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Assessment of the Impact of Anthropogenic Activities on Physicochemical Parameters and Phytoplankton Compositions of Kalgo River, Kebbi State

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Abstract

Anthropogenic activities can have significant and often detrimental effects on aquatic ecosystems, including water quality, biodiversity, and the overall ecosystem. This study aimed to assess the impact of washing, fishing, and agricultural activities on physiochemical parameters and phytoplankton composition in the Kalgo River. Water samples were collected from stations A (farming and irrigation), B (fishing activities), and C (washing site) using plankton nets and one-liter plastic bottles following standard methods. Phytoplankton species were identified through comparative morphological examination using a binocular light microscope (Olympus BH2) at a magnification of 100x after centrifuging the water samples. In August, higher values of pH (7.90±0.23), EC (793.91±3.56 µs/cm), P (0.31±0.05 mg/l), NH_4 (0.63±0.23 mg/l), and TDS (529.27±0.13) were recorded. The highest temperature (29.66±1.50°C) and maximum concentrations of DO (7.52±0.25 mg/l), BOD (22.4±10.29 mg/l), Ca^{2+} (164.0±13.21 mg/l), and Cl^- (15.40±0.59 mg/l) were found in June. A total of 341 phytoplankton species distributed across 37 genera and belonging to seven classes were identified. The dominant class was chlorophyceae (31.43%), followed by Bacillariophyceae (25.72%) and Cyanophyceae (20.00%), with Rhodophyceae recording the lowest percentage (2.86%). Station B exhibited the highest species composition (41.35%), while station C had the lowest (26.96%). No significant difference (P>0.05) was observed in phytoplankton composition variations between the stations. Crucigenia sp. had the highest occurrence (8.50%), followed by Navicula digitoradiata (7.33%), Volvox sp. (6.16%), and Craticula sp. (5.28%). Asterionella sp., Vaucheria sp., and Melosira variants each accounted for 0.88% of the composition. Despite the diverse phytoplankton assemblage in the Kalgo River, further studies are necessary to evaluate the specific impacts of anthropogenic activities on different phytoplankton species and their overall health in the river.

Keywords: Anthropogenic, Ecosystem, Kalgo River, Phytoplankton.

INTRODUCTION

Water is a crucial natural resource for sustaining human health and the survival of all living organisms. Rivers, as open and dynamic aquatic ecosystems, are influenced by wind and anthropogenic activities within and around their drainage basins. These rivers, being the oldest freshwater bodies, offer essential services such as domestic water supply, agricultural production, manufacturing, transportation, forest resource management, wildlife conservation, recreation, and aesthetic values (Solihua and Bilewu, 2022). Despite the ecological and domestic functions of river water, it is often poorly managed and contaminated by both point and non-point sources (Nwonumara, 2018; Mezgebe *et al.*, 2015). Many rivers, lakes, reservoirs, and ponds have experienced physicochemical changes due to anthropogenic disturbances from land use activities (Xiao-e *et al.*, 2008). The rapid urbanization, industrialization, and intense agricultural practices contribute to increased nutrient levels in the aquatic ecosystem, leading to eutrophication (Alum-Udensi and Awomand-Ofor, 2016). Surface runoff from various sources like roads, mechanical garages, municipal areas, agricultural lands, mining sites, and impervious surfaces is a significant cause of river pollution, carrying pollutants such as gasoline, heavy metals, trash, and other contaminants that directly enter streams and rivers (Irfan and Shakil, 2012).

