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Full Length Research Article

STUDY OF PHYTOPLANKTONIN RELATION TO PHYSICO-CHEMICAL PROPERTIES OF A DRAINAGE IN KAKURI INDUSTRIAL BASE SETTLEMENT IN KADUNA, NIGERIA.

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ABSTRACT

Studies were made on seasonal variation of Phytoplankton communities and some physico-chemical properties such as water temperature, pH, electrical conductivity, dissolved oxygen, transparency and biochemical oxygen demand in three selected stations on the drainage viz: station A, station B and station C for a period of one year from 2010 to2011. A total of 55 species of phytoplankton belonging to different taxonomic groups were identified out of which 27 species of phytoplankton belong to Chlorophyceae, 19 species to Bacillrophyceae and 9 species to Cyanophyceae. Six algal species were identified commonly in the 3stations; two algal species were identifying to station B while station C had eight algal species. The species occurrence of the different study stations reflects relationship between season and physico-chemical properties of the water, the phytoplankton density was high during rainy season and low during dry season, *Chlorophyceae* formed the dominant group. In the present investigation among the three stations, the water temperature in Station-A was generally high reaching 31.5°c in most of the months. Station-B and C temperature dropped from Decembers to February and also in the wet season's months. Conductivity highest value was 641mg/l recorded in March, dissolves oxygen recorded highest value of 6.5mg/l. Transparency recorded the highest value in May to July (908 to 909mg/l), Station-B was acidic in some months than Station –A and C. Station-A had the highest biological oxygen demand while Station –B had the highest dissolute oxygen values. Electrical conductivity and Transparency was higher during the dry season.

Keywords: Algae, Drainage, Effluent, Physic-chemical properties, Phytoplankton, Relation.

INTRODUCTION

The name phytoplankton consists of two Greek words meaning plant (phyto) and wander (plankton). There are two major groups of phytoplankton-1 fast-growing diatoms and 2 flagellates and dinoflagellates. This can migrate vertically in the water column in response to light. Each group exhibits a tremendous variety of cell shapes (Bukar, 2002).

All species of phytoplankton move at the mercy of oceanic current for transport to areas that are suitable for their survival and growth. However, the physical and chemical processes can play a significant role in determining the distribution of phytoplankton species. Thus phytoplanktons vary widely in physical and chemical requirements for population growth (Rani *et al.,* 2012).

All species of dinoflagellates and diatoms share certain basic requirement for growth (light, carbon dioxide, nutrients, trace element, habitable, temperature and salinity), they can differ considerably in their optimal requirement for these factors.

Phytoplanktons are first link in nearly all aquatic food chain (Babatunde *et al*., 2014), without phytoplankton, the diversity and abundance of aquatic life would be impossible. Phytoplankton provide, food for a tremendous variety of organisms, including zooplankton (microscopic animal), bivalve molluscan, shellfish (mussels, oysters, scallops and clams), and small fish. These animals provide food for other animals and humans (Bukar, 2002). Phytoplankton have both beneficial and detrimental effect on human, the presence of algae in any kind of water body is an indicator of pollution (Hassan *et al*.,2010).The study of phytoplankton diversity contributes to an understanding of the environment status of a water body(Rani *et al.,*2012). Much work has been carried out in Nigeria on phytoplankton on coastal water habitats

Studies on phytoplankton algae of Lotic effluents environment and fresh water in Nigeria are scanty, however, some research work have been carried out by Ajani (2010); Babatunde (2014); Ezra,(2000); Ezra *et al.*(1997); Hassan *et al.*(2010); Gabriel(2013); Onyema(2007); Onyema *et al*.(2007); Chia (2007); Nwankwo et al.(2003); Nwankwo et al.(1996); . and Yahuza (2010). Hence, the present study was aimed to know the influence of physicochemical parameter of water on phytoplankton population and their seasonal changes focused on Coca-cola and seven up (7up) bottling effluent, with the view to relate changes in algae taxa to some physic- chemical properties of the environments.

