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MONITORING OF SOME HEAVY METALS IN WATER AND FISH AT EL-GHARBIA AND KAFR EL-SHEIKH GOVERNORATES

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Abstract

Chemical analysis for forty surface water samples collected from some water drains at El-Gharbia and Kafer El-Sheikh governorates was carried out to check for heavy metal pollution. The results indicated high heavy metal contents in water samples ranged 0.480-0.610 ppm for lead, 0.450-0.810 ppm for mercury and 0.770-0.890ppm for arsenic.

No fish samples could be captured from El-Mahala El-Kobra. Twenty *Clarias lazera* fish samples collected from El-Hammol at Kafer El-Sheikh governorate were used for determination of the heavy metal residues in their tissues. The quantitative analysis of these heavy metal residues in their liver, kidney and muscles revealed the presence of high levels of Hg, As and Pb in liver (5.22, 1.93 and 1.72 ppm, respectively), followed by kidney (2.30, 1.08 and 0.90 ppm, respectively) and muscles (1.78, 0.40 and 0.32 ppm, respectively), of the same fish.

INTRODUCTION

Industrial water pollution is getting to be a major concern. Many of the chemicals contained in such industrial effluents may be potentially harmful to river life unless the concentrations are carefully controlled. Obvious effects are observed such as the colouring of river water and the formation of foam arising from effluents containing dyes and their additives when discharged to water courses without adequate treatment. The highly coloured industrial waste streams have been considered to be undesirable, due to their objectionable appearance. Such streams are presently coming under strict and more specific pollution regulations.

The presence of metallic salts in water can also be indirectly detrimental to inhabiting fish by affecting the balance between phytoplankton, zooplankton and invertebrates upon which they feed (Ericksen 1969 and Rizkalla & Abo-Donia 1996).

In general, heavy metals such as silver, mercury, copper, lead, cadmium, zinc, aluminium, nickel and chromium have been classed as metals of relatively high toxicity to fish (Doudoroff & Katz, 1953). There is a marked species variation to the metallic salts which is, however, believed to be a measure of the fish ability to detect and avoid toxic concentrations rather than to an intrinsic metabolic versatility (Ericksen 1969).

Most heavy metals and their salts are simple inorganic compounds, the toxicity of which is caused by anions, cations or physicochemical properties of the salt. Lead (Pb) is one of the important metals present naturally in many places in most of the countries due to its great industrial applications in many aspects of life. In studies on 300 fish of 17 species, associations were noted between hepatic steatosis, haemorrhage and raised liver lead values (Panebianco *et al.* 1988).

Scott (1974) found that mercury concentration in fish, white muscle increases with size and age and there was highly variable within and between different fish species. Panebianco *et al.* (1988) found that there was a relationship between haemorrhagic liver and raised values of mercury in environment. Mercury is highly toxic, non-essential, persistent, immutable and nonbiodegradable heavy metal which undergoes bioconcentration and bioamplification during its transfer through different tropic levels of food chain (Kirubagaran and Joy 1992). In Egypt, it is a relatively scarce element; it enters the marine and fresh water fish via industrial processes (Mahmoud 1993).

Arsenical (As) compounds are widely distributed in nature. The arsenicals may be grouped into inorganic and organic compounds. The inorganic arsenicals differ from the organic compounds in several important pharmacological and toxicological respects (Clarke *et al.* 1981). Nearly all the inorganic can be regarded as salts of the meta-arsenous acid (i.e. sodium and calcium arsenites and copper acetoarsenite) which have been employed mainly in agriculture as insecticides, rodenticides and herbicides (Vallee *et al.* 1960). Kobayashi *et al.* (1981) reported that, arsenic levels in fish muscles are positively correlated to body weight, and it is consistently higher in muscles than in livers and other tissues. They also found that, arsenic concentration in dorsal muscles is about twice that in ventral muscles from the same fish.

The present work is a survey on three heavy metals (Pb, Hg and As) in drainage water samples and fish tissues (liver, kidney and muscles) naturally present in two governorates (El-Gharbia and Kafr El-Sheikh) at Delta region. They are the main components of dyes used in the textile processing factories.

MATERIALS AND METHODS

Two governorates in Delta region were surveyed to estimate the heavy metals pollution due to industrial activities of textile and dye factories. El-Mahala El-Kobra (El-Gharbia governorate) is the main city for this type of activity. Kafr El-Sheikh is the nearest governorate to El-Mahala El-Kobra where water pollution may be affected by textile and dye factories.

