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# Seasonal Limnological Variation of Selected Streams and Their Associated Fish Ponds in Osun State, Nigeria

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**Abstract.** Chemical and physical water quality indicators are useful in assessing and/or protection of aquatic ecosystem integrity. This study assessed the seasonal trend in the physical limnology of three water bodies (Stream Yah at Ilesha, Stream Arula at Osogbo and Stream Ewuru at Yakoyo) in Osun state of Nigeria. The water sampling was carried out in the dry (November and February) and rainy (May and August) of the annual cycle for two consecutive years. Variations in the parameters were recorded across the three locations and between the two seasons. The oxygen parameters (Dissolved Oxygen (DO), DO saturation, Biological Oxygen Demand and Organic Matter) were significantly higher ($p<0.05$) in the rainy season than in the dry season, while TDS-a salinity parameter, was significantly higher ($p<0.05$) in the dry season than in the rainy season. The water quality indices in the sampled fish ponds indicated that the water is suitable for aquaculture production.

**Keywords:** Physicochemical, Rainy Season, Dry Season, Stream, Fish Pond.

## 1. Introduction

Water quality is one of the most critical factors in fish production. It is not constant but varies with the time of the day, season, weather conditions, water source, soil type, land use, fish stock density, feeding rate and culture systems. For a successful aquaculture venture, the dynamics and management of water quality in culture media must be taken into consideration [1]. There is a strong relationship between human activities and water pollution. The recognition of this connection and need to protect human health, recreation and fish's production led to early development of water quality regulations and monitoring methods [2], [3]. The characteristics of any water body usually indicate its level of pollution. Some of the identified effects of runoff water on such water bodies include nutrient enrichment, deterioration of the water quality, destruction of spawning grounds for aquatic life, general fish kill, etc. There is an increasing need to protect the quality of Nigeria's water resources from degradation due to pollution, which interferes with the water uses at any scale. In view of the spatial and temporal variations in the hydrochemistry of rivers, regular monitoring programs are required for reliable estimates of the water quality.

## 2. Study Area and Laboratory Analysis

A purposive sampling was used to select three fish ponds constructed on natural streams which feeds them. The selected streams are Yah in Ilesha, Arula in Osogbo and Ewuru in Yakoyo; all located in Osun State, Nigeria. Water samples were collected in the month of February and November (dry season) and May and August (rainy season) for two consecutive years. The samples were collected from three streams and their associated fish ponds using 4 – litre acid washed polypropylene containers and immediately taken to the laboratory for analysis. The water pH, temperature and dissolved oxygen were determined on-site using

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standard methods. All samples were stored in the refrigerator at a temperature of less than 4 ℃ and analyzed within one week. Other parameters determined are electrical conductivity, total dissolved solids (TDS), total hardness, acidity, alkalinity, hydrogen cyanide, biological oxygen demand, organic matter and dissolved oxygen saturation. All parameters were determined using standard methods according to APHA and Ademoroti [4], [5].

## 3. Results and Discussion

Table 1: Seasonal and Habitat Variation in the Physicochemical Water Quality of Yah Stream and Associated Fish Pond at Ilesha

