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PESTICIDE RESIDUES AND HEAVY METALS DISTRIBUTION IN QARUN LAKE (EL–FAYOUM - EGYPT) WATER AND FISH

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ABSRACT: The introduction of pollutants (e.g., pesticides, heavy metals, etc) into the environment can occur, accidentally or neglectfully. Release of these pollutants into the environment can originate from a variety of sources. The present study aimed at monitoring pesticide residues (e.g., organophosphorus and organochlorine compounds) and the levels of some heavy metals such as Cd, Cu, Fe, Pb and Zn in water and fish *(Tilapia zilli)* samples collected from Qarun lake at three locations (west, medium and east) throughout two successive seasons after the harvest of the summer and winter crops.

The water samples of the medium location manifested the greatest pollution. Also, the fish samples collected from the east location were more contaminated than the other locations. Seasonal variations of pesticide residues indicated that, summer favoured higher contamination with the organophosphorus and organochlorine pesticides in water and fish samples. The distribution pattern of these pesticides indicated that fish accumulated higher pesticide levels than water.

Also, the results showed that the levels of heavy metals fluctuated with time in water and fish samples. Water was most contaminated by heavy metals in the medium location and fish was most contaminated in the west location.

Key words: Organochlorine, organophosphorus, heavy metals, Qarun Lake.

INTRODUCTION

Pesticides are poisons used to control or destroy unwanted organisms, especially those that have economic implications. Aquatic ecosystems may be contaminated with pesticides (organochlorine, organophosphorus and carbamates...etc) used in crop protection. These pesticides reach aquatic ecosystems by direct application as drift, aerial spray, erosion and run off from agricultural land by discharge of effluents for factories and in sewage (Barlas, 1999).

Organochlorine (OC) pesticides were used extensively in Egypt since the early 1950s. Although the use of these pesticides has decreased, their chemical and physical stability has resulted in the accumulation of their residues in the environment and in the food chain (Sannino *et al.*, 1996). Organophosphorus (OP) compounds that have low persistence and are readily decomposed were used extensively during those years for pest control in Egypt (Dogheim *et al.*, 1996). The introduction of these pesticides into the aquatic ecosystem will adversely affect many nontargetted organisms including fish and birds (Dutta *et al.*, 1993 and Ayas *et al.*, 1997). Fish is an important organism of any aquatic system as a nontargetted organism, and so is one of the major sources of protein for human beings in Egypt (Sheehan *et al.*, 1984).

On the other hand, increasing pollution of aquatic environments with heavy metals has currently become a serious concern. The continual loading of metals into our environment creates water pollution problems due to their direct toxic effect on aquatic biota. In addition, metal ions can be incorporated into food chains and concentrated in aquatic organisms to a level that affect their physiological state (Zaghloul, 2000 and 2001).

The impact of heavy metals on fish has been of great concern for many years. Bioaccumulation of heavy metals in fish may critically influence the growth rate, physiological and biochemical status and consequently the meat quality of fish (Salah El-Deen *et al.*, 1996 and 1999;El-Nagar *et al.*, 1998; Haggag *et al.*, 1999 and El - Ghobashy, 2001).

Qarun Lake is one of the five large lakes in Egypt, it is inland closed lake of about 40 Km length, 5.7 Km mean width, and has an average depth of 4.2 m., it lies in an arid region. Occupying the deepest part of Fayoum province in the western desert of Egypt (Meshal and Morcos, 1981).

