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# FOOD AND FEEDING HABIT OF *OREOCHROMIS NILOTICUS* (LINNAEUS, 1758) FROM RIVER OKURA AT OFEJIJI, KOGI STATE, NIGERIA

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## ABSTRACT

The food and feeding habit of *Oreochromis niloticus* (Linnaeus, 1758) from River Okura was studied from October, 2010 to September 2011. Three hundred and sixty eight (368) samples of Oreochromis niloticus were collected forth - nightly from the local fishermen. The fish were caught with gillnets of mesh size 4.5cm x 4.5cm and gura traps. The fish were weighed, measured and dissected out for their guts. The guts were weighed and length of the gut was taken to the nearest 0.1g and 0.1cm respectively. Gut fullness was estimated visually and categorized. Analysis of the gut content was by frequency of occurrence and numerical methods. Out of 368 O. niloticus examined, 8.7% were completely empty guts while 58.5% of the guts had fullness of above 50% throughout the year. The mean gut fullness showed a significant variation throughout the season. Feeding intensity in the species is observed to be high in the months of July, August and September corresponding to the late rainy season when there was abundance of food. The species fed mainly on phytoplankton and detritus. It consumed a few zooplankton. The phytoplankton consumed include Microcystis spp, Anabaena spp, Chlamydomonas, Merismopedia spp (Cyanophyceae), Diatoma spp, Navicula spp, Melosira spp, (Baccillariophyceae),Closterium spp and Staurastrum spp. (Chlorophyceae). The gut length of O.niloticus is averagely 8.2 times the standard body length characterizing it to be herbivorous. Detritus which is a dominant food item in the gut of the species is considered to be majorly plant materials at various levels of digestion.

**Keywords**: Species, Fullness, Food, Detritus, Gut, Feeding

## INTRODUCTION

*Oreochromis niloticus* (Linnaeus, 1758), a Cichlidae is widely distributed in fresh waters both in the tropical and subtropical aquatic ecosystems (Olaosebikan and Raji, 2004). It is not only ecologically important but has great commercial value as food. It forms one of the major catches in local and national fisheries generating income for people engaged in its fishery. Due to its high elasticity, tolerance to environmental conditions and its ability to accept formulated and natural feeds, it is widely cultured across the world (Mohammed and Uraguchi, 2013, Mungu *et al,* 2022).

Food is the most vital factor for growth and survival, and it is very important for increasing fish production. The various species in a water body differ in their food and feeding habits depending on the niche of the species (Temesgen *et al.,* 2022). Stomach content of a fish varies with the time of the day, size of the fish and the season of the year. Given appropriate temperature and water conditions, the health and growth of a fish will depend entirely on what it feeds on and how it feeds. Differences in intestinal lengths (often captured as a ratio to the body length) among trophic groups is commonly used to classify fish species into one of the three conventional trophic levels: herbivores, omnivores or faunivore (Al-Hussaini, 1949). *Oreochromis niloticus* has been reported to feed on different diets by different authors in different locations**.** It is omnivorous, feeding on phytoplankton, macrophytes, insects, detritus and zooplankton (Adeyemi, 2009 and Tesfahun and Temesgen, 2018). According to Abebe *et al*. (2020) the species formed a link between lower and upper trophic levels feeding mainly on algae and other plant materials as well as detritus. Iyiola *et al.* (2020) and Wagaw *et al.* (2022) reported the species to feed on food items ranging from phytoplankton to zooplankton, chironomids, nematodes, fish scales and detritus.

Knowledge on the natural food of fish species and its feeding is an integral part of aquaculture development. It suggests to the farmers on the type as well as the quantity of local supplementary feed to use in the formulation of the diet of the species in captivity for maximum yield. The study of the food and feeding habit of *O. niloticus* in River Okura will not only add to the knowledge of the fish species of the river, but will give a better understanding on the trophic level of the species in the river for a better management strategy both in culture and in the wild.

