic (cadmium and lead), probably essential (nickel), and essential (copper, zinc, and selenium).

The essential metals can also produce toxic effects when the metal intake is excessively elevated (Munoz-Olivas and Camara, 2001, Tuzen 2003). Heavy metals are natural trace components of the aquatic environment, but their levels have increased due to industrial, agricultural and mining activities. As a result, aquatic animals are exposed to elevated levels of heavy metals. The levels of metals in upper members of the food web like fish can reach values many times higher than those found in aquatic environment or in sediments. Thus contamination in the region is an important issue regarding the health of the aquatic animals and in turn, health of the seafood consumers (Yilmaz, 2005).

2.5.2. Water chemical composition:

The chemical composition of rivers is very variable, depending on season, time of day, place, and depth (Golterman 1975). Of all the chemical substances in natural waters, oxygen is one of the most significant. The annual cycle of oxygen in a stream is closely correlated with temperature. Studies of large rivers and small streams in warm southern regions of moderate temperature regimes and in northern climates of broad temperature fluctuations have shown that the oxygen content of flowing waters is generally highest in winter and lowest in late summer. They documented oxygen levels falling to 14% saturation; the fish left the affected regions and congregated in a few more tolerable areas .The vernal decline of oxygen content in slow-flowing streams may be attributed to the action of spring floods in removing vegetation and to the increased rate of decay of organic material with increasing water temperature. Further decreases in oxygen content toward late summer are due to one or more factors.

High temperature water, reaching a maximum in late summer, holds less oxygen in solution; decreased discharge results in diminished physical mixing and reoxygenation; and greater decomposition of naturally produced organic material uses some of the available oxygen (Reid 1961).When rainfall is light, rivers are generally fed by groundwater. Often underground water is devoid of oxygen and contains large amounts of carbon dioxide, because of its exposure to organic matter and bacterial respiration in the soil; although in limestone strata, where underground water usually flows through large solution channels, oxygen content of the emerging water may be high. In many streams there is also a diurnal variation in oxygen content. The diurnal pulse is largely a reflection of temperature fluctuations and photosynthesis-respiration relationships. This diurnal pulse may become exaggerated in streams where the discharge is low and algal populations large. In summer, the diurnal curve is characterized by oxygen production lagging behind rising temperature, often by 2 or 3 hours, thus imparting high saturation values even after sundown. Depending upon oxygen demand, the minimum, and possibly most critical, level usually occurs prior to the early-morning low temperature. In streams of this nature, the oxygen concentration may be actively affected by sunlight intensity. Autumn leaf fall, in combination with low flow, has been shown to create seasonally low oxygen concentrations. . During autumn, great quantities of leaves are shed by riparian trees into the pools. The water acquires an inky black color, because organic matter leaches from leaves; oxygen concentrations fall to low levels; and these conditions persist until it rains (Schneller 1955, Slack 1964).

Any organism that survives in such streams must be either very resistant to low oxygen or have a life history that ensures that no specimens are active in the water during late summer and autumn (Hynes 1970).

2.6. Chemical composition in fish:

Fish meat contains significantly low lipids and higher water than beef or chicken and is favored over other white or red meats (Neil, 1996; Nestel, 2000). The nutritional value of fish meat comprises the contents of moisture, dry matter, protein, lipids, vitamins and minerals plus the caloric value of the fish (Evangelos et al., 1989; Chandrashekar and Deosthale, 1993; Steffens, 2006).

Minerals are essential nutrients, they are components of many enzymes and metabolism, and contribute also to the growth of the fish (Glover and Hogstrand, 2002). The human body usually contains small amount of these minerals and the deficiency in these principal nutritional elements induces a lot of malfunctioning; as it reduces productivity and causes diseases (Mills, 1980). Besides being used as food, fish is also increasingly demanded for use as feed. However, information concerning the chemical composition of freshwater fishes in general is valuable to nutritionists concerned with readily available sources of low-fat, high-protein foods such as most freshwater fishes (Sadiku and Oladimeji, 1991; Mozaffarian et al., 2003; Foran *et al.*, 2005) and to the food scientist who is interested in developing them into high-protein foods, while ensuring the finest quality flavor, color, odor, texture, and safety obtainable with maximum nutritive value.

It is also useful to the ecologists and environmentalists who are interested in determining the effects of changing biological/environmental conditions on the composition, survival, and population changes within fish species. The nutritional component of the freshwater fish was found to differ between species, sexes, sizes, seasons, and geographical localities (Zenebe *et al.,* 1998b).

It was also found to influence post-harvest processing and affect the shelf-life of the fish (Clement and Lovelli, 1994). Changes in fatty acid and amino acid concentrations were found to be useful as an index of freshness and decomposition of marinated fish in storage (Özkan, 2005). Likewise, different cooking methods affect the quality of fish meat (Prapasri, 1999).

Moreover, the measurement of some proximate profiles such as protein contents, lipids and moisture contents is often necessary to ensure that they meet the requirements of food regulations and commercial Specifications (Watermann, 2000).

Eltom (1989) studied the microbiology and Biochemistry of fassiekh fermentation. He reported that the proximate chemical composition of fresh fish were about 74% moisture, 19% protein, 4.2% fat and 2.5% ash.

Omer (1984) studied the preliminary studies on the chemical composition of the flesh of Hydrocynus forkali. She found that the proximate composition were in the range of 75.99- 79.1%, 17.13-17.33%, 1.4 – 1.45% and 1.28- 1.64%for moisture, protein, fat and ash, respectively.

Agab and Beshir(1987)found that the proximate composition of traditional salted fermented fish of the Sudan were 18.12 – 28.5%,20.7-45.5%,10.6-22.5%and 3.6-5.2% for moisture, protein, fat and ash, respectively. Ikeme (1991) studied characterization of traditional smoked fish in Nigeria. Found that the chemical composition showed that 60-80%mositure, 6-15%fat, 7-19%proteinand 5-15%ash.

Eyeson (1975), studied fermented fish in Africa. He reported that the proximate composition of raw fish was in the range of 72 – 80%, 14 - 20%, 3.6 – 6% and 1 – 7% for moisture, protein, fat and ash respectively.

Mahmoud (1977) studied the meat quality of some common Nile fishes. He reported that the proximate composition of the fish species were in the range of 63.29 – 75.19%, 14.99- 22.01%, .36 – 2.5%and .45- 1.94% for moisture, protein, fat and ash respectively.

2.6.1. Lipids:

Among the elements contained in fish, lipids vary the greatest. Fish are classified as lean, semi-fatty. These categories are distinguished by terming fish the store lipids only in the liver as lean and fish storing lipids in fat cells distributed in other body tissues as fatty. Typical lean species are bottom- dwelling ground fish like cod, saithe and hake. Fatty species include pelagic such as herring, mackerel and sprat. Some species store lipids in limited parts of their body tissues only, or in lower quantities than typical fatty species, and are consequently termed semi- fatty species (Huss, 1995). The lipids present in body fish species may be divided into two major groups: The phospholipids and the triglycerides.

The phospholipids make up the integral structure of the unit membranes in the cells, thus they are often called structural lipids. The triglycerides are lipids used for storage of energy in fat depots, usually within special fat cells surrounded by a phospholipids membrane and a rather weak collagen net work (Ackman, 1980).

Remijo (1992) reported that, the fat content in fresh. Labeo fish species was 3.5 – 5.4%. Johnson (1996) found that , fresh fish fat content varied widely from species to species and from season to another , it was 5.6% in lean fish .Clucas and Ward(1996) reported that , flesh from healthy fish contained 1 -- 2.2% fat. Ahmed (2006) found that, fat content in Hydrocynus spp. And schilbe spp. Ranged between 1.4 – 2.2 %.

2.6.2. Ash content:

Most of the known elements or minerals can be detected in the human and fish body, but only fifteen of those known to be essential to man need to be derived from food Clucas and Ward (1996). According to Ahmed (2006) the ash content of the fresh fish ranged between 1.1 – 1.7.Ash content was found to be of little value in evaluating the nutritive value of fish (Pike& Brown1976).

2.6.3. Moisture content:

Water is the men constituent, with considerable variations, typically 80%in the lean fish and 70% in fatty fish. In balancing the ration it is essential to know the water content of each component , also ,moisture in prepared feed must be monitored because levels over 8% favors the presence of insects , and over 14% there is the risk of contamination by fungi and bacteria (cockerel et al . , 1971) .

Remijo (1992) reported that, the moisture content of fresh labeo fish spp. was (70.4 -71.2 %).

Ali et al. , (1996) stated that , the moisture content in deep frozen fish of labeo species was 76.7 % Clucas and Ward (1996) reported that , flesh from healthy fish contained 70 – 80 % water .

Ahmed (2006) carried out comparison of nutritive value of fesseikh using hydrocynus species and schilbe species, he mentioned that, the moisture content of the fresh fish was in the range of 72.9 -81.92%

2.6.4. Protein:

The protein in fish muscle tissue can be divided into the following three groups:

- Structural protein (actin, myosin, tropormyosin and actomyosin) which constitutes 70- 80% of the total protein content.
- Sarcoplasmic proteins (myoalbmin, globulin and enzymes). This fraction constitutes 25-30% of the protein.
- Connective tissues protein (collagen), which constitutes approximately 3% of the protein. (Suzki, 1981).

Structural proteins make up the contractile apparatus responsible for muscle movement. The amino acid composition is roughly similar to corresponding protein in mammalian muscle, although the physical properties can differ slightly (Clucas and Ward, 1996).

The majority of sarcoplasmic proteins are enzymes participating in cell metabolism, such as the anaerobic energy conversion from glycogen to ATP.

