Canadian Journal of Agriculture and Crops

Vol. 1, No. 1, 11-18, 2016

Determinant of Water Quality and Suitability of River Ethiope for Fish Survival in Southern Nigeria

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ABSTRACT

The study examines the quality of water and suitability of River Ethiope for fish survival in Southern Nigeria. It is an empirical research work that involved field collection of water samples from six sampled sites along the course of River Ethiope and laboratory analysis of the water samples collected. The results showed that variation exists in the physico-chemical and biological parameters of the analyzed water samples. Also, some of the parameters examined such a pH, conductivity, temperature, turbidity, DO, TSS, hydrocarbon, Mg, Fe, Ca, among others are satisfactory and falls within the approved standard requirement for fish survival. While parameters such as BOD, ammonia, nitrate, COD, chloride and zinc concentrations were above the recommended amount for fish survival. However, the quality of water from River Ethiope does not differ significantly from approved standard for fish survival at P>0.05; hence, the water from the river is good for fish breeding and fish survival. Routine monitoring of human activities along the course of the river and periodic testing of the water be carried out to identify impairments and help check the increase in the concentration of physico-chemical and biological indices of the water in order to address issues of fish kills and boost fish production for man's consumption.

Keywords: Water quality, Suitability, River Ethiope, Fish, Survival.

DOI: 10.20448/803.1.1.11.18

Citation | Ushurhe, Ochuko; Origho Thaddeus; Ewhuwhe-Ezo John (2016). Determinant of Water Quality and Suitability of River Ethiope for Fish Survival in Southern Nigeria. Canadian Journal of Agriculture and Crops, 1(1): 11-18.

Funding : This study received no specific financial support.

Competing Interests: The authors declare that they have no competing interests.

History : **Received:** 21 May 2016/ **Revised:** 3 June 2016/ **Accepted:** 8 June 2016/ **Published:** 13 June 2016

Publisher: Online Science Publishing

1. INTRODUCTION

Food security is one of the most effective means of raising the health and general living standard of many people in Africa and Nigeria in particular. But reaching the food security target requires much greater efforts by policy makers, funding, planning and construction. Fish consumption is essential to health and efforts to prevent insecurity are doomed to failure unless people have access to its production and food security. Only by tackling the root causes of its survival such as the water quality, can we reduce to the barest minimum, cases of low fish production in the world.

Fish are generally categorized into warm water, cool water and cold water species based on optimal growth temperatures [4]. Channel cat fish and tilapia are examples of warm water species. Their temperature range for growth is between 75 – 90^0F. a temperature of 85^0F for catfish and 87^0F for tilapia is considered optimum [4]. Walleye and yellow perch are examples of cool water species. Ranges for optimum growth fall between 60 – 85^0F. Temperatures in the upper end of this range are considered best for maximum growth for cool water species. Cold water species include all species of salmon and trout, whose optimum temperature range is 48 – 65^0F.

Dissolved oxygen (DO) as a chemical parameter of surface water is by far the most important parameter for fish survival. Low dissolved oxygen levels are responsible for more fish kills, either directly or indirectly than all other problems combined [6]. Like humans, fish require oxygen for respiration. The amount of oxygen consumed by the fish is a function of its size, feeding rate, activity level and temperature. Small fish consume oxygen more than large fish because of their higher metabolic rate. Meade [12] determined the oxygen consumption of salmon reared at 57^0F was 0.002 pounds per pound of fish per day. Lewis and Heidinger [11] determined striped bass raise at 77^0F consumed 0.012 – 0.020 pounds per pound of fish per day. This increase was attributed to the increase in temperature. Therefore, the amount of oxygen that can be dissolved in water decreases at higher temperatures and decreases with increases in salinities [12].

To maintain good growth, fish must have an optimum level of dissolved oxygen of at least 5ppm. Dissolved oxygen levels less than 5ppm can place undue stress on fish and levels less than 3ppm will result in death. However, some warm water species such as tilapia and carp are better adapted to withstand occasional low DO levels, while most cool water species cannot.

In terms of carbon dioxide in surface water, fish can tolerate concentrations of 10ppm provided DO concentrations are high. Surface water supporting good fish populations normally contain less than 5ppm of free carbon-dioxide. Based on the period of the day, carbon-dioxide levels may fluctuate from 0ppm in the afternoon to 5 – 15ppm at daybreak. While in recirculation systems carbon-dioxide levels may regularly exceed 20ppm, excessively high levels of carbon dioxide may interfere with the oxygen utilization by the fish [19].

