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SURVEY OF SOME ENVIRONMENTAL POLLUTANTS IN FRESHWATER FISHES IN ASSIUT GOVERNORATE, EGYPT

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ABSTRACT :

Fifty samples representing eight species of freshwater Fish (*Oreochromis niloticus, Clarias lazera, Labeo niloticus, Bagrus bajad, Synodontis schall, Morymyrus niloticus, Lates niloticus and Malapterurus electricus*) were collected randomly from different sources at Assiut during March to August 2001. The samples were analyzed for residues of persistent organochlorines (p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD, alpha-, beta-, gamma- and delta HCH isomers, aldrin, dieldrin, heptachlor and its epoxide, endrin, HCB, chlordane isomers (α-, γ- and oxychlordane), and the elements lead (Pb), cadmium (Cd), total mercury (Hg), total arsenic (As), chromium (Cr) and copper (Cu). Pesticide residues were analyzed by using Gas Chromatography (GC-ECD). Pb, Cd, Cr and Cu were analyzed by using GF- AAS. Mercury levels were measured by using automated cold vapor atomic absorption spectrophotometer (CV-AAS). Arsenic was analyzed by using hydride generation atomic absorption spectrophotometer (HG-AAS). All analyses were done in the Chemistry Department, the Federal Institute for Veterinary Medicine Examinations, Mödling, Austria.

DDT was still the most prominent pesticide that represented with one or more metabolites in all investigated species. Among other pesticides, HCB and endrin were the most widespread. HCH isomers were found at relatively few incidences and characterized by very low concentrations. Total chlordane isomers (α-, γ- and oxychlordane) and transnonachlor residues were detected in two fish species only. Aldrin, dieldrin, heptachlor and its epoxide could not be detected in all tested species.

The most persistent DDT metabolite (p,p'-DDE) was detected in all samples and averaged 67.3% of total DDT residue values although in some species reached more than 80%. The other main metabolite (DDD) averaged 15%. The parent compounds (p,p'-DDT and o,p'-DDT) averaged 17% of the total DDT. Collectively, these findings indicated a low rat of influx and continued weathering of DDT in the environment. Nevertheless, DDT concentrations in some fish species remained high enough to constitute a hazard to fish consumers.

All detected DDT values were below the recommended maximum residue levels (5000 ng/g fresh wt.) in aquatic animals used for human consumption in some countries. Nevertheless, total DDT exceeded the recommended lower residue levels in four, three and five samples of *Bagrus bajad, Morymyrus niloticus and Lates niloticus*, respectively.

For elemental contaminants, the mean concentrations of Pb and Cd were 107.271, 251.583, 138.00, 143.917, 247.781, 172.063, 176.40, 190.188 and 12.258, 10.708, 12.542, 11.25, 16.063, 16.5, 11.75 and 16.5 μg/kg wet weight in *O. niloticus, C. lazera, Labeo niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively. Hg and As mean values reached 16.197, 57.045, 23.192, 76.33, 29.374, 78.958, 58.459, 68.91 and 13.0, 14.0, 12.833, 61.00, 14.875, 98.563, 34.25, 16.5 μg/kg wet weight in the investigated species, respectively. Cr and Cu mean levels were 191.358, 310.667, 137.667, 142.00, 231.25, 385.719, 105.20, 136.50 and 386.221, 574.833, 640.667, 808.833, 633.50, 735.75, 824.25 and 714.25 μg/kg wet weight in these tested fish species, respectively.

Concerning the health hazards to fish consumers, all investigated fish species had lead with mean values above the maximum Egyptian permissible limit (0.1 mg/kg) in fresh fishes. All cadmium and Hg concentrations

were lower than the maximum Egyptian recommended limit of 0.1 and 0.5 mg/kg wet weight. In Egypt no legal limits for the arsenic levels in fish products have been established. The concentrations of total arsenic in all investigated species were below the maximum permitted level (1 μg/g wet weight) by the strictest international legislation in seafood. Health hazards of these contaminants were discussed.

INTRODUCTION:

In recent years, fish and other aquatic foods have gained popularity among international consumers. Fish, a good source of protein and often low fat, has attracted consumers due to health benefits (Anonymous, 1993).

Organochlorine pesticides are a group of synthetic compounds developed in 1940s for use mainly as insecticides (BCPC, 1998). Although efficacious against a range of insects, they are highly lipophilic and stable, resulting both in their persistence in the environment and their tendency to pass up the food chain. Owing to environmental concerns primarily, their use has been prohibited or restricted in many countries since the 1980s.

Organochlorine pesticides are being extensively used in tropical countries in malaria control programmes and against livestock ectoparasites and agricultural pests (Flyianos *et al*., 1985, Mathur 1993, Curtis 1994). The usage of these highly persistent organochlorine pesticides has resulted in trace contamination of air, water and soil with their residues.

As far as health problems caused by the presence of pesticide residues in foodstuffs are concerned, several countries have for many years carried out food contamination monitoring programmes and evaluated data of pesticide residues according to criteria and guidelines recommended by the Codex Committee on Pesticide Residues (CCPR), as well as by the European Union (Camoni *et al*., 2001).

Organochlorine compounds have been used extensively as pesticides in Egypt since 1950s as in the other parts of the world, although, their use was officially banned in 1980s (Dogheim *et al*. 1996). There is limited surveys were conducted in Egypt which showed a widespread contamination of many foods and breast milk with their residues (Salem 1993, Salem *et al*. 1995, Dogheim *et al*. 1988, 1990 and 1996, Salem and El-Saied, 1997).

Metals and other elements in food are of interest due to their potential effects on human health. Some have no known beneficial biological function and exposures may harmful to health. For example, organic mercury compounds are neurotoxins, exposure to lead can harmful to neuropsychological development, inorganic arsenic is a human carcinogen and cadmium can affect renal function. Other elements can cause short-term health effects from one incidence of high-level exposure. For example, high concentrations of tin in food can cause stomach upsets. While some elements, such as copper and chromium are essential to health, they may be toxic at high levels of exposure (Ministry of Agriculture, Fisheries and Food 1998a,b).

The risk to health from certain elements in food can be assessed by comparing estimates of dietary exposures with the Provisional Tolerate Weekly Intakes (PTWIs) and Provisional Maximum Tolerable Daily Intakes (PMTDIs) recommended by the Joint Expert Committee on Food Additives (JECFA) of the Food and Agriculture Organization of the United Nations and the World Health Organization International Programme on Chemical Safety (WHO, 1982a,b, 1989a,b and 1993a,b).

People can be exposed to metals in a number of ways, including at work in certain industries, from drinking contaminated water

and eating contaminated food, or in hobbies that involve working with metals. Lead exposure stems primarily from its use in gasoline, paint, water pipes, and the lining of food cans. These uses have been banned in many countries, but still persist in many parts of the world. In addition, old, peeling paint and old water pipes can still cause exposures. Most people are exposed to methyl mercury from fish, particularly such predator fish as swordfish, shark and tuna. Freshwater fish from contaminated lakes, rivers, and estuaries can also bioacumulate very high levels of methyl mercury, which are passed on to humans who eat the fish. Other sources of mercury include coal burning, incineration and mining as well as some natural sources. Exposure to cadmium often comes as a result of work or through hobbies, including metal plating, semiconductor manufacture, welding, soldering, ceramics and painting. Cadmium can also be a contaminant of drinking water, air and food, particularly shellfish (ATSDR, 1990, NRDC, 2003).

A number of potentially toxic metals have been reported in fishes, including lead, mercury, cadmium and arsenic (Ysart et. al, 2000, Storelli and Marcotrigiano, 2000a,b, Storelli *et al*., 2002). Relatively very few studies have been carried out to measure metals concentration in fish in Egypt as EL Nabawi *et al*., (1987) and Seddek *et al*., (1996).

The objectives of this study were to estimate the incidence and levels of organochlorine pesticide residues as well as some toxic and essential metals in freshwater fishes in Assiut Governorate and compare these levels with previously documented national and international values. The study will also evaluate the toxicological hazard to fish consumers and serve as a mean of assessment of the environmental contamination in Egypt.

