# Physicochemical and Mineral Analysis of Fish Pond Water; Implications for the Environment

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**ABSTRACT:** This study examined the physicochemical parameters of fish pond water to ascertain if they pose any risk to the environment after disposal. Water samples were collected from metallic, tarpaulin and concrete ponds from Anambra, Imo and Lagos states, Nigeria and analysed for minerals and physicochemical parameters using standard analytical methods. The results obtained were as follows; pH 6.30±0.06 – 6.94±0.01, turbidity 40.00±0.01-315.00±1.73 NTU, TSS 324.00±9.59 – 1346.00±20.53 mg/L, TDS 24.2 ±2.20 – 45.6 ±17.2 mg/L, hardness 18.6±3.9 – 24.3±3.80, phosphate 0.12±0.01 - 0.23±0.01, nitrate 0.42±0.02 – 1.17±0.01, BOD 1.43.33±1.41 – 577.67±2.8, DO 27.67±1.41 – 57.67±0.02, Zn 0.12±0.03-0.92±0.02, Cu 0.18±0.03 – 0.53±0.01, Fe 0.24±0.02 – 0.55±0.02 and Ca 0.19±0.02 – 0.51±0.02. The results varied from one pond to another depending on the residence time of the samples and the nature of the pond. All parameters were within the established limit for effluent disposal except biochemical oxygen demand (BOD)and dissolved oxygen (DO).

Aquaculture plays a significant role in food security and adequate nutrition (FAO, 2020). It supplies fish which is a major and cheaper source of essential protein in human diet. However, uncontrolled aquaculture activities especially land-based aquaculture may adversely affect the environment (Masaba *et al.,* 2019). A number of chemicals including pharmaceuticals are used in aquaculture to improve water quality, prevent aquatic plant invasion, phytoplankton bloom and diseases. These chemicals include fertilizers, liming materials, oxidants, coagulants, algicides and herbicides, probiotics, pesticides, and heavy metals (Boyd and Massaut, 1999). Furthermore, aquaculture activities generate large amount of organic matter, nutrients and suspended solids from organic input of fish feeds (Amankwaah *et al.,* 2014). Fish ponds are also reservoirs of mineral components of fish feeds (Maule *et al.,* 2007). The impact on the immediate vicinity of discharge point source includes air pollution from foul odour, eutrophication, increased oxygen depletion and turbidity of receiving water channels (Ilechukwu *et al.,* 2020; Naylor *et al.,* 2000; Ilechukwu and Okonkwo, 2012). Antibiotics from pond effluents may also lead to the development of antibiotic resistant strains (Ajewole *et al.,* 2020). The effects of fish pond effluent on freshwater environment have been reported (Abbas and Al-Seria, 2020; Yoboué *et al.,* 2020; Amankwaah *et al.,* 2014; Buschmann *et al.,* 1996). A recent study in Nigeria evaluated the impact of effluent discharge from a medium-scale fish farm on a stream in Ijebu-ode, Ogun State (Famoofo and Adeniyi, 2020). Nigeria has embraced agriculture as one of the economy diversification strategies. This has led to the noticeable increase in fish farming with the resultant corresponding increase in the volume of discharged fish pond water from land-based aquafarms. Majority of these ponds are located in urban and semi-urban areas to maximise sales and productivity leading to the disposal of the fish pond water in storm water channels, open fields and street roads. Fish pond water is also an effluent from agricultural processes (Yoboué *et al.,* 2020; Amankwaah *et al.,* 2014). This is why it is essential that the physicochemical quality and mineral constituents of fish pond water is routinely examined to ensure that it meets set regulatory criteria that pose no harm to the environment after disposal. The aim of this study was to determine the physicochemical properties and mineral constituents of fish pond water. The minerals considered were those that are constituents of fish feeds. The conclusion drawn from the study is expected to aid in sustainable aquaculture management.

## MATERIALS AND METHODS

*Sample Collection:* The fish ponds used for this study are located in Anambra, Imo and Lagos states in Nigeria.Samples were collected July, 2019. Prior to sample collection, all the sampling bottles (1L) were thoroughly washed, dried and rinsed with the same water to be collected in the ponds. The pond

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description and the residence time of the pond water are shown in Table 1.

**Table 1:** Pond description and residence time of pond water at sampling

| S/N | Sample Code | Sample Location (State) | Pond Description | Residence Time |
|-----|-------------|-------------------------|------------------|----------------|
| 1 | A | Imo | Metallic tank | 1 day |
| 2 | B | Imo | Metallic tank | 2 days |
| 3 | C | Imo | Tarpaulin tank | 2 days |
| 4 | D | Lagos | Tarpaulin tank | 3 days |
| 5 | E | Lagos | Plastic tank | 1 day |
| 6 | F | Lagos | Tarpaulin tank | 1 day |
| 7 | G | Lagos | Metallic tank | 2 days |
| 8 | H | Lagos | Concrete | 2 days |
| 9 | I | Anambra | Concrete | 3days |

*Physicochemical Analysis:* The pH, total suspended and dissolved solids, dissolved oxygen, biochemical oxygen demand, turbidity, phosphate and nitrate concentration in the samples were determined using standards methods (APHA, 1998).

