

OCCURRENCE OF LEAD AND ARSENIC IN WATER AND FISH TISSUES FROM PRIVATE FISH FARMS AT SAHL AL-HUSAINIA

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Arsenic and lead were found to be 6 and 5-fold higher at fish farm water at Husainia than that at fish farm water at the Central Laboratory of Aquaculture Research at Abbassa village, as a reference agency, respectively. Accordingly, fish samples collected from private fish farms at Sahl Al-Husainia had at least double contents of both arsenic and lead more than those breed at Abbassa. However, different fish farms at Sahl Al-Husainia showed different levels of water and fish contamination by the two metals due to the various sources of pollutions, viz: domestic, agricultural and industrial wastes.

Introduction

Fish is considered as one of the main sources of proteins in human food and as healthy food due to its high contents of minerals and vitamins and low contents of fat in contrary to other animal protein sources⁽¹⁾. However, the problem of contamination of water sources where marine organisms live may represent a serious problem, particularly metal contaminants, which are not easily removable. The pollution of seafood by heavy metals becomes severe due to the

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bioaccumulation of these metals in the organism⁽²⁾. This metal accumulation raises the normal concentrations of heavy metals to toxic levels exposing the human population who consume seafood to potential danger⁽³⁾. Age, feeding habits, and the trophic level to which the respective species belong determine metal concentration in seafood. However, the mechanism of metal accumulation in living organisms is not well established yet. The contamination of water and food by lead and arsenic is considered as disastrous environmental problem.

Lead is a poisonous element, which tends to accumulate in the tissues and bones of exposed individuals⁽⁴⁾. It can be absorbed by inhalation from air or by ingestion of solids or liquids. Lead is a general protoplasmic poison having cumulative, slow acting, and subtle properties. It exerts much of its biochemical activity through sulfhydryl inhibition due to its high affinity for sulfur. Lead also interacts with carboxyl and phosphoryl groups and interferes with heme synthesis. Organic lead compounds are absorbed into body tissues and penetrate the intact skin more rapidly than inorganic compounds. Organic lead compounds may affect nervous tissues more readily than inorganic lead compounds. Most of the lead is excreted in the kidneys, but the process of elimination is much slower than the rate at which it is absorbed. According to the recommendations by the WHO⁽⁵⁾, the daily intake of lead should not exceed 5 µg/kg of body weight. On the other hand, the toxicity of arsenic is well known historically. Arsenic combines readily with proteins due to its great affinity for sulfhydryl groups. This results in the precipitation of proteins, producing gastrointestinal irritation and irreversible inhibition of important enzyme systems⁽⁶⁾.

A number of toxic metals and other pollutants were determined in the aquatic environment of El-Manzala area⁽⁷⁾.

The present study aimed to monitor the effect of using Bahr Al-Bakar's sewage which contains domestic, industrial and agricultural waste water in the private fish farms at Sahl Al-Husainia on the contamination of fish with lead and arsenic and comparing it with less

polluted fish samples taken from the Central Laboratory of Aquaculture Research at Abbassa.

Materials and Methods

Sampling:

Thirty six water samples (≈ 1 L) in clean brown bottle each and 36 fish samples were collected from 3 different fish farms at Sahl Al-Husainia in 4 successive seasons between October and April of the year 1999. The first fish farm was fed directly with water from Bahr Al-Bakar drain. The second fish farm was fed from the drain of the first farm. The third one lies three km far from Bahr Al-Bakar drain. Similar collections (24 samples) were taken from 2 pools of fish cultures at the Central Laboratory of Fish Research at Abbassa, Abou Hammad, Sharkia. The first pool was supplied with water from Ismalia Canal and the second was supplied with agricultural waste water.

Sample Preparation:

Water samples were immediately stored at 4°C in an ice box during transportation to the laboratory. One hundred milliliter from each sample was taken and 2 mL of concentrated nitric acid was added for acidification purpose. Three replicates were carried for each sample. Arsenic and lead in the water samples were determined by atomic absorption spectrometry with graphite furnace technique.

