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Research Article

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Distributions of Some metals in El Ebrahimia canal, BENI-SUEF, Egypt

Abdou KA[1], Khadiga IA[2]

Department of Toxicology and Forensic Medicine, Faculty of Veterinary Medicine, BENI-SUEF University, BENI SUEF, Egypt

Abstract Concentrations of some metals, cadmium (Cd), lead (Pb), iron (Fe), manganese (Mn) and zinc (Zn) in water, Ceratophillyum demersum (C. demersum) aquatic plant and in muscles, gills, liver, kidney and blood of Claries lazera (C. lazera) collected from seven stations, Beni Suef , Elfashn, Beba, Somosta, , Ehnasia, Elwasta and Naser along El Ebrahimia canal in Beni Suef province, Egypt during 2009-2010 were measured using atomic absorption spectrometer.

The obtained results revealed that, the examined metals were detected in all examined samples. In water, Pb has the highest concentration among the detected metals in Elfashn, Beba, Ehnasia, Naser and Elwasta; Mn has the highest concentration in Somosta and Fe has the highest concentration in Beni Suef. The concentration of Pb, Fe, and Mn were above the maximum permissible limits in all districts. Cd concentration was above the permissible limits except in Somosta and Naser while Zn concentration was below the permissible limit in the seven districts. Metal levels in water were compared with national and international water quality guidelines as well as literature values were reported for streams and rivers. Comparisons were made of metal concentrations in water and aquatic plant with those in the catfish tissues caught from the water. In C. demersum aquatic plant, distribution of metal concentrations in the seven studied districts were in the order of Mn > Zn > Pb >Fe > Cd and were above its level in water. In fish, metals were accumulated in different examined tissues by various levels but concentrations of metal in muscles (edible part) were below the metal levels in other organs (no-edible) of fish samples. The concentration of Cd, Pb and Fe in the different tissues of fish was above the international standard while the concentration of Mn and Zn was below that level. The high concentrations of these metals in water, aquatic plant and fish in El Ebrahimia canal may are thought to have resulted from anthropogenic activities producing industrial, agricultural, domestic waste discharges as well as accidental pollution incidents.

Keywords Heavy Metals, water, fish, aquatic plant, Nile River, Beni Suef, Egypt

Introduction

The River Nile is the principal fresh water resource in Egypt and supply Egypt with about 98 per cent of its fresh water [1-2]**.** El Ebrahimia canal is the longest artificial tributary of the Nile, 267 km length and extend along the Upper Egypt. It takes water from the Nile at Assiut, and ends at Elwasta in Beni Suef province. The canal water is mainly used for the irrigation, fishing and aquaculture purposes of three governorates, Assiut, Minya and Beni Suef.

Pollution in the Nile River main stem, drains and canals has increased in the past few decades. The River Nile receives from Aswan to El-kanater Barrage wastewater discharge from 124-point sources, of which 67 are agricultural drains and the remainders are industrial sources. Egyptian Environmental Affairs Agency reported that, the pollution of surface water in Beni Suef province constitutes a great hazard to all biological systems and the principle pollutants of water in the governorate are heavy metals especially lead manganese, cadmium, and iron [3].

Trace metal contaminants in aquatic ecosystem pose a serious environmental hazard because of their persistence and toxicity. Heavy metals are potentially harmful to most organisms at some level of exposure and absorption

[4]. Discharge of different types of waste, especially heavy metals deteriorated the water quality in the River Nile and consequently affecting fauna, fish production, human health and wildlife [5]. Macrophytes considered an important component of the aquatic ecosystem not only as food source for aquatic animals, but they also act as an efficient accumulator of heavy metals [6]**.** Fish may absorb dissolved elements and heavy metals from surrounding water and food, which may accumulate in various tissues in significant amounts and are eliciting toxicological effects at critical targets. Also, fish may accumulate significant concentrations of metals even in waters in which those metals are below the limit of detection in routine water samples therefore, fish might prove a better material for detecting metals contaminating the freshwater ecosystems [7]**.**

Contamination of aquatic ecosystems with metals has been receiving increased worldwide attention and the literature has many publications on this [8-12]**.** The aim of this work was to estimate the distribution of some metals in different compartments of aquatic environment in El ebrahimia canal along Beni Suef province, Egypt. For this purpose, concentrations of Cd, Pb, Fe, Mn and Zn were measured in surface water, C. demersum aquatic plant and in muscles, gill, liver, blood and kidney of C. lazera fish. The metal analyses of the previous digested samples were carried out using Atomic Absorption Spectroscopy (AAS) M6.

Materials and Methods

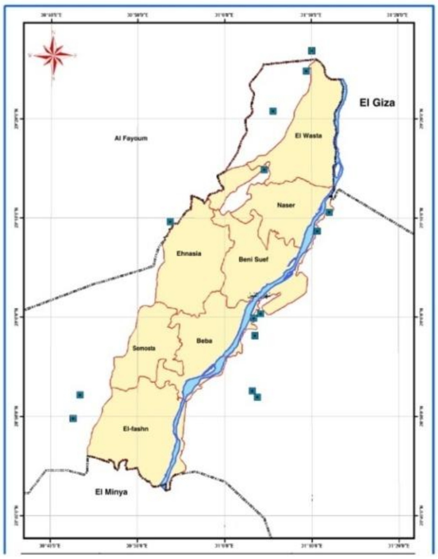

Figure 1: Map of Beni Suef governorate districts

Sampling Sites

El Ebrahimia canal is one of artificial tributary of the Nile extend along the Upper Egypt, taking water from the Nile at Assiut and ends at Elwasta in Beni Suef province. Seven sampling sites, Beni Suef, Elfashn, Beba, Somosta, Ehnasia, Elwasta and Naser were selected covering the different parts of El Ebrahimia canal in Beni Suef province, Fig. 1.

