SOME ASPECTS OF THE PHYSICO-CHEMICAL PARAMETERS OF KONTAGORA DAM, NIGER STATE NIGERIA

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Abstract

The seasonal variations in the physicochemical parameters were studied from January, 2007 to December 2007, in Kontagora Reservoir, Niger State, Nigeria. The physico- chemical parameters were determined bi-monthly , using the following methods , temperature using mercury thermometer in degree centigrade , transparency using Secchi-disc , Pye Unicam model 292 meter used for pH and electrical conductivity . Dissolved oxygen by modified Winkler – azide method, water hardness and Phosphate– phosphorus by method of Lind (1979), total alkalinity by standard method described by Boyd(1979) , Nitrate– Nitrogen by Phenoldisulphonic acid method. 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 values were higher than the rainy season mean value. As in most other Africa inland water bodies, there was seasonality in the physicochemical parameters variables. The torrential rains of the dam environment, the characteristics 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.

Key words: Kontagora Reservoir, physicochemical parameters, season.

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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 as pH, temperature, dissolved oxygen, transparency, total alkalinity, total hardness, electrical conductivity, total dissolved matter e.t.c. These factors serve as base 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 physic-chemical parameters have been studied on large man-made lakes in Northern Nigeria by Adeniji and Ita (1977) and Adeniji (1981). Other works on physic-chemical parameters include that of Balarabe (1989), on Makwaye Lake, Zaria, Oniye *et al.*, (2002), on Zaria Reservoir, Ugwumba 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 physic-chemical 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' and 7°40' East and longitude 8° and 11°3' North. (Figure 1). The climate is characterized by distinct dry and rainy season . The dam was officially commissioned in 1991 with a total storage capacity of 17.7 million cubic metre, and a surface area of 143 square kilometer. The height of the dam is 20 metres and the crest length is 1000 metres.

Sampling Stations

Water samples were collected from five sampling stations (Tunga Hajiya X_1, Tunga Kawo X_2, Jantaye X_3, Loko Kanboli X_4 and Loko Kuka X_5) on the dam (figure 1), bimonthly from January to December 2007, with corked specimen bottles.

Physicochemical Parameter Analysis

The air and water temperature were measured at each sampling station with a mercy thermometer, in °c. A calibrated measuring tape weighted at one end was used to measure water depth, while transparency was determined with the use of Secchi 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.

The modified Winkler-azide method (Lind, 1979 and APHA, 1985) was used to determine dissolved oxygen (DO) . Water hardness was determined by method of Lind (1979) and Apha (1985).

Total alkalinity was determined by 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 solid (TDS) was determined by method of O'wen (1979) by multiplying the specific conductivity value of the water sample from the reservoir by 0.65

