Bull. Nat. Inst.Ocean. & Fish., A.R.E., (1992), 18: 37 - 41

A COMPARATIVE STUDY OF TRACE ELEMENT ACCUMULATION IN TISSUES OF THE TELEOST TILAPIA ZILLII FROM CONTAMINATED AND CLEAN AREAS

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ABSTRACT

Concentrations of 9 trace elements were measured in the whole specimens, liver, kidneys and muscle of **Tilapia zillii** inhabiting contaminated and clean areas, Lake Mariut and El-Nasr channel, respectively. The amounts of the trace elements: arsenic, cadmium, copper, lead and manganese in the whole individuals and tissues of **Tilapia zillii** could be used to identify contaminated locations,. Their average concentrations were higher in the whole individuals and tissues of fish from Lake Mariut than in those of fish from El-Nasr channel. However, no interregional differences were noted between chromium, cobalt, mercury and zinc levels in the tissues of fish from both areas. Analyses of various elements in the muscle revealed that higher element concentrations were found in fish from Lake Mariut than in those from El-Nasr channel.

I suggest that the high tissue metal levels in **Tilapia zillii** from Lake Mariut are mainly due to contamination from anthropogenic sources.

INTRODUCTION

Contamination in lakes received interest in recent years. Large amounts of many elements and compounds are regularly discharged into the lakes from industrial and agricultural sources. These trace contaminants may have effects on the ecosystem as great as or greater than those of the more common pollutants. Considerable attention has been directed towards the trace elements and the commercial fish since high levels of such elements in these species are toxic and represent a potential human health hazard. At less than toxic levels, certain trace elements may be essential to physiological function of particular organisms or to the ecological system as a whole. Low concentrations of essential trace elements may suppress physiological action, leading to abnormal growth of an organism (Bowen, 1966). The difference in concentration between deficiency and toxicity is often small. The natural concentration is often very high so that a mere doubling of it may prove toxic to

the more sensitive species (Jones, 1964). The toxicity of an element appears to be directly correlated with the electronegativity or with the stability of the complexes of the metal ion, and is, therefore, probably due to the formation of the complexes in the proteins and enzymes at physiologically active sites (Doudoroff and Katz, 1953).

Depending on the metabolic behaviour of the individual elements and the species of aquatic life, trace elements are concentrated, maintained at a constant value, or are discriminated against at each of the various trophic levels (Gustafson et al., 1966). Because fish accumulate trace elements from their environment and can act as indicators of levels in the environment, they are excellent organisms for the study of some long-term changes in trace elements in the environment. It was the purpose of the present study to identify the effects of industrial contamination on the deposition of trace elements in whole individuals and in potential tissues of a commerical fish, **Tilapia zillii**, which is abundant among the fish caught from the polluted water localities of Lake Mariut (Saleh et al., 1983). A special effort was made to include elements known to be toxic, those released in industrial effluents.

MATERIAL AND METHODS

Fish were collected from two locations (Lake Mariut and El-Nasr channel) 8 and 70 Km west of Alexandria, respectively. Samples of whole fish, liver, kidneys and muscle were obtained and were stored frozen in separate plastic bags prior to analysis.

Either whole fish or tissue samples were prepared for analysis by oven drying followed by concentrated nitric acid digestion. Subsamples of approximately 1 g wet weight (0.022-0.31 g ash) whole fish or fish tissue were analysed with atomic absorption spectrophotometry. Statistical analyses were conducted using Student's t-test.

RESULTS

Whole individuals and tissues of **Tilapia zillii** inhabiting two .different areas were analysed for nine trace elements (table 1). The values for arsenic, cadmium, cooper, lead and manganse in the whole fish varied according to the collection area. Their average concentrations in the whole fish appeared to be significantly higher ($p < 0.05$) in fish from the lake than in those from the channel. Cobalt, mercury and zinc varied only slightly ($p > 0.05$), while chromium varied little ($p > 0.05$). **Tilapia zillii** showed considerable variation in the analysis of elements in tissues Liver, kidneys and mucle of fish in both areas. The amounts of arsenic, cadmium, copper, lead and manganese in the tissue of fish from Lake Mariut are generally greater than those in the corresponding tissues of fish from El-Nasr Channel. The arsenic, cadmium, copper, lead and manganese contents of liver and kidneys were found to be significantly

Table 1.