Increasing human activities, as well as natural processes such as precipitation, erosion, and weathering, degrade surface water quality and pose major hazards to all aquatic organisms, including humans (Kemp *et al.*, 2020). Disposal of industrial effluents and municipal wastes into rivers, as well as various agricultural operations occurring near water bodies primarily containing nitrogen and phosphorus compounds, significantly contaminate and impact the water quality of the river (Adeosun *et al.*, 2016). The physicochemical parameters of water vary from one ecosystem to another, often determined by input from the surrounding environment, catchment area, or runoff and the addition of pollutants from human sources (Kumar *et al.*, 2022). Evaluation of the physicochemical properties of water provides a synergistic interaction between aquatic organisms and their environment, which can be used to detect environmental changes affecting water quality and its potential productivity (Ezekiel *et al.*, 2020; Hassan and Ibrahim, 2021). Physicochemical parameters of water are the major factors influencing the aquatic environment, controlling the dynamics and structure of phytoplankton (Kane *et al.*, 2015), and limiting the survival, distribution, composition, and productivity of aquatic flora and fauna (Haag, 2012).

Phytoplankton are autotrophic microscopic organisms that undergo photosynthesis to produce their own food from sunlight and form the basis of aquatic food chains and webs (Jahan and Singh, 2023). They convert inorganic nutrients such as phosphate, nitrate, and carbon dioxide into complex organic compounds necessary for life, which serve as food for higher trophic level aquatic macroorganisms (Magami *et al.*, 2014). Acting as a valuable biological indicator, phytoplankton enable the assessment of aquatic ecosystem pollution and ecological status (Zaghloul *et al.*, 2020). Due to their low tolerance to environmental disturbances, phytoplankton are excellent indicators of water quality and highly susceptible to pollution, although some can survive and reproduce in disturbed and highly contaminated water bodies (Ugwumba and Esenowo, 2020). Phytoplankton produce various bioactive substances in aquatic environments, some of which are toxic to aquatic organisms and may pose a threat to humans through the food chain (Pradhan *et al.*, 2022). While fish can endure the accumulation of such substances without noticeable effects, higher vertebrates in the food chain, like humans, may experience illness or even death due to elevated concentrations of potent compounds. As noted by Khatri (2014), the distribution pattern of phytoplankton can be used to assess the water quality of an environment. The discharge of industrial effluents into rivers increases biochemical oxygen demand (BOD), dissolved oxygen, ecological status, productivity, and the concentrations of major ions and heavy metals (Khatri, 2014). In the case of the Kalgo River, various human activities including farming, irrigation, fishing, construction operations, trash disposal, and washing of clothing and vehicles have taken place. These activities could potentially impact both the physicochemical and biological features of the Kalgo River. Studies have been conducted on the effects of monthly variations in limnological parameters on phytoplankton distribution in the Kalgo River, with a higher species diversity found in Cyanophyceae, Bacillariophyceae, and Chlorophyceae (Jaafar *et al.*, 2019). Maishanu *et al.* (2019) investigated the impact of human activities on the phytoplankton communities of the River Rima in the Kwalkwalwa area of Sokoto State, Nigeria, along with other related studies on phytoplankton in Kebbi State. Maharana *et al.* (2019) reported the presence of Bacillariophyta, Chlorophyta, Cyanobacteria, and Dinophyta in the Chilika Lagoon. Magami *et al.* (2014) identified a higher phytoplankton assemblage in the class Chlorophyceae, followed by Bacillariophyceae and Dinophyceae in the Shagari reservoir. However, there is limited or no existing data on the influence of anthropogenic activities on phytoplankton assemblages in the Kalgo River. This study aims to fill this information gap by evaluating the impact of anthropogenic activities on the physicochemical parameters and phytoplankton composition of the Kalgo River.

MATERIALS AND METHODS

Study Area

The study was conducted in Kalgo Local Government Area, Kebbi State. The Kalgo River is located between Latitude 12°19'0" N and Longitude 4°12'0" E and is a tributary of the Anka River from the Zamfara River, running approximately 250 kilometers west into Kebbi State, where it connects with the Sokoto River. Kebbi State is located in the Sudan savanna in the extreme northwestern part of Nigeria between Latitude 12.45^{0}" N and Longitude 4.20" E. The state is marked by a single rainy season which lasts from May to October with a mean annual rainfall of about 720mm and a long dry season, which lasts for the remaining period of the year; March is considered a transition between the dry and rainy seasons (Salisu *et al.*, 2021). The mean temperature range is 26^{0}C during the harmattan season (November to February) and 38^{0}C to 40^{0}C from April to June. Agricultural operations and various human activities such as fishing, swimming, bathing, and washing (clothes and vehicles) occur along the river bank.