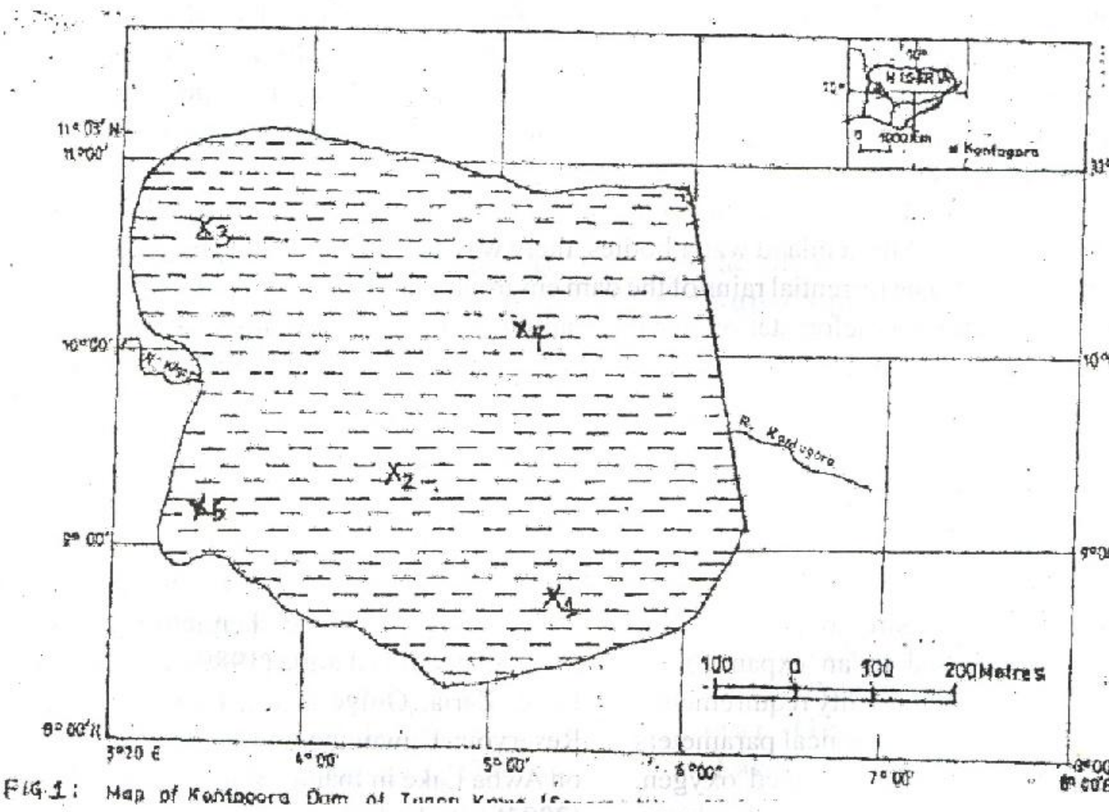

FIG 1: Map of Kontagora Reservoir (Source: Niger State Ministry of Land and Survey Kontagora Area Office

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 multiple range test (DMRT) (Steele and Terrie, 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 and 2. 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 of $CaCo_3$/l) and total dissolved solid (43.19ppm) were higher than those of rainy seasons (Table 2). While water temperature (27.65°c), water depth (7.74 m), pH (7.15), nitrate – nitrogen (5.21mg0f $CaCo_3$/l) mean values were higher in the rainy season than the dry season (Table 2)

Table 1: Anova showing variation of Physicochemical parameters during the seasons and and at the sampling stations of Kontagora Dam. Niger State

Source of variation	Df	Air temp.	Water Temp.	Depth	Transparency	pH	Conductivity	Dissolve (DO) Oxygen	Hardness	Alkalinity	P04-P	NO_3-N	Total Dissolve Solid
Treatment (Trt)	5	5.28*	51.93*	41.58**	1587.74*	0.09*	601.38*	4.78*	1002.29*	2662.84**	13.40*	5.35ns	122.66*
Station	4	1.9ns	0.72ns	37.49**	55.40ns	0.06ns	48.63ns	0.14ns	79.86ns	45.35ns	1.95ns	5ns	27.99*
Season	1	18.68*	256.81**	57.92**	7717.08*	0.23*	281240**	23.33**	4692.01**	13132.81**	59.21*	6.77*	501.33**
Error	174	5.7	7.64	1.51	502.81	0.09	105.79	0.98	132.18	109.98	3.23	9.22	24.33

* - Sgnificant (P<0.05)

** - Highly significant (P<0.01)

ns - Non significant (P>0.05)

Table 2: Mean dry and rainy season values of some physicochemical parameters of Kontagora Dam. Niger State. Nigeria (January-December, 2007)

SEASON	Air Temp. (°C)	Water Temp. (°C)	Depth (m)	Transparency (m)	pH	Conductivity (us)	Dissolved Oxygen (Mg/L)	Hardness (Mg/L)	Alkalinity (Mg/L)	PO4-P (mg of $CaCO_3$/L)	NO3-N (mg of $CaCO_3$/L)	Total dissolved solid (ppm)
DRY	29.96	25.74	6.94	12.46	7.06	86.41	4.70	56.07	53.38	6.86	4.74	43.19
RAINY	30.37	27.65	7.74	5.26	7.15	84.05	4.42	48.80	34.99	5.53	5.21	42.59

Means with the same letter within the same column are not significantly different

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 30^0C (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 reservoir. The water temperature range for Kontagora dam is within the range of 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 than that of the rainy season could be due to absence of flood water, surface run-off and settling effect of suspended materials that followed the cessation of rainfall. Kamdirim (1990), reported similar observations. These factors allow for increase in euphotic zone, which varied directly with rainfall in freshwater habitat (Akpan and John 1993). Low secchi-disc transparency recorded during rainy season, agree 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 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 neutral throughout both seasons, and it was within the range for inland waters (pH6.5 – 8.5), as reported by Antoine and Al-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, 1997) and for the recommended levels for drinking water (WHO 1980) . Federal Environmental protection Agency (F.E.PA) 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) , and, 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 and 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 reservoir.

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 reservoir 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 Talling and Rzoska (1967) on Rivers Sokoto and Nile 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 Easter Nigeria.

The higher nitrate nitrogen (NO_3^{-N}) concentration during the rainy season could be due to surface run-offs, that brought in fertilizers in solution into the reservoir, and also decomposition of organic matter, which is a continuous process throughout the year. Ufodike *et al.*, (2001), made similar observation for Dokowa mine lake. Kennedy and Hain (2002), also reported that nitrate-nitrogen increase with surface run-off and at deeper depths. Coming *et 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 characteristics 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 reservoir. The levels of the parameters determined were within the acceptable ranges for domestic water purposes and fish production.

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