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WATER QUALITY AND AQUACULTURE: AN ASSESSMENT OF THE SUITABILITY OF OGIDEKPE RIVER FOR AQUACULTURE

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ABSTRACT

The success of aquaculture depends on the quality of its water source. The increasing practice and establishment of earthen ponds for aquaculture in close proximity to lotic water bodies has necessitated the need for the suitability assessment of their water quality. The aim of this study is to ascertain the suitability of Ogidekpe River as source of water for aquaculture practice. Water samples were collected from four (4) designated stations along the Ogidekpe River from September 2023 to February 2024 and twenty (20) physico-chemical parameters were analyzed according to standard methods. Observed concentration values were compared with the Nigerian Standard Water Quality Criteria for Fisheries. Concentrations of physico-chemical parameters were within their respective permissible limits, except for turbidity (27 – 30.6 NTU), dissolved oxygen (3.06 – 5.06 mg/L), iron (0.33 – 0.39 mg/L), chromium (0.04 – 0.08 mg/L), lead (0.01 – 0.013 mg/L) and zinc (0.21 – 0.38 mg/L) at all the stations. High water turbidity and heavy metal – iron, chromium, lead and zinc content values which exceeded the water quality criteria for fisheries, makes the river an unsuitable water source for aquaculture. Utilizing the River as source of water for aquaculture requires that water retention ponds be constructed to allow for sedimentation and treatment before use for fish culture. There is need also to identify point sources of pollution within the watershed and enforce compliance to environmental laws in order to improve the overall water quality of the river.

Keywords: Water quality, Aquaculture, Fisheries, Ogidekpe River, Nigeria

INTRODUCTION

Fishes are totally dependent on water and so information on water quality (physico- chemical) and quantity of water source are indispensable in choosing a location for an aquaculture facility. Water quality in aquaculture refers to anything in the water, be it physical, chemical or biological that affects the fish normal health and production performance (Balogun, 2015). Fishes have a limited range of concentration values for physico – chemical properties of freshwater in which they can grow optimally (Wanja *et al.*, 2020; Mramba and Kahindi, 2023). Studies have shown that a special set of water chemistry requirements, and optimal water quality is essential to a healthy, balanced, and successful freshwater fisheries (DeLong *et al.*, 2009; Abubakar, 2013), as water quality directly affects the fishes' feed efficiency, growth rates, optimal survival and reproduction (ACTFR, 2002). Many undesirable chemical and environmental factors associated with certain fish farms have been linked to the absence of background information on the source of water used. Studies by NaFIRRI/NARO (2018) linked fish stuntedness and slow growth to changes in the physico-chemical properties of water. Hence the screening of source water for its physico – chemical properties is an important initial step in determining the suitability of the source water for aquaculture.

In recent times, there has been an increase in the establishment of earthen fish ponds within the watershed of inland freshwater bodies in Nigeria. As these water bodies such as rivers, streams and reservoirs offer a readily and inexpensive source of water for aquaculture. Although the use of natural surface freshwater sources has been shown to be good sources of zooplankton for fishes in aquaculture (Abo-Taleb, 2019), the increasing decline in their water quality due to pollution from anthropogenic activities (Egun and Ogiesoba-Eguakun, 2018: Egun and Oboh, 2022; Egun and Oboh, 2023; Biose et al., 2024) has necessitated studies to ascertain their present suitability for continuous use in aquaculture. The prevailing challenge of access to groundwater resources in the study area has placed an increasing demand on Ogidekpe River for freshwater supply for domestic and commercial activities including aquaculture. Therefore, the aim of this study is to ascertain the suitability of Ogidekpe River for aquaculture.

MATERIALS AND METHODS

Study Location

This study was carried out at Ogidekpe River (Latitudes 006º77'87'N and 006º45'78'N and Longitudes 06º15'86'E and 06º86'28'E) which transverses through Esan West Local Government Area and Owan East Local government area in Edo State, Nigeria. It is an oligotrophic lotic freshwater body (Imoobe and Adeyinka 2009), with vegetative canopy occurring laterally for most parts of its bank.