| **Physicochemical Parameter** | **DS Mean ± SEM** | **RS Mean ± SEM** | **F Value** | **P Value** |
|---|---|---|---|---|
| Temperature ($^0$C) | 28.36±1.15 | 27.01±1.11 | 0.37 | 0.09 |
| pH | 6.85±0.26 | 6.85±0.39 | 1.84 | 0.18 |
| Conductivity (µs/cm) | 269.52±60.17 | 202.05±44.58 | 3.11 | 0.07 |
| TDS (mg/L) | 141.77±43.62 | 105.74±31.17 | 4.09 | 0.04* |
| Alkalinity (mg$CaCO_3$/L) | 31.07±2.73 | 26.17±3.63 | 2.60 | 0.09 |
| Acidity (mg$CaCO_3$/L) | 20.63±1.44 | 16.65±0.99 | 2.36 | 0.32 |
| Hardness (mg$CaCO_3$/L) | 34.80±2.38 | 40.85±3.10 | 9.83 | 0.09 |
| DO Saturation (%) | 47.80±5.07 | 55.57±4.54 | 3.37 | 0.06 |
| DO (mg/L) | 3.75±0.23 | 4.44±0.12 | 4.60 | 0.04* |
| $BOD_5$ (mg/L) | 2.34±0.03 | 3.01±0.03 | 1.36 | 0.03* |
| Organic Matter (mg/L) | 2.61±0.15 | 2.88±0.10 | 1.12 | 0.07 |
| HCN (mg/L) | 5.04±0.31 | 4.37±0.03 | 0.02 | 0.11 |
| **Physicochemical Parameter** | **Pond Water Mean ± SEM** | **Stream Water Mean ± SEM** | **F Value** | **P Value** |
| Temperature (0C) | 27.75±1.16 | 27.62±1.10 | 3.22 | 0.11 |
| pH | 6.90±0.45 | 6.80±0.20 | 0.99 | 1.20 |
| Conductivity (µs/cm) | 244.31±60.58 | 227.26±44.18 | 2.22 | 0.94 |
| TDS (mg/L) | 126.29±41.08 | 121.22±33.70 | 1.99 | 0.22 |
| Alkalinity (mgCaCO3/L) | 26.42±2.24 | 30.82±4.12 | 4.44 | 0.09 |
| Acidity (mgCaCO3/L) | 17.11±1.03 | 20.17±1.39 | 1.34 | 1.74 |
| Hardness (mgCaCO3/L) | 52.23±4.25 | 23.43±1.23 | 6.78 | 0.04* |
| DO Saturation (%) | 45.00±4.55 | 58.37±5.07 | 5.67 | 0.98 |
| DO (mg/L) | 3.55±0.19 | 4.64±0.16 | 4.21 | 0.04* |
| BOD5 (mg/L) | 2.24±0.03 | 3.11±0.03 | 4.31 | 0.02* |
| Organic Matter (mg/L) | 2.79±0.12 | 2.70±0.12 | 0.69 | 0.11 |
| HCN (mg/L) | 3.97±0.31 | 4.77±0.17 | 0.12 | 0.19 |

*: Significant ($p<0.05$); **: Highly Significant ($p\leq0.01$); ***: Very Highly Significant ($p\leq0.001$)

In this study, the Physico-chemical parameters of water qualities of Yah, Arula and Ewuru/Rara streams and their associated fish ponds were investigated. The water pH in the three locations ranged from 6.80±0.20 to 8.55±0.50 respectively. The values are within the common pH range of 6.5 to 8.5 for surface waters as reported by Antoine and Al-saadi [6] and the range of 6.09 to 8.45 reported by Boyd and Lichtkoppler [7] considered ideal for supporting aquatic life including fish. The values also fall within the pH range 4.5 to 9 of survivability for most freshwater organisms stated by Farrell-Poe [8] and the level of 6.0 to 9.0 considered acceptable for culturing tropical fish species as reported by FAO/WHO [9] and FEPA [10]. Tables 1-Table 3 have also revealed that pH was generally higher in the rainy season than in the dry season though the seasonal difference was not statistically significant. The Electrical conductivity of the investigated water bodies was within the range of 113.02 µs/cm to 340.54 µs/cm in Ilesha, 107.54 µs/cm to 321.62 in Osogbo and 154.29 µs/cm to 251.21 µs/cm in Yakoyo. All these range of values fall within the classification of fresh water since the electrical conductivity of most freshwater ranges from 10 -1,000 µs/cm [11]. The fact that the differences in the conductivity of water sources in the three locations were not significant ($p>0.05$) suggest that there may not be significant difference in their species richness. Also, seasonal variation showed higher

