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Physico-Chemical Parameters and Heavy Metal Levels in Water and Fish Samples from River Jakara and Jakara Dam, Kano State, Nigeria

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The physico-chemical parameters and heavy metal levels in water samples from river Jakara and Jakara dam as well as in fish samples from the dam were determined during the wet and dry seasons of the year. From the results and the calculated t-value of the parameters, the physico-chemical parameters and heavy metals determined were generally higher in dry season than the wet season. The recorded pH ranged between 6.1 ± 0.2 to 8.45 ± 0.35, conductivity 970 ± 90 µS/cm to 3300 ± 60 µS/cm, dissolved oxygen 5.5 ± 0.5 mg/L to 12 ± 0.1 mg/L, hardness 42 ± 0.0 mg/L to 326 ± 74 mg/L while the concentration ranges of heavy metals in mg/L and mg/kg were as follows: Pb (0.035 ± 0.01 to 0.070 ± 0.01), Cr (0.115 ± 0.03 to 0.256 ± 0.0), Cu (0.049 ± 0.01 to 0.209 ± 0.04) and Pb (0.108 ± 0.0 to 0.323 ± 0.0), Cr (0.233 ± 0.0004 to 0.930 ± 0.0), Cu (0.484 ± 0.16 to 1.774 ± 0.163) in water and fish samples respectively. The results showed that temperature, pH, dissolved oxygen, chloride, sulphate, nitrate were within World Health Organization/Standards Organization of Nigeria (WHO/SON) permissible limits for drinking water. However conductivity, alkalinity, hardness, TDS, turbidity and heavy metals (Fe, Cr, Pb) were outside (WHO/SON) permissible limits for drinking water; whereas Cu and Zn were within the standard. The heavy metal (Zn, Cu, Fe, Cr, Pb) concentrations in fish samples were within permissible limits set by WHO even though the transfer coefficients calculated revealed higher concentrations of heavy metals in fish than in water.

Keywords: Physico-chemical, Parameters, Heavy metals, Pollution, Transfer coefficient.

INTRODUCTION

Water occupies about 70 % of the earth's surface and yet it is one of the scarcest commodities especially in the developing countries of the world[1]. Water is an essential constituent of all living tissues, cells, blood and fluids. An average human adult contains about 60-70 % w/w water[2]. Water therefore remains an important nutrient particularly as drink and food, which are needed for the well being of the body cells. About 97.7 % of the total fresh water exists as groundwater and the balance of 2.3 % exists as surface water which is mainly found in lakes, streams and rivers.

Fishes, apart from being a good source of digestible protein, vitamins, minerals and polyunsaturated fatty acids, are also an important source of heavy metals. Some of the metals found in the fish might be essential as they play important roles in the biological system of the fish as well as in human beings. Some of these metals may also be toxic and can cause serious damage to human health even in trace amounts[3]. Fishes are notorious for their ability to concentrate heavy metals in their muscles and since they play important roles in human nutrition, they need to be carefully screened to ensure that unnecessary high level of some toxic trace metals are not being transferred to man through fish consumption[4].

The aims of this study were to determine selected physico-chemical parameters and the heavy metals levels of the water samples from river Jakara and Jakara dam and the trace metal levels in the fish samples from the dam.

EXPERIMENTAL

Study area: Jakara basin is located on longitude 8º 31' E and 8º 45' E and latitude 12º 10' N and 12º 13' N. The basin is about 30 km^2 with northwest, southwest orientation sprawling about 0.33º.

River Jakara took its name from one of the early historic settlements near Dala in the Kano city. Although this is not the natural behaviour of most rivers in semi arid regions, it so happens that the river receives wastewater from urban Kano, mainly industrial and domestic sewage in addition to seasonal rainfall. In 1976, a dam was constructed on the upstream of the river for irrigation, recreation and wildlife conservation.

The reservoir was designed[5] to contain up to 54.34 m^3 of water with a surface area of 1659 ha.

The reagents used in this work were all of analytical grade and were used as received without further purification. Deionized water was used in the preparation of stock solutions used for elemental impurities studied and distilled water was used in all other procedures.

