PHYSICOCHEMICAL AND MICROBIAL ANALYSIS OF POND WATER IN SOME FISH FARMS IN AWKA METROPOLIS, AWKA, ANAMBRA STATE, NIGERIA

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Abstract
This study assessed the physicochemical parameters and microbial profiles of pond waters in some fish farms in Awka metropolis, Awka, Anambra State, Nigeria. . Water samples were collected from rearing tanks in five fish farms designated as A, B, C, D and E located within Awka metropolis. Fourteen physiochemical parameters and four microbial variables were analyzed using standard laboratory methods and procedures. The results indicated that the parameters ranged as follows: pH 4.97-6.94, Temperature 27.40-29.20°C, Dissolved oxygen 3.50-5.50mg/L, Turbidity 4.43-7.97NTU, Total dissolved solids 73.60-226.83mg/L, Chemical oxygen demand19.81- 42.45mg/L, Biological oxygen demand 3.35-4.15mg/L, Total hardness 23.70-34.35mg/L, Electrical conductivity159.84- 255.48 µs/cm, Alkalinity 43.45-54.87ppm, Nitrate 2.49-7.52ppm, Sulphate 23.92- 84.48ppm, Phosphate 2.17-9.67ppm and Ammonia 0.00-2.36ppm. The results of the microbial analysis are as follows; Total Heterotropic count ranged between 15.51-81.77,Total Coliform count 4.03-23.90, Total yeast/Mould count 0.94-6.01 and Total staphylococcus Count 0.00-9.28. Most of the values obtained from each of the water parameters did not fall within the acceptable range for fish growth and survival, except in Farm D whose water parameters fits into the acceptable range and has the highest fish production rate. It is therefore recommended that there should be a constant monitoring of physicochemical parameters and microbial profiles of Fish farm located within Awka metropolis in order to easily detect changes in water quality which may be harmful to aquatic organisms.

Keywords: Water, Aquaculture, Microbial profiles, Fish, Physico-chemical parameters

INTRODUCTION

Nigeria is endowed with an abundance of water resources, encompassing the Atlantic Ocean, brackish waters found in deltaic rivers and estuaries, and interior freshwaters found in rivers, streams, and lakes [1]. Since the middle of the 1990s, the production of aquaculture has been increasing globally, with Nigeria being one of the major and fastest-growing producers in Africa. Nigeria like other numerous sub-Saharan African nations, possesses abundant marine and inland fisheries resources, which serve as the foundation for the fisheries industry. Nigeria is 923768 km in land area, 47934 km in continental shelf area, and 853 km in coastline length. It also boasts an extensive system of inland waters, including flood plains, lakes and reservoirs, both natural and man-made, and rivers. The inland waters have the capacity to yield 512,000 metric tons of fish each year. With an estimated 1.4 million metric tons of fish consumed annually, the nation continues to rank among the top consumers of fish. Nonetheless, there remains a national demand-supply gap of at least 0.7 million metric tons, with imports covering the shortfall at a cost of over 0.5 billion dollars annually. Nigeria's total domestic fish production has fluctuated between 242,525 and 615507 metric tons between 1981 and 2007 [2].

Three methods are used to produce fish in Nigeria: industrial fishing, aquaculture (fish farms), and artisanal fishing in interior rivers, lakes, coastal, and brackish waterways. Nonetheless, the artisanal subsector often provides the great majority of the fish supply [3].A vital component of the economy and well-being of the planet are aquaculture and fisheries. Particularly when compared to meat from terrestrial farm animals, aquaculture is the food production industry with the greatest rate of growth in the world [3]. Since the mid-1990s, as capture production has tapered off, aquaculture has been the primary driver of expansion in total fish production. Its share of global fish production increased gradually over time, from 20.9% in 1995 to 32.4% in 2005 and 40.3% in 2010 [4]. Aquaculture's share of human consumption increased from 9% in 1980 to 47% in 2010. Nigeria is currently one of the biggest and fastest-growing aquaculture producers in Africa. This is the outcome of the nation being on a market-driven route due to the rising population and strong demand for seafood. Despite Nigeria's impressive aquaculture expansion, it is commonly known that the country is Africa's top importer of frozen fish.[4].