Sampling and sample preparation:

A total of 105 samples of surface water, C. demersum and of C. lazera fish (thirty five sample of each) were collected from El Ebrahimia canal along seven districts Beni Suef, Elfashn, Beba, Somosta, , Ehnasia, El wasta and Naser of Beni Suef province during one year in the period 2009-2010.

Water were taken using 0.5 liter bottles (pre-cleaned with polyethylene and acidified with 5 ml of concentrated Hno3) and stored approximately at −20°C. The water samples digested using equal volumes of a mixture of nitric and perchloric acids. All digested samples were (pH) adjusted and volumetrically recorded [13]. C. demersum samples were packed in labeled clean plastic bags in deep freezer (-20 ºC) for chemical analysis then were digested according to the method described by Chapman and Pratt (1982), used an acid mixture of 750 ml of concentrated nitric acid, 150 ml of concentrated sulfuric acid and 300 ml of 60-62% perchloric acid [14]. A total of thirty five of C. lazera were collected with nets by professional fishermen. The body length of the fish was ranged from 35-40 cm and the body weight was ranged from 500-600 gm. The samples were brought to the laboratory on the same day. Approximately 2 g of the epaxial muscle on the dorsal surface of the fish, two gill racers, the entire liver, two ml of blood using the tail cutting method and 2 gm of kidney from each sample were dissected, washed with distilled water, dried in filter paper, weighed, packed in polyethylene bags and kept at −20°C until analysis for metals concentrations determination. Samples were digested using mixture of nitric acid and perchloric acid according to method applied by Agemain et al., (1980) [15] while blood samples was digested according to method applied by Zilva (1973) [16]**.**

Samples Analysis:

The metal analyses of the previous digested samples (Cd, Pb, Fe, Mn and Zn) were carried out using Atomic Absorption Spectroscopy M6, Thermo scientific 2009 [17]. The concentrations of heavy metals are expressed as mg/kg wet weight of tissues. The absorption wavelength values were 228.8 nm for Cd; 0.5 nm for Pb; 228.8 nm for Fe; 279.5 nm for Mn and 213.9 nm for Zn.

Statistical procedures**:**

Statistical analyses were performed using the statistical software package GraphPad InStat Version 2. The 0.05 level of probability was used as the criterion for significance.

Results

Table 1: Metal concentrations (*mean±S.E*) in surface water samples collected from El Ebrahimia canal in Beni Suef Governorates different districts (N=5).

Districts	Metal concentrations (ppm)				
	Cd	**Pb**	**Fe**	**Mn**	**Zn**
Beni Suef	0.029±0.0006	0.254±0.086	0.293±0.130	0.196±0.093	0.019±0.001
Elfashn	0.025±0.002	0.247±0.120	0.182±0.006	0.089±0.054	0.008±0.004
Beba	0.017±0.002	0.379±0.024	0.050±0.002	0.016±0.006	0.017±0.0004
Somosta	0.010±0.004	0.422±0.131	0.048±0.001	0.053±0.025	0.015±0.0003
Ehnasia	0.014±0.001	0.433±0.046	0.307±0.005	0.725±0.132	0.019±0.004
Elwasta	0.029 ±0.0006	0.710±0.023	0.090±0.003	0.461±0.037	0.028±0.008
Naser	0.006±0.002	0.889±0.102	0.145±0.026	0.01± 0.003	0.017±0.0005
WHO, 1993	0.01	0.01	0.01	0.01	4
US-EPA, 1998	0.01	0.05	0.30	0.10	0.30
EOS, 1993	0.01	0.1	0.3	--	5
CCME (2005) for irrigation water	0.051	0.2	0.05	0.2	1 - 5
CCME (2005) Livestock water	0.080	0.1	--	--	50

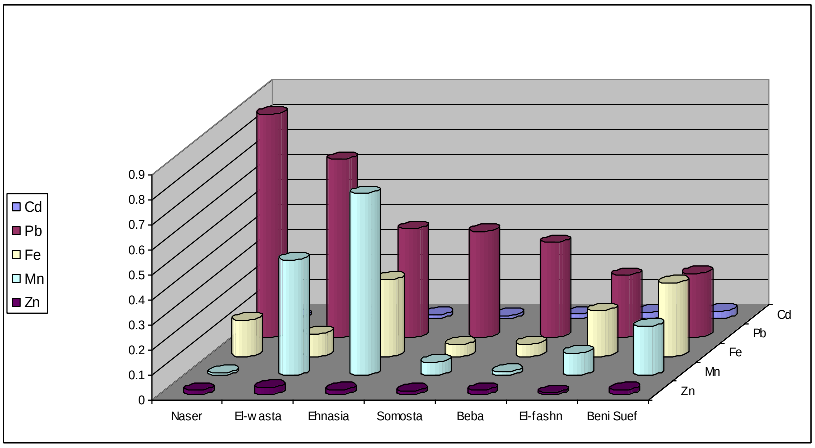

Figure 2: Metal concentrations (ppm) in water samples collected from Beni Suef Governorate districts.