Sample collection: Water samples for physico-chemical and heavy metal determinations were collected in clean 4 L and 2 L plastic containers respectively from the designated sampling points twice during the wet season (August/September 2011) and dry season (March/April 2012) between 11 am-12 pm. The samples collected were transported to the laboratory in boxes containing ice. Similarly samples of fish (tilapia and mudfish) were bought from fishermen at the bank of the dam and transported to the laboratory in boxes containing ice.

Sample pretreatment: The samples for heavy metal analysis were preserved by adding 5 mL concentrated HNO_3 acid to each 1 L sample to adjust the pH to 2 and also to prevent the metals from adhering to the walls of the containers. The samples were stored in a refrigerator at about 4 ºC prior to analysis[6]. The fish species were rinsed with distilled water and were dissected; the muscles and gills tissues were removed. These tissues were dried to a constant weight in a hot air oven at 103 ºC and were ground to a fine powder using a porcelain mortar and pestle. 5 g of homogenized sample powder was weighed accurately in a porcelain crucible and was ashed in a muffle furnace at 550 ºC for 4 h[7].

Sample digestion

Water sample: 100 mL of water sample was transferred into a clean beaker and 5 mL concentrated nitric acid (HNO_3) was added. The beaker with content was placed on a hotplate and was brought to a slow boil. The solution was allowed to evaporate to about 20 mL volume. The beaker was cooled and another 5 mL concentrated HNO_3 was added and the beaker was covered with a watch glass and the heating continued. A small portion of HNO_3 was again added until the solution appeared light coloured and clear. The beaker wall and watch glass were washed with distilled water and the sample was filtered to remove any insoluble materials. The volume was made up to 100 mL mark with distilled water in a volumetric flask[8].

Fish sample: About 0.1 g of ash was dissolved in 5 mL concentrated nitric acid and made up to 20 mL with distilled water. The mixture was heated on a hotplate to about one third of the total volume and the solution was then filtered using a Whatman filter paper into a 50 mL volumetric flask and the volume was made up to the mark with deionized water[7].

Determination of physico-chemical parameters and heavy metals: The temperatures of water samples were taken using a mercury in glass thermometer. The water pH/TDS/ conductivity were measured with a pH meter and TDS meter (Hanna instrument) and Conductivity meter (Jenway model) respectively. The nitrate and phosphate levels were determined using a Wagtech Photometer model CP 1000. Dissolved oxygen was measured using a DO meter (Jenway model 9071) while turbidity was measured using Wagtech turbidimeter model CP1000. The total alkalinity, hardness and chloride were determined by titration method[8]. The heavy metal concentrations were determined using (Buck scientific model 210 VGP) atomic absorption spectrophotometer (AAS) as described in the manufacturers' instruction manual.

RESULTS AND DISCUSSION

Tables 1 and 2 show the mean values of physio-chemical parameters concentrations in water samples from Jakara River/ Dam during the wet and dry seasons respectively. Table-3 is the comparison of seasonal variations of parameters in the water samples. Figs. 1 and 2 show the various mean values of the heavy metals in water and in fish respectively. Tables 4 and 5 show the transfer coefficients calculated for some heavy metals in wet and dry seasons respectively.

