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Effect Of Water Treatment Effluent On Microbial Load Of *Clarias Gariepinus* And *Oreochromis Niloticus* Juveniles Under Cage Culture System In River Benue Makurdi, Benue State

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ABSTRACT

The present investigation was undertaken to evaluate the effect of water treatment plant effluent on microbial load of *Clarias gariepinus* and *Oriochromis niloticus* juvenile under cage culture. 50 fish were stocked per cage at each site Upstream (BE), at point of discharge (AE) and downstream (PS). Microbial study was done on the fish species and the data was subjected to statistical analysis (ANOVA). The result shows significant difference within groups for Dissolved Oxygen (DO), turbidity, Biological Oxygen Demand (BOD), Conductivity, Chemical Oxygen Demand (COD), pH and Phosphate. The highest value for DO, BOD and COD was obtained at effluent AE (4.48±0.18, 2.44±0.11 and 4.88±0.23 respectively). Turbidity and Chloride was found to be highest at AE (12.81±0.11 and 35.66±0.45 respectively). pH was found to highest at PS (7.74±0.36). The highest fungi count (FC) was observed in water sample in all the sites. S. *aureus*, E. *coli* and Yeast cell was observed in all the species and water sample at each sites. *Aspergillus* spp was observed only in O. niloticus at BE while Shyella spp was observed in water sample at BE and PS. Others micbrobes observed include *Bacillus* spp, *Klebsiella* Spp and *Salmonella* spp. The study revealed that effluent from the water treatment plant in Makurdi was idle with respect to most of the physiochemical parameter as these are within the recommended values for unpolluted water and for aquaculture. This could however not be said for their microbial counterpart as levels of biological indicators of pollution all exceed the WHO. It is recommended that further studies on the effect of waste water effluent from other sources should be carried out to determine pollution of water bodies by industries in order to help in evidence-base decision by relevant authorities to control pollution of River in Nigeria. Finally, this information will encourage aquaculturists to carefully monitor culture environment to minimize stress to the animals.

INTRODUCTION

Fish is important to human populace in trade and economy; it is of importance in the diet of different countries especially in the tropics and subtropics where malnutrition is a major problem (Alune and Andrew, 1996; Osuigwe and Obiekezie, 2007). As the human population inevitably increases, the demand for fish as source of protein will grow (Abolarin, 1996). Fish make up more than 40% of the world's vertebrate species and protein diet of two – third of the global population (Eyo, 1992; FAO, 1999) and occupy different levels of the aquatic food chain. Since they are restricted to a particular mode of life related to their food source and reproductive requirement, they interact with various levels of food chain and influence the structure of rivers, lakes, streams and estuaries (Ashade et al, 2013).

Fisheries can be divided into two: capture and cultured fisheries (artisanal and aquaculture respectively). Fish can be cultured in one of four culture systems: ponds, raceways, recirculation systems, or cages. Rearing of fish in enclosure (suspended cage in reservoirs) is a practice that is relatively new in the Northern part of Nigeria as compared to the Southern parts of Nigeria (Dasuki et al., 2013). There is a considerable increase in the range of production values of fish catch and thus tropical water bodies offer better opportunities for extensive and semi-intensive cage and pen culture (Le Cren and Lowe-McConnell, 1980). Cage culture is an alternative means of aquaculture especially for land-less fish farmers and it is almost none existing in the North Central part of the country. Nigeria is blessed with abundant inland water mass of 12.5million hectares comprising of lakes, reservoirs, ponds, dams, streams and rivers (Ita et al., 1985) part of which lies in the northern parts of the country and have the potential to serve in a multiuse capacity. Nigeria's domestic fish production is dominated by the small scale artisanal farmers who could be encouraged to go into cage fish farming system utilising the vast available scattered inland water bodies which abounds in the Northern parts of the country and the arable lands used in other agricultural ventures. Cage culturing makes it possible to grow fish in bodies of water where draining and seining would be difficult or impossible (Dasuki et al., 2013).