## MATERIALS AND METHODS

### Study Area

River Okura at Ofejiji is located on latitude N:07$^0$24.55′ and longitude E:007$^0$19.39′ (Figure 1). It took its source from water issuing out from the ground in Igbobe and Olla in Omala local government area of Kogi State and empties into the Anambra River. The river is perennial and has so many minor tributaries along its course which are seasonal. The climate is characterized by that of Tropical Guinea Savannah. The hydrological regimes are two main seasons, the dry season (October/November to March) and the rainy season (April to September/October) approximately corresponding to the dry and flood phase respectively. Annual rainfall ranges from 1,100mm to 1,300mm. The average minimum and maximum temperatures are 22.8$^o$C and 33.2$^o$C respectively. The vegetation consists essentially of short to tall trees of different sizes, heights and species. Generally, there is a thick vegetation cover around the study area which is strongly supported by the flow of the river during the dry and wet seasons. There are economic trees such as cashew, mangoes and palm plantation along the water course. The river serves for irrigation and domestic purposes for the villagers. Fishery activity around the settlement area is dominated by occasional fishermen.

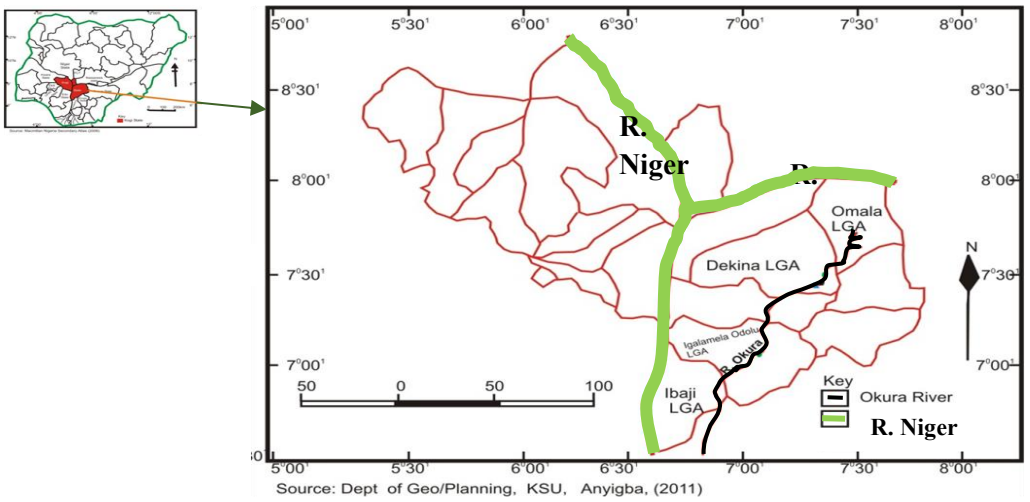


Figure 1: Map of Nigeria showing River Okura in Kogi State

**Collection of Fish Samples**

368 samples of *Oreochromis niloticus* were collected forth - nightly from the local fishermen from October, 2010 to September 2011. The fish were caught with gillnets of mesh size 4.5cm x 4.5cm and gura traps. The samples were transported to Prince Abubakar University Fish Biology Laboratory in a cooler of ice block to avoid postmortem. The fish samples were identified using keys and catalogue provided by Leveque *et al.* (2001) and Olaosebikan and Raji (2004). The weight and standard length were taken using a weighing balance (Acculab V-600) and a meter rule respectively. Larger sized fish of above 600g were weighed using the manual kitchen balance. Weight was measured in grams while length was measured in centimeters.

**Dissection and Determination of Gut Fullness ($G_F$)**

The already weighed and measured fish samples were dissected out for their guts. Each fish was placed on the table and dissected using a dissecting kit. Dissection was from the vent to the jaw. Care was taken to avoid the cutting of the internal organs. The gut was weighed and length of the gut was also taken to the nearest 0.1g and 0.1cm respectively. The gut/stomach fullness was estimated visually and categorized into 10 after Chuwen *et al*. (2007).