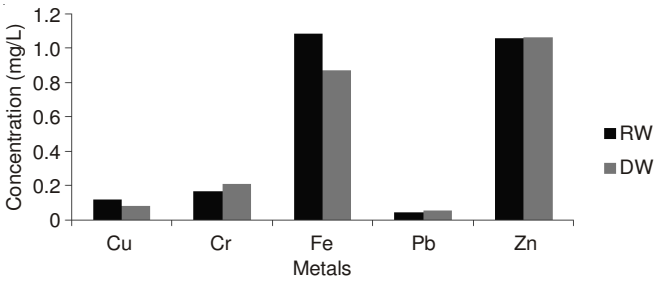

Fig. 1. Mean values of heavy metals concentration in water sample

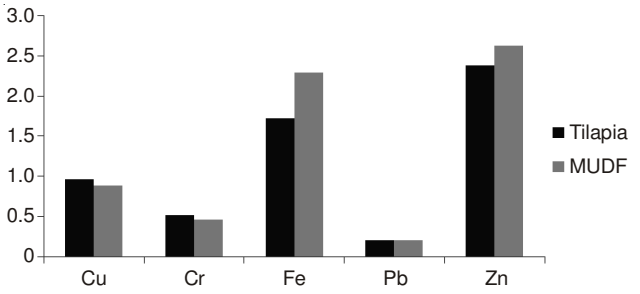

Fig. 2. Mean values of heavy metals in fish samples from Jarawa Dam

The levels of physico-chemical parameters and heavy metals concentrations determined in the water and fish samples showed variations during the wet and dry seasons. Based on the results obtained and the t-values calculated are shown in Table-3. The major trend is that the dry season values were observed to be relatively higher than the wet season results. The mean pH values ranged between 7.05 ± 0.35 and 7.65 ± 0.50 and 8.45 ± 0.35 and 8.50 ± 0.20 in the wet season for the Jakara river and dam respectively and the mean values ranged between 6.10 ± 0.2 and 6.40 ± 0.0 and 7.10 ± 0.1 and 7.30 ± 0.1 in the dry season for the Jakara river and dam respectively. These results fall within the (6.5-8.5) standard value of WHO permissible limit for drinking water. The result is in accord with ranges of (6.27 to 7.99 and 5.6 to 10.6) reported by Adamu and Ahmed[9] in their studies of Jakara river. The low values by these workers may be attributed to organic decomposition in the dry season. However high or low pH values in a river have been reported to affect aquatic life and alter toxicity of other pollutants in one form or the other[10]. The mean temperature values ranged between 26.5 ± 0.5 ºC and 28.5 ± 0.0 ºC and 25.0 ± 0.0 ºC and 26.0 ± 0.0 ºC in the wet season for the Jakara river and dam. The mean values also ranged between

TABLE-1
MEAN VALUES OF PHYSIO-CHEMICAL PARAMETERS CONCENTRATIONS IN WATER SAMPLES FROM JAKARA RIVER/DAM DURING THE WET SEASON

S. No.	Location	Temp. (°C)	pH	Conductivity (μs cm^{-1})	Total alkalinity (mg/L)	Hardness (mg/L)	Nitrates (mg/L)	Chloride (mg/L)	Dissolved oxygen (mg/L)	Total dissolved solid (mg/L)	Total suspended solid (mg/L)	Total solid (mg/L)	Sulphate (mg/L)	Turbidity (NTU)
		(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)
1	RWA	26.5±0.5	7.05±0.35	2575±55	1195±85	226±16	23.43±0.33	131.5±4.5	9.9±0.7	1350±30	1470±790	2820±820	87.0±17.0	170.5±39.5
2	RWB	27.5±1.5	7.20±0.50	2010±40	900±0	197±3	8.50±0.65	99±24.0	9.3±0.8	1270±10	1159±39	2429±29	67.5±6.5	143.0±23
3	RWC	27.5±0.5	7.65±0.10	1895±335	855±245	167±15	4.39±0.12	109±6.0	9.7±0.5	920±140	1311±805	2231±665	46.5±11.5	152.5±3.5
4	RWD	28.0±0.0	7.50±0.80	1835±245	720±130	195±5	11.88±1.41	99±16.0	10.2±0.4	1005±115	685±375	1690±490	39.5±2.5	121.5±20.5
5	DWE	26.0±0.0	8.50±0.20	970±90	250±10	42±0	8.49±0.06	63±3.0	11.0±0.0	560±30	2418±846	2978±216	4.5±0.5	23.0±4.0
6	DWF	25.0±0.0	8.45±0.35	995±25	260±10	45±0	1.72±0.20	62.5±3.5	12.0±0.1	560±30	2324±1052	2884±1041	6.0±3.0	16.5±0.5

RWA, RWB, RWC, RWD = River water sampling point A, B, C & D; DWE and DMF = Dam water sampling point E and F, respectively

TABLE-2
MEAN VALUES OF PHYSIO-CHEMICAL PARAMETERS CONCENTRATIONS IN WATER SAMPLES FROM JAKARA RIVER/DAM DURING THE DRY SEASON