MATERIALS AND METHODS

Study area

The drainages of Coca- cola and 7up Company are located in Kakuri Kaduna South Local government area of Kaduna state (Fig 1).This drainage forms part of the numerous ecological niches associated with freshwater environment. It flows throughout the year and receives inflow from Coca-cola and seven up (7up) bottling effluents and waste water from settlement around. The drainage is used as a source of drinking water for domestic animals as well as for dry season farming.

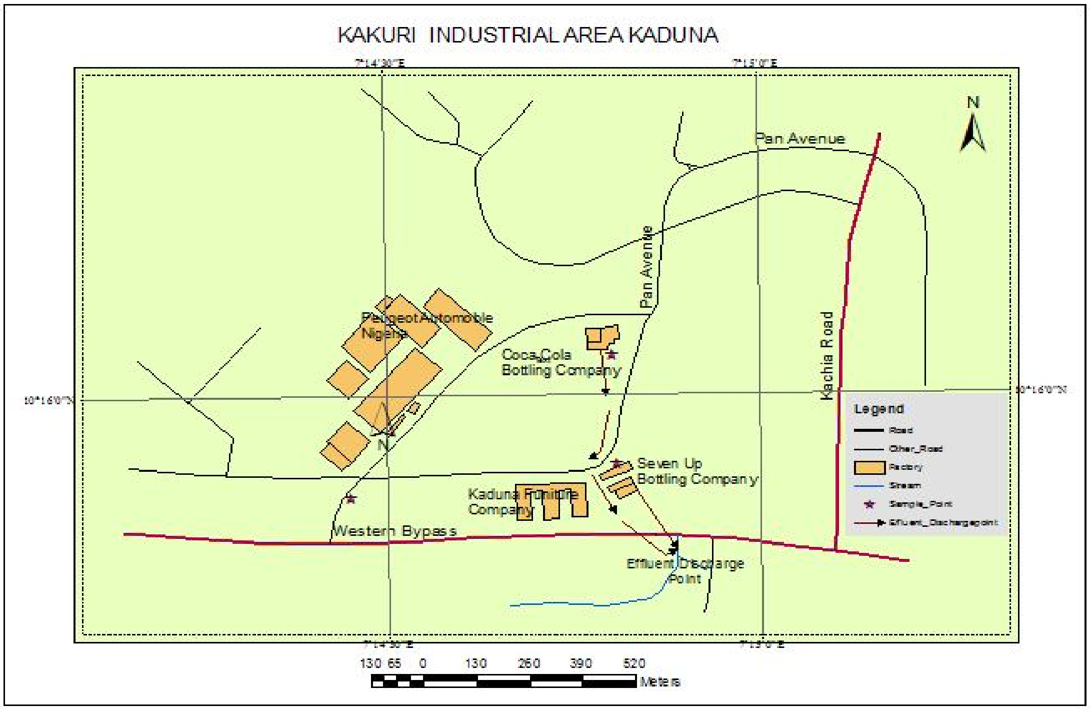

Fig.1: Map showing Kakuri industrial area and sampling sites.

Sample Collection

Duplicate water samples were collected for physicochemical and biological analysis at interval of month from January to 2009 December, 2010 between 9:00am - 10:00am. Three sampling stations Viz. Station A, B, and C- Sampling stations were selected to represent different environment and ecological variations within the drained. Sampling Station A is at Coca-cola effluent discharging point, Station B is 7-Up bottling discharging effluent drainage and Station C is the (Confluent Station of A & B).. Water sample was collected in two liters jar, the jar was screwed tight. The plastic containers were labeled appropriately and place in a plastic box containing ice and transported to the laboratory for further analysis.

