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Assessment of Physico-Chemical Properties and Plankton Composition of Ajiwa Reservoir In Katsina State, Nigeria

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Abstract

Plankton composition and physicochemical properties of Ajiwa water reservoir were assessed over a twelve (12) month period. The physicochemical and biological parameters were determined using conventional methods and procedures at three sampling points. The outcome was revealed. The phytoplankton composition was Chlorophyta (57.66%), Bacillariophyta (25.70%), Cyanophyta (14.73%), and Dinophyta (1.91%), with Rotifera (30.55%), Copepoda (29.33%), Protozoa (22.27%), and Cladocera (17.85%) being the least. The temperature fluctuated with a mean SE value of (23.08 0.8^{O}C); the pH fluctuated with a mean SE value of 6.8 0.1; and the turbidity fluctuated with a mean SE value of 99.3 3.6NTU. DO readings range from 3.8mgL-1 to 7.9mgL^{-1}, with a mean SE of 6.6 0.3mgL-1. BOD showed monthly fluctuation, with a mean SE value of 3.2 0.4mgL^{-1}. The electrical conductivity ranged from 102.4 µS/cmto 105.1S/cm, with a mean SE of 129.9 4.1µS/cm. The higher chlorophyta and rotifer composition in the reservoir indicated that the water quality is good, but increased human activities such as runoffs of inorganic fertilisers and pesticides may influence change in water quality over time. The reservoir water is suitable for irrigational and domestic purposes in terms of most of the physicochemical and biological parameters analysed. As a result, an effective anthropogenic inputs control strategy in the reservoir is required.

Keywords: Composition, Physico-chemical parameters, Phytoplankton and Zooplankton

INTRODUCTION

Stability of life in aquatic environment is largely governed by physico-chemical characteristics (Shekhar et. al, 2018). These characteristics have enabled biota to develop many adaptations that improve continuous productivity and regulate its metabolism (Suleiman, et al., 2021). Some of these reservoirs were constructed as a result of societal demand for drinking and industrial water supplies, irrigation, hydroelectric power generation, fish production and recreation (Bolawa et. al., 2018). However, most of these reservoirs have secondary functions such as navigation, industrial processing, flood prevention, urban run-off control and tourism superimposed on them. Changes in the water quality are revealed in the biotic community structure, with the most vulnerable dying, while the most sensitive species act as indicators of pollution (Mustapha, 2011).

Africa, has many shallow reservoirs, but their number is still rare considering their functions and demand for their resources. Reservoirs to perform the function of their creation as well as other purposes that might be superimposed on them (Hameed et. al., 2019). Plankton community structure and composition of these reservoirs should be well known; this will provide a valuable insight to its effective management (Khaire,2020). Nigeria has about 853,600 hectares of freshwater which can producing over 1.5 million metric tonnes of fish annually (FAO, 2009). There is need to exploit means of using these valuable resources, even though there are some limitations, which includes effects of domestic and agricultural wastes on the water quality and aquatic life (Suleiman, et al., 2021). Bolawa et. al., (2018) reported that reservoirs contributed to the economic development of many nations and Nigeria included.

MATERIALS AND METHODS

Study Area

Ajiwa reservoir was built since 1975; it's located on Latitude 12°98'N, Longitude7°75'E, in Batagarawa Local Government, Katsina State, Nigeria. The reservoir is used for irrigation and water supply to the people of some local Governments.

It has height of 12m but after being rehabilitated in 1998 the height is now 14.7m; original crest length of 880m, but after rehabilitation the crest length is now 1491.8m. Has the surface area of 607.0 ha. The water volume is almost 22,730,000m^3; the dam serves as source of livelihood to the nearby communities (Abdulkarim & Ibrahim, 2018)

Sampling Procedures

Three sampling stations were used based on stratified method of sampling in the reservoir. Station I was at the downstream called Kanyar Bala, station II was located at Loko, while station III was at upstream called Gada. The stations were 200m apart. Monthly sampling of water and plankton was conducted from period of twelve (12) months. The sampling was done at the surface of water level by sinking one liter plastic sampling bottle sliding over the upper surface of water with their mouth against the water current to permit passage of the water into the bottle.