Collection of Water Samples and Processing

Water samples were collected from March to August 2021, between 8 am to 10 am. Based on human activities, three sampling stations were selected and their positions were accurately determined using a GPS kit (IEC - 529 IPX7 Model). The pH, total dissolved solids, transparency, electrical conductivity (EC), and temperature were determined *in-situ* using pH meter, TDS tester (mg/L), Secchi disc, and conductivity meter (Hanna H198303), and mercury-in-glass thermometer, respectively. The water sample was collected by immersing a one-liter capacity plastic bottle into the river to collect water, properly labeled, and then transported to the Laboratory of the Department of Biological Sciences, Federal University Birnin Kebbi, for analyses of physicochemical parameters.

For phytoplankton analysis, water samples were collected using a plankton net (25m mesh size) equipped with a flow meter to determine the volume of water **filtered**. A glass jar (50cl) tied with a cotton rope at the end of the plankton net was used for sample collection (Maharana *et al.*, 2019). The net handle was submerged in the **water**, dragged to the desired depth for sample collection, and then raised to allow the samples to drain into the glass jar. Subsequently, the samples were transferred into 1-liter capacity plastic bottles for further analysis. To preserve the samples, Lugol's iodine solution and concentrated formaldehyde solution were added immediately after collection in an amber glass bottle (Kürten *et al.*, 2015**).**

After allowing the samples to sit overnight, the supernatant was discarded, and the sediment was collected. Subsequently, 5 ml of the sediment was transferred into a centrifuge tube, which was then spun at 2500 rpm for 15 minutes (Maishanu *et al.*, 2019). The supernatant was then removed, and a small amount of the sediment was placed in the center of a sterilized glass slide. A cover slip was gently applied to avoid air bubbles and overflooding (Maishanu *et al.*, 2019). Phytoplankton species were identified through comparative morphological examination using a binocular light microscope (Olympus BH2) at a magnification of 100x. Taxonomic identification of phytoplankton species was conducted with the assistance of identification keys as per Ibrahim and Nafi'u (2017). Each sample was analyzed in triplicate, and the quantity of each specific phytoplankton species in the mount was documented in a datasheet.

RESULTS AND DISCUSSION

Physicochemical Parameters of Kalgo River

Table 1 showed monthly physicochemical parameter concentrations of Kalgo River water from March 2021 to August 2021. The concentrations of pH, dissolved oxygen (DO), biological oxygen demand (BOD), P, Na^{+}, and NH_4 were found to be higher in August with 7.90±0.23, 7.52±0.25 mg/l, 22.41±0.29 mg/l, 0.31±0.05 mg/l, 1.17±2.28 mg/l, and 0.63±0.23 mg/l, respectively. The lowest concentrations of pH (6.00±2.60), DO (5.20±2.02 mg/l), BOD (19.40±1.88 mg/l), Na+ (0.60±3.26 mg/l) and NH4 (0.40±0.06 mg/l) were found in March, but equal concentrations of P (0.22±0.12 mg/l) were