Collection of water samples

Thirty surface water samples were collected from El-Kobra as follows:

1. Ten samples from Abo-Shahin drain in which water from factories were received as outlet effluents.
2. Twenty samples from El-Doakhlea station (water purification station for Abo-Shahim drain, about one kilometer away from El-Mahala El-Kobra). Ten samples from the inlet and ten samples from its outlet to drain No. 6.

Another ten surface water samples were collected from drain No. 6 at El-Hammol (Kafr El-Sheikh governorate).

The collected water samples were preserved by addition of 1 ml of conc. nitric acid to one litre of water.

Collection of fish samples

No available fish (*Clarias lazera*) were captured at El-Mahala El-Kobra. Twenty fish were collected from drain No. 6 at El-Hammol at Kafr El-Sheikh. Specimens from liver, kidney and muscle were taken from the collected fish for heavy metal residues determination.

Heavy metal residues determination

Analysis of water and dried fish tissues were performed using atomic absorption spectrophotometer (Perkin-Elmer Model 2380) with air/acetylene burner. Optimum conditions for each element were obtained within the guidelines of the guidelines of the instrument manufacturer. A minimum of one blank were analyzed in each sample run to account for any analytical and instrumental errors.

All chemicals used in the sample pre-treatment were of reagent-grade quality.

The obtained data were statistically analysed according to Snedecor (1971).

RESULTS

The results of the survey on the surface water and fish naturally present in El-Gharbia (El-Mahala El-Kobra) and Kafer El-Sheikh (El-Hammol) governorates for these heavy metals are presented in figures (1 & 2).

Concerning the results of water analysis for its content of Pb, He and As, it was clear that, arsenic was the major water pollutant in El-gharbia (El-Mahala) with a mean value of 0.890 ± 0.009ppm at the inlet port of the Doakhlea station. In Kafer El-Sheikh (El-Hammol), mercury was the most important water pollutant with a meav value of 0.810±0.040 ppm. Lead residue was mainly abundant at the inlet port of El-Doakhlea station (0.610±0.004 ppm), but, it decreased to reach its lowest value (0.480±0.004 ppm) at Kafer El-Sheikh.

In El-Gharbia governorate, the highest value of water mercury was (0.675±0.011 ppm) at the inlet port of El-Doakhlea station and the lowest value (0.450±0.004 ppm) at the outlet port of the same station.

In El-Gharbia governorate, no fish samples could be captured either at Abo-Shahim or at El-Doakhlea station. Several trials for capturing fish from the drain No. 6 (connected El-Gharbia with Kafr El-Sheikh governorates) failed.

The residual content of mercury in fish samples obtained from El-Hammol at Kafer El-Sheikh were in the liver tissues (5.22 ± 0.31 ppm) and the lowest value in the fish muscle (1.78±0.26 ppm).

The higher values of Pb and As were present in liver tissue with values of 1.72±0.22 and 1.93±0.23 ppm, respectively. Kidneys contained 0.90±0.25 and 1.08±0.23 ppm and As, respectively, less than those present in liver, but higher than those in muscle tissues (0.32 ± 0.05 and 0.40±0.09 ppm, respectively).

DISCUSSION

Lead, mercury and arsenic concentrations in the surface water samples vary with the site of collection (Fig. 1). Pb and As started with a value reaching 0.565±0.002 and 0.870±0.070 ppm, respectively, at Abo-Shahin drain. These values increased to reach their peaks at the inlet port of El-Doakhlea station (0.610±0.004 and 0.890±0.009 ppm, respectively). This was followed by gradual

