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Water Quality Parameters; Wet-Season; Ammonia; Nitrite; Nitrate; Alkalinity; Co2; Salinity; Dissolved Oxygen; Temperature; Physicochemical Parameters

Research Article

Wet-Season Variation in Some Water Quality Parameters of Buguma Brackish Fish Farm, Rivers State, Nigeria

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Abstract

Water Quality parameters such as pH; ammonia; nitrite; nitrate; alkalinity; CO_2; salinity; Dissolved Oxygen (D.O) and temperature were monitored bimonthly from April to October in 2021; which is the wet season of the region. The results showed that pH was 6.5-7; ammonia 0.0-1.5ppm; nitrite 0.05; nitrate 0.05-0.25ppm; alkalinity 36-85ppm; CO_2 5-15ppm; salinity 7-20ppt; D.O 3.3-5.6ppm and temperature 26-30°C.

Introduction

It is well-known that fish can only survive within certain limits of the water quality of the surrounding water. There is usually an optimum level and also a range within which they will survive [1]. The life; health; growth; reproduction etc. of fish to a very large extend; depend on the quality of the surrounding water in which it stays. Water quality parameters affect the biotic components of any aquatic environment [2]. As a result; it becomes important to know the productivity; population of the fish and the life cycle of the fish through the water quality parameters of the surrounding water [3]. The brackish water fish farm in Buguma is constructed in such a way to allow constant water exchange between the ponds and creek. To ensure maximum productivity of the pond the optimal; sub-lethal and lethal levels of physicochemical parameters are constantly monitored.

Materials and Methods

Samples were collected bimonthly and water quality parameters such as pH; ammonia; nitrite; nitrate; alkalinity; CO_2; salinity; Dissolved Oxygen (DO) and temperature were monitored bimonthly from April to October in 2021; which is the wet-season of the region. Water surface temperature was monitored with a thermometer. Salinity was measured with Atago hand-held refractometer S/mill-E cat No.2442 while other parameters were measured with La Motte Salt Water Aquaculture Test Kit Code:3635-03. The results were subjected to statistical analysis.

Results

The average pH values for the months April; May; June; July; August; September; October was 6.9; 6.9; 6.9; 6.8; 6.9; 6.9 and 6.8 respectively. The measured range for pH was 6.5-7.0 (Table 1 and Figure 1).

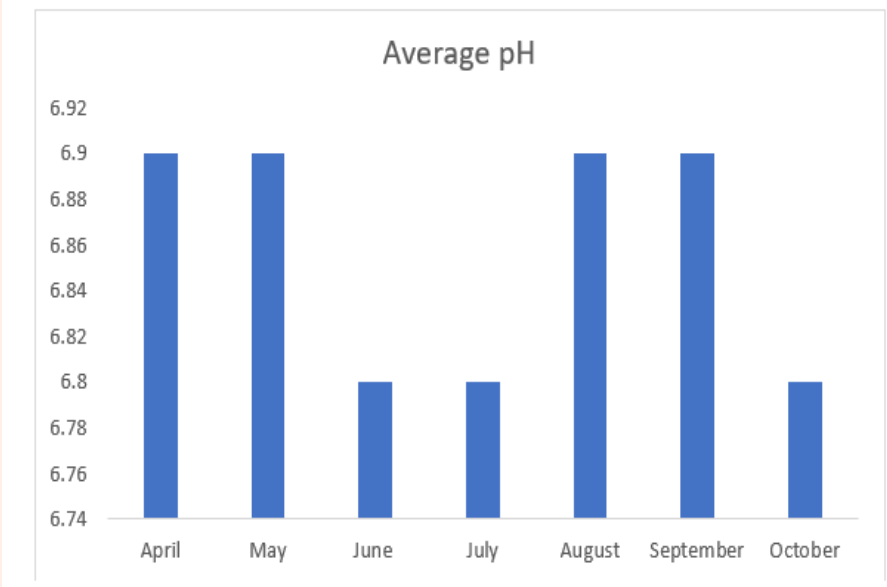

Figure 1: Variation in pH for the season.

Table 1: Mean pH values for the season.

Months	Mean	Min	Max
April	6.9± 0.06	6.5	7
May	6.9± 0.06	6.5	7
June	6.9± 0.08	6.5	7
July	6.8± 0.09	6.5	7
August	6.9± 0.05	6.5	7
September	6.9± 0.06	6.5	7
October	6.8± 0.09	6.5	7

The average ammonia values for the months of April; May; June; July; August; September; October was 0.11ppm; 0.05ppm; 0.04ppm; 0.02ppm; 0.21ppm; 0.08ppm and 0.07ppm respectively. The measured range for ammonia was 0.0-1.5ppm (Table 2 and Figure 2).

