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Effect of Effluents on Fish and Water Quality from Selected Tributaries of Ureje Reservoir in Ado-Ekiti.

[1]Adebayo I. A, [2]Familusi, O. A and [3]B.W. Obe

[1,2,3]Department of Fisheries and Aquaculture Management, Faculty of Agricultural Sciences, Ekiti State University, Ado Ekiti, Ekiti State, Nigeria.

Abstract: *The impact of effluents on water and fish quality in some Nigerian waters is alarming due to indiscriminate dumping of domestic and industrial wastes into the waters. Ureje reservoir and its tributaries are no exception to this menace; hence the need to examine the effect of unrestricted dumping of refuse into the reservoir on fish and water quality. Four sampling stations (A-D) were selected namely: A (Upstream tributary) along Busy Minds International School; B (Downstream tributary) along Aba Igbira settlement; C (Tributary close to the middle of the reservoir) along Sije road and D (the main reservoir) respectively. Site selection was based on the high volume of water contribution to the main reservoir and proximity to refuse dump site. Water and fish Samples were collected for Laboratory Analysis using Standard Methods. Results obtained were subjected to one-way analysis of variance using Statistical Package for Social Sciences. Results of water analysis showed the values of Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) to besignificantly ($p<0.05$)highest (272.67mg/l O_2 and 340 mg/l) respectively in sampling station C, denoting it as the highest point of effluents influx. The values for Iron (Fe) were significantly ($p<0.05$)high than the maximum permissible limits to man in all the sampling stations with the highest value (12.30mg/l) in station B indicating highest mineral deposits. The highest Values of alkalinity (182.67mg/l$CaCO_3$); acidity (304.85mg/l$CaCO_3$); phosphates (0.04mg/l) and chloride (11.70mg/l) were recorded in the main reservoir (Station D), showing highest ionic exchange due to much aquatic activities. The microbiological analysis showed Water Total Bacterial Count (WTBC) and Fish Total Bacterial Count (FTBC) to be significantly ($p<0.05$)highest (580.00 and 5173.0) in sampling stations C and D respectively. While Water Total Faecal Streptococci (WTFS) and Fish Total Faecal Streptococci (FTFS) followed almost the same trend with the highest values in station D (9.00CFU/100ml and 25.00 CFU/100ml) respectively. The almost sedentary nature of the main reservoir may accounts for its high bacteria load in fish and water. Influx of pollutants through the sampling station C, that is, tributary close to the middle of the reservoir should be checkmated for better water quality.*

Key words: *Effluents, bacteria load, Fish, Water analysis, reservoir*

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I. Introduction

Water is the most widely distributed substance in the natural environment which constitutes the earth's oceans, seas, lakes, rivers and underground water sources (Du Pleiess, (2017). It is crucial for various aspects of human health, development and well-being; hence the need for its effective and efficient management. Aquatic ecosystems have been suffering changes, in most cases irreversible, often associated with human activities such as deforestation, release of industrial and domestic effluents, and even the use of pesticides in agricultural fields, (Rafael *et al*,2012). The effects of these changes on fish and water resources often adversely affect the health and economic benefits of the end users.Wakawa *et al* (2008). Indiscriminate dumping of effluents into water ways is an important factor to be considered and tackled in a bid to ensure a healthy aquatic ecosystem.

In Nigeria, the continuous indiscriminate disposal of municipal solid wastes on roadsides, open pits, flowing gully water and drainage channels as a result of increase in human population and urbanization has resulted in contaminated and polluted waters (Adewuyi *et al*, (2009). Water quality is an index of water pollution and fish is considered as one of the most significant indicators of effluent quality in aquatic environment (Babayemi and Dauda, 2009). The major sources of aquatic contamination are derived from industrial processing plants, leachates from solid waste dumpsites, mechanized farms, industrialization, and increased vehicular use. The quantity and composition of waste generated vary from urban areas to rural areas and likewise from State to State. Ayeni *et al* (2017).

