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A Preliminary survey of toxigenic algae of Pindiga Pond Akko Local Government Gombe State Nigeria

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Abstract
Studies were carried out on the toxigenic algae of Pindiga pond at ten (10) days interval for a period of three months using standard methods. Physicochemical characteristics of the pond were also determined for the same time interval. Four species of toxigenic algae were identified namely: *Microcystis* sp*., Planktothrix* sp., *Nostoc* sp. and *Anabaena* sp. were identified using standard identification keys. The ranges of the values of physicochemical characteristics determined and recorded include pH (6.5-8.5), Temperature (28-29ºC), Transparency (0.34-0.57cm), Conductivity (168-1885) µs/cm, Dissolved Oxygen (1.0-1.9) mg/l, Biological oxygen demand (0.2-0.6) mg/l, Nitrate (11.0-12.33) mg/l and phosphate (9.68-10.52) mg/l. Most physicochemical parameters recorded were found to be within the ranges prescribed by WHO standard for drinking water and algal productivity except for few cases like phosphate and conductivity. *Mycrocystis sp*. shows highest number in percentage 4, (40%) of the toxigenic algae identified while *planktothrix sp*. was the least 1, (10%) in percentage. Pindiga pond poses danger, a potential health hazard based on identified algae of this pond

Keywords: Toxigenic algae, pond, hazard, productivity, standard method.

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Introduction

Algae are green thallophytes containing the green colouring matter called chlorophyll. In many algae, the green colour may be masked by other colours, but in all of them, chlorophyll is always present. Algae are also autotrophic, i.e. they manufacture their own food with the help of chlorophyll contained in them and the body of algae is composed of a pseudoparenchymatous tissue (Dutta, 1994). Algae are the simple rootless plants that grow in water in proportion to the amount of available nutrients. They can affect water quality adversely by lowering the dissolved oxygen in the water. They are food for fish and small aquatic animals. Algae are photosynthetic plants, almost exclusively aquatic, non-vascular plants that range in size from simple unicellular forms to giant kelps, several feet long. They have extremely varied life cycles and first appeared in the pre-Cambrian era (Mc Cracken, 2005)

Toxigenic algae are a group of algae capable of causing abnormalities to both aquatic and human life and these algae belong to the divisions Bacillariophyta (diatoms), Dinophyta. (Dinoflagellates) and Cyanophyta (blue green algae) which were identified in Nigerian coastal waters and some of which occur in fresh water too (Kadiri, 2010).

Algal bloom is a dense aggregation of algae/phytoplankton in an aquatic environment which has been colloquially called "Red tide". This is a misnomer because algal bloom can produce different coloration, not necessarily red, depending on the species causing it; secondly blooms are not associated with tides. Of the numerous species existing, some species are known to cause negative impact on the aquatic environment, damage to other organisms through the production of toxins, most instances, these are very common among the dinoflagellates, diatoms and blue green algae. Sometimes these algae proliferate to form what is known as harmful algal bloom (HAB). They are caused by natural processes (circulation river flow, storms, and currents) and anthropogenic loadings culminating in eutrophication (Sellner *et al*., 2002). Example of fresh water toxigenic algal Species include *Nostoc*, *Anabaena*, *Microcystis* and *Gonyaulax* etc, are responsible for causing toxicity in freshwater habitats.

Harmful algae are capable of producing a variety of deleterious effects. Harmful algal blooms have direct consequences such as social impact (tourism, recreation aesthetics) economic impact, aquaculture – fish kill, shell fish loss, increased drinking water treatment cost, health impact, ecosystem impact, ecosystem loss, alteration of food web interaction, ecological (Anaxia) wild life mortalities (birds, whales, Dolphins, Turtles etc.) trophic level impact (accumulation and transfer of toxin along the food chain. Of the harmful algae, some produce potent toxin called phycotoxin (Takahashi *et al*., 2007) culminating in respective syndromes termed Neurotoxin shellfish poisoning (NSP) Paralytic shellfish poisoning (PSP), Ciguatera fish poisoning (CFP). Such toxins include brevetoxin responsible for (NSP) saxitoxin for PSP, cignatoxin, mitotoxin and dinophysistoxin for DSP and demoic acid for ASP (De Charon *et al.,* 2001).