Fish samples were washed and immediately stored at 4°C in an ice box during transportation to the laboratory. Each fish sample was divided into two parts, viz: the flesh and the remainder, just for comparative reasons. The samples were dried at 70 °C overnight. Dry ashing was used for the dissolution of samples⁽⁸⁾. In this technique the samples which have a high carbon content is heated in air in an oven until all the organic material has been burned away. Accurate weights (± 0.001 g) of the dried samples were placed in porcelain crucibles

and dry ashed at 550°C for 2 hours. The ash was then dissolved in 15 ml 20% nitric acid solution. The sample solution was filtered through Whatman filter paper No.1. The filtrate was transferred quantitatively into 100 ml volumetric flasks and completed to the mark with bidistilled water. Three replicates were carried out for each sample. Arsenic and lead in samples were determined by atomic absorption spectrometry with graphite furnace technique (Table 1).

Table (1)
Instrumental Parameters for the Determination of Lead and Arsenic by Atomic Absorption Spectrometry

Element	Wavelength (nm)	Slit Width (nm)	Ashing Temperature (°C)	Atomization Temperature (°C)
Lead	217	0.5	400	1200
Arsenic	193.7	0.5	800	2100

Chemicals:

All the chemicals used were analytical grade reagents. nitric acid from BDH CO. was used...

Instrumentation:

- 1- Muffle Furnace with a temperature control up to 1000°C.
- 2- Perkin Elmer Atomic Absorption Spectrometer model 460 attached with HGA 300 graphite furnace.

Results and Discussion

1. Determination of Lead and Arsenic in the Water Samples

Table (2) shows the concentration of lead and arsenic (µg/L) in water samples collected from two different pools of fish cultures from the Central Laboratory of Aquaculture Research at Abbassa village. The

first pool received water from Ismaelia canal, while the second pool received agricultural waste water. The results given in this table showed no general trend for the concentration of lead and arsenic in the two pools over the four time intervals. The concentration of lead in water samples collected from the first pool in October, December, February and April were 3, 12, 16 and 1 $\mu\text{g/L}$ with an average of 8 $\mu\text{g/L}$, while its concentration in the water samples collected from the second pool in the same collection months were 1, 6, 1, and 21 $\mu\text{g/L}$ with an average of 7.3 $\mu\text{g/L}$. The concentration of arsenic in the same water samples collected from the first pool were 88, 41, 58 and 85 $\mu\text{g/L}$, respectively, with an average of 68 $\mu\text{g/L}$. While its concentration in the second pool in the same collection months were 51, 53, 100 and 47 $\mu\text{g/L}$, respectively, with an average of 62.8 $\mu\text{g/L}$.

Table (2)
The Concentration of Lead and Arsenic ($\mu\text{g/L}$) in the Water of Some Pools of Fish Culture at the Central Laboratory of Aquaculture Research, Abbassa Village

Pools	Time Substance	October	December	February	April	Mean
First	Lead	3	12	16	1	8
	Arsenic	88	41	58	85	68
Second	Lead	1	6	1	21	7.3
	Arsenic	51	53	100	47	62.8

Table (3) shows the concentration of lead and arsenic in water samples collected in the four collection months, from three private fish farms at Sahl Al-Husainia. From this table it can be noted that the concentration of lead in the water samples are 32.8, 39.3, 54 and 65.5 $\mu\text{g/L}$ for the first fish farm, 17, 35.9, 42.5 and 55 $\mu\text{g/L}$ for the second

fish farm and 43, 44, 100.5 and 113.5 for the third fish farm, with averages of 47.9, 37.6, and 75.3, respectively. The concentration of arsenic in the same water samples are 325, 364, 326 and 529 $\mu\text{g/L}$; 253, 397, 404, and 464 $\mu\text{g/L}$ and 257, 458, 551 and 458 $\mu\text{g/L}$ with averages of 386, 379.5 and 431 $\mu\text{g/L}$ for the three private fish farms, respectively.

From this results it is noted that the concentration of lead in the water samples collected from the three private fish farms are 5 to 10 fold and six-fold, in case of arsenic, their concentration in water samples collected from the two pools at the Central Laboratory of Aquaculture Research at Abbassa, regardless of the source of water whether it is from Ismaelia canal or from agricultural waste water. Figures (1 and 2) show the graphical representation of these results.