The aquatic environment, where fish and other aquatic organisms live, is subjected to different types of pollutants which enter water bodies through industrial, domestic and agricultural discharges thereby polluting the environment. The negative impacts of these effluents to aquatic ecosystems and to humans, from harmful substances found in them have been documented both at national and international levels. Some of these impacts include parasitic infestation, disease outbreak, death of aquatic life, algal blooms, habitat destruction from sedimentation, debris, and increased water flow as well as other short and long term toxicity from chemical contaminants; in combination with chemical accumulation and magnification at higher levels of the food chain (Canada Gazzette, 2010). Globally, the effluents that are discharged from wastewater treatment systems represent one of the largest sources of pollution (Akpor, 2011). The discharge of untreated wastewater into surface water bodies such as streams, rivers, lakes and oceans results in the pollution of such aquatic environments. This pollution of surface water bodies, resulting from anthropogenic activities, is a growing concern worldwide (Zhai et al., 2014; Hillel et al., 2015). The elevated levels of nutrients (Nitrogen and Phosphorus) in surface water due to pollution accelerate the growth of oxygen-depleting microbes which destroy the aquatic ecosystems resulting to eutrophication (Zhang et al., 2015). Eutrophication causes many adverse effects on the water body such as increased biomass of phytoplankton and macrophyte vegetation, increased blooms of gelatinous zooplankton, growth of benthic and epiphytic algae, increased toxins from bloom-forming algal species, loss of commercial and sport fisheries, reduced carbon availability to food webs, increased taste and odour problems, reduced species diversity, increased treatment costs prior to human use, and decreased aesthetic value of the water body (Smith and Schindler, 2009; Badruzzaman et al., 2012). These affect the fish health introducing stress to living creatures and thereby making them susceptible to microbial infection. Fish are conditioned by their environment and hence it is obvious that if the growing and harvesting environment of fish is polluted chemically or microbiologically, the fish are also polluted

Clarias gariepinus (C. *gariepinus*) and *Oreochromis niloticus* (O. *niloticus*) are among the fishes of high commercial importance in Nigeria. They are the most common cultured fish species. The market value of these fishes are reduced due to the deterioration caused by the disease as a result of the effluent which distort the environment of the fish. Water pollution from disposal of industrial wastewater is becoming an environmental concern as it leads to the deterioration of water quality in natural waters such as streams, rivers, lakes, etc. River waters including River Benue has been polluted because of industrial and intensive agricultural practices as well as indiscriminate disposal of domestic wastes. There is paucity of information on the effect of effluent discharge on surrounding water bodies linked with the microbial load of these fish species and its environs. The set objectives of this study to determine the effect of water treatment effluent on microbial load on the fish species at each sampling site.

MATERIALS AND METHODS

The study area is River Benue in Makurdi Benue State at Benue State Water Board. Makurdi is located along 7o 43'50"N and 8o 32'10" coordinate and it is major drained by River Benue. The map of the study site is show below. Three study sites will be considered which are before

the point of effluent discharge (upstream), at the point of effluent discharge (Point source) and after the point of effluent discharge (downstream).

Cage Construction And Installation

The cage was constructed according to Swann et al. (1994) using 2" pressure pipe of 1 × 1 × 1m to enable floatation, ½" mesh nylon net No. 6, a cover was also constructed to cover the top of the cage so as to prevent the entry of other organisms. Twine and sticks was used as the anchor line and anchor respectively. After the construction, two cages were installed at each site i.e. before effluent discharge unit (upstream, BE), at the point of water board effluent discharge (point source, AE) and after effluent discharge point (downstream, PS) about 50m to 100m between the sites (Mulu et al., 2013).