Table 2: Metal concentrations (mean±S.E) in aquatic plant samples (Ceratophillyum demersum) collected From El Ebrahimia canal in Beni Suef Governorate different districts water (N=5)

Districts	Metal concentrations (ppm)				
	Cd	**Pb**	**Fe**	**Mn**	**Zn**
Beni Suef	1.095±0.019	3.107±0.878	1.670±0.026	209.240±0.136	16.934±0.406
El fashn	0.245±0.068	6.307±0.325	22.255±1.429	209.438±0.021	19.726±0.971
Beba	0.751±0.028	3.235±0.296	1.472±0.063	208.756±0.112	18.114±0.299
Somosta	0.121±0.004	21.431±0.988	5.768±1.946	209.639±0.033	18.173±0.212
Ehnasia	0.986±0.068	6.032±0.437	1.439±0.022	209.358±0.058	19.095±0.709
Elwasta	0.511±0.066	7.549±0.275	1.553±0.030	209.221±0.060	17.424±0.711
Naser	0.896±0.041	2.214±0.120	1.657±0.025	209.182±0.072	17.503±0.622
CCME, 1996	0.1–0.2	--	--	--	--
WHO, 2003	--	--	15 - 20	--	--

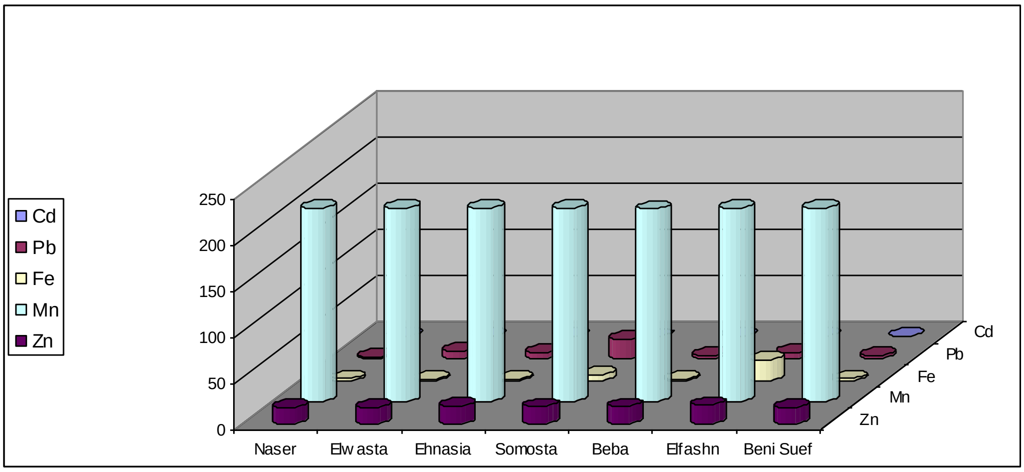

Figure 3: Metal concentrations (ppm) in C. demersum samples collected from Beni Suef Governorate districts.

Table 3: Metal concentrations (mean±S.E) in different organs of Claries lazera fish samples collected from El Ebrahimia canal in Beni Suef Governorate different districts (N=5)

Districts	**Fish organs**	**Metal concentrations (ppm)**				
		Cd	**Pb**	**Fe**	**Mn**	**Zn**
Beni Suef	Muscle	0.48±0.15	2.36±0.105	66.016±0.770	0.728±0.078	4.146±0.495
	Gills	0.17±0.100	4.319±0.095	41.886±0.993	11.915±0.337	4.56±0.293
	Liver	0.89±0.038	3.743±0.206	61.315±1.137	1.701±0.093	13.989±3.253
	Blood	0.49±0.051	0.414±0.031	147.383±1.412	1.346±0.175	0.083±0.072
	Kidney	0.77±0.105	1.705±0.180	143.903±0.482	1.331±0.213	7.526±0.394
Elfashn	Muscle	0.29±0.118	1.48±0.095	4.11± 0.685	1.205±0.397	6.325±1.518
	Gills	0.09±0.042	8.636±0.229	66.378±0.208	10.446±0.383	0.345±0.205
	Liver	1.08±0.024	8.273±0.302	170.370±2.190	1.593±0.122	12.998±0.258
	Blood	0.35±0.019	0.547±0.078	142.304±0.600	0.521±0.069	0.025±0.008
	Kidney	1.585±0.020	1.68±0.117	4.493±0.164	1.308±0.234	9.353±0.270
Beba	Muscle	0.611±0.121	2.336±0.095	40.996±1.427	1.67±0.155	10.441±0.719
	Gills	0.176±0.055	6.192±0.220	14.061±1.428	4.955±0.121	1.305±0.782
	Liver	0.148±0.013	8.375±0.532	59.588±0.496	0.748±0.156	10.825±0.451
	Blood	0.224±0.059	0.529±0.079	187.654±0.213	0.451±0.063	0.016±0.004
	Kidney	2.136±0.058	1.838±0.119	5.508±0.131	1.187±0.252	11.083±0.308
Somosta	Muscle	0.621±0.104	2.26±0.110	88.016±0.336	1.116±0.643	7.419± 1.226
	Gills	0.087±0.022	8.977±0.212	5.468±0.505	9.1±0.412	08.05 ±0 0.16
	Liver	0.728±0.055	7.101±0.401	207.711±1.624	1.235± 0.062	15.128±0.339
	Blood	0.613±0.069	0.438±0.047	131.232±0.612	0.562±0.203	00.252±0.220
	Kidney	1.463±0.153	1.996±0.435	3.726±0.151	1.815±0.367	10.453±0.243
Ehnasia	Muscle	0.263±0.045	2.698±0.072	58.368±0.164	0.883±0.121	6.08±0.113
	Gills	0.695±0.202	4.576±0.139	29.753±1.266	8.005±0.312	5.746±0.594
	Liver	0.751±0.070	5.576±0.284	95.33±1.374	1.661±0.072	13.491±1.234
	Blood	0.398±0.047	0.364±0.061	152.886±0.909	0.556±0.043	0.051±0.026
	Kidney	1.033±0.103	1.6±0.110	8.203±0.542	1.061±0.306	8.698±0.691
Elwasta	Muscle	0.031±0.006	2.808±0.105	53.783±0.859	0.731±0.201	9.475±0.396
	Gills	0.383±0.143	4.607±0.124	40.071±0.241	8.288±0.877	2.568±0.087
	Liver	0.735±0.018	9.585±0.126	53.783±0.859	1.786±0.158	12.845±1.372
	Blood	0.475±0.020	0.382±0.139	136.659±0.790	2.244±0.069	1.147±0.386
	Kidney	0.834±0.058	1.211±0.034	29.288±1.387	1.36±0.118	6.181±0.488
Naser	Muscle	0.96± 0.023	2.553±0.213	69.938±0.864	1.41±0.114	6.083±0.271
	Gills	0.919±0.531	8.091±0.414	4.468±0.150	4.878±0.649	8.653±0.183
	Liver	1.266±0.081	7.235±0.264	277.821±1.472	1.306±0.179	15.111±0.484
	Blood	0.193±0.027	0.598±0.043	125.290±1.194	0.48±0.081	5.036±0.733
	Kidney	1.355±0.065	1.203±0.073	3.181± 0.004	1.604±0.178	9.6±0.322
WHO, 2003		--	--	15 - 20	2-9	40
EOS, 1993		0.5	2	30	--	40
US EPA Abdelnaser et al., 1996		0.01	--	--	--	--
UK,MAFF		--	0.5	--	--	--