Sampling and Water Analysis

Water samples were collected from four (4) designated stations along the Ogidekpe River from September 2023 to February 2024. The designated Stations were identified access points to the river for water collection for various purposes. Sampling was carried out in the dry season in order to minimize the influence of surface runoffs and storm water on the water physico-chemical parameters. Water samples were analyzed for twenty (20) physico-chemical parameters according to the outlined procedures in the Standard Methods for the Examination of Water and Wastewater (APHA, 1998). Observed concentration values were compared with the Nigerian Standard Water Quality Criteria for fisheries (NESRA, 2011).

Data Analysis

Statistical analyses were computed using Microsoft Excel and the Statistical Package for Social Sciences (SPSS 16.0). The data are presented as pooled mean ± standard deviation (SD) of each physico-chemical parameter for all water samples collected from each station. Analytical results from each station were compared with the Standard Water Quality Criteria for fisheries (NESRA, 2011)

RESULTS AND DISCUSSION

Water quality is of critical importance in aquaculture practice as it significantly influences the physiology, development and nutritional composition of the fish (Himmel *et al.*, 2010; Egun, 2021). Results of the physico-chemical parameters of Ogidekpe River are presented in Table 1. Across the four (4) study stations, the mean values of water pH (6.57 – 7.15), electrical conductivity (19.33 – 30.00 µS/cm), biochemical oxygen demand (1.27 – 2.43 mg/L), chloride (9.41 – 16.47 mg/L), sulphate (3.00 – 10.00 mg/L), phosphate (0.19 – 0.23 mg/L), nitrate (0.03 – 0.05 mg/L), calcium (2.14 – 2.68 mg/L), magnesium (1.46 – 3.41 mg/L), lead (0.009 – 0.013 mg/L) and nickel (0.03 – 0.04 mg/L) did not exceed their respective NESRA (2011) permissible limits for water quality criteria for fisheries. The dissolved oxygen levels (3.63 – 5.10 mg/L) were below the minimum acceptable limits of 6.00 mg/L. While mean values for suspended solids (2.67 – 19.33 mg/L), turbidity (4.67 – 30.67 mg/L), iron (0.34 – 0.39 mg/L), chromium (0.04 – 0.08 mg/L) and zinc (0.21 – 0.38 mg/L) exceeded their respective permissible limits for aquaculture (Table 1).

The level of water turbidity is a reflection of the amount of suspended matter such as clay, silt, organic matter, plankton and some other microscopic organisms present in the water (Fondriest Environmental, 2014). High turbidity and total suspended solids levels in surface freshwater bodies inhibits photosynthesis resulting in decreased dissolved oxygen output (Egun and Oboh, 2022); affect the ability of fish gills to absorb dissolved oxygen from the water and lowers their resistance to diseases and parasites (Balogun, 2015; Wanja et al., 2020). The influence of the observed high total suspended solids and turbidity levels in Ogidekpe River is shown in the depleted dissolved oxygen levels in the surface water. Dissolved oxygen is a very basic requirement for aquaculture and the first limiting factor to occur in pond aquaculture. Low dissolved oxygen levels impede fish reproduction, as a good dissolved oxygen content (≥ 6.00 mg/L) is needed for eggs and immature development stages (Oram, 2014). Yovita (2007) reported that good dissolved oxygen levels in grow out aquaculture had a significant positive effect on the growth and fish conversion ratio of fishes.

Table 1: Summary of the Physico–chemical characteristics of Ogidekpe River and its suitability for Fisheries