(but not significant) conductivity (269.52±60.17 µs/cm, 225.30±62.30 µs/cm and 207.10±20.90 µs/cm) in the dry season than that in the rainy season in Ilesha, Osogbo and Yakoyo respectively. This is in agreement with the report of Atobatele and Olutona [12]. Carr and Neary [13] reported that conductivity declines in the wet periods as the concentration of salts becomes more dilute or may be attributed to evaporation resulting in the concentration of the constituents in the water [14]. The mean values of total acidity in the present study is 18.6±1.21 mg$CaCO_3$/L in Ilesha, 13.7±1.08 mg$CaCO_3$/L in Osogbo and 11.6±1.01 mg$CaCO_3$/L in Yakoyo respectively. These values fall within the range of 14 mg$CaCO_3$/L to 23 mg$CaCO_3$/L for Tiga Lake [15]. The total acidity values fell within the range suitable for aquaculture development. The acidity recorded in the dry season was generally higher than that in the rainy season [15]). This could be due to concentration of ionic species in the water bodies during the dry season as a result of evaporation. Significantly higher ($p \leq 0.05$) values of DO observed in the rainy season than in dry season in Ilesha (4.44±0.12 mg/L), Osogbo (4.90±0.40 mg/L) and Yakoyo (5.50±0.45 mg/L) could be attributed to lower water temperature and increased aeration due to water turbulence in the rainy season at the stations. The DO values recorded in the three locations all occurred within the range of 1.75 and 11.20 mg/L [16], which have been found to be suitable for fisheries resource development. The mean $BOD_5$ value recorded (2.68 mg/L) in Ilesha, (2.93 mg/L) in Osogbo and (3.05 mg/L) in Yakoyo showed a variation from clean to fairly clean water in the three investigated water bodies. Significantly ($p<0.05$) higher values of $BOD_5$ were recorded in the rainy season than in the dry season in the three locations under study. The concentration of cyanide detected in the water (3.97±0.31 mg/L in Ilesha, 5.01±0.11 mg/L in Osogbo and 2.71±0.21 mg/L in Yakoyo) was within the range of 1.58–7.89 mg/L [17] in natural water sources near large-scale cassava processing facilities in Nigeria. The order of HCN concentration in the water sample based on their location was Osogbo>Ilesha>Yakoyo. CN is a potent cytotoxic agent that kills the cell by inhibiting cytochrome oxidase of the mitochondrial electron transport chain [18]. In the local traditional settings around stream Arula, which had the highest concentration of HCN, it is a common thing for cassava tubers to be steeped in the flowing stream for processing into other food products. This is a possible source of cyanide in this water.

Table 3: Seasonal and Habitat Variation in the Physicochemical Water Quality of Ewuru Stream and Associated Fish Pond at Yakoyo

| **Physicochemical Parameter** | **DS Mean ± SEM** | **RS Mean ± SEM** | **F Value** | **P Value** |
|---|---|---|---|---|
| Temperature ($^0$C) | 28.85±1.80 | 27.55±2.35 | 1.22 | 0.23 |
| pH | 8.30±0.70 | 8.35±0.55 | 0.99 | 1.21 |
| Conductivity (µs/cm) | 207.10±20.90 | 198.40±27.55 | 3.12 | 0.06 |
| TDS (mg/L) | 112.15±11.08 | 103.60±11.40 | 4.12 | 0.04* |
| Alkalinity (mg$CaCO_3$/L) | 40.82±3.40 | 37.01±3.56 | 2.16 | 0.06 |
| Acidity (mg$CaCO_3$/L) | 11.98±0.92 | 11.24±1.11 | 2.13 | 0.14 |
| Hardness (mg$CaCO_3$/L) | 29.83±4.20 | 34.33±2.25 | 4.11 | 0.04* |
| DO Saturation (%) | 70.55±5.50 | 73.70±8.50 | 1.10 | 0.08 |
| DO (mg/L) | 4.50±0.40 | 5.50±0.45 | 0.22 | 0.07 |
| $BOD_5$ (mg/L) | 2.85±0.20 | 3.25±0.25 | 3.33 | 0.01* |
| Organic Matter (mg/L) | 1.53±0.15 | 1.98±0.17 | 2.23 | 0.32 |
| HCN (mg/L) | 3.11±0.21 | 2.89±0.23 | 0.16 | 0.23 |
| **Physicochemical Parameter** | **Pond Water Mean ± SEM** | **Stream Water Mean ± SEM** | **F Value** | **P Value** |
| Temperature (0C) | 28.05±1.17 | 27.90±1.50 | 3.45 | 0.14 |
| pH | 7.38±0.60 | 7.25±0.60 | 5.14 | 0.22 |
| Conductivity (µs/cm) | 194.40±44.74 | 234.75±62.30 | 5.67 | 0.09 |
| TDS (mg/L) | 101.05±27.27 | 127.65±43.80 | 7.98 | 0.04* |
| Alkalinity (mgCaCO3/L) | 32.41±2.28 | 36.61±2.66 | 4.34 | 0.22 |
| Acidity (mgCaCO3/L) | 12.16±1.01 | 15.24±1.16 | 3.89 | 0.14 |
| Hardness (mgCaCO3/L) | 36.03±2.64 | 27.84±2.31 | 5.67 | 0.08 |
| DO Saturation (%) | 55.05±5.10 | 76.85±6.00 | 4.23 | 0.04* |
| DO (mg/L) | 4.30±0.50 | 5.20±0.45 | 2.13 | 0.07 |
| BOD5 (mg/L) | 2.60±0.45 | 3.25±0.25 | 3.12 | 0.14 |
| Organic Matter (mg/L) | 2.13±0.16 | 2.13±0.14 | 1.18 | 0.92 |
| HCN (mg/L) | 5.01±0.11 | 6.07±0.13 | 0.09 | 0.14 |