MATERIALS AND METHODS:

Eight species of freshwater fish (*Oreochromis niloticus, Clarias lazera, Labeo niloticus, Bagrus bajad, Synodontis schall, Morymyrus niloticus, Lates niloticus, and Malapterurus electricus*) were collected from different markets at Assiut Governorate. Fifty representative samples (6 *O.niloticus, 6 C. lazera, 6 L. niloticus, 6 B. bajad, 8 S. schall, 8 M. niloticus, 5 Lates niloticus, and 5 M. electricus)* were collected randomly during March to August 2001. Each sample was constituted from five fishes, which represent a separate lot of fishes. Raw fish samples prepared according to FDA Pesticide Analytical Manual, (1968). The edible portions were obtained by removing heads, gills, fins, scales and guts. Muscle samples were minced, homogenized and frozen till analysis. All analyses were carried out in the Chemistry Department, the Federal Institute for Veterinary Medicine Examinations, Mödling, Austria.

Pesticide residues analysis:

Organochlorine pesticide residues were extracted and analyzed according to the method established in the Chemistry Department, the Federal Institute for Veterinary Medicine Examinations, Mödling, Austria (Anonymous, 2001a).

Gas chromatographic analyses were carried out on a Perkin-Elmer Autosystem XL Gas Chromatograph equipped with an electron capture detector (GC-ECD) with split-splitless injector. Chromatographic determination of organochlorine residues was carried out using a 50m X 0.2mm X 0.11 um capillary column HP Ultra 2 from Hewlett-Packard.

The operating conditions were as follows: injector temperature 250°C; 1/50 split ratio; 4 mm i.d. wide bore liner; detector 350°C. Oven

program: initial temp: 80°C; initial hold: 1 min; Ramp 1: 45.0°C/min to 160°C, hold for 1 min; Ramp 2: 2.0°C/min to 220°C, hold for 1 min; Ramp 3: 45.0°C/min to 280°C, hold for 5 min. Carrier gas: helium (1 ml/min) and Make Up-gas: nitrogen (35 ml/min). Peak areas were used as the basis for quantification. Residue levels are expressed as µg/kg extracted fat (ppb).

All solvents and chemicals used were pesticide residue analytical grade reagents free of interfering residues as tested by Gas chromatography. All glassware used for the analysis was rinsed with distilled water and then with acetone and petroleum ether before use to prevent contamination. All pesticide reference standards for quantification and spiking were obtained from Supelco SA, Switzerland (Supelco-Pesticide-mixture, Article No. 20077400, Lot. No. LA-85759) except oxychlordane which obtained from Ehrenstorfer company (Article No. LA11203000CY, Lot. No. 90629CY).

HP8500-5926 and 8500-5927 standards (Lot No. P1788 and M1329) used for quality control were obtained from Agilent Company, while transnonachlor that used as internal standard (Article No. 48137, Lot. No. LA-79258) was obtained from Supelco.

Recoveries from fortified samples at 20 µg/l each level were in the range of 90-120% on this method, including internal standard. Organochlorine pesticide recovery percents, detection and quantification limits are presented in (Table 1). All residue levels were corrected according to their recoveries.

Table (1): Recovery percents and limits of detection and quantification of the analyzed pesticides.

Pesticides	Spiked conc. (µg/kg)	Recovery percent	Limit of detection (µg/kg)	Limit of quantification (µg/kg)
HCH alpha	20	97	0.73	1.47
HCH beta	20	113	0.60	1.20
HCH gamma	20	105	0.47	0.93
HCH delta	20	109	1.04	2.08
DDE p,p	20	90	0.21	0.43
DDD p,p	20	108	0.37	0.75
DDT o,p	20	94	0.95	1.91
DDT p,p	20	75	0.32	0.64
Heptachlor	20	107	0.51	1.02
Hep. Epoxid	20	95	3.93	7.86
Aldrin	20	98	0.29	0.57
Dieldrin	20	94	0.31	0.62
Endrin	20	120	0.45	0.91
HCB	20	107	0.18	0.35
Oxychlordane	20	108	2.56	5.12
g-Chlordane	20	108	0.64	1.27
a-Chlordane	20	107	0.25	0.50
Nonachlor	20	94	-	-

Metals Analysis:

Preparation of samples:

For screening of lead and cadmium, samples were subjected to wet digestion with nitric acid suprapur® (Merck, 441) in screw stoppered glass at 90˚C water bath as described by Ruttner and Jarc (1979). Positive samples were repeated and digested as followed for mercury and arsenic.

Samples were digested for total mercury, arsenic and other elements by using microwave digestion system (Ethos 900 Microwave system with Terminal 240, MLS GmbH) after addition of 3 ml Nitric acid 65% and 1.5 ml H_2o_2 to 2 grams of minced fish samples in a closed Teflon-high temperature container.

GFAAS mixed standard (PE: No.930-0244) was used for qualification and checking of calibration curve for all elements except for mercury that controlled by using ACROS Hg standard obtained from Acros Organics company.

Measurements of lead, cadmium, chromium and copper:

The concentrations of lead, cadmium, chromium and copper were prepared and measured by using SIMAA 6000 PE Simultaneous Multielement Atomic Absorption Spectrophotometer fitted with graphite furnace, combined with PE AS 72 autosampler (GF-AAS) and a Zeeman background correction (Anonymous, 2001b,c). The detection limits were 2.17, 0.35, 1.97 and 7.52 µg/kg for lead, cadmium, chromium and copper, respectively.

Matrix modifier for lead and cadmium was constituted from Mg modifier (2.4 ml Mg $(NO_3)_2$ -solution (10.0 gm/L), Merck: B729813 040), ammonium modifier (25 ml $NH_4H_2PO_4$– solution (100 gm/L), PE: N930-3445) and 60 ml HNO_3 concentrated (AAS grade). Matrix modifier for chromium and copper was Mg modifier only (0.1% Mg $(NO_3)_2$ consisted of 400 µl modifier and 6 ml 65% HNO_3 completed to 50 ml with water.

Measurements of total mercury:

Samples were prepared and analyzed according to (Anonymous, 2001d) using Automated Cold Vapor Atomic Absorption Spectrophotometer (CV-AAS). Total mercury was measured by a Flow Injection Mercury System 400 "FIMS" with an AS-91 PE auto-sampler (Perkin Elmer). Sodium borohydrate was used as reducing agent in analysis of mercury. The detection limit was 0.5 µg/kg.

Measurements of total arsenic:

Samples were prepared and analyzed according to (Anonymous, 2001e) by using Hydride Generation Atomic Absorption Spectrophotometer (HG-AAS). Arsenic was measured by a (SIMAA 6000 PE Atomic Absorption Spectrophotometer coupled with FIMS and AS-91 autosampler (Perkin Elmer). Sodium borohydrate was used as reducing agent in the analysis. The detection limit was 2.875 µg/kg.

RESULTS AND DISCUSSION:

The recorded results showed that all fish species were contaminated with one or more of the investigated pesticides. Total DDT's were represented in all samples with one or more of its metabolites (p,p'-DDT, o,p'-DDT, p,p'-DDE and p,p'-DDD), followed by HCB and endrin. Frequency and levels of total HCH isomers (alpha-, beta-, gamma-and delta-isomers) were detected in three fish species only. Aldrin, dieldrin, heptachlor and heptachlor epoxide residues could not be detected in all tested samples. Total chlordane residues were detected in two fish species accompanied with excessive amounts of transnonachlor that used as internal standard (Table 2).