According to recent reports from The Egyption Company for Salts and Minerals (EMISAL-1995), the lake receives annually about 400 million cubic meters of agricultural wastewater drainage. About 70 private fish farms are located near the lake, and depend mainly upon agricultural drainage into their irrigation .The drainage water discharges into the lake via twelve drains into the lake. There are two main drains: one at the east (El-Bats) and another at the middle (El-Wadi), while the remaining ten drains are minor ones. These minor drains are recently connected with a large drain namely Dayer El-Birka, which transfers a part of wastewater to the lake by pumping stations at the southern side. The northern side of the lake is bordered by uninhabited sandy dune of the western desert, whereas the southern and eastern borders are inhibited. It is affected by the influx of the drainage water, which approximately balances the amount of lake water lost annually by evaporation leading to progressive increase of salinity and detrimental effects to the lake environment, e.g. its fauna and flora (Abdel-Malek and Ishak 1980; Abdel-Moniem, 1991; Ahmed, 1994; El-Shabrwy and Taha, 1999; Sabae and Rabeh, 2000; Abdel-Moneim and Kanswa, 2001).

The aim of the present study was to monitor the geographical and seasonal changes of pesticides and heavy metals residues in water and fish of Qarun Lake to enable the plans of its remediation.

MATERIALS AND METHODS

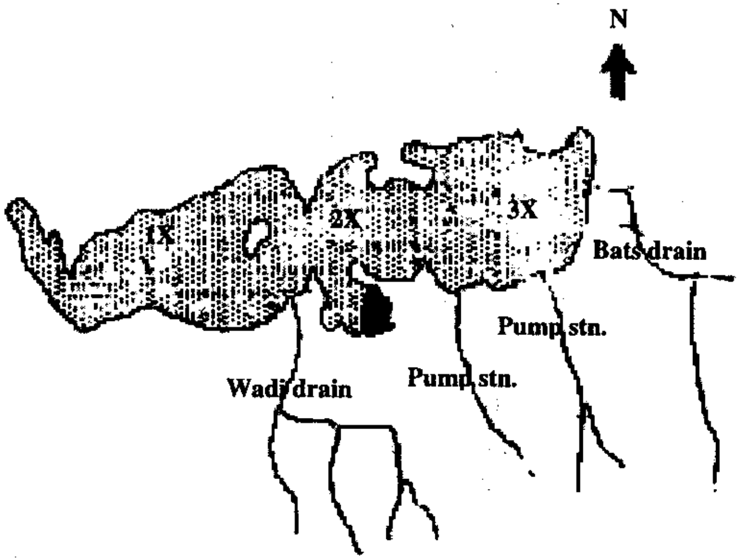
1. Sampling Location

Three definite locations across the lake were selected for collecting water and fish samples. These locations are shown in Figure (1), as following:

Location (1): Western part of the lake, representing the lake terminal. Location (2): Middle part of the lake, representing El-Wadi drain. Location (3): Eastern part of the lake, representing El-Bats drain.

2. Sampling Procedure

Samples of water and fish were taken from the lake during October 2003 (after summer season) and April 2004 (after winter season). Water samples were taken from



X: sample locations.
Salt factory.

STN. = Station.

Fig. 1: Key map of sampling locations in Qarun Lake, El - Fayoum, Egypt

surface water into a polypropylene bottle (ca.5L). Fish samples (*Tilapia zilli)* were collected from the lake (at least 2Kg) and kept in iceboxes during transportation. The collected samples were transferred quickly to laboratory and kept at –20 ^{0}C till analysis within few days after sampling.

3. Determination of Pesticide Residues

Water samples (1L) were extracted with 15% methylene chloride in hexane (v/v) and cleaned up by passing through florisil column using system 6, 15, 50% petroleum ether in diethylether (v/v). Residues analysis carried out using GLC according to method of AOAC, 1995. Fish samples (50g muscles) were extracted with petroleum ether, then defatting of the extract by dissolved sample residue in 1 ml hexane saturated with acetonitrile per gram of sample and transferred to a 100 ml separatory funnel. Added equal volume of acetonitrile saturated with hexane and shacked for 2 minutes. After phase separation, collected acetonitrile phase and evaporated acetonitrile phase to dryness and redissolve in 1 ml hexane. The latter extract was transferred to florisil column and eluted with solvent system 6, 15, 50% diethylether in petroleum ether (v/v). Determination of pesticide residues was performed using gas liquid chromatography (GC Hewlett Packard HP serial 6890) according to method of AOAC, 1995.

