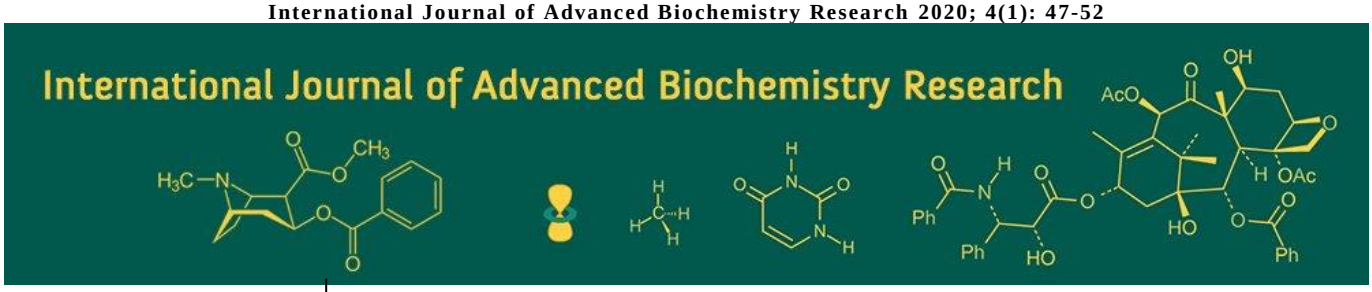

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Studies on spread of algal species in some fish samples from three water bodies in Zaria-Kaduna state Nigeria

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Abstract
Microalgae are photosynthetic organisms that cannot be seen with the naked eye due to their microscopic nature. They abundantly inhabit fresh water ecosystems and frequently form blooms in mesotrophic and eutrophic lakes and ponds. Algal blooms usually occur because of the progressive eutrophication of water bodies and excessive proliferation as a result of heavy nutrient leakage in these water bodies. They contain chlorophyll *a* and account for about 40% of the world's oxygen production. In this current studies, fish samples were aseptically collected from three water bodies in Zaria local government area of Kaduna state Nigeria namely Bomo lake, Kubanni lake, and Makwaye reservoir during rainy and dry seasons. The fishes were then dissected to remove their guts and subsequently observed under a compound Microscope. *Microcystis* sp were the predominant algal species found in the gut of *Hemichromis guttatus, Oreochromis niloticus, Clarias camerunensis* and *Clarias anguilaris* in both rainy and dry seasons from Bomo and Kubani lakes. Whereas In Makwaye Lake, *Microcystis* sp. And *Cladophora* sp. were the major species identified in the gut of *Lates niloticus, Clarias jaensis* and *Oreochromis niloticus* for both rainy and dry seasons. These findings suggest a need for regulatory measures to be taken in discharging anthropogenic substances into water bodies around Zaria especially for Bomo Lake, as these discharge leads to algal bloom in water bodies.

Keywords: Microalgae, Fishes, lakes, River, Zaria, Kaduna state

Introduction
Microalgae are photosynthetic organisms that are abundantly found in fresh water ecosystems and frequently form blooms in mesotrophic and eutrophic lakes and ponds. Algal blooms usually occur because of the progressive eutrophication of water bodies and excessive proliferation as a result of heavy nutrient leakage in these water bodies (Nwaura *et al.,* 2004) [15]. Blooms are also caused by complex interaction of high concentration of nutrients, pH, sunlight, warm temperature, turbidity, salinity, carbon availability and slow-flowing or stagnant water. Due to eutrophication and climate changes, cyanobacteria blooms have increased in marine and fresh water ecosystem worldwide (Markensten *et al.,* 2010; Paerl and Hulseman, 2009) [14, 17]. These blooms severely disrupt the functioning of ecosystems, affecting animals and human health in general. The photoautotrophic cyanobacteria are found in natural lakes, streams, ponds and other surface water in suitable environmental condition (Pearl and Hulseman, 2009). Some species of cyanobacteria have the ability to produce toxins.

Toxic cyanobacteria are found worldwide in land and coastal water environment at where about at least 46 species have been shown to cause toxic effect in vertebrate (Sivonen and Jones, 1999). The most widely spread cyanobacteria toxins are microcystins and neurotoxins. These are group of more or less related compounds produced by cyanobacteria in the environment with different chemical and physical properties. Worldwide, about 60% cyanobacteria samples investigated, contain toxins. Demonstration of toxicity of the cyanobacteria population in a given lake do not necessarily imply an environmental or human hazard as long as the cells remain thinly dispersed. Mass development and especially surface scums pose the risk. Toxic cyanobacterial blooms occur frequently in eutrophic fresh waters worldwide (Pearl *et al.,* 2001, XIe and Liu, 2001) [27].

