DISTRIBUTION OF SOME HEAVY METALS IN WATER AND SOME FISH SPECIES IN ZOBE DAM

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ABSTRACT

The distribution of chromium, zinc and lead in the water and fish of Zobe dam was investigated. Water and fish samples were digested with perchloric acid and nitric acid in the ratio 1:3. Atomic absorption spectrophotometer was used to determine metal concentrations with a calibration. For all metals, there was a correlation between concentration in the muscle and in the liver of the three species of fish investigated, excepting zinc in carpio specie where a significant variation in the level of metal was indicated.

INTRODUCTION

Zobe dam was established in July, 1977. It is located in the southern part of Dutsin-Ma in Katsina State of Nigeria. Before dam establishment, the settlers had a history of blacksmithing and agrarian farming activities. The dam has an average storage capacity of 170 million m^3 and about 8137 hectares of land for irrigation. It covers an estimated surface area of 39.6km^2. The annual rainfall is estimated to be about 817mm per year. This research work was aimed at determining the distribution of some heavy metals in the water of Zobe dam and how they are distributed in some fish species. Many studies have been carried out to determine the level of heavy metals in the aquatic environment. For instance, Szefer *et al.*[1] have found the concentration of metals in water and that found in fishes to correlate significantly. Also, Menasveta[2] has reported lead in water to have heavily contaminated phytoplankton and zooplankton of the lower gulf of Thailand. His report indicated a mean lead concentration of 117 μg/g and 199 μg/g in phytoplankton and zooplankton respectively. Correlation between the concentration of heavy metals in water and fishes is possible, because, according to Menaśveta and Cheevaparanapiwat,[3] fishes take in heavy metals by filtration into their bodies and this results in bio-accumulation of these metals.

Heavy metals accumulation in natural waters and, by extension, in phytoplankton and zooplankton can be a source of concern since significant concentrations are toxic. Tompkins *et al.*[4] reported that over half of the whiting fish embryos in the German Bight had growth deformities associated with heavy metals. The same study showed that between 5% and 20% of the dermersal sole, cod, flonder and plaice embryos showed fatal deformities as a result of heavy metals contamination. In summary Hardy[5] stated that heavy metals do not degrade but accumulate in food and are a serious threat to the fertility and systems of chordates, most especially dolphins, seals and pisces.

EXPERIMENTAL

Materials

Chemicals used were of analytical reagent grade. All containers used were washed with nitric acid and rinsed with distilled water. HNO_3 was used to acidify samples for preservation. 70% $HClO_4$ and HNO_3 were used in sample digestion on a Gallenkamp hot plate at constant temperature. Atomic absorption measurements were made with a Buck Scientific Model 210 VGP atomic absorption spectrophotometer (AAS) with an air acetylene flame.

Water samples

Four water samples were collected at different depths of 3m interval in July, 1999, from three different areas of Zobe dam (Fig. 1). Water samples were collected stored in one litre high density linear polythene bottles until needed. On evaporation, water samples were digested with 1:3 mixture (v/v) of 70% $HClO_4$ and concentrated

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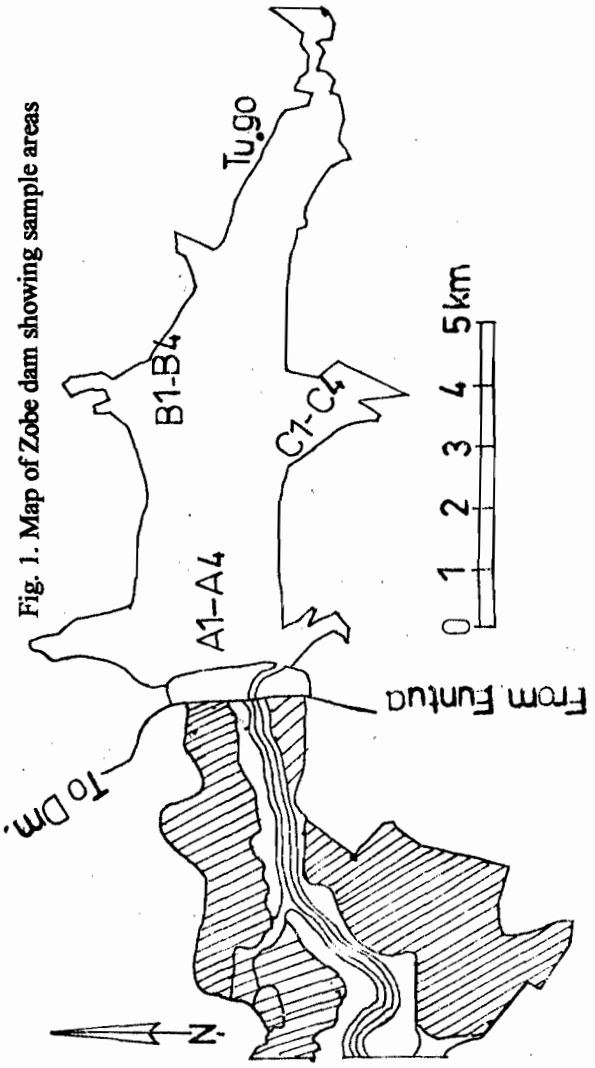

Fig. 1. Map of Zobe dam showing sample areas

HNO_3 on a hot plate at 80°C until a yellow straw colour was obtained. The resultant solution was quantitatively transferred to a 50ml volumetric flask and made up to mark. Both the standard and blank solutions were prepared at the same time.