*: Significant ($p<0.05$); **: Highly Significant ($p \leq 0.01$); ***: Very Highly Significant ($p \leq 0.001$)

# 4. Conclusion

Analysis of the physicochemical parameters showed significant variation in the dry and rainy season for the studied locations. Higher concentration of the salinity parameters and major ions than the oxygen

parameters were recorded in the dry season. The investigated water bodies are high in pH and organic matter. These water bodies are low in DO, electrical conductivity and may also be classified as soft waters which are suitable for fisheries and aquaculture.

Table 2: Seasonal and Habitat Variation in the Physicochemical Water Quality of Arula Stream and Associated Fish Pond at Osogbo

| **Physicochemical Parameter** | **DS Mean ± SE** | **RS Mean ± SE** | **F Value** | **P Value** |
|---|---|---|---|---|
| Temperature ($^0$C) | 28.40±1.50 | 27.55±1.17 | 1.27 | 0.09 |
| pH | 7.17±0.60 | 7.46±0.60 | 2.89 | 0.11 |
| Conductivity (µs/cm) | 225.30±62.30 | 203.85±44.74 | 1.84 | 0.18 |
| TDS (mg/L) | 118.70±44.30 | 110.00±26.77 | 0.37 | 0.08 |
| Alkalinity (mg$CaCO_3$/L) | 37.51±2.66 | 31.51±2.28 | 3.02 | 0.09 |
| Acidity (mg$CaCO_3$/L) | 15.28±1.16 | 12.12±1.01 | 4.38 | 0.21 |
| Hardness (mg/$CaCO_3$L) | 32.00±1.90 | 31.86±3.05 | 2.60 | 0.09 |
| DO Saturation (%) | 64.05±6.00 | 67.85±5.10 | 4.36 | 0.02* |
| DO (mg/L) | 4.60±0.55 | 4.90±0.40 | 3.11 | 0.04* |
| $BOD_5$ (mg/L) | 2.70±0.25 | 3.15±0.45 | 4.09 | 0.04* |
| Organic Matter (mg/L) | 2.07±0.13 | 2.19±0.18 | 8.49 | 0.09 |
| HCN (mg/L) | 5.98±0.23 | 5.67±0.08 | 0.13 | 0.08 |
| **Physicochemical Parameter** | **Pond Water Mean ± SEM** | **Stream Water Mean ± SEM** | **F Value** | **P Value** |
| Temperature (0C) | 28.15±2.15 | 28.25±2.00 | 5.43 | 0.49 |
| pH | 8.10±0.75 | 8.55±0.50 | 3.41 | 0.12 |
| Conductivity (µs/cm) | 189.95±25.50 | 215.55±22.95 | 9.02 | 0.04* |
| TDS (mg/L) | 99.05±11.56 | 116.70±10.92 | 7.02 | 1.13 |
| Alkalinity (mgCaCO3/L) | 36.45±3.76 | 41.38±3.21 | 4.22 | 0.43 |
| Acidity (mgCaCO3/L) | 10.04±1.03 | 13.19±1.00 | 5.13 | 0.98 |
| Hardness (mgCaCO3/L) | 41.63±2.90 | 22.53±3.55 | 5.60 | 0.01** |
| DO Saturation (%) | 54.10±6.95 | 90.15±7.05 | 7.89 | 0.01* |
| DO (mg/L) | 4.15±0.45 | 5.85±0.40 | 1.14 | 0.002 |
| BOD5 (mg/L) | 2.75±0.25 | 3.35±0.20 | 2.34 | 0.12 |
| Organic Matter (mg/L) | 1.76±0.15 | 1.76±0.17 | 1.19 | 0.003 |
| HCN (mg/L) | 2.71±0.21 | 3.29±0.23 | 0.15 | 0.13 |

*: Significant ($p<0.05$); **: Highly Significant ($p\leq0.01$); ***: Very Highly Significant ($p\leq0.001$)

# 5. References


[1] Onome, A. D. and Ebinimi, A. (2010). Comparative Assessment of Water Quality Parameters of Freshwater Tidal Earthen Ponds and Stagnant Concrete Tanks for Fish Production in Port Harcourt, Nigeria. *Int. J. Sci. Nature,* 1(1): 34-37.