Temperature (°C) was measured using a glass mercury thermometer by dipping it into the water at each station for about 1-2minutes then the readings were recorded. Hanna Dissolved Oxygen was determine using microprocessor HI 98186; the readings were recorded in mgL^{-1}. Biochemical oxygen demand; 100ml part of the sample was incubated for five days in cupboard at room temperature and was tested (Jose et.al., 2015). Turbidity was measured with turbidity tube and recorded in Nephelometric Turbidity Unit (NTU). pH was measured with Hanna 420 pH meter it was calibrated according to the manual . The electrode of the pH meter was dipped into the sample for 2-3minutes and readings recoded. (APHA, 1999; Bolawa et. al., 2018).). Water Hardness; was determine by titration using 0.1N (EDTA) solution. Electrical Conductivity and Total Dissolved Solids (TDS were measure with WTW 320 conductivity meter and resistance measured in µS/cm. Phosphate-phosphorus was determined using the Deniges method. Nitrate-Nitrogen was determine using spectrophotometer at the wavelength 430nm, absorbance of the sample treated. The concentration of nitrate-nitrogen obtained from the Calibration curve in mgL^{-1} (APHA, 1999; Abdulkarim & Ibrahim, 2018).

Plankton sample was collected using plankton net of 25cm diameter of 70meshes/cm attached with 50ml collection bottle at the base. The net was towed beneath surface of the water for a distance of 5m. The content collected vial was then poured into plastic bottle of 70ml capacity and preserved in 4% formalin. Counting was done by shaking the preserved sample and pipetting 1ml of it into a Sedgwick Rafter Counting Cell under a microscope. Identification was done to the lowest possible taxa. Samples were preserved in Lugol's solution and slides were observed under a binocular microscope (Jose et. al., 2015).

Statistical Analysis

Mean, Mean Standard Error (SE), Standard deviation, and Pearson product moment correction coefficient were employed to examine the level correlation between the physicochemical parameters at significance at $P<0.05$.

RESULTS AND DISCUSSION

Phytoplankton composition of the Ajiwa reservoir

Table 1 shows the Phytoplankton composition in the reservoir belonging to four groups and their percentage: Chlorophyta, Bacillariophyta, Cyanophyta and Dinophyta.

The phytoplankton found at the three sites is classified into four groups: Chlorophyta, Bacillariophyta, Cyanophyta, and Dinophyta (Pyrrophyta). The phytoplankton was dominated by Chlorophyta, which is consistent with Suleiman's (2021) findings in the same Ajiwa reservoir. The greater phytoplankton composition could explain the high values of soluble oxygen. This contradicts Araoye's (2008) report, which said that high oxygen concentrations (8.2 mg/L) found during the dry season were attributable to increased photosynthetic activities. Copepoda, Cladocera, Protozoa, and Rotifers are the four groups of zooplankton identified. The percentage composition of Zooplankton revealed that Rotifers have the highest proportion, correlating with the findings of Abdulkarim and Ibrahim (2018) in the same study. The reservoir had higher biological oxygen demand values, this could be because to the slow decay of phytoplankton and other living things in the reservoir. Kozak et al. (2014) made a similar observation and proposed that it was related to oxygen loss in the water during decomposition during the dry season.The high Nitrate-Nitrogen concentration in the reservoir may be owing to an excessive intake of nutrients from farmlands where fertiliser is used to promote crop productivity, particularly around the reservoir, as well as input through runoff. The findings corroborated the findings of Balogun et al. (2005), who discovered a significant concentration of Nitrate-Nitrogen in Makwaye (Ahmadu Bello University, Zaria Farm)

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Table 1: Phytoplankton composition and proportion in Ajiwa reservoir

Months	Bacillariophyta (No. /L)	Chlorophyta (No. /L)	Cyanophyta (No. /L)	Dinophyta (No. /L)
Mar.	13	48	14	0
Apr.	18	57	12	0
May	20	50	12	1
Jun.	36	87	22	8
Jul.	55	121	40	10
Aug.	63	117	33	7
Sept.	63	106	29	4
Oct.	53	103	26	2
Nov.	42	90	21	0
Dec.	36	81	17	0
Jan.	20	57	12	0
Feb.	12	50	9	0
Total	431	967	247	32
Percentage (%)	25.70	57.66	14.73	1.91

Table 2: **Composition and proportion of Zooplankton in Ajiwa reservoir**

Months	Protozoa (No. /L)	Copepods (No./L)	Cladocera (No./L)	Rotifera (No. /L)
Mar.	0	10	0	3
Apr.	0	7	0	3
May	24	12	24	24
Jun.	28	18	28	40
Jul.	37	42	32	54
Aug.	41	81	36	76
Sept.	22	72	52	90
Oct.	54	60	36	49
Nov.	54	44	28	40
Dec.	40	46	18	38
Jan.	28	24	9	24
Feb.	0	16	0	9
Total	328	432	263	450
%	22.27%	29.33%	17.85	30.55

Physico-chemical properties of Ajiwa Reservoir

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Table 3 Mean ± SE and Standard Deviation of Physico-chemical properties of Ajiwa Reservoir