4.Monitoring of Heavy Metals

The samples (muscles of fish and water) were prepared by the method of the association of official analytical chemistry (AOAC, 1980) for trace metal analysis of Cu, Cd, Fe, Pb and Zn by Atomic Absorption spectrophotometer thermal Elemental M. Series using a deuterium lamb at wavelengths of Cd, Cu, Fe, Pb and Zn lames (228.8, 324.8, 248.3, 217.0 and 319.9 respectively).

RESULTS AND DISCUSSION

1. Monitoring of Pesticide Residues

1.1. Pesticide residues in water

The results presented in Table 1 demonstrate the types and concentrations of pesticides detected in water samples collected from three locations of Qarun lake in two seasons (after summer-after winter). The data showed that, the highest polluting concentration was recorded for β -BHC which reached 8.4 and 12.3 ppb in summer at the west and medium location, respectively. The level of this pesticide declined to 5.7 and 5.2 ppb in winter in the two previous respective locations. Although this pesticide was not detected at the east location in summer, it recorded the highest concentration in winter (15.2 ppb). The second highest polluting pesticide in the water lake was γ-BHC, which was detected at the different locations during summer and winter at levels fluctuating between 1.7 ppb in the west and 6.3 ppb in the east. Hence, it can be concluded that the two most polluting pesticides were β -BHC and γ-BHC being most conspicuous at the east location in winter. Generally the contents with organochlorine pesticides were more spread in the different locations of the lake than organophosphorus pesticides (Table 1).

The frequency of pesticide contaminants presented in Table 2, was higher in summer than winter at all the locations; it ranged between 55.5% to 74.07% in summer against 44.4% to 48.1% in winter. Generally, the frequency of positive samples (F.P.S,%) of both surveyed pesticides were higher in summer than winter .The west and medium locations of the lake were the most contaminated at summer by pesticide residues since the frequency of positive samples attained a very high level (74.07 for each). Generally, it can be noticed that in Table 2, water samples collected from the medium location have got higher frequency of positive samples (on average, 61.11%) than water of west or east location. The analysis shows similarity between the source pesticide contaminants, since 85% of the pesticide detected were the same and at near levels of contamination.

The present findings agree with the pervious studies conducted on lake Manzala, Egypt (Abou-Arab *et al.*, 1995) and on Qarun Lake (Ibrahim, 1996 and Mansour *et al.*, 2001).

In Table 3 it can be observed that, the frequency of pesticide residues (F.P.R.%) were 100% at α.BHC, γ.BHC, heptachlor, heptachlor epoxide, pp - DDE, endrin, pp - DDD and pp - DDT so they appeared in different locations and two seasons. Generally, organochlorine pesticides were more frequent than organophosphorus. These results are inagreement with previous

Table 1: Residue levels (ppb) of organophosphorus (OP) and organochlorine (OC) pesticides in Qarun Lake