[2] Chari, K. B. and Abbasi, S. A. (2005). A Study on the Fish Fauna of Oussudu- a rare freshwater lake of South India. *Int. J. of Env. Stud*. 62(2), 137-145

[3] Yusuf, K. A and Osibanjo, O. ( 2006) *Pakistan Jour. of Sci. and Industr. Resear*., 49, 88-89.

[4] APHA-AWWA-WPCF (2005). Standard Methods for the examination of water and waste water. Anold, E.G., Joseph, J. C. and David, J. Eds, 15th Edition, Donelley and Sons Company, U.S.A., pp. 547.

[5] Ademoroti, C. M. A. (1996). Standard method for water and effluent analysis Ibadan, Nigeria, Fludex Press Limited.

[6] Antoine**, S**. E. and AL-Saadi, H. A. (1982) Limnological Studies on the Polluted Ashar Canal at Baraf IIraq). *Reveges hydrobiologia* 67, 465-418.

[7] Boyd, C.E. and Lichktoppler, L. (1979). Water quality management in fishponds. Research and Development series No. 22. International Centre for Aquaculture Agriculture (ICAA) Experimental station, Auburn University, Alabam 45-47.

[8] Farrell-**Poe,** K. (2000). Water Quality and Monitoring. Alan Levere, Connecticut Department of Environmental Protection (revised 2005) Master Watershed Steward. http://cals.arizona.edu/watershedsteward/resources/docs/guide/ (10)Water%20Quality.pdf (Last visited 10/11/2013).

[9] FAO/World Health Organization, WHO (1972): Evaluation of certain food additives and contaminants- mercury, lead and cadmium. Joint FAO/WHO Expert Committee on Food Additives. WHO Technical Report Series No. 505, pp. 63.

[10] FEPA. (1992). Guidelines and Standards for Environmental Pollution Control in Nigeria, pp. 231.

[11] Akin-**Oriola,** G. A. (2003). Zooplankton Associations and Environmental factors in Ogunpa and Ona rivers, Nigeria. *Revista de Biologia Tropical,* 51(2), 391- 398.

[12] Atobatele, E. O. and Olutona, G. O. (2013). Spatio-seasonal physico-chemistry of Aiba stream, Iwo, Nigeria. *Afri. J. Biotech.* 12(14), 1630-1635.

[13] Carr**,** G. M. and Neary, J. P. (2008).Water Quality for Ecosystem and Human Health, 2nd Edition. United Nations Environment Programme Global Environment Monitoring System (GEMS)/Water Programme, pp. 1-130.

[14] Chikere, B. O. and Okpokwasili, G. C. (2002). Seasonal Dynamics of the Pollution in Niger Delta River Receiving Petrochemical Effluents. *Trop. Freshw. Biol*. 11,11-22

[15] Akindele**,** E. O., Adeniyi, I. F. and. Indabawa, I.I. (2013). Spatio-Temporal Assessment and Water Quality Characteristics of Lake Tiga, Kano, Nigeria. *Res. J. Environ. Earth Sci.* 5(2), 67-77.

[16] Atobatele**,** O.E. and Ugwumba, O. A (2008). Seasonal variation in the physico- chemistry of a small tropical reservoir (Aiba Reservoir, Iwo, Osun, Nigeria). *Afr. J.* Biotech. 7(12), 1962-1971.

[17] Okafor P. N. (2001) Cyanide contamination of natural water sources during large scale cassava processing. *Afr. J. Biomed. Res.* 4, 25–27.

[18] Baskin**,** S. I. and Brewer, M. D. (2000). Cyanide Poisioning. Pharmacology Division, U.S. Army Medical Research Institute of Chemical Defense. Rosenthal, G. A. and Janzen D. Eds. Academic Press, New York, pp. 175-242.