A study on physicochemical parameters of fish pond effluents:
A case study of Umudibia fish farm

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Abstract. This study investigated the physicochemical characteristics of fish pond effluents. Four (4) effluent samples were collected at two-day intervals from a fish pond located at Umudiba Nekede, Owerri, and analyzed to ascertain their characteristics. The physiochemical parameters assessed are the temperature, biochemical oxygen demand, chemical oxygen demand, total dissolved solids, turbidity, ammonia, total hardness, alkalinity, pH, and electrical conductivity. The result revealed the following ranges for the physicochemical characteristics: temperature (23.0 to 25.9°C), pH (6.24 to 3.1), total alkalinity (43.1 to 50.4mg/l), total dissolved solid (27.9 to 95.2 mg/l), total hardness (19.7 to 21.5mg/l), turbidity (12 to 170 NTU), and electrical conductivity (137.6 to 144.3 μmhos/cm). The result of the study indicated that the effluents from the fish pond could constitute a threat to the ecology of the aquatic water bodies if not properly treated before discharge.

Keywords: Physicochemical characteristics; fish pond effluents; fish farm; Umudibia

1. Introduction
The most abundant compound on earth is water, and it covers approximately seventyfive percent of the earth’s surface. Most of the water on the earth crust is saline in nature, with just a little amount existing as freshwater. Overexploitation and pollution have made freshwater a scarce commodity [1]. Water is becoming more unfit every day to mankind due to unwise use, neglect, and mismanagement. The entry of toxic substances into water bodies results in dissolution, suspension, and deposition on the bed of the water body, resulting in water pollution. This leads to the deterioration of water quality and negative effects on the aquatic ecosystem. When the wastewater in aquaculture is discharged, the pollutants seep down and affect the groundwater sources. If the concentration of nutrients, organic matter, and suspended solids in fish ponds rise, it results in a direct increase in turbidity, oxygen demand, and eutrophication in receiving water. Because of these problems, it becomes imperative to monitor water bodies’ physicochemical properties to ensure that the quality is good for whatever purpose it is meant for. Some of the physicochemical properties regularly monitored for water quality include pH, dissolved oxygen, biochemical oxygen demand, temperature, total hardness, and chemical oxygen demand. However, the characteristics of the water bodies are influenced by seasonal variations [2].
Aquaculture consumes a large amount of water and this large amount of water is usually required in high quality. According to Boyd and Gross [3], similar principles are applied in the execution of the different forms of aquaculture. Water chemistry and the net results are usually determined by these principles [4]. Studies have shown that when water quality and quantity are both insufficient, profitable fish farming may be seriously threatened. Physicochemical and biological features of water used in fish ponds greatly define successful fishing farming and the survival of other aquatic biotas that form important food chain components [5]. Thus, maintaining good water quality is critical for optimum growth and sustenance of the aquatic organisms. Furthermore, information on the physicochemical qualities of raw water is essential to determining its appropriateness for use. Physicochemical parameters may also give insight into the various metabolic occurrences in the aquatic ecosystem. This research is therefore aimed at determining the physicochemical characteristics of wastewater from a fish pond located at UmudibiaNekede, Owerri, Imo State Nigeria as well as their effect on water quality in Materials and Methods

1.1. Study area
Umudibia Nekede is situated in Owerri West Imo State, South East, Nigeria. There are three Local Government Areas in Owerri; the Imo state capital; Owerri Municipal, Owerri West and Owerri North. Umudiba Nekede is bounded by latitude 5.4266° N and longitude 7.0176° E. The annual rainfall is between 2250 – 2500 mm. The study area has an average temperature of 25-27°C and a relative humidity of 80%, and it is located within the vicinity of Otamiri River which links Nworie River Owerri [6]. Figure 1 shows the map of the study area.

![Figure 1: Map of the study area.](image)

**Legend:** The black spot indicates the sampling area

1.2. Sample collection and analysis
Wastewater samples were collected from Umudibia Nekede fish farm. Plastic and glass screw-capped bottles were deployed in the sample collection for physicochemical factors. The bottles were washed with non-ionic detergents and rinsed with tap water as a pre-cleaning measure. Thereafter, the bottles were rinsed three times, first with distilled water and then with the sample before being filled with the sample. The sample containers were labelled and transported to the laboratory immediately in an ice pack. The temperature of the water was measured using a thermometer and electrical conductivity with the conductivity meter. Sample pH was measured using a pH meter (Q150 pH meter); measurement of total
hardness was performed using the ASTM-2340C method (EDTA titration method). Total dissolved solids (TDS) was determined using ASTM-D5907 method; ASTM D6238-98 determined dissolved oxygen (DO) and Biochemical oxygen demand (BOD), turbidity was measured using a hatch turbidity meter, ammonia by ASTM D1426-08 method, and total alkalinity was determined using the method consisting of methyl orange, Erlenmeyer flask and sulphuric acid.