Also, other dissolved gases especially nitrogen and other physico-chemical parameters such as ammonia, nitrate, calcium, magnesium, iron, zinc, potassium and phosphate are studied in the light of their impact on fish production. These parameters coupled with the effects of anthropogenic inputs and inadequate management of resources have impacted changes in water quality vis-à-vis on the survival of fish. Thus, knowledge of the hydrological conditions, such as the physico-chemical parameters of the water will not only be useful in assessing its productivity but will also permit a better understanding of the population and life cycle of the fish community.

River Ethiope rises from Umuaja and flows through such settlements as Umutu, Abraka, Oria, Umegbe, Okpara, Jesse, Sapele, among others for over 100km to empty into River Benin [18]. The inhabitants of these settlements depend on the water from the river for domestic purposes, such as drinking, washing, recreational purposes, transportation, fishing, agricultural and industrial purposes. However, impairments as a result of geologic and anthropogenic activities of man on the course of the river have been reported. This may have

had a detrimental effect on the quality of water from the river and consequently on the survival of fish and other marine organisms, hence this study.

1.1. Statement of the Problem

Fish production and food security are essential ingredients of a life of dignity and sustainable development in all sectors of a nation's economy. Food security remains a challenge in many parts of the world. The World Health Organization estimated that in 2005, 1.6million children under the age of five, with an average of 4,500 die every day from the consequences of poverty and inadequate nutrition [24]. Provision of fish in one of the most effective means of raising the health and general living standard of many people in Africa and Nigeria in particular.

However, it has been reported that the river water which sustains the growth of fish and other marine lives suffers from contamination caused by the use of detergents, solid waste disposal, effluent discharges, industrial waste, hydrocarbon and selwage leakages [7,1, 2] which have hitherto affected negatively the survival of fish along the course of the river. As a result of these impairments, there is the growing uncertainties as to the survival of fish coupled with the poor harvest of fish from the river by fishermen. This poor situation has negative impact on food security and health of the people. It is therefore imperative that a research be conducted to address these doubts, hence this study is undertaken.

1.2. Aim, Objectives and Hypothesis

The aim of the study is to assess the quality of water and the suitability of River Ethiope for fish survival in Southern Nigeria.

The specific objectives are to:

1. Assess the quality of water from River Ethiope
2. Ascertain if the quality of water from the river is good for the survival of fish.
3. Suggest ways on how to check the variation in water quality (if any) and hence achieve sustainable fish production along the course of the river.

Ho: The quality of water from River Ethiope does not differ significantly from approved standard for fish survival.

2. METHODOLOGY

The study is an empirical research work. It involves field collection of water samples along the course of River Ethiope and laboratory analysis of the water sample collected.

2.1. Method of Data of Collection

The systematic and simple random sampling techniques were adopted for the study. The systematic random sampling technique was used for the collection of water samples along the course of River Ethiope, while the simple random sampling technique was used for choosing the sampling points (communities) along the course of the river. The sampling points were Sapele, Jesse, Okpara, Abraka, Umutu and Umuaja. The method of data collection was through direct field collection of water samples along the course of the river at

varied measured distances using a 2 litre sterilized plastic can for the collection. The water samples were collected from the upstream and downstream of the river. The water samples were collected early in the morning between 7am and 10am to reduce the effect of temperature on the collected samples. A total of 72 water samples were collected from the six (6) sampling points at an average of one sample each month from January, 2011 to December, 2011. The water samples were collected from the surface and sub-surface of the river. Collected water samples were securely corked and stored in ice packed container before transporting them to the laboratory. This was done within six hours of collection. All collected samples were allowed to settle down before any forms of laboratory analysis were carried out on them. This was to eliminate any form of turbidity influence on test. The materials that were used for the analysis include: a pH meter, turbidity meter, sterilized beakers, conical flask, pipette, burette, cylinder, spectrophotometer, hot plate, thermometer, sterile plastic, petric dishes and reagents such as potassium chromate, indicator solution, stock nitrate solution, concentrated nitric acid, buffer solution, ammonium acetate, stock iron solution and some improvised equipment such as plastic container and coolers. The apparatus and reagents ate standardized equipment recommended and validated by the World Health Organization [23] United States Environmental, Protection Agency [21] and the Nigerian Industrial Standard [14] for testing water quality. The United States Department of Agriculture and Co-operative Extension Services [20] standard was used as impact criteria. The posited hypothesis was tested using the Analysis of Variance (ANOVA) statistical technique. The SPSS computer package was used in the ANOVA statistics to determine the F – ratio.

3. RESULTS AND DISCUSSION

The minimum, maximum and mean values of the analyzed water quality parameters of River Ethiope are summarized in table 1 in order to maintain a balance for the survival of fish along the course of the river.