Procurement And Stocking Of Live Fishes

A total of 150 juvenile of *Clarias gariepinus* and 150 juvenile of *Oreochromis niloticus* each were obtained from the University of Agriculture Department of Fisheries farm and acclimatized in a concrete pond and fed aquafeed for 14 days prior to the experiments. Prior to stocking, the average weight of the fish was taken. 50 fish were stocked per cage for O. niloticus and 50 fish C. *gariepinus* per site. The fishes were fed 5% body weight for eight (8) weeks. At the end of eighth week, Samples were collected from each cage for examination.

Water samples were also collected from each site and analysis was done on it to determine the physichemical parameters of the water using water quality testing kits.

Microbiological Study

All glass wares (glass Petri dishes, bijou bottles, test tubes, conical flask, etc) were sterilised using hot air oven at 175OC for 30minutes. All the media were sterilised using autoclave at 121OC for 15minutes while inoculating wire loop was sterilised over a Bunsen flame until it was red hot.

Samples were carried to Biological Science Laboratory of the University of Agriculture Makurdi. One (1) gram of each fish sample from each site was weighed using a digital laboratory balance and serially dilution method was used to get countable colonies (viable, coliform and mould colony count) on all samples (Onyeagba et al., 2004; Cheesbrough, 2006). Nutrient agar, MacConkey and Potato dextrose agar was prepared and used for isolation of bacteria and fungi respectively.

All isolates were sub-cultured to obtain a pure culture and a gram-staining carried out. Also biochemical test such as Simmon citrate, indole, catalase, coagulase, urease test were carried out on the isolates. Identification of the isolates was carried out based on morphological and biochemical characteristics (Sakazaki and Shimad, 1986; Collins et. al.,1989 and Cheesebrough, 2006).

Statistical Analyses

SPSS 17 software was used to analyse all the data obtained. Data obtained for water quality, growth performance, microbial and haematology at each sampling site was subjected to analysis of variance (ANOVA). Values equal to or less than 0.05 ($p \leq 0.05$) were regarded as significant.

RESULTS

Water Quality Parameter

Results obtained for the physicochemical parameter s of the study area is presented in table 1. Significant difference occurred within groups for Dissolved Oxygen (DO), turbidity, Biological Oxygen Demand (BOD), Conductivity, Chemical Oxygen Demand (COD), pH and Phosphate. The highest value for DO, BOD and COD was obtained at effluent AE (4.48±0.18m/l, 2.44±0.11 m/l and 4.88±0.23 m/l respectively) while the lowest value for DO, BOD and COD was obtained before effluent BE (3.50±0.22 m/l, 1.88±0.15 m/l and 3.56±0.68 m/l respectively). Turbidity and Phosphate was found to be highest at AE (12.81±0.11 and 0.308±0.055 m/l respectively) and lowest after the effluent PS (11.91±0.50 and 0.228±0.013 respectively) while Conductivity and Total Dissolved Solid (TDS) was observed to be highest at BE (84.40±1.95 and 45.00±4.69 respectively) and lowest at PS (80.20±1.48 and 43.60±3.58 respectively). The highest value observed for Chloride is 35.66±0.45 at AE while the lowest was 35.44±0.02 at PS while pH was found to highest at PS (7.74±0.36) and low at AE (7.30±0.23). There was no significant different found between group for Temperature, TDS, Ammonia, Nitrite and Chloride.

Result obtained from microbial analysis of C. *gariepinus*, O. *niloticus* and water samples obtained from water treatment plant effluent in River Benue, Makurdi is shown in Table 2, Table 3, Table 4 and Table 5.