Every household in Ekiti State, more importantly, Ado-Ekiti, the state capital generates waste of different types on daily basis which has negative impact on the environment. Waste management in the Ado metropolis is observed to be generally poor, contributing immensely to poor environmental conditions, especially in and around the Ureje reservoir. The existing system of waste management in the city appears to be incapable of coping with the mountain of waste generated and heaped on the road side (Ogunleye and Uzoma, 2018). The best approach to waste management is to collect, treat and dispose it by urban dwellers in an environmentally and socially satisfactory manner, but open dumping and burning in unapproved locations has been the norm (Abila and Kantola, 2013). Meanwhile, aquatic ecosystem is the ultimate recipient of almost everything including the discarded wastes (Adeniran *et al,* 2014). It is expected that proper waste management through effective education and social awareness will promote sustainable environmental cleanness

Ureje reservoir is one of the major Dams in Ekiti State, located in Ado Ekiti, the State capital which overflows across Ado Ekiti /Ikere road and cut across the southwest region of the State. The reservoir is strategic to the people of Ekiti State especially the residents of Ado Ekiti, since it is the major source of pipe borne water and irrigation (Adebayo, 2017). Effluents come into the reservoir primarily through the tributaries since they are the main points of water entry. Garbage finds its way into the water body through erosion or intentional human disposal (Oladejo *et al* 2017). Large proportion of these wastes is in organic form which easily interferes with the biota when decomposed. Continuous influx of effluents from domestic waste (kitchen waste, laundry and sewage) and agricultural establishments provides an enabling media for the growth of microbial species and adversely affects water and fish quality. This study is geared towards understanding the tributaries as the major points of effluents influx into the reservoir and to establish any detrimental impact on the water quality and fish. The finding is expected to provide information that would bring healthy and safe utilization of the reservoir.

II. Materials and Methods

Study Area

The focus was on out-sourcing tributaries of Ureje reservoir, geographically located between lat 7^{0} 35’56$^{”}$ N long. 5^{0} 12$^{”}$ 47E. The reservoir is utilised as a major source of municipal water supply and is managed by Federal Ministry of Water Resources, Ado-Ekiti. Fish are harvested in the reservoir by artisanal fishermen using dugout canoes. Below (Fig. 1) is the aerial view of the reservoir.