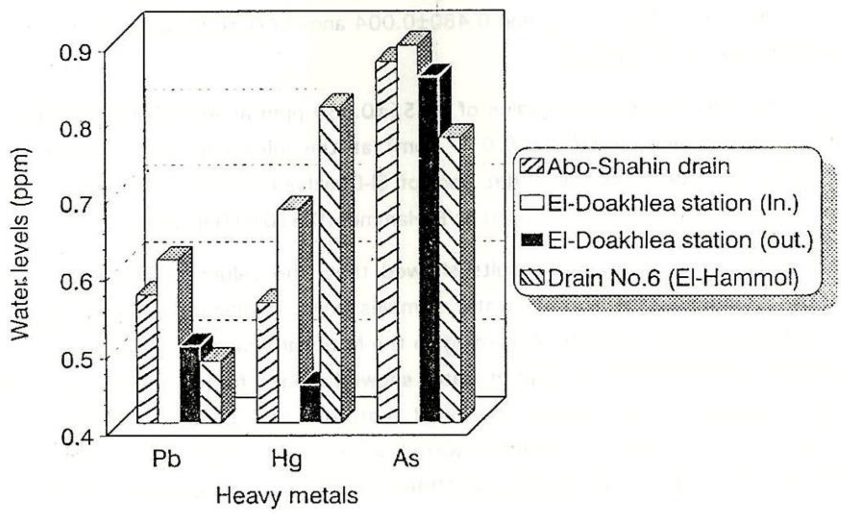

Fig. 1. Pb, Hg & As levels (ppm) in water samples collected from El-Mahala and El-Hammol areas.

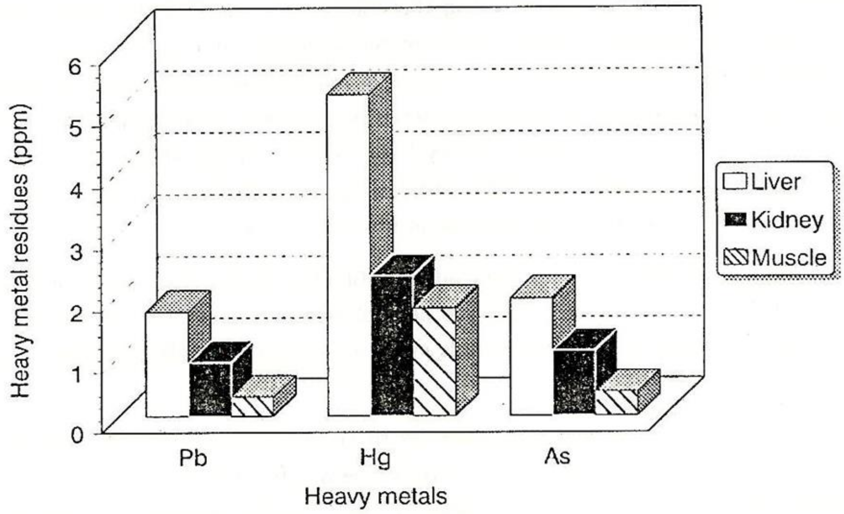

Fig. 2. Pb, Hg & As residues (ppm) in liver, Kidneys and muscle of Clarias lazera collected from El-Hammol areas.

decrease in their values to reach 0.500±0.004ppm Pb and 0.850±0.004 ppm As at the outlet port of El-Doakhlea and 0.480±0.004 and 0.770±0.020ppm for Pb and As respectively, at El-Hammol.

Mercury stated with a value of 0.555±0.030 ppm at Abo-Shahin, followed by an increased value (0.675 ± 0.011 ppm) at the inlet port and a lower value (0.450±0.004 ppm) at the outlet port pf El-Doakhlea station. Unexpected higher value of mercury residue was found at El-Hammol (0.810±0.040 ppm).

The above mentioned results showed that, the values of the three heavy metals studied in the surface water samples were significantly higher than the acceptable permissible limits. According to the National Academy of Science (1973), the safe concentrations of lead in water showed ranges from 0.00059 to 0.0059 ppm. Fresenius *et al.* (1988) mentioned that, the safe concentrations for lead, arsenic and mercury in healthy water were 0.05, 0.05 and 0.001 ppm, respectively. Rizkalla and Abo-Donia (1996) mentioned in their survey on the river Nile's water in upper Egypt, that the average concentration of lead (0.001 ppm) was much lower than the World's mean stream concentration (0.003 ppm) according to Goldberg *et al.* (1971).

The remarked high values at the inlet and outlet ports of the purification station at El-Doakhlea indicated a negligible role in lowering the water pollution in relation to these heavy metals. During the course of running of the water from El-Mahala to El-Hammol, a dilution factor of this polluted water by the agricultural drainage system was observed, and resulted in lowering lead and arsenical levels. Also, the decreased levels of these two metals may be due to precipitation of their residues along the course, while, mercury level increased finally at El-Hammol. The real cause of such event is not fully understood, but could this be due to other nonspecified factor leading to its increase in the drain stream.

No fish samples could be captred at El-Gharbia govermorate either in Abo Shahin or El-Doakhlea station. This colud be explained by the presence of the toxic levels of residues of these heavy metals in the water samples collected from such areas.

