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Full Length Research Article

DETERMINATION OF PHYSICOCHEMICAL PARAMETERS AND HEAVY METALS CONTENT OF WATER SAMPLES FROM DOMESTIC AND KADUNA RIVER IN KADUNA METROPOLIS, KADUNA STATE

J.U. Ukwenya[1*] P.A. Vantsawa[1], K.B. Dikwa[1], T.E. Effiong[2], S. Bitrus[3], O. Bello[3], R. Abdullahi[1] and J. Abdulkadir[1]

[1]Department of Biological Sciences, Nigerian Defence Academy, Kaduna
[2]Department of Biotechnology, Nigerian Defence Academy, Kaduna
[3]Department of Biological Sciences, Kaduna State University, Kaduna

*Corresponding Author Email Address: joyceuneku@gmail.com Phone: +2348132946553

ABSTRACT
Water is very essential for the survival of all living things both plants and animals depend on the availability of water. The aim of this work is to determine the physicochemical parameters and heavy metals content of water samples from domestic and Kaduna River in Kaduna metropolis. Standard method were used for physicochemical parameters and atomic absorption spectrophotometer were used for heavy metals of the water samples**.** The range of temperature (25.1±0.78°C and 27.6±0.21°C), pH value (6.30±0.29 and 8.46±0.06), turbidity (5.05±0.07m and 9.94±0.08m), the respective water conductivity were 5.95±0.49µS/cm and 98.0±2.82µS/cm, the TDS (4.15±0.35mg/l and 0.71±0.01mg/l), DO content recorded (1.18±0.01mg/l and 8.55±0.12mg/l), COD value were 1.08±0.11mg/l and 6.81±0.11mg/l and BOD (1.08±0.11mg/l and 6.81±0.11 mg/l) domestic and Kaduna River. In heavy metals, copper and cobalt concentrations were higher in domestic and Kaduna River water. The concentration of Zinc in domestic water (0.090±0.044ppm) was higher than that observed in Kaduna River (0.027±0.004ppm). Lead were 0.264±0.011ppm and 0.129±0.07ppm, Cadmium were 0.331±0.013ppm and 0.329±0.019ppm, respectively. The results showed that the water analyzed from domestic and Kaduna River water were within limit except chemical oxygen demand which was below, lead, cadmium and cobalt were above.

Keywords: Physicochemical Parameters, Heavy Metals, Water.

INTRODUCTION
Water is very essential for the survival of all living things both plants and animals depend on the availability of water. Accessibility of fresh clean water is the key to sustainable development and an essential element in health, food production and poverty reduction (Mgbemena, 2016). The basic purposes for which water is domestically required include drinking, bathing, cooking, and general sanitation such as laundry, flushing of closets and other household chores (Anzene & Aremu, 2007). Thus, an assured supply of water both qualitatively and quantitatively for these purposes greatly improves the social and economic activities of the people (Umo & Okoye, 2006). Freshwater has become a scarce commodity due to over exploitation, population growth and also pollution. Industrial effluents, domestic sewage and municipal wastes are being continuously added to the fresh water reservoirs affecting the water and changing its physicochemical quality and making it unfit for fish production. Concentrations of physicochemical parameters increase due to human activities and also by lack of environmental regulations (Mehedi *et al.,* 1999). Many researchers have reported the status of water bodies (lentic and lotic) after receiving various kinds of pollutants altering water quality characteristics (physical, chemical and biological). All living organisms have tolerable limits of water quality parameters in which they perform optimally (Davenport, 1993). The decline in fish yield has been attributed to a wide range of causes ranging from inadequate management of the fisheries resources to environmental degradation of the water bodies (Dumont, 1999). The quality of water in a river had been reported to affect abundance of fish species (Mustapha, 2009).
Human activities result in the discharge of heavy metals into the environment includes industrial processes, mining, automobile emissions, agricultural, wastewater discharge, and urban runoff (Wei & Yang, 2010 & Mohiuddin *et al.,* 2011). Heavy metal contamination has been occurring for centuries, and in the previous decade it has increased rapidly due to technological developments (Vrhovnik *et al.,* 2013). The increased use of metal containing fertilizers due to the agricultural revolution could lead to a continued rise of the concentration of metal pollutants in fresh water reservoirs due to water runoff (Ademoroti, 1996 & Aremu *et al.,* 2006). Heavy metals are the most important forms of aquatic pollutants and may accumulate in the tissues of fish, which are often at the top of the aquatic food chain (Dirican *et al.,* 2013). The progressive and irreversible accumulation of metals in various organs of aquatic creatures ultimately leads to metal-related diseases in the long run because of the toxicity of the metals, thereby endangering the aquatic biota and other organisms (Mallampati *et al.,* 2007). Among the aquatic organisms, fishes remain the important member which often accumulates metals in different body parts. The danger of heavy metal pollutants in water bodies lies in two aspects with respect to their impact. Firstly, heavy metals have the ability to persist in natural ecosystems for an extended period. Secondly, they have the ability to accumulate in successive levels of the biological chain, thereby causing acute and chronic diseases (Akpor & Muchie, 2010).