Table (3)
The Concentration of Lead and Arsenic ($\mu\text{g/L}$)
in the Water Samples Collected from
the Three Private Fish Farm at Sahl Al- Husainia

Farms	Time Substance	October	December	February	April	Mean
First	Lead	32.8	39.3	54	65.5	47.9
	Arsenic	325	364	326	529	386
Second	Lead	17	35.9	42.5	55	37.6
	Arsenic	253	397	404	464	379.5
Third	Lead	43	44	100.5	113.5	75.3
	Arsenic	257	458	551	458	431

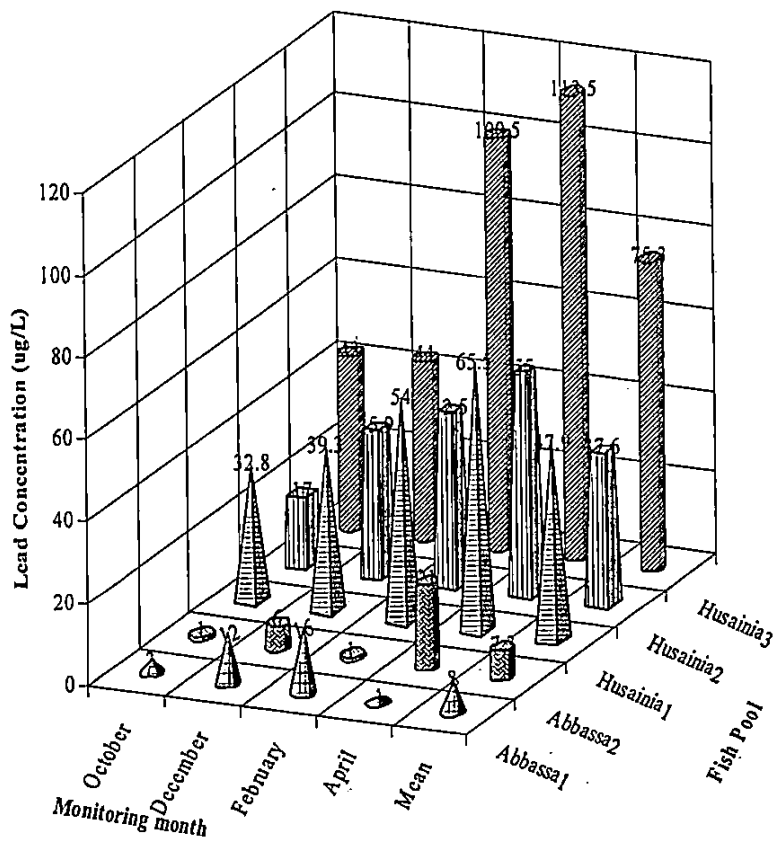


Fig (1): The Concentration of Lead in Water of Fish Cultures

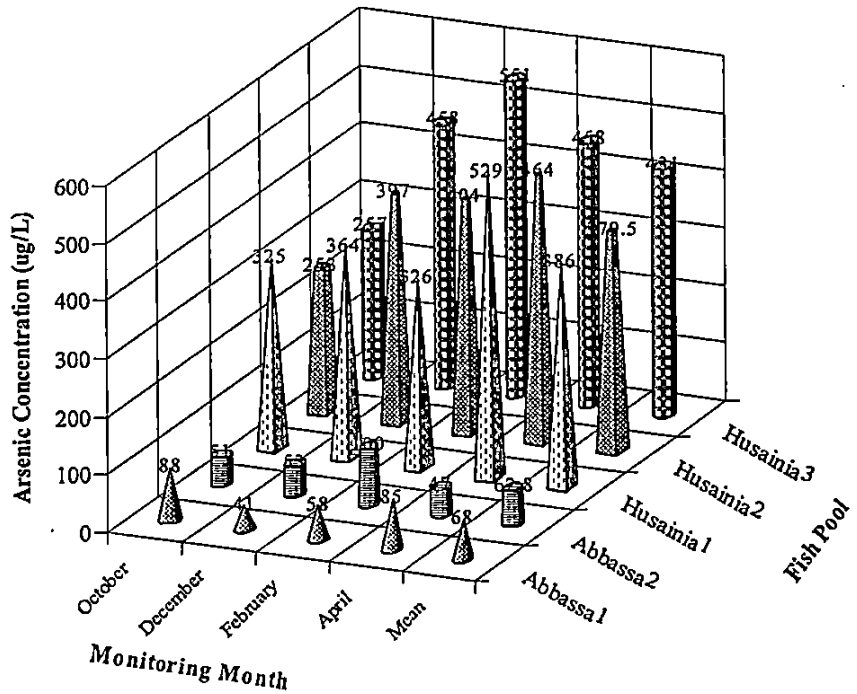


Fig (2) : The Concentration of Arsenic in Water of Fish Cultures

2- Determination of Lead and Arsenic in the Fish Samples

Tables (4 and 5) show the concentration of lead and arsenic in the fish samples collected from the two studied pools of fish culture at the Central Laboratory of Aquaculture Research at Abbassa. From the two tables it is noted that the concentration of lead in fish flesh collected from the first pool, which is supplied with water from Ismaelia canal, ranges between 46.4 and 55.5 $\mu\text{g}/\text{kg}$ for dry flesh samples with an average of 51.8 $\mu\text{g}/\text{kg}$. For the dry skin and head samples the concentration of lead ranges between 146.9 to 255.2 $\mu\text{g}/\text{kg}$ with an average of 199 $\mu\text{g}/\text{kg}$. The average lead concentration in total dry fish samples is 125.4 $\mu\text{g}/\text{kg}$. On the other hand, the range of concentration of arsenic in dry fish flesh samples collected from the same pool is 819.3 to 1199.7 $\mu\text{g}/\text{kg}$ with an average of 1011.4 $\mu\text{g}/\text{kg}$. For dry skin and head samples the range is 315.3 to 535.1 $\mu\text{g}/\text{kg}$ with an average of 421.9 $\mu\text{g}/\text{kg}$. The average arsenic concentration in total dry fish samples is 716.7 $\mu\text{g}/\text{kg}$.

