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Studies on Some Physico-Chemical Parameters of River Argungu, North-Western Nigeria

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Abstract: *Some physicochemical parameters including Temperature, pH, DO, BOD, TDS, HCO^3, Cl^-, NO_3, PO^-_4, Ca^{2+}, Mg^{2+}, K and Na of River Argungu were assessed for 12 months (March 2014 – February 2015). The parameters fluctuated throughout the study period with maximum values recorded mostly during and after rainy season. Temperature was negatively correlated to TDS, NO_3, K, Cd and Zn, and increase in pH was observed to moderately reduce levels of PO_3 and Mg^{2+}. However, NO_3 and Ca^{2+} and Mg^{2+} were positively correlated to TDS and BOD, HCO^-_3 and PO_3 respectively. Highest concentrations of CL^-, NO_3, PO_3^-, Ca^{2+}, Mg^{2+}, K, and Na recorded after the rainy season was possibly due to the excessive run-off into the river, although the values were still within the recommended permissible levels.*

Keywords: *Maximum, Rainy season, Concentration, Rriver.*

I. Introduction

Water arising from market stalls, slaughter houses, streets washing and flushing of sewage which flow through drains into rivers is known to alter the chemical composition of water bodies thereby resulting in pollution [1]. Optimum fish production can be achieved only when the water quality is effectively managed. The availability of food organisms (plankton) and the influence of naturally occurring substances such as dissolved oxygen, carbon dioxide, ammonium nitrite and hydrogen ions (H^+) are important factors affecting the growth and survival of fish. Temperature, turbidity, light intensity, pH, dissolved ions such as NO_3 and PO_4^- are reported to affect the activities and composition of organisms [2]. Organic waste dump caused environmental stress in coastal waters which resulted in the low landing of some important fish species [3]. Size, structure and biomass of phytoplankton population and production are closely related to physico-chemical conditions of the water body [4]. Fish have an average blood pH of 7.4, so water with a pH close to this is optimum. An acceptable range would be 6.5 to 8.5. Fish can become stressed in water with a pH ranging from 4.0 to 6.5 and 9.0 to 11.0. Fish growth is limited in water pH less than 6.5, and reproduction ceases and fry can die at pH less than 5.0. Death is almost certain at a pH of less than 4.0 or greater than 11.0. Water quality is determined by various physico-chemical and biological factors, as they may directly or indirectly affect its quality and consequently its suitability for the distribution and production of fish and other aquatic animals [5]. Many workers have reported the status of water bodies (lentic and lotic) after receiving various kinds of pollutants altering water quality characteristics (physical, chemical and biological). All living organisms have tolerable limits of water quality parameters in which they perform optimally. The decline in fish yield has been attributed to a wide range of causes ranging from inadequate management of the fisheries resources to environmental degradation of the water bodies [6]. The quality of water in a river had been reported to affect abundance of fish species [7]. In Nigeria, several studies had been carried out on the effects of pollution on physico-chemical parameters and the general ecology of water bodies. Obaroh *et al.* [8] reported a pH range of 6.65±1.14 - 7.17±0.84 from River Jega. Mustapha [7] observed pH range of 6.8 – 8.2, dissolved oxygen 4.80±0.25 – 8.20±0.30 mg/l and carbon dioxide between 1.60±0.2 – 3.0±0.6 mg/l.

Therefore, maintaining proper water quality is very essential for improved survival and growth which also forms the ultimate basis for conducting this research.

II. Materials And Methods

Study area

Argungu is located on latitude 12.75° N longitude 4.54° E. The river source is near Funtua in the south of Katsina State, some 275 km in straight line from Sokoto, it flow north-west through Gusau in Zamfara State. Further downstream the river enters Sokoto State where it passes by Sokoto town and is joined by River Rima, then turning south and flowing through Argungu to Birnin Kebbi, Kebbi State, Nigeria. About 120 kilometers south of Birnin Kebbi, it reaches its confluence with the River Niger [9].

Water sampling

Water samples were collected for 12 months from the 3 sampling stations and taken to the Agriculture Physical laboratory of Usmanu Danfodio University Sokoto, Sokoto State, for some of the physico-chemical parameters and heavy metal concentration analysis. Temperature, dissolved oxygen and pH were measured *in-situ*.

Water analysis

Samples of water taken to the laboratory were analyzed using standard methods for the analysis of water as given by APHA [10] and Hatch [11].

Statistical analysis

Data collected was subjected to analysis of variance (ANOVA) and Duncan Multiple Range Test was used to separate the means where there was significant difference.

