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Assessment of physicochemical parameters of river Yobe, Gashua, Yobe State, Nigeria

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Abstract
The present study assessed the influential physicochemical parameters of Yobe River (Gashua), Yobe state. Studies were conducted for a period of six months, from June to November, 2015 using standard water analysis methods, to evaluate the potential and productivity of the river to enhance fish production for rural dwellers. The monthly variation of physicochemical parameters [temperature, conductivity, transparency, dissolved oxygen (DO), pH, ammonia, phosphorus (PO_2), alkalinity, free carbon dioxide (CO_2) and biochemical oxygen demand (BOD)] ranged from, 21-30 ^{0}C, 0.38-0.74µS, 0.30-0.97m, 5-6.32mg/L, 6.8-7.8, 0.435-1.343 mg/L, 0.0070-1.7500 mg/L, 200-480 mg/L, 0.00030-0.00181 mg/L and 1.40-2 mg/L respectively. Results showed significant (p<0.05) across month and were not significant (P>0.05) across Site. The results revealed that Yobe River contains high level of alkalinity, and other parameters were within the recommended range for a drinking water or tolerable limits for fish production.

Keywords: Fish, physicochemical parameters, pollution, productivity, River Yobe

1. Introduction
Water has been known as a changing system that contains living and non-living components, organic, inorganic soluble and insoluble substance. Therefore there is possibility of variation in its quality that could occur on a daily bases and also from the origin of water [1]. Aquatic organisms need a healthy environment to live and have adequate nutrient for their survival and growth. The productivity depends on the physicochemical characteristics of the water body [2]. The maxima productive are obtained when the physical and chemical parameters are at optimum level [3]. Water pollution is a major global problem which requires ongoing evaluation and revision of water resource policy at all levels (international down to individual aquifers and wells). Unfortunately, the availability and quality of water have been impacted upon by both natural and anthropogenic sources leading to poor quality and productivity of aquatic Environment [4].
The availability of good water quality is an indispensable feature for preventing diseases and improving quality of life [5]. Natural water contains different types of impurities which are introduced into aquatic system by different ways such as weathering of rocks and leaching of soils, dissolution of aerosol particles from the atmosphere and from several human activities, including mining, processing and the use of metal based materials [5-7]. The increased use of metal-based fertilizer in agricultural revolution of the government could result in continued rise in concentration of metal pollutions in fresh water reservoir due to the water run-off [8]. People on globe are under tremendous threat due to undesired changes in the physical, chemical and biological characteristics of water [9]. Industrial development (Either new or existing industry expansion) results in the generation of industrial effluents, and if untreated results in water, sediment and soil pollution [10, 11]. High levels of pollutants mainly organic matter in river cause an increase in biological oxygen demand, chemical oxygen demand, total dissolved solids, total suspended solids and fecal coli form [12]. They will pose a threat to fish species and other living organism in the water body [13].
This research aims at assessing the physicochemical parameters of river yobe, gashua. The results will provide base line information for the management of the river to prevent it from future pollution as a result of human activities.

2. Materials and methods

River Yobe is situated in the Sudan Sahel zone of northeast. It covers a total area of 148,000km^2 [14]. The river originates from the flood plain overlaying the lake sediment of the Lake Chad formation (plateau and Kano states). The two western tributaries of the formation (Jama`ares and Hadeja) met around Nguru Gashua wetland area about 250km north of Damaturu the Yobe state capital. The river is located in Gashua Bade local government of Yobe state, the town lies near Nguru-Gashua wetland economic and ecological system [15]. Coordinates 12$^0$12`5 N 11^{0}2"47`E and 12.8606^{0}N 11.04639^{0}E with the population of 125, 000 people [16] and the river flows from Hadeja to Lake Chad [17].

The water samples were collected once in a month for the period of six months, (June-November, 2015). The levels of physicochemical parameter in the water were assessed for this period. Some water quality parameters such as Temperature, pH, Conductivity and Transparency were determined *in situ*, while for other parameters, water samples were collected in labeled and fixed sampling bottles and were transported to laboratory for analysis. Collections were done at depth just below the sechi disc reading. Water quality parameters were determined as described [18].