Parameters	ST 1	ST 2	ST 3	ST 4	Standard Water Quality Criteria for fisheries (NESRA, 2011)	Remarks
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD		
pH	6.57 ± 0.20	7.15 ± 0.51	6.77 ± 0.02	6.69 ± 0.09	6.5 – 8.5	Satisfactory
EC. (µS/ cm)	19.33 ± 1.89	20.00 ± 2.83	20.00 ± 1.63	30.00 ± 0.23	400	Satisfactory
Suspended Solid	2.67 ± 2.05	10.67 ± 5.44	11.00 ± 2.94	19.33 ± 6.13	0.25	Not Satisfactory
Turbidity (NTU)	4.67 ± 2.62	27.00 ± 3.27	24.00 ± 1.41	30.67 ± 12.28	< 20	Not Satisfactory
DO (mg/L)	3.63 ± 0.82	5.10 ± 0.51	5.07 ± 0.21	4.97 ± 0.37	≥ 6.0	Not Satisfactory
BOD (mg/L)	1.27 ± 0.49	2.43 ± 0.33	1.77 ± 1.09	1.83 ± 0.25	≤ 3.0	Satisfactory
Chloride (mg/L)	9.41 ± 3.33	9.41 ± 3.33	14.12 ± 0.33	16.47 ± 3.33	300	Satisfactory
Sulphate (mg/L)	3.00 ± 1.63	7.67 ± 1.70	7.33 ± 0.47	10.00 ± 2.94	100	Satisfactory
Phosphate (mg/L)	0.23 ± 0.02	0.23 ± 0.04	0.23 ± 0.05	0.19 ± 0.04	3.50	Satisfactory
Nitrate (mg/L)	0.03 ± 0.01	0.05 ± 0.01	0.06 ± 0.01	0.05 ± 0.01	≤ 9.1	Satisfactory
Calcium (mg/L)	2.67 ± 1.00	2.14 ± 0.38	2.68 ± 0.38	2.41 ± 0.14	180	Satisfactory
Magnesium (mg/L)	1.46 ± 0.40	1.94 ± 0.38	1.79 ± 0.23	3.41 ± 0.69	40	Satisfactory
Iron (mg/L)	0.39 ± 0.03	0.35 ± 0.04	0.39 ± 0.02	0.34 ± 0.06	0.05	Not Satisfactory
Lead (mg/L)	0.012 ± 0.003	0.009 ± 0.001	0.01 ± 0.003	0.013 ± 0.004	0.01	Satisfactory
Zinc (mg/L)	0.25 ± 0.02	0.21 ± 0.02	0.38 ± 0.19	0.38 ± 0.20	0.01	Not Satisfactory
Chromium (mg/L)	0.04 ± 0.004	0.06 ± 0.03	0.07 ± 0.03	0.08 ± 0.04	0.001	Not Satisfactory
Nickel (mg/L)	0.031 ± 0.003	0.03 ± 0.01	0.04 ± 0.01	0.038 ± 0.01	0.1	Not Satisfactory

*Result presented as pooled mean ± standard deviation (SD) of each physico-chemical parameter for all water samples collected from each station.

Iron content in surface freshwater bodies is dependent on the on the geological area and other chemical components of the waterway (Lenntech, 2019). The toxicity of iron to fishes is dependent on the physico – chemical properties of the water such as water temperature, pH and dissolved oxygen. For zinc, the principal mode of asction for acute zinc toxicity to freshwater fish is inhibition of calcium uptake, and destroying of gill tissues, thereby inducing stress and death of fish (Bhateria and Jain, 2006; Giardina *et al.*, 2009). The recorded elevated iron, chromium and zinc levels in the river implies that its reliance as source water for fish culture in its untreated form, predisposes the fishes to heavy metal toxicity and physiological stress. Similar results of unsatisfactory levels of turbidity, total suspended solids, dissolved oxygen, iron, copper and zinc in surface water were reported by Egun and Oboh (2022) in their study on the suitability of Ikpoba reservoir for aquaculture in Edo State Nigeria. Also, Tumwesigye et al. (2022) asserted that the water content of certain physico-chemical parameters has a detrimental effect on fish farming, as parameters such as temperature, pH, ammonia, biochemical oxygen demand and Iron content had a significant effect on the weight and size of both tilapia and catfish in their study on the effect of water quality on aquaculture productivity in Ibanda district, Uganda. Therefore, there is the need to educate fish farmers on the importance of water quality in aquaculture practice and how to maintain water quality at suitable levels in order to improve fish farm productivity.

CONCLUSION

The choice of a good source of water that will provide large quantities of high-quality water is one of the paramount undertakings to a successful aquaculture business, as fishes require large quantities of unpolluted water to grow rapidly and maintain their state of well-being. Although Ogidekpe River can provide the volume of water needed for fish culture, the unsatisfactory levels of several key physico-chemical parameters and their attendant effects on the development of fishes makes the water source unsuitable for use in aquaculture. Therefore, utilizing the river as source water requires that water retention ponds be constructed to allow for sedimentation and treatment before use for fish culture. Also, there is need to identify point sources of pollution within the watershed and enforce compliance to environmental laws in order to improve the overall water quality of the river.

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