Pesticides	Location						Safe Limits (ppb)
	West		Medium		East		
	After summer	After winter	After summer	After winter	After summer	After winter	
OP							
Methamidaphos	ND	ND	ND	ND	ND	ND	
Ethoprophos	ND	ND	0.30295	ND	0.024251	ND	
Cadusaphos	0.186635	ND	0.16135	ND	3.07515	ND	
Phorate	ND	ND	ND	ND	ND	ND	
Diazinon	ND	ND	ND	ND	ND	ND	
Disyston	0.058719	ND	ND	ND	0.039638	ND	
Chloropyrifos-m	0.132639	ND	0.35836	ND	3.025976	ND	
Pirimiphos-m	0.028508	ND	ND	0.020124	ND	ND	
Chloropyrifos	ND	ND	0.046396	ND	ND	ND	
Phenthoate	0.222511	ND	0.097134	ND	0.226286	ND	
Fenitrothion	0.010211	ND	0.004114	ND	0.008517	ND	
Profenophos	0.285736	ND	0.083452	ND	0.293023	ND	
Ethion	ND	ND	ND	ND	ND	ND	
Triazophos	ND	ND	ND	ND	ND	ND	
OC							
α – BHC	0.043809	1.065796	0.349673	0.851644	0.395901	1.32894	
γ- BHC	1.692434	2.878252	2.775708	2.75286	2.095048	6.34316	
β – BHC	8.417725	5.744919	12.34236	5.282916	ND	15.17789	-
Heptachlor	0.455046	0.686271	0.32345	0.588687	0.117037	1.042826	*0.1*
δ- BHC	0.755243	1.993396	0.963075	1.89583	ND	3.00821	
Aldrin	0.218172	ND	0.14336	ND	ND	ND	*10*
Hepta. epoxide	0.426872	0.145325	0.62566	0.110159	0.569108	0.230772	
γ-chlordan	0.118517	0.583516	0.020373	0.404692	ND	0.76558	
pp-DDE	0.087989	0.243871	0.120152	0.054171	1.573596	2.048558	-
Endrin	0.663276	0.56958	0.557517	0.037869	0.104271	0.035194	*0.2*
pp-DDD	0.215514	1.414156	0.119979	0.81167	10.83904	0.633092	
op-DDT	0.612395	0.359473	1.42818	0.324712	ND	0.633092	*50*
pp-DDT	0.22555	0.084948	0.356424	1.839704	0.695728	0.155273	

ND = Not Detected.
Pirimiphos-m = Pirimiphos methyl.
BHC = Benzenhexachloride.
Chloropyrifos-m = Chloropyrifos methyl.
Hepta. Epoxide = Heptachlorepoxide.
ppb. = part per billion.

Table 2: Frequency of positive samples (F.P.S%) of organophosphorus (OP) and organochlorine (OC) pesticides in Qarun Lake

Season	Location			
	West	Medium	East	Average
After summer	74.07407	74.07407	55.55556	67.90123
After winter	44.44444	48.14815	44.44444	45.67901
Average	59.25926	61.11111	50	56.79012

$$F.P.S = \frac{\text{No. of pesticides detected in location}}{\text{Total No. of pesticides in the lake}} \times 100$$

Table 3: Frequency of pesticides residues (F.P.R.%) of organophosphorus (OP) and organochlorine (OC) pesticides in Qarun Lake.

Pesticides	Location		
	West	Medium	East
OP			
Methamidaphos	0	0	0
Ethoprophos	0	50	50
Cadusaphos	50	50	50
Phorate	0	0	0
Diazinon	0	0	0
Disyston	50	0	50
Chloropyrifos-m	50	50	50
Pirimiphos-m	50	50	0
Chloropyrifos	90	50	0
Phenthoate	0	50	50
Fenitrothion	50	50	50
Profenophos	50	50	50
Ethion	0	0	0
Triazophos	0	0	0
OC			
α – BHC	100	100	100
γ- BHC	100	100	100
β – BHC	100	100	50
Heptachlor	100	100	100
δ- BHC	100	100	50
Aldrin	50	50	0
Hepta. epoxide	100	100	100
γ-chlordan	100	100	50
pp-DDE	100	100	100
Endrin	100	100	100
pp-DDD	100	100	100
op-DDT	100	100	50
pp-DDT	100	100	100

$$F.P.R = \frac{\text{No. of appearance of a pesticide in location}}{\text{No. of surveyed seasons in location}} \times 100$$

research works (El-Dib and Badawy, 1985, Abou-Arab, 1995, Ibrahim, 1996; and Mansour *et al.*, 2001); which indicated the presence of organochlorine pesticides in many environmental samples including water, sediment and fish in different locations of Qarun Lake although it was banned in Egypt since the last three decades.