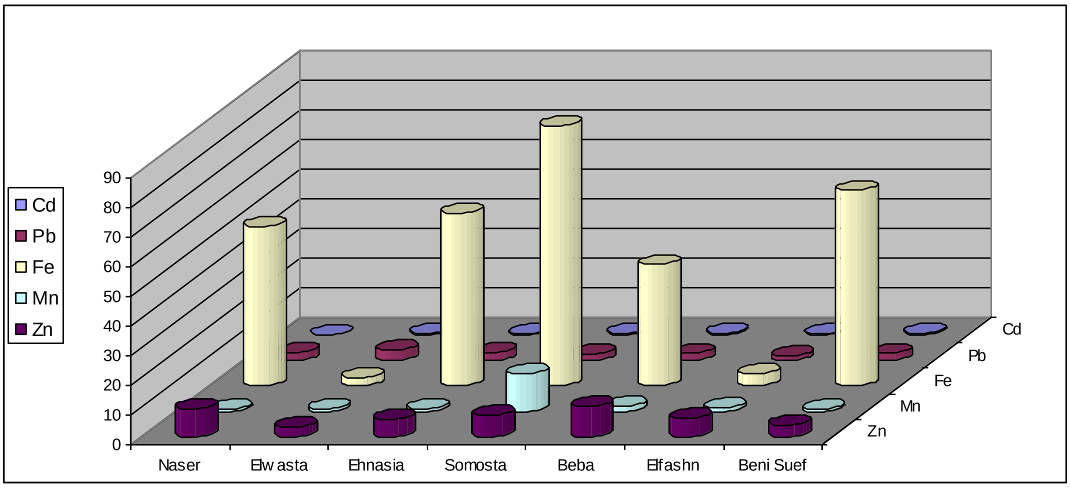

Figure 4: Metal concentrations (ppm) in muscles of Claries lazera fish samples collected from Beni Suef Governorate districts.

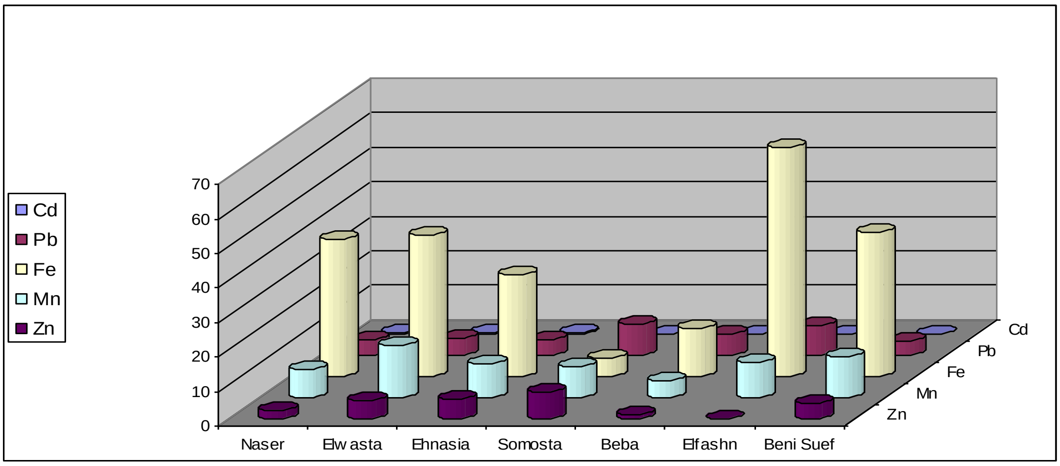

Figure 5: Metal concentrations (ppm) in gills of Claries lazera fish samples collected from Beni Suef Governorate districts.

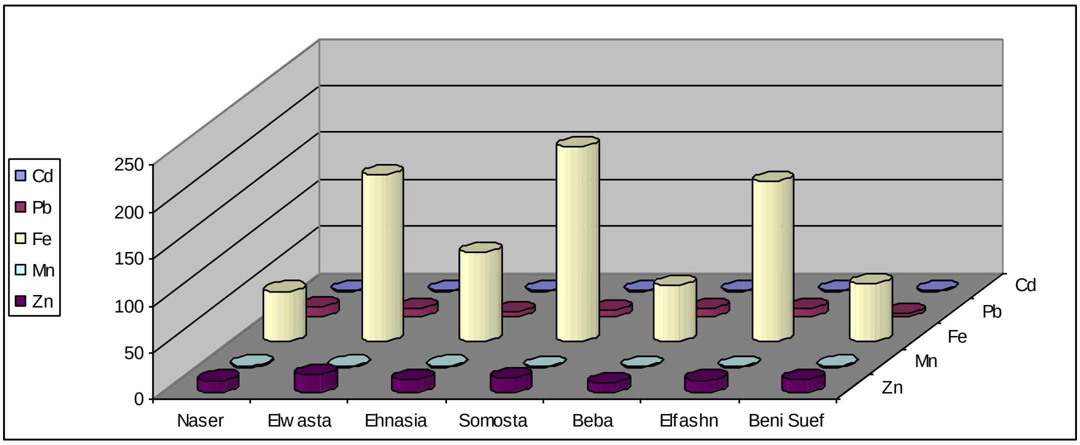

Figure 6: Metal concentrations (ppm) in liver of Claries lazera fish samples collected from Beni Suef Governorate districts.

