Toxicological studies on some industrial pollutants and its effect on fishes

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SUMMARY

Nowadays, industrial water pollution is getting to be a major concern. Many chemical involved in the industrial processes may be potentially harmful to the aquatic life unless their concentration are strictly regulated. Among these harmful chemical copper, lead, chromium, cadmium and fluorine which are toxic to many forms of life.

This study handles 10 water samples collected from different localities at El-Mehala Al-Kobra (as an industrial city), also 10 sediment samples around these drainage were collected. In addition, 10 samples of fish found in these drainages were collected. All these samples were used to determine concentrations of copper, lead, chromium, cadmium and fluorine.

The obtained results revealed high concentration of copper, lead and cadmium in water , sediment and fish flash which were more than the permissible limits recorded by WHO. Concentrations of chromium and fluorine were variable in water, sediment and fish flash according to the localities of sampling. The obtained results indicated that, there is positive correlation between heavy metal concentration in water, sediment and fish. As sediment act as a high source for heavy metal pollution because metal has the ability to accumulate in clay particles and so cause contamination of fish and plants grow around it.

Public health importance and hazardous toxic effect of these heavy metals as well as recommendation to minimize water pollution were discussed .

INTRODUCTION

Pollution with heavy metals is considered as one of the most important environmental problems in Egypt. It is well known that heavy metals have a great ecological significant due to their toxicity and accumulation behavior. They playing a prominent role in the aquatic ecosystems. Water pollution affects not only the aquatic ecosystems which are exposed to it, but also have an impact on human health. The continuous exposure to low concentration of heavy metal may result in bioaccumulation and resulting health consequence in man, so recently the heavy metal come to fore front dangerous substance causing serious health hazards in human and other organisms including fish.

The bioaccumulation of metals is therefore, an induce of pollution status of the relevant water. Fish is one of the most important food for human consumption due to its high protein quality, its essential amino acids, trace elements and minerals that are not easily synthesized in mammalian body *(Tantawy, 1997)*.

Copper

Copper is often present with other minerals especially zinc at harmful concentration. Repeated exposure to high concentration of copper leads to hemolytic anemia *(Elsa 1991)*. *Emara et al., (1993)* showed that copper accumulated in bone to greater extent than in muscle. Also, *Zdenka et al., (1993)* recorded that the physical (temperature of water) and chemical (alkalinity or hardness) properties of water exert a strong influence on the mode of toxicity of copper to fish because these properties affect solubility of copper salts & consequently its absorption by fish.

WHO (1984) recommended that concentration of copper must not exceed 100 mg/L in water to be available for human consumption.

Khargarot & Tripathi (1991) recorded clinical signs of copper toxicity in fish exposed for 0.33 mg/L copper for 7 days. These symptoms were hypersecretion of mucous, loss of shape & size and appearance of nervous movement.

Lead

Lead is one of the most frequent causes of poisoning. It is the most common toxicant in cattle and is available through ingestion of paint, lead solder and battery terminals and various lead containing spray *(Louis & John 1975)*. The metal plays essential roles in protein structure enzyme catalysis, osmotic balance & transport process. These biological process are sensitive to alteration by toxic metal that are chemically similar to essential metals that functioning as coenzyme *(pounds 1985)*. In the same time, *Zdenka, et al., (1993)* recorded that lead toxicity to fish and to other aquatic organisms is significantly influenced by water quality, solubility of lead compound, concentration of Ca and Mg in water and pH value in water as the solubility of salts decrease with increase pH. Lead inhibits the biosynthesis of hem, so it affects the membrane permeability of liver, kidney and brain cells which reduces the function or completely breakdown the tissue *(Chevreuil, et al., 1995)*.

Chrominm

Little reports were recorded about chromium in water as those by *Johnson & Sigg, (1992); Zdenka et al (1993) and Gwynettr (1994)*. They concluded that the relatively unreactive oxidized anion of chromium VI is removed from water column by adsorption to particulate or by reduction to chromium III quite rapidly at pH 7. They recorded that chromium can enter the tissue of fish & become accumulated to an asymptomatic level to its concentration in the medium.

Feldman, (1986) showed that Chromium inhibit several microsomal & soluble enzyme, impaired respiratory function. Gwyneth, (1994) studied the acute poisoning by chromium compound who found that body surface of fish was covered with mucous. The respiratory epithelium of the grills is damaged and the fish die with symptoms of suffocation. Fish suffering from chronic chromium intoxication accumulated an orange yellow liquid in their body cavity showing highly nervous state in all direction of aquarium. *WHO, (1984)* reported water permissible limit should not exceed 0.05 ppm to be available for human consumption.