Table 2 show the mean Fungi Count (FC), Coliform Count (CC) and Viable Count (VC) of C. *gariepinus*, O. *niloticus* and water samples obtained from water treatment plant effluent in River Benue, Makurdi at $P < 0.05$. The highest FC was obtained at the Police Station site for C. gariepinus, O. niloticus and water samples which is 73.50±0.71 (104CFu/g), 67.50±2.12 (104CFu/g) and 2900.00±141.42 (104CFu/g) respectively. The lowest FC was reported at the point of effluent for C. *gariepinus*, O. *niloticus* and water samples i.e. 42.50±0.71 (104CFu/g), 35.00±0.00 (104CFu/g) and 117.00±40.55 (104CFu/g) respectively. Significant different was observed between site for all the samples ($P<0.05$). The CC was found highest at AE for C. *gariepinus* (72.50±0.71. 104CFu/g), at PS O. niloticus (64.50±0.71. 104CFu/g) and at PS for Water Sample (1680.00±168.71. 104CFu/g). CC was low BE for C. gariepinus i.e 71.00±1.41 (104CFu/g), at AE for O. niloticus and Water Sample i.e. 52.50±0.71 (104CFu/g) and 1165±21.21 (104CFu/g) respectively. There was no significant difference in CC across the Sites for C. *gariepinus* but it was observed for O. niloticus and Water Sample ($P<0.05$). The VC was observed to be low at PS for C. *gariepinus* (74.50±0.71. 104CFu/g), at BE for O. *niloticus* (62.00±1.41.104CFu/g) and at AE for Water Samples (1350±212.13. 104CFu/g). The highest VC was found at PS for O. niloticus and Water Sample i.e. 67.50±2.12 (104CFu/g) and 2900.00±141.42 (104CFu/g) respectively. Significant difference occurred in VC across groups for O. niloticus and Water Sample but there was no significant difference for C. *gariepinus* ($P<0.05$).

Table 1: Physiochemical Parameters of Water Obtained from Water Treatment Plant Effluent in River Benue, Makurdi.

Parameter	Sampling Site		
	BE	AE	PS
DO (m/l)	3.50 ± 0.22^{c}	4.48 ± 0.18^{a}	3.80 ± 0.19^{b}
Temperature (°C)	28.72 ± 0.80	28.72 ± 0.83	29.04 ± 0.22
Turbidity (cm)	12.43 ± 0.52^{ab}	12.81 ± 0.11^{a}	11.91 ± 0.50^{b}
BOD (m/l)	1.88 ± 0.15^{b}	2.44 ± 0.11^{a}	1.96 ± 0.11^{b}
Conductivity (NTU)	84.40 ± 1.95^{a}	82.60 ± 1.82^{ab}	80.20 ± 1.48^{b}
TDS (ppm)	45.00 ± 4.69	43.80 ± 2.77	43.60 ± 3.58
COD (m/l)	3.56 ± 0.68^{b}	4.88 ± 0.23^{a}	3.92 ± 0.23^{b}
pH	7.44 ± 0.23^{ab}	7.30 ± 0.23^{b}	7.74 ± 0.36^{a}
Ammonia (m/l)	0.058 ± 0.008	0.054 ± 0.011	0.052 ± 0.008
Nitrite (m/l)	0.0250 ± 0.0012	0.0254 ± 0.0013	0.0240 ± 0.0010
Phosphate (m/l)	0.228 ± 0.013^{b}	0.308 ± 0.055^{a}	0.214 ± 0.011^{b}
Chloride (m/l)	35.45 ± 0.01	35.66 ± 0.45	35.44 ± 0.02

Mean in the same row with different superscript differs significantly ($P<0.05$)
DO = Dissolved Oxygen, BOD = Biochemical Oxygen Demand, TDS = Total Dissolved Solid, COD = Chemical Oxygen Demand, BE = Before Effluent, AE = Point of effluent and PS = Police Station (Downstream).

Table 2: Mean Fungi, Coliform and Viable Count of Clarias gariepinus, Oreochromis niloticus and Water Samples obtained from Water Treatment Plant Effluents in River Benue, Makurdi.