One of the most vital components of life is water, and having high-quality water is crucial to raising one's standard of living [5]. Aside from excellent feed, one of the most important variables in fish productivity is water quality [6]. It fluctuates according on a number of factors, including the time of day, season, weather, soil type, temperature, stocking density, feeding rate, and culture systems [7]. The dynamics and management of water quality in culture medium must be taken into account for an aquaculture project to be successful. It is possible to evaluate the water quality of any given source or location by utilizing physical, chemical, and biological factors. If these parameters' values exceed certain bounds, it could be detrimental to people's health. For this reason, the Water quality index has been used to characterize the acceptability of water sources for human consumption [8].

Nonetheless, the environment's equilibrium in aquatic habitats deteriorates as a result of the surface waters' quick changes in their physical and chemical characteristics [9]. Water contamination and quality decreases are the result of these changes. For these reasons, it's critical to routinely assess the physicochemical characteristics and heavy metal concentrations of freshwater resources in order to track any changes [9].

The amount, quality, and use of water are significantly impacted by the fast growing population as well as the expansion of industrial, agricultural, and forestry activities [10]. These ideas make up the field of water chemistry and its ultimate outcome, or water quality. Water chemistry problems result in declining water quality, which stresses the organisms that are being raised. The exact organisms to be cultivated determine the balance of the pond system, which is made up of many interconnected components and is in harmony with nature. Only then can efficient feed conversion, growth, and marketability of the end product occur. While a component may occasionally be handled independently, the composition of the entire array needs to be addressed due to the intricate interactions between components[11]. Thus, maintaining "balance" or "equilibrium conditions" with regard to water chemistry and the ensuing natural consequence of high water quality is the primary focus of fish farmers [12]. For aquaculturists, the quality of water is defined as that which permits the successful proliferation of the target species. Numerous ecological factors and management techniques have an impact on development and survival, which together define the final yield and the necessary water quality [13].

Water is the only medium necessary for the majority of aquatic species, including fish, to survive [14]. Fish require water to breathe, eat, develop, expel waste, maintain the proper salt balance, and reproduce [15]. As a result, the water quality utilized for fish culture is just as crucial as that for human consumption, which has sadly not been critically examined [16]. Since the principle of water quality governs fish culture, a high level of water quality chemistry directly correlates with effective productions [17]. The majority of fish cultures worldwide use fish ponds as habitat, and they are easily manipulable by adjusting the water's quality, which affects the amount of fish produced. The ability of aquatic organisms, including fish, to maintain their internal environment is impacted by the presence of environmental stresses such as low dissolved oxygen, high concentrations of nutrients, and trace elements in poor water quality [18]. Due to the low quality of water utilized in aquaculture production, fish farmers have been extremely concerned in recent years about the microbiological profiles and water quality of their ponds. This study's goal is to examine the physicochemical characteristics and microbiological makeup of the pond waters in some fish farms in Awka metropolis of Anambra State, Nigeria.

II. Materials and Method

Study Area

Awka is located in Awka South Local Government Area (LGA). The LGA is made up of nine towns, namely, Amawbia, Awka, Ezinato, Isiagu, Mbaukwu, Nibo, Nise, Okpuno and Umuawulu. There are three major streets that span this area, which are the Zik Avenue, Work road and Arthur Eze Avenue. This study was conducted in five farms were designated as A, B,C,D and E. These farms are located in Awka metropolis in Awka south Local Government of Anambra state, Nigeria.