Many cyanobacterial species able to produce toxins and microcystin are usually the predominant ones presenct in drinking, fisheries and recreational waters (Carmichael 1994) [6]. During cyanobacteria blooms, Microcystins contamination in the field has been widely reported for various groups of aquatic animals such as fish (Magalhaes *et al.*, 2001; XIe *et al.*, 2004, 2005) [13, 26, 25] mussels (Yokoyama and park, 2002) [28], snails (Zurawell *et al.*, 1999) [29] and shrimps (Chen and XIe, 2005) [7], attracting increasing concern from the public about food safety. The most widely studied microcystins are Microcystin-RR (MC-RR) and Microcystins-LR (MCLR).

Mass occurrences of toxic cyanobacteria have been associated with feral fish kills (Toranzo *et al.*, 1990; Jewel *et al.*, 2003) [23, 11]. Cyanotoxins from fresh water cyanobacteria blooms have been reported to cause substantial damage in estuarine and marine aquaculture facilities (Hallegraeff, 1993) [10]. At the moment, information on the occurrence and effect of cyanobacteria blooms is scanty in Africa except South Africa where substantial work has been done. There is paucity in the number of published work on cyanobacteria diversity; blooms and toxin in Nigerian aquatic ecosystem. A few studies in Nigeria have reported the occurrence of algal blooms namely: Delimi River Jos. Awba reservoir Ibadan (Akin-oreola, 2003) [2]. Only one study in Nigeria has dealt with the study of cyanotoxins in Niger delta region of the country (Odokuma and Isirima, 2007) [16]. The presence of cyanobacteria especially those that produce toxins in aquatic system cause acute and chronic poisoning of wild/domesticated animals and humans. They also have the ability to bioaccumulate in living tissues of plants as shown in the work of Codd *et al.*, 1999 [9] on salad lettuce where the cells of *Microcystins aeruginisa* were retained in the leaves of the plants. Cyanobacteria represents both economic and public health concerns to resource managers, drinking water treatment plant operators, and others. There is a very high probability that human and wild life in Nigeria are perpetually exposed to chronic cyanobacteria poisoning from rivers, lakes and reservoirs. Occurrence of cyanobacteria mass population can create a significant water quality problem particularly as many cyanobacterial species are capable of synthesizing a wide range of odors, bioactive compounds or potent toxins. It has become therefore important to establish how microcystins are transferred in food web when toxic cyanobacterial blooms occur. It is also important to monitor microcystins in tissue of fishes and other aquatic animals in order to evaluate the potential risk humans face from contaminated foods. A reliable and sensitive method for extracting microcystins from a sample is therefore paramount. Extensive studies on the extraction and detection of microcystins have led to a number of methods, such as protein phosphate inhibition assays (PPIA), enzyme-linked Immunosorbent assay (ELISA) (Rapala *et al.*, 2002) [19], Liquid chromatography (LC) and capillary electrophoresis (CE). Currently, routine analysis of microcystins in animal tissue is mostly carried out using HPLC-PDA. The aim of this current work is to determine the presence of algal species in fish samples from three water bodies (Bomo Lake, Kubanni lake, and Makwani reservoir) in Zaria local government area of Kaduna State, Nigeria. This is with a view to identifying the type of algal species present in fish samples in Zaria Nigeria.

Materials and Method

Study area

Zaria is situated centrally in the North Guinea Savanna of Nigeria (11^0 3'N, 7^0 42' E). Climatic conditions in Zaria are tropical with well-defined wet and dry seasons. The rainy season occurs from May to October while dry last season from November to April. Kubanni lake is located within the premises of Samaru campus of Ahmadu Bello University (11^0 08'N, 07^0 43'E). The lake has two major tributaries: Kampagi River and Kubanni River. It is the major source of drinking water to the university community and environs. It receives high level of municipal waste from the surrounding university campus and Samaru village. Makwaye Lake ($11^011'N$,$07^037'$E) is located north to Kubanni Lake. The lake is an unprotected natural ecosystem. Around the catchment of this lake, a lot of irrigation farming and animal grazing goes on unchecked. While Bomo Lake is situated near Bomo village, a rural community east of the University campus ($11^012'N$,$07^038'E$) and has evidence of human faecal discharges.

Sampling

The sampling period of this survey was done between April and July for the rainy season and November-March for the Dry Season. Fishes were harvested from each of the water bodies using simple fishing nets early in the morning, stored in sterile containers and immediately transported to the Lab.

Identification

The fish samples were identified in the Department of Biology, Ahmadu Bello University Zaria using keys on Fishes and Fisheries of Nigeria by Adesulu and Syndehan (2002).

Fish analysis

The fish samples were carefully dissected under a dissecting microscope set to remove the guts. The gut content was put in sample bottles and labeled against each fish sample.