Procedures of Measuring Parameters

The surface water temperature, Log of concentration (pH), Electrical conductivity (Ec) were measured in situ with portable metre model 210.Transparency was measure with secchi disc painted black and white, dissolved oxygen (DO) was measure with yellow spring instrument model 57, Biochemical Oxygen Demand (BOD) was estimated using APHA (1995).

Preservation – planktonic algal materials were preserved in 4% buffered formalin solution prior to observation. Sub- sample of the original sample were preserved in Lagols iodine to prevent any loss of flagella in the flagellates.

Wet mounts of alga materials on glass slide were examined using an Olympus light microscope fitted with a phase – contrast condenser. It had calibrated eye – piece graticules.

All the species from the three stations were studied, compiled and arranged in systematic order following the classification used by Hardy *et al.* (1986) which places them in alphabetical order. Identification was carried out with the aid of a reference manual by Palmer(1980), Prescott, (1961) and, Patrick and Reimer (1965).

RESULTS

A total of 55 species were studied and compiled systematically (Hartley, 1986), placing the species into 3 divisions, 3 classes and 9 orders. Station A had species representative from 8 orders while Station B and Station C had species representative from the 9 orders. Table 1.

Table 1: List of Algae abundance and Composition in water sample of Stations(A,B and C).

DIVISION	CLASS	ORDER	STATIONS		
			A	B	C
Bacillariophyta	Bacillariophyceae	*Centrales*	+	+	+
		Pennales	+	+	+
Chlorophyta	Chlorophyceae	*Chlorococcale*	+	+	+
		Englenales	+	+	+
		Ulotrichales	+	+	+
		Volvocales	-	+	+
		Zygematales	+	+	+
Cyanophyta	Cyanophyceae	*Chrococales*	+	+	+
		Nostocales	+	+	+

Key + = Present; - = Absent. Phytoplankton species presented in Division, Class and Order Station-A (Coca-Cola effluent), Station B (7-UP Effluent) and Station C (confluent of Station of A& B).

Physico- Chemical Aspects
The surface water temperatures in the three stations are presented in Table2. Lowest temperatures values of 23.6°Cand25.6°C were recorded in December and February respectively, after which it began to rise reaching a peak in all the stations in April and began to , dropping to about 26 °C in May and August in stations- A and B. Station- A had high values all through the study period.

The pH of the Station-A ranges from 7.2 (recorded in February and March) to 8.1 (recorded in October). For Station- B the lowest pH of 5.2 was recorded in August, while the highest (8.0 to 8.1)was again recorded in February. Station C had the lowest pH values 6.5 in August.

The conductivity values (Table 2) varies considerably during the study period generally, the values were relatively higher from February to April in the three Stations after which it began to decline especially during the wet season in Station- B and C. The highest value (641 µS/cm)was recorded in Station –A in September throughout the study period. There was significant variation regarding their monthly fluctuation in each Station.

Table 2. Monthly variation of some physico-chemical properties in the three Stations (A,B and C)

Months	**Temperature**(°C)			**pH**			**Ec** (µS/cm)		
	A	**B**	**C**	**A**	**B**	**C**	**A**	**B**	**C**
January	30	30	29	7.5	7.3	7.4	239	239	243
February	30	26.3	28	7.2	8.0	7.6	249	218	233
March	31.5	31	31.5	7.5	8.0	7.6	239	241	245
April	30	31.5	31.5	7.2	7.3	7.5	249	240	238
May	31	26.5	26	7.8	6.8	7.5	266	223	242
June	31.5	27.5	29.5	7.8	7.0	7.5	283	226	245
July	31	25.5	28.7	7.5	6.8	7.3	263	224	243
August	31	27	29	7.8	5.2	6.5	270	209	239
September	29.4	25.6	27.5	8.1	6.7	7.4	641	558	599
October	31	27.9	29.1	7.8	7.4	7.6	266	239	241
November	31	27	29	7.6	8.1	7.9	419	364	390
December	30	23.6	27	7.5	6.5	7.8	239	188	214

Variables were measured in mg/g except for Temperature (°C) and electrical conductivity (µS/cm)Station-A (Coca-Cola effluent), Station B (7-Up Effluent) and .Station C (confluent of Station of A& B).