1.2. Pesticides in fish muscles

Bioaccumulation of xenobiotics including pesticides in aquatic species represents a significant threat to aquatic life. A variety of fish species accumulate many contaminants such as pesticides (Heger *et al.,* 1995). Accumulation patterns of contaminants in fish depend on both the uptake and elimination rates. The uptake of pollutants from the water is influenced by species of fish and various environmental factors such as pH and temperature (Hakanson, 1984). The elimination of such chemicals is an active biochemical and physiological process dependent on growth, salinity, age, sex, position relative to shoreline, water depth and pollutant intermissions (Phillips, 1980).

The results obtained from fish muscles analysis (*Tilapia zilli)* show that, the highest pollution concentration was recorded for organophosphorus triazophos at levels of 111.9 and 365.6 ppb in summer at the west and east locations, respectively while after winter this pesticide was not detected. The second pesticide was disyston detected at levels of 34.3and 77.7 ppb in summer at west and east location, respectively. In winter this pesticide was decreased to 19.7 and 30.9 ppb at east and medium locations, respectively. Also, fish at medium location after summer contained the same pesticide (disyston) at level 1.6 ppb. Also, the data showed that, heptachlor pesticide was the most appear in different locations since their frequency of pesticide residues was 100%. Generally, organochlorine pesticide residues fluctuated in different locations and two seasons (Table 4).

Generally, the frequency of positive samples (F.P.S%) was higher in summer than winter it ranged between 48.1% to 62.96% in summer against 18.5% to 33.3% in winter. Moreover the frequency of positive samples of both organophosphorus and organochlorine pesticides were higher in summer than winter

Table 4: Residue levels (ppb) of organophosphorus (OP) and organochlorine (OC) pesticides in the muscles of *Tilapia zilli* fish of Qarun Lake

Pesticides	Location						MRL (mg / kg b.wt.)
	West		Medium		East		
	After summer	After winter	After Summer	After winter	After summer	After winter	
OP							
Methamidaphos	ND	ND	4.714587	ND	ND	ND	
Ethoprophos	13.89781	ND	5.048405	ND	7.833229	ND	
Cadusaphos	4.255004	ND	ND	ND	9.319502	ND	
Phorate	6.126127	ND	ND	ND	13.81048	ND	
Diazinon	ND	ND	ND	ND	2.250297	ND	
Disyston	34.33495	ND	1.568831	30.93668	77.68696	19.65088	
Chloropyrifos-m	1.672707	ND	1.743312	ND	4.397961	ND	
Pirimiphos-m	7.433982	ND	ND	ND	23.38493	ND	
Chloropyrifos	ND	ND	0.754441	ND	0.835858	ND	
Phenthoate	9.700409	ND	1.468502	ND	25.27476	ND	
Fenitrothion	3.059199	ND	0.11747	ND	8.81977	ND	
Profenophos	9.677912	ND	10.23181	ND	33.43752	ND	
Ethion	ND	ND	0.690786	ND	0.707965	ND	
Triazophos	111.8949	ND	ND	ND	365.6061	ND	
OC							
α - BHC	ND	ND	ND	0.832755	ND	0.437106	
γ- BHC	2.18232	0.467372	ND	0.713604	6.572952	ND	
β - BHC	40.02424	ND	ND	ND	ND	ND	-
Heptachlor	7.12266	15.16832	4.15937	4.50724	10.84146	1.37056	*0.2*
δ- BHC	ND	9.4892	ND	6.3238	ND	7.44833	
Aldrin	ND	ND	ND	ND	ND	ND	*0.2*
Hepta. epoxide	9.543864	ND	ND	1.456868	ND	2.965636	
γ-chlordan	ND	ND	ND	37.0797	ND	2.003072	
pp-DDE & dieldrin	ND	8.70299	ND	102.44	47.9331	ND	-
Endrin	2.378744	ND	5.959424	ND	3.585368	33.9445	*1.0*
pp-DDD	68.21366	ND	54.52699	2.732684	ND	ND	
op-DDT	35.08932	4.98748	65.61523	ND	ND	ND	*5.0*
pp-DDT	ND	ND	ND	ND	ND	ND	

ND = Not Detected. MRL = Maximum Residue Limit.
Chloropyrifos-m = Chloropyrifos methyl. Pirimiphos-m = Pirimiphos methyl.
BHC = Benzenehexachloride. Hepta. Epoxide = Heptachlorepoxide.