2. Results and discussion
A total of ten (10) different physicochemical parameters were analyzed. The results obtained from the study are presented in Table 1 and Figure 2.

Table 1: Comparison of Results with other Standards Values

| Parameters          | Sample 1 | Sample 2 | Sample 3 | Sample 4 | WH O | FEP A | Acceptable range BD |
|---------------------|----------|----------|----------|----------|------|-------|---------------------|
| Temperature (°C)    | 24.9±1.5 | 25.30±2.1| 23.00±1.03| 25.10±0.8 | <35  | 27    | -                   |
| pH                  | 6.24±0.2 | 6.28±0.1 | 6.58±0.19 | 6.68±0.3 | 6.5- | 6-9   | 7-9.5               |
| Ammonia (mg/l)      | 0.90±0.0 | 0.10±0.0 | 0.13±0.0 | 0.15±0.0 | 50   | 20    | 0-1                 |
| Dissolved Oxygen (mg/l) | 13.30±0.8 | 11.90±0.9 | 10.30±0.4 | 9.30±0.2 | 6    | 8-10  | 3-5                 |
| BOD (mg/l)          | 2.90±0.0 | 3.00±0.0 | 3.18±0.0 | 3.53±0.1 | 6    | 10    | 3-6                 |
| Total Alkalinity (mg/l) | 43.10±2.5 | 45.20±1.9 | 47.60±2.09 | 50.40±2.4 | 600  | -     | 50-200              |
| Turbidity (NTU)     | 125.00±6.7 | 135.00±1.6 | 145.00±7.1 | 170.0±8.1 | 10   | <     | -                   |
| TDS (mg/l)          | 27.90±1.4 | 49.80±0.1 | 55.20±2.4 | 95.20±3.8 | 500  | 500   | -                   |
| Total hardness (mg/l) | 19.70±1.8 | 20.10±0.1 | 20.70±1.1 | 21.50±0.9 | 600  | <     | >20                 |
| Electrical conductivity (µmhos/cm) | 137.6±7.0 | 128.50±6.4 | 117.30±5.1 | 144.30±6.9 | 200  | 20-1500 | -                   |

The values represent mean and standard error of triplicate measurements. a: sample 1; b: sample 2; c: sample 3; d: sample. Note: For a given row, all values containing similar alphabets are statistically significant with the given sample. For example, all values containing “a” are statistically significant with sample 1; all values containing “b” are statistically significant with sample 2; all values containing “c” are statistically significant with sample 3 and all values containing “d” are statistically significant with sample 4. WHO-World Health Organization [7], FEPA-Federal Environmental Protection Agency [8], BD – Bhatnagar and Devi [9].

Temperature
Temperature is a key physiological controller and primarily influences the digestive system of aquatic organisms [10]. A change in temperature affects the physiology and metabolism and productivity of fishes. An optimum temperature range of 31°C to 36°C is required for the growth and sustenance of fishes [11]. In this study, the temperature range was between 23°C to 25.3°C (Table 1), which implies that the temperature of the water in the pond is not favourable for the fishes.
pH
This is a measure of hydrogen ion concentration. In this study, the pH values ranged from 6.24 to 6.68 (Table 1), which is a favourable condition for fish production. The optimal water pH range for fish farming is usually 6.5 to 9. Typically, pH ranges 4 to 6 or 9 to 10 reduce the growth rate of the fishes, although the majority of the fishes will still be alive. The pH of less than six results in a decrease in regeneration. The mortality of fish starts at pH less than 4 (acidic) or more than 11 (fundamental) in the fish farm [12]. The pH value also agrees with the results of Bisht et al. [13] and falls within the standard limit of WHO and FEPA. Thus, it is favourable for fish life.

Figure 2: Result of selected physico-chemical parameters

Ammonia
Ammonia enters the ponds through uneaten feeds, phytoplankton, decaying, and dead organics. It is a bye-product from the fish excreta produced during the organic matter degradation [9]. The values recorded ranged between 0.9 and 0.15 mg/l, thus are beyond the acceptable range (Table 1 and Figure 2). Values of ammonia greater than 0.1 mg/L could cause damages to the gills of fishes as well as other adverse effects such as reduced immune system; poor bolster change, decreased growth and crush mucous creating membrane [9].