If the organelles within the muscle cell are broken, this protein fraction may also contain the metabolic enzymes localized inside the endoplasmatic reticulum, mitochondria and lysosomes (Huss, 1995).

The chemical and physical properties of collagen protein are different in tissues such as skin, swim bladder and the myocommata in muscle. In general, collagen fibrils form delicate network structure with varying complexity in the different connective tissues in a pattern similar to that found in mammals. However, the collagen in fish is much more thermo labile and contains fewer, but more labile, cross- links than collagen from warm –blooded vertebrates (Huss, 1995).

Different fish species contain varying amounts of collagen in body tissues. These matches with a theory that the distribution of collagen may reflect the swimming behavior of the species Furthermore, the varying amounts and varying types of collagen in different fishes may also have an influence on the textural properties of fish muscle. Fish proteins contain all the essential amino acids and, like milk, eggs and mammalian meat proteins, have a very high biological value (Huss1995).

The protein content is usually in the range of 15- 20 percent, whereas the fat content varies widely from species to species and from season to season (Johnson, 1994) Remijo (1992) reported that, the protein content in fresh labeo fish species was 20 – 21 %, while Johnson (1994) found 15.2 % in fresh fish .Clucas and Ward (1996) reported that flesh from healthy fish contained 15- 24b% protein. Ahmed (2006) reported that, the protein content was in the range between 18.9-20.5 %.

2.7. Water quality characteristics:

Is the physical, chemical and biological characteristic of water and is most frequently used by references to a set of standards against which compliance can be assessed. (Thomas; etal 1981). Water quality is used to describe the condition of the water, including its chemical, physical and biological characteristics, usually with respect to its suitability for a particular purpose (i.e., drinking, swimming or fishing). Water quality is also affected by substances like pesticides or fertilizers that can negatively affect marine life when present in certain concentrations (Nancy; etal 2009).The quality of drinking-water may be controlled through a combination of protection of water sources, control of treatment processes and management of the distribution and handling of the water. Guidelines must be appropriate for national, regional and local circumstances, which require adaptation to environmental, social, economic and cultural circumstances and priority setting (WHO, 2008). The basic requirements for safe drinking water are that it should be:

- Free from disease-causing organisms
- Containing no compounds that have an adverse effect on human health
- Fairly clear (low turbidity and little color)
- Has no offensive test or smell

The practical application of these requirements varies from place to place depending on the living standard of a community and type of water source. The World Health Organization (WHO) guidelines are basically a source of reference for accurate and reliable information (Jefferson, 1954).

2.7.1. Temperature:

Temperature is an important parameter that regulates dissolution of gases such as carbon dioxide and oxygen. Rates and levels of chemical reactions are also affected by temperature. Therefore, it also affects biological activities.

2.7.2. pH

The parameter pH is a measure of the concentration of hydrogen ions in water. Mathematically, it is represented as: pH= -log [H+] The state of pH in natural waters primarily determines the fate of most geochemical processes like solubility, ion exchange, weathering, sorption, precipitation, and buffering capacity (Drever, 1997).

A pH between 7.5 and 9 has been recommended for drinking water. However, normal lakes can naturally have a pH around 6. Acidified lakes can have a pH around 4. Unless the water is naturally acidic, a pH below 6 could harm life in the lake (Drever, 1997), since the biological life is dependent on a certain pH. The rate of oxygen consumption in freshwater fishes is not constant (Clausen 1936); it varies in the same fish from hour to hour, and it varies between individuals of the same species. Daily fluctuations are probably part of larger rhythms that harmonize with the physiological cycles of the animal. Wells (1914) pointed out differences in the resistance of fishes during breeding and later in the summer. Beamish (1964) investigated the standard rate of oxygen consumption (when the fish is nearly or completely resting) and the active rate of oxygen consumption (when the fish is stimulated to continuous activity) for brook trout, carp, and goldfish.

These data indicate that, over a range of relatively high partial pressures of oxygen, the standard rate of consumption remains constant while the active rate increases with increases in the partial pressure Basu (1959) found that, when the oxygen concentration of water falls below a critical level, the fish is unable to satisfy its need for oxygen and oxygen consumption becomes dependent on the oxygen concentration of the water. For many fish species, oxygen concentrations below which activity is limited have been determined (Fry and Hart 1948, Graham 1949, Gibson and Fry 1954, Job 1955).

Robin (1998) mentioned that, the demand (Biochemical Oxygen Demand). It's expressed as the amount of oxygen in a sample of water consumed during a period of five days at 20ċ and is generally used to give an indication of the degree of organic pollution in water.

Hambal; etal (2000) studied the effect of the Feed- additive, Aquagen on the growth of red Tilapia cultured in the rain – fed water reticulating system. Analysis of the results showed that there were no significant difference between the water quality in the 4 experimental tanks and the average water quality parameters ranges from 8-40 ppm Alkalinity. 6.5-7.5 PH, 26.0 -27.0c, 3.5-7.0 ppm Oxygen.

Santiagio (1988) studied the feasibility study on a wastewater treatment fish farming system for cola waste. The study showed that an algae – fish waste treatment pond showed potential for Chemical Oxygen Demand removal up to about 88% treatment of high pH effluent to levels acceptable to both fish and National pollution Control Commission Standards (pH 7.0 to 9.0), and an as medium for raising tilapia. The algae, however, gave low production consequently; photosynthetic oxygen input a lone was inefficient to satin the Chemical Oxygen Demand load of the effluent. Paddle wheels and aerators therefore cannot be dispensed with if aerobic condition is to be mentioned. The algae number (less than 100000cells/m) was reflected in the slow grow increment of the test fishes and their low fat content (1%) indicative starvation.

2.8. Fish body measurement:

2.8.1. The length measurements:

Fish length is important to recreational anglers. In many fisheries, length is used to define legal size for harvest. Weithman and Anderson (1978) and Weithman and Katti (1979).Developed a fish quality index that describes the value of a captured fish in terms of the world record length for that species .Gabelhouse (1984a) used this fish quality index to define , for several recreationally important species . Length categories that can be used to evaluate length frequencies of fish samples in terms of management objective – Fishery managers thereby can use length – Frequency data to assess fish populations and to monitor them over time in response to management strategies.

Fisheries biologists use three different measures of length:

2.8.2. Total length is the maximum length of the fish, with the mouth closed and the tail fin pinched together. The best way to obtain this length is to push the fish's snout up against a vertical surface with the mouth closed and the fish lying along a tape measure, then pinch the tail fin closed and determine the total length. Do not pull a flexible tape measure along the curve of the fish. Prior to getting a final measurement the caudal (tail) fin will be pinched shut.

2.8.3. Standard length is defined as the measurement taken from the tip of the lower jaw to the posterior end of the hypural bone (Anderson and Gutreuter 1983).

2.8.4. Fork length is defined as the measurement taken from the anterior-most part of the fish to the end of the median caudal fin rays (Anderson and Gutreuter 1983).

Chapter three

3. Material and Methods:

3.1. Study sites:

The sampling site was chosen at Jabel Awlia dam reservoir (Khartoum city) and Lake Nubia, the Khartoum is first large city, which is passed by the River Nile. Therefore it is important to know the impact of this city on the water quality of the river and how this impact might change when the river have passed through the city. At Khartoum, the Blue Nile and the White Nile merge into the single river. From downstream Khartoum, the river is called River Nile. Also, 320 km north of Khartoum, they joined by the seasonal Atbara river that rises in the Ethiopian highland, also Lake Nubia on Nile River, Northern part of Sudan. The Lake Nubia was formed in 1964 as a result of the construction of the Aswan High Dam in Egypt in 1961 to provide long term water storage for irrigation and hydroelectric power and possible increase the fishery resources.

Survey and operation of fishery in Lake Nubia existed since 1967, to conduct the sustainable and commercial utilization of the fishery resources. The potential of Lake about 5000 tons /year.

Map showing study sites (1). River Nile.

The Nile is a major north-flowing river in northeastern Africa. Generally regarded as the longest river in the world. It is 6,650 km (4,130 miles) long. The Nile is an “international” river as its water resources are shared by eleven countries, namely, Tanzania, Uganda, Rwanda, Burundi, Democratic Republic of the Congo, Kenya, Ethiopia, Eritrea, South Sudan, Sudan and Egypt. The Nile has two major tributaries, the White Nile and Blue Nile.

The White Nile is longer and rises in the Great Lakes region of central Africa, with the most distant source still undetermined but located in either Rwanda or Burundi. It flows north through Tanzania, Lake Victoria, Uganda and South Sudan. The Blue Nile is the source of most of the water and fertile soil. It begins at Lake Tana in Ethiopia at 12°02′09″N 037°15′53″E and flows into Sudan from the southeast. The two rivers meet near the Sudanese capital of Khartoum, the river is called River Nile. Also, 320 km north of Khartoum, they joined by the seasonal Atbara river that rises in the Ethiopian highland.

The Blue Nile and the Atbara are subject to heavy seasonal fluctuations in flow as a result of the seasonal rains of the Ethiopian highlands. Between the months of July and September, flow increases dramatically due to heavy rains, but the Blue Nile may run during dry seasons or droughts.

Within the southern section between Aswan and Khartoum, at land which is called Nubian, the River passes through formations of hard igneous rock, resulting in a series of rapids, or cataracts, which form a natural boundary to the north. The Nile receives no additional water during the rest of its 3.000 km journey through the desert before it ends up in the Mediterranean Sea.