Parameter	Sampling Site	*C. gariepinus*	*O, niloticus*	Water Samples
FC (10^4CFu/g)	BE	47.00±1.41^b	36.00±1.41^b	123.50±42.73^b
	AE	42.50±0.71^c	35.00±0.00^b	117.00±40.55^b
	PS	52.00±1.41^a	48.50±0.71^a	205.00±7.07^a
CC (10^4CFu/g)	BE	71.00±1.41	58.50±0.71^b	1190.00±14.14^b
	AE	72.50±0.71	52.50±0.71^c	1165.00±21.21^b
	PS	69.50±2.12	64.50±0.71^a	1680.00±168.71^a
VC (10^4CFu/g)	BE	74.50±0.71	62.00±1.41^b	1900.00±141.42^b
	AE	74.00±1.41	63.50±0.71^b	1350.00±212.13^c
	PS	73.50±0.71	67.50±2.12^a	2900.00±141.42^a

Mean in the same column with different superscript differs significantly (P<0.05).
FC = Fungi Count, Coliform Count, VC = Viable Count, BE = Before effluent, AE = Point of Effluent Discharge and PS = Police Station (Downstream).

Table 3: Mean Total of Fungi, Coliform and Viable Count of *Clarias gariepinus*, *Oreochromis niloticus* and Water Samples obtained from Water Treatment Plant Effluents in River Benue, Makurdi.

Parameter	*C. gariepinus*	*O. niloticus*	Water Samples
FC(10^4CFu/g)	47.17±4.36^b	39.83±6.77^c	148.50±44.07^a
CC(10^4CFu/g)	71.00±1.79^b	58.50±5.39^b	1345.00±270.83^a
VC(10^4CFu/g)	74.00±0.89^b	64.33±2.80^b	2050±718.84^a

Mean in the same column with different superscript differs significantly (P<0.05)
FC = Fungi Count, CV = Coliform Count, and VC = Viable Count.

Table 4: Morphology and Biochemical Characteristics of Bacteria Isolates Obtained from Water Treatment Plant Effluents in River Benue, Makurdi.

Shape	Gram's Reaction	Catalase	Coagulase	Citrate	Urease	Indole	Organism
Cocci in Clusters	+	+	+	-	-	-	Staph aureus
Rods	+	+	NA	+	-	-	Bacillus spp
Rods	-	+	NA	-	-	+	E. coli
Rods	-	+	NA	+	+	-	Klebsiella spp
Rods	-	+	NA	+	-	-	Salmonella spp
Rods	-	+	NA	-	-	-	Shyella spp

WhereNA = Not applicable, + = present and - = not present

Table 4 shows the morphology and biochemical characteristics of bacteria isolates obtained from water treatment plant effluents in River Benue, Makurdi. Staph aureus was confirmed when the bacteria cocci appeared in Clusters to Gram's Reaction, Catalase and Coagulase. Rod-like shapes appeared when there was no reaction of the isolates with Coagulase and Bacillus spp, E. coli, Klebsiella spp, Salmonella spp and Shyella spp was suspected and Bacillus spp was confirmed in further reaction to Gram's Reaction, Catalase and Citrate, E. coli confirmed in further reaction to Indole, Klebsiella spp confirmed in further reaction to Catalase, Citrate and Urease, Salmonella spp confirmed in further reaction to Catalase and Citrate, and finally, Shyella spp confirmed in further reaction to Catalase only.

Table 5 shows the prevalence of microbial isolate obtained from water treatment plant effluents in River Benue, Makurdi. *Staph aureus*, E. *coli* and Yeast cell was detected in all the samples at the different sites. *Bacillus* spp was not found at PS for all the samples, at BE for O. *niloticus* and at AE for water sample. *Klebsiella* Spp was only find absent in O. niloticus at AE and PS. *Salmonella* spp was only found in O. *niloticus* and water sample at (AE and PS and BE respectively). *Shyella* spp was only found in water sample at BE and PS while Aspergillus spp was only found in O. *niloticus* at BE.

Table 5: Microbial Isolate observed in C. *gariepinus*, O. *niloticus* and Water Samples Obtained from Water Treatment Plant Effluents in River Benue, Makurdi.

