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Full Length Research Paper

Assessment of stomach contents of *Oreochromis niloticus* from the Lagos Lagoon, Nigeria

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Fish sustainability in an aquatic environment involves continuous and judicious management towards optimum production of resources, for rational utilization and availability for future generation. Stomach composition of *Oreochromis niloticus* collected from a tropical brackish water environment was investigated to assess food availability towards optimum fish productivity for rational public utilization. *Oreochromis niloticus,* a fish of high economic importance and a generalize omnivore endemic to fresh and brackish water of Sub-Saharan Africa, and Asia, was reviewed to know the food availability status of the Lagos Lagoon, Nigeria. The conditions of stomach contents of *O. niloticus* samples collected were visually determined and subjected to frequency of occurrence, dominance, numerical, volumetric and relative index methods. Analytical and descriptive statistics were used to show occurrence, prevalence and availability of food organisms, within Lagos Lagoon. Results of the investigation revealed the presence of phytoplankton, dinoflagellates, sand grains, insect parts, plants parts, fish parts and unidentified constituents in *O. niloticus* stomach contents. *O. niloticus* revealed herbivorous feeding habit and Bacillariophyceae food item with highest occurrence. Food items satisfy requirements for optimum sustainability.

Key words: Stomach contents, tropical, *Oreochromis niloticus*, Lagos Lagoon, Nigeria.

INTRODUCTION

Public unawareness of the benefits obtainable in aquatic environment, and uncareful use and management has considerable adverse influence on aquatic ecosystems, especially in Sub-Saharan Africa. Lagos City is urban environment around the coast. The urbanization status has been considered to have tremendous tendencies of introducing contaminants into the aquatic ecosystem. This could result in degradation of the physico-chemical parameters of the water body; hence affecting optimum yield of the aquatic resources (Oribhabor, 2016). Therefore, the socio-economy status of the Lagos city and indiscriminate disposal of waste / pollutant have resulted in anthropogenic input, affecting the aquatic ecosystem output and ecosystem services (Sankoh et al., 2013). Investigation of stomach contents of *O. niloticus* fish is carried out to know the status of food available for optimum production in Lagos Lagoon. *Oreochromis niloticus* also known as Nile tilapia belongs to the family Cichlidae, which is a tropical freshwater and estuarine species of high economic importance and a generalized

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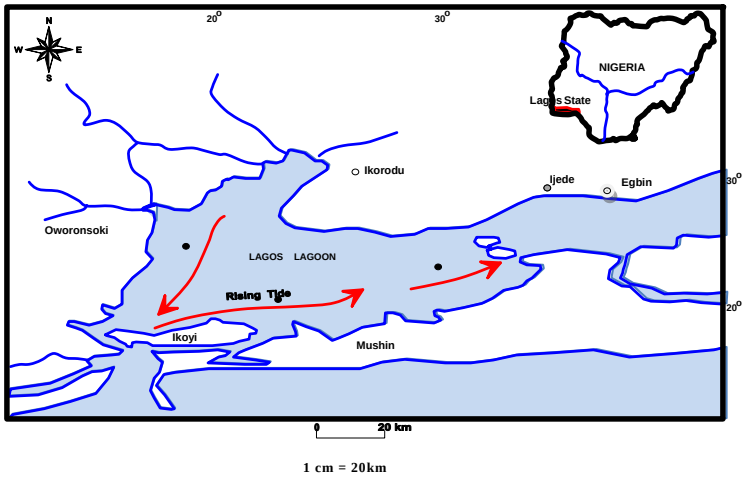

Figure 1. Map of Nigeria showing the Lagos Lagoon.

omnivore. It thrives well in shallow, still waters and in vegetated areas of lakes and rivers (Picker and Griffiths, 2011). It is a herbivore that feeds on phytoplankton, trapping plankton in a plankton rich bolus using mucus excreted from their gills (Rupinder et al., 2014). It consumes periphyton as well as aquatic plants. It eats invertebrates, benthic fauna, and at times found to have consumed fish eggs (Trewavas, 1982; FAO, 2012). *O. niloticus* exhibits suspension filtering feeding method, and also surface grazers (Lee et al., 2018). Agumassie and Mathewos (2018) mentioned that Tilapia fish shifts feeding behavior.

Earlier studies conducted by Moriarty and Moriarty (1973) and Pinka et al. (2014) showed that *O. niloticus* feeds on bottom deposits derived from the plankton rain and other sources, deriving its nutrient from organic particles and micro-organisms (Kumar and Gopal, 2015). Rupinder et al. (2014) reported that *O. niloticus* feeds on plankton which is structured and usually driven by nutrient dynamics of the habitat. Tesfahun (2018) stated that the feeding habit of *O. niloticus* and stomach contents are dependent on availability and abundance of plankton in the habitat, which contribute to the growth rate of the fish.