Table 2: Mean ammonia values for the season.

Months	Mean	Min	Max
April	0.11± 0.16	0.05	0.5
May	0.05± 0.03	0	0.1
June	0.04± 0.03	0	0.1
July	0.02± 0.03	0	0.05
August	0.21± 0.48	0.05	1.5
September	0.08± 0.07	0.05	0.25
October	0.07± 0.07	0	0.25

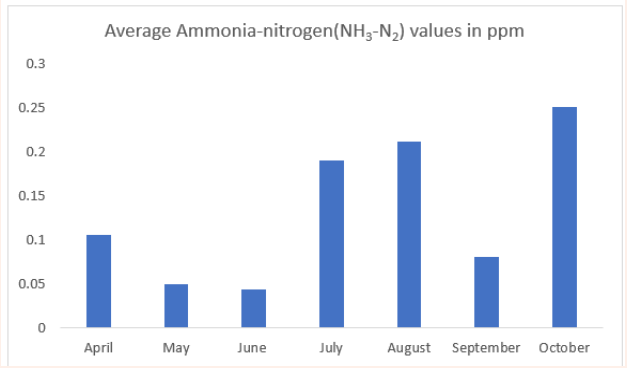

Figure 2: Variation in ammonia for the season.

The average nitrite-nitrogen (NO_2-N_2) values for the months of April; May; June; July; August; September; October remained constant at 0.05ppm (Table 3 and Figure 3).

Table 3: Mean nitrite-nitrogen values for the season.

Months	Mean	Min.	Max.
April	0.05± 2.62 x10^{-18}	0.05	0.05
May	0.05± 2.62x10^{-18}	0.05	0.05
June	0.05± 2.62x10^{-18}	0.05	0.05
July	0.05± 2.62x10^{-18}	0.05	0.05
August	0.05± 2.45x10^{-18}	0.05	0.05
September	0.05± 2.62x10^{-18}	0.05	0.05
October	0.05± 2.45x10^{-18}	0.05	0.05

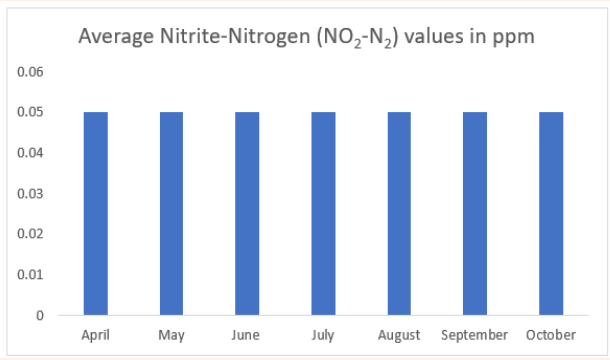

Figure 3: Variation in nitrite-nitrogen for the season.

The average nitrate-nitrogen (NO_3-N_2) values for the months of April; May; June; July; August; September; October was 0.244ppm; 0.219ppm; 0.243ppm; 0.238ppm; 0.228ppm; 0.244ppm and 0.228ppm respectively. The measured range for nitrate-nitrogen was 0.05-0.25ppm (Table 4 and Figure 4).

Table 4: Mean nitrate-nitrogen values for the season.

Months	Mean	Min	Max
April	0.244± 0.006	0.2	0.25
May	0.219± 0.025	0.05	0.25
June	0.243± 0.006	0.2	0.25
July	0.238± 0.008	0.2	0.25
August	0.228± 0.022	0.05	0.25
September	0.244± 0.006	0.2	0.25
October	0.228± 0.022	0.05	0.25

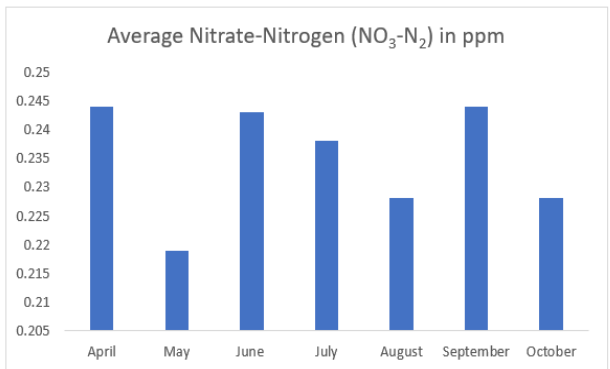

Figure 4: Variation in nitrate-nitrogen for the season.