For the second pool which is supplied with agricultured waste water, the lead and arsenic concentration are; For fish flesh, the lead concentration range is 33.3 to 250 $\mu\text{g}/\text{kg}$ with an average of 136.2 $\mu\text{g}/\text{kg}$ of the dry fish samples. For arsenic the range of concentration in fish flesh is 562.9 to 4208.3 $\mu\text{g}/\text{kg}$ with average of 1894 $\mu\text{g}/\text{kg}$ of the dry fish samples. The range of lead in dry skin and head is 120.7 to 732.5 $\mu\text{g}/\text{kg}$ with an average of 405.1 $\mu\text{g}/\text{kg}$ and that for arsenic is 414.3 to 1423.4 $\mu\text{g}/\text{kg}$ with an average of 906 $\mu\text{g}/\text{kg}$. The total average concentration of lead in dry fish samples is 270.7 $\mu\text{g}/\text{kg}$ and that for arsenic is 1400 $\mu\text{g}/\text{kg}$.

For the studied private fish farms at Sahl Al-Husainia, the lead concentration in dry fish flesh collected from the first fish farm at the four collection time intervals range from 106 to 252 $\mu\text{g}/\text{kg}$ with an average of 166.5 $\mu\text{g}/\text{kg}$ Table (6) and Figure (3).

For the second fish farm, the lead concentration in dry fish flesh range between 78 and 297 $\mu\text{g}/\text{kg}$ with an average of 188.3 $\mu\text{g}/\text{kg}$.

Table (4)
The Concentration of Lead and Arsenic ($\mu\text{g}/\text{kg}$)
in Dried Fish Samples Collected from the First Pool at the
Central Laboratory of Aquaculture Research, Abbassa Village.