**Seasonal Feeding Intensity**

Gut fullness for each species was recorded seasonally. The season of the year was classified into four (4) as early dry season (ED), late dry season (LD), early rainy season (ER) and late rainy season (LR). The various months within each season is presented in Table 1.

**Table 1: Seasonal Classification of the Year**

| Season | Months of the season |
|---|---|
| Early dry season (ED) | October, November and December |
| Late dry season (LD) | January, February and March |
| Early rainy season (ER) | April, May and June |
| Late rainy season (LR) | July, August and September |

**Identification of Food Items**

The stomach content was emptied into a Petri-dish to which a small amount of 10% saline was added to disperse and preserve the contents. Identification of large food categories was performed visually, whereas a compound light microscope was used to identify microscopic food items. The food items were sorted into categories and identified to the lowest possible taxonomic level using identification keys provided by Jeje and Fernando (1986).

**Analysis of the Gut Content**

Analysis of the gut content was done by frequency of occurrence and numerical methods as described by Hyslop (1980).

**Frequency of occurrence method**

The number of stomach samples containing one or more of a given food item was expressed as a percentage of all stomachs examined excluding the empty stomachs (Bagenal and Braum, 1978). It is expressed as:

$$\%FO = \frac{NP}{NF} \times 100$$

Where % F O is frequency of occurrence

NP is the total number of stomachs with a particular food item

NF is the total number of stomach with food

**Numerical methods**

In numerical method, the number of food items was counted from three fields of visions at different parts of the cover slip. The total number of each food item per stomach sample was calculated by multiplying the mean number of each food items in a field of vision by the total number of field of vision under a cover slip area and by total number of drops in the diluted stomach sample.

**Commonness of Food Items in the Diet**

The commonness field of each food item was determined. It refers to the percentage of specimens containing the food item, as percentage and as choice, i.e., rare (1-5%); common (6-20%); very common (21-50%); dominant (>50%) (Palomares *et al.*, 1993).

## RESULTS AND DISCUSSION

Out of 368 stomachs of *O. niloticus* examined, 8.7% (N=32) were completely empty (F < 10%), 58.5% (N=96) had stomach fullness of above 50% while 41.5 % (N=136) had stomach fullness of 50% and below, and the overall $G_F$ was > 0.5 (i.e. above half-filled). (Table 2).

**Table 2: Gut fullness of *Oreochromis niloticus* in River Okura at Ofejiji**

| Gut Fullness | Number of guts / Percentage Fullness | | | | | |
|---|---|---|---|---|---|---|
| **$G_F \leq 50$** | 10 | 20 | 30 | 40 | 50 | Total |
| **Number (N)** | 22 | 26 | 30 | 26 | 32 | 136 |
| **% N** | 6.7 | 7.9 | 9.1 | 7.9 | 9.8 | 41.5 |
| **$G_F > 50$** | 60 | 70 | 80 | 90 | 100 | Total |
| **Number (N)** | 34 | 40 | 42 | 36 | 40 | 192 |
| **% N** | 10.4 | 12.2 | 12.8 | 11.0 | 12.2 | 58.5 |

Key note- GF: gut fullness

On the average the guts were always greater than 50% (58.5 %) full throughout the year. The mean gut fullness ($G_{Fm}$) showed a significant variation throughout the season. It was lowest in early rainy season with mean value of 40.7 ± 0.92 %. The early rainy season months were April ($G_{Fm}$ = 40.1%), May ($G_{Fm}$ = 41%) and June ($G_{Fm}$ =41%). The highest value of (53.4± 3.06) % was observed in the late rainy season covering the months of July ($G_{Fm}$ = 55%), August ($G_{Fm}$ = 53%) and September ($G_{Fm}$ =52.1%) (Table 3)