3.2. Samples collection:

3.2.1. Fish samples:

Two different commercial fish species for this investigation namely family: Bagrus bayad, local name (Bayad) and Oreochromis niloticus local name (Bluti) were selected from two areas, Lake Nubia and Jabel Awlia dam reservoir (these areas are suffering severe disturbance form human activity). The samples collected at two stations and two seasons (summer and winter). Summer samples were taken in May, while winter samples were taken in December.

These samples were prepared and washed with tap water to remove any adhering soil, then placed in insulated boxes containing ice for preservation during assessment indices and transferring to lab for analysis. taken during December 2015. The samples were taken for determining heavy metals and chemical Compossion.

3.3 Water samples:

Water samples were taken from two seasons at a depth of 50 cm below the water surface in the morning. The samples were kept in a plastic container and referring to Lab for analysis to water parameters including (dissolved oxygen, chemical oxygen demand and biochemical oxygen demand) and heavy metals which were (cadmium, nickel and lead). The temperature and pH. Were measured directly in the field.

3.4. Determination of heavy metals:

3.4.1. Water samples:

Heavy metal concentrations in water were determined by flame Atomic Absorption Spectrophotometer. The samples were prepared and analyzed sequentially for cadmium, Nickel and lead. The samples were filtered and there required volume (100ml).

3.4.2. Fish samples:

Forty fish from each species (Oreochromis niloticus and Bagrus bayad) were collected at two seasons from each site for heavy metal analysis. The collected fish were washed with clean water, put in cleaned plastic bags and stored frozen until analysis was carried out. The internal viscera, head and Scurfs were removed.The Fish flesh samples were dried using an electric oven at 105c for at least 18hours till a constant weight is achieved. Dry samples were grinded using manual porcelain mortar. Powder samples were kept in airtight plastic bags.Weight 2gram of powder sample placed in a silica evaporating crucible of known weight the crucible was placed on a hot plate and allow smoking until completely charred the transferred to a muffle furnace at of 550ċ and ached at this temperature for eighteen hours. When aching is complete, cooled, and extracted with 5ml of 20%Hcl and filtrated, solution and make up to 50ml with water, and mixed. This solution is used for determination of heavy metals.

3.5. Chemical composition analysis:

Chemical composition analysis described by the Association of Official Analytical Chemists (AOAC, 2000). Fish samples were collected and preserved in ice and chemical tests were performed as follows:

3.5.1. Moisture determination:

Moisture was determined by weighting 5g of flesh, Dry in the oven at 105C for 24hrs, cool in a desiccators and weight, loss in weight (represents moisture). The moisture % was calculated as:

$$\text{Moisture \%} = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Fresh weight (samples)}} \times 100.$$

3.5.2. ASH determination:

Total ash was determined by weighing out 5g of the sample into silica dish which has previously been ignited and cooled before weighting then the dish and contents were igniting first gently and then at 550 C until the Ash got a grey \ white color . The dish was cooled at room temperature and by subtracting the weight before and after aching, the ash % was determined as below formula.

$$\text{Ash \%} = \frac{\text{Fresh weight} - \text{Ashed weight}}{\text{Fresh weight}} \times 100.$$

3.5.3. Fat determination:

Fat was determined according to the method of Bligh and Dyer (1959) where 2.0g of flesh were put in homogenization flash 20ml of chloroform and 40ml of ethanol were added and homogenized for 60 seconds .20ml of chloroform was added and distilled and mixing continued for 30 seconds. The mixture was transferred to a glass tube, and centrifuged at 1000rpm for layer was collected and transferred to a measuring cylinder to measure the volume. A sample of lipid/ chloroform of 10 to 20 ml were pip petted into a weighed measuring flask and heated 40c in a water bath to evaporate the chloroform and the oil left was determined.

$$\text{Lipids} = \frac{m \times X}{(Y - M / 0.9)M} \times 100 .$$

0.9= specific weight of the oil

X= total volume of lipid ⁄ chloroform phase (ml).

Y= volume of lipid ⁄ chloroform phase for evaporation (ml).

m= weight of the lipid

M= weight of the sample.

3-5-4. Protein content determination:

The protein content was determined by Kjeldhal method (AOAC).In Kjeldhal flask 1gr of sample (flesh) were placed. Two Kjeldhal tabs (1mg $Naso_4$ equivalent of 0.1mg Hg) were added 25ml. of conc. Sulphuric acid were added to the flask .The mixture was then digested on a heater until a clean solution is obtained , and the flask were removed and left to cool.

The digested sample was poured in a volumetric flask (100ml) and diluted to 100ml with distilled water. 5ml of the dilution was taken and poured in a Markham still. The distillation was received in a conical flask containing 25ml of 2% boric acid plus three drops of indicator (methyl red) the distillation was continued until the volume in flask was 75ml. The flask was then removed from the distiller .The distillate was then titrated against 0.1NHCI until the end point was obtained (red color). Protein content was then calculated as follows:-

Nitrogen (%) = $T \times 0.1 \times 0.014 \times 20 \div$ Weight of sample $\times 100$.

Crude protein % = $N \times 6.25$ =CP%.

3.6. Physic- chemical measurements:

3.6.1. Temperature (°C)

Temperature is a simple but useful measurement to include in a sampling regime. Methods for temperature measurement in the field and laboratory are described in standard methods (APHA, 2000). In this case, the temperature measured in the field while the samples were collecting by using thermometer, scale 0.1°C.

3.6.2 PH measurement:

Water pH was measured at taken water sample immediately by using pH meter (range 0.0 to 14.0pH).

3.6.3. Dissolved Oxygen (DO):

Water samples were taken in 500ml clean bottles and analyzed according to the standard Winkler method as modified by (Grasshoff 1983).

Reagents:

Sodium sulfate

Sodium iodide

Sulfuric acid

Manganese chloride

Procedures:

1. Take 200ml for sample, added 2ml Manganese chloride

2. Added 2ml sodium iodide and bout the sample for short time ionization

3. Added 2ml H_2SO_4 to remove iodine

4. Added starch and showed the black color

5. Added sodium sulfate for titration and till the color remove and recorded the volume Color

Calculations:

Calculate the concentration of COD in the sample using the following formula:

$$\text{Mg/L COD} = \frac{(\text{mL titrant x normality of titrant x 8000})}{\text{Equivalent volume of sample titrated}}$$

3.6.4. Biochemical Oxygen Demand (BOD):

The BOD test takes 5 days to complete and is performed using a dissolved oxygen test kit. The BOD level is determined by comparing the DO level of a water sample taken immediately with the DO level of a water sample that has been incubated in a dark location for 5 days. The difference between the two DO levels represents the amount of oxygen required for the decomposition of any organic material in the sample and is a good approximation of the BOD level.

Reagents:

Calcium chloride

Manganese chloride

Procedures:

1. Take 2 samples of water

2. Recorded the DO level (ppm) of one immediately using the method described in the Dissolved oxygen test.

3. Placed the second water sample in an incubator in complete darkness at 20oC for 5 days. If you don't have an incubator, wrap the water sample bottle in aluminum foil or black electrical tape and stored in a dark place at room temperature (20oC or 68 °F).

4. After 5 days, taked another dissolved oxygen reading (ppm) using the dissolved oxygen test kit.

5. Subtracted the Day 5 reading from the Day 1 reading to determine the BOD level. Recorded your final BOD result in ppm.

3.6.5. Chemical Oxygen Demand (COD):

Chemical Oxygen Demand preparation by the open reflux Methods

Reagents:

Mercuric sulfate, $K_2cr_2o_7$, Silver sulphate.

Procedures:

1. Taken 10 ml samples of water and added 10 ml for distilled water
2. Added .4 g for Mercuric sulphate 2. ddaed 10ml for $K_2cr_2o_7$
3. added 30ml for silver sulphate

Calculated the concentration of DO in the sample using the following formula:

$$\text{COD ml/L} = \frac{(A-B) \text{ x} M \text{x} 8000}{\text{Ml sample}}$$

A= ml FAS used for blank,

B= ml FAS used for sample,

m = molarities of FAS

8000 = mill equivalent weight of oxygen x 1000 ml /l

3.7. Statistical Analysis:

The data of the present study was analyzed using computer statistical package of social science software (SPSS, Version 11). The statistical analysis was performed using the analysis of variance (ANOVA) to determine the differences between treatments mean at significant level of 0.05. Standard errors were also estimated. McCreadie et al. (2006).

Chapter Four

4. Results:

4.1. Physiochemical characteristic of the water, analytical according to areas:

The results of Physiochemical characteristic of the water sample are presented in (table 1, figure 1). The high temperature showed in Jabel Awlia dam reservoir (summer) 21 ± 0.45°C, while the lower temperature showed in Lake Nubia (20°C) at significant difference ($P \leq 0.05$).

The level of pH for two areas was 8.7 ± 0.15 mg/l from Jabel Awlia dam reservoir water samples and 8.5 ± 0.17 mg/l at Lake Nubia. There was no significant different ($P > 0.05$). Also there was high value in level of Dissolved oxygen in Jabel Awlia dam reservoir 5.72 ± .016 mg/l comparing to Lake Nubia 5.2 ± 0.19 mg/l. There was significant different ($P \leq 0.05$).

The value of Chemical oxygen demand in Lake Nubia 11.02 ± 0.41 ml/l and 10.68 ± 0.70 mg/ l at Jabel Awlia dam reservoir. There was no significant different ($P > 0.05$).

Also the result showed that the high value in level of Biochemical Oxygen Demand in Lake Nubia 1.92 ± 0.28 ml/l, while the lower in Jabel Awlia dam water samples 1.11 ± 0.25 ml/l. There was significant different ($P \leq 0.05$).