S. No.	Location	Temp. (°C)	pH	Conductivity (μs cm^{-1})	Total alkalinity (mg/L)	Hardness (mg/L)	Nitrates (mg/L)	Chloride (mg/L)	Dissolved oxygen (mg/L)	Total dissolved solid (mg/L)	Total suspended solid (mg/L)	Total solid (mg/L)	Sulphate (mg/L)	Turbidity (NTU)
		(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)	(mean ± SD)
1	RWA	30.5±0.5	6.40±0.0	2865±855	1100±310	270±46	21.91±4.84	143.05±1.05	5.6±0.4	1125±255	1999±231	3185±37	131.5±12.5	108.0±33
2	RWB	31.5±1.5	6.10±0.2	2665±585	975±215	243±43	12.28±1.10	155.15±15.25	6.0±1.0	1085±195	2070±250	3155±55	63.0±9.0	126.0±16.0
3	RWC	31.5±1.5	6.20±0.2	2970±220	1070±70	258±70	13.73±2.38	125.0±7.80	5.5±0.5	1200±120	2037±505	3237±385	77.5±1.5	66.5±14.5
4	RWD	31.5±0.5	6.40±0.0	3300±60	1170±90	326±74	11.42±0.77	142.35±14.55	5.6±0.5	1315±45	2465±289	3780±244	64.5±1.5	58.5±8.5
5	DWE	32.5±0.5	7.20±0.1	1095±5	285±5	56±4	1.19±0.09	74.55±3.55	9.5±0.5	495±5	2321±89	2816±94	12.5±0.5	15.8±4.2
6	DWF	33.5±0.5	7.40±0.0	1139±39	270±0	51±5	2.12±0.20	80.95±4.25	10.4±0.2	445±15	1350±220	1795±205	16.5±1.5	12.5±2.5

RWA = River water sampling point A; DWD = Dam water sampling point D

TABLE-3
SEASONAL VARIATIONS OF PARAMETERS IN WATER SAMPLES FROM JAKARA RIVER/DAM

Parameters	pH	Conductivity (μS/cm)	DO (mg/L)	Total hardness (mg/L)	Pb (mg/L)	Cr (mg/L)	Cu (mg/L)
Wet season mean ± SD	6.1±0.2	970±90	5.5±0.5	42.0±0.0	0.108±0.005	0.233±0.0004	0.484±0.16
Dry Season Mean ± SD	8.45±0.35	3300±60	12.0±0.1	326.0±74	0.323±0.002	0.930±0.0	1.774±0.163
t-value	7.9231	475.5781	20.9745	82.5294	97.1271	87.1189	5.6753
p-value	0.00	0.00	0.00	0.00	0.00	0.00	0.00

TABLE-4
WET SEASON TRANSFER COEFFICIENT

Heavy metals	Pb	Cr	Cu
Heavy metals concentration in fish (mg/kg)	0.108 ± 0.00	0.233 ± 0.0004	0.484 ± 0.16
Heavy metals concentration in water (mg/L)	0.035 ± 0.01	0.115 ± 0.0300	0.049 ± 0.01
Transfer coefficient	3.09	2.03	9.88

TABLE-5
DRY SEASON TRANSFER COEFFICIENT

Heavy metals	Pb	Cr	Cu
Heavy metals concentration in fish (mg/kg)	0.323 ± 0.00	0.930 ± 0.0	1.774 ± 0.163
Heavy metals concentration in water (mg/L)	0.070 ± 0.01	0.256 ± 0.0	0.209 ± 0.040
Transfer coefficient	4.61	3.63	8.49

30.5 ± 0.5 ºC and 31.5 ± 0.5 ºC and 30.5 ± 1.5 ºC and 33.5 ± 0.5 ºC in the dry season for the Jakara river and dam respectively. These values were found to be within WHO permissible limit for drinking water[11]. The temperature range is optimal for metabolic activities and will support fish growth[12]. Dissolved oxygen values were observed to be lower during the dry season which may be attributed to low aeration of the waters at high temperature.