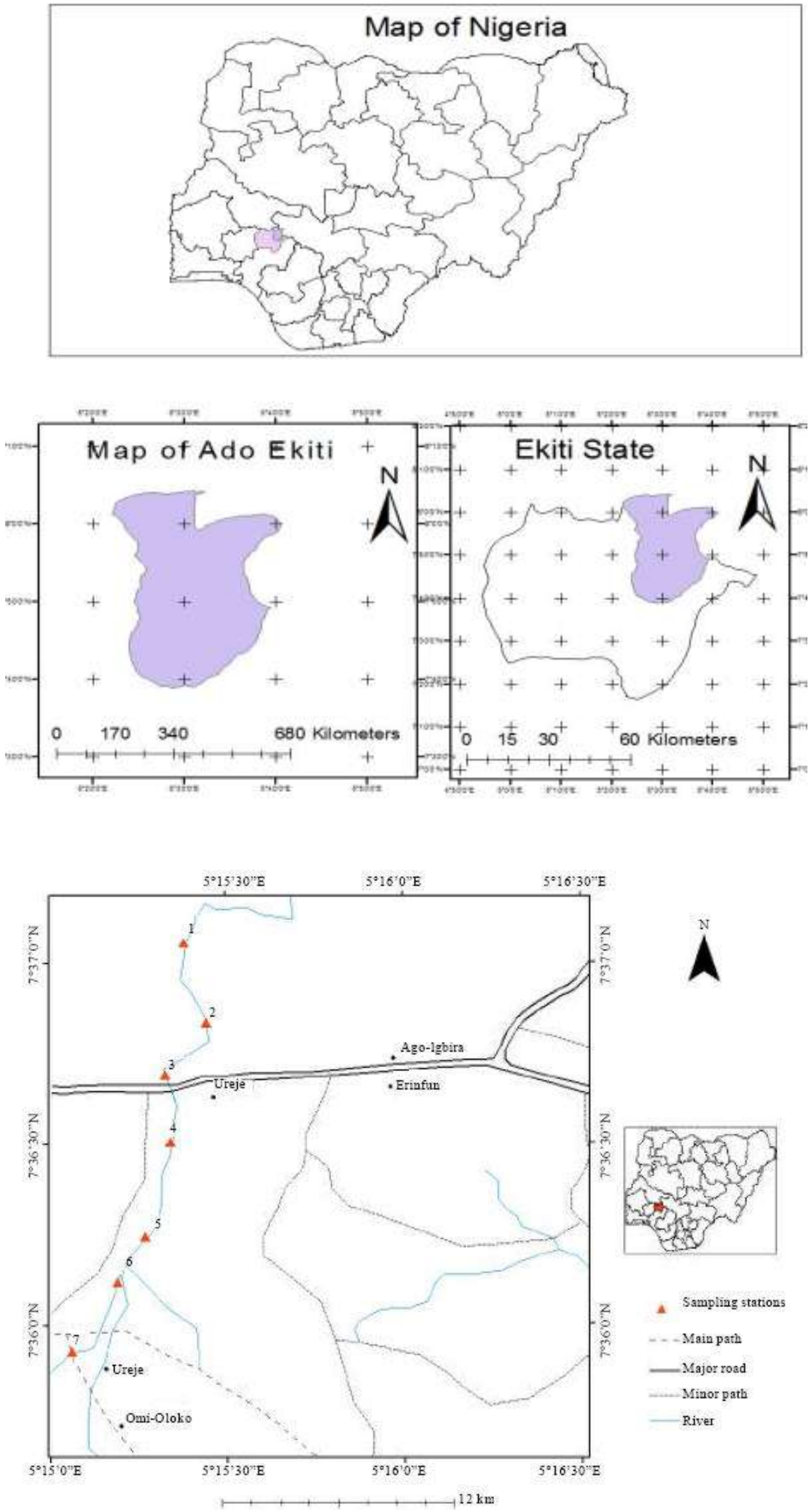

Fig 1: The Ureje Reservoir.

Study Design.

Four sampling stations (A-D) were selected (Fig. 2-4) namely: A (Upstream tributary) along Busy Minds International School; B (Downstream tributary) along Aba Igbira settlement; C (Tributary close to the middle of the reservoir) along Sije road and D (the main reservoir) respectively. Site selection was based on the high volume of water contribution to the main reservoir and proximity to refuse dump site. The study was designed to look at the effect of effluents influx through the tributaries into the reservoir on the physicochemical parameters of water and microbial load in both water and fish samples obtained from the tributaries with the aim of establishing the impact of effluents on both fish and water quality.

Sampling point A is about 890m away from the reservoir (Fig. 1) and point B is 1.01km away from the reservoir (Fig.2) and point C is about 1.18km away from sampling point in the reservoir (Fig3).

At each sampling point, GPS readings were taken as well as landmarks as presented below.

Sampling Station A :(Upstream tributary) .Along Busy Minds School: 7^0 36’23” N 5012’27” E

Fig 2: Estimate of the distance between sampling station for tributary A and the Reservoir.

Sampling Station B: (Downstream tributary). Along Alasia Bus-Stop: 7^0 36’1” N 5^0 12’17” E

Fig 3: Distance between tributary B sampling station and reservoir sampling station

Sampling station C: (Major tributary@ the middle of the reservoir) Sije Road: 7^{0}36’7” N 5^{0}12’40” E

Fig 4 Distance between tributary C and main reservoir sampling station.

Sampling Station D: (Main reservoir): 7^{0}35’44” N 5^{0}12’13” E. as shown in fig 1.0

Collection and Analysis of Water Samples.