Tables-1. Physico-chemical characteristics for the survival for fish in River Ethiope.

Parameters	**Water Quality Values**			**Standard Water Quality Criteria for fish**	**Remarks**
	Min	Max	Mean		
pH	5.18	7.20	6.59	6.5 – 10.0	Satisfactory
Conductivity	59.41	92.00	77.52	400us/cm	Satisfactory
Temperature	26.55	30.15	27.97	0^0 – 30^0C	Satisfactory
Turbidity	3.48	15.16	7.99	20,000NTU	Satisfactory
DO	6.85	18.14	11.15	5mg/l	Satisfactory
BOD	1.50	16.12	7.60	3.0 – 6.0mg/l	Not Satisfactory
Ammonia	0.04	2.10	0.84	0.0125mg/l	Not Satisfactory
Nitrate	0.01	1.26	0.59	0.03mg.l	Not Satisfactory
Hydrocarbon	0.96	5.01	3.49	200mg/l	Satisfactory
TSS	15.12	24.14	18.58	80mg/l	Satisfactory
COD	10.12	50.14	25.89	3.0 – 6.0mg/l	Not Satisfactory
Alkalinity	0.76	1.82	1.21	10 – 400mg/l	Satisfactory
Bicarbonate	1.75	4.26	2.63	100mg/l	Satisfactory
Chloride	0.21	0.96	0.59	0.04mg/l	Not Satisfactory
Coliform Count	10.25	68.00	29.57	200/100ml	Satisfactory
Magnesium	2.41	5.60	3.80	Needed for buffer system	Satisfactory
Calcium	1.24	4.26	2.82	160ppm	Satisfactory
Lead	0.001	0.027	0.01	0.03ppm	Satisfactory
Zinc	0.01	0.51	0.23	0.05ppm	Not Satisfactory
Iron	<0.001	0.05	0.02	0.15ppm	Satisfactory

Source: Fieldwork, 2011.

As shown in table 1, pH values range between 5.18 at Sapele to 7.20 at Umuaja, with a mean value of 6.59. These values fall within the United States Department of Agriculture and Co-operative Extension Servies [20] used as impact criteria. This finding also corroborates the works of Offem et al (2011) in a similar study on the Ikwori lake in South-Eastern Nigeria.

In terms of conductivity values ranged from 59.14 us/cm to 92.00 us/cm at Sapele. A mean value of 77.52 us/cm was recorded in the area. This mean value is satisfactory and falls within the acceptable limit for fish survival. Also, temperature values were within the acceptable limit of 0^0C – 30^0C. In the area, values vary from 26.55^0C to 29.15^0C, with a mean value of 27.98^0C. These values also corroborate similar results obtained by Kolawole et al [10]; Chapman [5] and Fransolet, Villers and Masschein [9] in similar studies.

In River Ethiope, a minimum and maximum turbidity value of 3.48NTU and 15.16NTU, with a mean value of 7.99NTU were recorded. Dissolved oxygen values ranged between 6.85mg/l and 18,14mg/l, with a mean of 11.15mg/l. This increase in dissolved oxygen values is satisfactory and can be attributed to the in-flow of water from farmlands, markets during the rains and bottom nature of the river. This finding corroborates the results obtained by Asuquo [3] along the Calabar River in Southern Nigeria. While BOD values vary from 1.50mg/l to 16.12mg/l, with a mean value of 7.60mg/l recorded in the area. This implies a decrease in organic pollution and self-purification process of the river. The finding is in line with the works of Kolawole et al [10] on the Asa River in Western Nigeria.

In River Ethiope, a mean ammonia value of 0.84mg/l was recorded. This mean value is however higher than the 0.0125mg/l permissible standard as water quality criteria for fish survival. However, according to Rottmann and Shiremann [19] natural waters such as rivers, ammonia may never reach a dangerous high level because of the low densities of fish. This implies that the high value of ammonia recorded in the area may not affect the survival of fish along the course of the river. Nitrate values recorded in the area ranged between 0.01mg/l and 1.26mg/l with a mean value of 0.59mg/l. This mean value is not satisfactory and above the required standard for the survival of fish. In terms of TSS, recorded values vary from 15.12mg/l to 24.14mg/l. These values are within the 80mg/l standard water quality criteria for fish. This recorded value is satisfactory and does not affect the survival of fish along the course of the river.