Organism	Site	*C. gariepinus*	*O. niloticus*	Water
S. aureus	BE	+	+	+
	AE	+	+	+
	PS	+	+	+
Bacillus spp	BE	+	-	+
	AE	+	+	-
	PS	-	-	-
E. coli	BE	+	+	+
	AE	+	+	+
	PS	+	+	+
K. spp	BE	+	+	+
	AE	+	-	+
	PS	+	-	+
Salmonella spp	BE	-	-	+
	AE	-	+	-
	PS	-	+	-
Shyella spp	BE	-	-	+
	AE	-	-	-
	PS	-	-	+
Yeast cell	BE	+	+	+
	AE	+	+	+
	PS	+	+	+
Aspergillus spp	BE	-	+	-
	AE	-	-	-
	PS	-	-	-

BE = Before effluent, AE = Point of effluent and PS = Police Station (Downstream), + = present and - = not present

DISCUSSION

Water Quality

The pH of water samples collected during the cause of the study from the different stations were slightly below neutral (Table 1) and these values fall within the accepted range of 6.0–8.5 indicative of good water quality for aquaculture (Chapman, 1996; Burlington, 2000; WHO, 2002 and Kolawole et al., 2011). The value of pH obtained in all the sites is similar to that obtained by Kolawole et al. (2011) and it is above the values obtained by Siyanbola et al. (2011) and Hassan et al. (2014). Statistically, there are no significant difference between mean temperature values of the water samples ($p < 0.05$) and also, these values fall within the normal temperature range that supports good surface water quality which is 0 °C to 30 °C (Chapman, 1996; Kolawole et al, 2011). The observed range of the temperature allows for optimum proliferation of most of the bacteria isolated from the water samples especially the family enterobacteriaceae which are mesophiles and most grows optimally at temperature range of 20 °C and 32 °C (Fransolet et al, 1985; Kolawole et al, 2011). The value of DO and Temperature obtained from this research is in accordance with Olorode1 and Fagade (2012) and Omoleke (2004) who stated that the higher the temperature, the lower would be the dissolved oxygen value in the water bodies. These values obtained for these parameters are still adequate according to World Health Organization.

The Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values are indicative of the presence of organic and inorganic pollutants, respectively. The mean BOD values of all is below the recommended maximum allowable concentration (RMC) set by the European Union for good quality water for fisheries and other aquatic life which is 3.0–6.0 mg/L (Chapman, 1996). Unpolluted waters typically have BOD values of 2 mg/L or less, whereas those receiving wastewaters may have values up to 10 mg/L or more (Chapman, 1996). The COD usually includes all, or most of the BOD as well as some other chemical demands. The COD values also do not exceed the acceptable concentrations for unpolluted surface water quality which is 20 mg/L or less. It however falls below the range of polluted waters (20–200 mg/L) (Chapman, 1996)..

The high turbidity values obtained from site AE (12.81±0.11mg/L) may be due to the turbulent nature of the discharge water into the river. The high turbidity value obtained in the three sites might be due to the dissolution of organic wastes such as faeces, other nitrogenous wastes being discharged upstream by inhabitants of the area. The result is in consonant with the result obtained by Hassan et al. (2014). Conductivity and TDS decreased from downstream. This was expected as conductivity is related to the total dissolved solids in the water. This correlates with the result obtained by Kwadzah and Iorhemen (2015)

There is no significant difference in the chloride concentration in the water samples. The value obtained in this study is lower than those obtain by Dawodu and Ajanaku (2008) and they are within the acceptable limit which is 250mg/L. There is no significant difference in the nitrate value obtained in this study. These findings are consistent with the established fact that nitrate levels in water which exceed WHOs limit are is said to be polluted (Dawodu and Ajanaku, 2008).