Comparison of 9 trace element levels in the whole individuals and tissues of *Tilapia zillii* from two different areas. All values are expressed as means ± SE (n = 4 estimates).

Element	Area	Element concentrations (ppm)			
		Whole fish	Liver	Kidneys	Muscle
As	L	2.58±0.24	4.21±1.02	2.92±0.03	0.88±0.11
	C	0.42±0.33*	0.94±0.16*	0.71±0.51*	0.10±0.09*
Cd	L	4.95±1.00	4.91±1.09	1.23±0.02	0.31±0.06
	C	1.13±1.02*	0.60±1.03*	0.09±0.41*	0.02±0.01*
Cr	L	1.44±0.31	1.02±0.92	0.50±0.81	0.54±1.32
	C	1.29±2.06	0.89±1.41	0.52±0.03	0.07±1.70
Co	L	0.71±1.04	0.21±0.13	0.132±2.31	0.04±0.83
	C	0.53±0.65	0.18±1.09	0.09±0.21	0.01±0.09
Cu	L	2.82±0.12	3.49±0.41	1.67±0.02	0.09±0.01
	C	0.16±0.31*	0.91±0.72*	0.08±0.38*	0.03±0.02*
Pb	L	4.66±1.05	5.31±0.86	4.77±1.11	0.72±0.02
	C	1.71±0.09*	0.62±0.13*	0.24±1.03*	0.05±0.11*
Mn	L	5.49±1.22	3.97±0.69	1.46±0.35	1.01±0.05
	C	0.32±1.05*	1.14±0.12*	0.25±0.09*	0.02±0.12*
Hg	L	1.61±0.85	1.54±0.42	0.73±1.06	0.06±0.67
	C	1.26±1.28	1.26±2.46	0.58±0.78	0.04±0.82
Zn	L	1.01±2.05	2.12±2.14	1.18±2.01	0.28±1.23
	C	0.93±0.38	1.86±0.69	0.97±2.34	0.19±0.86

* Statistically significant compared with controls
L Lake Mariut
C El-Nasr channel

higher ($p < 0.05$) in fish of the lake than in those of the channel. Liver was found to be the tissue containing the highest concentrations of these metals. No statistical differences between the fish in the two areas were detected for chromium, cobalt, mercury and zinc. Muscle contained significantly lesser ($p < 0.05$) amounts of elements in fish from the channel than in those amounts of elements in fish from the channel than in those from the lake.

DISCUSSION

Cadmium, chromium, copper, manganese and zinc are essential for mammals and presumably for fish. Essential trace elements are usually characterized by relatively small variations within a species (Lucas et al., 1970). Since these metals are essential trace elements, their concentrations may be under physiological control. Ranking the metals according to their deposition in each tissue of fish from both areas indicates that the effects of contamination on the tissue deposition of metals are consistant for arsenic, cadmium, cooper, lead and manganese, whereas the effects on deposition of chromium, cobalt, mercury and zinc are not. This difference in metal contents of the fish from the two different areas may indicate variations in habitat or be caused by chemical pollution. In an investigation to study the metal interregional differences, Uthe and Chou (1987) found that neither cadmium concentration nor burden could be used to identify contaminated areas.

The finding of significantly greater amounts of manganese in the whole specimens, liver and kidneys of fish in Lake Mariut than those in El-Nasr channel is unexpected. A possible explanation could be that the fish in Lake Mariut experienced an acute exposure to manganese, either in the food chain or as an atmospheric pollutant. The major sources of manganese as air pollution are iron and steel manufacturing and the burning of diesel fuel (Beliles, 1979).

Mercury, which is not biologically essential element, was not significantly higher in the whole individuals and tissues of **Tilapia zillii**. This suggests that mercury was being acquired by the Tilapias. It is probable that this metal was acquired from chemical pollution or food, although air borne metal contamination is a possibility.

The lower cocentration of cobalt in **Tilapia zillii** from Lake Mariut than in those from El-Nasr channel may indicate that cobalt is not under homoestatic control.

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