**Table 3: Seasonal Feeding Intensity of *Oreochromis Niloticus***

| Season | Months of the season and % gut fullness | | | Mean | SD |
|---|---|---|---|---|---|
| Early dry season (ED) | Oct | Nov | Dec | | |
| | 10(52%) | 8(50%) | 11(54%) | 52% | 1.98 |
| Late dry season (LD) | Jan | Feb | Mar | | |
| | 7(51.5%) | 7(51.5%) | 9(52%) | 51.70% | 1.53 |
| Early rainy season (ER) | April | May | June | | |
| | 8(40.1%) | 9(41%) | 9(41%) | 40.70% | 0.92 |
| Late rainy season (LR) | July | Aug | Sept | | |
| | 12(55%) | 11(53% | 10(52.1%) | 53.40% | 3.06 |

Omoigberale and Aruoture (2002) reported that if the percentage of full stomachs was more than that of empty stomachs, there is high degree of feeding intensity, and this phenomenon was observed in this present study in River Okura. The intense feeding observed in *O. niloticus* in the months of July, August and September corresponded to the late rainy season indicating abundant food items for them to feed on**.** It has been reported that the availability of food determines the quantity of food consumed Iyiola *et al.* (2020).The high gut fullness in the late dry season corresponded to the time of favorable and high biomass as a result of flooding which occurred in the mid rainy season.

**Diet of *Oreochromis Niloticus***

The dietary characteristics of *Oreochromis niloticus* in river Okura are summarized in Table 4. The food items consumed by *O niloticus* are Cyanophyceae, Baccillariophyceae, zooplankton Chlorophyceae with numerical percentage of 39.5, 28.3, 16.7 and 15.5 respectively. By frequency of occurrence method, the least frequent food item was *Brachionus* with percentage frequency of 4.1 while the most frequent is *Closterium* with percentage frequency of 85.9% respectively.

**Table 4: Diet Table of *Oreochromis Niloticus* in River Okura at Ofejiji**

| Food Items | Numerical method | | Freq. Occur. method | | Commonness field | Choice |
|---|---|---|---|---|---|---|
| | Number | % | FO | % | | |
| **PHYTOPLANKTON** | | | | | | |
| **Cyanophyceae** | | | | | | |
| *Chlamydomonas* spp | 838 | 14.3 | 68 | 43.2 | 21-50% | Very common |
| *Microcystis* spp | 926 | 15.8 | 87 | 54.8 | >50% | Dominant |
| *Anabaena* spp | 240 | 4.1 | 81 | 51.5 | >50% | Dominant |
| *Merismopedia* spp | 310 | 5.3 | 64 | 40.2 | 21-50% | Very common |
| Subtotal | 2314 | 39.5 | | | | |
| **Bacilariophyceae** | | | | | | |
| *Melosira* spp | 568 | 9.7 | 53 | 33.4 | 21-50% | Very common |
| *Navicula* spp | 667 | 11.4 | 62 | 39.2 | 21-50% | Very common |
| *Diatoma* spp | 422 | 7.2 | 67 | 42.1 | 21-50% | Very common |
| Subtotal | 1657 | 28.3 | | | | |
| **Chlorophyceae** | | | | | | |
| *Staurastrum* spp | 298 | 5.1 | 51 | 32.5 | 21-50% | Very common |
| *Closterium* spp | 607 | 10.4 | 136 | 85.9 | >50% | Dominant |
| **Subtotal** | 905 | 15.5 | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **ZOOPLANKTON** | | | | | | |
| **Rotifera** | | | | | | |
| *Brachionus* spp | 369 | 6.3 | 6 | 4.1 | 1-5% | Rare |
| *Keratella* spp | 609 | 10.4 | 26 | 16.2 | 6-20% | Common |
| Subtotal | 978 | 16.7 | | | | |
| **DETRITUS** | - | - | 103 | 65.2 | 6-20% | Dominant |
| **Total** | **5854** | **100** | **158** | | | |