The Secchi disc-determined transparency values for the different Stations are shown in Table 3. Station-A had its highest value(56mg/l)in November, while the lowest value (18cm) in March, May and October. Station –B had the highest value ranging from(908cm to 908 cm) in May to July and the lowest value (20.5 cm) in April. Station- C had the lowest value ranging from 112 cm in July and 121 cm in October.

The DO values for the three Stations are also shown in Table 3.Station –A had the lowest DO value ranging from (36 mg/l) to(46 mg/l), this was followed by Station-B with DO values ranging from (38.4 mg/l) to(50 mg/l). Differences between wet and dry season values on temperature, pH and Conductivity were significant ($p < 0.05$).

The biochemical oxygen demand (BOD) reading for the three Stations are presented in Table 3. Generally, higher BOD reading was recorded in some dry season months as well as some months in the wet season. Station –B had the highest BOD varying between(4.0 mg/l) in August and(6.5 mg/l) in December. This was followed by Station-C with BOD ranging between(4.0mg/l) in August and (5.4 mg/l) in November. Station –A had lowest BOD ranging between(2.0 mg/l) in October and(2.2 mg/l) in January. There was a significant difference ($p < 0.05$) between wet and dry season values on transparency and BOD were significant.

Table 3: Monthly variation of some physico-chemical properties in the three Stations (A,B and C)

	Transp.			**DO** (mg/l)			**BOD** (mg/l)		
	A	B	C	A	B	C	A	B	C
Months									
January	21	519	270	46	60.4	52.3	2.2	2.88	2.5
February	19	430	202	49	57.5	53.2	3.1	3.6	3.3
March	18	410	195	49.5	57.8	54.3	4.0	3.8	3.4
April	19	20.5	206	49	50	52.5	3.1	3.6	3.4
May	18	908	122	42	49	48	3.0	3.5	3.2
June	19	909	120	43	50	48.5	3.5	4.0	4.0
July	20	908	112	44	49.6	46.8	3.3	3.7	3.5
August	20	627	323	46	38.4	42.2	3.1	2.5	2.8
September	24	526	275	69	44	51.5	2.7	1.7	2.2
October	18	222	121	48	55.6	50.8	2.0	2.3	2.1
November	56	376	210	36	56	45	4.2	6.5	5.4
December	21	420	205	46	45.6	45.8	2.2	2.1	2.1

Variables were measured in mg/l except for Temperature (°C) and electrical conductivity (µS/cm). Transparency (Transp.), Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD).Station-A (Coca-Cola effluent), Station B (7-Up Effluent) and Station C (confluent of Station of A& B).

Result of Phytoplankton

Distributions of plankton identified from the water samples in stations (A, B& C), are showed in Table 3. A total of 55 phytoplankton taxa were identified and recorded. The phytoplankton diversity at both stations of study was dominated by the *Chlorophyeace* (51.6%), followed by *Cyanophyeace* (35.1%) and the *Bacilirophyeace*(9.3%). Species diversity and biomass in terms of number of cell of phytoplankton were higher at station B (4810 taxa) followed by station A (3106 taxa) and C (2967 taxa) during the study period.

Table 3: Relative abundance and percentage (%) of cell counts in water sample Stations (A, B and C)

Phytoplankton	Station A	Station B	Station C	Mean
Bacilirophyta	431 (13.9)	170 (3.5)	408(13.8)	1009(9.3)
Chlorophyta	1548(49.8)	2977(61.9)	1531(51.6)	6056(55.6)
Cyanophyta	1127(36.3)	1663(34.6)	1028(34.6)	3818(35.1
Total	3106(100)	4810(100)	2967(100)	10883(100)