Water samples were biweekly collected for spot and laboratory analysis within the space of three months (June – August, 2018) using appropriately rinsed (with distilled water) sampling bottles in the four (A-D) sampling stations. Water samples were collected early in the morning labelled as sample A-D for identification purposes. Samples were kept under tight lid and away from direct sunlight during transit to the laboratory. Water quality in all the sampling stations (A-D) was determined using Standard Methods (AOAC, 1998). The following physicochemical parameters were analysed:

(i) Conductivity and Total Dissolved Solids (TDS)

Conductivity and TDS were analysed using Jenway conductivity meter and electrometric method respectively.

(ii) Total Hardness and Alkalinity

Total Hardness and Alkalinity were determined through titration with EDTA and Titration with Hydrochloric Acid respectively (AOAC, 1998).

(iii) Dissolved Oxygen and pH

Dissolved Oxygen and pH of water from the sampling stations were measured using YSI DO meter (YSI model 57) and Electronic pH meter (metler Toledo 320 model) respectively.

(iv) Acidity, Phosphates and Sulphates

Acidity, Phosphates and Sulphates of the water samples were determined Using titrimetric, Colorimetric, Turbidimetric (Barium Sulphate) methods respectively as described by (AOAC, 1998).

(v) Fe (Iron), Pb (Lead) Calcium (Ca) and Magnesium (Mg)

Iron, Lead, Calcium and Magnesium were determined using Atomic Absorption Spectrophotometer.

(vi) Chemical Oxygen Demand. (COD) and Biochemical Oxygen Demand (BOD)

Chemical Oxygen Demand and Biochemical Oxygen Demandwere determined through UV-VIS spectrophotometry (TasnimAlam, 2010).

(vii) Determination of Water Quality Index (WQI)

Calculation of WQI was carried out in this work using TasnimAlam method (2010).

Table 1: Water Quality Status

WQI	**Status**	**Possible Usage**
1 0 – 25	Excellent	Excellent Drinking, Irrigation and Industrial
25 – 50	Good	Good Domestic, Irrigation and Industrial
51 -75	Fair	Fair Irrigation and Industrial
76 – 100	Poor	Poor Irrigation
101 -150	Very Poor	Very Poor Restricted use for Irrigation
Above 150	Unfit for Drinking	Unfit for Drinking Proper treatment required before use

Source: United State Environmental Protection Agency (USEPA), 2016.

Microbiological Analysis of Water and Fish Samples

Water samples for microbiological analysis were obtained separately from the samples used for physicochemical analysis, though they were obtained from the same coordinates; samples were obtained in the morning using pre-sterilized reagent bottles and taken to the laboratory. Water Total Bacterial Count (WTBC), Water Total Faecal Coliform Count (WTFC) and Water Total Faecal Streptococci (WTFS) were all analysed for as described by Environmental Protection Agency (EPA, 2016). Also, the endemic fish species (*Oreochromis nilticus*) in all the sampling stations were biweekly collected alive through the help of fishermen operating in each sampling station for laboratory analysis. Fish Total Bacterial Count (FTBC), Fish Total Faecal Coliform Count (FTFC) and Fish Total Faecal Streptococci (FTFS) were analysed for

((APHA, 1998; WHO, 2004, USEPA, 2016).

III. Data Analysis

The mean values of the raw data collected for both water and fish samples were subjected to Analysis of Variance (ANOVA) using Statistical Package for Social Sciences. Standard deviations, level of significance with reference to Maximum Permissible Limit were expressed for easy understanding by the public with results obtained.