Hence, the objective of the study on stomach contents aims to reassess the status of *O. niloticus* food varieties in a lagoon that is impacted by urban activities and varying complex environmental factors for optimum production of the fish**.**

MATERIALS AND METHODS

Study area

The brackish water Lagos Lagoon (Figure 1) is part of the continuous system of lagoons and creeks that are found along the coast of Nigeria from the border with the Republic of Benin to Niger-Delta. This lagoon bordering the Lagos Island is located between longitude 30° 10' and 30° 4' SE and latitude 60° 5' and 60° 36' N. Lagos lagoon lies along the coast for more than 50 km long and 3 to 13 km wide. It is bounded by tidal wetlands and swamps, and is a major lagoon among 10 other lagoons along the coastline. The Lagoon has a surface area approximately 6,354.7sq km, and it receives influx of freshwater from several rivers, the most important of which are the Ogun, Ona/Ibu, Oshun, Shasha and Oni. It is tidal in nature and it receives water from Atlantic Ocean during high tides which recede during low tides. Lagos Lagoon is fairly shallow with averages depth of 2 to 4 m and it is isolated from sea by beach barrier ridges. The lagoon empties inside the Atlantic Ocean via Lagos Harbour where it has depth increase of 10 m, with 0.5 to 1 km width and 10 km long, (Badejo et al., 2014).

Collection of samples

A total of four hundred and eighty (480) live *Oreochromis niloticus* were collected from Lagos Lagoon with the assistance of fishermen using cast net from January to December 2015. The fish were carried in a 25 L plastic container for analysis in Fish Biology Laboratory for analysis.

Measurements

The Standard Lengths (SL) of fish samples were determined to the nearest 0.01 cm using a graduated board and the corresponding weights (W) were also measured with Mettler Toledo electronic weighing balance (Model; PB8001).

Sample preparation

The fish were dissected to remove gut samples which were dissected individually to reveal the condition of the stomach. The guts and intestine contents were categorized based on degree of fullness as: {full (4/4), three quarter full (3/4), half full (2/4), one quarter full (1/4), and empty (0/4)}. The stomach contents were fixed in 4% formalin prior to examination. Stomach samples were mixed with 2.0 mL distilled water in a petri-dish for proper separation and easy identification. A drop of the prepared sample was placed on a glass slide with the aid of a dropper and covered

Table 1. Length range of O. niloticus and frequency of occurrence.

Length Range	Frequency of occurrence of fish	Mean weight of fish
13.70 – 14.69	113	85.73 ± 2.32
14.70 – 15.69	107	92.45 ± 2.45
15.70 – 16.69	82	103.33 ± 2.21
16.70 – 17.69	111	142.45 ± 3.17
17.70 – 18.69	67	185.44 ± 3.42

with cover slip.

Microscopy and observations

The prepared samples on the glass slides were viewed under light microscope at a magnification of x40. Stomach items were also examined using hand lens (magnifier). The observed organisms were identified using identification keys and taxonomic work (Idodo, 2002).

Analysis of stomach contents

The various items in the fish stomach were analyzed using frequency of occurrence, dominance, numerical, volumetric and relative index methods to show food item prominence and importance.

Frequency of occurrence (FOC) Method (Hyslop, 1980)

FOC = Total number of specific food item occurrence
Percentage occurrence of a food item (% FOC):-

$$\%FOC = \frac{\text{Total number of stomachs with the particular food item}}{\text{Total number of stomachs with food}} X \ 100$$

Dominant method (Hyslop, 1980)

Percentage dominance of a food item = Number of stomachs that particular food item is dominant
Total number of stomachs with food X 100

Volumetric method (Hyslop, 1980)

$$\text{Percentage volume of a food item} = \frac{\text{Volume of the particular stomach content}}{\text{Total number of all stomach contents}} \text{ X } 100$$

Numerical Method …… (Hyslop, 1980)

$$N = \frac{\text{Total number of particular food item}}{\text{Total number of all stomach contents}} \text{ X } 100$$

$$N = \frac{\text{Total number of particular food item}}{\text{Total number of food item}} \text{ X } 100$$

: percentage numerical index (%N)

$$N = \frac{\text{Total number of particular food item}}{\text{Total number of all food item}} \text{ X } 100$$

Relative Index (I) (Hyslop, 1980; Costal et al. 1992)

$I = (\%\text{occurrence X \% volume}) \text{ X } 10^{-2}$

The percentage numerical index of occurrences was expressed to know the food item in stomach of *O. niloticus* fish samples. The percentage occurrences of organisms were recorded according to Hyslop, (1980) and Costal et al. (1992).

