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AN ASSESSMENT OF THE PHYSICO-CHEMICAL PARAMETERS OF KONTAGORA RESERVOIR, NIGER STATE, NIGERIA

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ABSTRACT
The seasonal variations in the physicochemical parameters of water reservoir in Kontagora, Nigeria were studied from January to December, 2007. The physico-chemical parameters were determined bimonthly. They include: temperature (using mercury in glass thermometer), transparency (using Secchi-disc), while Pye Unicam model 292 meter was used for pH and electrical conductivity determination . Dissolved oxygen by modified Winkler-azide method, water hardness by Lind method and Phosphate – phosphorus by Denges method, total alkalinity by titration method, total dissolved solid by O'wen method, while Nitrate-Nitrogen was determined using Phenoldisulphonic acid method. Water depth was determined using a calibrated measuring tape weighted at one end. The rainy season mean values for water temperature, depth, pH, Nitrate-Nitrogen, were significantly (P<0.05) higher than those for the dry season. However, for transparency, conductivity, dissolved oxygen, hardness, alkalinity, phosphate-phosphorus and total dissolved solid, the dry season mean value were significantly higher than the rainy season mean value. As in most other African inland water bodies, there was seasonal variation in the physicochemical parameters evaluated in this study. The torrential rains of the reservoir environment, the characteristic trade winds of the dry season, effect of deforestation, fertilizer application, herbicides, insecticide and other chemical factors might have contributed to the fluctuations of some of the physicochemical parameters determined in the reservoir.

Keywords: Kontagora reservoir, physicochemical parameters, Seasonal, Environment.

INTRODUCTION

The general desire to protect fresh water fisheries has led to an expansion of research into their water quality requirements, in terms of their physicochemical parameters such pH, temperature, dissolve oxygen, transparency, total alkalinity, total hardness, electrical conductivity, total dissolved matter, e.t.c. These factors serve as a basis for the richness or otherwise biological productivity of any aquatic environment (Imevbore, 1970). The physical and chemical properties of water immensely influenced its uses, the distribution and richness of the biota (Courtney and Clement, 1998; Unanam and Akpan, 2006). Several of these physicochemical parameters have been studied on large man-made lakes in Northern Nigeria by Adeniji and Ita (1977) and Adeniji (1981). Other works on physicochemical parameters include that of Balarabe (1989), on Makwaye Lake, Zaria, Oniye *et al.,* (2002),on Zaria Dam, Ugumba and Ugwumba (1993), on Awba Lake in Ibadan, Kolo and Oladimeji (2004), studied water quality and some nutrient levels in Shiroro Lake, Niger State.

Kontagora Reservoir was created with major objective of providing domestic water to Kontagora town and its environment, however, fishing and irrigation have become other established uses of the reservoir. This study was carried out to determine some physicochemical parameters of Kontagora reservoir in relation to water quality requirement for domestic purpose and fish production.

MATERIALS AND METHODS

Study Area

Kontagora reservoir lies in the Northern Guinea Savannah zone between Latitude 3° 20^1 and 7°40^1 East and longitude 8° and 11°3^1 North. (Figure 1). The climate is characterized by distinct dry and rainy season .The reservoir was official1y commissioned in 1991, with a total storage capacity of 17.7 million cubic metres, and a surface area of 143 square kilometer. The height of the reservoir is 20 metres and the crest length is 1000 metres.

Sampling Stations

Water samples were collected from five sampling stations (Tunga Hajiya I, Tunga Kawo II, Jantaye III, Loko Kamboli IV and Loko Kuka V. on the reservoir (Figure 1), bimonthly from January to December 2007, with corked specimen bottles.

Analysis of physicochemical parameter

Water temperature were measured at each sampling station with using mercury in glass thermometer ^oC.

A calibrated measuring tape weighted at one end was used to measure water depth, while transparency was determined with the use of Seechi disc.

Pye Unicam model 292 metre,(after standardization with buffer solution at pH4.0, 7.0 and 9.0) was used for pH and electrical conductivity determination.