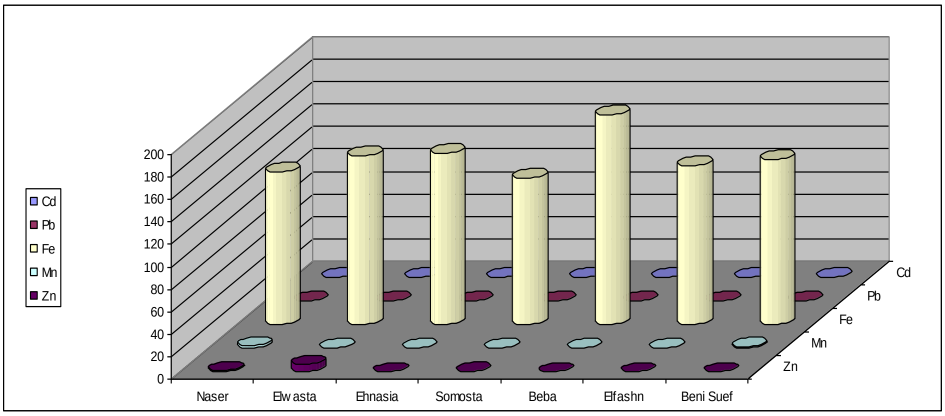

Figure 7: Metal concentrations (ppm) in blood of Claries lazera fish samples collected from Beni Suef Governorate districts.

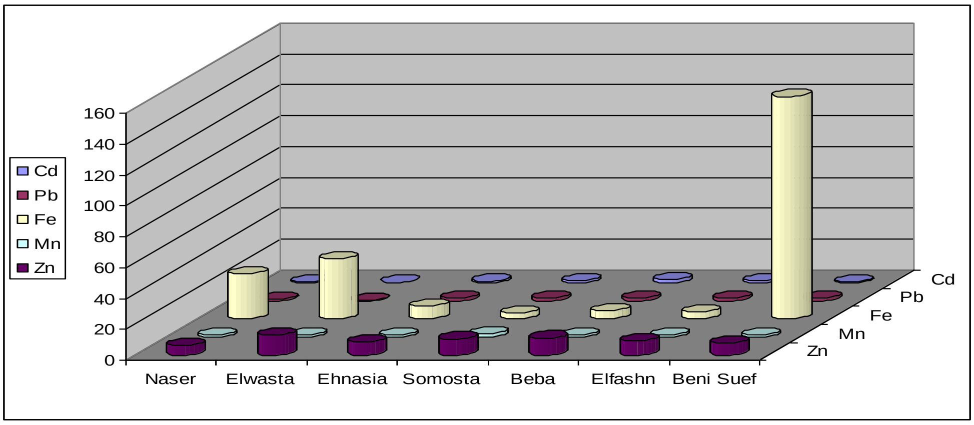

Figure 8: Metal concentrations (ppm) in kidney of Claries lazera fish samples collected from Beni Suef Governorate districts

Discussion

Metal concentrations in water

Metal concentrations in water samples are represented in Table 1 and Fig. 2. Pb has the highest concentration among the detected metals in Elfashn, Beba, Ehnasia, Naser and Elwasta while Fe has the highest concentration in Beni Suef and Mn has the highest concentration in Somosta. In order of metals concentration in different sites of El Ebrahimia canal, concentration of metals in water follows the order of: In Beni Suef were Fe > Pb > Mn > Cd > Zn; In El Fashn were Pb > Fe > Cd > Zn >, In Beba were Pb > Fe > Cd > Zn > Mn, in Somosta were Pb > Mn > Fe > Zn > Cd in Ehnasia were Mn > Pb > Fe> Zn > Cd, in Elwasta were, Pb > Mn > Fe > Cd > Zn and in Naser were Pb > Fe > Zn > Mn > Cd. Concentrations of Pb, Fe, Mn in the seven sites were above the maximum permissible limits. Cd concentration was above the permissible limit except in Somosta and Naser while Zn concentration was below the permissible limit in the seven districts.

The highest concentration of Cd was in Beni Suef, Elwasta, Elfashn, Beba, Ehnasia, Somosta and Naser (0.029±0.0006; 0.029± 0.0006; 0.025±0.002; 0.017±0.002; 0.014±0.001; 0.010±0.004 and 0.006±0.002 ppm respectively). Cd concentrations were above the national recommended limit (0.01 mg/l) adopted by (EOS, 1993); (WHO, 1993) and (U.S.EPA, 1998) except in Naser and Somosta sites were below the level [18-20]. Metals concentrations were below the limits adopted for irrigation water and livestock water by CCME, (2005) (5.1 and 80 ug/l respectively). Our results were above concentrations of Cd in water from River Nile in Aswan, Assiut and Beni-Suef regions (0.011 ± 0.005, 0.011 ± 0.01 and 0.013 ± 0.007 mg/L respectively); in surface water samples collected from Elfashn, Beba, Beni Suef, Somosta, Naser and Ehnasia districts (0.07±0.002, 0.091±0.0019, 0.107±0.036, 0.0879±0.014, 0.086±0.019 and 0.089±0.0034 ppm respectively) [21] and from selected khors of Lake Naser [7] but were below the results obtained in water from the Nile in Hawamdia and Kafer ElZayat. The highest concentration of Pb was in Naser, Elwasta, Ehnasia, Somosta, Beba, Beni Suef and El fashn (0.889±0.102; 0.710±0.023; 0.433±0.046; 0.422±0.131; 0.379±0.024; 0.254±0.086 and 0.247±0.120 ppm respectively). Pb mean values were relatively above the recommended limit (0.01 mg/l) adopted by WHO (1993) and above the highest contaminant level (0.05 mg/L) recommended by the National Interim Primary Drinking Water Regulations (U.S.EPA, 1998) but it was below the limits adopted by