The average alkalinity ($CaCO_3$) values for the months of April; May; June; July; August; September; October was 76ppm; 71.63ppm; 63.75ppm; 50ppm; 45.22ppm; 42.75ppm and 45.67ppm respectively. The measured range for alkalinity was 36-85ppm (Table 5 and Figure 5).

Table 5: Mean alkalinity values for the season.

Months	Mean	Min	Max
April	76± 1.51	72	80
May	71.63± 2.75	64	85
June	63.75± 4.31	48	80
July	50± 1.81	46	60

August	45.22± 0.997	40	48
September	42.75± 2.83	36	60
October	45.67± 0.782	41	48

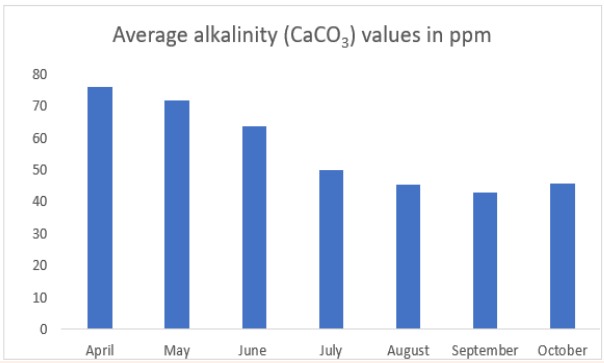

Figure 5: Variation in alkalinity for the season.

The average carbon(iv)oxide (CO_2) values for the months of April; May; June; July; August; September; October was 8.75ppm; 8.88ppm; 8.75ppm; 6.0ppm; 10.22ppm; 9.38ppm and 9.44ppm respectively. The measured range for carbon(iv)oxide (CO_2) was 5-15ppm (Table 6 and Figure 6).

Table 6: Mean CO_2 values for the season.

Months	Mean	Min	Max
April	8.75± 0.25	8	10
May	8.88± 0.295	8	10
June	8.75± 0.619	5	10
July	6± 0.378	5	7
August	10.22± 0.812	7	15
September	9.38± 0.653	7	13
October	9.44± 0.530	8	13

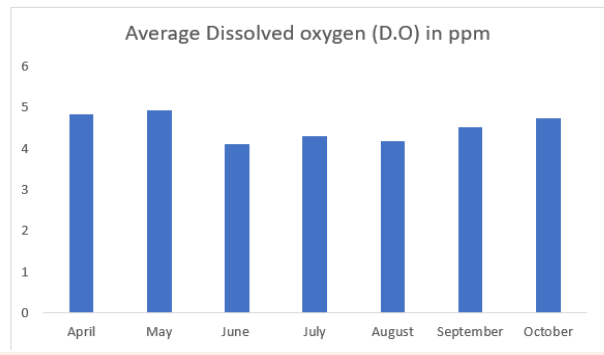

Figure 6: Variation in CO2 for the season.

The average salinity values for the months of April; May; June; July; August; September; October was 18.75ppt; 18.50ppt; 16.38ppt; 11.63ppt; 9.56ppt; 9.38pptand 9.0ppt respectively. The measured range for salinity was 7-20ppt (Table 7 and Figure 7).

Table 7: Mean salinity values for the season.+

Months	Mean	Min	Max
April	18.75± 0.313	18	20
May	18.50± 0.378	17	20
June	16.38± 0.778	14	20
July	11.63± 0.905	9	15
August	9.56± 0.176	9	10
September	9.38± 0.263	8	10
October	9.0± 0.289	7	10

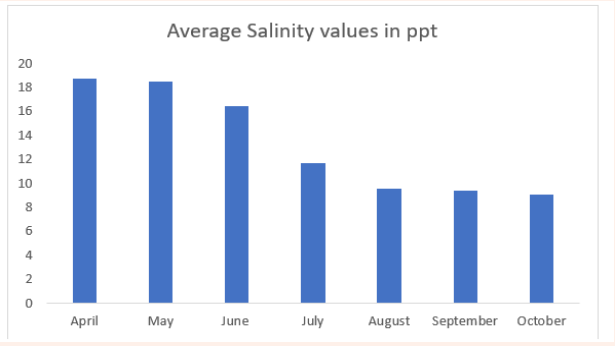

Figure 7: Variation in salinity for the season.