Table 1: Physicochemical Parameters of River Kalgo, 2021

Parameters	March	April	May	June	July	August
T (^{0}C)	27.66±0.33	28.27±1.16	28.66±0.58	29.66±1.54	27.66±0.58	27.40±0.01
pH	6.00±2.60	6.10±1.7	6.13±2.90	6.99±0.07	6.79±0.25	7.90±0.23
EC (µs/cm)	175.70±0.07	186.5±19.90	202.00±0.23	222.00±0.29	273.71±14.20	793.91±3.56
DO (mg/l)	5.20±2.02	5.90±2.06	6.20±1.96	7.40±0.087	6.90±0.17	7.52±0.25
BOD (mg/l)	19.40±1.88	20.00±6.94	20.9±7.11	22.31±2.90	21.60±2.76	22.41±0.29
Ca$^+$ (mg/l)	110.01±2.56	96.10±2.96	84.00±4.46	164.01±3.21	122.12±3.71	144.10±5.29
Mg^{2+} (mg/l)	183.6±0.99	103.20±2.63	99.61±0.12	87.63±1.25	97.21±1.17	81.60±2.51
K$^+$ (mg/l)	0.80±0.09	0.70±0.12	0.42±0.30	0.33±0.15	0.62±0.07	0.41±0.59
Na$^+$ (mg/l)	0.60±0.26	8.01±1.17	1.04±2.69	1.02±3.50	1.10±2.29	1.17±2.28
P (mg/l)	0.22±0.12	0.23±0.13	0.21±0.11	0.21±0.12	0.25±0.15	0.31±0.05
CO$_3$ (mg/l)	ND	ND	ND	ND	ND	0.22±0.17
HCO$_3$ (mg/l)	56.22±5.39	60.02±7.46	60.23±6.28	64.11±9.59	60.33±5.65	56.01±3.15
Cl$^-$(mg/l)	4.80±0.41	3.03±0.60	4.72±0.12	15.40±0.59	5.03±0.40	2.50±1.70
NH$_4^+$ (mg/l)	0.40±0.06	0.42±0.21	0.44±0.16	0.60±0.09	0.42±0.50	0.63±0.23
NO$_3$ (mg/l)	1.02±0.22	1.81±1.29	1.40±0.52	1.20±0.32	1.20±0.32	1.60±1.15
Trnsp (m)	2.93±0.36	2.44±0.38	2.11±1.11	1.56±0.22	1.66±1.23	2.76±1.23
TDS	117.13±0.12	124.33±0.40	134.67±0.10	144.67±0.14	182.47±0.09	529.27±0.13