*Mineral Analysis:* Fifty millilitres (50 mL) of each water sample were transferred to a digestion flask and digested with 10 mL aqua regia ($HNO_3/HCl$; 1:3 v/v) on a thermostated hot plate at $150^oC$. Deionised water was added to rinse the flask after cooling. The sample was filtered and the filtrate made up to 50 mL with deionised water. The samples were analysed for zinc,

## RESULTS AND DISCUSSION

The physicochemical parameters of the fish pond water samples are presented in Table 2. The pH of the samples was between 6.30±0.06 and 6.94±0.01 and was slightly acidic. The least pH values were observed in samples from concrete ponds. Pond water released into the environment at this pH is not likely to pose any harm to the environment. pH variations may be as a result of the initial pH of the water before introduction into the pond. The turbidity of the samples was between 40.00 ± 0.01 and 315.00 ± 1.73 NTU. Highly turbid waters require some treatment before release into environment. The high turbidity of some of the samples may be due to poor housekeeping. Ponds that are always washed and kept clean will be less turbid. Turbidity may also be as a result of over population. Introduction of feeds and metabolic activities of fishes in the pond such as excretion contribute to the turbidity of fish pond water. Release of high turbid fish pond water into the environment destroys the aesthetic nature of the environment.

**Table 2:** Physicochemical parameters of the fish pond water samples

| Parameter | Sample A 1 metallic | Sample B 2 metallic | Sample C 2 Tarpaulin | Sample D 3 Tarpaulin | Sample E 1 Tarpaulin | Sample F 1 Tarpaulin | Sample G 2 Metallic | Sample H 2 Concrete | Sample I 3 Concrete |
|-----------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| pH | 6.97±0.02 | 6.70±0.06 | 6.83±0.05 | 6.94±0.02 | 6.73±0.05 | 6.59±0.16 | 6.50±0.03 | 6.30±0.06 | 6.39±0.01 |
| Turbidity | 41.22±0.0 | 94.67±0.71 | 73.67±11.31 | 42.72±0.44 | 45.62±0.30 | 71.67±0.71 | 40.00±0.21 | 179.67±0. | 315±1.73 |
| Phosphate | ND | ND | ND | 0.12±0.01 | ND | ND | 0.23±0.01 | ND | ND |
| Nitrate | 0.42±0.02 | 0.46±0.02 | 0.47±0.03 | 0.96±0.02 | 1.17±0.03 | 0.79±0.05 | 0.73±00.02 | 0.70±0.03 | 0.78±0.02 |
| DO | 57.67±0.0 | 42.67±2.12 | 37.40±0.07 | 38.20±0.85 | 35.20±0.33 | 27.67±1.41 | 32.47±0.12 | 39.33±0.5 | 41.13±0.1 |
| BOD | 165.6±1.7 | 283±4.95 | 143.33±1.41 | 328±0.46 | 577.67±2.8 | 173.33±3.53 | 194±2.11 | 173.33±2. | 240±1.32 |
| Hardness | 19.7±4.10 | 24.3±3.80 | 22.9±3.21 | 20.7±3.90 | 18.6±3.60 | 22.8±4.00 | 19.7±4.10 | 21.3±3.12 | 22.1±2.90 |
| TSS | 360±8.74 | 720±16.32 | 754±18.14 | 1346±20.53 | 324±9.59 | 351±8.23 | 697±14.68 | 651±13.7 | 934±2.53 |
| TDS | 24.7±2.28 | 32.4±3.15 | 33.8±3.72 | 45.6±17.20 | 26.3±2.70 | 24.2±2.20 | 31±2.59 | 30±2.58 | 43.2±16.4 |

The total suspended solids (TSS) in the samples were between 324±9.59 - 1346±20.53 mg/L while the values of total dissolved solids (TDS) were between 24.2±2.20 – 45.6±17.2mg/L. The highest concentration of solids was in samples that have stayed three days in the pond (samples I and D). Solids in the pond water are usually from fish meal (Omitoyin *et al.*, 2005). Variations in the fish meals may have been responsible for the difference in the solid contents of the ponds. The solids are within limits for effluent discharge into the environment (DPR, 2002; FEPA, 1991). There was a strong positive correlation between the residence time of the samples and TDS (+0.96) and TSS (+0.98) respectively indicating that the concentration of solids in fish pond water increases with the duration of water in the pond. The values of water hardness for the samples were between 18.6±3.93 – 24.3±3.80 mg/L. No particular trend was observed in the water hardness of the samples. The

hardness of the pond water may have been that of the water before introduction into the pond and this confirms that aquaculture activities may have negligible effects on hardness of pond water. The water hardness of the samples was within the recommended values for effluent discharge into the environment (DPR, 2002; FEPA, 1991). The phosphate concentration in the samples was between 0.12±0.01 - 0.23±0.01mg/L while the nitrate concentration was between 0.42±0.02 – 1.17±0.01mg/L. The concentration of both phosphate and nitrate in the samples were within the recommended limits for disposal into the environment. It may also be an indication that aquaculture activities introduce minimal phosphate and nitrate into the environment. These nutrients were higher in samples from Lagos state and may have been in the samples prior to introduction into the ponds. The weak positive correlation between residence time of the samples and