3. Results and discussion

Table 1 presents the monthly mean variation of temperature. The value varied from 21 ^{0}C in the month of November to 30 ^{0}C in the month of June, July and August showing significant difference across month (p<0.05). There was no significant difference across Sites (p>0.05). The study revealed that the observed temperature value fall within the ranged of 21-30 ^{0}C The values reported in this work are within the range recommended by [19] (30 ºC) and National Guideline and standards for water quality (20 ºC-33 ºC) in Nigeria for aquatic life, industrial and agricultural uses [20]. This result varies with the work of [21] in Jakara Lake Kano who reported a temperature range of 17-28 ^{0}C as a recommended or desirable range. The difference in temperature might be due to wet season weather condition that prevailed from the month of June to its peak in August when atmospheric temperature was low [22]. The influence of temperature on the aquatic system is emphasized by [23] who reported that temperature is one of the important environmental parameters having a profound influence on the life cycle of an organism, as it exerts a lethal directive and controlling effect on it.

Table 1: Monthly Mean Variation of Temperature (ºC) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	30.00	30.00	30.00	30.00a	0.00
July	30.00	30.00	30.00	30.00a	0.00
August	30.00	30.00	30.00	30.00a	0.00
September	29.00	30.00	29.00	29.33a	0.33
October	25.00	27.00	28.00	26.67b	0.88
November	22.00	21.00	23.00	22.00c	0.58
Mean	27.67a	28.00a	28.33a		
SEM	1.38	1.48	1.12		

F-LSD $_{(P>0.05)}$: Sites=0.940; Months=0.000

Means followed by the same letter(s) are not significantly different.

Table 2: Monthly Mean Variation of Conductivity (µS) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	0.45	0.52	0.58	0.52a	0.04
July	0.49	0.59	0.64	0.57a	0.04
August	0.50	0.50	0.58	0.53a	0.03
September	0.56	0.57	0.56	0.56a	0.00
October	0.70	0.72	0.74	0.72b	0.01
November	0.39	0.39	0.38	0.39c	0.00
Mean	0.52a	0.55a	0.58a		
SEM	0.04	0.04	0.05		

F-LSD $_{(P>0.05)}$: Sites=0.611; Months=0.000

Means followed by the same letter(s) are not significantly different.

Table 2 shows the result of monthly mean conductivity for the period of this study (June-November, 2015). The monthly mean conductivity ranged between 0.39µS in November and between 0.72µS in October showing significant difference across month (p<0.05). There was no significant difference across Sites (p>0.05) throughout the study period. The monthly means conductivity for Site I (0.52 µS), Site II (0.55 µS) and Site III (0.58 µS) fall below the recommended values of [19] maximum permissible limits (8-10,000 µs/cm) for drinking water and 10-1000 µs/cm recommended by [24]. However the values obtained were higher than values reported in Dass, Kaltungo and Langtang in Nigeria by [25] and were also higher than values reported in the streams, wells and bore-hole water in Eggon local government area of Nasarawa State, Nigeria by [26]. The observed low conductivity value may be due to the narrow fluctuation of pH values around the neutral point of 7 in the river. The implication of low conductivity may cause lower condition factor and fecundity of the fish as reported by [22].

The monthly mean value of transparency is presented in Table 3. The monthly mean value of transparency ranged between 0.30m in July and 0.93m in November showing significant difference across month (p<0.05). There was no significant difference across Sites (p>0.05). The observed values of mean monthly variations in transparency fall within 0.30m to 0.93m. This result varies with the work of [27] in Kigera fish farm, who reported a monthly mean value of transparency between 19cm and 25cm. The river reached its highest depth between the months of July and August which indicate the impact of rainfall on the water level because this period is regarded as the rainy season; same was reported by [28]. [29] have reported that low transparency implies low photosynthetic activities and therefore low productivity. The period of greatest light penetration was in November. This may be as a result of sedimentation due to high evaporation as reported by [28]. Decrease in water transparency increases water temperature because suspended particles absorb more heat. This in turn reduces the concentration of dissolved oxygen (DO) because warm water holds less dissolved oxygen than cold water [30].