(Table 5). The fish of west and east locations of the lake were the most contaminated at summer by pesticide residues since, the frequency of positive sample attained a very high level at (62.96% for each), as well as the fish of the medium location was the most contaminated at winter by pesticide residues since, the frequency of positive samples attained a very high level at 33.3%. Also, it could be noticed that fish samples in east location have got higher frequency of positive samples 44.4% than fish at the medium location or west location.

From the data presented in Table 6 noticed that frequency of pesticide residues (F.P.R%) was 100% as heptachlor in different locations. Disyston came in the next order attaining 100% in the medium and east locations and 50% in the west location.

According to the present results, fish (*Tilapia zilli)* were found to contain organophosphorus pesticide residues although these pesticides have been low persistence and are readily decomposed. This observation may be explained as some types of organophosphorus pesticides were found in the fat phase in fish (Abou-Arab *et al.*, 1996) also, the flesh was analyzed without removing the skin which is supposed to contain a quantity of pesticide residues (Mansour *et al.*, 2001).

Nowell *et al.*, 1999 stated that pesticides in general were found to have the potential to or / and octanol-water partition coefficient (K_{OW}) greater than 1000 and soil half-life greater than 30 days. The majority of pesticides used now in Egypt are some organophosphorus; carbamate and pyrethroid compounds which are known to be highly toxic but quickly degradable. Also, the results which presented in Table 1, it was noticed that, organophosphorus pesticides such as disyston; triazophos, profonphos and chloropyrifos were occasionally detected in some of the analyzed samples referred to there used extensively in agriculture.

According to the present results, the appearance of organochlorine pesticides in different locations in Qarun Lake (water and fish) was explained by Abou-Arab *et al.* (1995) and Ibrahim (1996) which showed that, most organochlorine compounds (e.g. DDT, lindan, heptachlor, endrin, dieldrin, etc) are banned in Egypt, during the last three decades, however they are still detectable in many environmental samples including water, sediment

Table 5: Frequency of positive samples (F.P.S%) to organophosphorus (OP) and organochlorine (OC) pesticides in the muscles of *Tilapia zilli* fish of Qarun Lake

Season	Location			
	West	Medium	East	Average
After summer	62.96296	48.14815	62.96296	58.02469
After winter	18.51852	33.33333	25.92593	25.92593
Average	40.74074	40.74074	44.44444	41.97531

Table 6: Frequency of pesticides residues (F.P.R.%) to organophosphorus (OP) and organochlorine (OC) pesticides in the muscles of *Tilapia zilli* fish of Qarun Lake

Pesticides	Location		
	West	Medium	East
OP			
Methamidaphos	0	50	0
Ethoprophos	50	50	50
Cadusaphos	50	0	50
Phorate	50	0	50
Diazinon	0	0	50
Disyston	50	100	100
Chloropyrifos-m	50	50	50
Pirimiphos-m	50	0	50
Chloropyrifos	0	50	50
Phenthoate	50	50	50
Fenitrothion	50	50	50
Profenophos	50	50	50
Ethion	0	50	50
Triazophos	50	0	50
OC			
α - BHC	0	50	50
γ- BHC	100	50	50
β - BHC	50	0	0
Heptachlor	100	100	100
δ- BHC	50	50	50
Aldrin	0	0	0
Hepta. epoxide	50	50	50
γ-chlordan	0	50	50
pp-DDE & dieldrin	50	50	50
Endrin	50	50	100
pp-DDD	50	100	0
op-DDT	100	50	0
pp-DDT	0	0	0

and fish as well as in the irrigation water since its have highly chemical and physical stability. Also the data showed that, the residue levels of organochlorine pesticides were higher in the water of the lake than in the fish. It can be explained with Stout (1980) who stated that, fish species with low oil content<3% were found to contain less amounts of organochlorine pesticides (such as DDT, dieldrin and endrin).