As shown in Table (2) total DDT residues were found in all analyzed samples of all species. The highest values were detected in *Lates niloticus, Bagrus bajad, Morymyrus niloticus* followed by *Clarias lazera, Synodontis schall, Malapterurus electricus,* and *Labeo niloticus* while *Oreochromis niloticus* contained the lowest

concentration (Fig. 2). Total DDT mean levels± SD in these species were 3464.848±360.63, 2281.51±1150.07, 2184.816±1880.8, 650.253± 208.37, 483.579±639.54, 382.968± 507.6, 333.45± 3330.102 and 68.71±52.198 µg/kg (fat basis). These values of total DDT were lower than those reported by Dogheim *et al*., (1990), Salama, (1993) and Salem *et al*., (1995) because of the decrease in mean and maximum levels of total DDT recorded in this study in the same area and the same fish species. The highest mean value was 3464.848 µg/kg (fat basis) in *Lates niloticus*, although the maximum value was 4799.5 µg/kg (fat basis) in *Morymyrus niloticus*. Dogheim *et al*., (1990) reported 22.11, 13.32 and 6.35, 6.61 mg DDT/kg fat as maximum values in *C. lazera* and *O. niloticus* from Beni-Suef and Fayoum Governorates with averages of 13.90, 5.86 and 4.17, 4.77 mg/kg fat. 5.866 mg DDT/kg fat was an average value in *O. niloticus* from 12 local markets in Cairo (Salama, 1993). The maximum and mean values ranged from 2.06–11.804 and 1.077–3.911 mg/kg fat in previously studied five fish species obtained from Assiut markets (Salem *et al*., 1995).

The most persistent DDT metabolite (p,p'-DDE) was detected in all samples and averaged 67.3% of total DDT residue values although in some species reached more than 80%. The other main metabolite (DDD) averaged 15%. While the parent compounds (p,p'-DDT and o,p'-DDT) averaged 17% of the total DDT (Table 2 & Fig. 1). Collectively, these findings indicated a low rate of influx and continued weathering of DDT in the environment. These findings were in agreement with that obtained by Schmitt *et al*., (1999) and Mehdaoui *et al*., (2000) Nevertheless, DDT concentrations in some fish species remained high enough to constitute a hazard to fish consumers.

All detected total DDT values were below the recommended maximum residue levels in aquatic animals used for human consumption (5000 ng/g fresh wt.) established in some countries like Canada, Germany, Denmark, Sweden, United States and Thailand (FAO, 1983). Nevertheless, total DDT exceeded the recommended lower residue levels (2 ppm) in four, three and five samples of *Bagrus bajad*, *Morymyrus niloticus* and *Lates niloticus*, respectively (Table 3).

On the other hand, Table (2) indicates that HCH isomers that frequently detected in previous studies (Salama, 1993 and Salem *et al*., 1995) were found with relatively few incidences and characterized by very low concentrations that never exceed the recommended values. However, these values were mainly due to the beta isomer as the alpha and gamma isomers were very low and delta isomer was absent. As beta HCH is the most persistent HCH isomer (IPCS, 1992), and considering the possible isomerization of alpha and gamma isomers to the beta isomer (IPCS, 1992). Total HCH values listed in (Table 2) indicates the continuous degradation and elimination of HCH isomers from our environment even the most persistent beta-HCH.

Among other pesticides, endrin and HCB were found with low frequencies and levels in comparison with the previous study in the same area (Salem *et al*., 1995) although they are the most frequent pesticides followed DDT that found in most of the investigated fish species. The obtained results revealed also that endrin residues were below those recorded by Dogheim *et al*., (1990). Aquatic invertebrates and fish take up endrin rapidly from water. Bio-concentration factors ranging between 14 and 10000 have been recorded after continuous exposure. Exposed fish transferred to uncontaminated water lose endrin rapidly (WHO, 1991), which could explain the low levels

of this pesticide. There are no international recommended limits for endrin although 11 out of 50 samples exceeded the recommended maximum Austrian permissible limit of 10 µg/kg (Table 3).

HCB has been used in the manufacture of industrial chemicals, including chlorinated pesticides, and a fungicide and seed dressing in agriculture. The production and use of HCB have decreased since the 1970s owing to bans and restrictions on its use in many countries, but it still occurs as a by-product of the production of a number of chlorinated solvents and other industrial chemicals (IARC, 2001). HCB values could not be exceed the recommended limits (Table 2 & 3).

Total chlordane isomers (α-, γ-chlordane and oxychlordane) and transnonachlor residues were detected in two species. These pesticides were not investigated in freshwater fishes obtained from Assiut before. Oxychlordane residues were detected in two species of freshwater fish obtained from two Egyptian Governorates with low frequency and concentration (Dogheim *et al*., 1988) while transnonachlor could not be detected. γ-chlordane was found with a frequency of 11.1% in fishes obtained from Ismaillia Governorate (Abdallah *et al*., 1990). Total chlordane residues could not be evaluated due to the absence of any recommendation concerning the safe levels although 2 samples exceeded the recommended maximum Austrian permissible limit of 10 µg/kg (Table 3).

Total heptachlors (heptachlor+heptachlor epoxide) and total aldrins (aldrin+dieldrin) could not be detected in the investigated samples. This result showed that the use of these pesticides were strongly restricted or completely prohibited in our area.

In general, organochlorine pesticide residues were lower in this study than any time reported previously. Nevertheless, estimations of these pesticides in fishes must be continued due to increase of parent compounds frequency as p,p'-DDT and o,p'-DDT, indicating a new addition of such pesticides to the Nile River during its running all over African countries.

Different heavy metals mean, range and median values in various investigated fish species are presented in Table (4) and Fig. (2). All measured elements were found in fish samples with values above their detection limits.

Exposure to lead of concern mainly because of possible detrimental effects on intelligence. Studies on exposure to lead and children's intelligence have indicated an adverse effect of low-level lead exposure on neurophysiological development (WHO, 1995). For example, it has been found that a doubling of blood levels (from 10 to 20 µg/dl) is associated with a reduction in Intelligence Quotient (IQ) of around one to two IQ points (Pocock *et al*., 1994). Food is one of the major sources of lead exposure, the others are air (mainly lead dust originating from petrol) and drinking water (Ysart *et al*., 2000). Exposure from these three sources should be reduced and can be demonstrated through following up the blood lead levels of different Egyptian population. Although industrial and agricultural discharges are the primary source of lead poisoning of fish in Egypt (El Nabawi *et al*., 1987), highways also pose a threat to fish because of lead contamination from automobile exhausts (Pagenkopf and Neuman, 1974).

Mean values±SD of Pb were 107.271± 52.179, 251.583±59.994, 138.00 ± 36.489, 143.917 ±26.958, 247.781±73.338, 172.063±34.371, 176.4 ±56.1 and 190.188±66.69 µg/kg wet weight in *O. niloticus, C. lazera, L. niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively. This survey revealed

that lead levels were decreased than the previously recorded by Seddek *et al*., (1996) as the lead averages ranged from 0.12 to 0.864 mg/kg wet weight. *S. schall* had the highest concentrations of lead in relation to the other species in accordance with Seddek *et al*., (1996) but with lower maximum level that reached 362.5 µg/kg wet weight in comparison with 2400 µg/kg wet weight that obtained. These values of lead were also lower than those published in U.S. freshwater fish (Schmitt *et al*., 1999), who recorded 0.058, 1.90 and 0.21 µg/g wet weight as geometric mean, maximum and 85th percentile concentrations and than those reported from Turkey (Yilmaz, 2003).

The provisional tolerable weekly intake (PTWI) of 0.025 mg/kg was recommended for infants and adults, which is equivalent to 0.21 mg/day for a 60 kg person (WHO, 1993a). This level refers to lead from all sources. Accordingly and referring to the maximum level of lead obtained in this study, a person of 60 kg weight need to eat 1.7 kg fish daily to reach this recommended limit. This position depends upon the behavior of population.

All investigated fish species had lead with mean values above the maximum Egyptian permissible limit (0.1 mg/kg) in fresh fishes recommended by Egyptian Organization for Standardization (1993). Italian legislation with the Ministerial Decree n. 131 of 27/01/1992 fixed a maximum limit for lead of 2 mg/kg solely for bivalve molluscs (Gazzetta Ufficiale, 1992), but it is customary to apply this limit as a maximum tolerable value in other fish species. All concentrations of lead were lower than this maximum Italian tolerable value.