ND= Not detected

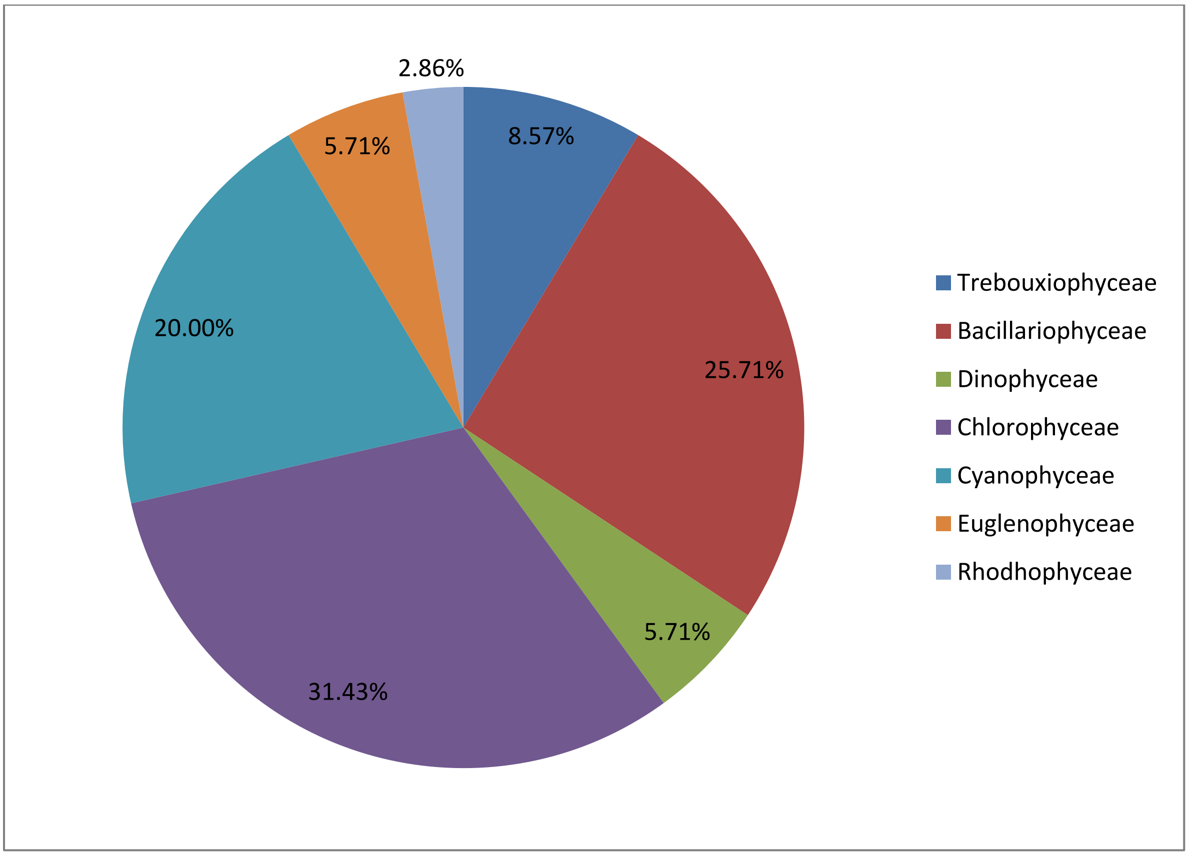

Figure 1: Percentage Composition of Phytoplankton Identified among the Classes in Kalgo River, Kebbi State, 2021.

Table 2: Phytoplankton Composition and Distribution in River Kalgo, 2021

Class	Species	Sampling Stations				RF (%)
		A	B	C	Total	
Bacillariophycae	*Synedra ulna*	3	1	4	8	2.35
	Navicula digitoradiata	8	12	5	25	7.33
	Cymbella sp.	6	8	0	14	4.11
	Melosira varians	0	1	2	3	0.88
	Rhopolodia gibberula	6	0	5	11	3.23
	Craticula sp	4	9	5	18	5.28
	Nitzchia acicularis	1	4	3	8	2.35
	Cyclotella sp	5	8	4	17	4.99
	Pseudontzshia fraudulena	4	0	2	6	1.76
Cyanophycae	*Oscillatoria agrdhii*	4	9	1	14	4.11
	Lyngbya sp.	2	0	2	4	1.17
	Westella botryoiden	5	6	1	12	3.52
	Microcystis sp.	2	4	5	11	3.23
	Oesdugonium sp	2	0	4	6	1.76
	Rivularia sp	1	0	3	4	1.17
	Anaebana sp	0	2	2	4	1.17
Chlorophycae	*Volvox sp*	2	11	8	21	6.16
	Pediastrum boryanun	4	7	1	12	3.52
	Ankistrodesmus sp.	3	4	3	10	2.93
	Ulothrix zonata	0	1	3	4	1.17
	Pediastrum duplex	3	6	3	12	3.52
	Ulothrixva riabilis	0	2	0	2	0.59
	Spirogyra sp.	3	4	6	13	3.81
	Rhizoclourium sp	0	2	3	5	1.47
	Estrum sp	1	2	3	6	1.76
	Vaucheria sp.	1	0	2	3	0.88
	Chlorolla sp	0	5	2	7	2.05
Trebouxiophycae	*Crucigenia sp.*	9	13	7	29	8.5
	Dictyusphasium sp	6	3	0	9	2.64
	Closterium sp	4	6	3	13	3.81
Euglenophycae	*Euglena viridis*	5	0	1	6	1.76
	Karenia brevis	5	3	0	8	2.35
Dinophycae	*Sarchina ventriculi*	1	4	2	7	2.05
	Asterionell Sp.	1	2	0	3	0.88
Rhodophyta	*Cosmopogon Sp.*	2	2	2	6	1.76
Total		**103 (30.21%)**	**141 (41.35%)**	**97 (28.45%)**	**341**	**100.00%**