It can also notice that the concentrations of pesticides in all locations for all pesticides were lower during winter than summer. This decrease may be caused by excessive use in summer than in winter.

Since Qarun Lake water is highly saline and not used for drinking, it is not necessary to compare its pesticides levels with the safe limits for drinking water. However it may be convenient to do such comparison with the irrigation water. Therefore it would be advisable not to eat except the flesh of fish in order to minimize the intake of significant amount of pesticide residues. On the other hand, human exposure to a mixture of pesticide residues may cause health risks exceeding those induced from exposure to residue of a single pesticide. This has led to suggested permissible tolerance limits in food, generally, for pesticides mixtures parallel to that established already by FAO/WHO for individual pesticides.

According to Mansour (1998) pesticides such as BHC, lindan, DDT, DDD, aldrin, endrin, heptachlor, disyston, malathion, parathion and profonphos were classified very toxic to fresh water fish. In general the data obtained in this investigation show that organochlorine still contribute to problem of human exposure to their residues through certain foods.

2. Monitoring of Heavy Metals

2.1. Heavy metals in water

Heavy metals in water (Table 7) were influenced by two factors (i.e. season and sampling location).

The averages of heavy metals such as Cd, Cu, Fe, Pb and Zn in lake water at summer were 0.058, 0.033, 1.646, 0.031 and 0.315 ppm respectively; against relatively low concentrations in winter (Table 8) indicating that heavy metals concentrations may fluctuated with time. Our results agree with Ibrahim (1996) and Mansour and Messeha (2001).

The results in Table 8 show variation in heavy metals concentrations according to the

Table 7: Heavy metals concentrations (ppm) in Qarun Lake

Metals	Location						Safe limits
	West		Medium		East		
	After summer	After winter	After summer	After winter	After summer	After winter	
Cd	0.053	0.021	0.054	0.053	0.067	0.044	0.01
Cu	0.019	0.022	0.043	0.034	0.037	0.015	1.0
Fe	1.553	1.164	1.981	1.284	1.494	1.266	0.30
Pb	0.034	0.052	0.035	0.075	0.023	0.015	0.05
Zn	0.262	0.610	0.311	0.094	0.373	0.084	5.0

Table 8: Average of heavy metals concentrations (ppm) in Qarun Lake

Metals	Average				
	Season		Location		
	After summer	After winter	West	Medium	East
Cd	0.058	0.039	0.037	0.0535	0.0555
Cu	0.033	0.024	0.0207	0.0385	0.026
Fe	1.646	1.238	1.3585	1.5875	1.38
Pb	0.031	0.047	0.043	0.055	0.019
Zn	0.315	0.263	0.436	0.2025	0.2285

location (west, medium and east), for example Cd level was 0.037, 0.054 and 0.056 ppm in the west, medium and east locations respectively. Likewise Cu was 0.021, 0.039 and 0.026 ppm. Similar changes can be observed for Fe, Pb and Zn. Generally, all average concentrations of heavy metals were higher in summer than in winter, exception with Pb. Fortunately the highly contents of Zn and highly saline in water lake were may be compensating hazard effects of Cu by their antagonistic action or the role in protection fish against copper toxicity, as stated by Zaghloul (2001).

From data presented in Table 8 it could be noticed that medium location contained higher concentrations of total heavy metals than those estimated for west location or east location. Such finding agrees with results of Mansour and Messeha (2001).

2.2. Heavy metals in fish muscles

The data recorded in Table 10 showed that, the seasonal variations of heavy metals accumulated in the muscles fish (*Tilapia zilli*) collected from different locations of lake as following. The average of contents in summer of Cd, Cu, Fe, Pb and Zn were 0.047, 0.689, 10.880, 0.842 and 4.687 ppm respectively, while in winter these levels decreased considerably. It can also be noticed that, the average levels of muscle heavy metals fluctuated according to location. The most conspicuous fish muscle contaminated with heavy metals can be observed in the west location.

