International Journal of Science, Environment and Technology, Vol. 3, No 5, 2014, 1817 – 1825

ISSN 2278-3687 (O)

WATER QUALITY CHARACTERISTICS OF NWAORIE RIVER FOR FISH SURVIVAL: A WET SEASON STUDY

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Abstract: The water quality characteristics of Nwaorie river for fish survival was investigated during the wet season. The physico-chemical parameters and the microbial characteristics were determined and examined. The study was carried out in three different sample sites. Sample A, sample B and sample C which the source of the river. Samples were collected in triplicates and were analysed for over one hundred variables. The findings from the physico-chemical parameters from the different sample sites Dissolved Oxygen, chloride, hardness, magnesium, calcium, phosphate, alkalinity, biological oxygen demand showed no significant difference ($P>0.05$) from the source and fell below the standard limit suitable for fish survival. pH, temperature, total dissolved solid were significant ($P<0.05$) and fell within the standard limit suitable for fish survival though at different ranges. The microbial organisms identified in the river include Escherichia coli, Bacillus spp, pseudomonas aeruginosa, others are klebiseilla spp, proteus spp, Salmonella spp, Citobacter and Shigella at different concentrations.

Keywords: Nwaorie river, Water quality, Wet season, Fish survival.

Introduction

Water quality is defined in terms of the chemistry, physical and biological content of water. The water quality of rivers and lakes changes with the seasons and geographical areas, even when there is pollution present [15]. They further observed there is no single measure that constitutes good water quality. This was buttressed by [18] who revealed that the chemistry of natural surface water is complex, and depends on the equilibrium reached with the normal physical, chemical and biological characteristics of the surrounding environment. Thus there can never be normal surface water quality. Every natural water will have a different composition.

However, [24] recalls many factors which affect water quality as substances present in the air such as dust, volcanic gases, natural gases (oxygen, carbon dioxide and nitrogen) have

*Received Sep 02, 2014 * Published Oct 2, 2014 * www.ijset.net*

dissolved in entrapped water. Other substances such as sulphurdioxide, toxic chemical or lead also dissolve in rain water as it falls to the ground. Rain as run off on earth dissolve other substances such as limestone, calcium carbonate, rock metals ore bodies [29]. Another factor influencing water quality is the run-off from urban areas. It will collect debris littering the streets, animals waste, petroleum products, road salt and take it to the receiving stream or water body. Industrial activities can increase concentration of metals and toxic chemical and suspended sediment, increase temperature and lower dissolved oxygen in the water [15]. Fish species of most inland water bodies, reservoirs and lakes in africa have been identified to rarely survive harmful chemical pollution. [1] observed that farm activities like spraying of chemical pesticides, herbicides and fungicides, deposit residue at receiving water bodies whose increased concentration kills fish species. Excessive exploitation, use of tarry chemicals for fishing pollutes the water and endanger most fish species to an extent [20]. In view of the increase concentration of water quality parameters, it has been established that the fish survival rate decline. [14] reported plerophillum scalar fish which 10,000 fish species diminishes (dies) as changes occur in the quality parameters. This also led to other fish"s normal behaviours alteration. Each specie lives its life within certain temperature limit, quality of dissolved oxygen, hardness and ammonia content of water [14].

Mihursky and Kennedy [19], low oxygen, increase in nitrite and nitrate, temperature, carbon dioxide, magnesium, calcium, iron, copper and chlorine impact on the migration, spawning, incubation, emergence and survival rate of fish, [19]. Therefore, the quality of surface water is never constant, it constantly changes in response to daily seasonal and climate rhythm. Organisms including fish in particular water body dies or suffer to adapt to these natural fluctuations of water quality parameter as they occur [18].