Table 3: Monthly Mean Variation of Transparency (m) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	0.32	0.42	0.36	0.37a	0.03
July	0.30	0.30	0.30	0.30a	0.00
August	0.38	0.40	0.37	0.38a	0.01
September	0.44	0.45	0.44	0.44a	0.00
October	0.75	0.70	0.68	0.71b	0.02
November	0.97	0.93	0.90	0.93c	0.02
Mean	0.53a	0.53a	0.51a		
SEM	0.11	0.10	0.10		

F-LSD $_{(P>0.05)}$: Sites=0.984; Months=0.000
Means followed by the same letter(s) are not significantly different.

There was significant variation in dissolved oxygen (DO) during the period of this study. The lowest value was recorded in August while the highest value was recorded in June. The monthly mean value of dissolved oxygen (DO) ranged between 5.11mg/L in August and 6.21mg/L in June (Table 4). Showing significant difference across months (p<0.05), and there was no difference between sites (p>0.05). Concentrations of monthly mean of dissolved oxygen in water along the studied Yobe River reach from 5.11 to 6.12mg/l. the observed range is below 15.78-17.26mg/L as reported by [22] in Lughu reservoir Michika, Adamawa State [31]. Recorded that temperature has profound effect on solubility of Oxygen. The values recorded are higher than 4mg/l recorded in Delmi River [32]. The highest DO value observed in the month of June might be attributed to active photosynthetic process from phytoplanktons in the River [33]. Have also reported that high DO values during wet season are due to the prevailing cool wind action.

Table 4: Monthly Mean Variation of Dissolved Oxygen (mg/L) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	6.21	6.10	6.32	6.21a	0.06
July	5.00	5.14	5.21	5.12b	0.06
August	5.11	5.00	5.21	5.11b	0.06
September	6.10	5.81	5.43	5.78c	0.19
October	5.23	5.34	5.43	5.33b	0.06
November	5.10	5.21	5.11	5.14b	0.04
Mean	5.46a	5.43a	5.45a		
SEM	0.22	0.18	0.18		

F-LSD $_{(P>0.05)}$: Sites=0.996; Months=0.000
Means followed by the same letter(s) are not significantly different.

Table 5 shows the monthly mean value of pH. The highest value was recorded in August and the lowest value was also recorded in November. The mean values ranged between 6.97-7.67 in August and November respectively, thus showing significant difference in the month of June and other months. There was no significant difference across Sites (p>0.05). The test for pH of water was carried out to determine whether it is acidic or alkaline in nature. The mean values obtained for the river were within the range of 6.5-8.9 recommended by [19] for drinking water. Although the values indicate that the river water samples are slightly basic, it is in agreement with what was reported by other researchers in similar study [34, 26, 30]. Have reported that low pH allows toxic elements compound to become mobile and available for uptake by plants and animals. The increase in pH value in the Month of August may be as a result of increases in rain water, which eventually increases the volume of the river.

Table 5: Monthly Mean Variation of pH in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	7.10	7.10	7.10	7.10a	0.00
July	7.50	7.49	7.66	7.55b	0.06
August	7.70	7.80	7.50	7.67b	0.09
September	7.50	7.40	7.70	7.53b	0.09
October	7.50	7.50	7.30	7.43b	0.07
November	7.20	6.80	6.90	6.97a	0.12
Mean	7.42a	7.35a	7.36a		
SEM	0.09	0.14	0.14		

F-LSD $_{(P>0.05)}$: Sites=0.916; Months=0.000
Means followed by the same letter(s) are not significantly different.