MATERIALS AND METHODS
Description of study area
The study was conducted in Kaduna metropolis, Kaduna State. Kaduna metropolis has a total land area of about 3,080 km^2. It has an approximate landmass of about 431 km^2 and located between

latitude 10º 52' N and 10º 30' N and longitude 7º 15' E and 7º 45' E. The area is situated on a relatively low plain liable to flood. The river divides the Kaduna metropolis into two major areas, Kaduna North and Kaduna South (BLSK, 2010).

Determination of physicochemical parameters

The following physicochemical parameter of the water sampled from both ponds was determined as follows: Temperature and pH were measured with pH meter (Hanna 8424) and secchi disc was used to measured turbidity (transparency) of the water. The secchi disc was dipped into the water, points of disappearance and reappearance was noted (Wetzel, 1983). Conductivity and TDS was measured using probe meter (pH OX 52). COD was determined by titration method. Fifty (50) mL of the water sample was measured in three 100 mL conical flasks (triplicate), and simultaneously distilled water was run as blank standards (triplicate). Five (5) mL of potassium dichromate solution was added in each of the six flasks and kept in water bath at 100ºC (boiling temperature) for one hour. The samples was allowed to cooled for 10 minutes and 5 mL of potassium iodide with 10 mL of conc. H_2SO_4 was added in each flask, the contents of each flask was be titrated with 0.1M sodium thiosulfate until the appearance of pale yellow colour and 1.0 mL of starch solution was added to each flask (solution turns blue). It was then titrated again with 0.1M sodium thiosulfate until the blue colour disappeared completely. Dissolved oxygen and biological oxygen demand (BOD) were determined using titration method (Dubey & Maheshwari, 2004).

Determination of Heavy Metals

Heavy metal content of water samples were determined by using atomic absorption spectrophotometer. The elements determined by this method were lead, zinc, copper, cadmium and cobalt. The water samples were collected and digested by transferring 100cm^3 into a flask and 5cm^3 of freshly prepared HNO_3, 15$cm^3$of conc. H_2SO_4 and 0.3cm^3 of $HClO_4$ were added. The solution was stirred and heated on a hot plate for 2hours. The mixture was digested in a fume cupboard, heating continued until a dense white fume appeared which was then ingested for 15min, allowed to cool and filtered into a 100cm^3 volumetric flask. The filtrate was diluted to the mark with distilled water (Yusuf *et al.,* 2015). The digested sample solution was placed in a 100cm^3 volumetric flask and made up to 100cm^3, three concentrations of standard solution of a particular metal to be analyzed were selected; blank solution was aspirated and adjusted to zero. Each standard solution was aspirated into flame, the prepared samples solution were obtained using the hollow cathode lamp for the respective elements at the proper wavelength and slit width of 0.5 nm (AOAC, 2005).

Data analysis

All the data collected were analyzed using Statistical Package for Social Sciences (SPSS 19.0 software). The chi square test was used to establish any statistical difference. Probability values of less than 0.05 (< 0.05) were considered as statistically significant. Anova was used to determine the mean ± SD of physicochemical parameters and heavy metals.

RESULTS AND DISCUSSION

The mean temperature of water sampled from Kaduna River was higher than the domestic; however the difference was not statistically significant ($p \geq 0.05$). The temperature of water sampled from Kaduna River was 27.6±0.21°C while in domestic had average of 25.1±0.78°C. The pH value recorded water sampled from Kaduna River was 8.46±0.06 being significantly higher ($p \leq 0.05$) than that recorded from domestic with a mean of 6.30±0.29. Water sampled from the Kaduna River were significantly more turbid ($p < 0.05$) than water from domestic. The mean turbidity values of water sampled from domestic and Kaduna River and selected domestic were 5.05±0.07m and 9.94±0.08m respectively. A significantly higher ($p \leq 0.05$) electrical conductivity was observed of water sampled from Kaduna River when compared with values recorded from domestic water; the respective water conductivities were 98.0±2.82μS/cm and 5.95±0.49 μS/cm. The TDS from domestic (4.15±0.35mg/l) was significantly higher ($p < 0.05$) than that recorded of water sampled from Kaduna River (0.71±0.01mg/l). The DO content recorded from domestic and Kaduna River were 1.18±0.01mg/l and 8.55±0.12mg/l, respectively, with the DO content of water sampled from Kaduna River being significantly higher ($p < 0.05$). There was no significant difference ($p > 0.05$) in the COD values recorded in water sampled from domestic or Kaduna River; the respective mean values for COD were 3.78±0.21mg/l and 3.88±0.16mg/l. BOD was significantly higher in water sampled from Kaduna River than domestic; the mean values of BOD of sampled water from domestic and Kaduna River were 1.08±0.11mg/l and 6.81±0.11 mg/l, respectively (Table 1).