The hazards of cadmium as a food contaminant have emerged in relatively recent times compared with mercury, with the appearance in Japan in 1946 of a syndrome affecting man called 'Itai-Itai' due to the ingestion of rice heavily contaminated by cadmium (Storelli and Marcotrigiano, 1999). The use of cadmium for several decades in many industrial fields, especially in the production of paint, plastic and special alloys (Lucisano, 1989; Cappelli and Vannucchi, 1990) have led to the distribution of this element throughout the environment.

Cd concentrations had mean values ± SD of 12.258±3.023, 10.708±2.466, 12.542±3.969, 11.25 ±2.421, 16.063±2.012, 16.5±4.276, 11.75±1.212 and 16.5±4.75 µg/kg wet weight in *O. niloticus, C. lazera, L. niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively (Table 4). Although the obtained Cd levels shows a little variation among fish species *M. electricus* and *M. niloticus* had the highest values followed by *S. schall*. These levels of cadmium are similar to those reported by EL-Nabawi *et al.* (1987) and lower than that recorded by Seddek *et al*., (1996). This survey indicates that Cd levels were also lower than that published in US freshwater fish (Schmitt *et al*., 1999), who recorded 0.011, 0.32 and 0.04 µg/g wet weight as geometric mean, maximum and 85th percentile concentrations.

Concerning the health hazards to fish consumers, all cadmium concentrations were lower than the maximum Egyptian recommended limit for Cd (0.1 mg/kg) in fresh fishes (Egyptian Organization for Standardization, 1993).

In 1993, the Joint FAO/WHO Expert Committee on Food Additives (JECFA) established a PTWI for cadmium of 7 µg/kg bw. In addition, JECFA estimated the dietary intake of cadmium to be usually 1-4 µg/kg body weight /week, and recognized that ' there is only a relatively small safety margin between exposure in the normal diet and exposure that produces deleterious effects'. Consequently, JECFA recommended that levels of cadmium in foods

and total diets should continue to be monitored and should not increase further (WHO, 1993a). By considering mean values of cadmium found in the single species, the estimated intakes differ according to the weekly consumption of fish as some people do not consume massive amounts of fish while some people eat more than others. A studied carried out by the European Commission in 1995 and 1996 found that dietary exposures to cadmium in the 15 States of the EU ranged from 0.007-0.057 mg/kg day (European Commission,1997). Dietary exposure estimates have also been reported for the USA: 0.015 mg/day (MacIntosh *et al*., 1996); Canada: 0.024 mg/day (Dabeka and McKenzie, 1995); France: 0.02 mg/day (Decloitre, 1998) and Egypt: 0.24 mg/day (Saleh *et al*., 1998).

The main sources of exposure to mercury (apart from occupational sources) are from diet and dental amalgam. Mercury is present in food naturally (e.g. in fish which take up mercury from marine sediments), or as a result of population (e.g. emissions from industrial processes, Fossil fuel combustion) (Ministry of Agriculture, Fisheries and Food, 1988b). The main dietary source of mercury is fish and this has led to recent interest in the potential effects of exposure to mercury on the neurological development of children from populations (i.e. Faroe Island, Republic of the Seychelles, Madeira) with high rates of fish consumption (Grandjean *et al*., 1997; Davidson *et al*., 1998; Murata *et al*., 1999).

Exposure to mercury from dental amalgam is mainly to the metallic and inorganic forms of the element, which are considered to be less toxic than the organic forms of mercury. Most of the mercury in food is present as methyl mercury or other organic forms (Ministry of Agriculture, Fisheries and Food, 1998b). This is reflected in the PTWI for mercury of 300 µg/person, of which not more than 200 µg should be methyl mercury (WHO, 1989b).

Total Hg mean values ± SD reached 16.197± 2.017, 57.045±48.463, 23.192±14.242, 76.33± 19.871, 29.374±16.717, 78.958±3.843, 58.459± 28.424 and 68.91 ± 26.42 µg/ kg wet weight in *O. niloticus, C. lazera, L. niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively (Table 4). *M. niloticus* and *B. bajad* had the highest values while *O. niloticus* had the lowest levels of mercury. There is no available data concerning the levels of mercury in Egyptian fishes. US freshwater fish contained higher values of mercury in comparison with fishes from Assiut because of geometric mean, maximum and 85th percentile concentrations of Hg were 0.087, 0.44 and 0.18 µg/g wet weight (Schmitt *et al*., 1999). Similar result was reported from UK, where Hg was found with mean value of 0.043 mg/kg fresh weight (Ysart *et al*., 2000). Fish from Mexico Gulf had Hg levels with mean value of 0.4± 0.22 and a range of 0.08-0.85 µg/g wet weight (Lewi *et al*., 2002) and from the Apalachicola River, Florida, USA with a mean value of 0.85 µg/k wet weight (Brim *et al*., 2001) that exceeding all values found in this survey.

The US Food and Drug Administration has set an action level of 1 mg/kg wet weight for the concentration of total mercury in fish. In Japan, fish containing total mercury concentrations exceeding the Japanese maximum permitted limit of 0.4 mg/kg wet weight is considered unsuitable for human consumption (Storelli *et al*., 2002). In Europe the limit value for total mercury regulated by European Commission Decision 93/351 of 19 May 1993 (Official Journal of the European Communities, 1994), is set at 0.5 mg/kg wet weight, except for some species with a high trophic level for which it is raised to 1 mg/kg. Accordingly and referring to the Egyptian permissible limit (0.5 mg/kg wet

weight) for methylmercury in fishes (Egyptian Organization for Standardization, 1993), all Hg values that detected in Assiut freshwater fishes did not reach these recommended limits.

Table (2) : Organochlorine pesticide residues mean±S.D., range, and median values (ppb[a]) and percent of positive samples of different investigated freshwater fish species collected from Assiut..

