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Archives of Applied Science Research, 2013, 5 (1):140-145
(http://scholarsresearchlibrary.com/archive.html)

ISSN 0975-508X
CODEN (USA) AASRC9

Bio magnification factor of some heavy metals in sediment and fish samples from major dams in Ekiti state, Nigeria

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ABSTRACT

Biomagnification factor of some heavy metals (Zn, Fe, Pb and Mn) were determined in sediment and fish (Tilapia mossambis) samples collected from major dams in Ekiti- State, Nigeria. It was established that the biomagnification factors for fish were higher in both season than in water, while that of sediment were greater in both seasons than for fish and water. The concentration of heavy metals in water and fish were within the international permissible level, however the study have shown that fish and sediment can be adequately used to monitor pollutional trend of heavy metals in the dams in Ekiti- State.

Key words: Biomagnification, Heavy metals, Sediment, Fish, Dams

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INTRODUCTION

The occurrence of metals in excess of natural loads is a problem of increasing concern (1). Some of these metals have been reported to be extremely dangerous to human health. Cadium accumulation is associated with hypertension, osteomalacial and Itai-itai disease (2). Lead poisoning have been associated with permanent brain damage, behavioural disorders and impaired hearing (3)

Toxic and essential metals enter the aquatic environment through natural and artificial process that involved weathering of rocks and soil, dissolution of aerosol particles in the atmosphere, oil spillage, sewage affluent, auto emission, dredging activities and industrial effluent (2,4,5). The potential of most heavy metals to bioaccumulate, biomagnified and become transferred to man through food chain has attracted global health concern (6). High percentage of acid leached metal such as Fe, Mn, Zn, Pb, Cu, and Ni have been reported for some lakes in around Ibadan, Nigeria (7) after entering the water, metals may precipitate, adsorb on solid surface, remain soluble, suspended in water or may be taken up by fauna or flora and eventually accumulate in marine organization that are consumed by human being (5). Mineral element are of vital concern in nutrition, calcium, phosphorous, potassium, sulphur, sodium, chlorine and magnesium are required in relatively large amount in the body and they are known as major element(8) .

Heavy metal availability in aquatic organisms is influenced by many external factors such as seasonal variations, pH, and hardness of water, concentrate and composition of particulate matter (9)

Pollution of heavy metals in aquatic ecosystem is growing at alarming rate and has become an important worldwide problem (10). Increase in population, urbanization, industrialization and agricultural practices have aggravated the situation (11). As heavy metals cannot be degraded, they are deposited, assimilated or incorporated in water, sediment and aquatic animals and thus, causing heavy metal pollution in water bodies (12).

In natural aquatic ecosystem, metals usually occur in low concentration normally at monogram to microgram per litre level. However some of these metals occurring at low concentration in surface waters have been reported to

occur at relatively high concentration in the corresponding sediment and fish from aquatic environment (5, 8, 12, 13, 14, 15). The objective of the present study is to examine the biomagnification level of some metals in sediment and fish from major dams in Ekiti State for baseline documentation and environmental awareness.

MATERIALS AND METHODS

2.1 **Sample Location**

Ekiti State was created on 1st October, 1996 from the former Ondo state. The state is situated entirely within the tropics, located between longitude $4^{0}15^{1}$ to 5^{0} 45^{1} east of Greenwich meridian and latitude $7^{0}15^{1}$-$8^{0}5^{1}$ North of equator. The state is mainly an upland one rising 200 metres above sea level. It enjoys tropical climate with two distinct seasons, these are wet season (April – October) and dry season (November – March). There are four major dams (Ureje, Egbe, Ero, and Itapaji) in the state that provides potable water for the teeming population. Fish from these dams are sold to the public for consumption. The samples for the study were taken from the four dams in Ekiti State.

2.2 **Sample Collection**

Four samples of water, sediments and fish (Tilapia mosambis) were collected from the four major dams (one per dam) during the dry and wet seasons of 2010. The water samples at each dam site was collected in a 2.5 litres plastic bottles, the water samples were chemically preserved by addition of 5ml conc. HNO3 per litre and kept in a refrigerator prior to analysis .

The sediments samples were collected by divers at each dam site where the water sample were collected, kept in a polythene bag and then allowed to drain to dryness. The fish samples (Tilapia mosambis) were bough t randomly from fishermen at the dam sites, carefully washed with distilled water, drained under folds of filter paper, wrapped in aluminium foil and kept in a freezer prior to analysis. All the fish samples collected are of average weight.

2.3 **Sample Treatment and Determination**

250ml each of the water samples was measured into a beaker, 5ml of concentrated HCl was added. The mixture was evaporated to 25ml, transferred into 100ml volumetric flask and made to mark with distilled water (16). Metals in the extract were determined by atomic absorption spectrophotometer (Buck model 200A). About 2 g of each sediment samples were digest ed with mixtures of HNO3: HCl: HF in ratio 15:3:15 respectively (17) . Metals were determined in the resultant solution using AAS (Buck model 200A). The fish samples (T. mosambis) were descaled, carefully washed and homogenised. All the homogenised samples were digested with a mixture of Conc. HNO3 and 73% HCLO4 in the ratio 5:3, filtered into standard flask. Metal concentrations were determined in the resultant solution using AAS (Buck model 200A).