RESULTS

Standard length ranged from 13.72 to 18.45 cm with a mean of 14.67 ± 1.56 cm whilst weight ranged from 83.32 to 140.68 g with a mean weight of 135.40 ± 31.46 g for the 480 samples of *O. niloticus* collected from the Lagos Lagoon. Table 1 shows fish length range and frequency of occurrence.

The stomach contents of *O. niloticus* included phytoplankton, insect parts, plant parts, sand grains and some unidentified food items. Table 2 shows percentage occurrence of stomach contents of *O. niloticus* from the lagoon. Phytoplankton ranked highest in occurrence of food items in the stomach of the fish with a percentage of 62.32%.

Table 3 shows the degree of stomach fullness of the fish samples. This indicated that 70% of *O. niloticus* stomach examined revealed half full and above degree of fullness. Hence, it is an indication of food availability in the brackish environment.

From Table 4, percent frequency of occurrence revealed that plant parts was the highest (93.13%) and also dominated the food items with a value of 58.54%. *Cyclotella meniggniana* species, which is a Bacillariophyceae ranked second desired food item (51.88 %); while Dinophyta *Ceratium sp.* ranked third (35.92 %) desired food item from the environment. This indicated all food items on rank list were plant source.

The results in Table 5 identified Bacillariophyceae as the most desired food item (R.I = 4.08) and admist all the methods used, it is indicated that Bacillariophyceae had highest presentation, in species occurrence. This

Table 2. Percentage Occurrence of food items in Stomach of *Oreochromis niloticus* from Lagos Lagoon.

Stomach Contents	Percentage occurrences
Insect parts	3.93
Unidentified Food Items	7.10
Sand grains	10.80
Plant parts	15.86
Phytoplankton	62.32

Table 3. Degree of Stomach Fullness in *Oreochromis niloticus*

Degree of Fullness	Frequency of *O. niloticus*	Percentage of degree of fullness
Full	123.00	25.63
Three quarter full	43.00	8.96
Half full	168.00	35.00
One quarter full	117.00	24.38
Empty	29.00	6.04

Table 4. Occurrence and Dominance of organisms in the Stomach of *Oreochromis niloticus* collected from Lagos Lagoon

Stomach contents	Frequency of Occurrence (FOC) in *O. niloticus*	Percentage (%) FOC in *O. niloticus*	Dominance food Item in stomach of *O. niloticus*	Percentage Dominance food Item in stomach of *O. niloticus*
Chlorophyta				
Closterium sp.	172.00	38.14	112.00	24.83
Pediastrum sp.	74.00	16.41	36.00	7.98
Volvox sp.	225.00	49.89	72.00	15.96
Dinophyta				
Ceratium sp.	300.00	66.52	162.00	35.92
Bacillariophyceae				
Cyclotella meniggniana	228.00	50.55	234.00	51.88
Fragillaria	82.00	18.18	49.00	10.86
Gyrosigma balticum	48.00	10.64	46.00	10.20
Navicular sp	82.00	18.18	68.00	15.08
Nitzschia sp	197.00	43.68	126.00	27.94
Tabellaria fenestrata	243.00	53.88	102.00	22.62
Sand grain	286.00	63.41	180.00	39.91
Plant parts	420.00	93.13	264.00	58.54
Insect remains	104.00	23.06	98.00	21.73
Unidentified food items	188.00	41.69	136.00	30.16

revealed similar output of the varying methods used to assess stomach contents of the fish. The least desired food item is insect remain which has (R. I = 0.04).

Figure 2 shows the percentage occurrence of food item in the stomach of *Oreochromis niloticus* from Lagos Lagoon. Bacillariophyta were the highest (38.22%) indicating that the fish highly desired this food item. Bacillariophyta species were highest in occurrence of food items identified; hence the result revealed that O. niloticus is a generalized grazer with higher relative index

Table 5. Percentage Occurrence, volumes and Numerical of food, of *Oreochromis niloticus* from Lagos Lagoon.

Food Items	%O	%V	%N	RI
Chlorophyta	17.78	3.65	20.07	1.30
Dinophyta	11.33	1.08	6.26	0.24
Bacillariophyceae	33.21	6.14	38.22	4.08
Sand grain	10.87	1.24	6.95	0.27
Plant parts	15.86	2.67	10.19	0.85
Insect remains	3.93	0.54	9.96	0.04
Unidentified food items	7.10	0.72	8.34	0.10

%O, Percentage Occurrences of a food item; %V, Percentage volume of a food item; %N, Percentage Number of a food item; RI, Relative Index.