The modified Winkler-azide method (Lind, 1979 ; APHA, 1985) was used to determined the dissolved oxygen . Water hardness was determined by methods of Lind (1979) and APHA (1985). Total alkalinity was determined using standard method described by Boyd (1979) and APHA (1992). The phosphate - phosphorus was determined using the Denges method (Lind, 1979) and APHA (1985), while the Nitrate - nitrogen was determined by phenoldisulphonic acid method as described by Mackereth (1963). Total dissolved solids (TDS) were determined by the method of O'wen (1979), by multiplying the specific conductivity value of the water sample from the reservoir by 0.65.

Statistical analysis

Data collected were subjected to statistical analysis. One-way analysis *of* variance was used to test differences, while the means were compared using Duncan's Multiple Range Test (DMRT) (Steele and Torrie, 1980).

RESULTS

Some marked variations in the physical and chemical parameters were observed between sampling stations and seasons. The results are presented in Tables 1, 2 and 3. Analysis of variance (ANOVA) (Table 1) showed that there was significant variation in all the physico-chemical parameters for the seasons. However, water temperature, depth, conductivity, dissolved oxygen, water hardness, alkalinity and total dissolved solid are highly significant ($p < 0.01$), while others are significant at ($p < 0.05$) (Table 1) .The mean dry season values of transparency (12.46m), conductivity (86.41µs) , dissolved oxygen (4.70mg/l), water hardness (56.07mg/l), alkalinity (53.38mg/l) , phosphate - phosphorus (6.86mg/1) and total dissolved solids (43.19ppm) were higher than those of rainy seasons (Table 2) . Water temperature (27.65°c), water depth (7.74 m) , pH (7.15) nitrate - nitrogen (5.21mg/l) mean values were higher in the rainy season than the dry season (Table 2). Analysis of variance (ANOVA) (Table l), revealed that with the exception of water depth and dissolved solids, that showed significant variations at ($p < 0.05$) (Table 1), in the five sampling stations, all other parameters showed no significant variations ($p > 0.05$). The mean values of the physico-chemical parameters presented in table 3, showed that Loko-Kamboli recorded the highest mean value for total alkalinity (43.67mg/l). Tunga - Hajiya recorded the highest mean value for depth (8.78m), pH (7.14), conductivity (86.92µs) and dissolved oxygen (4.65mg/l). Jantaye recorded the highest mean value for transparency (10.64m) and Nitrate - nitrogen (5.58mg/l). Loko-Kuka recorded the highest mean value for Phosphate - phosphorus (6.59mg /1) and total dissolved solid (43.86ppm).