Table 1: Mean ± standard deviation of physicochemical parameters of water sampled from domestic and Kaduna River in Kaduna metropolis

Parameters	Domestic	Kaduna River	p-value
Temperature (ºC)	25.1±0.78	27.6±0.21	0.113
pH	6.30±0.29	8.46±0.06	0.010
Turbidity (m)	5.05±0.07	9.94±0.08	< 0.001
Conductivity (μS/cm)	5.95±0.49	98.0±2.82	< 0.001
TDS (mg/l)	4.15±0.35	0.71±0.01	0.005
DO (mg/l)	1.18±0.01	8.55±0.12	< 0.001
COD (mg/l)	3.78±0.21	3.88±0.16	0.655
BOD (mg/l)	1.08±0.11	6.81±0.11	< 0.001

Copper and cobalt concentrations were significantly higher ($p \leq 0.05$) in water sampled from Kaduna River than domestic. Mean Copper concentrations of water sampled from Kaduna River and domestic were 0.475±0.002ppm and 0.250±0.045ppm respectively, while those for cobalt were 0.189±0.004ppm and 0.047±0.029ppm respectively. The concentration of Zinc in water sampled from domestic (0.090±0.044ppm) was higher than that obtained in water sampled from Kaduna River (0.027±0.004ppm) however the difference was not significant ($p \geq 0.05$). Lead and Cadmium were higher in water sampled from Kaduna River than from domestic; however the differences recorded were not statistically significant ($p \geq 0.05$). The concentrations of Lead in water sampled from Kaduna River and domestic were 0.264±0.011ppm and 0.129±0.079ppm, respectively, while those for Cadmium were 0.331±0.013ppm and 0.329±0.019ppm, respectively (Table 2).

Table 2: Mean ± standard deviation of heavy metal concentration from domestic and Kaduna River in Kaduna metropolis

Metal	Domestic	Kaduna River	p-value
Copper	0.250±0.045	0.475±0.002	0.020
Zinc	0.090±0.044	0.027±0.004	0.182
Lead	0.129±0.079	0.264±0.011	0.142
Cadmium	0.329±0.019	0.331±0.013	0.924
Cobalt	0.047±0.029	0.189±0.004	0.022

In this study, the temperature of water sampled was 25.1-27.6°C from domestic and Kaduna River could be attributed to many factor that influence the fish production and other aquatic organism growth. The result agrees with the work of Ewim *et al.* (2022) that reported temperature of 27.00 — 28.30°C of water samples in active war zones of Borno State. It was also in conform with the reports of Shelle *et al.* (2010) on water temperature (26.88 - 30.98°C) sampled from Nigerian institute for oceanography and marine research jetty station that the pattern of distribution of temperature is similar in time and space which are influenced by the same meteorological factors couple by tidal flushing.

The pH range of 6.30 - 8.46 recorded in water sampled from domestic and Kaduna River were all within normal range (6.5-9.0). This could be attributed to largest varieties of fresh water aquatic organisms prefer a pH range from 6.5-8.0 for growth and survival in the water (Oduor, 2000). This is similar to the results obtained by Oyeleke *et al.* (2019) in water samples from Lagos lagoon with pH ranged of 7.86-8.50. Ewebiyi *et al.* (2015) also obtained similar results on water pH recorded which were found to be in a range of 6.73- 8.35, indicating that the water is near neutral and alkaline range. The findings of this study on turbidity from domestic and Kaduna River showed that the water not turbid and there are less materials suspended in the water which hinder penetration of light to pass through the water (Omondi *et al.,* 2011). The findings corroborated with the work of Orobator *et al.* (2020) that recorded turbidity value of 0.78-19.33NTU observed in fish pond from Benin and that the status of turbidity for all the studied fish ponds is favorable for the fish health since it does not poses severe risk to their survival.

The conductivity was high from Kaduna River than the domestic and this could be as a result of free flow of effluent in the water body. According to Ehiagbonare *et al.* (2020) low conductivity value of 0.006 - 0.017 mS/cm can be as a result of organic compounds like oil which are poor conductors of electrical current very well and therefore have a low conductivity when in water.