The consumption of toxin contaminated food by humans can lead to grave health problems such as Allergy, dermatological, respiratory and cardiovascular problems, liver damage, gastrointestinal and neurological disorders typified by headache, diarrhoea, vomiting, abdominal pains, sneezing, short term amnesia, sweating, paralysis and coma (Van Dolah, 2000). Examples of harmful algae identified in Nigerian fresh water include *Microcystis aeruginosa* (Cyanophyta) *Cylindrosphermopsis racigorskii*, *Anabaena circinalis*, *Anabaena flosaquae*, *Aphanizomenon flos-aqua* (Kadiri 2010). At least 46 species of cyanobacteria have been shown to be toxic to vertebrates (Chorus and Bartram 1999).

Pindiga pond is an artificial reservoir producing water for neighboring villages, drinking by humans and other animals. Toxigenic algae are known to course harmful effect on these organisms therefore a need to isolate and identify these organisms with the view to establish a potential health hazard of this pond water on these organisms. The major aim of this research is to carry out a preliminary survey of the toxigenic algae of the pond. Also determine the physico-chemical characteristics of the Reservoir and to determine if the consumption of the water poses a potential health hazard to human and other vertebrates

Materials and Methods

Study Area

The study area is located in Pindiga, Akko Local Government Area Gombe State The pond lies between latitude 10.13' 15° N and longitude 11.11' 19° E and 110m, length and 60m width and total surface of 6600m^2.It is situated at elevation of 523 meters above sea level Pindiga has a population of 106,322 (2006 census). Pindiga pond was established in January 2008. It's an artificial pond being constructed from the pools of rocks cited in the Madagascar town, the pond was named as "Madagascar pond" after the name of the town. Pindiga pond was divided in to three(3) sampling points A,B and C .A being the inshore B the midshore and C the offshore again being and agrarian environment there were farming and other anthropogenic activities taking place in both inshore and offshore of the pond such as washing clothes, drinking by animals including humans.