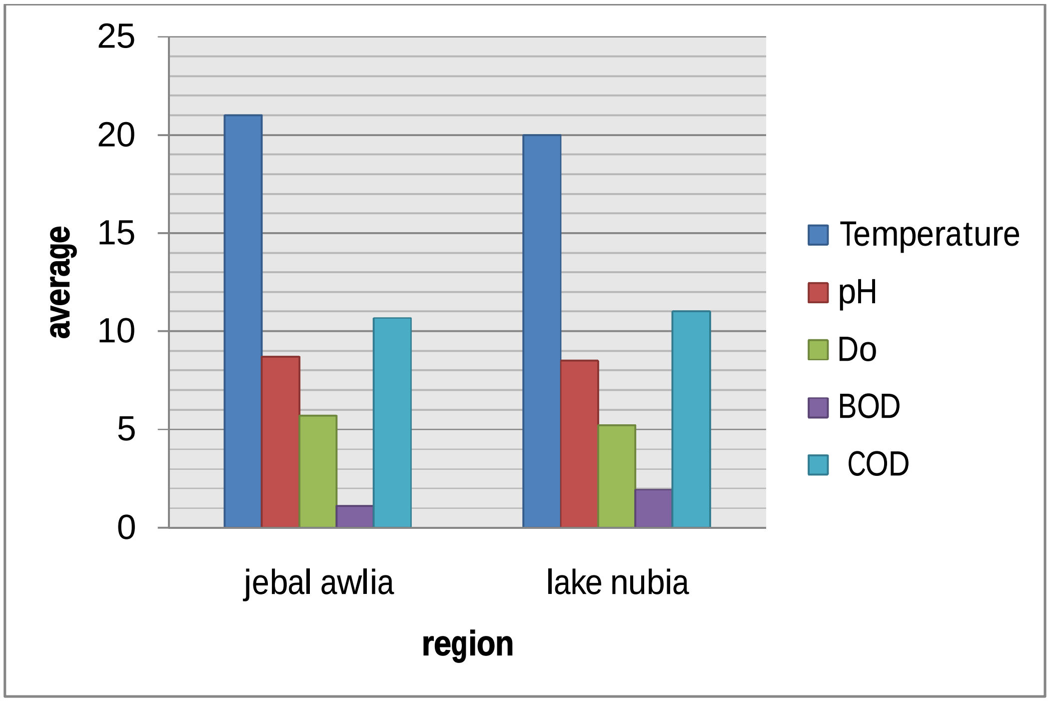
Tables (1) Physic-chemical characteristic of the water at different Areas:

Areas	Water Parameters				
	Temperature (°C) Mean ± SE	pH(mg/l) Mean ± SE	DO(Mg/L) Mean ± SE	BOD(Ml/l) Mean ± SE	COD (Ml/L) Mean ± SE
Jabel Awlia	21±0.45	8.7±0.15	5.72±0.16	1.11±0.25	10.68±0.70
Lake Nubia	20±0.52	8.5±0.17	5.2±0.19	1.92±0.28	11.02±0.41
Sig	NS	NS	*	*	NS

- **DO= dissolved Oxygen**
- **BOD= Biochemical Oxygen Demand**
- **COD= chemical Oxygen Demand**
- **Sig= significant difference.**
- **NS = no significant different ($P > 0.05$).**

***= level of significant differen at ($P \leq 0.05$).**

Figure (1) Distribution of Physic-chemical characteristic of the water from different Areas:



4.2. Physic-chemical characteristic of the water at different Seasons:

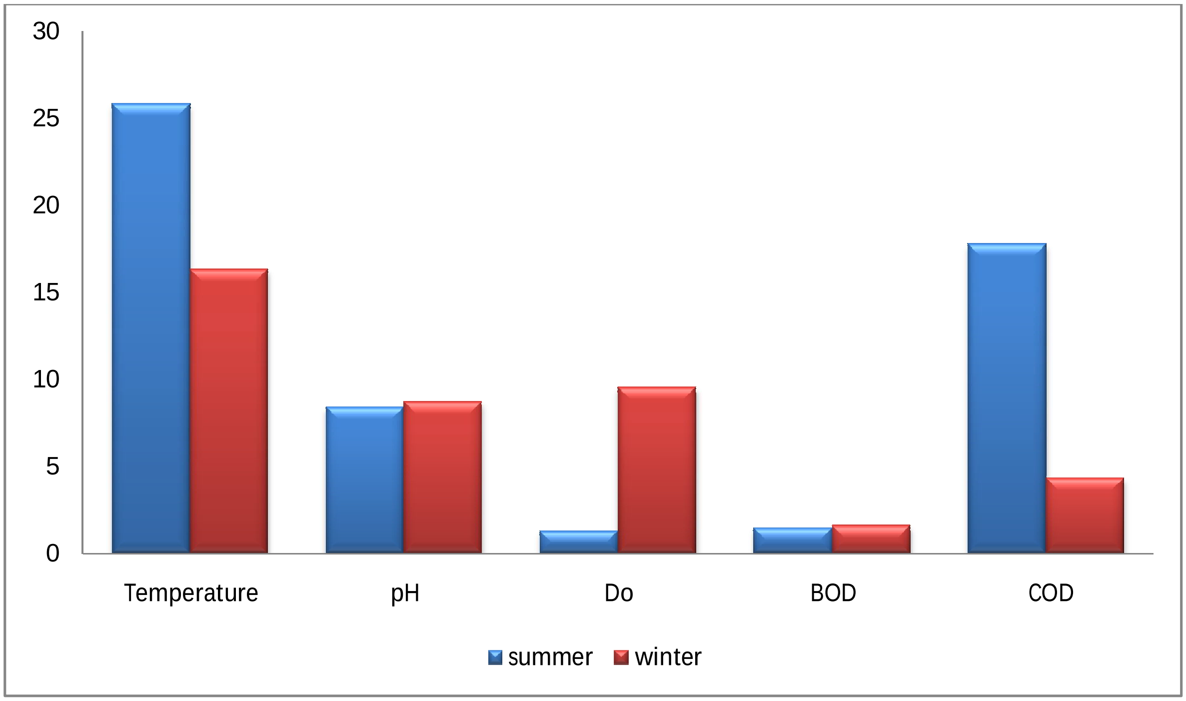
The result showed that the highest water temperature in summer season 25.81± 0.93°C in Jabel Awlia and 16.3 ± 0.83°C in Lake Nubia at summer season, while lower was found 17.04± 0.93°C Jabel Awlia, 15.6 ± 0.83°C in Lake Nubia at winter Was significantly difference ($P< 0.01$). The level of pH showed 8.4± 0.21 mg/l in Jabel Awlia and 8.5± 0.19 mg/l in Lake Nubia at summer and 8.7 ± 0.21 mg/l in Jabel Awlia, 8.6 ± 0.19 mg/l in Lake Nubia at winter season. There was significantly different. Also the high value of DO found in winter 9.54 ± 0.18 mg/l in Lake Nubia, 9.6 ± 0.21 mg/l in Jabel Awlia while the lowers found in summer season. 1.0 ± 0.21 mg/l in Lake Nubia,1.3 ± 0.21 mg/l in Jabel Awlia, There was significant difference ($P< 0.01$). The BOD value showed that 1. 45 ± 0.29 ml/l in Jabel Awlia, 1.58 ± 0.25 ml/l in Lake Nubia, at summer season and 1.2 ± 0.29 ml/l in Jabel Awlia, 1.68± 0.25 ml/l in Lake Nubia, at winter season. There was no significantly difference. Also the value of COD found in summer season 17.77 ± 0.79 ml/l in Jabel Awlia, 3.95 ± 0.79 ml/l in Lake Nubia comparing to winter 4.32 ±0.70 ml/l and 3.7 ±0.70 ml/l from Jabel Awlia and Lake Nubia respectively. There was highest significant different ($P< 0.01$).

Tables (2) The Physic-chemical characteristic of the water at different Seasons:

Season	Water Source	Water Parameters				
		Temperatur Mean ± SE	pH(mg/l) Mean±S	Do(mg/l) Mean±SE	BOD(ml/l) Mean ± SE	COD(ml/l) Mean ± SE
Summer	Jabel Awlia	25.81± 0.93	8.4±0.21	1.3±0.21	1.05±0.29	17.77±0.79
	Lake Nubia	16.3 ± 0.83	8.5±0.19	1.0±0.21	1.58±0.25	3.95±0.79
Winter	Jabel Awlia	17.04± 0.93	8.7±0.21	9.6±0.21	1.2 ±0.29	4.32±0.70
	Lake Nubia	15.6 ± 0.83	8.6±0.19	9.54±0.18	1.68±0.25	3.7±0.70
Sig		***	NS	***	NS	***

- **DO= dissolved Oxygen**
- **BOD= Biochemical Oxygen Demand**
- **COD= chemical Oxygen Demand**
- **Sig= significant difference.**
- **NS = no significant difference ($P > 0.05$).**
- *****= level of significant difference at ($P \leq 0.001$).**

Figure (2) Distribution of Physic-chemical characteristic of the water at different seasons:



4.3. Heavy metals in water samples according to areas:

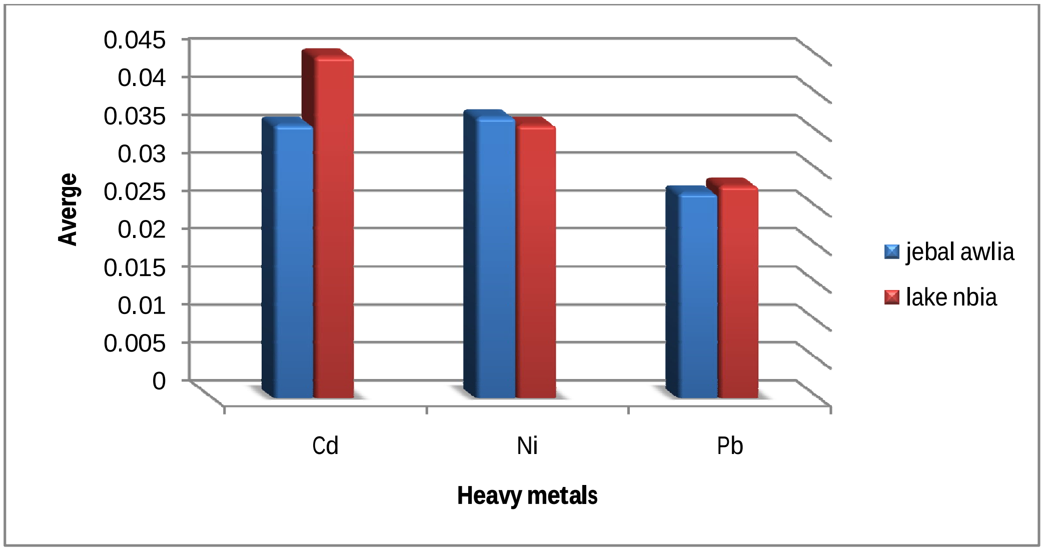
The levels of concentration of heavy metals in water samples are presented in (table 3, figure 3). Showed that the highest heavy metals concentration in water samples from Jabel Awlia dam compeering to the Like Nubia. The mean concentration of Nickel in water from Jabel Awlia dam was 0.011± 0.001ppm. Witch was significantly higher than water from Like Nubia 0.005± 0.001ppm. (P< 0.01). Cadmium and Lead were higher in water of Jabel Awlia dam they were 0.027± 0.001 and 0.060± 0.003ppm. Was significantly difference (P< 0.05).

Table (3). Heavy metals in water samples at different sites.

Areas	Level of heavy metals		
	Cd (ppm) Mean ± SE	Ni (ppm) Mean ± SE	Pb(ppm) Mean ± SE
Jabel Awlia	0.011± 0.001	0.027± 0.001	0.056± 0.003
Lake Nubia	0.005± 0.001	0.015± 0.001	0.042± 0.004
Sig	**	***	**

- **Cd = Cadmium**
- **Ni = Nickel**
- **Pb = Lead**
- **Sig= significant difference.**
- ***= highest significance (P< 0.05).**
- **** = highest significance (P< 0.01).**
- ***** = highest significance (P< 0.001).**

Figure (3) Distribution of Heavy metals in water samples according to areas:



4.4.Heavy metals concentration of water samples collected from different seasons:

The results of the concentration of heavy metals in water samples at different seasons are presented in table and figure (4). The result showed that the highest concentration of Pb in summer. The mean concentration at 0.056±0.004ppm which was significance higher than the from winter 0.045±0.003ppm.there was significance different (P< 0.05).The level of Cd and Ni were 0.008±0.001ppm, 0.020±0.001ppm in summer and 0.008±0.001ppm and 0.022±0.001ppm in winter respectively. There was no significant different between them.

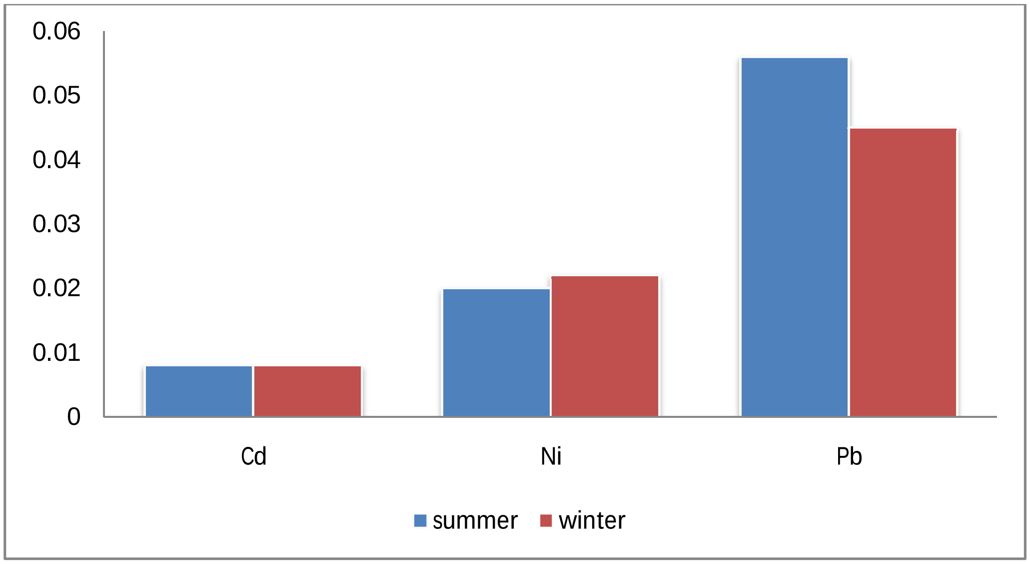
Table (4): the level of Heavy metals in water samples at different seasons:

seasons	Areas	Level of heavy metals		
		Cd (ppm) Mean ± SE	Ni (ppm) Mean ± SE	Pb (ppm) Mean ± SE
Summer	Jabel Awlia	0.008±0.001	0.020±0.001	0.056±0.004
	Lake Nubia	0.008±0.001	0.022±0.001	0.045±0.003
Winter	Jabel Awlia	0.008±0.001	0.021±0.001	0.046±0.004
	Lake Nubia	0.008±0.001	0.023±0.001	0.034±0.003
Sig		Ns	Ns	*

Cd = Cadmium

- **Ni = Nickel**
- **Pb = Lead**
- ***= highest significance (P< 0.05).**
- **Ns = not significance different (P> 0.05).**
- **Sig= significant difference.**

Figure (4): Distribution of Heavy metals in water samples according to seasons:



4.5. Heavy metals in fish samples collected from at different areas:

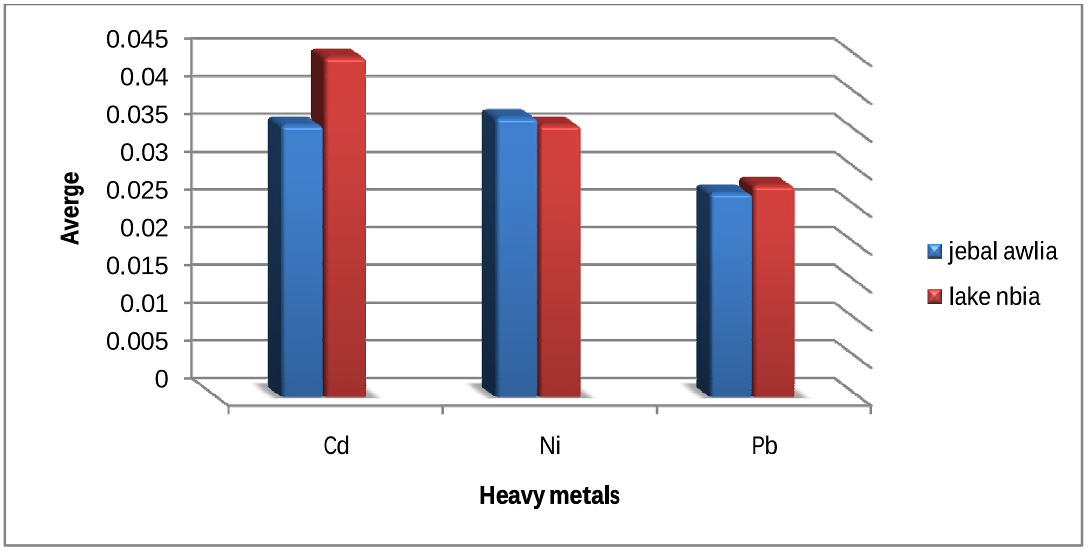
The concentration of heavy metals in fish samples are measured in table, figure (5) according to areas. The result showed that the different significance in level of Cd in fish flesh samples the mean concentration from Jabel awlia dam was 0.036 ±0.003 (µg/g) and 0.045 ±0.003 from Lake Nubia at Oreochromis niloticus ($P< 0.05$) and 0.038± 0.003 from Jabel Awlia , 0.036 ±0.003 from Lake Nubia in Bagrus bayad .The level of Ni and Pb was 0.037 ±0.001 , 0.036 ±0.001 ppm from Jabel Awlia dam in Oreochromis niloticus and 0.027 ±0.001, 0.028 ±0.001 from Lake Nubia in Bagrus bayad respectively. There was no significant different between them.