Fish samples

Three fish species namely *Polypterus senegalus, Tilapia zilli* and *Clarias carpio* were collected from three different areas of the dam. The fish samples were carefully dissected and after drying to constant weight at 110°C, the muscle and liver tissues were carefully separated and ground to powder. 0.5g of each of the species muscle and liver was taken and digested with 1:3 mixture (v/v) of 70% $HClO_4$ and concentrated HNO_3 on a hot plate for five hours. Each digested sample was quantitatively transferred into a 50ml volumetric flask and made up to mark with distilled water.

Instrumental analysis

The optimised conditions of the spectrometer are shown in Table 1. Samples were analysed for Zn, Cr and Pb under these conditions[6] , recording averages of three replicate measurements of each sample. The metals in water, liver and muscle of fish species were treated and analysed separately.

Table 1. Optimised instrument conditions

Elements	Wave Length (nm)	Slit (Å)	Burner height (mm)	HC Lamp current (mA)	Detection limit (ppm)
Cr	357.9	7	5	6.5	0.005
Pb	283.3	7	6	7.5	0.08
Zn	213.9	7	5-6	6.5	0.005

Stock solutions and calibration procedure

Working standards were obtained by appropriately diluting 1000ppm stock solutions prepared by dissolving 0.2829g, 1.598g and 0.100g of $K_2Cr_2O_7$, $Pb(NO_3)_2$ and Zn metal in 0.1M HCl and making up to 1,000ml in a volumetric flask for Cr, Pb and Zn respectively. A calibration curve was constructed for the standards plotting absorbance versus concentration. By interpolation on graphs, the concentrations of the elements in sample digests were determined from the measured absorbances.

RESULTS AND DISCUSSION

Table 2 gives the mean metal content of each water sample. The same table also gives the metal concentration found in the muscle and liver of each fish specie. Concentration factor (cf) which is the ratio of the mean metal concentration of liver to muscle of each fish specie has also been found. The correlation coefficient (r) which indicates the level of agreement between metal concentration found in liver and muscle of each fish specie has also been found.

Many metals including those that are essential to life can be toxic at high doses or in certain compound formulations according to Last[7]. In this study the concentrations of Cr and Pb have exceeded the suggested permissible limit for drinking water as outlined by Dauda[8]. However,

...suggested permissible limit for irrigation water ... not been exceeded, this has also been confirmed by Dauda[8]. Anthropogenic activities such as agriculture, weathering of rocks, soil erosion, mining activities and industrial discharge are considered as factors responsible for the presence of these metals. Usage of Zobe dam water for drinking may have consequent effect on man and will have cumulative consequences.

Table 2. Mean concentration of metals in water and fish and their cf and r.

Sample	Concentration (ppm)			cf			r		
	Cr	Pb	Zn	Cr	Pb	Zn	Cr	Pb	Zn
Water	0.188	0.933	1.709						
P. Senegalus									
Muscle	0.069	0.241	0.689	2.740	1.370	2.780	0.9856	0.9809	-0.5080
Liver	0.189	0.329	1.917						
T. zilli									
Muscle	0.066	0.133	0.820	1.110	1.850	1.500	0.9995	0.9872	0.8330
Liver	0.073	0.246	1.232						
C. carpio									
Muscle	0.035	0.149	0.922	3.090	0.550	1.310	0.9947	0.9955	0.8540
Liver	0.108	0.082	1.204						

Metal distribution in water

The mean concentration of the metals in water appeared in the order; Zn>Pb>Cr (Table 2). Zn concentration is twice that of Pb and eight that of Cr. The levels of these metals in the lake are lower than those reported by many investigators elsewhere. For instance Szefer[1] reported higher levels of Cr, Zn and Pb in a lake near an industrial plant.

Metal distribution in fish

The mean concentrations of the three metals in muscle and liver from different species of fish are as shown in Table 2. Liver accumulates higher concentrations of all the metals than muscles in all species except in C. carpio. Szefer[1] reported similar work for the sea of Antartica. Blood accumulation in the liver may account for the higher level of metals in it than in other parts of the fish.

The levels of the three metals found in the fish correlate positively with the corresponding level in water, except for Pb whose level in fish is significantly lower than in water. This may be related to its highly toxic effect imposing a target body regulation.

Comparing the mean concentration of the metals among the three species of fish shows that, *P. Senegalus* accumulates the highest concentration of all the metals (Table 2). A positive correlation ($P<0.001$) was found between metal levels in liver and muscles. Except for Zn in *P. Senegalus* which shows no significant difference and, hence, no correlation between muscles and liver concentrations.

The concentration factor for the metals concentrations in liver compared to their levels in muscle are high except Zn which shows a low cf. in *C. Carpio*.

CONCLUSION

From the results found in this study and the accompanying discussions, it is evident that, there is the risk of pollution by Cr and Pb in Zobe dam.

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