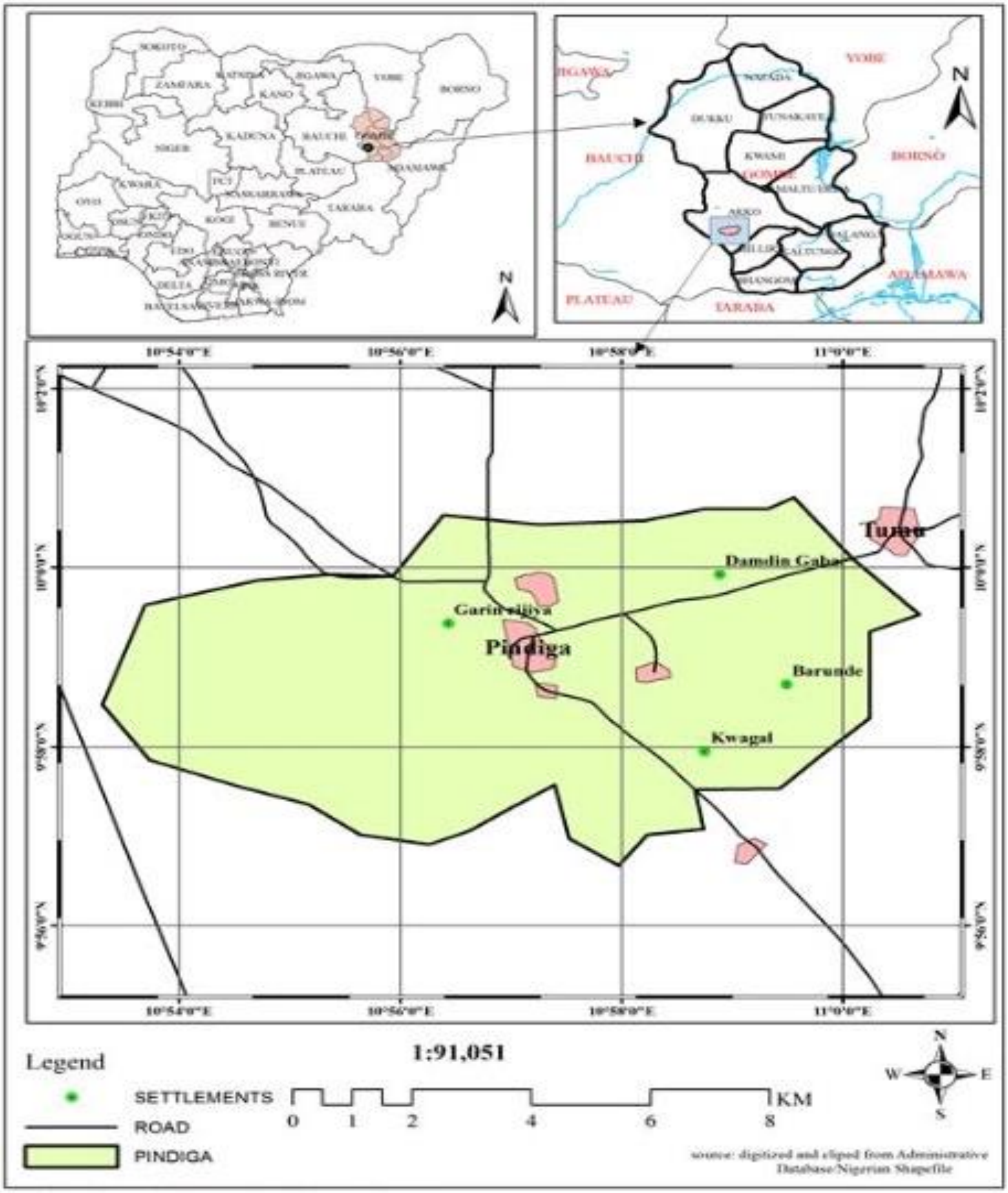

Figure 1: Map of the Study area

Collection of water samples

Water samples for physico-chemical characteristics were collected in 250ml bottle and then taken it to the laboratory for analysis. Water samples for both phytoplankton and physicochemical parameters were collected at ten (10) days interval for a period of two month (APHA, 2000).

Collection of toxigenic Algae

The toxigenic algae were collected by filtering of water using planktonic net of mersh size 55µm in diameter. The filtrate was then transferred immediately into dark brown sampling bottles 250mls. It was fixed preserved using 4% formalin and was taking to Federal University of Kashere, Biology laboratory for analysis. 10ml of sample containing algae was filtered in to 20ml vial it was centrifuged and supernatant decanted at 3000rpm for 10 minutes.

Determination of some physico-chemical characteristics of the pond

Water Temperature.

The water temperature was measured insitu in the field by dipping the electrode of a calibrated mercury bulb thermometer in to the water and it was allowed to settle for about two minutes and the value were recorded in (℃) following the methods of Zaky (2015).

Water pH.

The pH of the water sample was determined in the laboratory using conductivity meter model DDSJ-308A, the water sample was poured in a beaker for about 100ml and the electrode of the conductivity meter was immersed into the water sample and the reading values were taken and recorded hydrogen ion concentration values (Zaky, 2015)

Electrical Conductivity

The water conductivity was measured in the laboratory using water conductivity meter model DDSJ-308A, the water sample was poured in a beaker for about 100ml and the electrode of the conductivity meter was immersed into the water sample and the reading values were taken and recorded and the value was recorded in (µS/cm) according to Abdullahi *et al*. (2019).

Transparency

Transparency was determine using standard secchi disc according to (Ezra 2000). It was placed in the sampled water and where the black and white colour on the secchi disc disappear then reading was taken in (cm).

Dissolved Oxygen.

Dissolved Oxygen was determined using dissolve oxygen meter model HI9142 and the electrode of the dissolved oxygen meter was immersed into the water sample and the reading values of dissolved oxygen of the water sample was recorded in (mg/l) (Abdullahi *et al*., 2019).

Biological Oxygen Demand

Biological Oxygen Demand was determined using dissolve oxygen meter model HI9142 and the electrode of the dissolved oxygen meter was immersed into the water sample after five days incubation of a water sample at 20ºC and the values recorded was referred to as final Dissolve Oxygen, therefore the initial Dissolved Oxygen value was subtracted from the final Dissolved Oxygen which gives the value of Biological Oxygen Demand. Abdullahi *et al*.,2019.

Nitrate and phosphate

Phosphate and nitrate were determined using portable data logging spectrophotometer Hach DR/2010.The sample was placed in the various meter holder for nitrate (Nitraver 5) and phosphate phos ver.3) nitrate and phosphate pillow powder the sampled water was placed in the container containing the pillow powder after calibration and various reading were taken in mg/l of both phosphate and nitrate.