Footnote: FO – Frequency of occurrence, Freq. Occur. - Frequency of occurrence

The diets of *O niloticus* in River Okura was dominated majorly by phytoplankton (of the species *Microcystis*, *Anabaena* and *Closterium*) and detritus. Several species of phytoplankton were very common in the diet of the species, *Keratella* a zooplankton was common in the diet (Table 4). This implies that the species tended towards plankton feeding. This report confirms Wagaw *et al.* (2022) that *O. niloticus* fed majorly on plankton. However, *O. niloticus* has been reported to be herbivorous feeding majorly on plants and plant materials Iyiola (2020). Omondi *et al*. (2013) reported the species in Lake Baringo to be omnivorous feeding majorly on algae, detritus and zooplankton. Fish herbivory is particularly difficult to categorize (Clements and Raubenheimer, 2006), for example, a fish traditionally considered as herbivorous can actually consume quite a range of diets including detritus (Choat *et al*., 2002). The species exhibited trophic plasticity according to the environment and the other species they coexisted with (Bwanika *et al*. 2007). The detritus observed to be dominant in the gut of the species is considered to be majorly plant materials at various levels of digestion.

**Gut Length and Standard Length Relationship**

The gut lengths ranged from 81.2cm in an individual that measured 9.9 cm standard length and 28g body weight to 195.8 cm in another individual that measured 19.2cm standard length and 286.4g body weight. The mean gut length was 132.5 ± 62.7cm. The gut length relative to the standard length ranged from 6.8 to 10.2 with the mean value of 8.2 ± 0.85 (Table 4)

**Table 5: Relationship Between gut Length and Standard Length of *Oreochromis Niloticus***

| Body parameters | Minimum | Maximum | Mean |
|---|---|---|---|
| SL(cm) | 9.9 cm | 19.2 | 14.5±3.4 |
| BW(g) | 28 | 286.4 | 94.3±21.5 |
| GL(cm) | 81.2cm | 195.8 | 132.5± 62.7 |
| GL /SL | 6.8 | 10.2 | 8.2±0.85 |

Key: SL-standard length, BW-body weight, GL-gut length

Fish vary tremendously in morphology and physiology of digestive gut and in feeding behaviour (Wagner *et al*. 2009; Keppeler *et al*., 2020; Ghilardi *et al*., 2021). Some fish have gut lengths less than one half of their body lengths and others have gut about six to eight times of their body length especially herbivorous fishes (Falayi, 2009). The gut length of 8.2 times standard body length of *O. niloticus* observed in this study is typical of herbivorous fish. This report confirms Opuszynski and Shireman (1995) who reported the digestive tract of *O. niloticus* to be at least six times the total length of its body. The long digestive tract of the species provides abundant surface area for digestion and absorption of nutrients from its mainly plant-based food sources.

**CONCLUSION**

Out of 368 stomachs of *O. niloticus* examined, 8.7% were completely empty while 58.5% of the guts had fullness of above 50% throughout the year. The mean gut fullness showed a significant variation throughout the season. Feeding intensity in the species is observed to be high in the months of July, August and September corresponding to the late rainy season when there was abundance of food as a result of flooding. *Oreochromis niloticus* in River Okura fed mainly on phytoplankton and detritus. It consumed a few zooplankton. The phytoplankton include *Microcystis* spp, *Anabaena* spp, *Chlamydomonas, Merismopedia* spp (Cyanophyceae), *Diatoma* spp, *Navicula* spp, *Melosira* spp, (Bacilariophyceae), *Closterium* spp and *Staurastrum* spp. (Chlorophyceae). The zooplankton *Keratella* spp was consumed as a common food item**.** The gut length of *O.niloticus* is averagely 8.2 times the standard body length characterizing it to be herbivorous. Detritus which is a dominant food item is considered to be majorly plant materials at various levels of digestion.

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