Algal species identification and cell counts

Algal species ware identified using keys of Prescott (1978), APHA (1998), Bartram and Rees (2000). Cyanobacteria analysis were carried out in the Research laboratory of the Department of Zoology and Postgraduate laboratory of the Department of Botany, Ahmadu Bello University Zaria, Nigeria. The cell count was done using haemocytometer which was covered with cover slip by adding few drops of gut water samples and observing under the microscope at different magnifications.

Results and Discussion

Table 1a present the algal species with their abundance as identified in each gut of fish that are obtained from Bomo Lake during rainy season. *Microcystis* sp. was found in the gut of *Hemichromis guttatus, Oreochromis niloticus, Clarias camerunensis* and *Clarias anguillaris.* The algae had an abundance of 75,000cell/mL in *Hemichromis guttatus,* 85,000cell/mL in *Oreochromis niloticus,* 70,000cell/mL in *Clarias camerunensis* and 80,000cell/mL in *Clarias anguillaris.*

Table 1b presents the algal species with their abundance that ware identified in each of the fish that are obtained from Bomo Lake during dry season. *Microcystis* sp. were found in the gut of *Clarias anguillaris* and *Schilbe mystus.* The algae had an abundance of 165,000cells/mL in *Clarias anguillaris,* 120,000cell/mL in *Schilbe mystus.*

Table 1a: Algal sp. identification and count in fish from Bomo Lake during rainy season

S/N	Scientific name of fish	Common name of fish	Algal sp. (cell abundance/mL)
1	*Hemichromis guttatus*	Jewel fish	*Microcystis* sp. (75,000)
2	*Oreochromis niloticus*	Nile tilapia	*Microcystis* sp. (85,000)
3	*Clarias camerunensis*	Cat fish	*Microcystis* sp. (70,000)
4	*Clarias anguillaris*	African cat fish	*Microcystis* sp. (80,000)

Table 1b: Algal sp. Identification and count in fish gut from Bomo Lake during dry season

S/N	Scientific name of fish	Common name of fish	Algal sp. (cell abundance/mL)
1	*Clarias anguillaris*	Mud fish	*Microcystis sp. (165,000)*
2	*Schilbe mystus*	African buffer cat fish	*Microcystis sp. (120,000)*

Table 2a present the algal species with their abundance identified in the gut of fish that were obtained from Makwaye Lake during rainy season. *Microcystis* sp. were found in the gut of *Clarias jaensis* and *Oreochromis niloticus*. The algae had an abundance of 60,000cell/mL in *Clarias Jaensis* and 80,000cell/mL in *Oreochromis niloticus*
Table 2b presents the algal species with their abundance identified in the gut of fish obtained from Makwaye Lake during dry season. *Microcystis* sp and *Cladophora* sp. were found in the gut of *Lates niloticus* and *Microcystis* sp. were found in the gut of *Hemichromis* niloticus. The algae had an abundance of 90,000cell/mL of *Microcystis* sp. And 27,000cell/mL of *Cladophora* sp in *Lates niloticus* and 10,000cell/mL of *Microcystis* sp. In *Hemichromis niloticus.*

Table 2a: Algal sp. Identification and count in fish gut from Makwaye during rainy season

S/N	Scientific name of fish	Common name of fish	Algal sp. (cell abundance/mL)
1	*Clarias jaensis*	Cat fish	*Microcystis sp. (60,000)*
2	*Oreochromis niloticus*	Nile tilapia	*Microcystis sp. (80,000)*

Table 2b: Algal sp. Identification and count in fish gut from Makwaye during dry season

S/N	Scientific name of fish	Common name of fish	Algal sp. (cell abundance/mL)
1	*Lates niloticus*	Nile perch	*Microcystis sp. (90,000)* *Cladophora sp. (27,500)*
2	*Hemichromis niloticus*	Jewel fish	*Microcystis sp. (10,000)*

Table 3a presents the algal species with their abundance identified in gut of fish obtained from Kubanni Lake during rainy season. *Microcystis* sp. were found in the gut of *Clarias anguillaris* and *Oreochromis niloticus*. The algae had an abundance of 60,000cell/mL in *Clarias anguillaris* and 45,000cell/mL in *Oreochromis niloticus.*
Table 3b presents the algal species with their abundance identified in the gut of fish obtained from Kubanni Lake during dry season. *Microcystis* sp. And Euglena sp. were found in *Oreochromis niloticus* and *Microcystis* sp. were found in *Clarias anguillaris.* The algae had an abundance of 35,000cell/mL of *Microcystis* sp. In *Oreochromis niloticus*, 12,500cell/mL of *Euglena sp*. In *Oreochromis niloticus* and 32,500cell/mL in *Clarias anguillaris.*

Table 3a: Algal sp. Identification and count in fish gut from Kubanni reservoir during rainy season