RESULTS AND DISCUSSION

3.1 **Heavy metals in water**

In the water samples, the average concentration of heavy metals (Zn, Fe, Pb, and, Mn) were 0.45, 0.30, ND and 0.6 mg/100ml respectively (Table 1a)) for dry season while 0.51, 0.21, ND and 0.42 respectively (Table 1b) for wet season. Concentration of Pb was not detected in both seasons. Zn content was the highest for both season and that of Mn lowest for dry season while Zn lowest for wet season. The order of metal accumulation in water was Zn > Fe >Mn>Pb.

Table 1a: Metals levels (mg/100ml) in water samples from major Dams (Dry season)

Dams	Zn	Fe	Pb	Mn
Ureje	0.24	0.36	ND	0.12
Egbe	0.96	0.48	ND	0.12
Ero	0.48	0.24	ND	ND
Itapaji	o.12	0.12	ND	ND
Mean	0.45	0.30	Nd	0.06
SD	0.33	0.16	Nd	0.05
CV	72.80	52.92	Nd	81.65

ND = Not detected, Nd = Not determined

Table 1b: Metals levels (mg/100ml) in water samples from major Dams (wet season)

Dams	Zn	Fe	Pb	Mn
Ureje	0.24	0.12	ND	0.84
Egbe	0.96	0.48	ND	0.84
Ero	0.60	0.12	ND	ND
Itapaji	0.24	0.12	ND	ND
Mean	0.51	0.21	Nd	0.42
SD	0.34	0.18	Nd	0.34
CV	67.58	85.71	Nd	81.65

ND =Not detected, Nd = Not determined

3.2 **Heavy metals in sediment**

The mean value of Zn, Fe, Pb and Mn were 24,90, 58.68, 3.42 and 21.84 mg/100g respectively (Table 2a) in dry season and 29.82, 77.69, 16.62, and 13.29 mg/100g respectively (Table 2b) in wet season. The order of heavy metal concentration in sediment is Fe> Zn >Mn>Pb> for both seasons. The data indicate that Fe accumulated most in the sediment while Pb is the least

Table 2a: Metals levels (mg/100g) in sediment samples from major Dams (Dry season)

Dams	Zn	Fe	Pb	Mn
Ureje	40.08	24.24	ND	38.16
Egbe	24.00	59.64	ND	38.16
Ero	24.12	108.12	9.60	8.64
Itapaji	11.40	42.72	4.08	2.40
Mean	24.90	58.68	3.42	21.84
SD	6.78	35.99	3.60	19.02
CV	27.24	61.33	104.92	87.07

ND = Not detected

Table 2b: Metals levels (mg/100g) in sediment samples from major Dams (wet season)

Dams	Zn	Fe	Pb	Mn
Ureje	38.40	63.24	ND	23.04
Egbe	33.60	97.08	ND	16.44
Ero	38.76	83.28	6.12	9.27
Itapaji	8.52	67.20	0.36	3.96
Mean	29.82	77.69	1.62	13.29
SD	14.39	15.56	2.30	8.26
CV	48.27	20.02	142.00	62.17

ND = Not detected

3.3**Heavy metals in Fish**

The mean concentration of metals in fish (Tilapia M.) for both seasons are presented in Table 3a and 3b. Zn, Fe, Pb and Mn have average values of 18.54, 16.32, 0.47 and 6.87 mg/100g respectively for dry season and 19.44, 22.53, 1.37 and 4.50 mg/100g respectively for wet season. In both season Fe has the highest concentration while Pb is the least.

Table 3a: Metals levels (mg/100g) in fish samples from major Dams (Dry season)

Dams	Zn	Fe	Pb	Mn
Ureje	15.60	24.48	0.33	12.24
Egbe	24.36	12.48	0.60	10.44
Ero	23.04	13.32	0.72	3.84
Itapaji	11.16	15.00	0.27	0.96
Mean	18.54	16.32	0.47	6.87
SD	6.25	5.54	0.23	5.38
CV	33.71	33.95	49.36	78.33

Table 3b: Metals levels (mg/100g) in fish samples from major Dams (Wet season)

Dams	Zn	Fe	Pb	Mn
Ureje	17.04	24.24	2.72	11.52
Egbe	19.68	24.00	2.20	1.08
Ero	30.72	17.76	0.11	3.72
Itapaji	10.32	24.12	0.44	1.68
Mean	19.44	22.53	1.37	4.50
SD	8.49	3.18	1.29	4.81
CV	43.67	14.12	94.16	106.88

3.4 **Biomagnification factors in sediment and fish.**

The biomagnification factors of metal in sediment for both seasons were presented in Table 4a and 4b. The results shows iron has the highest for both season with an average value of 183.14 and 185.24 for dry and wet season respectively while lead has no values for both seasons. Also the value for fish are given in Tables 5a and 5b which indicate that fish concentrate Iron more than other metals in both season.