Nigeria is blessed with estimated inland water mass of about 283,293.47 hectares capable of producing about 2.3 million metric tones of fish annually, and its rate of production has failed to keep pace with the rate of population growth and demand [17]. Despite the global awareness that fishes are the major source of protein, its resourses are yet to be tapped or properly harnessed [25]. One of the reasons this problem persist is lack of designed management strategies which will match experience with action [21]. The above reasons imply that Nigerian people especially stakeholders in fish production lack the pre-requisite knowledge for controlling water quality pollutant and the improved protection of fish species in the river, in spite of government laudable efforts to boost agricultural programmes through fish production. The Nworie river is not excluded in this problem which have been identified

to affect the survival of fish species in the water body having notably observed series of anthropogenic activities in the river varying from organic farming, washing, swimming activities from urban dwellers there increase the intensity of fluctuation of the water quality of the river. Therefore this study aims at determining some aspects of the physico-chemical and biological parameters of Nworie river during the wet season and to know the sampling points that will stimulate highest survival rate of fish species.

MATERIALS AND METHODS

Area of study

Nwaorie is a first order river that flows through owerri, the capital city of Imo state in south eastern Nigeria and its environments. It is among the surface water bodies threatened by human activities, its source is from Egbeada and cuts across Federal medical centre owerri and Alvan Ikoku Federal College of Education Owerri and empties into the otamiri river near Nekede.

Sampling methods & location

The sampling locations lies between the latitudes 05.49°N and longitude 08.07°E (sample A, Alvan), sample B (wetheral) lies between 06.49°N and longitude 08.01°E , sample c which is the source(Egbeada) served as the control lies between 05.51°N and longitude 07.43°E. the water samples were collected 2 weeks interval for six months during the wet season period (march – August). At each sampling point, 14 composite samples were collected and pooled as a sample. These sampling points were at least 200m apart and sampling was done both morning and evening against the water current. The samples for the physicochemical and biological analysis were collected in triplicates in clean sterile plastic containers, stoppered and taken immediately to the laboratory for analysis.

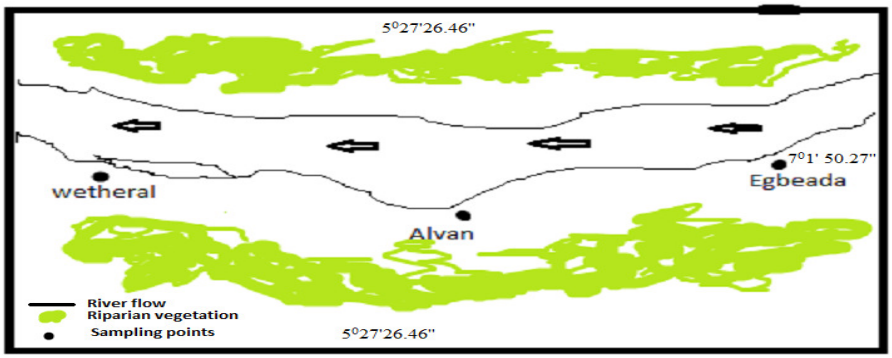

Figure 1. Nwaorie River showing the different sampling points

Physico-chemical and biological parameters determination

Pye Unicam Model 7065 electronic metre at 25ºC after standardization with buffer solution at pH 4, 7 and 9 was used for pH, Temperature values were recorded from a mercury-in glass thermometer graduated in units of ^{0}C by immersing the thermometer slightly under the surface of water (2cm) for 5 minutes until mercury stood at one place), Dissolved oxygen concentration of the water samples was determined with a Jen-way 9071 digital oxygen analyzer, total hardness (calcium and magnessium and alkalinity were determined titrimetrically using the method prescribed by [2], total dissolved solids, nitrates and sulphates were determined using the method prescribed by [6], the biological oxygen demand(BOD) was determined titrimetrically as prescribed by [6]. The microbial analysis was done by collecting water samples which was inoculated on different culture media using the spread plate technique as prescribed by [10], after serially diluting the water sample. The organisms were viewed with a binocular microscope and identified using the method prescribed by [13]. One way univariate analysis was done to compare the sampling sites with the source (sample c) and the Duncan multiple range test was used to separate the means.