Stations number of Phytoplankton cells count in division

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The green forms 27 taxa comprising of *chlorococcales*(15 taxa) were more prevalent than *Euglenales*(2 taxa), *Volvocales* (6 taxa),*Ulotrichales* (2taxa) and *Zygematales* (2taxa) respectively. Among the diatoms, the pinnate forms 16taxa which were more prevalent than the centric forms (3 taxa). The blue-green algae forms 9 taxa, (5 taxa) were *Chrococales* and *Hormogondu* (4taxa). In terms of diversity and cell number in the three stations (Table3), Station A was dominated by green algae. Among them are *Ulothtix* (41),*Sphacrocystis (27), Tetraedron (25),Anabaena (19)* were the more *prevalent green algae* taxa*.* The diatoms were *Gyrosigma (64),Geminella (52)Diatoma (48) Pleurotaenium (45),Nitzschia (39),Navicula(26) and Gomphonema (22) Euglena Sanguinea (747)*and *Euglena Klebs (107).* Blue green algae diversity is *Microcystisaeruginosa (799) Microcystisincerta (119), Oscillatoriaagardhii (160), and Oscillatoria princes. (98)*Station B was dominated by green algae, in terms of diversity. *Amphora (27) Cyclotella (10),Nitzschia (10) and Euglena gracilis* were more prevalent.

Station C was generally dominated by green algae. In terms of diversity *Euglena Klebs*(450), *Euglena Sanguinea*(106),*Chlamydomonasauguiesa*(542),*Palmella*(98), *Anabaena* (46),*Coelastrum*(15),*Coscinodiscus*(96)*Navicula*(69)*and Nitzschia*(52)*.*The green algae were recorded in both stations throughout the study period with *Ulothrix, Sphacrocystis* and blooms of *chlamydomonas.* The relative abundance of cell counts was higher at station B (3776) than station A (3106) and station C (3034). Fig.2.