Table 3: Phytoplanton Species Diversity Index in Kalgo River, 2021

	A	B	C	Remarks
Taxa_S	29	28	30	Highest in station C and lowest in station B
Individuals	103	141	97	Highest in station B and lowest in station C
Dominance_D	0.047	0.052	0.043	Highest in station B and lowest in station A
Simpson_1-D	0.953	0.948	0.957	Highest in station C and lowest in station B
Shannon_H	3.191	3.112	3.262	Highest in station C and lowest in station B
Evenness_e^H/S	0.839	0.803	0.871	Highest in station C and lowest in station B
Brillouin	2.804	2.813	2.842	Highest in station C and lowest in station A
Menhinick	2.857	2.358	3.046	Highest in station C and lowest in station B
Margalef	6.041	5.456	6.339	Highest in station C and lowest in station B
Equitability_J	0.948	0.934	0.959	Highest in station C and lowest in station B
Fisher_alpha	13.43	10.48	14.86	Highest in station C and lowest in station B
Berger-Parker	0.087	0.092	0.083	Highest in station B and lowest in station C

recorded in May and June. The concentrations of Mg^{2+} ranged from 81.60±2.51 mg/l in August to 183.6±0.99 mg/l in March and K^{+} recorded (0.33±0.15 mg/l in June to 0.80±0.09 mg/l in March), while Ca^{2+}, Cl^{-}, and HCO_3 concentrations ranged from (84.0±04.46 mg/l in May to 164.0±13.21 mg/l in June), (2.50±1.70 mg/l in August to 15.40±0.59 mg/l in June) and maximum value of HCO_3 (64.11±9.59 mg/l) was found in June. Nitrate (NO_3), a form of nitrogen vital for the growth and survival of aquatic organisms, was found to be between the ranges of 1.02±0.22 mg/l in March to 1.81±1.29 mg/l in April. The concentrations of electrical conductivity (EC) and total dissolved solids (TDS) in this study were continuously increased from lower in March (175.70±0.07 µs/cm and 117.13±0.12) to higher (793.91±3.56 µs/cm and 529.27±0.13) in August.

Phytoplankton Composition in Kalgo River

The phytoplankton composition comprised a total of three hundred and forty-one (341) species distributed over thirty-seven (37) genera and belonging to seven (7) classes (Table 2). Among these genera in Figure1, the highest percentage composition of 31.43% was found to be under the class Chlorophyceae, followed by class Bacillariophyceae with 25.71%, while 20.00% and 8.57% were respectively recorded under Cyanophyceae and Trebouxiophyceae. The classes Euglenophyceae and Dinophyceae each recorded 5.71%, but only 2.86% were found under class rhodophyceae.

Regarding the sampling stations, the occurrence of phytoplankton in the seven classes was not uniform, with species composition found to be higher in station B, accounting for 41.34%, followed by station A with 30.21%, and the lowest species composition recorded at station C (28.45). Although species composition varies between the sampling stations, the results were not statistically significant (P>0.05) at a 95% confidence interval. The species *Crucigenia* sp. of the class Trebouxiophyceae is the most dominant at 8.50%, followed by *Navicula digitoradiata* of the Bacillariophyceae at 7.33%, while *Volvos* sp. of the Chlorophyceae and *Craticula sp*. of the Bacillariophyceae had 6.16% and 5.28%, respectively. The rare individual species of *Asterionell* sp. of the class Dinophyceae, *Vaucheria* sp. of the Chlorophyceae, and *Melosira varians* of the Bacillariophyceae were each recorded with a 0.88% percentage distribution (Table 2).

Phytoplanton Species Diversity in Kalgo River

Table 3 shows the diversity indices of the three (A, B and C) sampling stations. The Simpson and Shannon diversity index varied from lower of

0.948 and 3.112 in point B to a maximum in points A with a Simpson and Shannon diversity index of (0.957 and 3.262), respectively. The Margalef Species Index, Evenness, Brillouin, Equitability and Fisher alpha was found to be higher in sampling point B with the following values, (6.339), (0.871), (2.842), (0.959) and (14.86), respectively.