RESULTS AND DISCUSSION

Table 1

Parameters	Sample A	Sample B	Sample C (Source)	WHO standard limit
Temperature (°C)	26.7±1.05	26.16±1.08	25.18±1.08	25-32
pH	5.5± 0.7	5.8±0.3	7.6± 0.8	6.5-8.5
DO (mg/l)	2.62± 0.3	2.52±0.35	3.57± 0.31	5-8
Total dissolved solids (mg/l)	74.5± 0.41	73.6± 0.34	360.71± 0.3	250.00
Chloride (mg/l)	0.065±1.08	0.054± 0.63	0.043±1.09	0.01
Hardness(mg/l)	28.72±1.64	28.07±1.6	33.4±1.5	500
Magnessium(mg/l)	8.2±2.9	8.4±2.6	9.5±3.1	150
Calcium(mg/l)	2.87±0.24	2.68±0.21	4.02±1.3	200
Phosphates(mg/l)	2.08±0.9	2.63±0.3	2.54± 0.5	0.1
Alkalinity(mg/l)	22.17± 0.9	22.21±0.82	43.23±1.3	<500
Nitrate(mg/l)	40.48± 0.2	50.43±0.23	30.49±0.21	<90
Sulphate(mg/l)	5.4±0.18	5.6±0.16	7.2±0.17	250.00
BOD (mg/l)	1.23±0.4	1.36±0.5	1.54± 0.7	0.05

Field Survey 2013: Reported are means and standard deviation
Microbiological parameters identified in Nwaorie river

Table 2

Microbes	Sample A	Sample B	Sample C
Bacillus spp	**	***	*
Chromobacteria	-	*	-
Citobacter spp	**	**	*
Escherichia coli	***	***	**
Klebisiella sp	**	***	*
Proteus sp	**	***	*
Pseudomonas aeruginosa	**	**	*
Salmonella sp	**	**	*
Shigella spp	*	*	*

Field survey 2013: ***= **present in high concentration**, **=**present in moderate concentration**, *= **Present in low concentration**

The physico-chemical parameters of Nwaorie river is summarized in table 1 above which is very important in the determination of its productive capacity and effect on the biota [2007]. The temperature of Nwaorie river (25.18±1.08 and 26.7±1.05) falls within the normal range as prescribed by WHO for fish culture and for drinking, temperature of water is important in terms of its intended use , the pH in point A and B fell within (5.5± 0.7 and 5.8±0.3) which is lower than the range prescribed by WHO, also significantly different from point C ($P<0.05$), Low pH value in these points was attributed to anthropogenic acidification of allochthonous organic matter, these aquatic life forms release proteins including ammonia upon decay. The released ammonia dissolved in water hence causing a drastic change which manifest as low pH [13]. Dissolved oxygen level recorded in this study is lower than WHO standard (2.62± 0.3 to 3.57± 0.31). High organic enrichment of the river due to human activity which is a quality suitable for aquatic organisms may be the reason for this low DO considering the fact that organic fertilizers are used by those who have farmlands around the river and they wash off into the river and biodegrade [22]. From table 1, Total dissolved solids of Nwaorie river ranges from 73.6± 0.34 to 360.71± 0.3 which implies that point A and Point B fell below the WHO standard for fish culture and significantly different ($P<0.05$)from point C which is suitable for fish culture (360.71± 0.3). Consumption of water high dissolved solids could lead to gastrointestinal diseases [5]. These solids which can be suspended or damaged can cause gill damage that may lead to death if the concentration is too high [4]. The chlorine content in the river fell within (0.043±1.09- 0.065±1.08) which is above the standard limit. Chloride in water are indicators of agrochemical usage of lands surrounding the river. It is important to realize chlorine becomes more toxic as the pH level of the water drops. And it becomes even more toxic to fish when it is combined with other toxic substances such as cyanides, phenols