Pesticide	Values	Fish species							
		Oreochromis Niloticus	*Clarias lazera*	*Labeo niloticus*	*Bagrus bajad*	*Synodontis schall*	*Morymyrus niloticus*	*Lates niloticus*	*Malapterurus electricus*
p,p'-DDE	Mean±SD	51.32±44.87	527.62±169.62	262.34±273.248	1379.46±554.412	236.969±320.151	754.97±1036.214	1735.172±418.94	355.078±500.995
	Range	10.36–92.28	326.54–714.5	19.42 – 561.92	415.9 – 1909.08	22.62 – 953.78	324.94 – 2469.5	1429.22–2194.10	35.36 – 1220.28
	Median	51.32	532.82	205.68	1433.56	119.12	752.615	1429.22	129.31
	percent	100	100	100	100	100	100	100	100
p,p'-DDD	Mean±SD	9.93 ± 3.429	73.49±24.531	85.427±25.346	490.08 ± 391.958	173.355±125.577	420.071±428.896	648.172 ± 15.128	13.88 ± 7.58
	Range	6.8 – 13.06	39.04– 92.56	56.1 – 100.06	63.32 – 971.44	56.1 – 349.06	37.84 – 953.98	631.6 – 659.22	8.52 – 24.6
	Median	9.93	85.74	100.06	378.34	144.13	206.845	659.22	11.2
	percent	100	100	50	100	50	100	100	80
o,p'-DDT	Mean±SD	ND	6.56 ± 2.598	6.58 ± 2.425	40.757 ± 22.897	32.655 ± 20.874	154.748 ± 50.003	135.268 ± 7.274	ND
	Range	ND	3.56 – 8.06	3.78 – 7.98	10.82 – 59.82	12.68 – 61.7	79.747 – 180.22	127.3 – 140.58	ND
	Median	ND	8.06	7.98	50.78	28.12	179.51	140.58	ND
	percent	ND	50	50	100	50	50	100	ND
p,p'-DDT	Mean±SD	7.46 ± 3.9	45.863 ± 15.099	25.107 ± 4.633	371.21±221.314	191.473±190.721	615.158±657.555	946.236 ± 35.91	23.147 ± 11.436
	Range	3.90 – 11.02	22.44 – 56.28	21.26 – 31.06	75.6 – 571.02	35.9 – 541.6	48.12 – 1433.72	906.9 – 972.46	15.06 – 39.32
	Median	7.46	54.6	22.42	447.64	144.56	301.32	972.46	19.104
	percent	100	100	100	100	75	100	100	80
Total DDTs	Mean±SD	68.71±52.198	650.253±208.37	333.45±330.102	2281.51±1150.07	483.579±639.536	2184.816±1880.8	3464.848±360.63	382.968±507.599
	Range	21.06–116.36	391.58 – 869.72	41.84 – 701.02	565.64 – 3511.36	22.62 – 1906.14	454.18 – 4799.5	3201.48–3859.96	59.18 – 1259.6
	Median	68.71	674.84	257.49	2310.32	222.92	1296.235	3201.48	153.91
	percent	100	100	100	100	100	100	100	100
Total HCH	Mean±SD	4.143 ± 1.738	ND	ND	16.3 ± 2.121	3.03 ± 0.666	ND	ND	ND
	Range	3.14 – 6.15	ND	ND	14.8 – 17.8	2.6 – 3.8	ND	ND	ND
	Median	3.14	ND	ND	-	2.7	ND	ND	ND
	percent	50	ND	ND	33.3	37.5	ND	ND	ND
HCB	Mean±SD	3.08 ± 1.289	4.65 ± 1.258	ND	8.216 ± 5.371	16.871 ± 19.452	5.15 ± 1.886	6.575 ± 1.502	9.6 ± 4.213
	Range	2.46 – 5.7	3.4 – 6.4	ND	1.2 – 13.64	2.01 – 52.4	2.7 – 7.3	5.2 – 8.2	4.1 – 12.9
	Median	2.58	4.4	ND	6.3	5.8	5.3	6.45	10.7
	Percent	100	66.7	ND	83.3	87.5	50	80	80
Endrin	Mean±SD	6.7 ± 1.8	11.495 ± 1.6334	5.05 ± 1.768	16.225 ± 15.098	5.52 ± 3.559	15.095 ± 5.017	11.707 ± 1.321	ND
	Range	4.9 – 8.5	10.34 – 12.65	3.8 – 6.3	3.1 – 29.3	1.5 – 12.0	8.18 – 20.2	9.8 – 13.0	ND
	Median	6.7	-	-	16.25	4.39	16	11.06	ND
	Percent	50	33.3	33.3	66.67	75	50	80	ND

ND: not detected **(ppb[a]): fat basis**

Table (2): Continued.

Pesticide	Values	Fish species							
		Oreochromis Niloticus	*Clarias lazera*	*Labeo niloticus*	*Bagrus bajad*	*Synodontis schall*	*Morymyrus niloticus*	*Lates niloticus*	*Malapterurus electricus*
Total Chlordane isomers	Mean±SD	ND	ND	24.82	ND	ND	ND	ND	85.9 ± 112.43
	Range	ND	ND	-	ND	ND	ND	ND	6.4 – 165.4
	Median	ND	ND	-	ND	ND	ND	ND	-
	Percent	ND	ND	16.7	ND	ND	ND	ND	40
Total Aldrin & Dieldrin	Mean±SD	ND	ND	ND	ND	ND	ND	ND	ND
	Range	ND	ND	ND	ND	ND	ND	ND	ND
	Median	ND	ND	ND	ND	ND	ND	ND	ND
	percent	ND	ND	ND	ND	ND	ND	ND	ND
Total Heptachor & Hept. epoxide	Mean±SD	ND	ND	ND	ND	ND	ND	ND	ND
	Range	ND	ND	ND	ND	ND	ND	ND	ND
	Median	ND	ND	ND	ND	ND	ND	ND	ND
	percent	ND	ND	ND	ND	ND	ND	ND	ND
Nonachlor	Mean±SD	ND	ND	29.38 ± 6.887	ND	ND	ND	ND	81.49
	Range	ND	ND	24.51 – 34.25	ND	ND	ND	ND	-
	Median	ND	ND	-	ND	ND	ND	ND	-
	percent	ND	ND	33.3	ND	ND	ND	ND	20

ND: not detected **(ppb[a]): fat basis**

Table (3): Number Range of fish samples exceeded the international minimum and maximum permitted limits (FAO limits[a]) for organochlorine pesticides in fish.

Pesticides	Range (ppm)	No. of samples exceeding maximum range limits[b]							
		O. niloticus	*C. lazera*	*L. niloticus*	*B. bajad*	*S. schall*	*M. niloticus*	*L. niloticus*	*M. electricus*
Total DDTs (DDT, DDE, DDD)	2.0-5.0 3.00[c]	0-0 0	0.0 0	0-0 0	4-0 2	0-0 0	3-0 3	5-0 5	0-0 0
Endrin	0.010[c]	0	2	0	2	1	3	3	0
HCB	0.2-0.5	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0
Total HCH ($\alpha+\beta+\gamma+\delta$)	0.2-0.5	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0
γ-HCH	0.5	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0
Total Chlordane	0.010[c]	0	0	1	0	0	0	0	1

[a] Limits issued from Canada, Germany, Denmark, Sweden, United States, and Thailand (after Dogheim et al., 1990).

[b] First value = number of samples exceeding lowest maximum limit; second value = number of samples exceeding highest maximum limit.

[c] Austrian maximum residue limit.

Table (4): Elements mean, range and median concentrations of metals (ppb) that measured in eight freshwater fish species collected from Assiut.

Element	Values	Fish species							
		Oreochromis niloticus	*Clarias lazera*	*Labeo niloticus*	*Bagrus bajad*	*Synodontis schall*	*Morymyrus niloticus*	*Lates niloticus*	*Malapterurus electricus*
Pb	Mean±SD	107.271 ± 52.179	251.583 ± 59.994	138.00 ± 36.489	143.917 ± 26.958	247.781 ± 73.338	172.063± 34.371	176.4 ± 56.10	190.188 ± 66.69
	Range	48.25 – 164.5	205.25 – 328.5	111.75 – 185.00	123.25 – 178.5	188.625 – 362.5	118.75 – 205.0	123.125 – 234.75	123.5 – 256.875
	Median	109.063	221	117.25	130	220	182.25	166.25	190.188
Cd	Mean±SD	12.258 ± 3.023	10.708 ± 2.466	12.542 ± 3.969	11.25 ± 2.421	16.063 ± 2.012	16.5 ± 4.276	11.75 ± 1.212	16.5 ± 4.75
	Range	8.75 – 16.50	8.375 – 13.75	7.625 – 16.25	8.375 – 13.75	13.75 – 18.75	12.5 – 20.5	10.25 – 13.0	11.75 – 21.25
	Median	12.15	10	13.75	11.625	15.875	16.5	11.25	16.5
Hg	Mean±SD	16.197 ± 2.017	57.045 ± 48.463	23.192 ± 14.242	76.33 ± 19.871	29.374 ± 16.717	78.958 ± 3.843	58.549 ± 28.424	68.91 ± 26.42
	Range	13.5 – 18.51	24.22 – 119.585	13.3 – 41.56	51.865 – 94.905	12.905 – 54.935	72.77 – 81.35	34.81 – 99.825	42.49 – 95.33
	Median	15.965	27.33	14.715	82.22	24.828	80.855	41.65	68.91
As	Mean±SD	13.0 ± 2.881	14.00 ± 8.346	12.833 ± 4.745	61.00 ± 47.157	14.875 ± 4.365	98.563 ± 101.154	34.25 ± 18.869	16.5 ± 8.0
	Range	9.75 – 16.5	8.00 – 24.75	6.75 – 16.5	18.5 – 120.00	9.25 – 19.25	18.0 – 255.25	6.25 – 50.0	8.5 – 24.5
	Median	12.625	9.25	15.25	44.5	15.5	55	45.25	16.5
Cr	Mean±SD	191.385 ± 30.746	310.667 ± 108.73	137.667 ± 27.029	142.0 ± 102.095	231.25 ± 114.61	385.719±277.045	105.2 ± 30.161	136.5 ± 54.5
	Range	150.16 – 225.5	206.00 – 444.00	101.00 – 182.00	56 – 271.5	137.0 – 411.5	116.5 – 811.5	77.5 – 151.0	82.0 – 191.0
	Median	195.95	282	133.25	98.5	188.25	294	102.5	136.5
Cu	Mean±SD	386.221 ± 106.12	574.833 ± 45.875	640.667 ± 125.25	808.833 ± 87.552	633.5 ± 184.894	735.75 ± 68.906	824.25 ± 358.2	714.25 ± 50.75
	Range	280.925 – 548.5	543 – 634.00	484.5 – 764.5	696 – 871.0	498.5 – 929.0	653.0 – 814.5	566.5 – 1356.5	663.5 – 765
	Median	368.112	547.5	688.75	859.5	553.25	725.5	669.25	714.25