The results of the water pollution by these heavy metals to fish collected from El-Hammol are tabulated in Fig. 2. Liver tissue was found to contain the highest residual concentrations of lead, mercury and arsenic reaching 1.72±0.22; 5.22±0.31 and 1.93±0.17 ppm, respectively. Kidneys were occupying the 2nd position as they contained 0.90±0.25; 2.30±0.23 and 1.08±0.23 ppm, respectively.

Muscle tissues were found to contain the lowest values of these residues (0.32 ± 0.05; 1.78±0.26 and 0.40±0.09 ppm, respectively). Our results are similar with those mentioned by Sorensen *et al.* (1979) who proved that, arsenic is extremely poisonous to fish and can be accumulated to higher levels in their hepatic tissues. Also, Sprenger *et al.* (1988) found increased concentrations of mercury in liver than in muscles of the yellow perch fish collected from 6 acidic lakes in New Jersey.

Contrary to our results, Bohn and Fallis (1978) recorded that, high levels of arsenic were found in muscle tissues followed by liver. Also, Crespo *et al.* (1986) mentioned that, in lead poisoned rainbow trout, the highest lead concentrations were found in kiddneys followed by liver and finally spleen. Emara *et al.* (1993) collected samples of different species of fishes from the Mediteranean and Red seas and analyzed the muscles for some trace metals. They found increased levels of lead in *Mugil cephalus* and *Epinephelus alexandrinus* (2.6-3 mg/Kg). They attributed the presence of such metals in the fish to the pollution of the Alexandria coastal water with these metals.

Muscle Pb residue in our results is much lower than that found in th eresults of Rizkalla & Abo-Donia (1996).They reported that, lead concentrations in river Nile Tilapia (2.815 ug/g dry wt.) were slightly lower than the average levels in *Tilapia* of Wadi El-Raiyan Lakes (Saleh *et al.*1988) and Manzalla, Maruit and Wadi El-Raiyan Lakes (Abo-Donia 1990).

Finally, our investigation declared that, level of pollution with Pb, Hg and As in the surface water samples was extremely dangerous in El-Mahala El-Kobra city, and this was the cause of the absence of fish from such areas. Also, we want to focus on the role of the purification station (El-Doakhlea) which was not effective in lowering the water pollution with these three metals. We would like to register that, residual content of heavy metals, either in surface water samples or fish, were high and exceeding the acceptable permissible limits for human consumption. We advise a good treatment of the industrial effluents using specific to avoid this form of pollution.

REFERENCES

1. Abo-Donia , M.A.M.M. 1990. "Specified Deviced Techniques for Detecting Fish Contaminants". Thesis Ph.D. in Food Technology, Fac. Agric., Ain Shams Univ.

2. Bohn, A. & B.W. Fallis. 1978. Metal concentration (As, Cd, Cu, Pb and Zn) in *Shorthorn sculpins, Myoxocephalus scorpius* from the vicinity of stratcona sound, Northwest Territories. Water Res., 12 (9):569.

3. Clarke, M.L., D.G. Harvey. & D.J. Humpheys. 1981. "Veterinary Toxicology". 2nd ed., Cassel and Collier MacMillan Publishers Ltd. Bailliere Tindall, P: 61.

4. Crespo, S., G., Nonotte. D.A., Colin, C. Leray & L. Nonnotte. 1986. Morphological and functional alterations induced in trout intestine by dietary cadmium and lead. J. Fish Biol., 28:1.

5. Doudoroff, P. & M. Katz. 1953. Critical review of literature on the toxicity of industrial wastes and their components to fish. Sewage Ind. Wastes, 25: 802.

6. Emara, H.I., M.S. El-Deek. & N.S. Ahmed . 1993. A comparative study on the level of trace metals in some Mediterranean and Red Sea fishes. Egypt. Chem. Ecol., 8 (2): 119.

7. Ericksen, J.R. 1969. "Fish and River Pollution". Butterworths, London.

8. Fresenius, W., A.E. Quentin. & W. Schneider. 1988. Water Analysis: A Practical Guide to Physico-Chemical, Chemical and Microbiological Water Examination". Verlag, Berlin, Heidberg, N.Y., London, Paris. Tokyo.

9. Goldberg, E.D., W.S., Brocker. H.G. Grass. & R.R. Turekian. 1971. Radioactivity in marine environment. In: Marine Chemistry. Seymour A.H. (ed.), US National Acad. Sci. Washington, DC, PP: 137-146.