Time	October			December			February			April			Mean Total Flesh +Skin	Total Average	
	Fish Part	Flesh +Skin	Head Total	Flesh +Skin	Head Total	Flesh +Skin	Head Total	Flesh +Skin	Head Total	Flesh +Skin	Head Total				
Lead	54.8	146.9	100.9	50.4	157.2	103.8	46.4	236.5	141.5	55.5	255.2	155.4	51.8	199	125.4
Arsenic	819.3	315.3	567.3	1012.4	535.1	773.8	1199.7	470.5	835.1	1014.2	366.8	690.5	1011.4	421.9	716.7

Table (5)
The Concentration of Lead and Arsenic ($\mu\text{g}/\text{kg}$)
in Dried Fish Samples Collected from the Second Pool at
the Central Laboratory of Aquaculture Research, Abbassa Village

Time	October			December			February			April			Mean Total Flesh +Skin	Total Average	
	Fish Part	Flesh +Skin	Head Total	Flesh +Skin	Head Total	Flesh +Skin	Head Total	Flesh +Skin	Head Total	Flesh +Skin	Head Total				
Lead	134	732.5	433.3	127.4	120.7	124.1	33.3	251.2	142.3	250	516	383	136.2	405.1	270.7
Arsenic	4208.3	1327.7	2768	1548.3	458.6	1003.5	1256.6	414.3	835.5	562.9	1423.4	993.2	1894	906	1400

Table (6)
 The Concentration of Lead and Arsenic ($\mu\text{g}/\text{kg}$)
 in Dried Fish Samples Collected
 from the First fish farm at Sahl Al- Huasinia

Time	October			December			February			April			Mean		
	Fish Part	Flesh	Head +Skin	Flesh	Head +Skin	Total	Flesh	Head +Skin	Total	Flesh	Head +Skin	Total	Flesh	Head +Skin	Total Average
Lead	252	396.5	324.3	135	1934	1034.5	173	1184.5	678.8	106	133	119.5	166.5	912	539.3
Arsenic	1369	1744	1556.5	1012	1353.5	1182.8	2035	1902.5	1968.8	256	596	426	1168	1399	1283.5

Table (7)
 The Concentration of Lead and Arsenic ($\mu\text{g}/\text{kg}$)
 in Dried Fish Samples Collected
 the Second fish farm at Sahl Al- Huasinia

Time	October			December			February			April			Mean		
	Fish Part	Flesh	Head +Skin	Flesh	Head +Skin	Total	Flesh	Head +Skin	Total	Flesh	Head +Skin	Total	Flesh	Head +Skin	Total Average
Lead	78	486.5	282.3	297	543	420	100	135.5	117.8	278	1276.5	777.3	188.3	610.4	399.4
Arsenic	1674	1146	1410	1772	1627	1699.5	360	877.5	618.8	1217	1395	1306	1255.8	1261.4	1258.6

For the third fish farm, the lead concentration in dry fish flesh range between 255 and 491 $\mu\text{g}/\text{kg}$ with an average of 383.3 $\mu\text{g}/\text{kg}$ (Table 8). The range of concentration of lead in dry fish skin and head collected from the first farm is 133 to 1934 $\mu\text{g}/\text{kg}$ with an average of 912 $\mu\text{g}/\text{kg}$. For the second fish farm is 135.5 to 1276.5 $\mu\text{g}/\text{kg}$ with an average of 610.4 $\mu\text{g}/\text{kg}$, while for the third fish farm it is 176 to 1406 $\mu\text{g}/\text{kg}$ with an average of 607.9 $\mu\text{g}/\text{kg}$ (Table 8 and Figure 3).

On the other hand, the range of arsenic concentration in the dry fish flesh collected from the first farm at Sahl Al Husainia is 256 to 2035 $\mu\text{g}/\text{kg}$, with an average of 1168 $\mu\text{g}/\text{kg}$ Table (6) and Figure (4), while it is 360 to 1772 $\mu\text{g}/\text{kg}$, with an average of 1255.8 $\mu\text{g}/\text{kg}$ and 583 to 3267 $\mu\text{g}/\text{kg}$ with an average of 1402.5 $\mu\text{g}/\text{kg}$ for the second and third fish farm.

For skin and head of fish samples collected from the studied three private fish farms the concentration of arsenic rang is 596 to 1902.5 $\mu\text{g}/\text{kg}$, with an average of 1399 $\mu\text{g}/\text{kg}$, for the first farm, and 877.5 to 1627 $\mu\text{g}/\text{kg}$ with an average of 1261.4 $\mu\text{g}/\text{kg}$, 1163 to 7430 $\mu\text{g}/\text{kg}$ of the dry samples with an average of 3007.6 $\mu\text{g}/\text{kg}$ for the second and third fish farms respectively.