Figure1. DDT and its metabolites mean values (ppb) in freshwater fish

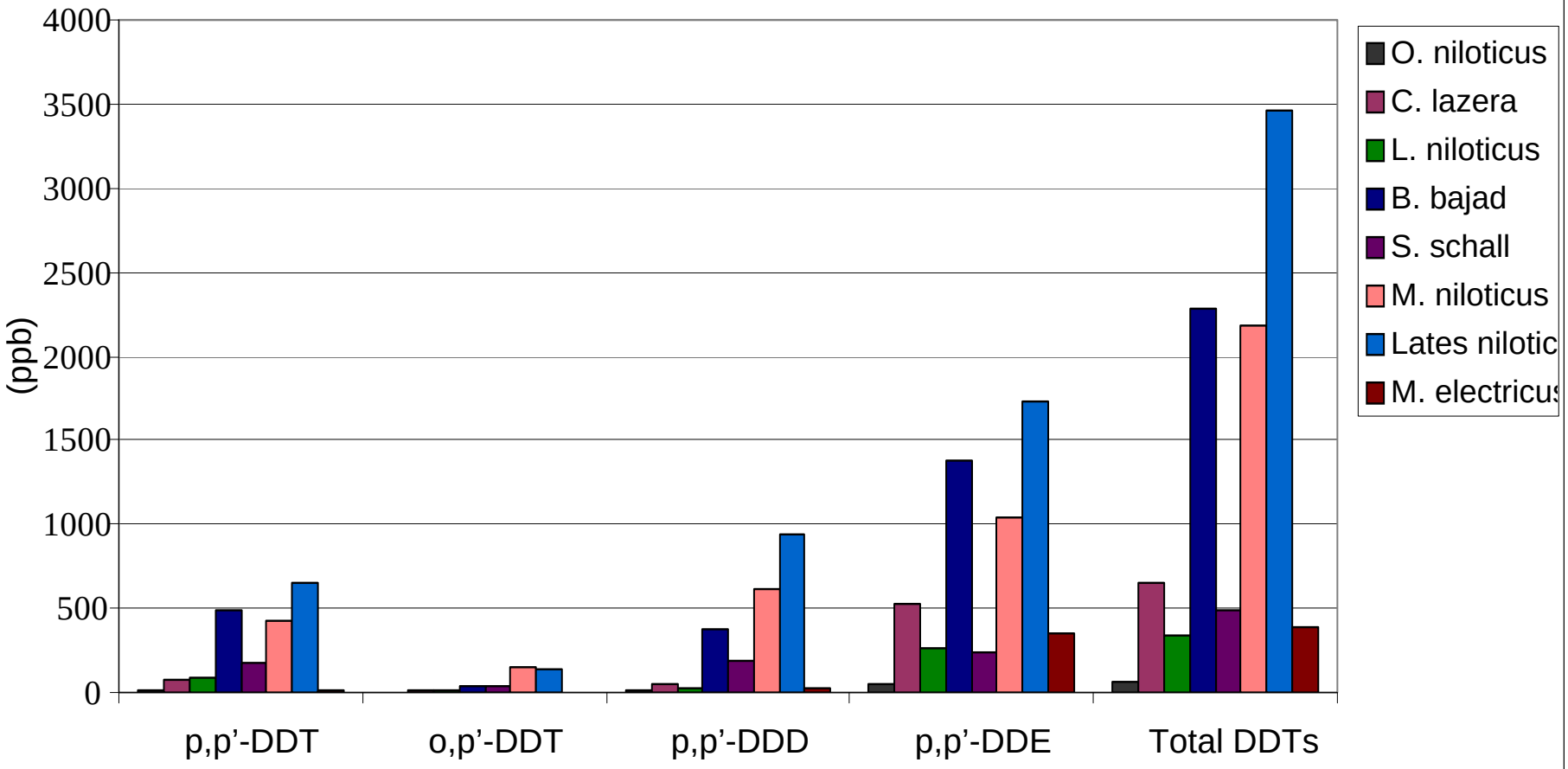
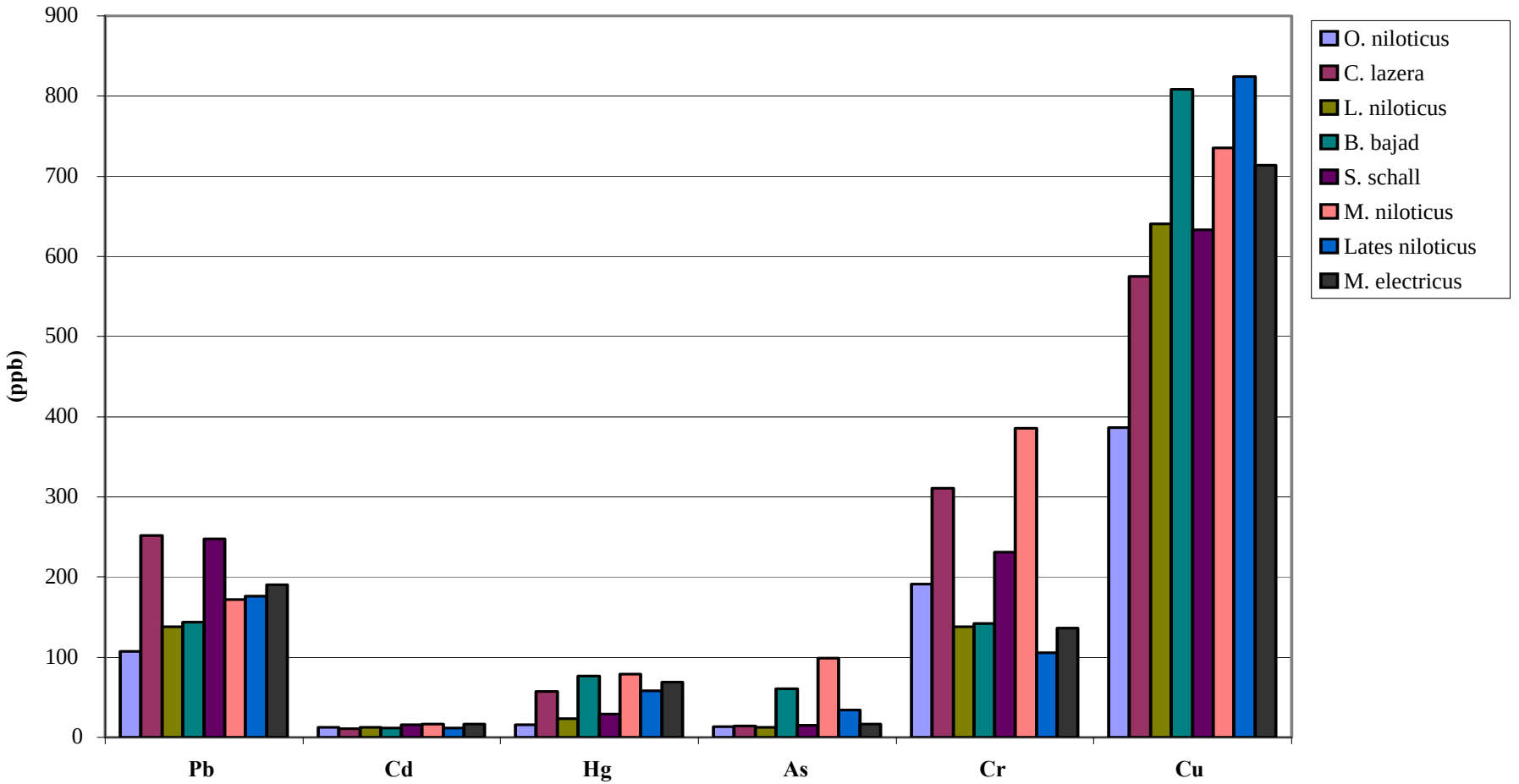


Figure 2. Heavy metals mean concentration values (ppb) in freshwater fishes from Assiut.