S/N	Scientific name of fish	Common name of fish	Algal sp. (cell abundance/mL)
1	*Clarias anguillaris*	Mud fish	*Microcystis sp. (60,000)*
2	*Oreochromis niloticus*	Nile tilapia	*Microcystis sp. (45,000)*

Table 3b: Algal species identification and count in fish gut from Kubanni reservoir during dry season

S/N	Scientific name of fish	Common name of fish	Algal sp. (cell abundance/mL)
1	*Oreochromis niloticus*	Nile tilapia	*Microcystis sp. (35,000)* *Euglena sp. (12,500)*
2	*Clarias anguillaris*	African cat fish	*Microcystis sp. (32,500)*

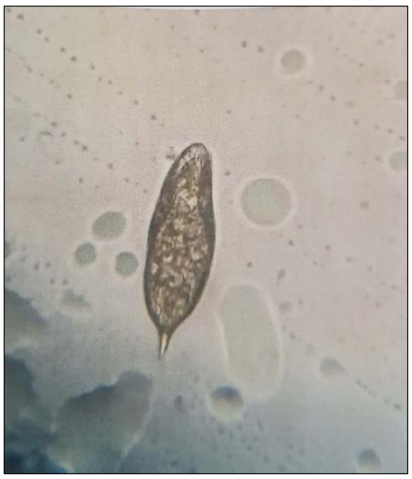
The fish samples obtained from Bomo Lake during rainy and dry season, *Clarias anguillaris* were more abundant as seen from tables1-3. This may be due to their wide tolerance to environmental factors like temperature, low dissolved oxygen and probably due to the favorable condition in their breeding site such as adequate nutritional value in both the water bodies. *Hemichromis guttatus, Clarias camerunensis, Clarias jaensis, Lates niloticus,* and *Hemichromis niloticus* were found not to be abundant in dry season probably due to their inability to withstand environmental changes in the water body. Algal population in Bomo lake were all *Microcystis* sp. in both dry and rainy seasons but more abundant during rainy season than in dry season. This may be due to the increase in anthropogenic activities during the rainy season than in dry season. Also there is increase in the rate of pollution of water from drainages into the lake which leads to progressive eutrophication of the water and excessive proliferation of heavy metals. Which is line with the finding of Nwaura *et al.,* (2004) [15].
The fish samples obtained in Makwaye Lake were *Clarias jaensis, Oreochromis niloticus, Lates niloticus,* and *Hemichromis niloticus* probably due to their ability to withstand anthropogenic activities or other environmental factors such as low dissolve oxygen and temperature in the lake. The algal species were *Microcystis* sp. Which was more abundant during rainy season probably due to increase in anthropogenic activities in rainy than in dry season. The fish samples obtained from Kubanni Lake in dry and rainy season were *Clarias anguillaris* and *Oreochromis niloticus* and this may be due to low anthropogenic activities in the lake. *Microcystis* sp were still the abundant algal species here. They were more during rainy season than in dry season which could be due to high eutrophication and pollution emanating from hostel's drainage in to the reservoir. Some species of algae were also found in Kubanni reservoir such as *Euglena* sp due to high eutrophication in line with the finding of Bako *et al.,* 2007 [4]. *Oreochromis niloticus* and *Clarias anguillaris* were abundant in all the water bodies such as Bomo and Makwaye Lake and Kubanni reservoir probably due to their ability to withstand environmental factors or due to the favorable condition for their breeding such as optimal nutrient. Overall, Bomo lake was found to have high abundance of *Microcystis* sp due to high level of eutrophication, followed by Makwaye Lake because Makwaye Lake is mesotrophic that is having a medium amount of dissolve nutrient. Kubanni reservoir is

the least in *Microcystis* sp. Likely due to little anthropogenic activities and this may be characterized as oligogenic that is having little nutrient in the water body. In conclusion, algal species were seen in the gut of each of the fish species used in this work and cyanobacterial sources have detrimental effect on various uses of water. There is need to prevent our natural water sources from being taken over by cyanobacteria or the use of inorganic fertilizer within the catchment areas of our water bodies. There is need of regulatory measures against anthropogenic discharges in to the water body in our study areas so as to ensure that the discharges fall within acceptable limit. We recommend that further research be carried out on *Microcystis* sp in other aquatic organisms for general water quality.

Appendix

Appendix I: *Cladophora* sp.

Appendix II: *Microcystis* sp.



Appendix III: *Euglena* sp.

Appendix IV: *Clarias camerunensis*

Appendix V: *Hemichromis niloticus*

Appendix VI: *Clarias anguillaris*

Appendix VII: *Hemichromis guttatus*

Appendix VIII: *Schilbe mystus*

Appendix IX: *Lates niloticus*

Appendix X: *Oreochromis niloticus*

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