Cadmium

Cadmium was found to be the causative agent of human modady known as Itai-Itai disease which result from chronic cadmium poisoning.

The data of *Klee & Vanaman (1989)*, showed that cadmium of feets calcium, phosphate & bone metabolism as it combined with sulphydryl group & inhibit a number of enzyme systems.

Cadmium input to aquatic environment is through industrial waste surface run off and deposition is strongly adsorbed into sediment soil. The average concentration recorded were 5 mg/kg and 0.03 to 1 mg/kg in fresh water, sediment & marine sediment respectively *(WHO, 1992)*.

El-Bouhy et al., (1994) reported that the rate of uptake and toxic impact of cadmium on aquatic organisms is greatly affected by physiochemical factors as temperature, ionic concentration and organic matter content. Also, they reported that in case of chronic toxicity beside nervous sides there was periodical attack of neuromascular spasm followed by continuous tension of opposing mode. Fish remained lying down on the bottom of the aquarium with tension in their muscles for long period that reached few weeks before dying.

Flourine

Flourine is present naturally in rock, often in association with phosphate and thus soils and surrounding water can contain large amount of fluorine, even as high as 8.7 ppm in water *(Payne 1989)*. Flourine is a general tissue poison, when large amount are ingested, death are rapidly occur following gastric irritation due to formation of hydrofluoric acid. Nervous signs & tetany may follow the drop of calcium level in serum as formation of inactive calcium fluoride. Blood clotting may also be inhibited *(Payne 1989)*. Toxicity of fluorine localized in bones & teeth causes enlargement and softening of mineral structure.

Louis & John (1975) reported that the fluorine substituted acetate gives flouroacetate which produce toxic action by inhibiting citric acid cycle. So, there is an accumulation of large quantities of citrate in the tissue & the cycle is blocked. So, heart and central nervous system are the most critical tissue involved in poising by general inhibition of oxidative energy metabolism.

The present study was undertaken to investigate the degree of heavy metal pollution in water, sediment and fish (Tilapia Nilotica) at El-Mahala El-

Kobra (as an industrial city) and its refliction on the health hazard of human consumers. Five metal were analyzed (copper, lead, chromium, cadmium and fluorine) in water, sediment and fish to give spot line on the degree of water pollution at this area.

MATERIALS AND METHODS

A- Sampling:

1- Water sample:

Ten water samples were collected from main drainage pipe of one of the textile factory in El-Mahala El-Kobra at different localities of the drainge. The technique of water sampling was conducted according to *A.P.H.A (1989).*

2- Sediment samples:

Ten sediment samples were collected from the same localities of water samples according to technique recorded by *De Vevey et al., (1993).*

3- Fish samples:

Five samples of (Tilapia nilotica) fish were taken from each of the different localities with total number of 10 samples. The average weight/fish was 120 – 230 gm.

B- Preparation and analysis of samples:

1-The preparation of water samples for determination heavy metal were conducted according to *Polprasert (1982).*

2-The preparation of sediment samples for estimation of heavy metal were conducted according to *Alloway (1995).*

3-The preparation of fish samples for determination heavy metal were conducted according to *Greig et al., (1989).*

All samples were analyzed by atomic absorption spectrophotometer (Unicam 969 AA spectrophotometer).

The obtained data were statistically analyzed by using method described by *zlevin (1996).*

Result and Discussion

It is important to determine the concentration of heavy metals in marine organisms as it is considered as monitor for pollution of water. These pollutant may constitute a health hazard for human consumers. The present study was concerned with pollution of water with heavy metal through the drainage of some industrial establishment and the complication of this problem on sediment where plants may grow and consumed either by human or animal and on the marine tissue in Egypt. The study was carried out at El-Mahala El-Kobra city at El-Gharbia Governorate as a big industrial city with high percent of pollution.

Water monitored for pollutants include seawater, moving surface, water at various depths in lakes, pools and ground water in aquifers. In addition, water needed to be monitored and will be subjected to the stricfaest regulation for maximum permissible concentrations of pollutants *(Fifield 1995).*

In our study we selected an area e.g. El-Mahala El-Kobra city as it contains many industrial factories.

Copper

From the obtained results recorded in table (1) it is clear that the copper concentration in water was higher than permissible limits. Similar to our results, those recorded by *Manal (1995)* who estimated copper concentration at El-Max region and results recorded by *Salah et al., (1985)* at El-Max industrial factories while *Saad (1995)* detected lower level of copper in Mariute lake and *Beltagy, (1995)* at Brulus.

