PROXIMATE COMPOSITION, FOOD AND FEEDING HABIT OF *HETEROTIS NILOTICUS* FROM RIVER KADUNA FLOOD PLAINS, NIGERIA

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Abstract
In order to evaluate the proximate composition and feed and feeding habit of Heterotis niloticus, a total of 144 H. niloticus specimen were collected from River Kaduna flood plains using the gill net. Moisture, crude protein, Lipid and ash were evaluated for proximate composition, while Frequency of occurrence; point method and dominance method were used to evaluate the feed and feeding habit. Sampling of the specimen was done fortnightly and variations in the percentage composition of the food items were recorded. It was observed that the fish fed mostly on plankton with rotifer and polycysits having the highest number of frequency and dominant value with mean value of 43.03±4.12 and 11.73±1.15, 37.45±3.27 and 8.32±0.38 respectively while Arcella had the least mean frequency of occurrence of 3.27±1.7, Amoeba sp had the least mean dominance value of 7.06±3.0, while Aphnocapsa sp had the least mean frequency of occurrence of 1.10±0.29 and Navasota sp had the least mean dominance value of 4.31±1.11. We can conclude from this investigation that H. niloticus fish is a semi fatty fish and the food and feeding analysis of H. niloticus from River Kaduna flooded plains are predominantly planktivorous.

Keyword: Dominance method; Frequency of occurrence method; Gut length; Proximate compostion

Introduction
The importance of fish in the economy and ecology of island water has generated a lot of interest. Over the years aquaculture has gained a rapid interest due to the importance of fish as a cheap source of animal protein, since beef is beyond the reach of the average Nigerian citizen

The importance of fish in developing countries has increased greatly. Foran et al, (2005) reported that fish is a highly proteinous food. Therefore, considering the nutritional benefits associated with fish consumption, it has become important that fish's mineral and proximate composition be assessed in order to establish the safety level of the table-sized species before consumption. The principal constituents most affected by the seasonal cycle changes are fat and moisture. The knowledge of proximate composition of fish species is important in the application of different technological processes (Huss, 1988) and as an aspect of quality of raw material, sensory attributes and storage stability (Sikorski *et al.*, 1990).

Moreover, the measurement of some proximate profiles such as protein contents, carbohydrates, lipids, moisture contents and ash percentage is often necessary to ensure that they meet the requirements of food regulations and commercial specifications (Watermann, 2000).

Fish like other animals require adequate nutrition to grow and survive. In the wild, nature offers a great diversity of food; these include nutrient in solution and a host of different plant and animals. However natural food is not sufficient to the fish culture especially in ponds, with high density of stockfish. Therefore in fish farming, for efficient and effective management to avoid high cost of production to produce fish at cheaper price there is need for proper and effective strategies, which can only be achieve via proper understanding of the food and feeding habit of the fish to be cultured.

The success of fishes in terms of their diversity and number is to a large extent the measure of their success in finding adequate food, sometimes in the most unlikely situations. The magnitude of fishes stocked in a region is a function of its food potentialities (Bhuiyan *et al.* 2006). Food is an important factor in the biology of fishes to the extent of governing their growth. Hence the study of the food and feeding habits of fish species is a subject of continuous research because it constitutes the basis for the development of a successful fisheries management programme on fish capture and culture (Oronsaye and Nakpodia, 2005).

The African bonytongue has been characterized as microphagous (Lowe-McConnell 1975;1987) and feeding on variable amounts of plant material, including seeds, and benthic and water column invertebrates (Lowe-McConnell 1975, Lauzanne 1976, Hickley and Bayley 1987). In contrast, bonytongues from other tropical regions are piscivorous (*Arapaima gigas*) or are generalized carnivores that feed on fishes and a variety of terrestrial vertebrates and invertebrates (*Osteoglossum* and *Scleropages spp*.) (Goulding 1980, Rainboth 1996, Allen *et al.* 2002).

Kaduna River rises or over flood its bank during the raining season, that is between May-September (Odekunle, 2004). Field investigations revealed that the flood plains have shown considerable effect on the population of plankton communities, which is as a result of nutrient of both allochthonous and anthodithonous materials concentration within the flood plains during the flooding and during the retreat of the floodwater.