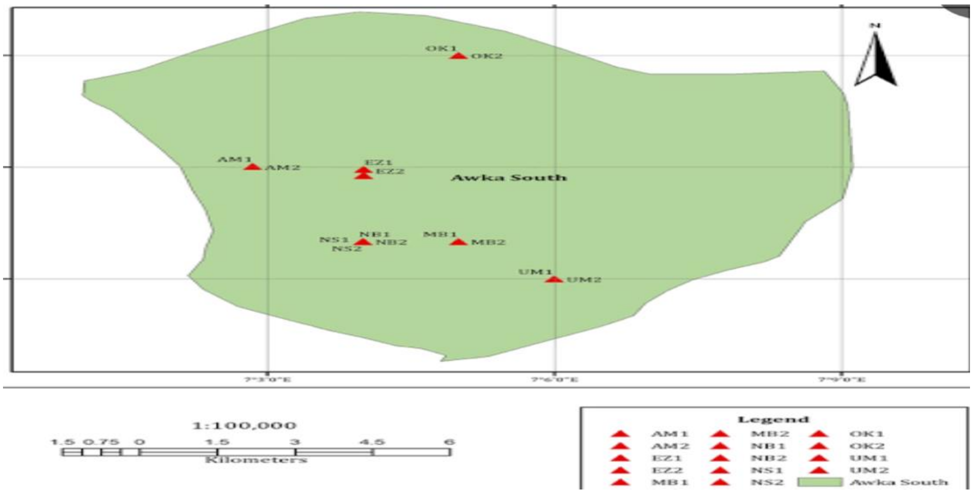

Figure 1: Map of Awka South Metropolis

Sample Collection

The water samples were collected from the pond water in five fish farms located in Awka south metropolis which uses borehole water for fish production. The water samples collected from these farms was tested for temperature in-situ and then stored in a clean plastic can and taken to Alpha Research Laboratory, Awka for the test analysis. Plastic cans were used for sample collection because, the level of contamination from the water especially from heavy metals is low. Questionnaire was given to the fish farmers to ascertain the rate of fish production in their farms.

Water Quality Test

The parameters analyzed include temperature which was taken with a calibrated Thermometer at the farm, pH, Nitrate, Phosphate and dissolved oxygen, conductivity, biological oxygen demand, Turbidity, salinity, chemical dissolve oxygen, total suspended solid, total hardness, sulphate, nitrate and ammonia were determined with standard laboratory methods described by APHA [19]. Winkler's method [19] was used for determination of the dissolved oxygen (DO) using azide modification. All the measurements were done in triplicates and values were expressed as mean ± standard deviation.

Microbiological Test

Total Bacterial Count

One millilitre of each of the water samples was introduced into a petri-dish containing ketoconazole at a concentration of 0.05mg/ml to inhibit fungal growth. Sterile nutrient agar (NA) was added to the petri-dish and the mixture was gently swirled and left to solidify. Duplicate plates from each sample were prepared and one incubated at 37^0C for 24 hours and the other incubated at 22^0C for 24 hours after which the colonies that developed were counted using a colony counter. Only plates that showed between 30 and 300 colonies were counted and the values expressed as colony forming unit per millilitre of the sample. Each colony was purified by repeated sub-culturing on sterile nutrient agar plates and later stored on sterile NA slants for characterization and identification [20].

Total Coliform Test

The most probable number (MPN) technique was used. Ten milliliters (10ml) of each of the water samples were introduced into each of a first set of five tubes each containing 10ml double strength bile salt-lactose broth. One milliliter (1ml) of each of the samples was also introduced into each of a second set of five test tubes each containing 5ml single strength bile salt-lactose broth. 0.1 milliliter re of each of the samples was also introduced into each of a third set of test tubes each containing 5ml single strength bile salt-lactose broth. Durham tubes were inserted into each of the test tubes. All the test tubes were incubated at 37^0C for 48 hours and examined for the presence of acid and gas. Acid production was indicated by a change of colour of the broth to yellow while gas production was indicated by the presence of sufficient gas space at the top of the Durham tubes. The potable number of coliform per 100ml of each water sample was obtained using the McCray's Probability Table.

Total Staphylococcus Count

This was done using the most probable number technique. Ten millilitres (10ml) of each of the water samples were inoculated into each of first set of five tubes each containing 10ml of double strength azide dextrose broth. One milliliter (1ml) of each of the water samples was added to each of a second set of five tubes containing 5.0ml of single strength azide dextrose broth. 0.1ml of each of the water samples was also added to each of another set of five test tubes each containing 5ml of single strength azide dextrose broth. The test tubes were incubated at 35^0C for 48 hours and examined for growth which was indicated by the turbidity of the broth. The number of tubes that showed turbidity were noted and the most probable number of the faecal *Enterococci* per 100ml of each sample was determined using the McCrady's Probability Table. The organism was confirmed by transferring a loopful from the tubes that showed turbidity to plates of bile esculin azide agar and incubating at 35^0C for 24 hours. The plates were observed for the development of blackish brown colonies with brown halos.