From the above mentioned results, the concentration of lead and arsnic in the total fish samples collected from the three private fish farm at Sahl Al Husainia are 539.3 and 1283.5 $\mu\text{g}/\text{kg}$ of the dry samples collected from the first fish farm, 399.4 and 1258.6 $\mu\text{g}/\text{kg}$ of the dry samples collected from the second fish farm and 495.6 and 2205.1 $\mu\text{g}/\text{kg}$ of the dry samples collected from the third fish farm respectively.

Also, the concentration of the two studied elements in fish samples collected from the second fish pool at the central laboratory of aquaculture research at Abbassa which is supplied with agriculturd waste water is almost double that found in the fish samples collected from the first pool, where the water source is from Ismaelia canal.

Table (8)
 The Concentration of Lead and Arsenic ($\mu\text{g}/\text{kg}$)
 in Dried Fish Samples Collected from
 the Third fish farm at Sahl Al- Huasimia

Time	October			December			February			April			Mean		
	Flesh	Head	Total	Flesh	Head	Total	Flesh	Head	Total	Flesh	Head	Total	Total	Total	Total
Lead	462	1406	934	255	176	215.5	419	389	440	325	460.5	392.8	383.3	607.9	495.6
Arsenic	1153	1163	1158	607	1287.5	947.3	583	2150	1366.5	3267	7430	5348.5	1402.5	3007.6	2205.1