DISCUSSION

The results of the studies reveal an overall increase in the physicochemical parameters of the Kalgo River, which are attributed to increasing agricultural practices, precipitation that washes out organic matter, such as animal waste, plants, and animal debris from land into the water bodies, and re-suspension of bottom sediments. However, the presence of this organic material would serve as a food source for decomposer microorganisms (Maishanu *et al.*, 2018). During the present study, it was observed that the concentration of pH in the Kalgo River water is moderately acidic from March to July and shifts to slightly alkaline in August. The pH values recorded during the present study were found within WHO-recommended limits (5.5-7.5) suitable for aquatic life (Magami *et al.*, 2014). The maximum concentrations of biological oxygen demand (BOD), Mg^{2+}, K^+, Ca^{2+}, Cl^-, HCO_3 P, Na^+, and NH_4 may be due to pollution of agricultural and domestic runoff, and other human activities like washing of vehicles and clothes, and waste disposal, within and around the river. Ayobahan *et al.* (2014) reported that DO levels fluctuate due to the presence of organic pollutants in water, mostly from human activities. In line with the findings of Olalekan *et al.* (2017) in the Ogun River, the maximum levels of DO recorded in August during this study are consistent with their report of the lowest DO levels in the dry season. The presence of low DO concentration in March indicates a potential increase in decomposition processes by bacteria and other decomposers, suggesting pollution susceptibility in the River Kalgo from human activities along its banks (Hassan and Ibrahim, 2021). The more decomposable matter is in the water, the higher the oxygen demand and BOD values (Ayobahan *et al.*, 2014). The BOD measures the amount of oxygen required for the survival of aquatic organisms or the oxygen required by bacteria to decompose organic matter present in water bodies (Ayobahan *et al.*, 2014). The highest P concentrations recorded in August might be due to the fertilizer and herbicide applications by local farmers around the river Kalgo, which are deposited by runoff. The nitrogen and phosphorus concentration in water bodies increase through anthropogenic activities such as fertilization and industrial releases (Shen *et al.*, 2020). However, the findings of this study contradict the findings of Obaroh *et al.* (2019), who reported higher water temperatures in June in the River Argungu. The variation in water temperature observed in this study compared to other studies might be because of the rate of human activities and the local climatic conditions. The amount of dissolved oxygen in water is influenced by temperature, which in turn affects the survival of aquatic organisms (Ayobahan *et al.*, 2014). The stress on aquatic ecosystems caused by high water temperatures is due to the diminished capacity of water to retain essential dissolved gases like oxygen, leading to mortality in fish and other invertebrates (Kumar and Bahadur, 2009).

From lower concentrations in March to a higher concentration in August, the electrical conductivity (EC) and total dissolved solids (TDS) recorded in this study showed a continuous increase. The higher EC and TDS values in August might indicate a high amount of total dissolved solids, possibly due to the influx of dissolved inorganic substances from agricultural runoff, carrying particles from the surrounding land, discharge of domestic waste, and other anthropogenic activities like washing of vehicles, clothes, bathing, and runoffs. Consistent with Verla *et al.* (2015), our results demonstrate a similar trend of TDS with electrical conductivity in the River Galma Zaria, Kaduna State. The concentrations of EC and TDS in river water reflect the types of ions present as dissolved substances in the water (Priyanka, 2017). According to Anago *et al.* (2013), water conductivity values below 50µmhos/cm are considered low, between 50-600µmhos/cm are considered medium (acceptable for aquatic life), and EC values above 600µmhos/cm are considered high. The EC value (846.8 µs/cm) recorded in October during this study indicates high water EC values, contrasting the findings of Nababa *et al.* (2024), who reported maximum EC value during the dry season and minimum during the wet season.