Total Fungi Count
One ml of each sample was serially diluted using sterile distilled water as diluents. 9ml of distilled water was measured out into test tubes, using separate sterile pipettes; 1ml of the sample was measured out into the first test tube properly mixed. Using a different sterile pipette, 1ml from the first test tube was pipette into the second test tube already containing 9ml of distilled water, this continued following the same procedure till the last dilution (i.e. the 4th test tube). Using the streak method 1ml each of each sample unit from the test tubes was collected with wire loop and streak into the sterile Petri dishes. The plates were incubated at 37°c for the 24hr.
The number of colonies were counted on all the agar agar and calculated using the formula below;
CfU (ml) = $\frac{N}{V \times D}$

Where
Cfu=Colony forming unit
N=Mean number of colonies
V=Volume of innoculum
D=Dilution factor.

Data Analysis
Data obtained for physico-chemical and microbial analyses were recorded and analyzed using Statistical Package for Social Science (SPSS) 22.0 version. Mean and standard deviations were calculated of the three samples per sampling site.

III. Results
Table 1 showed the personal information about fish farmers in Awka south, from the table it is observed that they 100% of the fish farmers are males with the age bracket above 60 and 31-40, while 20% of the fish farmer were within the age bracket 51-60. 60% of the fish farmers were married, while 40% were single. The household size of the farmers were majorly 6-10, while 40% were within 1-5 household size. 60% of the educational status of the fish farmers were B.Sc/HND while 20% are NCE/OND and M.Sc and PhD. 100% of the fish farmers were Christians. Table 2 showed the species used for fish production in Awka, which is 100% Catfish. 100% of the fish farmers are processors, while the 80% of the fish dies rarely while 20% dies occasionally. 40% of the fish below 5 tons are harvest annually. 40% of the fish within 6-10 tons are harvested annually, while 20% of the fish above 10 tons are harvested annually. 80% of the waters used for aquaculture production in Awka are tested while 20% are not tested. 20% of water quality affects the growth of fish and aquaculture production while 80% of water quality does not affect fish growth and production.
Physicochemical parameters of water samples from some fish farms in Awka metropolis are presented in Table 3. The results revealed that Farm D has the highest pH of 6.94 followed by Farm A with pH of 6.11, followed by Farm B with pH of 6.05, followed by Farm E with pH of 5.64, while Farm C has the least water pH level of 4.71 which is quite acidic. The value of temperature were within the same range of 27.40-29.20 in all the fish farms. For dissolved oxygen, the highest value of 5.50mg/l was observed in Farm D, while the lowest value of 3.5mg/l was observed in Farm A. For turbidity, the highest value of 7.97NTU was observed in Farm E, while the lowest value of 4.43NTU was observed in Farm C. For TDS, the highest value of 226.83mg/l was observed in Farm E, while the lowest value of 42.43mg/l was observed in Farm C. For COD, the highest value of 42.43mg/l was observed in Farm E, while the lowest value of 19.87mg/l was observed in Farm C. For BOD, the highest value of 4.15mg/l was observed in Farm C, while the lowest value of 3.35mg/l was observed in Farm D. For Total hardness, the highest value of 34.35mg/l was observed in Farm D, while the lowest value of 23.70mg/l was observed in Farm A. For Electrical conductivity, the highest value of 255.48µs/cm was observed in Farm A, while the lowest value of 159.84 µs/cm was observed in Farm A. For Alkalinity, the highest value of 54.87mg/l was observed in Farm A, while the lowest value of 43.45mg/l was observed in Farm D. For Nitrate, the highest value of 7.52mg/l was observed in Farm C, while the lowest value of 3.07mg/l was observed in Farm E. For sulphate, the highest value of 6.91mg/l was observed in Farm C, while the lowest value of 2.79mg/l was observed in Farm A. For phosphate, the highest value of 9.67mg/l was observed in Farm C, while the lowest value of 2.17mg/l was observed in Farm E. For ammonia, the highest value of 1.04mg/l was observed in Farm C, while the lowest value of 0-03mg/l was observed in Farm E. Microbial analysis of water samples of in some fish farms in Awka metropolis are presented in Table 4. The results revealed that the highest value of total heterotrophic bacteria (81.77) was recorded in Farm B. while the lowest (16.50) was in Farm A. Also, the highest value of total coliform count (23.90) was recorded in Farm D. while the lowest (4.03) was in Farm C. In addition to this, the highest value of total yeast/mould count (6.01) was recorded in Farm D. while the lowest (0.94) was in Farm C. Moreover, the highest value of total staphylococus count (9.28) was recorded in Farm A. while the lowest (6.00) was in Farm C.