IV. Results

Physicochemical parameters of water samples

The result of the physicochemical parameters of water in all the sampling stations (A-D) is shown in Table 2 below. Dissolve Oxygen was significantly ($P > 0.05$) highest in B (14.8±0.10) and C (14.6±0.20) respectively. Biochemical Oxygen Demand showed significant difference in values in all stations with the, highest value in C (272.67). There was no significant difference ($P > 0.05$) in the values of water hardness across the sampling stations indicating an even distribution of Ca and Mg ions. Analysis indicates highest values (304.85mg/l) of acidity to be found in the main reservoir (D). No Lead (Pb) was found in all the sampling stations with values of 0.00. The mean values of Iron (Fe) was significantly ($P > 0.05$) highest ($12.30^{a} \pm 0.10$) in sampling station B (Downstream tributary)

Table 2: Mean values of physicochemical parameters of water samples analysed after subjection to one –way ANOVA

Parameters	Sampling Stations			
	A Upstream tributary	**B** Downstream tributary	**C** Tributary close to the middle of Reservoir	**D** Main Reservoir
Dissolve Oxygen (DO) mg/l	$10.37^{c}\pm0.02$	$14.8^{a}\pm0.10$	$14.6^{a}\pm0.20$	$13.98^{b}\pm0.07$
Biochemical Oxygen Demand (BOD) Mg/LO_2	$256.73^{b}\pm0.21$	$96.26^{d}\pm0.01$	$272.67^{a}\pm0.15$	$240.64^{c}\pm0.20$
Chemical Oxygen Demand (COD) mg/l	$320.03^{b}\pm0.06$	$120.00^{d}\pm1.00$	$340.33^{a}\pm1.53$	$300.00^{c}\pm2.00$
Total Hardness (mg/l $CaCO_3$)	$33.13^{a}\pm0.23$	$36.00^{a}\pm1.00$	$34.67^{a}\pm1.52$	$36.00^{a}\pm2.00$
Alkalinity (mg/l $CaCO_3$)	$176.00^{b}\pm0.00$	$176.00^{b}\pm1.00$	$172.00^{b}\pm2.00$	$182.67^{a}\pm1.15$
Conductivity (µS/cm)	$217.00^{a}\pm0.00$	$208.00^{b}\pm1.00$	$207.00^{b}\pm2.00$	$214.00^{a}\pm2.00$
PH	$6.29^{b}\pm0.02$	$6.79^{a}\pm0.01$	$6.85^{a}\pm0.05$	$6.77^{a}\pm0.22$
Total Dissolved Solids (mg/l)	$150.27^{b}\pm0.12$	$138.40^{d}\pm0.10$	$160.80^{a}\pm0.20$	$146.50^{c}\pm0.20$
Acidity (mg/l $CaCO_3$)	$293.73^{b}\pm0.21$	$293.80^{b}\pm1.70$	$287.15^{c}\pm3.35$	$304.85^{a}\pm2.05$
Phosphates (mg/Lp_2O_5)	$0.023^{a}\pm0.02$	$0.02^{a}\pm0.00$	$0.03^{a}\pm0.00$	$0.04^{a}\pm0.00$
Sulphates (SO_4)	$7.40^{b}\pm0.10$	$18.8^{a}\pm0.10$	$10.00^{b}\pm2.00$	$8.00^{b}\pm1.00$
Iron (FE)	$1.07^{b}\pm0.01$	$12.30^{a}\pm0.10$	$0.60^{c}\pm0.02$	$0.35^{d}\pm0.01$
Lead (pb) mg/l	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
Chlorine (Cl) mg/l	$2.50^{d}\pm0.10$	$7.40^{c}\pm0.10$	$9.50^{b}\pm0.20$	$11.70^{a}\pm0.20$
Calcium (Ca) mg/Ca	$9.40^{a}\pm0.10$	$8.10^{b}\pm0.10$	$7.60^{c}\pm0.20$	$9.40^{a}\pm0.20$
Magnesium (Mg) mg/l	$3.40^{d}\pm0.10$	$6.40^{b}\pm0.10$	$4.60^{c}\pm0.20$	$6.87^{a}\pm0.16$

Microbiological Analysis of Water Samples

In Table 3 below, the value for Water Total Bacterial Count (WTBC) were significantly different ($P > 0.05$) in all the sampling stations with the highest value ($580.00^{a} \pm 1.00$) in station C and least in station A ($165.00^{d} \pm 1.00$). This result indicates that tributary C contributes 3 times as much bacterial contamination into the reservoir when compared to other tributaries. Water Total Faecal Coliform Count (WTFC) was minimum in station A ($100.00^{a} \pm 10.0$) and maximum in station D ($180.00^{a} \pm 78.10$). Water Total Faecal Streptococci (WTFS) was nil in station A (0.00). This result indicates recent faecal contamination in stations B, C and D.