The average Dissolved Oxygen (DO) values for the months of April; May; June; July; August; September; October was 4.83ppm; 4.93ppm; 4.10ppm; 4.29ppm; 4.17ppm; 4.52ppm and 4.73ppm respectively. The measured range for dissolved oxygen was 3.3-5.6ppm (Table 8 and Figure 8).

Table 8: Mean Dissolved Oxygen (DO) values for the season.

Months	Mean	Min	Max
April	4.83± 0.215	3.8	6
May	4.93± 0.160	4.6	6
June	4.10± 0.191	3.3	4.8
July	4.29± 0.103	3.8	4.6
August	4.17± 0.037	4	4.4
September	4.52± 0.175	3.9	5.6
October	4.73± 0.197	4.2	6

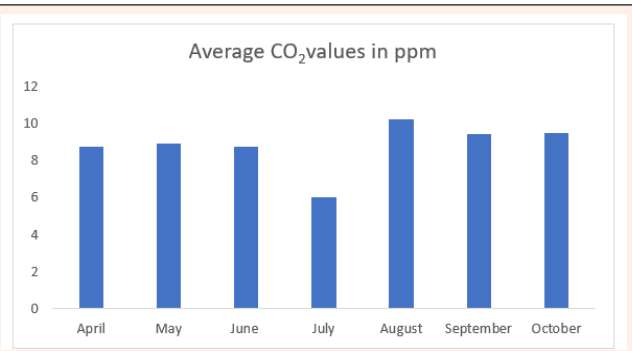

Figure 8: Variation in Dissolve Oxygen (DO) for the season.

The average temperature (°C) values for the months of April; May; June; July; August; September; October was 30°C; 29°C; 28°C; 27°C; 27°C; 28°C and 28°C respectively. The measured range for temperature was 26°C-30°C. See (Table 9 and Figure 9).

Table 9: Mean Temperature (°C) values for the season.

Months	Mean	Min	Max
April	30± 0.189	29	30
May	29± 0.250	28	30
June	28± 0.267	27	29
July	27± 0.327	26	29
August	27± 0.242	27	29
September	28± 0.429	27	30
October	28± 0.412	26	30

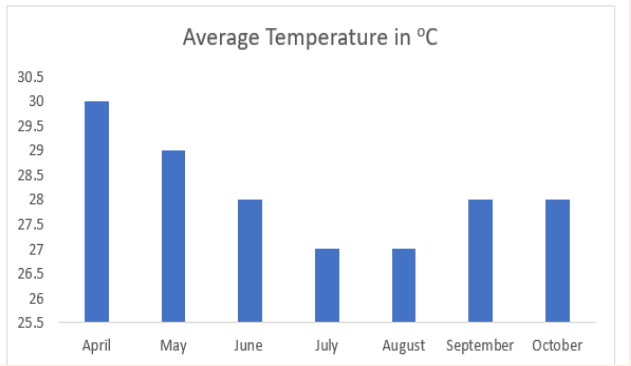

Figure 9: Variation in temperature (oC) for the season.

Discussion

pH

(Tables 1-9 and Figures 1-9) show the observation of the various physicochemical parameters during the season under study. The study of water quality parameters of a water body sheds light on the dynamics of the water body. Although each of the individual physicochemical property has its role; the overall effect of any water body is a contribution of all [5;6]. It is well-known that air temperature; humidity; wind and solar energy all influence the temperature of a water body [6] while temperature in turn; affects both zooplankton and phytoplankton which determine the productivity of a pond. pH (hydrogen ion potential) is a major factor that determines the well-being of organisms. This is because biologic activities can only occur within certain pH range. Outside this pH range it becomes impossible for organisms to survive. pH is used to measure the hydrogen ion concentration and is mathematically expressed as the logarithm of the reciprocal of the hydrogen ion activity at a particular temperature (Table 1 and Figure 1) shows the pH fluctuations during the season under study. For this season the pH range observed was 6.5-7.0. According to [4]; pH fluctuations exert heavy stress on aquatic organisms especially; if those fluctuations occur at a very fast rate. From the results; large pH fluctuations did not occur. The findings of [7-9] are consistent with the range of pH observed. Thus; the pH fluctuation observed are within the limits that allow aquatic organisms such as fish; algae and plants to survive.