Table 1: Socio-Economic Characteristics of Farmers in in Some Fish Farms in Awka Metropolis

Parameters	Frequency	Percentage (100)
Gender		
Male	5	100
Female	0	0

Total	**5**	**100**
Age		
20-30	0	
31-40	2	40
51-60	1	20
Above 60	2	40
Total	**5**	**100**
Marital Status		
Single	2	40
Married	3	60
Divorced	0	0
Total	**5**	**100**
Household size		
1-5	2	40
6-10	3	60
Above 10	0	0
Total	**5**	**100**
Educational status		
FSLC/SSCE	0	
NCE/OND	1	20
B.Sc/HND	3	60
M.Sc/PhD	1	20
Total	**5**	**100**
Religion		
Christianity	5	100
Islamic	0	0
Traditional	0	0
Others	0	0
Total	**5**	**100**

Table 2: Species of fish, Value chain of production, mortality rate, Tons of fish Harvested, and Effects of water parameters on fish production in Some Fish Farms in Awka Metropolis

Parameters	**Frequency**	**Percentage**
Value Chain		
Fish farmers	0	0
Processors	5	100
Marketers	0	0
Others	0	0
Total	**5**	**100**
Mortality Rate		
Regularly	0	0
Occasionally	1	20
Rarely	4	80
Total	**5**	**100**
Tons of fish harvested		
Below 5	2	40
6-10 tons	2	40
Above 10 tons	1	20
Total	**5**	**100**
Testing of waters		
Yes	4	80
No	1	20
Total	**5**	**100**
Water parameters affecting fish growth & production		
Yes	1	20
No	4	80
Total	**5**	**100**
Species of fish		
Tilapia	0	0
Catfish	5	100
Others	0	0
Total	**5**	**100**

Table 3: Physicochemical Parameters of Bore Hole Water Samples in Some Fish Farms in Awka Metropolis

Parameters	Farm A	farm B	Farm C	Farm D	Farm E
pH	6.12± 0.72^{c}	6.05±0.05^{c}	4.71±0.44^{a}	6.94±0.02^{c}	5.64±0.09^{b}
Temperature (°C)	27.50±0.22^{a}	27.40±0.33^{a}	27.50±0.11^{a}	29.20±0.00^{a}	28.60±0.11^{a}
D.O(mg/L)	3.50 ±0.55^{a}	3.70±0.55^{a}	4.00±1.09b^{b}	5.50±0.55^{c}	4.50±0.55^{b}
Turbidity (NTU)	6.78±0.52^{c}	5.29±0.98^{b}	4.43±3.00^{a}	5.11±0.23^{b}	7.97±1.36^{c}
TDS (mg/L)	118.47±2.53^{b}	160.92±4.49^{b}	70.3± 0.8^{a}	77.97±2.65^{a}	226.83±15.55^{c}
COD(mg/L)	34.30±0.93^{b}	37.11± 0.84^{b}	19.81±2.24^{a}	39.54±15.119^{b}	42.45±0.42^{c}
BOD(mg/L)	3.65±0.48^{a}	3.67±0.13^{a}	4.15±0.39^{b}	3.35±0.25^{a}	3.78±0.18^{a}
Total hardness (mg/L)	23.70±0.40^{a}	24.83± 2.75^{a}	26.35±0.21^{a}	34.35±1.35^{b}	25.82±1.92^{a}
Electrical conductivity (µs/cm)	255.48±1.76^{b}	159.84±17.54^{a}	237.5±17.07^{b}	252.57±1.66^{b}	228.75±18.35^{b}
Alkalinity(mg/L)	54.87±2.82^{b}	54.11±3.17^{b}	51.50±1.45^{b}	43.45±0.42^{a}	47.49±1.92^{a}
Nitrate (mg/L)	4.49±1.79^{a}	5.35±2.19^{b}	7.52±1.99^{c}	4.56±1.24^{a}	3.07±0.59^{a}
Sulphate(mg/L)	2.79±2.27^{a}	4.48±4.84^{b}	6.91±6.74^{c}	3.92±1.55^{a}	3.79±4.00^{a}
Phosphate (mg/L)	5.57±0.47^{b}	5.38±0.38^{b}	9.67±0.23^{c}	6.69±0.17^{b}	2.17±0.16^{x}
Ammonia (mg/L)	0.03±0.04^{a}	0.25±0.03^{a}	1.04±0.21^{b}	0.10±0.00^{a}	0.80±0.30^{a}