The recorded data are in agreement with the finding of Zaghloul (2001). Amounts of metals may be correlated with fat-content in muscles tissues and its great affinity to combine with heavy metals. The low concentration of the water heavy metals is not indication of low bioaccumlated metals in fish or adsorption on sediment. Moreover the impact of the heavy metals appears to be associated with the source of pollution (industrial, waste municipal, waste domestic and agricultural drainage water) in accordance with Shenoda *et al.* (1992). On the other hand the very high levels of water salinity, hardness and water alkalinity observed in Qarun lake could play a role in inhibiting the accumulation of the recorded heavy metals on fish as previously reported by Sorensen (1991) and Zaghloul (1997).

Table 9: Heavy metals concentrations (ppm) in the muscles of *Tilapia zilli* fish of Qarun Lake

Metals	Location						Permissible limits
	West		Medium		East		
	After summer	After winter	After summer	After winter	After summer	After winter	
Cd	0.070	0.015	0.050	0.003	0.020	0.021	0.50
Cu	1.200	0.635	0.730	0.434	0.138	0.109	20.0
Fe	14.23	7.632	12.530	4.563	5.880	9.166	30.0
Pb	0.720	0.288	0.967	0.224	0.840	0.385	0.60
Zn	4.280	3.462	4.980	4.547	4.800	5.218	50.0

Table 10: Average of heavy metals concentrations (ppm) in the muscles of *Tilapia zilli* fish of Qarun Lake

Metals	Average				
	Season		Location		
	After summer	After winter	West	Medium	East
Cd	0.047	0.013	0.0425	0.0265	0.0205
Cu	0.689	0.393	0.9175	0.582	0.1235
Fe	10.880	7.120	10.931	8.5465	7.523
Pb	0.842	0.299	0.504	0.5955	0.6125
Zn	4.687	4.409	3.871	4.7635	5.009

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توزيع متبقيات المبيدات و المعادن الثقيلة فى مياه وأسماك بحيرة قارون (الفيوم – مصر)

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توجد مصادر عديدة لوصول الملوثات (مثل المبيدات، المعادن الثقيلة ....إلخ) للبيئة والتي قد تحدث بصورة عرضية أو بقصد أو نتيجة الإهمال.

لهذا كان الهدف من هذه الدراسة قياس متبقيات بعض المبيدات (مركبات الفسفور العضوية ومركبات الكلور العضوية) وكذلك تركيزات بعض المعادن الثقيلة –مثل الكادميوم، النحاس، الحديد، الرصاص، الزنك – في عينات المياه والأسماك (البلطى النيلى) المجمعة من بحيرة قارون من ثلاث مناطق مختلفة (الغرب، الوسط، الشرق) وذلك علي مدار موسمين متتاليين (بعد حصاد المحاصيل الصيفية والشتوية).

ولقد أوضحت النتائج المتحصل عليها إلى أن عينات مياه وسط البحيرة أكثر المناطق تلوثاً و كذلك كانت عينات السمك فى منطقة الشرق أكثر المناطق تلوثاً عن باقى المناطق. ومن ناحية أخرى دل التأثير الموسمى لمتبقيات المبيدات أن موسم الصيف كان أعلى تلوث بالمبيدات الفسفورية والكلورنية على السواء فى كلا من عينات الماء و السمك. أما نظام تراكم هذه المبيدات فى مكونات البحيرة كان فى عينات السمك أكبر مما كان فى عينات المياه.

أما بالنسبة لتركيزات المعادن الثقيلة فأشارت النتائج أن مستويات هذه المعادن كانت بصورة متذبذبة من حين لآخر فى كلا من المياه والأسماك. إذ كانت المياه أكثر تلوثاً بالمعادن الثقيلة فى منطقة الوسط كما أن أسماك منطقة الغرب كانت أكثر تلوثاً.