10. Kirubagaran, R. & K.P. Joy. 1992. Toxic effects of mercury on testicular activity in the freshwater teleost, Clarias batrachus (L.). J. Fish Biol., 41:305.

11. Kobayashi, R., K. Shiomi. H. Yamanaka & T. Kikuchi. 1981. Distribution of arsenic in some fishes. Bull. Jap. Soc. Sci. Fish., 46 (10): 1265.

12. Mahmoud, N. 1993. Aquatic funa and water pollution in Egypt. Vet. Med. J., 41 (1): 125.

13. National Academy of Science. 1973. Annual Report No. 9, P: 213. Panebianco, F.P., A. Corrao & B. Macri. 1988. Spontaneous liver lesions in Marine fish. II. Correlation with contents of lead, cadmium, mercury and organochlorine III food hygiene concentrations. J. Arch. Vet. Italino, 39 (3): 65.

14. Rizkalla, E.H. &. M.A. Abo-Donia. 1996. Monitoring of some heavy metals in river Nile water in relation to their levels in *Tilapia* in upper Egypt. Egypt. J. Agric. Res., 74 (1): 239-250 .

15. Saleh, M.A. M.M. Fouda, M.S. Abdel Lattif & B.L. Wilson. 1988. Inorganic pollution of the man-made lakes of Wadi El-Raiyan and its impact on aquaculture and wildlife of the surrounding Egyptian desert. Environ. Contam. Toxic., 17: 391-403.

16. Scott, D.P. 1974. Mercury concentration of white muscle in relation to age, growth and condition in four species of fishes from Clay lake, Ontario. J. Fish. Res. Bd. Can., 31 (11): 1723.

17. Snedecor, G.W. 1971. "Statistical Methods". 14th. Ed. Ames, Iowa. The Iowa State Univ. Press, P. 593. Sorensen, E.M.B. & R.E. Henry. 1979. Arsenic accumulation, tissue distribution and cytotoxicity in teleosts following indirect aqueous exposures. Bull. Envir. Contam. Toxicol., 21: 162.

18. Sprenger, M.D., A.W. McIntosh, & S. Hoenig. 1988. Concentration of trace elements in yellow perch (*Perca flavescens*). Water, Air and Soil Pollution, 37 (3-4) : 375.

19. Vallee, B.L. D.D. Ulmer & W.E.C. Wacher. 1960. Arsenic toxicology and biochemistry. A.M.A. Rachs. Ind. Hlth., 21: 132.

رصد تلوث بعض العناصر الثقيلة لمياه وأسماك القراميط بمحافظتى الغربيه وكفر الشيخ

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جذبت مدينة المحلة الكبرى (محافظة الغربية) انتباهنا كمثال للمدن الصناعية الكبرى بمصر لأجراء بحث ميدانى عن تلوث المياه الناتج من صرف المخلفات الكيميائية للمصانع الكبيرة خاصة مصانع النسيج والصباغة للمنسوجات.

تم تجميع أربعين عينة مياه سطحية من مصرف أبو شاهين ومحطة الدوخلية (محافظة الغربية) والمصرف رقم ٦ بمحافظة كفر الشيخ.

كانت كمية العناصر الثقيلة فى عينات المياه تتراوح ما بين ٠,٠٤٨ الى ٠,٠٦١ جزء فى المليون للرصاص و ٠,٠٤٥ الى ٠,٠٨١ جزء فى المليون للزئبق و ٠,٠٧٧ الى ٠,٠٨٩ جزء فى المليون للزرنيخ.

لم يمكن اصطياد عينات أسماك من منطقة المحلة الكبرى. ولكن تم تجميع عشرين من سمكة قرموط النيل من منطقة الحامول بمحافظة كفر الشيخ لتقدير قيم متبقيات العناصر الثقيلة فى الأنسجة المختلفة.

وجد أن الكبد يحتوى على أعلى نسب متبقيات الزئبق والزرنيخ والرصاص (٥,٢٢ – ١.٩٣ – ١,٧٢ جزء فى المليون على التوالى). ثم تاتى الكلى فى المرتبه الثانيه (٢,٣٠ – ١,٠٨ – ٠,٩٠ جزء فى المليون على التوالى). أما العضلات فأنها تحتوى على أقل كمية من هذه المتبقيات (١,٧٨ – ٠,٤٠ – ٠,٣٢ جزء فى المليون على التوالى).