Ammonia

(Figure 2 and Table 2) shows the average ammonia values measured for the season. The range of ammonia value measured for the season is 0.0-1.5ppm. The major product in the breakdown of protein which is a major component of fish feed is ammonia. Ammonia is one of the physicochemical parameters that must be closely monitored. It is best if ammonia remains at 0.0ppm. Large fluctuations of ammonia can spell doom for the entire fish population. The feeding rate also affects ammonia concentration in ponds and should be closely monitored too. Another culprit for large ammonia values may be fecal solids. Fecal solids settle at the pond bottom and decompose into ammonia. Ponds with constant water flow may not show high ammonia values.

Nitrite-nitrogen (NO_2-N_2)

From (Table 3 and Figure 3) the average nitrite-nitrogen (NO_2-N_2) values for the season remained constant at 0.05ppm. The acceptable range for nitrite is 0-0.25ppm. Nitrite occurs when ammonia is broken down. It is very important that nitrite is kept at 0.0ppm. This is because large nitrite values can suppress the fish ability to carry oxygen in its bloodstream. At a certain high nitrite value; the fish may suffocate. This problem is even made worse if the pH of the pond is above 8 and the ammonia value also high. The measured value of nitrite for the season is within the tolerable limit of the aquatic species.

Nitrate-nitrogen (NO_3-N_2)

Although nitrate is known as an essential nutrient it also indicates contamination resulting from human and natural activities (Table 4 and Figure 4) shows the average nitrate-nitrogen (NO_3-N_2) values measured for the season. The measured range of nitrate-nitrogen for the season was 0.05-0.25ppm. The acceptable range of nitrate is 0-2ppm. Therefore; the measured range will not cause harm to the aquatic species. Nitrate is formed when nitrite is broken down by bacteria.

Alkalinity ($CaCO_3$)

Alkalinity is the measurement of the ponds ability to neutralize acid or the buffering ability of the pond. Alkalinity in pond is generally a contribution of bicarbonates; carbonates and hydroxide ions. The measured range for alkalinity was 36-85ppm (Table 5 and Figure 5). This range agrees with the finding of Ehiagbonare and Ogunrinde (2020) [9]. The low range of pH earlier observed was as a result of the buffering ability of the pond. According to [10] the ideal value of alkalinity for fish culture is 50-300ppm.

Carbon(iv)oxide (CO_2)

Carbon(iv)oxide (CO_2) in water is as a result of metabolism. It is toxic to aquatic species. Thus; the amount in water should be minimal. The measured range for carbon(iv) oxide (CO_2) was 5-15ppm (Table 6 and Figure 6) [11] measured as high as 18ppm in the month of October.

Salinity

Salinity measures the amount of dissolved salt in the pond. The measured range for salinity was 7-20ppt (Table 7 and Figure 7). This is one parameter that showed high fluctuation. It is no surprise as it is a brackish water pond. Aquatic species that survive here must be able to undergo osmoregulation of body minerals from that of the surrounding water. Salinity generally decreased as the month progressed. This is probably due to increase in rainfall because increase in rainfall also increased the dilution of the salts in the pond. Thus; lowering salinity [12] noted that high salinity was as a result of high fungi and bacterial density of phytoplankton.

Dissolved oxygen (DO)

This is the amount of dissolved oxygen in the pond. Generally; fish need a little amount of dissolved oxygen to survive. However; that little amount of dissolved oxygen must stay within a specific range to avoid mortality. The measured range for dissolved oxygen was 3.3-5.6ppm (Table 8 and Figure 8) [13] stated that the amount of dissolved oxygen in water depends on water turbulence; surface diffusion; rate of photosynthesis; biological oxygen demand (BOD; water temperature and carbon(iv)oxide concentration [14] reported similar value of dissolved oxygen.

Temperature

Temperature measures how hot or cold the pond water is. Temperature fluctuations affect metabolic activities. Temperature fluctuations can slow down; speed up or even stop metabolic activities completely. Thus; fish productivity of a pond can be affected by temperature. The measured range for temperature was 26°C-30°C (Table 9 and Figure 9) [15]. According to Ntegwu and Edema (2008) temperature range of 20-30°C are optimum for fish culture.

Conclusion

This study was undertaken to monitor the physicochemical parameters such as pH; ammonia; nitrite; nitrate; alkalinity; CO_2; salinity; Dissolved Oxygen (DO) and temperature during the wet-season. The results showed that fluctuations occurred; but these fluctuations are still within the survival limits of aquatic species. While some parameters such as salinity widely fluctuated others remained almost constant for the season. Thus; aquatic species in this brackish water region must have some level of adaptability to survive the brackish water region during the wet season.

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