III. Results

As shown in Table 1, the highest water temperature of 28.17±0.31 ºC was observed during the month of June, 2014 (onset of rainy season), while the lowest (22.27±1.41 ºC) was recorded in January, 2015. Maximum mean pH value of 7.17±0.01 was observed in April, 2015, while the minimum value of 6.30±0.05 was recorded in November, 2014. The highest mean dissolved oxygen (DO) value of 7.33±0.15 mg/l was recorded in December, 2015; with the lowest value of 5.87±0.06 mg/l recorded in February, 2015. Biological oxygen demand (BOD) was observed to have a maximum value of 30.77±0.40 mg/l in November, 2014, and a minimum value 15.10±0.26 mg/l in March, 2014; (Table 1).

Similar highest total dissolved solid (TDS) values of 6.33±0.58 mg/l was observed in March and September, 2014 (Table 1) and the lowest mean value of 3.67±0.58 mg/l in July, 2014. The highest value of hydrogen carbonate ion (HNO_3) was observed during the month of October, 2014 with a mean value of 2.50±0.10 mg/l, while the lowest value was observed in March, 2014 and January, 2015 both with a similar mean value of 0.53±0.06 mg/l. The highest value of chloride ion (CL^-) was recorded during the month of December, 2014 with a mean value of 2.97±3.49 mg/l, while the lowest was recorded during the month of June, 2014 with a mean value of 0.43±0.06 mg/l (Table 1).

The highest value for the nitrate oxide ion (NO_3) was observed during the month of January, 2015 with a mean value of 3.07±0.12 mg/l, while the lowest was observed during the month of May, 2014 with a mean value of 0.53±0.06 mg/l. The highest value of potassium oxide ion (PO^-_4) was observed during the month of November, 2014 with a mean value of 0.50±0.01 mg/l, while the lowest was observed during the month of 0.15±0.01 mg/l. The highest value of calcium (Ca^{2+}) was recorded during the month of November, 2014 with a mean value of 2.07±0.06 mg/l, while the lowest value was observed during the month of May, 2014 with a mean value of 0.33±0.03 mg/l, as there was no calcium detected in the months of June and July, 2014. The highest value of magnesium (Mg^{2+}) was observed during the month of October, 2014 with a mean value of 7.73±0.12 mg/l, while the lowest was observed during the month of January, 2015 with a mean value of 0.15±0.01 mg/l. The highest value of potassium (K) was recorded during the month of February, 2015 with a mean value of 3.40±0.10 mg/l, while the lowest was observed during the month of June, 2014 with a mean value of 1.06±0.12 mg/l. Maximum value for sodium (Na) was recorded during the months of April and May, 2014 with mean values of 2.00±0.10 and 2.00±0.20 mg/l respectively, while the lowest was observed during the month of January, 2015 with a mean value of 0.78±0.08 mg/l.