The mean dissolved oxygen values ranged between 9.3 ± 0.8 mg/L and 10.2 ± 0.4 mg/L and 11.0 ± 0.0 and 12.9 ± 0.3 mg/L in the wet season; the values ranged between 5.6 ± 0.4 mg/L and 6.0 ± 1.0 mg/L and 9.5 ± 0.5 mg/L and 10.4 ± 2.0 mg/L in the dry season for the Jakara river and dam respectively. The results obtained are in accord with findings reported in the range of 6.22 ± 0.23 mg/L and 8.43 ± 0.56 mg/L by Akan and co-workers[5] in their studies of physico-chemical parameters of Jakara wastewater. The dissolved oxygen value is a measure of the degree of pollution by organic matter, the destruction of organic matter and the self purification capacity of a water body[10]. The standard for sustaining aquatic life is stipulated at 5 mg/L. Thus a concentration below this value negatively affects aquatic biological life, while concentration below 2 mg/L may lead to death for most fishes[11]. The study revealed higher values of total dissolved solids during the wet season which may be attributed to deposition of more organic matter from surface runoffs of domestic waste in addition to ions into the water.

The mean values of total dissolved solid (TDS) ranged between 920 ± 140 mg/L and 1350 ± 30 mg/L and 560 ± 30 mg/L and 775 ± 45 mg/L in the wet season while the values ranged between 1085 ± 195 mg/L and 1315 ± 45 mg/L and 445 ± 15 mg/L and 495 ± 5 mg/L in the dry season for the Jakara river and dam respectively. These values exceeded the desirable limit of 500 mg/L value for drinking water[11]. This result agrees with studies by Akan *et al.*[5] in Jakara wastewater. There is no evidence of adverse health effect of total dissolved solids of over 500 mg/L, although at about 600 mg/L taste problem is likely due to conductivity values[9] were lower during the wet season and this may be attributed to dilution effect of high volume of water and deposition of more organic matter in the rainy season.

It was observed that the mean values of conductivity ranged between 2010 ± 40 µS/cm and 2575 ± 55 µS/cm and 970 ± 90 µS/cm and 1365 ± 15 µS/cm in the wet season and 2665 ± 585 µS/cm and 3300 ± 60 µS/cm and 1095 ± 5 µS/cm and 1148 ± 7.5 µS/cm in the dry season for the Jakara river and dam respectively. The values were found to exceed the WHO permissible limit of 1000 µS/cm for drinking water. This result agrees with findings in the range of 1052-3631 µS/cm in studies of some shallow wells located near Jakara dam reservoir which was attributed to industrial and municipal waste in Kano city entering the river and dam water[12]. This is also supported by findings earlier reported[5] in the range of 1021.17 ± 14.32 µS/cm to 1534.21 ± 12.43 µS/cm) in studies of physico-chemical parameters of Jakara wastewater channel. Electrical conductivity is a useful indicator of salt content in water. High salt concentration may result in adverse effects on aquatic biota. The turbidity of water samples were relatively higher in the wet season when compared to dry season, this may be attributed to higher turbulence which brings in clay, silt and other particles into the water.

The mean turbidity values obtained ranged between 121.5 ± 20NTU and 170.5 ± 39.5NTU and 16.5 ± 0.5NTU and 23.0 ± 4.0NTU in the wet season and 58.5 ± 8.5NTU and 126.0 ± 16 and 12.5 ± 2.5 and 15.8 ± 4.2NTU in the dry season for the Jakara river and dam respectively. These mean values were found to be outside the permissible limits of 5 NTU for drinking water[13,14]. Excessive turbidity or cloudiness in drinking water is aesthetically unpleasant and may also represent a health concern. Turbidity can provide food and shelter for pathogens. The nitrate values were higher in the dry season which may be as a result of oxidation of ammonia to nitrates at high temperatures during the nitrogen cycle[15]. The chloride and sulphate values were also higher in the dry season and this may be attributed to concentration effect of low volume of water in the dry season.