Microbial Analysis

The bacteriological examination of water has a special significance in pollution studies, as it is a direct measurement of deleterious effect of pollution on human health (APHA, 1981). Coliforms are the major microbial indicator of monitoring water quality (Brenner et al., 1993; Grant, 1997). Bacteriological analysis of the water and fish samples showed six different genera which are Bacillus spp, S. Aureus, Escherichia coli, Klebsiella spp, Salmonella spp and Shigella spp with two fungi which are Yeast cell and Aspergillus spp.The detection of Escherichia coli and S. aureus provides definite evidence of faecal pollution in fish habitat and in fish; in practice (Kvenberg, 1991; WHO, 1997).

The VC for each fish sample per site is slightly above the acceptable limit (5×105 cfu/g) (Shewan, 1970).The result obtained in this study for FC and CC is similar to those observed in the case of Little Akaki River at the point of discharge, upstream and downstream respectively by Abrha et al. (2015). High bacteriological population in the river may reflect the input of microorganisms from extra sources mainly municipal sewer lines entered to the river, slaughter house effluent, domestic sewage located upstream. The bacteria loads were generally high in all water samples. This would be limit variety uses of the rivers water including recreation, drinking water sources, and aquatic life and fisheries (Abrha et al., 2015). The study shows the level of pollution of water from all the sampling points with PS (downstream) as the most polluted which was closely followed by AE (point of discharge) and that of BE (upstream). This result follows the same trend as that obtained by Gyasi et al. (2014). The higher microbial load at PS (downstream) may also be due to the human activities around the police station such as excretes, domestic sewages, etc. However, the microbial load is not due to the water treatment plant effluent.

The coliforms isolated were an indication of the contamination of the river water with fecal materials which may result to the presence of pathogenic organisms. The fecal material may be as a result of fertilization of the river with organic substance which is from sewage upstream or other sources directly into the river, or excreted by the fish into or through runoff (Kay et al., 2008). The diverse groups of bacteria isolated from the sites are related to those reported by Okpokwasili and Ogbulie (1999) in pond water, Dabbor (2008) who reported similar organisms in the microbiological study of El-quanter fish pond. Njoku (2015) also reported similar organisms. Sujatha et al. (2011) reported similar microorganism isolated from the gills, intestines, muscle and skin of Megalaspis cordyla and muscles of Priacanthus hamrur from Royapuram waters in India. Sichewo et al. (2014) observed similar result in edible fish in Zimbabwe. Ogundiran et al. (2014) reported the similar microbes in Sardina pilcladus a marine fish species in south west Nigeria.

The presence of pathogenic microorganisms especially E. coli, Salmonella, Shigella, etc, can lead to the transmission of water borne diseases such as, Typhoid fever, Cholera, food poisoning and gastroenteritis (Piet, 2009) on consumption of improperly cooked fish cultivated in these river (Njoku, 2015). The presence of E. coli in water or food indicates the possible presence of causative agents of many gastro intestinal diseases (Ampofo and Clerk, 2010; Njoku, 2015). It has been shown that Escherichia coli and Salmonella can survive for very long periods in tropical waters and once introduced, may almost become indigenous to the environment (Fujioka et al., 1988).The bacterial ecology of fish products is connected to environmental factors such as water pollution, anthrop activities, fish feed quality, hygienic procedures of slaughter, handling, transport, commercialization and storage conditions (Begum et al., 2010). In freshwater aquaculture, the microbial load in the water used for cultivation is closely connected to several factors such as bacterial ecology of supply water, environment (air and contamination by animal excrements), fish feed, soil and water table (Begum et al., 2010).
The present study found level of total aerobic bacteria, coliform and fecal coliform in catfish, tilapia and water increase and exceed the microbiological standard. This result is related to that obtained by Budiati et al. (2015) in Catfish (Clarias Gariepinus) and Tilapia (Tilapia Mossambica).

CONCLUSION

The study revealed that effluent from the water treatment plant in Makurdi was idle with respect to most of the physiochemical parameter as these are within the recommended values for unpolluted water and for aquaculture. This could however not be said for their microbial counterpart as levels of biological indicators of pollution all exceed the WHO.

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