Table 3: Microbiological Analysis of Water Samples
Values with the same alphabet in a row are not significantly different at $p<0.05$

Parameters	A	B	C	D
Water Total Bacterial Count(WTBC)	$165.00^{d}\pm1.00$	$185.00^{c}\pm1.00$	$580.00^{a}\pm1.00$	$540.00^{b}\pm1.00$
Water Total Faecal Coliform Count (WTFC) CFU/ml	$100.00^{a}\pm10.0$	$155.00^{a}\pm25.00$	$166.67^{a}\pm72.34$	$180.00^{a}\pm78.10$
Water Total Faecal Streptococci (WTFS) CFU/100ml	$0.00^{c}\pm0.00$	$5.00^{b}\pm2.00$	$8.00^{a}\pm2.00$	$9.00^{a}\pm3.00$

Microbiological Analysis of Fish Samples

In Table 4 below, the mean values for Fish Total Bacterial Count (FTBC), Fish Total Faecal Coliform Count (FTFC) and Fish Total Faecal Streptococci (FTFS) were significantly ($p<0.05$) highest ($5173.0^{a} \pm 152.3$; $803.00^{a} \pm 110.00$ and $25.00^{a} \pm 10.02$) respectively in the main reservoir (D). The relative sedentary nature of this station (D) may accounts for the high microbial loads in fish.

Table 4: Microbiological Analysis of Fish Samples

Microbiological Parameters	Sampling Stations			
	A	B	C	D
Fish Total Bacterial Count(FTBC)	$154.00^{b}\pm11.00$	$114.0^{b}\pm7.5$	$136.0^{b}\pm4.7$	$5173.0^{a}\pm152.3$
Fish Total Faecal Coliform Count (FTFC) CFU/ml	$160.0^{b}\pm27.00$	$137.00^{b}\pm16.50$	$189.00^{b}\pm43.06$	$803.00^{a}\pm110.00$

Fish Total Faecal Streptococci (FTFS) CFU/100ml	$8.00^{b}\pm2.00$	$8.00^{b}\pm0.58$	$8.00^{b}\pm4.00$	$25.00^{a}\pm10.02$

Values with the same alphabet in a row are not significantly different at $p<0.05$

The Water Quality Index.

The values for the water quality index (WQI) in Table 5 below indicated suitability of water from all sampling stations (A –D) to be good for irrigation and industrial use. Station C indicates the highest departure from ideal WQI values which denotes higher level of pollution and degradation of water quality.

Table 5: Water Quality Index.

Parameters	Sampling Stations			
	A	**B**	**C**	**D**
Dissolved Oxygen (mg/l)	50	50	87	50
Biochemical Oxygen Demand	5	5	5	5
Water Faecal Coliform	39	40	44	38
pH	84	83	63	82
Temperature	12	12	12	12
Phosphate	99	99	99	98
Total Dissolved Solids	78	80	79	79
Overall Water Quality Index (WQI)	**52**	**53**	**56**	**52**

V. Discussion

In this study, high dissolve oxygen (DO) levels in all the sampling stations may be due to the abundant vegetation along the water routes. Though the main reservoir had the least DO level but still higher than the limit established by the Irish Environmental Protection Agency (USEPA, 2016) for utilization as a source of portable water supply and fish culture. Biochemical Oxygen Demand (BOD) in all the sampling stations exceeded the maximum permissible limit of the World Health Organization (WHO) of 50mg/l (WHO, 2004). This is an indication of high level of pollution.According to previous study, the presence of hydrogen sulphide is noticeable in the reservoir due to putrescible sludge on the bed of the river by deposition of settleable organic solids which give rise to sulphide odours in the water and on the fish (Awosusi, 2010). In this study, the high level of chemical oxygen demand in all the stations especially in station C which is a major tributary close to the middle of the reservoir indicates heavy load of organic and inorganic contaminants that utilize high amount of oxygen (Abila and Kantola, 2013). The water hardness across the tributaries and the main reservoir indicated even distribution of Ca and Mg ions with values characterizing the water as soft waters. However the low levels of alkalinity showed the water to be prone to sudden pH fluctuations (Obasi *et al* 2012).