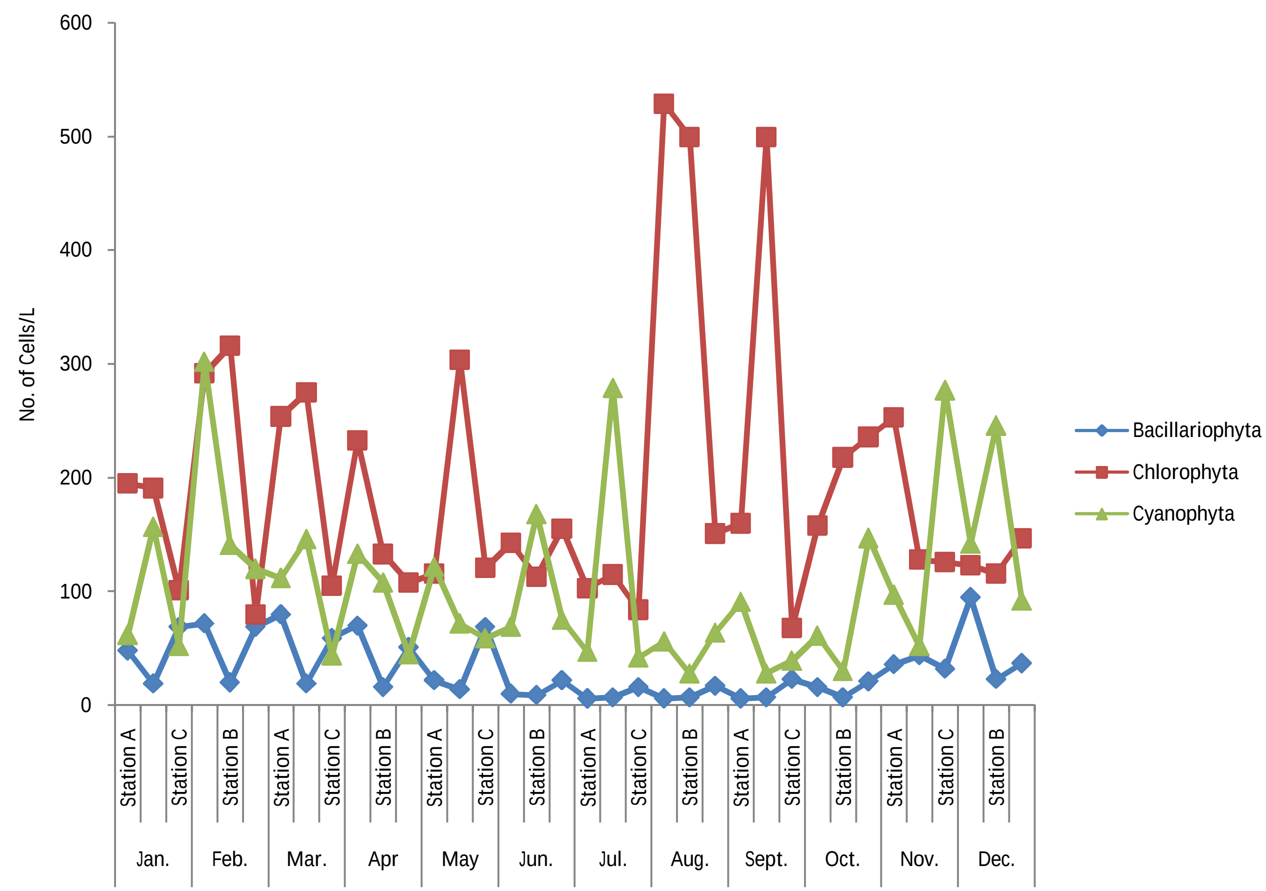

Fig. 2. Phytoplankton abundance and cell count in the three Stations (A, B and C.

DISCUSSION

The highest and abundance of the phytoplankton like *Euglena gracilisElakatothrixhindak,Chlamydomonasauguiese,Pandorinacal ifornica,Microcystisaeruginesa,Microcystisincerta* in water environment could encourage accumulation of micocystins and neurotoxin in the water, passing through the food chain could pose significant threat to public health. The international Agency for Research on Cancer classified microcystins and neurotoxin as possible human carcinogens based on the consideration of the accumulated toxicological data (Babatunde *et al*., 2014). In both stations bloom of phytoplankton also indicates eutrophication of water body's and death of fish and other aquatic organisms. The nutrient load mainly from industrial wastes which flow into the drainage, could be expected that the algae present may be pollution tolerant and hence indicators species.

The major factors in water quality affected by pollution are dissolved oxygen and logs of concentration (pH). Depletion of dissolved oxygen value arises from bacterial degradation of the organic constituents utilizing oxygen. In Kakuri drainage dissolved oxygen value was low at the unset of the raining season, this could be due to the turbidity and lots of organic matter introduce into the water. The subsequent increase in dissolved oxygen values in the latter part of the wet season could be due to the role played by aquatic plant like organism in increasing the oxygen levels in the water. These findings are similar to that found by (Nwankwo *et al.,* 1988 and Olawusi-Peter 2008).

As water level decrease, surface water temperature and transparency increased, such increase could be due to relative stability of the water and the high rate evaporation, (Ezra, 2000).
The observed seasonal variation and distribution of the phytoplankton algae may be a reflection of the changing water environment conditions. Chlorophyta were observed in the three studies station as indicator of relatively clearer water bodies. Similar observation were made by (Abubakar *et al*., 2008) in Nguru lake, (Janan, 2011), in Derbendlkhan lake, Iraq (Haruna *et al,* 2006) in lake Geriyo (Venkateswarlu *et al*., 2000).Microcycsts sp. and other Cyanophyta occurred in greatest abundance, suggesting eutrophication will result in negative effect on the water quality Similar observations were made by (Babatunde *et al*., 2014)

This thus suggests that there is a strong relationship between the phytoplankton with the industrial effluents physicochemical properties.

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