Chemical Oxygen Demand (COD) values vary from a minimum of 10.12mg/l to a maximum of 50.14mg/l, with a mean value of 25.89mg/l. These recorded values are above the permissible limit for fish survival and hence not satisfactory limit for fish survival and hence not satisfactory for the survival of fish in the area. This high mean value recorded in the area can be attributed to the presence of inorganic pollutants and untreated waste in the river. This finding corroborates the results obtained by Kolawole et al, [10] in their assessment of water quality of Asa River in Western Nigeria and its indigenous clarias gariepinus fish.

Hydrocarbon values vary from 0.96mg/l to 5.01mg/l, with a mean value of 3.49mg/l. These values are satisfactory and are within the standard water criteria for fish. This implies that hydrocarbon concentration in the water has no negative impact on the survival of fish in the area.

Moreso, alkalinity values vary from 0.76mg/l to 1/82mgll. These values are also satisfactory and fall within the standard water quality criteria for the survival of fish. These values are considered to contain suitable quantities of carbon-dioxide to permit plankton production for fish culture [8].

In the study area, bicarbonate concentration values vary from 1.75mg/l to 4.26mg/l. These values are satisfactory and have no negative impact on the survival of fish in the area. Chloride concentration varies from a minimum value of 0.21mg/l to a maximum value of 0.96mg/l and a mean value of 0.59mg/l. These high mean values of chloride are however not satisfactory for the survival of fish. This high value can be attributed to wastewater discharge along the course of the river. The implication of this is that, high chloride concentration has negative impact on trout fry, salmon and kills most oysters at that level [15,17, 22]. In terms of coliform count, a mean value of 29.57/100ml was recorded. This value is within the permissible criteria for fish survival. Magnesium mean value of 3.80ppm was recorded. This value is satisfactory and needed for fish production along the course of the river.

In River Ethiope, calcium concentration value varies from 1.24ppm to 4.26ppm. These values are satisfactory and fall within the 160ppm standard water quality criteria for the survival of fish. Lead values in the area vary from a minimum of 0.001ppm to a maximum value of 0.027ppm, which is within the required standard for fish survival. However, zinc concentration ranges from a minimum value of 0.01ppm to a maximum value of 0.51ppm, with a mean value of 0.23ppm. These values are not satisfactory for fish survival. This implies that the excess zinc has a depressive effect on the tissue of different species of fish found in the area [13]. Iron concentration along the course of the river recorded a mean value of 0.02ppm. This implies that there will be increase in phytoplankton, which will influence the reproduction and feeding

3.1. Test of Hypothesis

The hypothesis which states that “the quality of water from River Ethiope does not differ significantly from approved standard for fish survival” was tested using the analysis of variance (ANOVA) statistical technique. The test was conducted using the one way ANOVA analysis on the variation of the approved standard quality of water from River Ethiope for fish survival. The calculated values are as shown in table 2.

Table-2. Water Quality for Fishing Purposes

	Sum of Squares	Df	Mean Square	F	Sig
Between Groups	35205.291	3	11735.097	2.474	.068
Within Groups	243187.541	72	3377.605		
Total	278392.832	75			

From table 2, the calculated F value (2.474) is less than the critical table value (2.73) at P>0.05 and thus the model is not significant.

Therefore, the null hypothesis is accepted; which implies that the quality of water from River Ethiope does not differ significantly from approved standard for fish survival in the area.

4. FINDINGS

Based on the aim and objectives of the study, the following findings emerged.

1. There is variation in the concentration of physico-chemical and biological parameters of the water samples examined along the course of River Ethiope.
2. The concentration of pH, electrical conductivity, temperature, turbidity, dissolved oxygen, hydro carbon, total suspended solids, alkalinity, bicarbonate, total coliform, magnesium, calcium, lead and iron are favourable for fish survival in the river.

3. The level of concentration of BOD, ammonia, nitrate, COD, chloride and zinc do not favour the breeding and survival of fish along the course of the river.
4. The quality of water from the river does not differ significantly from approved standard for fish survival at P>0.05 along the river.

5. CONCLUSION

The study has been able to discover that variation exist in the physico-chemical and biological characteristics of the water quality along the course of the river. This variation is caused by geologic and anthropogenic factors which have impaired the quality of water. However, the concentration of most of the parameters examined are within the required permissible standard for the survival of fish, hence fish breeding is favourable along the course of the river.

6. RECOMMENDATIONS

The following are additional precautionary measures for improving on the present state of the water in order to ensure maximum fish production for the benefit of mankind.

1. The river water should be monitored from time to time through periodic testing to ascertain if the concentration of the parameters are increasing or decreasing.
2. Human activities such as industrial activities, agriculture, mining and wastewater generation be monitored to check impairments caused by these activities on the water.
3. Indiscriminate fishing along the course of the river be discouraged to allow for the growth of fingerlings before actual harvest is carried out.

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