The mean nitrate, chloride and sulphate values ranged between 4.39 ± 0.12 mg/L and 23.43 ± 0.33 mg/L and 1.72 ± 0.20 mg/L and 8.49 ± 0.06 mg/L, 99.0 ± 16.0 mg/L and 131.5 ± 4.5 mg/L and 62.5 ± 3.5 mg/L and 63.0 ± 3.1 mg/L, 39.5 ± 2.5 mg/L and 87.0 ± 17.0 mg/L and 4.5 ± 0.5 mg/L and 6.0 ± 3.0 mg/L in Jakara river and dam water in the wet season respectively. The values were found to range between 11.42 ± 0.77 mg/L and 21.91 ± 4.84 mg/L and 1.91 ± 0.09 and 2.12 ± 0.20 mg/L, 125.0 ± 7.80 mg/L and 155.15 ± 15.25 mg/L and 74.55 ± 3.55 mg/L and 80.95 ± 4.25 mg/L and 63.0 ± 9.0 mg/L and 131.5 ± 12.5 mg/L and 12.5 ± 0.5 mg/L and 16.5 ± 1.5 mg/L in the dry season for the Jakara river and dam. The

values were found to be within the WHO maximum permissible limits of 50 mg/L, 250 mg/L and 250 mg/L for nitrate, chloride and sulphate levels in drinking water.

The mean values of alkalinity and hardness of the parameters ranged between 720 ± 130 mg/L and 1195 ± 85 mg/L and 250 ± 10 mg/L and 260 ± 10 mg/L and 167 ± 15 mg/L and 226 ± 16 mg/L and 42 ± 0 and 45 ± 5 mg/L in the wet season and were observed to be between 975 ± 215 mg/L and 1170 ± 90 mg/L and 270 ± 0 mg/L and 285 ± 5 mg/L and 243 ± 43 mg/L and 326 ± 74 mg/L and 51 ± 5 mg/L and 56 ± 4 mg/L in the dry season for the Jakara river and dam respectively. The water samples were observed to have high values of hardness and alkalinity above the 100 mg/recommended value for drinking water. However the Jakara dam water sample was found to have hardness value within the recommended standard. The mean values were observed to be relatively higher in the dry season which may be attributed to the concentration effect of low volume of the water.

The mean respective concentrations of the heavy metals (Figs. 1 and 2): copper, chromium, iron, lead and zinc ranged between 0.05 ± 0.02 mg/L and 0.08 ± 0.02 mg/L, 0.13 ± 0.01 mg/L and 0.14 ± 0.02 mg/L, 0.60 ± 0.05 mg/L and 0.97 ± 0.04 mg/L, 0.035 ± 0.02 mg/L and 0.04 ± 0.00 mg/L and 0.60 ± 0.00 mg/L and 1.58 ± 0.73 mg/L in the wet season for Jakara river and respective values ranged between 0.11 ± 0.2 mg/L and 0.15 ± 0.04 mg/L, 0.18 ± 0.06 mg/L and 0.24 ± 0.4 mg/L, 0.91 ± 0.06 mg/L and 1.60 ± 0.03 mg/L, 0.04 ± 0.01 mg/L and 0.06 ± 0.01 mg/L and 0.95 ± 0.20 mg/L and 1.55 ± 0.15 mg/L in the dry season for Jakara river. Similarly, the respective mean concentrations of those heavy metals were found to range between 0.05 ± 0.02 mg/L and 0.07 ± 0.00 mg/L, 0.15 ± 0.01 mg/L and 0.21 ± 0.02 mg/L, 0.52 ± 0.23 mg/L and 0.69 ± 0.09 mg/L in the wet season and 0.08 ± 0.02 mg/L and 0.13 ± 0.00 mg/L, 0.22 ± 0.01 mg/L and 0.26 ± 0.00 mg/L, 1.12 ± 0.17 mg/L and 1.16 ± 0.10 mg/L, 0.05 ± 0.01 mg/L and 0.07 ± 0.01 mg/L and 1.10 ± 0.05 and 1.63 ± 0.03 mg/L in the dry season for the Jakara dam. The study revealed heavy metals concentrations as Zn > Fe > Cr > Cu > Pb with concentrations of Cr, Fe and Pb being outside the recommended permissible limits of drinking water of 0.01 mg/L, 0.05 mg/L and 0.3 mg/L for Pb, Cr and Fe respectively. The levels of Fe and Pb are above values earlier determined in Jakara river[16]. The low heavy metal concentration observed in the wet season may be attributed to sedimentation, dilution and depuration effect. The relatively high concentrations of Fe, Cr and Pb which are above acceptable limits may be as a result of reduction of ferric to ferrous in the presence of organic matter whereby the latter is readily soluble and also different anthropogenic inputs such as industrial, agricultural and sewage effluents which have been implicated as major sources of metal enrichment in rivers[16]. High lead levels are associated with diseases such as cancer, mental development in infants, toxicity to central and peripheral nervous system and interference with vitamin D metabolism.