This variation may be attributed to the fact that the factories in these areas use large quantities and different types of dyes containing copper. The source of copper is mainly from agricultural activities contaminated by copper sulphate which is the most important algicide used by ministry of agriculture & irrigation of water source. Also, copper concentration in sediment were ranged from 28.7+1.18 to 44.3+2.25 ppm as it received industrial wastes from industrial area. Similar results were recorded by *Omaya (1982).*

Concerning to the mean copper concentration in fish samples, the results were 9.4+0.83 to 13.9+0.29 ppm. Results recorded by *Samaha and Mousa (1993)*in Alxandria ; *Amal (1993)* at Manqabad and *Manal, (1995)* in Assiut were lower than our results while those recorded by *Hassan & Youssef (1985)* and *Amal (1993)* in El-Moteha were nearly similar to our data.

WHO (1992) recorded that permissible limit of copper in flesh of fish shouldn't exceed 1.00 ppm. So our results revealed that all sample of fish have many times higher level than the permissible limits.

Lead

Our results demonstrated an elevation of lead concentration in all tested water & sediment samples. These could be attributed to the industrial exhausts & sewage discharge. Several studies have been concerned with lead pollution in water in Egypt. *Asaad (1994)* reported that lead concentration in fresh water at El-Gharbia was 0.48 to 0.61 ppm. *Ghalab (1997)* found that the residual contents at El-Manzala lake ranged between 0.208 to 0.368 ppm. More over *Khalaf – Alla (1998)* found that the average of lead at Nile River at Helwan district was 0.371 ppm.

Regarding to the concentration of lead in fish tissue, results were summarized in table (1) revealed high level of lead concentration. It is obvious that the residual concentration of lead in fish tissue is higher than those recorded in water. This is may be attributed to the fact that fish have ability to accumulate trace metals dissolved in water *(Khattab, 1992).*

Chromium

Concerning frequency distribution of chromium in water sample and sediment it was ranged from between 0.084+0.03 to 0.132+0.01 and 28.9+3.11 to 35.7+3.47 ppm, respectively.

Our results was agreed with the results recorded by *Saleh et al., (1985)* in western Harbour and *Sanaa (1994)* in Mariut Lake in water and also our data resemble those recorded by *Saad (1995)* in Egypt.

Regarding to the mean values of chromium concentration in fish muscle, it was found to be 4.24+0.11 to 8.11+0.25 ppm. Similar level was recorded by *Sanaa (1994)* in Maruite lake. *WHO (1984)* recorded that the level of chromium in fish tissue should not exceed 0.02 to 0002 ppm to be available for human consumption. So all samples contain more than permissible limit & represent a dangerous effect to fish

Cadmium:

From Table (1) it is clear that, cadmium concentration was ranged from 0.003+0.001 to 0.025+0.001 ppm in water while in sediment it was found to be 0.714+0.07 to 0.930.0.06 ppm, this is may due to industrial pollution. Similar finding was recorded by *Khalil, (1996)* for tap water delivered by copper pipe., *Abou Salem, (1991)* in Moshtohor and *Abd El-Kadr et al., (1993)* in Isamailia.

Cadmium concentration in fish muscle were 0.95+0.01 to 2.7+0.01 ppm. Higher levels were recorded by *Hassan & Youssef (1985)* in Assuit.

So our results give an idea about the amount of metal precipitated by mud particles depend on water concentration for that metal. Sediment tend to be a sink for most pollutants and also act as a filter which protect the ground water from pollution. So, it can be argued that all sediment in industrialized countries have been polluted with many trace substance. Also, sediment analysis was considered as monitor for industrial and other human activities and the relationship between water, sediment and other aquatic living organisms.

Fluorine

The analytical results listed in Table (1) revealed that the concentration level of fluorine water, sediment within the permissible limit and as recorded by *Payne, (1989)*. In fish muscle, the concentration of fluorine were nearly similar to the finding reported by *Seddek et al., (1996)* in River Nile, the panani of fluorine in fish indicate a normal level of fluorine in Nile water where no cumulative value are present in fish. So, fluorine can be considered safe in fish for human consumption.

Finally, the obtained results give us opportunity to conclude that the industrial area in El-Mahala El-Kobra suffer from continuous industrial, agricultural & sewage pollution although they use treatment units for textile drainage, adversely effect on aquatic environment in El-Gharbia Governorate.

Sediment act as a high source for heavy metal pollution because metal has ability to accumulate in clay particles and so it cause contamination to fish and plants grow around it.

Recommendation

1- Using of treatment units, hygienic disposal and treatment of agricultural & sewage wastes from the origin with decrease the hazard caused by heavy metal.

2- Regular & period monitoring for water and sediment samples at suspected area of pollution.