However inspite of River Kaduna being richly blessed with a lot of commercially culturable fish species, little studies have been done on the relationship between basic morphometric measurement, growth pattern and food and feeding habits especially *Heterotis niloticus.* It is in this view that this research was carried out. The main objective of this research is to investigate the seasonal proximate composition, food and feeding habits of *Heterotis niloticus* from River Kaduna flood plain in Niger state of Nigeria through morphological features and stomach, body content analysis.

Materials and Methods

Sampling area

The Kaduna River is a major tributary of the Niger River, which took its source from Jos Plateau and flows in a northwesterly direction then southwards to join the Niger downstream of Wuya at Nupeko in Niger state. It covers a distance of about 575km and drains on area of about 66,300km^2 of diverse topography. The river is dammed at Shiroro also in Niger state about 348km down its course to form a reservoir with a surface area of about 312 km^2. The river is divided into two topographical zones. The upper zone; from its source to Zungeru town. This area is undulating with many rocky hills and rapids. While the lower zone starts downstream of Zungeru town to the confluence a distance of about 150 km (Odekunle, 2004)). This area is characterized by the presence of an extensive flood plain covering a total of about 150,000 hecter down the Niger.

Fish Sampling and Measurement

Specimens of *Heterotis niloticus* were collected fourthnightly from fishermen at three sampling sites namely Nku, Nupeko and Fokpo along river Kaduna flood plains from May 2006 – October 2006. Gill nets of mesh sizes ranging from 5-10 cm were the fishing gear used. Specimens collected were kept chilled in an ice chest to reduce post humous digestion of the stomach contents while in transit to the laboratory. At the laboratory total length (TL) was measured from the tip of the snout (mouth closed) to the extended tip of the caudal fin. Standard length (SL) was measured from the tip of the snout to the caudal peduncle, other basic morphemetric features; head length, snout length and eyes diameter were measured with the aid of a measuring board and a mathematic set divider. The lengths were taken with measuring board to the nearest 0.1 cm. Body weight of individual fish was measured to the nearest 0.1 g with an electric balance after removing the adhered water and other particles from the surface of body.

Proximate Composition Analyses

After preparation of edible parts of fish as described, proximate composition analyses were performed according to AOAC procedures (AOAC, 2000). Water content was determined by drying samples at 105±2°C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and Ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as solvent. Crude protein content was calculated by using nitrogen content obtained by Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content (AOAC, 2000).

Stomach content analysis

The specimens were cut open and the stomachs were removed and immersed in 4% formalin. Each stomach was slit open, and the contents poured into a petri dish. The food were observed with unaided eye. Then, random samples of the stomach contents were taken and dropped on slides with the aid of a dropping pipette and observed under a light microscope. The stomach contents were identified and analyzed using the frequency of occurrence, point method and numerical methods (Bagenal, 1978). In the frequency of occurrence method, the number of stomachs containing each food item is expressed as a percentage of all non-empty stomachs, In the numerical method, the number of individuals in each food category is expressed as a percentage of the total individuals in all food categories.

Statistical analyses

Data were analyzed using one-way analysis of variance (ANOVA) using Statistical 6.0 (Stat-Soft, Inc., USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at $P<0.05$.

Results

Morphology and anatomy of Heterotis niloticus in relation to its food and feeding

Heterotis niloticus of River Kaduna flooded plain has a terminal mouth. They have (4) four gills at each side of the body beneath the operculum. They also posses very long intestine ranging from 34-104 cm with an average length of 86 cm (Table 1). The gut of *H. niloticus* is differentiated into fore gut, the mid gut (bulging stomach) and the long intestine (hind gut). The rectum open into the anus from the fore gut to the end of the stomach is a very thick walled tube, which act as a gizzard the stomach is in side shape hence modified into grinding organ. This organ is more or less similar to the gizzard of chicken and other poultry**.**

Proximate Composition

Table the proximate composition of *H. niloticus* from R. Kaduna flood plain collected over a period of six months and the result showed that Lipid from the samples collected ranged from 5.01±0.58–7.88±0.46% and was significantly highest in October and lowest in May ($P<0.05$). The Moisture and crude protein varied considerably over time in the samples, and ranged between 72.18±2.05-74.91±1.32 and 15.04±1.05-15.52±1.52% respectively and were significantly highest in May and lowest in October (P<0.05), however there was no significant different in the crude protein between the months of May-August in the sample (P>0.005). The Ash content ranged between 4.57±0.17-4.80±0.25 but there was no significant difference in the ash content of the samples throughout out whole period of the study (P>0.005).