Means within the same row with different superscript are significantly different ($p<0.05$)

Table 4: Microbial Analysis of Bore Hole Water Samples in Some Fish Farms in Awka Metropolis

Parameters	Farm A	Farm B	Farm C	Farm D	Farm E
Total Heterotrophic Bacteria count(x10^{3}cfu/ml)	16.50±5.39^{a}	81.77±4.38^{c}	15.51±2.59^{a}	53.48±8.15^{b}	50.01±2.61^{b}
Total coliform Count (MPN/100ml)	13.33±3.33^{b}	10.15±5.04^{b}	4.03±1.13^{a}	23.90±1.43^{c}	9.86±0.26^{a}
Total Yeast/Mould count (x10^{3}cfu/ml)	5.57±0.80^{c}	2.35±0.30^{b}	0.94±0.09^{a}	6.01±0.29^{c}	4.43±0.29^{b}
Total *Stapylococcus* Count (x10^{3}cfu/ml)	9.28±1.05^{c}	4.32±1.18^{b}	0.00±0.00^{a}	3.82±0.22^{b}	5.85±0.26^{b}

Means within the same row with different superscript are significantly different ($p<0.05$)

IV. Discussion

The degree to which a solution is basic or acidic at a particular temperature is known as the water pH. Because of the enhanced biological activity and improved availability of most nutritional elements, this pH range is thought to be favorable for aquatic production. Fish life is more optimal and receptive to pH values between 7.0 and 8.5. Fish can get stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0, and death is very inevitable at a pH of less than 4.0 or greater than 11.0 [21]. pH between 7 and 8.5 is optimum for biological productivity. However, Owhonda *et al* [22] state that the optimal pH range for fish cultivation is between 7.5 and 8.5; any pH level higher or lower than this may stress the fish. The ideal pH range for an aquaculture pond is 6.5 to 9.The five farms that are situated in the city of Awka have similar temperatures. The majority of the temperature range starts at 27°C, which is ideal for fish survival and growth. These results are consistent with those of Adika *et al.* [23], who noted a similar pattern in certain fish farms located in Kakamega County, Kenya.

According to Danba *et al*. [24], the dissolved oxygen obtained in this investigation is relatively low, making it unsuitable for fish production. In water, turbidity is the degree to which the suspended particles cause the sample to seem cloudy. Farm E exhibits the most turbidity, whilst Farm C displays the lowest turbidity. Olukunle and Oyewumi [25] state that turbidity prevents sunlight from penetrating the pond, which makes it harder for aquatic life—such as algae—that depends on light for photosynthesis to benefit from it. Shitu[26] claim that excessive turbidity reduces the amount of sunlight absorbed in the pond, which kills fish. Poor facility management may have contributed to the high turbidity by allowing undesired debris to enter the fish pond. Furthermore, Total Dissolved Solids was defined by Shitu [26] as a measurement of the dissolved organic and inorganic in the specified water sample. Farm E had the highest total dissolved solids value found in the investigation, whereas Farm C produced the lowest total dissolved solids value. Danba et al. [24] state that fish extracts and high feeding habits in the pond water may be the cause of the high suspended solids sedimentation because an accumulation of uneaten feed may raise the total dissolved solids value. Elevated suspended particles in the pond's water can harm fish gills and make it difficult for them to find food.