Heavy metal concentrations in the fish samples (tilapia and mudfish) from the Jakara dam were observed to be higher in the dry season than wet season as recorded in the dam water sample, this may be attributed to concentration effect of low volume of water. From Tables 4 and 5, the transfer coefficients calculated are all above 1, indicating that the heavy metals are more concentrated in the fish than in the water.

Conclusion

The study revealed that the levels of temperature, pH, DO, chloride, sulphate, nitrate were within permissible limits for drinking water while the levels of conductivity, alkalinity, hardness, TDS, turbidity and heavy metals namely chromium, lead, iron were outside permissible limits for drinking water, indicating pollution within the study area. However the levels of zinc and copper were within permissible limits. It was observed that levels were relatively lower during wet season as compared to the dry season. The study also revealed the levels of heavy metals in fish samples to be within (WHO) permissible limits. Heavy metals are not decomposed biologically; hence the levels of these metals will exist in the water for quite a long time and may lead to long term health related problems to people consuming the water and fish. Based on these results, there is need for the relevant body to put in place proper waste management approach to check indiscriminate refuse dumping. There is also the need for monitoring of the water quality of the dam to prevent fish contamination.

REFERENCES

1. T.O. Agbabiaka and G.P. Oyeyiola, *Int. J. Plant, Animal Environ. Sci.*, **2**, 209 (2012).
2. S. Karwamura, Integrated Design and Operation of Water Treatment Facilities, John Wiley & Sons, New York, edn 2 (2012).
3. J. Tashkourian and P. Hosseinkhegri, *Iran Int. Food Res. J.*, **18**, 791 (2011).
4 R.A. Olowu, O.O. Ayejuyo, G.O. Adewuyi, I.A. Adejoro, A.A.B. Denloye, A.O. Babatunde and A.L. Ogundajo, *E-J. Chem.*, **7**, 215 (2010).
5. J.C. Akan, F.I. Abdurrahman, G.A. Dimari and V.O. Ogugbuaja, *Eur. J. Sci. Res.*, **23**, 122 (2008).
6. A.U. Auno, U.U. Egereonu and J.C. Egereonu, *Anal. Sci. J.*, 1, 9 (2012).
7. A. Ali, D. Ahmadou, B.A. Mohamadou, C. Saidou and D. Tenin, *J. Fisheries Int.*, **5**, 54 (2010).
8. American Public Health Association (APHA), American Water Work Association (AWWA) and Water Pollution Control Federation (WPCE), Standard Method for the Examination of Water and Wastewater, New York, edn 16 (1985).
9. M. Adamu and Z.A. Ahmed, *J. Appl. Sci. Environ. Sanitation*, **6**, 411 (2011).
10. J.C. Akan and F.I. Abdurrahman, *J. Appl. Sci. Environ. Sanitation*, **4**, 103 (2009).
11. World Health Organization (WHO), Guidelines for Drinking Water Quality, Geneva (2003).
12. M.K. Mustapha, *Turk. J. Fish. Aquat. Sci.*, **8**, 309 (2008).
13. Environmental Protection Agency, EPA Guidance Manual, Turbidity Provisions, USA, (1999).
14. Standards Organization of Nigeria (SON): Nigerian Industrial Standards, NIS 554 Nigerian Standard for Drinking Water Quality, pp. 15-17 (2007).
15. N.I. Dike, S.J. Oniye, V.O. Ajibola, and A.U. Ezealor, *Sci. World J.*, **5**, 23 (2010).
16. N.I. Dike, A.U. Ezealor and S.J. Oniye, *Chem. Class J.*, **2**, 78 (2004).