and ammonia [28]. The hardness of the river ranges between 28.07±1.6 - 33.4±1.5 which fell below the prescribed standard by WHO indicating the soft nature of the water, point A and b were significantly different point C ($P<0.05$) the correct pH, alkalinity and hardness are essential for a successful pond fertility programme, where fertilizers containing nitrogen, phosphorous and potassium are added to encourage the growth of phytoplankton [9]. Magnesium and calcium in the river fell below the standard limits 8.2±2.9 - 9.5±3.1, 2.68 ± 0.21- 4.02±1.3 while phosphates fell above the standard limit 2.08±0.9- 2.54± 0.5. Magnesium and calcium impairs its taste and can result in gastro intestinal, irritation [5], the increase in phosphates in the water may be attributed to run-offs, effluents from human activities around the river. Nitrate and sulphate were below the standard limit 30.49±0.21- 40.48± 0.2 and5.4±0.18- 7.2±0.17 respectively and significantly different (P,0.05) from each other though they fell within the tolerable range of fish. Nitrate-nitrogen levels below 90 mg/L and sulphate levels below 250 mg/L seem to have no effect on warm-water fish, [28]. The biological oxygen demand of Nwaorie river also fell below the standard limit (1.23±0.4 - 1.54± 0.7) and no significant different from the different points ($P>0.05$), this could also be attributed to the run-offs from the surrounding environment which carries human wastes, nutrients from farm fertilizers, leaves, grasses, papers from the environment which increase oxygen demand by the bugs. This oxygen consumed in the decomposition process robs other aquatic organisms such as the fish of the oxygen they need to live thereby resulting to death [25].

From table 2, it is evident that several microorganisms more of bacteria are present in low and high quantities in Nwaorie river which include *Bacillus spp, Chromobacteria, Citobacter spp, Escherichia coli, Kleisbella sp, Salmonella sp, Shigella spp*, *Pseudomonas aeruginosa and Proteus spp.* Microorganisms contaminating water are potential threat to aquatic ecosystem and public health. Increased population of bacteria such E.coli, Klesibella and bacillus have been reported in this study as it conforms with the study carried out by [7] and [13]. This higher microbial load observed in the rainy season could be attributed to the simple fact that during the rainy season more water percolate through the waste promoting and assisting the process of decomposition by bacteria. This process has been known to release by-products of decomposition and rapidly use up any available oxygen creating an anoxic environment [11]. The presence of *E.coli, Klesibiella shigella, proteus,* and *salmonella spp* in nwaorie river indicates faecal waste contamination [13]. These microorganisms have been implicated as a causative agent of one water borne disease or the other. The presence of

Pseudomonas aeroginasa, citobacter and *vibrochlorae* in different concentrations indicates more pathogens in the water which can be attributed to varying human activities. Most of these bacteria in aquatic water column are aerobic. That means they use oxygen to perform their metabolic activities of decomposition [23]. Most of them feed on dead algae and other dead organisms and are part of the decomposition cycle. Algae and other producers in the water take up inorganic nutrients and use them in the process of building up their organic tissues [3]. Natural levels of oxygen in aquatic ecosystem are always somewhat depleted by normal levels of aerobic bacterial activity therefore when abnormally high levels of aerobic bacterial activity takes place, the level of dissolved oxygen can drop automatically and fish will be unable to live very long [25].

CONCLUSION

This study has shown that the physico-chemical parameters and microbial status of Nwaorie, Imo state is in serious danger, even though most of the physic- chemical parameters fell within the standard limits for fish culture. it is evident that aquatic life is seriously threatened and it bases on this that i recommend that the State ministry of Environment in laison with Federal ministry of environment should put up policies that should stop the various human activities in the river which have been identified as a major threat to the sustainability of aquatic life in Nwaorie river.

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