Table (5): Levels of heavy metals in fish samples at different sites:

Sites	Fish species	heavy metals in (µg/g) fish sample		
		Cd Mean ± SE	Ni Mean ± SE	Pb Mean ± SE
Jabel awlia	Oreochromis niloticus	0.036 ±0.003	0.037 ±0.001	0.027 ±0.001
	Bagrus bayad	0.038± 0.003	0.037 0±.001	0.026 0±.001
Lake Nubia	Oreochromis niloticus	0.045 ±0.003	0.036 ±0.001	0.028 ±0.001
	Bagrus bayad	0.036 ±0.003	0.036±0.001	0.027±0.001
Significance level		*	NS	NS

- **Cd = Cadmium**
- **Ni = Nickel**
- **Pb = Lead**
- **Sig= significant difference.**
- ***= highest significance (P< 0.05).**
- **NS = not significance different (P> 0.05).**

Figure (5): Distribution of heavy metals in fish samples at different areas:



4.6. Heavy metals concentration (mean ±SE) in fish samples at different seasons:

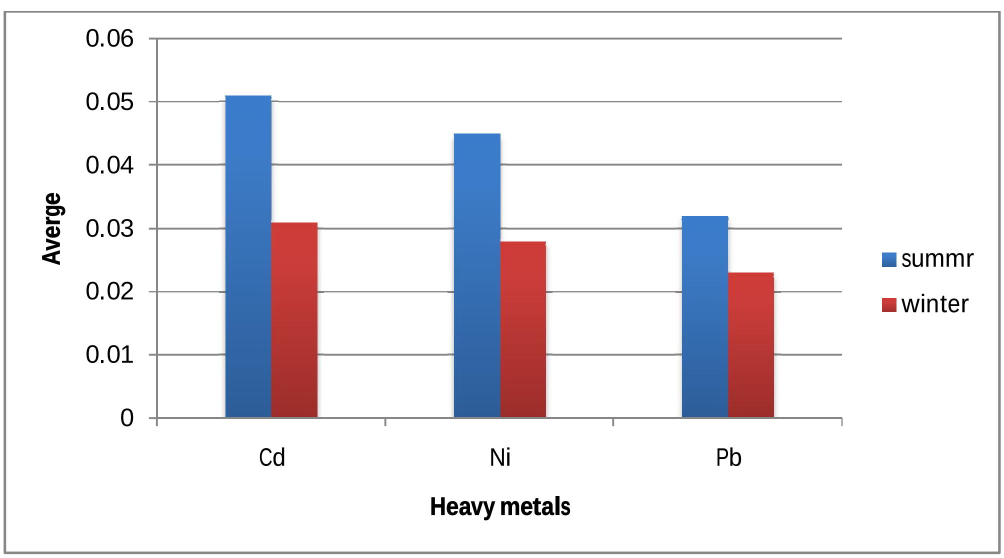
The result showed that the highest different significance in level of Cd, NI and Pb in fish flesh samples (P< 0.001). The mean concentration from summer season was0.031±0.003, 0.045±0.001, 0.032±0.001 µg/g in Oreochromis niloticus and0.051±0.003, 0.028±0.001, 0.023±0.001from Bagrus bayad respectively. Also the mean concentration of Cd, Ni and Pb from winter season was 0.03±0.001, 0.04±0.003and0.021±0.001 from winter season in Oreochromis niloticus and 0.03±0.001, 0.05±0.003 and 0.02±0.001 µg/g in Bagrus bayad.

Table (6): showed that the level of heavy metals in fish samples at different seasons:

Seasons	Species	Level of heavy metals in fish sample		
		Cd(µg/g) Mean ± SE	Ni(µg/g) Mean ± SE	Pb(µg/g) Mean ± SE
Summer	Oreochromis niloticus	0.031±0.003	0.045±0.001	0.032±0.001
	Bagrus bayad	0.051±0.003	0.028±0.001	0.023±0.001
Winter	Oreochromis niloticus	0.03±0.001	0.04±0.003	0.021±0.001
	Bagrus bayad	0.03±0.001	0.05±0.003	0.02±0.001
Sig		***	***	***

- **Cd = Cadmium**
- **Ni = Nickel**
- **Pb = Lead**
- **Sig= significant difference.**
- ***** = highest significance (P< 0.001).**

Figure (6) Distribution of heavy metals in fish samples at different seasons.



4.7. Chemical composition analysis of fish sample:

The result of proximate analysis of fresh fish species shown in tables and figures (7 and 8) according to areas, season and species. The result showed that highest moisture% in Bagurs (Jabel Awlia dam). 76.63%, the mean value of different high significantly (P< 0.01).also the fat percentage, there was difference between mean value of the different treatments was highest significant (P< 0.001, tables 7, 8).the high fat% found in tilapia in the summer in Jabel Awlia dam. Compared with fat% values in winter. the high value was 10.46% in tilapia and the lowest winter value was in Bayad 6.32.the mean value of Ash percentage there was highest different significant(P< 0.001).showed that in table(7, 8) there was high ash percentage in winter, Jabel Awlia dam and tilapia comparing with the summer, Lake Nubia and Bayad. Protein percentage of different mean value and significant (P< 0.05) in Jabel Awlia dam than Lake Nubia, the high mean value was17.64in bayad than16.42in tilapia (P< 0.001) and 17.49in summer than16.57in winter (P< 0.01). Seasons, areas and species there was all affected on chemical composition of fish samples.

Table (7): Levels of proximate analysis of fish samples at different areas:

Water Sources	Fish Species	Chemical composition			
		Moisture % Mean ± SE	Fat% Mean ±SE	Ash% Mean ±SE	Protein% Mean ±SE
Jabel Awlia	**Oreochromis niloticus**	**76.63±0.49**	**10.46± 0.47**	**4.52± 0.11**	**17.33± 0.21**
	Bagrus bayad	**76.31±0.47**	**6.95± 0.32**	**3.19± 0.92**	**17.64± 0.15**
Lake Nubia	**Oreochromis niloticus**	**75.05±0.47**	**9.83± 0.32**	**3.64± 0.92**	**16.42± 0.15**
	Bagrus bayad	**74.72±0.49**	**6.32± 0.47**	**3.49± 0.11**	**16.73± 0.21**
Sig		**	***	***	*

- **Sig= significant difference.**
- *** = highest significance (P< 0.05).**
- **** = highest significance (P< 0.01).**
- ***** = highest significance (P< 0.001).**

Figure (7): The proximate analysis of fish samples at different areas:

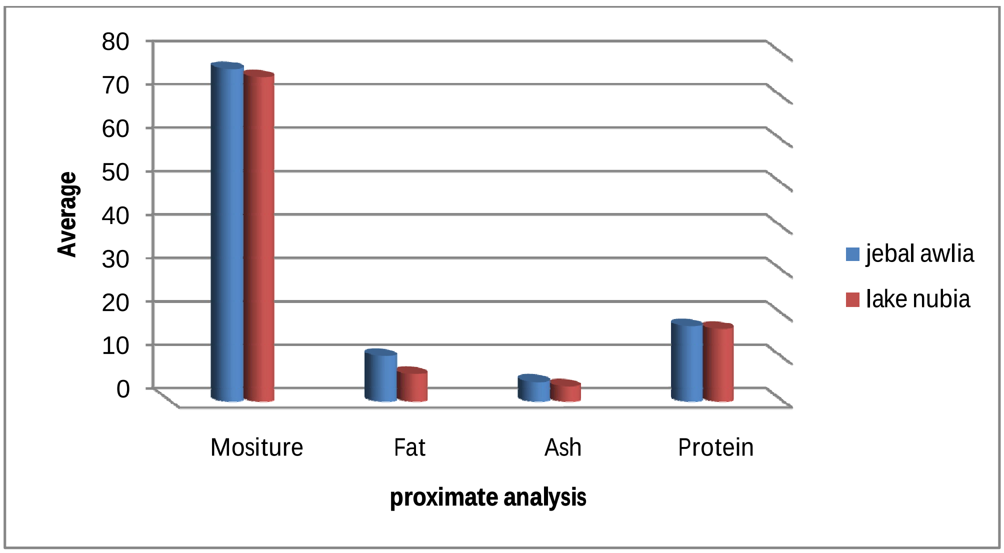
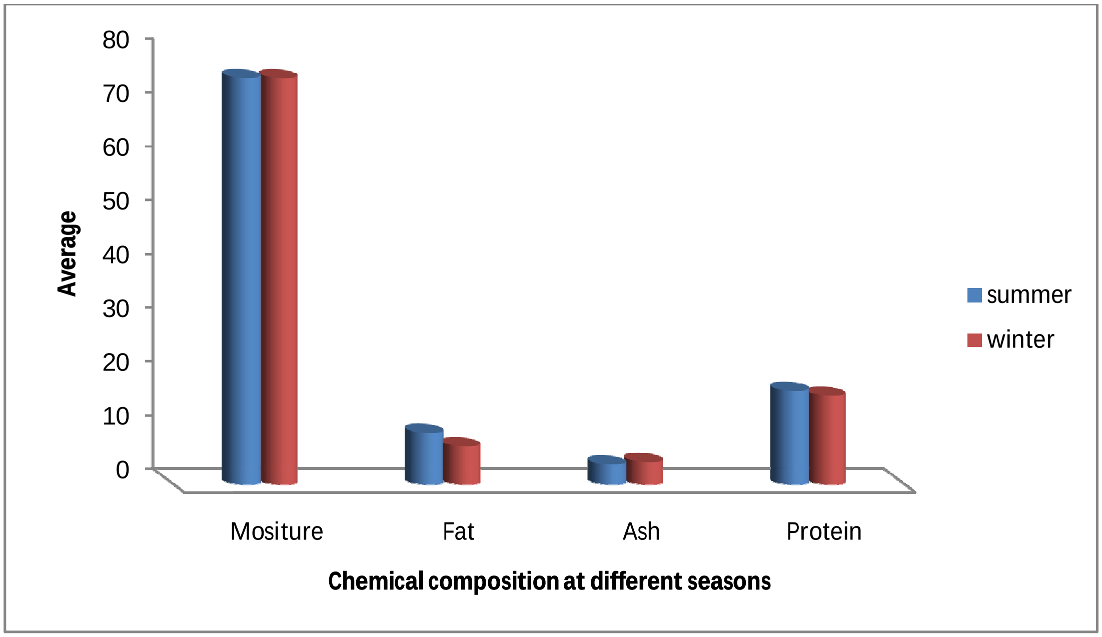


Table (8): Level of proximate analysis of fish samples at different Seasons:

Seasons	Species	Chemical composition			
		Moisture% Mean ± SE	Fat% Mean ± SE	Ash% Mean ± SE	Protein% Mean ± SE
Summer	Oreochromis niloticus	75.69± 0.49	9.64± 0.47	3.78± 0.11	17.49± 0.21
	Bagrus bayad	75.67± 0.49	7.14± 0.47	3.28± 0.11	16.57± 0.21
Winter	Oreochromis niloticus	75.05± 0.49	8.08± 0.47	4.46± 0.11	15.96± 0.21
	Bagrus bayad	76.29± 0.49	5.69± 0.47	3.74± 0.11	16.18± 0.21
Sig		NS	***	**	**

- **Sig= significant difference.**
- **NS = not significance different (P> 0.05).**
- ****= highest significance (P< 0.05).**
- ***** = highest significance (P< 0.001).**

Figure (8): Distribution of proximate analysis of fish samples at different seasons:



4.9. Body measurement of fish samples:

The result of body measurement of fish sample in tables, figures (10, 11) at different areas and season showed that the highest significant ($P< 0.001$). the high mean value of Total length, Standard length, Fork length cm was 28.05, 23.97, 25.57cm form Bagrus bayad in Lake Nubia site than the lower value was 25.97, 20.65, 22.63cm from Oreochromis niloticus in Jabel Awlia dam at summer season respectively and high mean value in winter was 28.12, 23.35, 25.13cm than lower mean value in summer was25.90, 21.28, 23.08cm respectively.Also26.3± 0.24, 22.45±0.23, 24.7±0.22cm from Oreochromis niloticus, 34.95± 0.24,25.3± 0.23, 26.8±0.22 cm from Bagrus bayad at winter respectively.

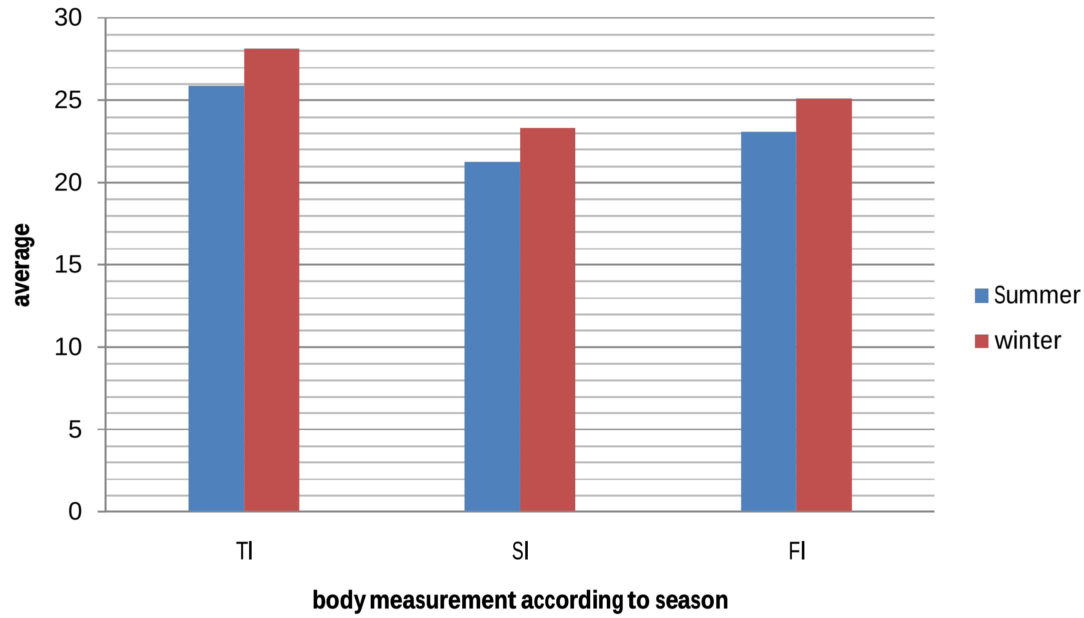
Table (9): showed that the level of body measurement of fish samples

Areas	Seasons	Species	Body measurement		
			Tl cm Mean ± SE	Sl cm Mean ± SE	Fl cm Mean ± SE
Jabel Awlia	Summer	Oreochromis niloticus	25.90± 0.24	21.28± 0.23	23.08± 0.22
		Bagrus bayad	28.12± 0.24	23.35± 0.23	25.13± 0.22
Jabel Awlia	Winter	Oreochromis niloticus	26.3± 0.24	22.45± 0.23	24.7± 0.22
		Bagrus bayad	34.95± 0.24	25.3± 0.23	26.8± 0.22
Sig			***	***	***

- **Tl = Total length**
- **St = Standard length**
- **Fl = fork length**
- **Sig = significant different**

***** = highest significance (P< 0.001).**

Figure (9): levels of body measurement of fish samples according to seasons:



5.0. Discussion

5.1. Physico-chemical characteristic of the water at different Areas

5.1.1. Temperature and pH

The sampling site was chosen at Jebal Aulia Dam which was constructed near to highly populated city (Khartoum) in the Sudan and Lake Nubia situated in Northern border of Sudan and Egypt. They both aim to provide long term water storage for irrigation and hydroelectric power and possible increase the fishery resources (Hassan et al.2011). The objective of this study is therefore to compare the effect of some water quality parameters including (water temperature, pH, dissolved oxygen, chemical oxygen demand and biochemical oxygen demand) on chemical composition of (Oreochromis niloticus and Bagurs bayad) collected from both studied water bodies.

The observed temperatures of water at the different sample locations Jebal Aulia Dam (21°C) and Lake Nubia (20°C) and pH levels (Lake Nubia 8.5 and Jebal Aulia 8.7) were within the range as shown in (Table 1,2 and Figure 1,2) which is slightly higher than the recommended limit according to Guidelines for Canadian Drinking Water Quality. But here and in this subtropical country this temperature might be a normal temperature. These results agree with (Omer, 2007) who found that the temperature ranged from 20 to 21°C. The pH of pure water is 7mg/l. In general, water with a pH lower than 7 are considered acidic, and with a pH above 7 alkaline. The normal range for pH in surface water systems is 6.5 to 8.57mg/l, as mentioned by APEC, 2007.The findings of this study showed that the level of pH were ranged from 8.77mg/l in Jebal Aulia around Khartoum City to 8.5 in Lake Nubia at Northern border of Sudan. In the present result the lower values were recorded in (summer) while the high value were found in cold period in winter. The decrease in pH values during hot period in summer because pH of the natural water may change due to biochemical processes taking place in the water. These results were agreed with finding of (Hassan et al., 2011and Omer, 2007) who found that pH ranged between 7.5 to 8.57mg/l.

5.1.2. Dissolved Oxygen (DO)

The values of Dissolved Oxygen (DO) in the studied water were showed a little variation resulted (5.72 ± .016 mg/ l) at Jebal Aulia around Khartoum city and (5.2 ± 0.19 mg/ l) at Lake Nubia. While the high value of DO (9.54 ± 0.18mg/l) recorded in winter at the cold period and the lower values (1.3 ± 0.21mg/l) were recorded in summer. However the demand for oxygen by the bacteria is high in summer than the winter, and they are taking that oxygen from the oxygen dissolved in the water. Also dissolved oxygen affected by solubility of many inorganic nutrients and it decreases with elevated high water temperature as mentioned by (Fatma, et al., 2008).They found that DO ranged between (8.22 to 9.25mg/l).

5.1.3. Biochemical Oxygen Demand (BOD):

Biochemical Oxygen Demand (BOD) refers to the amount of oxygen that would be consumed if all the organics in one liter of water were oxidized by bacteria and protozoa (ReVelle and ReVelle,1988).The concentration of BOD in this study ranged from (1.11 ± 0.25ml/l) in Jebal Aulia to (1.92 ± 0.28ml/l) at Lake Nubia. This variation might be to the presence of nitrates and phosphates in a body of Lake Nubia water which could be contributed in to higher BOD levels. Nitrates and phosphates are plant nutrients and can cause plant life and algae to grow quickly. When plants grow quickly, they also die quickly. This contributes to the organic waste in the water, which is then decomposed by bacteria. These could contributed and raised the BOD level. Also the result showed that the high value of BOD 1.58 ± 0.25ml/l in winter than the 1. 45 ± 0.29ml/l in summer. Because there were not be much organic waste present in the water supply at this time. The results of this study in the same line with findings of David (1981),who found that BOD level ranged between 1.1 to 1.7ml/l.

5.1.4. Chemical Oxygen Demand (COD):

Chemical Oxygen Demand (COD) is the amount of oxygen consumed by organic matter. The result of COD concentration showed that 10.68 ± 0.70ml/l in Jebal Aulia around Khartoum city and 11.02 ± 0.41ml/l in Lake Nubia. While the high value of COD (17.77 ± 0.79ml/l) were found in summer during hot period and lower value (4.32 ±0.70ml/l) in winter at cold period. These findings in the line of Thomas et al., 1981.

5.2. Heavy metals in water samples:

Heavy metals in water samples as per sites were exhibited in table (3, 4 and figures 3, 4). The levels of studied metals Cd, Ni and Pb in water from Jebal Aulia (Khartoum city) were recorded (0.011, 0.027 and 0.056 and 0.005, 0.015 and 0.042 ppm) from Lake Nubia, respectively. The concentrations of heavy metals for samples gathered from Jebal Aulia (Khartoum city) were higher than that gathered from Lake Nubia. However the high concentration might be resulted from anthropogenic procedures, for example, industry, agriculture, development, transportation, or residence, which are all around spoke to in the city. The outcome demonstrated that the high concentration of Lead (Pb) in Jebal Awlia (Khartoum city) and lower in Lake Nubia. This could be credited to wastes of industrial, farming or human activities releases around the urban areas (Khartoum Site).