CCME, 2005 for irrigation water and livestock water (200 and 100 ug/l) respectively [19-20, 22]. Abdou et al. (2003) [21] found that lead levels in water samples were 0.07±0.002, 0.091±0.0019, 0.107±0.036, 0.0879± 0.014, 0.086±0.019, 0.089±0.0034 ppm (mg/liter) in El-fashn, Beba, Beni-Suef, Somosta, Naser and Ehnasia districts, respectively. Our results were below the results of Pb concentrations in samples of water collected from Nile in Hawamdia and Kafer-El-Zayat (3.43 and 2.89 mg/l respectively) and from Nile River in Assiut governorate (1.940, 0.810, 0.810, 0.314, and 0.790 ppm) [23] and higher than the results of Pb concentration in water samples collected from lake Naser [7, 24]**.**

The highest concentration of Fe was in Ehnasia, Beni Suef, Elfashn, Naser, Elwasta, Beba and Somosta (0.307±0.005; 0.293±0.130; 0.182±0.006; 0.145±0.026; 0.090±0.003; 0.050±0.002 and 0.048±0.001 ppm respectively). Increase in Fe levels above the international standards (0.01 mg/l) [20] but below the limit (0.10 mg/l) adopted by (U.S.EPA) and (EOS, 1993) except in Ehnasia [18-19]. It was equal to the limit investigated for Fe concentrations in River Nile water at four main stations, Aswan, Mansoura, Damieta and Ras El-Bar were 0.30, 0.29, 0.38 and 0.08 mg/l respectively [25] and below the concentrations of Fe in water from ElRamla, Kalabsha, Korosko, and Toushka khors of Lake Naser which are 0.789, 0.441, 0.603, and 1.225 ppm respectively [7].

The highest concentration of Mn was found in Ehnasia, Elwasta, Beni Suef, Elfashn, Somosta, Beba, and Naser (0.725±0.132; 0.461±0.037; 0.196±0.093; 0.089±0.054; 0.053±0.025; 0.016±0.006 and 0.01± 0.003 ppm respectively). Increase in Mn levels above the international standards (0.01 mg/l) adopted by (WHO, 1993) and (0.10 mg/l) adopted by U.S.EPA (1998) except in Naser but it was below the international level (200 ug/l) for irrigation water adopted by CCME (2005) [19-20, 22]. Mn concentrations in River Nile water at four main stations, Aswan, Mansoura, Damieta and Ras ElBar are 0.36, 0.042, 0.092 and 0.08 mg/l respectively [25]. The Mn concentration found in the river Gomti water was in the range of 0.0038-0.0.0973 mg/L [26]. It was determined Mn level in water of lake in northern Thailand in concentrations ranged from 40-382 microg L.

The highest concentration of Zn was found in Elwasta, Ehnasia, Beni Suef, Beba, Naser, Somosta and Elfashn (0.028±0.008; 0.019±0.004; 0.019±0.001; 0.017±0.0004; 0.017±0.0005; 0.015±0. and 0.008±0.0040003 ppm respectively). Concentration of Zn was below the national standards (5 mg/l) adopted by (EOS, 1993) and below international standards (4 mg/l and 0.30 mg/l) adopted by WHO (1993) and U.S.EPA, (1998) in all districts along Elibrahimia canal in Beni Suef governorate [18-20]. Also it was below the international standards (1000-5000 ug/l and 50000 ug/l) adopted by CCME, (2005) for irrigation water and livestock water respectively [22]. Zinc concentrations in River Nile water at four main stations, Aswan, Mansoura, Damieta and Ras ElBar are 0.095, 0.137, 0.448, 0.128 mg/l respectively [25]. Zinc concentrations in different samples of water from the river Nile from Hawamdia and Kafer-El-Zayat, are 0.13, 0.16 and 0.16 mg/l respectively.

Metals concentrations in plant:

Macrophytes concentrate great amount of metals and are consequently useful indicators of local pollution [27-28]**.** One of the economic and rapid methods for elements removal is displacement of metals by biosorption. Ceratophyllum demersum (C. demersum) can be used for refining wastewater [12].

The analysis of C. demersum samples in Beni Suef Governorate Table, 2 and Fig.3, revealed that the distribution of metal concentration was in the order of Mn > Zn > Pb >Fe > Cd in the seven sites and that the concentrations of metal in plants were above its level in water which indicates accumulation. The highest concentration of cadmium was in C. demersum collected from Beni Suef, Ehnasia, Naser, Beba, Elwasta, Elfashn and Somosta (1.095±0.019; 0.986±0.068; 0.896±0.041; 0.751±0.028; 0.511±0.066; 0.245±0.068 and 0.121±0.004 ppm respectively). High concentrations of Cd were recorded in water and C. demersum plant grown up in lakes and canals in Serbia and Poland [29-31].