Analytical parameters such as chemical oxygen demand (COD) are essential for evaluating the quality of water. The level of organic contamination in water bodies is indicated by COD. Farm E exhibits the highest chemical oxygen requirement, whereas farm C displays the lowest chemical oxygen demand.The biological oxygen demand measured in the several farms under investigation falls within Boyd's recommended standard range of 3–20 mg/l [26]. This may be the consequence of the fish pond's ideal temperature, as a high temperature lowers the amount of dissolved oxygen, or it may be the effect of the fish farmers' use of artificial aeration to maintain the water's ideal temperature. Total hardness, which is typically found in aquatic bodies as a mixture of carbonates and bio carbonate, is the sum of the concentrations of calcium and magnesium. The overall hardness is significantly lower than the 50–200 ppm range that is typical for pond water. This suggests that there is not much salt in the water. The low overall hardness could be the result of additional chemicals and heavy metals not being concentrated enough. Lime should be added to the water to raise its overall hardness [28]. The ability of water to permit the flow of electricity through it is measured by its electrical conductivity [29]. The electrical conductivity found in this study falls between Boyd's (20–150us/cm) recommended range for fish rearing [27]. Aquatic life is significantly impacted by alkalinity, which demonstrates the water's capacity to act as a buffer. The natural charges in pH caused by the photosynthetic activities of the phytoplankton are balanced by alkalinity. With the exception of Farm D, where the alkalinity level is 43.45 mg/l, which is somewhat below the recommended alkalinity level, the levels of alkalinity obtained in this study fall within the range where fish are produced most optimally, which is between 50 and 200 mg/l [27]. The research findings indicated that the minimum nitrate level was found in farm A, and the maximum nitrate level was found in farm C, where it was recorded at 57.52. This level of nitrate is a consequence of eutrophication and can lead to an algal bloom. It is possible that the nitrate content will prevent the blood cells from absorbing oxygen from the water, which will cause the blood to turn a dull brown color. The water ecology may be impacted by low nitrate concentrations because they can cause algae to become more lipid-concentrated [30]. Phosphate and sulfate levels were within acceptable bounds for maximum fish yield [27].For fish that live in the water, ammonia is extremely harmful. According to this study, farm E has the highest ammonia value, but farm D has no ammonia at all.

One type of biological agent that breaks down organic debris and food waste in pond waters is heterotropic bacteria. The amount of total heterotropic bacteria is lowest at farm C and largest in the pond water from farm A. It is possible that the organic material in these farms, which serves as a substrate for the growth of microorganisms, is the cause of the occurrence of heterotropic bacteria. Coliform is a sign of fecal matter contamination in pond water. The pond water from these farms contains Coliform, a sign that the water is tainted with excrement. However, the presence of mold or yeast suggests the existence of fungal contamination. Staphylococcus is a type of bacteria pathogen that can cause a wide range of diseases. Farm C has no staphylococcus, whereas Farm A has the highest staphylococcus count.

Conclusion and Recommendations

Fish production rate is influenced by pond water's physiochemical and chemical characteristics. Pond water's physiochemical and microbiological characteristics must be considered in order to reduce death rates and enhance aquaculture output. Water quality affects fish growth, which increases fish productivity. With the exception of farm D, whose water parameters primarily fall within the acceptable range, the physiochemical parameters of the water sample from selected fish farms in Awka metropolis are not actually within the specified and acceptable range. This may be due to the fact that the water is tested prior to fish production, which has a positive impact on the farm's rate of fish production. In this study, no sample of a fish pond is uncontaminated by fungus and bacteria. Understanding the microbiological characteristics of the body of water is helpful not only for determining its production but also for gaining insight into the population and life cycle of the fish community. Hereby, the following are suggested. The physiochemical parameters of the fish farm in the Awka metropolis should be continuously studied in order to quickly identify any changes in water quality that can be detrimental to the aquatic life.

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