3- Periodic fish analysis for heavy metal should be conducted to measure pollution level.

4- Fishing should be prevented at the polluted sites and give people information about the dangerous effect of consuming contaminated fish.

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Table (1): Heavy metals concentration (ppm) in examined samples of water, sediment and fish muscles.

Heavy metal	Water	Sediment	Fish
Copper:			
Mean	0.230 ± 0.019	28.7 ±1.18	9.4 ±0.85
Max.	0.527 ± 0.015	44.6 ±2.25	13.9 ±0.29
Min.	0.387 ± 0.037	35.76 ± 1.23	11.633 ± 0.36
Lead			
Mean	0.148 ± 0.01	33.7 ±4.81	5.41 ± 0.7
Max.	0.459 ± 0.05	52.9 ±6.73	10.80 ±0.80
Min.	0.386 ± 0.106	45.96 ± 2.04	7.103 ± 0.82
Chromium			
Mean	0.084 ± 0.03	28.9 ± 3.11	4.24 ± 0.11
Max.	0.132 ± 0.01	35.7 ± 3.41	8.11 ±0.25
Min.	0.101 ± 0.016	32.74 ± 2.605	6.362 ± 0.45
Cadmium			
Mean	0.008 ± 0.001	0.714 ±0.07	0.95 ± 0.09
Max.	0.025 ± 0.003	0.937 ±0.06	2.70 ± 0.10
Min.	0.020 ± 0.004	0.825 ± 0.098	1.85 ± 0.12
Flourine			
Mean	0.060 ± 0.001	0.182 ± 0.08	0.115 ±0.01
Max.	0.090 ± 0.001	0.232 ± 0.03	0.300 ±0.01
Min.	0.075 ± 0.002	0.201 ± 0.04	0.213 ± 0.05

Table (2): Permissible limits of heavy metal (ppm) in water and fish as recorded by WHO (1984).

Heavy metal	Water	Sediment	Fish
Copper	1.00 ppm	No	0.05 ppm
Lead	0.05 ppm	Available	0.001 ppm
Chromium	0.05 ppm	Literature	0.02 – 0.002 ppm
Cadmium	0.05		0.05 ppm
Fluorine	100 – 180 µg/L		0.126 – 0.380 ppm

الملخص العربى

دراسة سمية بعض ملوثات الصناعة (المعادن الثقيلة) في المياه و أثرها علي الأسماك

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تلعب البيئة دورا هاما في حياة الأنسان و الحيوان ولذلك فإن وجود مواد ضارة بها يؤدى إلي تلوثها ويؤثر ذلك علي الحياة بها وقد يحدث هذا التلوث في الهواء و التربة و الماء سواء كان في البحار أو الأنهار. و نظرا للتلوث المستمر بالمعادن الثقيلة و خوفا من تأثير ذلك علي صحة الأنسان نتيجة نعرضة لمختلف الأثار السلبية لهذه الملوثات فقد كانت هذه الدراسة. تم إختيار مدينة المحلة الكبري كمدينة صناعية لنقوم بها بدراسة و تحديد نسبة المعادن الثقيلة (النحاس- الرصاص- الكروم- الكاديوم- الفلورين) في إخراجات المصانع وتتبعها علي بعد كبير حتي مصبها في مصرف أخر.

تم فحص عينات من الطمي لأنه يعتبر وسط جيد لتراكم المعادن الثقيلة وكونه أضا مصدر للنباتات و كان لابد من أخذ عينات من الأسماك التي تعيش في هذه المناطق و تقدير نسبة المعادن الثقيلة (النحاس- الرصاص- الكروم- الكاديوم- الفلورين) لمعرفة مدى خطورتها علي صحة الأنسان الذى يعتمد علي الأسماك كغذاء.

أظهرت نتائج تحليل المياة و الطمي و الأسماك إن تركيزات النحاس و الرصاص و الكاديوم تتعدي النسب المسموح بها عالميا من قبل منظمة الصحة العالمية. أما بالنسبة للكروم و الفلورين فقد كانت بعض العينات تتجاوز النسب المسموح بها عالميا و الأخري في الحدود المسموم بها علي حسب المواقع المختلفة

ولهذا نوصي

*بتغطية مجاري الصرف الصحي الصناعي الخارج من المصانع لمنع تعامل الناس معها بأي طريقة

*أخذ عينات عشوائية و بصفة مستمرة من أماكن التلوث لمعرفة مستوي التلوث بهذه المناطق و معاجتها عند الزيادة عن النسب العالمية

*إعلام و توعية الناس بمدى خطورة الأسماك المصطادة من الأماكن الملوثة