Identification of Toxigenic Algae

This was carried out using binocular microscope model 162 compound microscope referenced to the identification was made to the manual and atlas of Patrick and Reemer (1965), Needham and Needham (1962), Palmer (1980).

Cell counting

Direct algal cell count was adopted in estimating the number of toxigenic algae within the pond as modified by Ezra (2000). It was determine by agitating each sample to distribute organism evenly and one drop was placed on a clean grease free slide with a dropping pipette. It was then carefully covered with a cover slip and examined .the algal cell seen an a transect field of view were identified the number of specimen per taxon were in field of view in the transect were counted and scored in appropriate column on the scoring chart.in the colonial cell each colony was counted as one while in case of filament each was also counted as one from the total count obtained and the count of specimen observed per specie relative number of specie per sample were calculated in 15 field of view.

Results

Toxigenic algae identified in Pindiga pond were typical of fresh water and four (4) different toxigenic algal species were identified which were Anabaena, *Plantothrix*, *Microcystis* and *Nostoc*. This was Shown in fig 2 using pie-chart showing percentage composition of each toxic algal species, *Anabaena* sp., 20 %, *Nostoc* sp., 30%, *Microcystis* sp 40% , *Planktothrix* sp.10% respectively.The pH values ranges from a minimum of 6.50 - 6.80 maximum the values and the WHO standard of 6.5-8.5 , Conductivity range from a minimum of 168.00 - 1885.00 and the WHO standard, Nitrate values range from a minimum of 11.05 - 12.33 maximum and WHO standard was 50, Phosphate values range from a minimum value 9.68 - 10.52 maximum and the WHO standard is 10, The Dissolved Oxygen is measured in mg/l and the values range from 1.00 - 1.90 and a WHO standard was 4mg/l, Biochemical Oxygen Demand measured in mg/l the values range from a minimum of 0.20 - 0.60 with a WHO standard of 25mg/l, The Temperature is measured in (°C) and the values range from a minimum of 28.00 - 29.60 and WHO is 27.0 – 28.1° C, The Transparency values range from a minimum of 0.34 - 0.57 it was measured in millimeter.

Table 1: Values of physicochemical parameters recorded in Pindiga pond from month of August - September 2019.

Toxigenic Algae	Field of View									
	1	2	3	5	6	7	8	9	10	Total
Microcystis sp	-	-	1	-	2	-	1	-	-	4
Plankthotrix sp	-	3	1	-	-	-	-	1	-	3
Nostoc sp	1	-	-	-	1	-	-	-	-	2
Anabaena sp	-	-	-	-	1	-	-	-	-	1
Total Number of Toxigenic Algae Identified										10

Key: - = Absent, 1 Indicates Present

Table 2: Relative Number of toxigenic algae identified in all the field of view in Pindiga pond

Parameters	Minimum	Maximum	WHO Standard
pH	6.50	6.80	6.5-8.5
Conductivity(µS/cm)	168.00	1885.00	1000µS/cm
Nitrate (mg/l)	11.05	12.33	50(mg/l)
Phosphate (mg/l)	9.68	10.52	10(mg/l)
Dissolved Oxygen(mg/l)	1.00	1.90	4mg/l
Biological Oxygen Demand (mg/l)	0.20	0.60	25mg/l
Temperature (°C)	28.00	29.60	27.0 – 28.1°C
Transparency (cm)	0.34	0.57	None

Values are presented as Mean of four replicates.