Conductivity showed ions in the water were at very safe levels (EPA, 2001). The pH level of water influence several other important parameters of water quality such as Ammonia toxicity, chlorine disinfection efficiency, and metal solubility. In this study only the upstream tributary (station A) had a pH level below the permissible limit for drinking and fish culture. This may be due to its lotic nature with high level of aeration (Adewuyi, 2009). The low level of Phosphorus in the present study in all the stations established the fact that contributions were majorly from nature in plants, micro-organisms, animal wastes and not necessarily from run-off and sewage discharges (Ogunleye and Uzoma, 2018). Presence of sulphates may be as a result of rocks and geological formations (EPA, 2001). Lead (Pb) was not detected in all the sampling stations, while chloride, calcium, and magnesium had the highest deposition in the main reservoir (Station D) due to sedentary nature of the station (Adebayo, 2017).

In this study, bacteria load in water was highest in sampling station C (tributary close to the middle of the reservoir), contributing three times as much bacterial contamination into the reservoir when compared to other tributaries. This must be as a result of high inflow of pollutants into the reservoir through this source. The total faecal coliform (TFC) in water was at alarming rate in the main reservoir (Station D) 18 times exceeding the safe level according to United State Environmental Protection Agency (USEPA, 2016) Maximum Permissible Limit (MPL). This extreme value can be attributed to the unregulated disposal of raw human sewage in and around the reservoir as well as the tributaries. Faecal coliforms originate in human and animal waste. Total coliforms include faecal and other bacteria with similar properties (TasnimAlam, 2010). Water Total Faecal Streptococci indicated faecal contamination in tributary B, C and the reservoir. Fish Total Bacterial Count (FTBC) was highest in fish samples from the main reservoir. This same trend was observed in the amount of Total Faecal Coliform (FTFC) in Fish andTotal Faecal Streptococci (FTFS) in Fish, showing the most polluted sampling station. Though, the tributaries do not present favourable fishing ground for commercial exploitation unlike the reservoir, hence the need to prevent the influx of pollutants into the reservoir the tributaries.

Observation of the environment indicated extreme case of plastic and polyethylene pollution attributable to the indiscriminate deposition of commercial packaging into the environment. Other materials observed on the surface of the water include; dead animals, wood splinters, soft drink bottles, vegetation clippings and cartons. The amount of tarry residues present in each of the tributary is associated with the level of urbanisation surrounding each tributary.

VI. Conclusion

The study indicated that the reservoir and its major tributaries are currently infested with effluents with considerable negative effects on water quality and fish. Continuous influx of effluents will further diminish the condition of the water. Although some of the water parameters were under the maximum permissible limits but those that exceeded indicated high presence of sewage and organic contamination. Bacteriological analysis indicated the tributaries as a makeshift toilet which encouraged the growth of faecal coliform and the presence of nutrients for the growth of these microbes.

VII. Recommendation

Ado Ekiti, the State Capital is expected to keep expanding in human population and industrial growth as a result of its strategic position in the State. I hereby suggest a workable plan for central sewage collection, treatment and disposal within Ado Ekiti Metropolis. A functional collaboration between the Law enforcement agents that are strategically stationed and the community leaders saddled with a new responsibility of notifying and assisting the government around the reservoir would ensure cleanliness and proper management of the reservoir. While unrestricted human access to the reservoir for fishing and farming activities should henceforth be checkmated to curb the menace of tarry residues and floating matter physically observed around the reservoir.

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