The value of monthly concentration of Ammonia in relation to months and sites is presented in Table 6. The monthly mean ranged between 0.480mg/L in October and 1.092mg/L in June showing significant difference in the month of June and other months (p<0.05). There was no significant difference across Sites (p>0.05). The mean monthly variation of Ammonia ranged between 0.480mg/L to 1.092mg/l throughout the period of this study. This result is higher than 0.025mg/L reported by [35, 24] have reported that Ammonia is the nitrogen form that is most readily used by aquatic plants, high concentration of the toxic form is known to produce a lethal effect, while lower concentration inhibit growth rate [36]. Have reported that growth rate of fish slows down if total Ammonia values recorded in the reservoir is high [37]. Has also concluded that high Ammonia level cause susceptibility to disease and eventually death.

Table 6: Monthly Mean Variation of Ammonia (mg/L) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	1.023	1.343	0.909	1.092a	0.130
July	0.865	0.632	0.812	0.770b	0.071
August	0.572	0.435	0.741	0.583b	0.088
September	0.512	0.600	0.445	0.519b	0.078
October	0.488	0.512	0.439	0.480b	0.021
November	0.969	0.540	0.494	0.668b	0.151
Mean	0.738a	0.677a	0.640a		
SEM	0.099	0.136	0.084		

F-LSD $_{(P>0.05)}$: Sites=0.814; Months=0.007
Means followed by the same letter(s) are not significantly different.

The monthly mean concentration of Phosphorus is presented in Table 7. The highest mean value recorded were 1.5000mg/L in the month of November while the lowest value of 0.2990mg/L was recorded in the month of October showing significant difference in the month of October and other months (p<0.05). There was no significant difference across Sites (p>0.05). The monthly mean of phosphorus concentrations of each of the three locations are within the limits set by [19] (6.5mg/l). The observation is also in agreement with the findings of other work in similar studies [25]. The result is also higher than 0.04mg/L to 0.050mg/l recorded by [38] in river Suka [22]. Have reported that the high value of Phosphorus could be attributed to lock in nutrient phenomenon [39]. Has observed that in a well oxygenated water body, nutrient element form bond with bottom sediment that prevent their recycling.

Table 7: Monthly Mean Variation of PO_2 (mg/L) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	1.2014	1.1032	1.5201	1.2749a	0.1258
July	1.1020	1.0320	1.4251	1.1864a	0.1211
August	1.0715	0.8150	1.3895	1.0920a	0.1662
September	0.5000	1.6250	0.8750	1.0000a	0.3307
October	0.0070	0.0150	0.8750	0.2990b	0.2880
November	1.1250	1.7500	1.6250	1.5000a	0.1909
Mean	0.8345a	1.0567a	1.2850a		
SEM	0.1952	0.2549	0.1339		

F-LSD $_{(P>0.05)}$: Sites=0.313; Months=0.035
Means followed by the same letter(s) are not significantly different.

Table 8 present the monthly mean variation of Alkalinity from the study area. The highest mean recorded were 440mg/l in the month of July, while August recorded the lowest value of 226.67mg/l showing significant difference across months ($p<0.05$). There was no significant difference across Sites ($p>0.05$) throughout the period of the study. Monthly mean value of Alkalinity values of 376.67mg/L for Site I, 290.00mg/L for Site II and 313.33mg/L for Site III were higher than the maximum permissible level of [19] (150 mg/L). This may be due to the presence of carbonates and bicarbonates in the well water because they contribute to the hardness of the water [40, 41]. Has reported that in high productive water the alkalinity values increase the toxicity of heavy metal ions such as copper and Zinc to fish and invertebrates

Table 8: Monthly Mean Variation of Alkalinity (mg/L) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	480.00	320.00	320.00	373.33a	53.33
July	480.00	400.00	440.00	440.00a	23.09
August	240.00	240.00	200.00	226.67b	13.33
September	240.00	240.00	280.00	253.33b	13.33
October	400.00	240.00	280.00	306.00ab	48.07
November	420.00	300.00	360.00	326.67ab	34.64
Mean	376.67a	290.00a	313.33a		
SEM	45.14	26.20	33.33		

F-LSD $_{(P>0.05)}$: Sites=0.240; Months=0.009
Means followed by the same letter(s) are not significantly different.