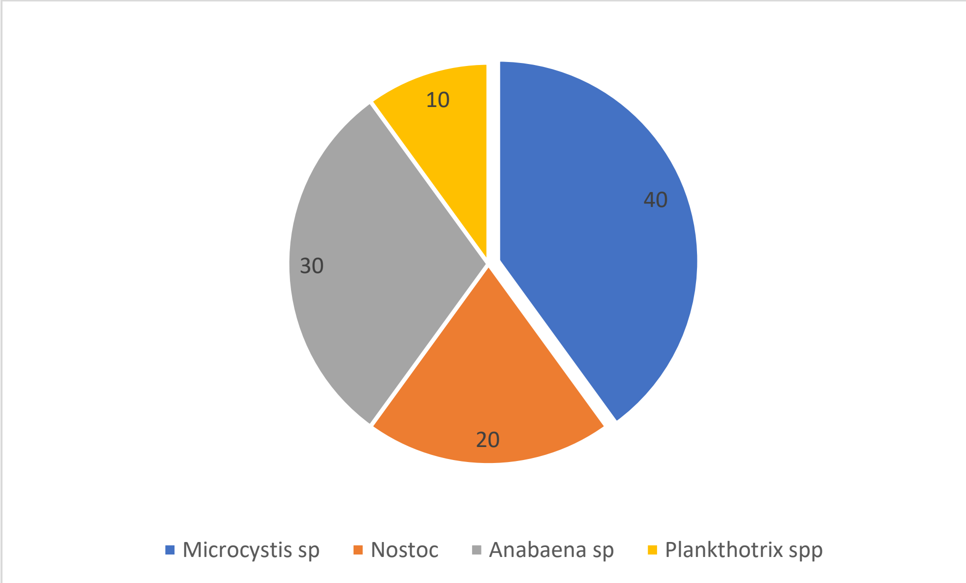

Figure 4.2: Pie chart showing the percentage composition of toxigenic algae

Discussion

The highest value of pH recorded in Pindiga pond was 6.8 and the lowest value recorded was 6.5 all the values recorded fall within (WHO, 2000) standard and was in line with similar pattern in freshwater ecosystems and also conforms with the work of (Ezra, 2000) who remarked that surface water pH ranges from 6.6 to 9.3 which encourages proliferation of aquatic organisms. The Dissolved oxygen was range from highest value 1.90 to 1.00 to lowest values which conform with (WHO, 2000). The amount of Nitrate mg/l in Pindiga pond ranged from 11.5 to 12.33mg/l in the months of August and September 2019. The mean high concentration obtained in August 2019 may be due to water floods during the rainy season and as a result of rural and agricultural run offs which tends to wash waste and other substances in the water body this is in line with the work of Sterner (1990). The lower values could be due to utilization by biota as reiterated by Chorus (2001) it is also within value set by WHO (2000) of up to 50mg/l in drinking water.

The concentration of Phosphate values of the Pindiga pond was ranged from 9.68 to 10.52mg/l in which all the values recorded were not within the WHO standard. Though nitrate and phosphate are limiting factors to biological activity, they are important factors to the growth of phytoplankton in the water under the right conditions of light, pH and temperature according to Smith (1984) and Lassus (1993). The effect of which brings about eutrophication in line with Mason (1996) deteriorating water quality due to low dissolved oxygen, unpleasant odour, contaminating drinking water and ultimately affect human health which is in line with the works of Carpenter (1998). This could be related to the vast distribution of algal species in Pindiga pond which belongs to four different species 30% *Anabaena*, 40% *Microcystis*,10% *Planktothrix* and 20% Nostoc. Some of these species were also found in river Hadejia, River Challawa, river Wudil and most Nigerian Coastal waters rich in nutrients as reiterated by Abdullahi and Indabawa (2004) and Kadiri (2010). The presence of the members of the class Cyanophyceae may pose serious public health harzards to people consuming the raw and fairly treated water as maintained (Chia *et al.*, 2009). These species of algae have been largely found to produce a wide range of Cyanotoxins as compared with the work of (Chorus, 1999) comprising of Microcystins, Cylindrospermopsins, saxitoxins and anatoxins which is related to the work of Eri, *et al.* (2007) and Miller, *et al.* (2010). These are responsible for a number of human and animal morbidity and mortality which have been well documented, by Carmichael (1998) and Sinonen, *et al*. (1990). Their presence in the water body may pose serious health implications as suggested by Sinonen *et al.* (1990).

Conclusion

In conclusion, the preliminary results obtained in this study shows the presence of toxigenic algal species in the sampled water of Pindiga pond as identified. The results of physicochemical characteristics were within limits set by WHO standard for drinking water except for phosphate and conductivity which exceeded the limit the values recorded were suitable for the growth of phytoplanktons and other toxigenic algae. These poses serious public health concern and the relevant authority to establish a basis for taking necessary action to quantify and characterize the toxins to further ascertain the safety of Pindiga pond water to humans and other vertebrates.

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