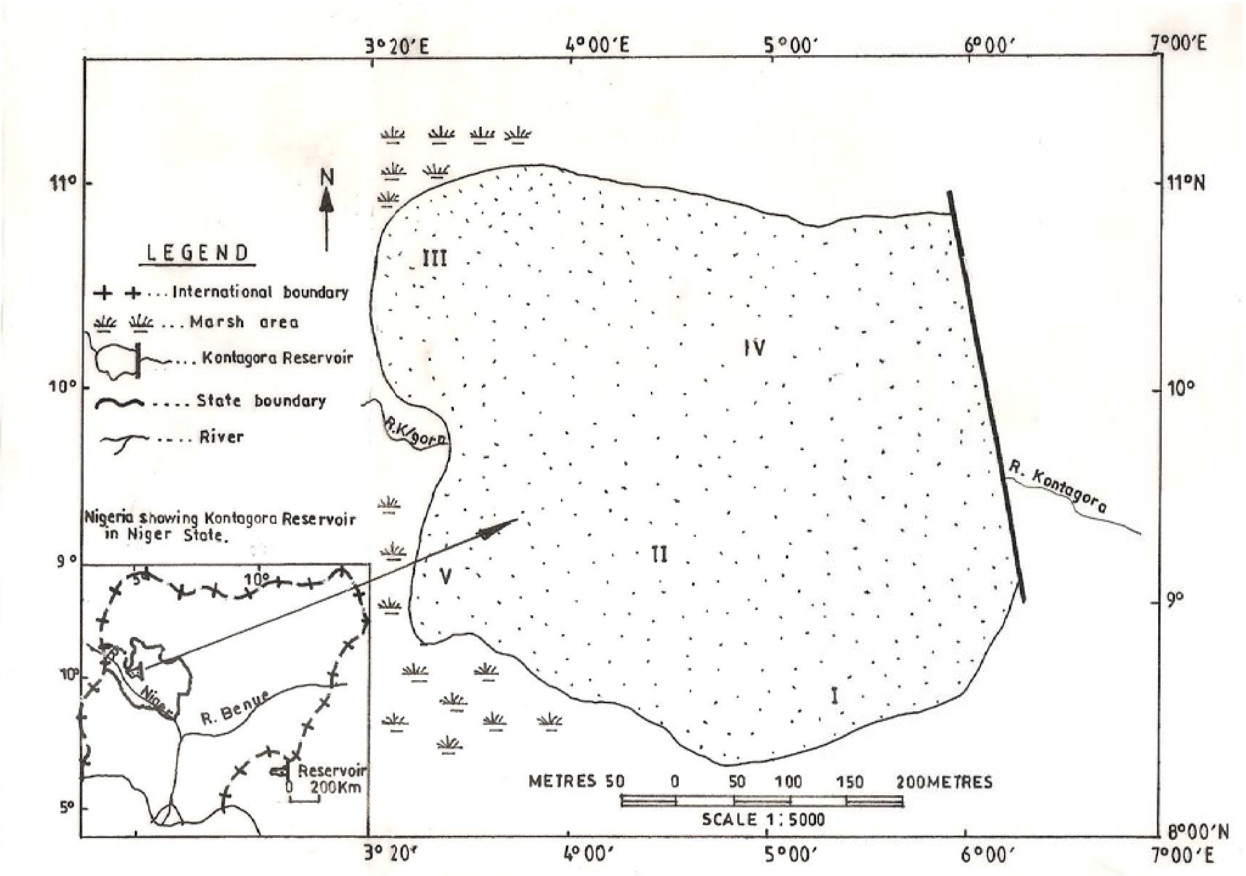

Fig. 1: Map of Kontagora Reservoir at Tunga Kawo (Source: Niger State Ministry of Land and Survey Kontagora Area Office).

Table 1: ANOVA showing seasonal variations of physico-chemical parameters at the sampling stations of Kontagora Reservoir.

Sources of variation	Df	Air Temp. °C	Water Temp. °C	Depth (m)	Transparency (m)	pH	Conductivity (µs)	Dissolved Oxygen (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	PO_4-P (mg/l)	NO_3-N (mg /l)	Total Dissolved Solid (ppm)
Treatment (trt)	9	3.90^{ns}	30.33*	25.18**	908.41*	0.05ns	366.13*	3.12*	614.12*	1486.93**	7.99*	4.96ns	73.05*
Station	4	1.90^{ns}	0.72ns	37.49**	55.40^{ns}	0.06^{ns}	48.63^{ns}	0.14^{ns}	79.86^{ns}	45.35^{ns}	1.95^{ns}	5.0ns	27.99*
Season	1	18.68*	256.81**	57.92**	7717.08*	0.23*	2812.40**	23.3**	4692.01**	13132.81**	59.21*	6.77*	501.33**
Station X Season	4	2.18^{ns}	3.33^{ns}	4.69*	592.25^{ns}	0.01^{ns}	72.08*	1.05*	128.92*	17.05^{ns}	1.24^{ns}	4.46^{ns}	11.04*
Error	170	5.79	7.73	1.43	513.24	0.09	106.58	0.98	132.25	112.16	3.27	9.33	24.64

*Significant (P<0.05), **Highly Significant (P<0.01), ns- Not Significant

Table 2: Mean dry and rainy season values of the physico – chemical parameters of Kontagora reservoir, Niger State , Nigeria (January – December, 2007)