Furthermore, the Joint FAO-WHO JECFA recommends a PTWI of 0.3 mg of total mercury not to be exceeded, of which no more than 0.2 mg should be present as methylmercury in the diet of an adult with a bodyweight of 60 Kg, which equivalent to 0.043 mg/day (WHO, 1993a). The fish group contained the highest mean concentration of mercury (0.043 mg/kg) and made the greatest contribution (33%) to the population dietary exposure estimate in UK. Mean mercury concentrations in the other food groups were very low (Ysart *et al*., 2000).

The dietary intake of mercury depends primarily on the concentrations of mercury in fish, which all present in the more toxic methyl form and the amount of fish consumed. The health of the general population will be protected if the PTWI established by JECFA is not exceeded. If the average methylmercury concentration in fish is 0.5 mg/kg, fish consumption by a 60-kg person should not exceed 400 g/week (approximately 60 g/day). If in a country fish consumption is on the high side, for example 700 g/person/week, the concentration of methylmercury in fish eaten should not exceed 0.2 mg/kg (Galal-Gorchev, 1987).

By considering the mean and maximum values of mercury in different fish species, the obtained result indicates that PTWI (which equivalent to 0.043 mg mercury/day) can be exceeded by eating half a kilo of *M. niloticus, B. bajad, M. electricus, Lates niloticus or C. lazera* daily. Dietary exposure estimates from some countries were as follows: USA: 0.008 mg/day (MacIntosh *et al*., 1996); Spain: 0.018 mg/ day (Urieta *et al*., 1996); France0.014 mg/day (Decloitre, 1998); Egypt: 0.078 mg/ day (Saleh *et al*., 1998) and UK 97 Total Diet Study: 0.003 mg/day (Ysart *et al*., 2000).

Arsenic is present in food as different species, which vary in toxicity with inorganic forms being the most toxic. This is reflected in the PMTDI (of 0.002 mg/kg bw) which applies to inorganic arsenic only (WHO, 1989a). Most of the arsenic in the diet is present as the less toxic organic species (Edmonds and Francesconi, 1993; Buchet *et al*., 1994 and Schoof *et al*., 1999). There is substantial epidemiological evidence that inorganic arsenic may cause lung and skin cancers (WHO, 1981, Furst, 1983).

The average mean concentrations±SD of total As were as follows: 13.0±2.881, 14.0± 8.346, 12.833±4.745, 61.0±47.157, 14.875±4.365, 98.563 ±101.154, 34.25±18.869 and 16.5±8.0 µg/kg wet weight in *O. niloticus, C. lazera, L. niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively. The highest levels were found in *M. niloticus* then *B. bajad*. Total arsenic levels were markedly lower than those detected in Chinese seafood whose values ranged from 0.086-7.54 µg/g wet weight in fish and shellfish (Li *et al*., 2003) and 1.06-23.3 mg/kg fresh weight as lowest and highest mean values in fish and shellfish from the Adriatic Sea (Juresa and Blanusa, 2003). Average total arsenic concentrations in muscle and liver tissue of 25 sea fish and 4 shellfish species from the North Sea were higher than 20 mg/kg wet weight (De Gieter *et al*., 2002). They found also that the same species as well as other flatfishes contained the highest amount of toxic arsenic (> 0.1 mg/kg wet weight. They observed that in a worst-case scenario (when fish has been dried or smoked and the toxic As level is high; for example 0.5 mg/kg wet weight), the As content of North Sea marine food may reach harmful levels. Freshwater fish from Assiut contained also lower values of As in comparison with those found in US freshwater fish whose geometric mean and maximum values were 0.083 and 1.53 µg/kg wet weight (Schmit *et al*., 1999). Two species of Assiut freshwater fish exceeded arsenic values reported in fish species from the Arabian Gulf of Saudi Arabia (Al-Saleh and

Shinwari, 2002), who reported 42.7±17.4 ng/g wet weight as a mean value±SD of arsenic.

In Egypt no legal limits for the arsenic levels in fish products have been established. The concentrations of total arsenic in all investigated species were below the maximum permitted level (1 µg/g wet weight) by the strictest international legislation in seafood (Munoz *et al*., 2000). In Italy, Storelli and Marcotrigiano (2000a) found that total arsenic mean values ranged from 9.7-49.4 mg/kg wet weight in five fish species from the South Adriatic Sea and the percent of toxic inorganic form ranged from 0.47-3.48%. The fish group made the greatest contribution to population dietary exposure (94%) and also had the highest mean arsenic concentration (4.4 mg/kg wet weight) in UK (Ysart *et al*., 2000). They found also that arsenic concentrations in all other food groups were below 0.01 mg/kg.

Saad and Hassanien (2001) studied the arsenic levels in the hair of nonoccupational Egyptian population and concluded that smoking and some dietary habits had an important role in the elevation of arsenic levels. They also reported that the frequency of meat and fish consumption per week was also found to be positively, significantly correlated with arsenic levels and the arsenic content of domestic tap water hardly contributed to arsenic exposure of the Egyptian population in the regions of the study.

Chromium is an essential nutrient required for sugar and fat metabolism. Normal dietary intake of Cr for humans is suboptimal. The estimated safe and adequate daily intake for Cr is 50 to 200 µg. However, most diets contain less than 60% of the minimum suggested intake of 50 µg. Insufficient dietary intake of Cr leads to signs and symptoms that are similar to those observed for diabetes and cardiovascular diseases (Anderson, 1997). Most of the chromium present in food is in the trivalent form [(Cr (III)] which is an essential nutrient. The more toxic but normally found in food hexavalent form of chromium [(Cr (VI)] has long been recognized as a carcinogen and there is concern as to the effects of continuous low-level exposure to chromium occupationally and environmentally. The most serious health effect associated with Cr (VI) is lung cancer, which has been associated with some occupational exposure scenarios (Ministry of Agriculture, Fisheries and Food, 1998b, Rowbotham *et al*., 2000). Trivalent Cr has a very large safety range and there have been no documented signs of Cr toxicity in any of the nutritional studies at levels up to 1 mg per day (Anderson, 1997).

Chromium emissions to the environment are predominantly derived from fuel combustion, waste incineration and industrial processes. The less toxic trivalent form Cr (III) is dominant in most environmental compartments, and any Cr (VI), the more toxic form, that is emitted to the environment can be reduced to Cr (III) (Rowbotham *et al*., 2000). Food is a major source to chromium Meat, fish and seafood, cereals and pulses were rich sources of chromium (>0.100 µg/g). Fruits, milk, oils and fats and sugar were poor sources (Bratakos *et al*., 2002)

Cr mean values ± SD were 191.358 ± 30.746, 310.667±108.73, 137.667±27.029, 142.0±102.095, 231.25±114.61, 385.719±277.045, 105.2 ± 30.161 and 136.5±54.5 µg/kg wet weight in *O. niloticus, C. lazera, L. niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively. *M. niloticus* contained the highest values followed by *C. lazera*. The obtained levels of Cr were higher than those detected in Seafood from Spain and UK (Lendinez *et al*., 2001 and Ysart *et al*., 2000) and lower than those reported from Turkey (Yilmaz, 2003).