The phytoplankton identified during this study slightly differs from the findings of previous studies conducted in different Nigerian water bodies. These variations could be attributed to species tolerance limits, the location of the river, climatic factors, human activities, and the physicochemical condition of water bodies. The findings of this study disagree with Maharana *et al.* (2019), who reported Bacillariophyta, Chlorophyta, Cyanobacteria, and Dinophyta in Chilika Lagoon. While Ewa *et al.* (2013) reported the distribution of phytoplankton in Chlorophyta, Baccillariophyta, Cryptophyta, and Euglenophyta from Gbedikere Lake, Bassa, Kogi State, Nigeria. Adesalu (2010) also identified Chlorophyceae, Bacillariophyceae, Euglenophyceae, and Cyanophyceae, but Chlorophyceae dominated the phytoplankton spectrum of the River Oli in Kanji National Park. Ugwumba and Esenowo (2020) revealed phytoplankton compositions in the order of Bacillariophyta, Chlorophyta, Cyanophyta, and Euglenophyta, in Lagos Lagoon, Nigeria. In various water bodies, the dominant phytoplankton and their seasonality exhibit significant variability based on factors like nutrient status, age, morphometrics, and others, as shown by studies (Celekli and Kulkoyluoglu, 2006).

The composition of phytoplankton species in the seven (7) classes was not uniform among the sampling stations, but generally highest in station B and lowest in station C. Species composition was found to be higher in station B (41.35%), followed by station A (30.21%), and the lowest species were recorded at station C (28.45%), which might be due to human activities, nutrient enrichment that favors phytoplankton growth, and the species' resilient ability to withstand the varied environmental factors. Although the results were not statistically significant ($P > 0.05$) between sampling stations, the results revealed that fishing activities do not negatively affect phytoplankton composition compared to washing and construction operations, but these activities do not significantly affect phytoplankton diversity. The variation in species composition might be due to human activities, nutrient concentrations that encourage phytoplankton growth, and the species' resilient ability to withstand the varied environmental factors. Nutrient availability from catchment inflow, coupled with sediment re-suspension, regulates phytoplankton composition (Muhammed and Saminu, 2012). The river's nutrients are sourced from agrochemicals (fertilizers and pesticides) from surrounding farmlands and deposited organic and domestic runoff. The composition of these species may be attributed to their ability to adapt to a wide range of physicochemical parameter changes and anthropogenic influences (Dauda *et al.*, 2020). Favorable physiochemical parameters greatly influenced the growth and reproduction of phytoplankton (Ajuonu *et al.*, 2012). Dauda *et al.* (2020) reported that in water bodies where domestic and agricultural activities persist, the growth of Chlorophyta and Cyanophyta is accelerated. According to Kshirsagar *et al.* (2012), the presence of *Nitzchia acicularis*, *Oscillatoria agrdhii*, *Navicula digitoradiata*, *Euglena viridis*, *Microcystis* sp., and *Chlorella* sp. in water bodies indicates water pollution, which also indicates water quality and environmental conditions as they are adapted to a wide range of physicochemical conditions. These microscopic organisms are highly sensitive to variations in their surroundings and respond by forming specific blooms. Ibrahim and Nafi'u (2017) reported that the presence of *Microcystis* sp., *Oscillatoria* sp., *Scenedesmus sp.*, *Euglena* sp., and *Phacus* sp. clearly indicate organic water pollution. The presence of algal communities can help determine the pollution levels and water quality in this globally important lake (Fonge *et al.*, 2012).

CONCLUSION

The physicochemical parameters of water and phytoplankton assemblages in River Kalgo were significantly impacted by human activities, and the species' resilience to environmental changes. The study revealed that fishing, agricultural, and irrigation activities do not negatively affect phytoplankton composition. Further research should be conducted on pollution-tolerant species and phytoplankton indicators of aquatic pollution. It is

recommended to conduct further monitoring and implement management practices to maintain the ecological health and water quality of the Kalgo River. This could involve strategies to minimize agricultural runoff, control domestic waste disposal, and raise awareness about the river's ecological importance.
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