The highest concentration of Pb was in C. demersum collected from Somosta, El wasta, Elfashn, Ehnasia, Beba, Beni Suef and Naser (21.431±0.988; 7.549±0.275), 6.307±0.325; 6.032±0.437; 3.235±0.296; 3.107±0.878 and 2.214±0.120 ppm respectively). Ali and Soltan, (1999) investigated the concentrations of lead River Nile in C. demersum aquatic plant at Aswan, Mansoura, Damieta and Ras Elbar and he found that the concentration of lead are 7.1, 55.7, 38.2 and 1.20 mg/kg respectively [25]. Concentrations of lead in tissue of Ceratophyllum demersum from locality Melenci (which is located on canal Banatska Palanka - Novi Be č ej after flowing of Kikinda canal and before flowing of Stari and Plovni Begej) and locality Lazarevo (downstream from Melenci, after flowing of Stari and Plovni Begej) are on localities Vlajkovac (23,0 µg/g) [31]**.**

The highest concentration of Fe was in C. demersum collected from Elfashn, Somosta, Beni Suef, Naser, El wasta, Beba and Ehnasia (22.255±1.429; 5.768±1.946; 1.670±0.026; 1.657±0.025; 1.553±0.030; 1.472±0.063 and 1.439±0.022 respectively). Fe concentrations in River Nile C. demersum at four main stations, Aswan, Mansoura, Damieta and Ras ElBar are 5527, 4520, 2200 and 380 mg/kg respectively [25]. Concentrations of Fe in C. demersum in different canals of Serbia were determined in reported literature [29, 31]

The highest concentration of Mn was in Somosta, Elfashn, Ehnasia, Beni Suef, Elwasta, Naser and Beba (209.639±0.033; 209.438±0.021; 209.358±0.058; 209.240± 0.136; 209.221±0.060; 209.182±0.072 and

208.756±0.112 ppm respectively). Concentrations of Mn in C. demersum from locality Melenci (which is located on canal Banatska Palanka - Novi Be č ej after flowing of Kikinda canal and before flowing of Stari and Plovni Begej) and locality Lazarevo (downstream from Melenci, after flowing of Stari and Plovni Begej) are on localities Novi (12561 µg/g) and Vlajkovac (6985.3 µg/g) and to much lower in locality Hetin (961,0 µg/g) [31]. Various aquatic plant species are known to accumulate heavy metals through the process of bioaccumulation especially Mn [32].

The highest concentration of Zn was in C. demersum collected from Elfashn, Ehnasia, Somosta, Beba, Naser, El wasta and Beni Suef (19.726±0.971; 19.095±0.709; 18.173±0.212; 18.114±0.299; 17.503±0.622; 17.424±0.711 and 16.934±0.406 ppm respectively). The concentrations of zinc in macrophytes collected from various stations of east and west Edku lake are 7.76, 4.43, 15.8 and 11.49, 9.66, 8.66, 13.55, 10.48 mg/kg in E.crassipes; 4.43, 8.75, 11.83, 11.8 and 11.65, 11.07, 15.46, 16.15, 13.58 in potamogeton and 11.7, 10.97 and 12.32, 12.59, 11.3, 12.9 in ceratophylum demersum [33]. Concentrations of Zn were determined in biota collected from the Eastern Harbour and El-Mex Bay in the Mediterranean Sea, Egypt. The levels of Zn in the macroalgae, Ulva lactuca, Enteromorpha compressa (green algae) and Jania rubens (red algae), recorded high concentrations and the two species of bivalves, Donax trunculus and Paphia textile, showed different amounts of zinc in their tissue. The levels of Zn accumulated in the Saurida undosquamis, Siganus rivulatus, Lithognathus mormyrus and Sphyraena sphyraena fish samples [34].

Metal contents in tissues of fish:

Metal concentrations in muscles, gills, liver, blood and kidney of C. lazera fish samples collected from different sites were measured from 35 specimens. Average metal concentrations in different tissues are shown in Table 3 and Figs 4-8 shows that the detected levels of metal were higher than the metal level in water which may be due to accumulation. Kock et al. (1995) found extremely high concentrations of Pb and Cd in the kidney of Arctic char from alpine lakes in spite of low metal concentrations in the water [35]. Kalfakakon and Akrida-Demertai (2000) demonstrate that metal concentrations in fish are higher than in water, which indicates the bio-accumulation in the trophic chain of Ioannina Lake ecosystem, Pamvotis, Greece [36].

There was difference in accumulation of trace metals in tissues of C. lazera fish collected from El Ebrahimia canal in different seven sampling sites. Comparing mean concentration of metals was recorded in different tissues showed the following accumulation ranking: liver > Gills > kidney > blood > muscles. The difference in the accumulation of trace metals in various tissues of C. lazera fish may be attributed to the quantity present in the water, sediment and plankton, age and type of the fish and presence of ligands in the tissues having an affinity to the metal and/or to the role of the tissue in the detoxification process [37].

Concentrations of metal in muscles of C. lazera fish collected from different sampling sites follows the order of: Fe > Zn > Pb > Mn > Cd in Beni Suef; Zn > Fe > Pb > Mn > Cd in Elfashn; Fe > Zn > Pb > Mn > Cd in Beba; Fe > Pb > Mn > Zn > Cd in Somosta; Fe > Zn > Pb > Mn > Cd in Ehnasia; Fe > Zn > Pb > Mn > Cd in Elwasta and Fe > Zn > Pb > Mn > Cd in Naser.

The difference in the behavior of metals distribution in fish muscles in different sampling sites may be due to the metal concentration in ecosystem and also geological nature of the place. Aida et al., (2007) reported that concentration of metals in fish tissues may be due to the direct contact with water and sediment and indirect exposure through the food chain [38]. It was reported that the culture site and culture condition exerted significant influence on levels of macro- and microelements in freshwater fish. The results obtained from muscle samples were compared with limit values and guidelines found indicated that, Cd concentration was above the permissible limits except in Somosta and Naser. Concentrations of Pb, Fe and Mn were above the maximum permissible limits, while Zn concentration was below the limits in the seven districts.