Average dietary Cr intake seems to fluctuate considerably among countries. In many developing countries, such Brazil, the Sudan and Iran, the dietary intake is high, from 50-100 µg/day, whereas in certain developed countries, such as Finland, Sweden, Switzerland and the US, the intake is 50 µg/day or lower and consequently, at or below the estimated safe and adequate daily dietary intake range of 50-200 µg/day established by the US National Academy of Sciences (Kumpulainen, 1992). Chromium intake correlated significantly with energy, protein, and carbohydrate intake and with the daily intake of Zn, Fe, Mg, K, Na, Ca and nicotinic acid in the diets analyzed (Garcia *et al*., 2001).

Copper is an essential element, but can be toxic at high levels of exposure. The UK Reference Nutrient Intake (RNI-defined as enough, or more than enough for about 97% in a population) for adults is 1.2 mg/day (Department of Health, 1991). JECFA has recommended a PMTDI of 0.5 mg/kg body weight, which is equivalent to 30 mg/day for a 60 kg person (WHO, 1982a). Copper is present in most foods, with offal and nuts containing the highest concentrations.

Cu mean levels±SD were 386.221±106.12, 574.833±45.875, 640.667±125.25, 808.833± 87.552, 633.5±184.894, 735.75±68.906, 824.25± 358.2 and 714.25 ± 50.75 µg/kg wet weight in *O. niloticus, C. lazera, L. niloticus, B. bajad, S. schall, M. niloticus, Lates niloticus and M. electricus*, respectively. *Lates niloticus* and *B. bajad* contained the highest levels of copper. Seddek *et al*., (1996) reported that Cu mean values ranged from 1.685–5.558 mg/kg wet weight in five species of River Nile freshwater fishes from Assiut that exceeding the levels in this survey. The recorded levels of Cu were also lower than those reported from Turkey (Yilmaz, 2003), USA (Schmit *et al*., 1999) and UK (Ysart *et al*., 2000).

CONCLUSIONS & RECOMMENDATIONS:

1-Some organochlorine pesticides evaluated in this study are lower than previously documented values while others couldn't be detected indicating the efficiently political protective measures.

2-Frequent and continuous monitoring of these pesticides and metals will help to take cautions in consuming fishes from contaminated areas.

3-The still high incidence and levels of DDT and lead enforces the responsible aspects to take more effective and continuous defenses.

4-Further studies should be enhanced to investigate the relationship between elemental concentrations in foods and some unexpected diseases.

5-It is necessary to continue efforts to reduce environmental releases of such contaminants into the aquatic environment.

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بعض الملوثات البيئية بأسماك المياه العذبة بمحافظة أسيوط

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تم في هذه الدراسة فحص ٥٠ عينة ممثلة لثمانية أنواع من أسماك المياه العذبة بأسيوط (البلطي النيلي، القرموط، اللبس، البياض، الشال، البويز، اللاتس والرعاد)، وذلك لتقدير كمية متبقيات المبيدات الكلورينية العضوية وكذلك مستويات كل من عناصر الرصاص، الكادميوم، الزئبق، الزرنيخ، الكروم والنحاس بأنسجة هذه الأسماك .

وقد أوضحت النتائج أن مستويات متبقيات المبيدات العضوية انخفض عن مثيله مقارنة بالدراسات السابقة ، حتى أن بعضها لم يوجد بالعينات التي تم فحصها على الرغم من أن بعضاً منها لا زالت موجودة بنفس النسب المئوية السابقة مثل مبيد الدي دي تي ومشتقاته (بارا بارا دي دي إي، بارا بارا دي دي دي ، بارا بارا دي دي تي) حيث كان أكثر الملوثات تواجداً في كل العينات التي تم تحليلها (١٠٠ %) تلاه الهكساكلوروبنزين ثم الإندرين.

تراوح مدى متوسط قيمة الدي دي تي الكلى بين ٦٨,٧١–٣٤٦٤,٨٤٨ ميكروجرام/كيلوجرام دهن، بارا بارا دي دي إي بينما كان مدى مماثلات الهكساكلوروسيكلوهكسان الكلى ٣,٠٣–١٦,٣ ميكروجرام/كيلو جرام مكونة بصورة رئيسية من مشتق بيتا هكساكلوروسيكلوهكسان، والذي لوحظ انخفاضه بشكل كبير ولم يوجد إلا في ثلاثة أنواع فقط من هذه الأسماك. وكانت معدلات تواجد الهكساكلوروبنزين والإندرين تالية للدي دي تي بينما تواجد مركبات الكلوردان في نوعين فقط من الأسماك. وفى حدود قياسات هذه الدراسة لم توجد عينة واحدة تحتوى على الألدرين، الداي الدرين، الهبتاكلور، الهبتاكلورإبوكسيد .

وقد تبين من الدراسة أن أياً من العينات التي تم فحصها لم تتعد الحد الأقصى المسموح به من بعض الدول والوارد في تقرير منظمة الأغذية والزراعة من الدي دي تي (٥٠٠٠ ميكروجرام/كيلو جرام)، بينما تعدت اثنتي عشرة عينة الحد الأدنى المسموح به من الدي دي تي الكلي. وكانت جميع مستويات الهكساكلوروسيكلوهكسان الكلى والهكساكلوروبنزين أقل من المعدلات المسموح بها في الأسماك. وتبين احتواء أحد عشر عينة وعينتان من هذه الأسماك على مبيدي الإندرين والكلوردان الكلي بمستويات أعلى من المعدل النمساوي المسموح والموصى به في الأسماك .

وتراوحت قيم متوسطات الرصاص في الأسماك المختلفة ما بين ١٠٧,٢٧١ و ٢٥١,٥٨٣ جزء في البليون وزن طازج متعدية بذلك الحد الأقصى المصري المسموح بتواجده من عنصر الرصاص وهو ٠,١ جزء في المليون وزن طازج. بينما تراوحت قيم متوسطات عنصر الكادميوم ما بين ١٠,٧٠٨ و ١٦,٥ جزء في البليون وزن طازج في الأسماك المفحوصة ولم يتعد أي تركيز الحد المصري المسموح به من الكادميوم وهو ٠,١ جزء في المليون وزن طازج.

وكانت تركيزات عنصر الزئبق والذي يعتبر من السموم الخطيرة على الجهاز العصبي أقل من المعدلات العالمية وكذلك أقل من الحد المسموح به في مصر وهو ٠,٥ جزء في المليون ، إلا أن تناول بعض هذه الأسماك قد يمثل خطورة إذا ما تعدت كمية نصف كيلو يومياً. وبلغ مدى تركيز عنصر الزئبق ١٦,١٩٧ – ٧٨,٩٥٨ جزء في البليون وزن طازج.

ولم تتعد تركيزات عنصر الزرنيخ المعدلات العالمية المسموح بها من هذا العنصر في الأسماك، وتراوحت قيم متوسطات الزرنيخ ما بين ١٢,٨٣٣ و ٩٨,٥٦٣ جزء في البليون وزن طازج. وبلغت تركيزات متوسطات عنصري الكروم والنحاس والذين يعتبران من العناصر الأساسية للعمليات الحيوية للجسم ما بين ١٠٥,٢ – ٣٨٥,٧١٩ ، ٣٨٦,٢٢١ – ٨٢٤,٢٥ جزء في المليون.

وثبت من النتائج أن تركيزات غالبية هذه الملوثات من مبيدات وعناصر ثقيلة كان أقل مما تم رصده وقياسه في دراسات سابقة لبعض هذه الأنواع من أسماك نهر النيل. كما تبين أن مبيد الدي دي تي ومشتقاته وكذلك عنصر الرصاص لا زالت تمثل خطورة على مستهلكي هذه الأسماك، الأمر الذي يتطلب معه الاستمرار في اتخاذ الإجراءات الصارمة والرادعة نحو تقليل ضخ هذه الملوثات للبيئة المائية ووضع برنامج قومي لرصد هذه الملوثات في المياه والأسماك وجميع مكونات البيئة المائية للحد من خطورة تعرض الإنسان لها سواء عن طريق مياه الشرب وتناول الأسماك كمصدر رئيسي للبروتين الحيواني.