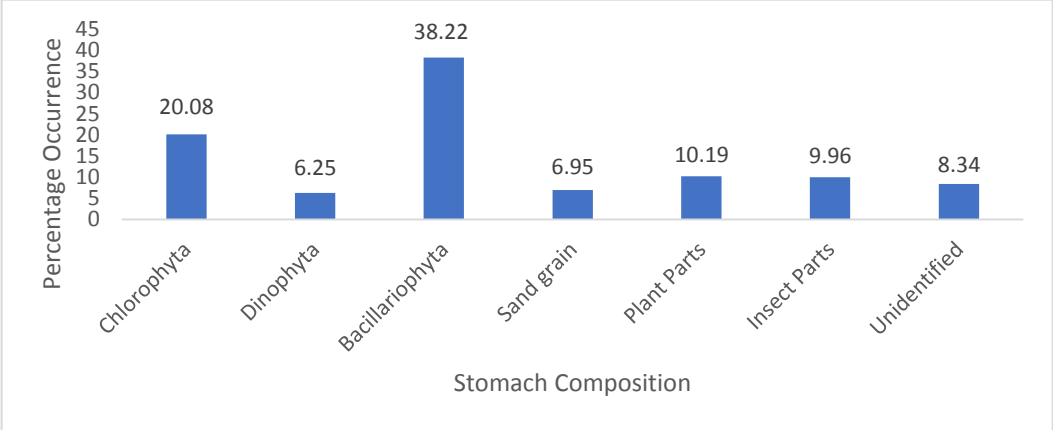

Figure 2. Percentage Occurrence of Food Item in the stomach of *Oreochromis niloticus* from Lagos Lagoon.

recorded in plant source food items (Figure 2).

DISCUSSION

Stomach contents in *Oreochromis niloticus* fish samples examined is in line with the work of Agbabiaka (2012) and Rini (2013) which reported Tilapia fish have varying food in its gut and shifting feeding behavior. These food contents seen in the stomach of the fish follow the work of Abari et al. (2015) who reported *O. niloticus* as obligate herbivore.

High desire of Bacillariophyceae by the fish is supported by Mohsen (2003) as Bacillariophyceae constituted 38.22% of the food items and the most prevailing food items, but plant parts had the highest percentage dominance food item (58.54%); while Bacillariophyceae *Gyrosigma balticum* had the least (10.20%). Hence, stomach contentsobtained corroborate the reports of Fagade and Olaniyan (1972) in the Lagos Lagoon; Houehanou et al. (2016), who reported that cichlids exploit more than one source of food item; having the ability to utilize different varieties of food makes *O. niloticus* omnivorous in nature. He et al. (2015) also reported high degree of overlap in diet of fishes from the same community.

The work of Rao (2017) supported the report that *cichlids* fed mainly on detritus, insects and plant materials; as seen in the result of this study that other unidentified food items, plants and insect materials identified from the gut of *O. niloticus* are members of its stomach contents. Ali et al. (2015) also supported the result that the species feed on plants, leaves, buds and seeds of water lilies and are thus herbivorous feeders.

The result that *O. niloticus* had higher frequency of plant material is supported by Oso et al. (2006) who also observed *O. niloticus* to be herbivores having highest percentage frequency of occurrence of higher plant remains as 49.2 %. *O. niloticus* preference for diatoms than the green algae, despite the latter being more abundant is in line with the work of Kariman et al. (2009) who reported diatom preference in the nutrition of *O.*

niloticus in Abu-Zabal lakes in Egypt.

Teferi et al. (2000) who studied the food and feeding habit of Nile tilapia in Lake Chamom Ethiopia on the stomach contents of adult and juvenile fish reported that *O. niloticus* fish is phytoplanktivorous, and that the component of the phytoplankton varied seasonally, and Ali et al. (2015) also reported that Nile tilapia are filter and benthic feeder as they consumed plankton, and detritus. These supported the result that the fish is planktivorous in the food item recovered from the stomach contents examined.

Hence, stomach contents of *O. niloticus* examined in Lagos Lagoon complemented and corroborated previous management assessments on stomach analysis of *O. niloticus* from Sub-saharan Africa.

Conclusion

Lagos Lagoon environment supported food constituent of *O. niloticus* which has generalized herbivorous feeding habit with great desire for bacillariophyte species of food items among other food items. Food availability and optimum requirement for fish daily need is supported by Lagos Lagoon environment status. And this will enable production of healthy *O. niloticus* fish for public fish food of plant nutrient source.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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