Comparing mean concentration of Cd in muscle samples collected from different sampling sites, showed the following accumulation ranking: Naser > Somosta > Beba > Beni Suef > Elfashn > Ehnasia > Elwasta (0.96± 0.023, 0.621±0.104, 0.611±0.121, 0.48±0.15, 0.29±0.1180, 0.263±0.045 and 0.031±0.006 ppm respectively).The level of Cd in muscle samples were higher than the WHO and EOS limits in fish tissues safe consumption [18, 39]. In our study Cd values were higher than the results reported in tissue of fish collected from river Nile in Hawamdia, Kafer ElZayat and Qena [40], approximately equal to results reported by Seddek et al., (1996) [41] from Nile in Assiut Governorate and lower than the results reported by Fatma, (2008) and Saeed and Shaker, (2008) [7, 42] for samples collected from lake Naser and River Nile northern Delta lakes (Edku, Borollus and Manzalla). Boscher et al., (2010) found cadmium values in 20 % of fish samples collected from seven rivers in North of Luxembourg exceeded the threshold of about 10-50 ng g (wet wt) recommended for human health. The average concentration of Pb, Cd, Zn and Hg in muscle of fish collected from Velenjsko jezero an artificisal lake in Solvenia were below their maximum limits, determined either by Solvenian legislation or by the Food and Agriculture Organization.

Pb showed the following accumulation ranking: Elwasta > Ehnasia > Naser > Beni Suef > Beba > Somosta > Elfashn (2.808±0.105, 2.698±0.072; 2.553±0.213; 2.36±0.105; 2.336±0.095; 2.26±0.110 and 1.48±0.095 ppm respectively). The reported values were higher than the limit adopted by the WHO for cadmium (0.05 ppm) in fish tissues safe consumption [39] and above the permissible level adopted by the Egyptian Organization for Standardization and above the mean concentrations (mg/kg) fresh weight of lead (0.02) for fish in a total diet study for metals and other elements conducted by the U.K. Ministry of Agriculture, Fisheries and Food [43]. Pb values were higher than the results reported for tissue of fish collected from Nile in Hawamdia; Wadi el Rayan lakes- Egypt and from Nile in Qena province [9, 40] and lower than those reported from River Nile northern Delta lakes and lake Naser [7, 42].

Fe concentration in muscles of fish showed the following accumulation ranking: Somosta > Naser > Beni Suef > Ehnasia > Elwasta > Beba > Elfashn (88.016±0.336; 69.938±0.864; 66.016±0.770; 58.368±0.164; 53.783±0.859; 40.996±1.427 and 4.11± 0.685 ppm respectively). Fe concentrations were higher than the international standards (15-20 mg/l) adopted by WHO, (2003) and the level adopted by Egyptian Organization of Standardization (30 mg/l) (EOS, 2003) except in Elfashn [18, 20]. Our results were lower than that of Fe concentration in Tilapia nilotica collected from Nasser lake [7, 24] and higher than that of Aegean and Mediterranean seas of Turkey [44]**.**

Mn concentration in muscles showed the following accumulation ranking: Beba > Beni Suef > Elfashn > Somosta > Ehnasia > Elwasta > Naser (1.67±0.155; 0.728±0.078; 1.205±0.397; 1.116±0.643; 0.883±0.121; 0.731±0.201 and 1.41±0.114 ppm respectively). Our results were below the international standard reported by WHO. Our results were below the results of Mn concentrations in tissues of fish collected from River Nile in Assiut and from northern Delta lakes [41-42] and higher than Slovak fish species (Chub-Leuciscus cephalus, Common carp-Cyprinus carpio, Prussian carp-Carassius gibelio, Roach-Rutilus rutilus, and Wels catfish-Silurus glanis**)** [45]**.**

Zn concentration in muscles showed the following accumulation ranking: Beba > Elwasta > Somosta > Elfashn > Naser > Ehnasia > Beni Suef (10.441±0.719; 9.475±0.396; 07.419±1.226; 6.325±1.518; 6.083±0.271; 6.08±0.113 and 4.146±0.495 ppm respectively). Zn concentrations are not above the WHO and EOS standards. Our results were below Zn concentrations in tissues of fish collected from Lake Qarun and River Nile northern Delta lakes (Edku, Borollus and Manzalla) and above, different samples of catfish from the Nile in Hawamdia and Kafer ElZayat (2.09 and 1.32, µg/g respectively). In conclusion, the high concentrations of these metals were reported in the present study are evident that water, aquatic plant and fish in El Ebrahimia canal contained high levels of trace metals. Increase the concentration of some metals in water above the national and international limits may poses a health risk to several rural communities who rely on the canal as their source of domestic water. Accumulated high concentrations of metals in the fish tissues collected from different districts lead to high mortality rate or cause many biochemical and histological alterations in the survived fish. The survived fish may be unfit for human consumption. High concentrations of these trace metals are thought to have resulted from agricultural sources as agriculture is the main activity in the vicinity of Beni Suef governorate and other anthropogenic activities producing industrial, transport, domestic waste discharges as well as accidental pollution incidents. Apart from natural mineralogical sources, other source of manganese and zinc as the result of application of these elements as an additive to macronutrient fertilizers to agricultural crops deficient in these elements. More investigations should be applied to discover the possible sources and the quantitative distribution of different heavy metals in Beni Suef Governorate surface water. It is necessary to have a monitoring system for heavy metals in water, plants and fish tissues, as they constitute the environmental compartment to human and fish health.

Declaration

All authors declared that there is no any conflict of interest in between all the authors.

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