phosphate (+0.40) and nitrate (+0.04) respectively confirms that aquaculture activities does not significantly introduce these nutrients into the ponds and the nitrate sources may be from the metabolic activities of the fishes in the pond (Chen *et al.,* 2017; Dolomatov *et al.,* 2011). The sample BOD values were between 143.33±1.41 – 577.67±2.80 mg/L. Sample E has the highest concentration and this is not surprising considering that it has the highest concentration of nitrate. There is also a moderate positive correlation (+0.64) between BOD and nitrate concentration in the samples. The BOD levels in the entire samples were higher than the permissible limit by FEPA which is 30 mg/L and will require treatment before disposal into the environment (FEPA, 1991). The dissolved oxygen

values in the samples were between 27.67±1.41 – 57.27±0.02 mg/L. Dissolved oxygen is necessary for optimum survival of aquatic organisms. Sample A has the highest dissolved oxygen concentration; while this may be attributed to the fact that it has been introduced in the pond for 24 hours, it is significant to observe that sample E and F have low DO concentration despite being in the pond for 24 hours. This may be attributed to the quality of Lagos samples before introduction into the pond. Microbial activities consume DO in aquatic environment. However, these results show that if these fish pond water were disposed after three days, the DO level would not be within acceptable limit for effluent disposal (DPR. 2002).

**Table 3:** Pearson correlation of the physicochemical parameters of the fish pondwater

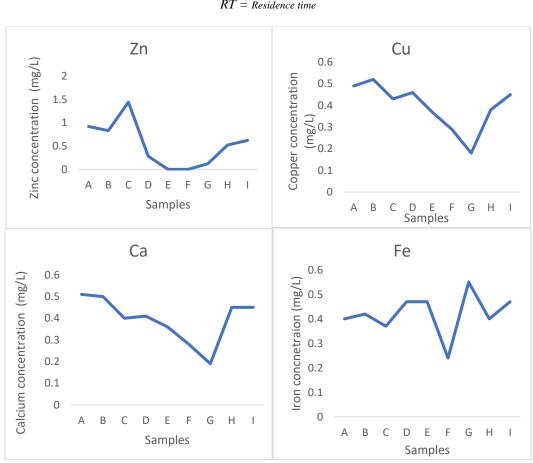|  | *pH* | *Turbidity* | *Phosphate* | *Nitrate* | *DO* | *BOD* | *Hardness* | *TSS* | *TDS* | *RT* |
|---|---|---|---|---|---|---|---|---|---|---|
| **pH** | 1 | | | | | | | | | |
| **Turbidity** | -0.04203 | 1 | | | | | | | | |
| **Phosphate** | 0.463596 | -0.40665 | 1 | | | | | | | |
| **Nitrate** | -0.13377 | -0.36321 | 0.414295 | 1 | | | | | | |
| **DO** | -0.01013 | -0.16524 | -0.21981 | 0.055928 | 1 | | | | | |
| **BOD** | 0.334798 | -0.41402 | 0.345064 | 0.638779 | -0.16958 | 1 | | | | |
| **Hardness** | 0.406928 | -0.11108 | 0.100108 | -0.22823 | 0.203815 | 0.339192 | 1 | | | |
| **TSS** | -0.13966 | 0.207175 | 0.464668 | 0.093696 | -0.38261 | -0.31345 | -0.53426 | 1 | | |
| **TDS** | -0.04984 | 0.217809 | 0.524777 | 0.149247 | -0.42464 | -0.19934 | -0.48173 | 0.989966 | 1 | |
| **RT** | -0.24701 | 0.244466 | 0.40303 | 0.038295 | -0.45376 | -0.33051 | -0.46104 | 0.979551 | 0.964588 | 1 |

*RT = Residence time*



**Fig 1:** Mineral concentration in the fish pond samples

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*Mineral Analysis:* The concentration of zinc in the samples was between 0.12±0.03-0.92±0.02 mg/L. Zinc was not detected in samples E and F; both ponds from Lagos state. Copper concentration in the samples was between 0.18±0.03 – 0.53±0.01 mg/L. copper was detected in all the samples. The concentration of iron and calcium in the samples was between 0.24±0.02 – 0.55±0.02 and 0.19±0.02 – 0.51±0.02 mg/L respectively. Manganese was found in only sample I from Anambra state at the concentration of 0.24±0.01 mg/L. The mineral concentration in the water sample before introduction into the ponds may have contributed more than aquaculture activities to the mineral concentration in the pond water. The concentration of all the minerals were within the recommended limit for effluent disposal.

*Conclusion:* The physicochemical parameters and the minerals determined in the fish pond water were all within permissible limits for release into the environment except biochemical oxygen demand (BOD) and dissolved oxygen (DO). Recommendations include frequent cleaning of fish ponds, controlled disposal of fish pond water and reuse of fish pond water especially for fertigation and in hydroponics.

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