The TDS (0.71-4.15mg/l) in water sampled from domestic and Kaduna River showed lower values compared to 200mg/l NESREA (2011) and WHO (2011) standard of 250mg/l. High or low concentrations might affect the growth of fish and lead to fish death. Reduction in water clarity can contribute to a decrease in photosynthetic activity combined with toxic compounds and heavy metals and consequently led to an increase in water temperature (Murphy, 2005). This negated that of Lekwot *et al.,* (2012) reported that when TDS is high with upstream 300mg/l, discharge point 400mg/l and downstream 250mg/l. It could be as a result of excessive organic manuring and feed wastage which have been reported to increase TDS (Ogbeibu and Edutie, 2006).

The DO value (1.18-8.55 mg/l) recorded from water sampled from domestic and Kaduna River, this could be attributed to aquatic insects and fish that live in streams and river gained oxygen from the atmosphere and plants as a result of photosynthesis (Oduor, 2000). This is similar with the work of Sani *et al.,* (2019) that reported dissolved oxygen of 8.28mg/l of water samples from Bodna River in Kwali. There are physical factors that can lessen the amount of oxygen dissolved in the river. High temperatures which may result from high turbidity, from the return of domestic used water to the river decrease the amount of gases that can be dissolved in water (Sani *et al.,* 2019).

The COD values (3.78-3.88mg/l) recorded in water sampled from domestic and Kaduna River were below the normal range. These negate the work of Orobator *et al.,* (2020) that recorded 14.35mg/l in black tarpaulin pond water; this could be harmful to the survival of aquatic life in the pond.

The BOD value recorded in the water sampled from domestic and Kaduna River could be due to the organics are broken down into simpler compounds, such as CO_2 and H_2O, and the microbes use the energy released for growth and reproduction. When this process occurs in water, the oxygen consumed is the DO in the water (Tchobanoglous *et al.,* 2003). This correlated the BOD value of 3.88-4.22 mg/l and 2.0-7.0 mg/l as reported by Mohammed *et al.,* (2020) in dry and raining season of water samples from Moussa stream in Bida, could be as a result of increase in volume of water in raining season, influx of organic matters into the stream though surface run. The findings of heavy metal concentration of copper and zinc in the water sampled from domestic and Kaduna River might be due to vehicle emissions, tyre and engine wear contribute sizeable concentrations of all metals particularly zinc and copper (Aremu *et al.,* 2017). This negated the work of Abui *et al.* (2017) that reports value of 0.502, 0.502 and 0.614 and the value of 0.408, 0.427 and 0.434 of copper and zinc from bypass, barnawa and down quarters along Kaduna River during rainy season. This could be attributed to geological distribution of minerals that vary from one location to the other (Adefemi and Awokunmi, 2010). The concentration of lead in water sampled from domestic and Kaduna River were above the permissible limit of 0.01. According to Hammani *et al.* (2021) might be due to mining activities in the area. This findings were in agreement the reports of Nnabo, (2015) in water sampled from Ameri stream, Ameri Mine shaft and Ebonyi River, Enyigba all in South Eastern with 0.20, 0.30 and 0.10 respectively, might be due to the effects of man's activities on the environment. The concentration of cadmium (0.329-0.331ppm) of water sampled from domestic and Kaduna River were higher than the standard limit of 0.003, as reported by EPA, (2003) the high concentration cadmium in that had high potential to cause health effect like nausea, vomiting, diarrhea, liver injury, convulsion, shock and renal failure short period of time. This correlated with the work of Edwin *et al.,* (2015) who reported that the presence of Cadmium

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in water samples ranged from 0.10-0.013 mg/l. According to Seema, *et al.* (2011) Cadmium in drinking water may be required by the body in small amounts but can be toxic in large doses. The value of cobalt in water sampled from domestic and Kaduna River were higher than the allowable limits of 0.005 which could lead to disadvantageous effects in humans, other organisms and the environment at large (Mansourri, *et al.,* 2016). Cobalt value recorded in this study differed from the findings of Oladeji and Saeed, (2015) that reported Cobalt ranged of 3.77-15.20 mg/l in wastewater along Kubanni stream in Zaria. These amounts were more than the standard limit of 0.005 in WHO (2011) and this could be as a result of the fact that the river is located near residential area that might cause the increase in the level of cobalt.

Conclusion

In conclusion, the physicochemical parameters of water sampled from domestic and Kaduna River were within the limit except chemical oxygen demand which was below. The heavy metals concentrations of water sampled from domestic and Kaduna River, copper and zinc were below the allowable limit except lead, cadmium, and cobalt were above. The results showed that some of the parameters and heavy metals are in optimum in the water whereas others have negative impact on the water.

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