Table 4a: Biomagnifaction factor of Metals in sediment (wet season)

Dams	Zn	Fe	Pb	Mn
Ureje	167.00	67.33	Nd	318.00
Egbe	25.00	124.25	Nd	318.00
Ero	50.25	450.50	Nd	Nd
Itapaji	95.00	356.00	Nd	Nd
Mean	84.31	249.52	Nd	Nd
SD	62.26	183.14	Nd	Nd
CV	73.4	73.40	Nd	Nd

Nd = Not determined

Table 4b: Biomagnificaction factor of Metals in sediment (dry season)

Dams	Zn	Fe	Pb	Mn
Ureje	160.00	527.00	Nd	27.43
Egbe	35.00	202.25	Nd	19.57
Ero	64.60	832.60	Nd	Nd
Itapaji	71.00	560.00	Nd	Nd
Mean	82.65	530.46	Nd	Nd
SD	53.90	185.24	Nd	Nd
CV	65.21	34.92	Nd	Nd

Nd = Not determined

Table 5a: Biomagnificaction factor of metals in fish (wet season)

Dams	Zn	Fe	Pb	Mn
Ureje	65.00	68.00	Nd	102
Egbe	25.38	26.00	Nd	87.00
Ero	48.00	55.50	Nd	Nd
Itapaji	93.00	125.00	Nd	Nd
Mean	57.85	68.63	Nd	Nd
SD	28.51	41.64	Nd	Nd
CV	48.66	60.67	Nd	Nd

Nd = Not determined

Table 5b: Biomagnification factor of fish sample (wet season)

Dams	Zn	Fe	Pb	Mn
Ureje	71.00	67.33	Nd	13.7
Egbe	20.50	50.00	Nd	1.29
Ero	51.20	148.00	Nd	Nd
Itapaji	86.00	201.00	Nd	Nd
Mean	57.18	116.58	Nd	Nd
SD	28.30	70.65	Nd	Nd
CV	49.49	60.60	Nd	Nd

Nd- Not determined

The levels of heavy metal recorded in water in this study were generally low when compared with the limit of chronic reference values suggested by WHO (18) and USEPA (19). Lead were not detected in the water sample for both season, this might have been so because the dams were not located where there are heavy traffic ,for most of the metals the values obtained during wet season were relatively higher than what was obtained in the dry season. This has been attributed to natural run off (during raining) from various sources including mineralised areas which eventually end up in aquatic system (3). Similar result was obtained by (5) in the coastal areas of Ondo state. Fe and Zn was the most abundant metal in the water samples, this has been attributed to the fact than these metals are the most abundant on Nigeria soil (8, 14, 20, 21, 22).

The mean metal levels in sediment samples are shown in Tables 2a&2b for both seasons. The values were higher in wet season than dry season as was noticed in the water samples .This has been attributed to the high flushing rate during wet seasons (2, 22) .The study revealed that the sediment from the dams contained very high significant amount of heavy metals when compared with their concentration in water. This is in agreement with the result obtained by (12).

Sediment act as the most important reservoir or sink of metals and other pollutants in the aquatic environment (9) Heavy metal containmination in sediment can affect the water quality and biomagnifications of metal in aquatic organism, resulting in potential long term implication on human health and ecosystem(12,23).

The mean metal levels in fish for both seasons (wet and dry) are shown in Tables 3a & 3b, the concentration of Fe and Zn were higher in the wet season. Similar Observation has earlier been reported by (5,8). The high concentration of metals in fish samples compared with water could be an advantage most importantly in respect of some role in the formation of haemoglobin and also Zinc have been found to play important role in enzymatic activities (24, 25).

Tables 4a, 4b, 5a, and 5b reveal the biomagnifications factor of metals in sediment and fish samples for both seasons respectively. It could be observed that biomagnification factor of Iron and zinc were higher in the wet season than those obtained in the dry season for both sediment and fish samples, the direct relationship between the concentration and biomagnifications factor of iron and Zinc in wet season suggest the soils around all the dams might be naturally rich in the metals and could be so leached into the dams. The biomagnifications factors of the metals determined in sediment reveals that the metals were present in greater amount than the corresponding surrounding water tables 1-4, these are similar to those of (4,5,12). This shows that the pollutional level of these metal can be better be monitored in the sediment of an aquatic environment. The biomagnifications factors for most of the metals for both season varied for one dam to another, this is attested to by the coefficient of variation that ranged between 48.66-141.42% and 34.92- 157.87%. This indicate that all the dams are not in the same geological location .The biomagnifications factors of metals in fish samples are higher that those of water samples for both season but lower than those of sediment samples this indicate that the organism have high tendency to concentrate the metals in their body tissue and as such could be use to monitor pollutional trend of the metals in aquatic environment.

CONCLUSION

The study reveal that the Concentration of metals in fish samples from all the dams are below the established toxicological limits for heavy metals in seafood (9) and WHO (26) standards.However, It is quite evident that there was bioaccumulation of these metals in fish tissues and condition may get worse, therefore a regular monitoring of heavy metals levels in fish is necessary.

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