Season	Physico-Chemical Parameters											
	Air Temp. (°C)	Water Temp. (°C)	Depth (m)	Transparency(m)	pH	Conductivity (µs)	Dissolved oxygen (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	PO_4-P (mg /l)	NO_3-N (mg /l)	Total Dissolved Solid (ppm)
Dry	29.96b	25.74b	6.94b	12.46a	7.06a	86.41a	4.70a	56.07a	53.38a	6.86a	4.74b	43.19a
Rainy	30.37a	27.65a	7.74a	5.26b	7.15a	84.05b	4.42b	48.80b	34.99b	5.53b	5.21a	42.59b

Means with the same letters in each column are not significantly different P≥0.05

Table 3: Mean values of the physico – chemical parameters at five sampling stations of Kontagora reservoir, Niger State, Nigeria (January – December, 2007)

Sampling Stations	Physico-Chemical Parameters											
	Air Temp. (°c)	Water Temp. (°c)	Depth (m)	Transparency (m)	pH	Conductivity (µs)	Dissolved oxygen (mg/l)	Hardness (mg/l)	Alkalinity (mg/l)	PO_4-P (mg/l)	NO_3-N (mg/l)	Total Dissolved Solid (ppm)
Tunga Hajiya	30.42^{a}	26.33^{a}	8.78^{a}	9.02^{b}	7.14^{a}	86.92^{a}	4.65^{a}	53.17^{a}	43.26^{a}	6.37^{ab}	5.15^{a}	43.64^{a}
Loko Kamboli	29.83^{a}	26.67^{a}	7.51^{b}	8.07^{bc}	7.10^{a}	84.51^{b}	4.53^{a}	53.67^{a}	43.67^{a}	6.39^{ab}	4.67^{a}	42.23^{bc}
Tunga kawo	30.31^{a}	26.67^{a}	7.31^{c}	7.33^{c}	7.12^{a}	85.92^{ab}	4.61^{a}	55^{a}	43.46^{a}	5.97^{b}	4.73^{a}	43.13^{ab}
Jantaye	30.03^{a}	26.47^{a}	6.75^{d}	10.64^{a}	7.09^{a}	84.01^{b}	4.62a	51^{a}	41.31^{b}	6.22^{ab}	5.58^{a}	41.83^{c}
Loko Kuka	30.08^{a}	26.56^{a}	6.03^{e}	8.58^{bc}	7.04^{a}	85.76^{ab}	4.51^{a}	52.63^{a}	41.57^{b}	6.59^{a}	4.92^{a}	43.86^{a}

Means with the same letters in each column are not significantly different P≥0.05

DISCUSSION

There are some marked variations in the physico-chemical parameters observed for the sampling stations and the seasons. Water temperature range for the entire reservoir, compares well with the ranges recorded for other tropical Lakes (Adebisi, 1981; Ovie and Adeniji, 1993). Aquatic organisms (from microorganisms to fish) depend on certain temperature range for optimal growth (APHA, 1992). The normal range to which fish is adapted in the tropics is between 8^0C and 30°C (Alabaster and Lloyd, 1980). The low water temperature of Kontagora reservoir during the dry season could be as a result of seasonal changes in air temperatures associated with the cool dry North-East trade winds (Harmattan). Oladimeji and Wade (1984), and Balarabe (1989), also observed low water temperature in Makwaye Lake, near Zaria, during this period. Kolo .and Oladimeji (2004), made similar findings in Shiroro dam. The water temperature range for Kontagora reservoir is within the range 6f 10^0C - 50^0C for river and dam water meant for domestic purposes, and for fish culture in tropical waters (WHO, 1984; Huet, 1977).

The higher dry season secchi-disc transparency mean value compared to that of the rainy season could be due to absence of floodwater, surface run-offs and settling effect of suspended materials that followed the cessation of rainfall. Kemdirim (1990), reported similar observations . Low secchi-disc transparency recorded during rainy season, agrees with the findings of Wade (1985), who observed that onset of rain decreased the secchi-disc visibility in two mine lakes around Jos, Nigeria. Lower transparency recorded during rainy season when there was turbulence and high turbidity, has a corresponding low primary productivity, because turbidity reduces the amount of light penetration, which in turn reduces photosynthesis and hence primary productivity (USEPA, 1991; APHA, 1992).