The monthly mean concentration of Carbon Dioxide (CO_2) is presented in Table 9. The highest mean value recorded were 0.00181mg/l in the month of July while the lowest value were recorded in the month of August which was 0.00040mg/l showing significant difference across months ($p<0.05$). There was no significant difference across Sites ($p>0.05$). The observed ranged of free CO_2 is less than 0.5 to 3.67mg/l mean monthly ranged reported by [30] in Lake Geriyo. The lowest values of CO_2 may be due to higher alkalinity of the river and it also implies loss of some aquatic macrophyte. However, the value fall within the recommended safety limit of 10mg/l as reported by [37]. The values recorded in this study are slightly lower than 6.5mg/l recorded for Delimi River [32]. The values of 0.00040mg/L-0.00181mg/L recorded throughout the period of study were an indication that River Yobe is good for fishery production. This is because a good fishery is correlated with low free carbon dioxide and at high concentration it is vice versa as reported by [42].

Table 9: Monthly Mean Variation of CO_2 (mg/L) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	0.00175	0.00179	0.00181	0.00178a	0.00002
July	0.00184	0.00180	0.00180	0.00181a	0.00001
August	0.00030	0.00050	0.00040	0.00040b	0.00006
September	0.00040	0.00060	0.00100	0.00067b	0.00018
October	0.00100	0.00040	0.00060	0.00067b	0.00018
November	0.00200	0.00120	0.00120	0.00147a	0.00027
Mean	0.00122	0.00105	0.00114		
SEM	0.00031	0.00026	0.00024		

F-LSD $_{(P>0.05)}$: Sites=0.911; Months=0.000
Means followed by the same letter(s) are not significantly different.

There was significant variation in Biochemical Dissolved Oxygen (BOD) during the period of this study. The lowest value was recorded in November while the highest value was recorded in the month of June, July, September and October. The monthly mean value of Biochemical Dissolved Oxygen (BOD) ranged between 1.80mg/l in November and 2mg/l in the month of June, July, September and October (Table 10) showing significant difference ($p<0.05$) and there was no significant difference across sites ($p>0.05$. The monthly mean variation of Biochemical Oxygen Demand (BOD) ranged from 1.80mg/l in the month of November to 2.0mg/l in month of June, July, September, and October respectively. This result is less than 3.3887mg/l to 5.3725mg/l reported by [28], and also the work of [38]. The Biochemical Oxygen Demand (BOD) is a fair measure of cleanliness of any water. [43] Classified values of less than 1.2mg/l as clean, 4-6mg/l as fairly clean and 8-10mg/l as bad polluted. This implies that water of Yobe River is fairly clean since the values obtained higher than the value for clean water. This may be due to organic content and human activities around the river.

Table 10: Monthly Mean Variation of BOD (mg/L) in River Yobe

Months	Site I	Site II	Site III	Mean	SEM
June	2.00	2.00	2.00	2.00a	0.00
July	2.00	2.00	2.00	2.00a	0.00
August	2.00	1.50	2.00	1.83a	0.17
September	2.00	2.00	2.00	2.00a	0.00
October	2.00	2.00	2.00	2.00a	0.00
November	2.00	1.40	2.00	1.80a	0.20
Mean	2.00a	1.82a	2.00a		
SEM	0.00	0.12	0.00		

F-LSD $_{(P>0.05)}$: Sites=0.118; Months=0.569
Means followed by the same letter(s) are not significantly different.

4. Conclusion

In conclusion, The results revealed that, the value of temperature, conductivity, transparency, dissolved oxygen (DO), pH, ammonia, phosphorus (PO_2), free carbon dioxide (CO_2) and biochemical oxygen demand (BOD) were within the WHO recommended range for a drinking water and fish production, while the value of Alkalinity were investigated to be above WHO maximum permissible level throughout the period of this study.

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