Table 1: Mean Physico-chemical Parameters of River Argungu

Parameters	March, 2014	April, 2014	May, 2014	June, 2014	July, 2014	August, 2014	Sept. 2014	Oct. 2014	Nov. 2014	Dec. 2014	Jan. 2015	Feb 2015
Temp. (°C)	25.033±0.31^{b}	27.77±0.65^{a}	26.27±0.21^{cd}	28.17±0.31^{a}	25.67±0.15^{bc}	26.40±0.26^{cd}	26.50±0.30^{cd}	27.20±0.52^{da}	26.40±0.78^{cd}	23.07±1.29^{a}	22.27±1.41^{a}	23.40±0.30^{a}
pH	6.71±0.02^{b}	7.17±0.01^{c}	6.83±0.06^{b}	6.90±0.00^{b}	6.47±0.15^{a}	6.45±0.30^{a}	6.71±0.02^{b}	6.34±0.12^{a}	6.30±0.05^{a}	6.90±0.00^{b}	6.43±0.06^{a}	6.77±0.06^{b}
DO (mg/l)	6.87±0.06^{de}	6.57±0.15^{cd}	6.77±0.11^{de}	7.17±0.15^{f}	6.80±0.10^{de}	6.37±0.32^{bc}	6.80±0.10^{de}	5.90±0.20^{a}	6.23±0.12^{b}	7.33±0.15^{f}	7.13±0.12^{f}	5.87±0.06^{a}
BOD (mg/l)	15.10±0.26^{a}	20.50±0.17^{b}	20.00±0.61^{b}	19.47±0.15^{b}	20.27±0.15^{b}	22.87±1.03^{c}	25.23±1.37^{d}	27.30±1.56^{e}	30.77±0.40^{f}	24.70±0.61^{d}	21.83±0.40^{f}	22.80±0.10^{e}
TDS (mg/l)	6.33±0.58^{d}	5.00±1.00^{abcd}	5.77±0.68^{cd}	4.67±0.58^{abc}	3.67±0.58^{a}	3.93±0.12^{a}	6.33±0.58^{d}	4.00±1.00^{ab}	4.00±1.00^{ab}	5.00±0.00^{abcd}	4.00±1.00^{a}	5.33±0.58^{bcd}
HCO_3 (mg/l)	0.53±0.06^{a}	0.63±0.06^{ab}	0.83±0.06^{bcd}	0.90±0.10^{cde}	0.67±0.15^{abc}	0.72±0.10^{abc}	1.05±0.30^{de}	2.50±0.10^{f}	2.30±0.20^{f}	1.13±0.12^{e}	0.53±0.06^{a}	0.87±0.06^{bcd}
CL^{-} (mg/l)	0.77±0.06^{a}	0.67±0.06^{a}	0.65±0.05^{a}	0.43±0.06^{a}	0.53±0.06^{a}	0.50±0.10^{a}	0.73±0.06^{a}	1.63±0.06^{ab}	1.33±0.12^{ab}	2.97±3.49^{b}	0.77±0.06^{a}	0.57±0.06^{a}
NO_3 (mg/l)	0.93±0.12^{bc}	1.13±0.12^{cd}	0.53±0.06^{a}	0.73±0.12^{ab}	0.80±0.20^{b}	0.90±0.10^{b}	0.93±0.12^{bc}	1.47±0.06^{e}	1.33±0.15^{da}	2.07±0.12^{f}	3.07±0.12^{g}	0.93±0.12^{bc}
$PO^{-}4$ (mg/l)	0.19±0.00^{b}	0.15±0.00^{a}	0.40±0.00^{e}	0.20±0.01^{b}	0.21±0.01^{b}	0.32±0.05^{d}	0.19±0.01^{b}	0.43±0.01^{f}	0.50±0.010^{g}	0.24±0.01^{c}	0.24±0.01^{c}	0.20±0.11^{b}
Ca^{2+} (mg/l)	0.43±0.03^{cd}	0.52±0.03^{de}	0.33±0.03^{b}	0.00±0.00^{a}	0.00±0.00^{a}	0.40±0.10^{bc}	0.43±0.03^{cd}	1.90±0.10 ^{g}	2.07±0.06^{h}	0.57±0.03^{e}	0.48±0.03^{cde}	0.82±0.03^{f}
Mg^{2+} (mg/l)	0.63±0.03^{b}	0.63±0.06^{b}	1.57±0.06^{c}	0.50±0.05^{ab}	0.83±0.03^{b}	1.87±0.15^{c}	2.46±0.45^{d}	7.73±0.12^{f}	6.90±0.20^{e}	0.45±0.48^{ab}	0.15±0.01^{a}	0.83±0.03^{b}
K (mg/l)	1.73±0.06^{c}	1.13±0.06^{a}	1.23±0.12^{ab}	1.06±0.12^{a}	1.27±0.15^{ab}	1.47±0.35^{b}	1.77±0.06^{c}	2.07±0.52^{d}	2.33±0.15^{e}	1.97±0.12^{cd}	2.63±0.12^{f}	3.40±0.10^{g}
Na (mg/l)	0.90±0.10^{ab}	2.00±0.10^{e}	2.00±0.20^{e}	2.07±0.15^{e}	2.20±0.21^{e}	1.33±0.35^{cd}	0.90±0.10^{ab}	0.97±0.06^{ab}	1.17±0.15^{bcd}	1.13±0.12^{bc}	0.78±0.08^{a}	1.43±0.06$^{d\,a}$

IV. Discussion

The result of the study indicated maximum temperature and dissolved oxygen during dry and rainy seasons respectively. Highest biological oxygen demand was recorded after the rainy season while maximum value for hydrogen carbonates was obtained both during and after the rainy season. Meanwhile the following ions CL^{-}, NO_3, PO^{-}_3, Ca^{2+}, Mg^{2+}, K, and Na recorded highest concentrations after the rainy season perhaps due to excessive run-off into the river, although the values still fall within the permissible levels as reported by [12, 13, 14, 15, 16, 17, 18 and 19]. Temperature was negatively correlated to TDS, NO_3, K, Cd and Zn, Increase in pH was also observed to moderately decrease the levels of PO^{-}_3 and Mg^{2+}. However, NO_3 was observed to be positively correlated to TDS. Ca^{2+} and Mg^{2+} were also observed to be positively correlated to BOD, HCO_3 and PO^{-}_3.

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