The hydrogen ion concentration (pH) was near neutral throughout both season, and it was within the range for inland waters (pH6.5 - 8.5), as reported by Antoine and AI-Saadi (1982). Boyd and Lichtkoppler (1979), reported pH range of 6.09 - 8.45 as being ideal for supporting aquatic life including fish. Thus, the pH range obtained in this study is within the acceptable level of 6.0 to 8.5 for culturing tropical fish species (Huett, 1977) and, for the recommended levels for drinking water (WHO, 1984). Federal Environmental protection Agency (FEPA) recommended pH 6.5-8.0 for drinking and 6.0-9.0 for aquatic life.

Higher dry season conductivity value obtained could be attributed to concentration effect as a result of reduced water volume from their main tributary channels. Ovie and Adeniji (1993), as well as, Kolo and Oladimeji (2004), observed a similar trend for Shiroro lake.

The dissolved oxygen in the reservoir was higher during the dry season than the rainy season. The high oxygen value for the dry season coincides with periods of lowest turbidity and temperature. The amount of dissolved oxygen in water has been reported not constant but fluctuates, depending on temperature, depth, wind and amount of biological activities such as degradation (Adeniji, 1973 ; Ibe, 1993). In this study, the cool harmattan wind which increases wave action, and decrease surface water temperature might have contributed to the increased oxygen concentration during the dry season, while the torrential rains, created increased turbidity and decreased oxygen concentration during the rainy season. Oniye *et. al.,* (2002), made similar observation for Zaria dam.

Water hardness was higher during the dry season than the rainy season. This could be as a result of low water levels and the concentration of ions, and the lower rainy season value could be due to dilution. This agrees with the result of Kolo and Oladimeji (2004) for Shiroro Lake and Ufodike *et al.,* (2001) for Dokowa mine lake.

The mean alkalinity agreed with the range value documented by Moyle (1946) and Boyd (1981) for natural water. The alkalinity is higher in the dry season and lower in the rainy season, when the dam had high water level. This could be due to low water levels with its attendant concentration of salts and the lower value in the rainy season could be due to dilution. Ufodike *et al.,* (2001), recorded similar result for Dokowa Mine Lake. The high level of alkalinity in the dry season agree with the findings of Adebisi (1981), on the correlation of the seasonal fluctuation of water level and alkalinity. The negative correlation values obtained indicate that alkalinity of water increase with decreasing water level. Similar observations have been made by Holden and Green (1960) and TaIling and Rzoska (1967) on Rivers Sokoto and Nile in Egypt respectively.

The high dry season mean value of phosphate phosphorus (PO_4-P) could be due to concentration effect because of reduced water volume. It could also be due to lower water hardness, thus less co-precipitation of phosphate with calcium carbonate, a phenomenon that has often been reported to occur in many fresh water lakes (House, 1990; Heleen *et al.,* 1995). Akpan and John (1993), made similar findings in Cross River state in Eastern Nigeria.

The higher nitrate-nitrogen ($N0_3$-N) concentration during the rainy season could be due to surface run-offs as well as the decomposition of organic matter. Ufodike *et al.,* (2001), made similar observations for Dokowa Mine Lake. Kennedy and Hain (2002), also reported that nitrate-nitrogen increase with surface run-off and at deeper depths. Coming e*t al.,* (1983), stated that high nitrate concentrations in lake is related to inputs from agricultural lands.

In conclusion, the torrential rains of Kontagora reservoir area (environment), the characteristic trade winds of the dry season, effect of deforestation, fertilizer application, herbicides, insecticides and other chemical factors might have contributed to the fluctuations of some of the physico-chemical parameters determined in Kontagora dam. The levels of the parameters determined were within the acceptable ranges for domestic water purposes and fish production.

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