Parameter/ Month	*Mar.*	*Apr.*	*May*	*Jun.*	*Jul.*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Jan.*	*Feb.*	*Mean ± SE*	*STD*
Temp(°C)	23.6	25.7	26	25.3	27.7	26	24	22.6	23.7	18.3	20.6	22.3	23.8±0.8	2.61
pH	7.4	7.8	6.9	6.9	6.7	6.5	6.9	6.8	6.8	6.9	7	7.2	6.8±0.1	0.34
Turbidity (NTU)	108.7	100	89.3	89.3	89.3	88	88.6	95.7	98.3	101	128.3	115	99.3±3.6	12.56
DO (mgL^{-1})	5	4.9	7.2	7.3	7.3	7.1	7.5	7.8	7.7	6.9	5.7	5.2	6.6±0.3	1.14
BOD(mgL^{-1})	2.1	2.3	3.6	3.6	3.6	3.6	3.6	3.8	3.9	4	2.3	2.1	3.2±0.4	0.79
EC (µS/cm)	144.6	150.1	102.4	112.4	120.7	122.2	122.7	129.7	133.3	136.6	140	144.1	129.9±4.1	14.28
TDS (mgL^{-1})	23.7	20.1	14.8	14	10.1	10.2	13.4	17	19.3	23.8	23.5	23.2	17.8±1.5	5.23
Depth (M)	4	4	5.3	5.4	5.4	6.4	7.5	6.1	5.7	5.3	5.3	4.1	5.4 ±0.3	1.03
PO_4-P (mgL^{-1})	3.4	3.2	1.7	2.5	2.7	3.1	3.6	3.8	2.4	2.7	2.4	3.2	2.9±0.2	0.59
NO_3-N (mgL^{-1})	5.9	6	6.3	6.4	6.4	7.1	7.2	6.5	6.6	5.3	4.2	5.4	6.1±0.3	0.83
Hardness (mg(CaCO3L^{-1})	99.4	91.5	83.1	84.1	84.1	87.9	88.6	84.3	87.3	90.7	90.9	94.1	88.8±01.4	4.82

Table 4: Relationship between Plankton composition and physicochemical properties in Ajiwa reservoir

	Temp	*PH*	*Turbidity*	*DO*	*BOD*	*EC*	*Hardness*	*NO_3-N*	*TDS*	*PO_4-P*	*Depth*	*Zooplankton*	*Phytoplankton*
Temp	1												
PH	-0.29ns	1											
Turbidity	-0.59*	0.867*	1										
DO	0.50*	-0.89*	-0.70*	1									
BOD	0.63*	-0.89*	-0.67*	0.97*	1								
EC	0.75*	-0.71*	-0.88*	0.62*	0.52*	1							
Hardness	-0.82*	0.29ns	0.59*	-0.01ns	0.07ns	-0.59*	1						
NO_3-N	0.64*	-0.67*	-0.92*	0.61*	0.53*	0.89*	-0.30*	1					
TDS	-0.75*	0.73*	0.81*	-0.64*	-0.52*	-0.96*	0.69*	-0.77*	1				
PO_4-P	0.41ns	-0.56*	-0.63*	0.41ns	0.27ns	0.68*	-0.31ns	0.69*	-0.65*	1			
Depth	0.58*	-0.37	0.83*	-0.65*	-051*	0.42 ns	0.47 ns	0.53*	0.57*	0.43 ns	1		
Zooplankton	0.78*	-0.37	0.83*	-0.65*	-051*	0.43 ns	0.45 ns	0.53*	0.51*	0.73*	0.81*	1	
Phytoplankton	0.57*	-0.47	-0.33*	0.75*	0.81*	0.43 ns	0.45 ns	0.81*	0.62*	0.75*	0.52*	6.33*	1

*= Significant; ns= Non Significant

The reservoir has a greater TDS value, which could be attributable to plant deterioration or a higher rate of evaporation caused by an increase in air temperature and wind during the dry season. Phosphate-phosphorus levels in the reservoir may be greater due to reduced water volume and intensive agricultural activity near the reservoir. Farmers were also using reservoir water for home purposes in which use of detergents may increased the phosphate-phosphorus level in the water. Ibrahim et al. (2009) observed a mean value of phosphorus-phosphorus (PO4-P) due to the concentration effect of decreased water volume in Kwantagora reservoir.

CONCLUSION

The higher composition of Chlorophyta and rotifers in the reservoir indicated that the quality of the water is good but increase anthropogenic activities such as; runoffs of inorganic fertilizers and pesticides may influence change in quality of the water as time goes on. The reservoir water is suitable for irrigational and domestic purposes in terms of most of the physico-chemical and biological parameters analyzed. However, considering that the reservoir is a source of drinking water, the potential of the amount of human inputs gains significance. Hence, there is need for an effective anthropogenic inputs control program in the reservoir.

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