The findings in concurrence with Khalifa, etal, (2010). Who found that the level of Cd and Pb 0.03 and 0.05, respectively in fish species and water samples could be high around coastline and cities.

Heavy metals contents in water samples at various sites were exhibited in table (3) and figure (3). The outcome demonstrated that the most noteworthy concentration of Pb Jebal Aulia, which was (0.056 ppm) as significantly higher than that (0.042 ppm) from Lake Nubia tests, there were no critical diverse between them.

5.3. Heavy metals concentration of fish samples:

Heavy metals concentration in fish samples according to sites were shown in table (5 figs 5). The concentrations of trace metals (Cd, Ni and Pb) in Orochromis niloticus samples were (0.045, 0.037 and 0.028 µg/g) , respectively in Jebal Awlia and that of Lake Nubia were (0.043, 0.036 and 0.028 µg/g). Lake Nubia tests demonstrated that there were lower gathered of heavy metals than that of Jebal Awlia tests. However Fish is among the dominant bio-indicator species used for acute toxicity assay of pollutants such as heavy metals since much attention has been drawn due to the wide occurrence of metals pollution in aquatic system. The quick advancement of businesses and agribusinesses have advanced the expansion of ecological contamination albeit heavy metals in water framework can be normally created by moderate draining from rocks and soil into water which happens at low levels. Additionally Cd and Pb were among the aquatic metals pollutants, which generally exhibit at huge levels in water framework which may posture high toxicities on the sea-going living beings (Zhou et al., 2008). The present outcomes were in concurrence with Nor Hasyimah et al., (2011) who found that the level of metals Cd, Ni and Pb in fish muscles (0.042, 0.13 and 0.05 µg/g) respectively.

The outcomes demonstrated that the abnormal amounts of Cd were (0.043 µg/g**)** in Oreochromis niloticus and the brings down were (0.038 µg/g**)** in Bagrus bayad, there was most noteworthy significant ($P< 0.001$). The abnormal state of Pb were 0.028 **(**µg/g**)** likewise in Oreochromis niloticus than that lower were 0.026 **(**µg/g**)** in Bagrus Bayad, there was elevated significantly ($P< 0.05$).While there was no centrality distinctive in level of Ni 0.037 **(**µg/g**)** for two species.

5.4. Chemical composition analysis of fish sample:

The result obtained on chemical analysis of fish samples showed that the high value of (Moisture, fat, Ash and protein) 76.63, 10.46, 4.52 and 17.33 respectively in fish samples from Jabel awlia dam than lower 74.72, 6.32, 3.49 And 16.73 respectively at fish samples collected from Lake Nubia. Also this result found at different season and between species. However the variation of the chemical composition of fish is closely related to feed intake, migratory swimming and sexual changes in connection with spawning during period of heavy feeding, at first the protein content of the muscle tissue will increase to an extent depending upon how much it has been depleted,e.g., in relation to spawning migration. Then the lipid content will show a marked and rapid increase. (Huss, 1995).

The results obtained on chemical analysis of fresh fish samples were matching with the results recorded by Eyeson (1975), studied fermented fish in Africa. He reported that the proximate composition of raw fish was in the range of 72 – 80%, 14 - 20%, 3.6 – 6% and 1 – 7% for moisture, protein, fat and ash respectively. The protein value obtained for all the samples selected (areas, season and species) ranged from 16% to 17%. These results also agree with the finding of Clucas and Ward (1996) reported that flesh from healthy fish contained 15- 24b% protein. Moisture content values ranged from 75% Tilapia to 76% Bagurs. These values agree with the finding of Ali et al. (1996) stated that, the moisture content in deep frozen fish of labeo species was 76.7 %.There was no effect of the season on Moisture content.

Lipid content ranged from 6% Bagurs (winter) to 10%Tilapia (summer). The lipid fraction is the component showing the greatest variation .Often, the variation within a certain species will display a characteristic seasonal curve with a minimum around the time of spawning (Huss, 1995).

These results matching with the finding of Ikeme (1991) studied characterization of traditional smoked fish in Nigeria. Found that the range 6-15%fat.

Ash content ranged from 3% Bagurs (summer) to 4% Tilapia (winter). The obtained values were matching with those recorded by Agab and Babiker(1987)found that the proximate composition of traditional salted fermented fish of the Sudan were 18.12 – 28.5%,20.7- 45.5%,10.6-22.5%and 3.6-5.2% for moisture, protein, fat and ash, respectively.

5.5. Body measurement of fish samples:

The results of body measurement showed that the high values of (Total length, Standard length , Frok length cm) was 28.12, 23.35, 25.13cm (summer) in Lake Nubia from Bagurs Bayad comparing to 25.90, 21.28, 23.08cm (summer). in Jabel awlia dam for Oreochromis niloticus respectively, were significantly (P >0.001).Also Also26.3± 0.24, 22.45±0.23, 24.7±0.22cm from Oreochromis niloticus , 34.95± 0.24,25.3± 0.23, 26.8±0.22 cm from Bagurs bayad at winter respectively. Effected by the seasons. Standard body length increased with increasing body weight. These results agreed with vander weight (1993).Who measured standard length (without caudal fin). Also with agree for Bailey (1994) who found that the total length of catfish in creased with increasing body weight, total body weight of African catfish weighing 60.0kg was 1.7 meter.

Conclusion

1. it is concluded that, the different concentration of heavy metals such as Cd, Ni and, Pb in the studied fish flesh of fresh water organisms collected from both sites Nile River (Jebal Aulia) around Khartoum city and Lake Nubia were found to be below the permissible level set by world health advisories (CODEX STAN 193-1995 (Amendment: 2010, Regulation (EC) No. 1881/2006 and FDA, 2001).

2. The outcomes demonstrated that the abnormal amounts of Cd were (0.043µg/g) in Oreochromis niloticus and the brings down were (0.038µg/g) in Bagrus bayad, there was most noteworthy significant ($P< 0.001$). The abnormal state of Pb were 0.028(µg/g) likewise in Oreochromis niloticus than that lower were 0.026 (µg/g) in Bagrus Bayad, there was elevated significantly ($P< 0.05$).While there was no centrality distinctive in level of Ni 0.037 (µg/g) for two species.

3. One can conclude that, the study provides a base line data on chemical composition and nutritional value of these species and considered both species as a good source of food with high nutritive value for human consumption, regardless of its sources.

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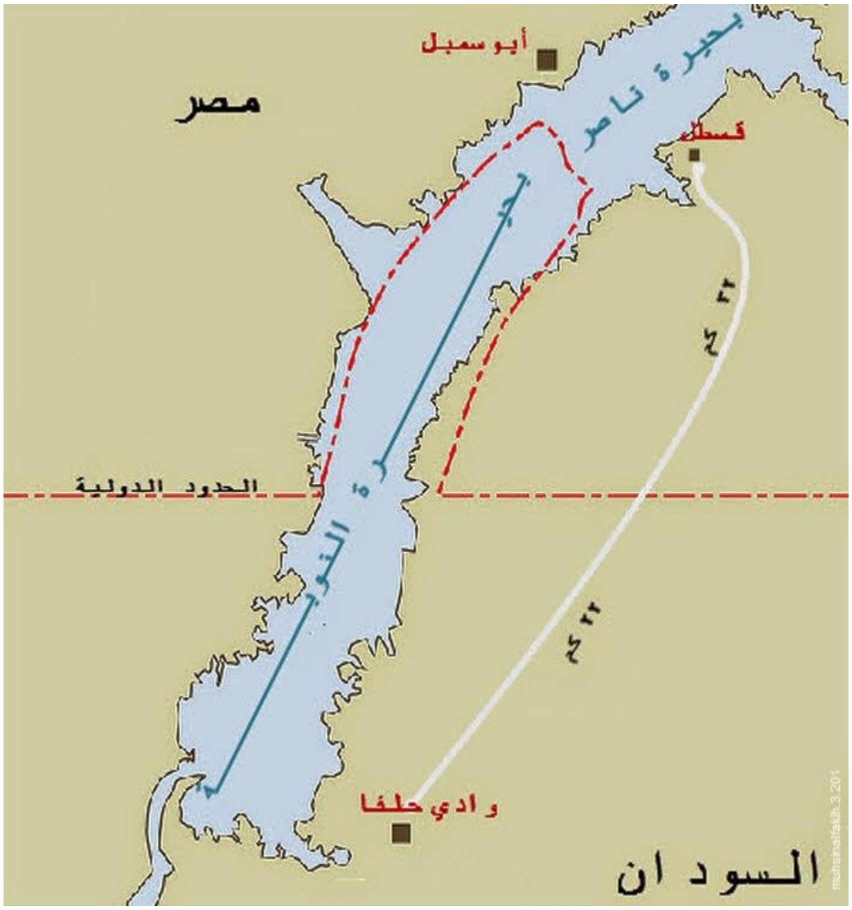
APPENDIXES:

Appendix (1): Amages for fish samples

Tilapia nilotica

Bagurs bayad

Appendix (2): LAKE NUBIA



Appendix (3): limits of heavy metals in fish muscles according to international organization

Metals	Water (mg/L)		Fish (mg/g)		Reference
	FAO	WHO	EPA	WHO	
Lead	0.005	0.01	0.05	1.5	WHO (1984) FAO/WHO(1992)
Cadmium	0.05	0.03	-	0.2	
Nickel	0.02	0.02	0.02	0.02	
COD	No guideline				WHO (1993)
BOD					
DO					