Turbidity
Turbidity in water refers to the intensity of the cloudiness of the sample due to the suspended particles [14]. In this study, the turbidity ranged from 125 to 170 NTU. Bhavimani and Puttaiah [15] reported a turbidity range of 20 to 72 NTU. The value of the turbidity obtained in this study (Table 1) is higher than both the FEPA [7] and WHO [8] stipulated limits. Excess turbidity leads in the reduction of sunlight absorbed in the pond which causes death of fishes [16]. This high turbidity could have arisen from the poor facility management, which allowed the influx of unwanted debris into the fish pond. Another reason may be due to the infrequent replacement of the source of water for the fish which causes the accumulation of wastes from the fishes. Turbidity arising from effluents when discharged into water bodies may hinder photosynthesis of organisms that usually participate in the phytoremediation of contaminated water [17]. However, according to WHO [18] it may form a shield against the hazardous effect of disinfectants on microorganisms.

Total Dissolved Solids (TDS)
The TDS is a measure of the dissolved organics and inorganics in the given water sample. The values of the TDS obtained in the current study are within the range of 27.9 to 95.2 mg/l (Table 1 and Figure 2).
Thus, the values were within the WHO and Federal Environmental pollution authority values, which shows a propensity to increase as the harvesting of fishes progresses [19].

**Dissolved Oxygen (DO)**
DO is a measure of the amount of dissolved oxygen in the aquatic ecosystem. The sustenance, development, mental soundness, behaviour and efficiency of living organisms are influenced by a change in dissolved oxygen [20], and it is used up usually during microbial decomposition of organic matter. In this study, the results of DO obtained ranged from 9.3 to 13.3 mg/l (Table 1). These values exceeded the limits set by WHO and FEPA. The higher values of DO obtained is an indication that the wastewater samples used in this study were polluted.

**Biochemical Oxygen Demand (BOD)**
According to Bhatnagar and Devi [9], BOD is the volume of oxygen microorganisms take up for decomposition of organics in water. Usually, the BOD value above 5mg/l is an indication of pollution of the water sample [21]. In this study, the value of BOD ranged from 2.9 to 3.53 mg/l (Table 1 and Figure 2). Previous studies reported that the levels of BOD range from 3.0 to 6.0 mg/l enhance fish activities [22]. The values obtained from the study were within the range of WHO and FEPA limits.

**Alkalinity**
This shows the buffering capacity of water and it has a strong impact on aquatic life. According to Bhatnagar and Devi [9] alkalinity equilibrates the changes in pH occurring naturally due to the photosynthetic activity exhibited by the phytoplankton. Fishes produce optimally at alkalinity between 50 and 200 mg/l. The alkalinity of unpolluted pond ranges from 171.2 to 235.5mg/l [23]. Therefore, the result obtained in this study which had alkalinity range from 43.10 to 50.40 mg/l is suitable for fish farming in the pond (Table 1).

**Total Hardness**
This is the sum of calcium and magnesium concentration in aquatic bodies usually present in the form of a combination of carbonates and bicarbonates which result in temporary hardness. Magnesium and calcium are essential nutrients needed for the formation of scale and bones in fishes [9]. Stoskopf [24] defined the total hardness as the minimum amount of hardness that is proper for fish farming is 100 mg/l [25]. The results of the total hardness obtained in the current study ranges from 19.7 and 22.5 mg/l which falls within the specified WHO and FEPA limits (Table 1 and Figure 2).

**Electrical Conductivity (EC)**
Electrical conductivity is a measure of the capacity of water to allow the passage of electricity through it [26]. The results of the electrical conductivity obtained in this study ranged from 117.3 to 144.3μmhos/cm (Table 1). Zimmermann [27] reported that the electrical conductivity values recommended for fish farming range from 20 to 150 μS/cm. They stressed that EC recognizes polluting sources and linearly increase with increasing concentration of salts within an aquatic setting.

3 Conclusions
From the results, the wastewater from Umudibia fish farm was polluted and could harm water bodies if not properly treated before discharge. Therefore, the fish pond needs to be checked at regular intervals for quality assurance procedure to guarantee there are no harmful substances in the ponds prompting a conceivable bio-aggregation. This will guarantee the great wellbeing of the aquatic ecosystem, man, and the environment. It is recommended that farmers should be acquainted with the standard practices with respect to waste minimization, pond management, feeding and the environmental protection.


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