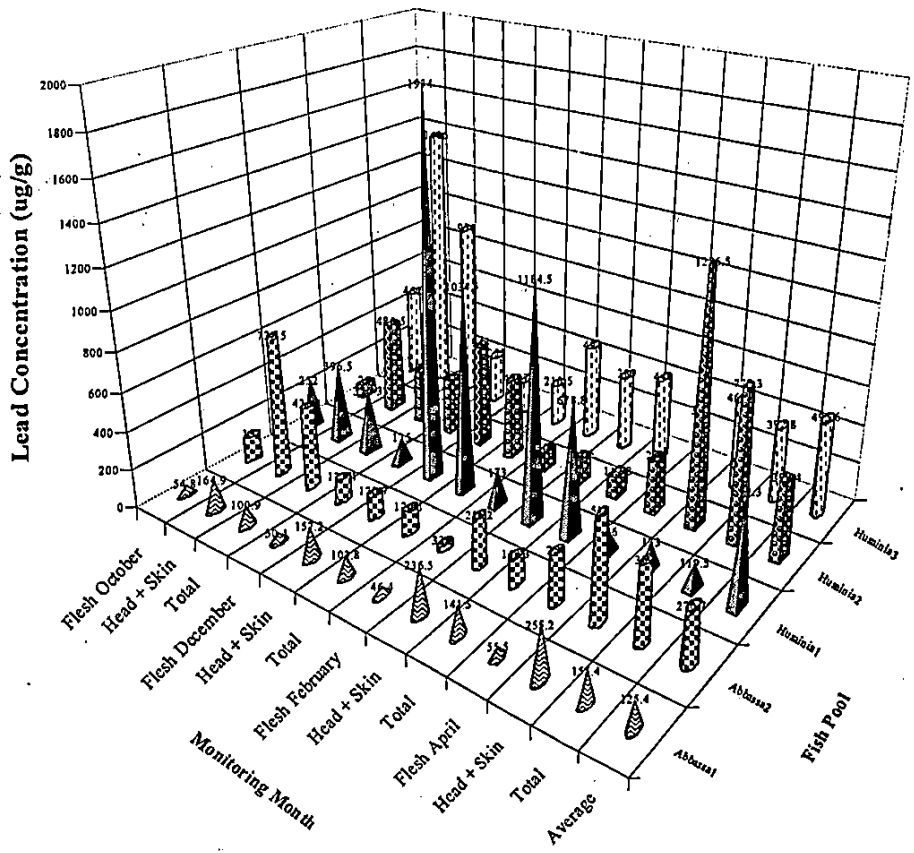


Fig (3): The Concentration of Lead in Dried Fish Samples

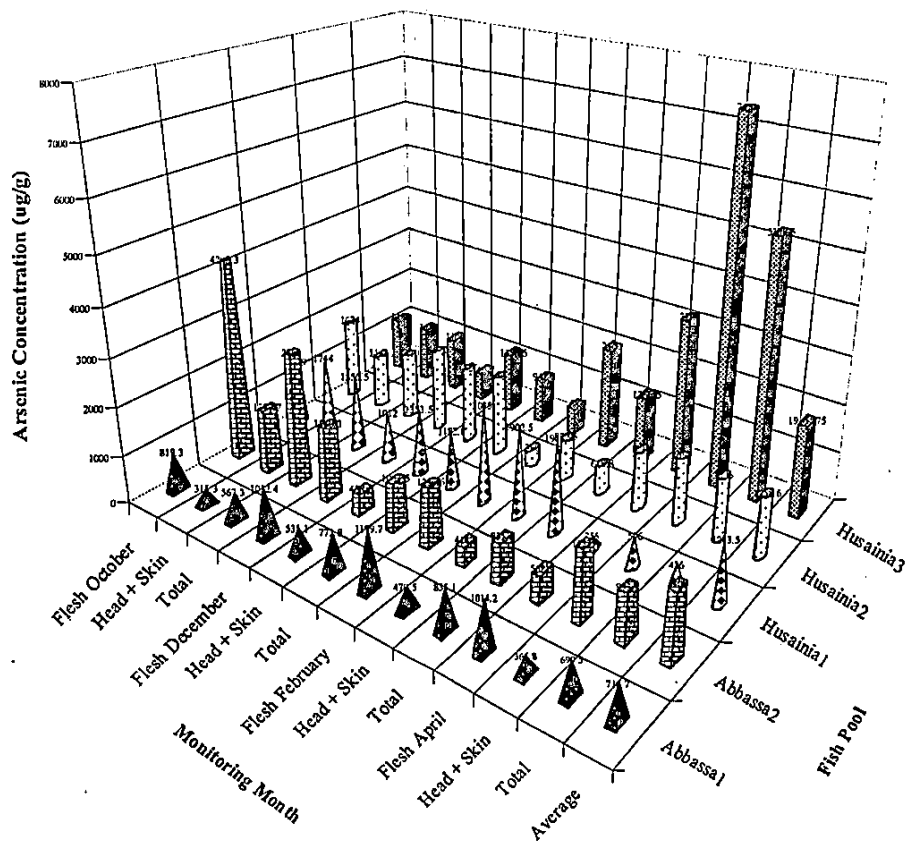


Fig (4): The Concentration of Arsenic in Dried Fish Samples

Conclusion

It is found that the concentration of lead in the fish samples collected from the private fish farm at Sahl Al-Husainia is four-fold its concentration in fish samples collected from first pool and double its concentration in fish samples collected from the second pool. While for arsenic its concentration in fish samples collected from the private fish farms at Sahl Al-Husainia is double its concentration in fish samples collected from the first pool and almost the same its concentration in fish samples collected from the second pool.

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See Also:

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تقدير كمية الرصاص والزرنيخ في عينات المياه
والأسماك ببعض المزارع السمكية بسهل الحسينية

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تم دراسة تأثير التلوث بعنصرى الزرنيخ والرصاص فى مياه مصرف بحر البقر على الاستزراع السمكى بمنطقة سهل الحسينية بمحافظة الشرقية ، ووجد أن تركيز العنصرين فى مياه المزارع السمكية بتلك المنطقة بلغ من خمسة إلى ستة أضعاف تركيز العنصرين فى مياه المزارع السمكية فى العمل المركزى لبحوث الاستزراع السمكى بقرية العباسة بالشرقية كجهة مرجعية . وتبعاً لذلك ، فإن أقل تركيز للعنصرين فى أسماك الحسينية بلغ ضعف ذلك التركيز فى أسماك المزارع السمكية بالعباسة ، وكذلك وجد أن تركيز العنصرين فى مياه و أسماك المزارع المختلفة بالحسينية يختلف تبعاً لمصدر التلوث من حيث إنه صرف صحى أو زراعى أو صناعى .