Food analysis

Three conventional methods were used to evaluate the food content in the gut of the specimens Table 3and 4 give a summary of dominance and frequency of occurrence.

Frequency of occurrence

From Tables 3 and 4 the stomach content analysis showed wide variety of items. *Polycystic* had the highest value of frequency of occurrence followed by *chlorella* and *trochiscia* while the least frequency of occurrence phytoplankton are *gloecaystis, ophiocytium*. *Rotifers* had the highest value of frequency of occurrence with Amoeba *frontina, diaptomus* having the least occurrence among the zooplankton that was found in their stomach.

Dominance method

Tables 3 and 4 showed that the first stomachs were mostly dominated by phytoplankton by *polycystic, oocystyis trochicia* and *chlorella* while *rhozosolenia* and c*yelsppcrium* were the least dominant. The Zooplankton analysis observed showed that Rotifer and volvox dominated the stomach of *H. niloticus* while *frontina* Amoeba and Arcella were least dominate.

Point method

It was noted or observed that no fish stomach was completely empty; 34% were half full stomach and 66% were full.

Discussion

The proximate composition of *H. niloticus* varies considerably between May- October. According to Stansby 1985 variation in proximate composition of fish flesh may vary with species variation, season, age and feeding habit of fish. The result of the present study shows that the crude protein of *H. niloticus* was moderately high and declined gradually from May-October. The relatively moderate percentage crude protein in *H. niloticus* could be attributed to the fact that; fishes are good source of pure protein, but the differences observed, in the obtained values may also be attributed to fish's consumption or absorption capability and conversion potentials of essential nutrients from their diet and availability of feed during the experimental period or their local environment into such biochemical attributes needed by the organisms body (Adewoye and Omotosho, 1997). From this study variation in water and Lipid content of the samples indicated that while there was a decline in water content, fat content evidently increased, this is inline with the previous works reported on freshwater fisheries by Sadiku *et al* 1991. Huss 1995; Love, 1997 also reported that Fat content has shown inverse proportionality to water content in some semi fatty fish species muscle, this may be attributed to the seasonal differences in availability of food and changes in the reproductive cycle having considerable effect on the tissue biochemistry of the fish particularly changes in the lipid and water content of there body system. The range for the ash content gave an indication that the fish samples may be good sources of minerals such as calcium, potassium, zinc iron and magnesium.

From the shape of the mouth and the gills arrangement *H. niloticus* exhibited filter feeding with the aid of its fine gill rakers hence capable of filtering phytoplankton and zooplanktons. However, this species is more of plankton feeder as earlier suggested or describe by Reed *et al* (1967), Olaosebikan and Raji (1998), Monentcham *et al.* (2009). They also reported that fishes with terminal mouth either prey upon other fishes or filter plankton from water, while Welcome (1967) reported that gills enable such species with this type of gills to feed on planktons. Reeds (1967) observed that fishes with numerous and fine gill rakers are either microphages or plankton feeders. The gut type is that of the omnivore, as reported by Larger (1977) he described the stomach of an omnivore as a food grinder. It was observed that smaller specimen had short gut length and weight in relation to the body length, however the gut length and weight shows that the gut is very long which range from 34-104 cm. This suggests a long gut transit time from the food of this fish. 45% of the specimens observed, have more food in the stomach (mid gut) than the hindgut. It was also observed that smaller specimens had short gut length and weight but in relation to the body weight. Fishes develop morphological and behavioral adaptations that allow efficient ingestion, digestion, and assimilation of organic matter in detritus (Bowen, 1983). The gizzard-like (muscular, thick-walled pyloric stomach) and pyloric caecae (blind pouches) of the gut of *H. niloticus* are examples of such adaptations (Moreau 1982) that are usually exhibited by advanced omnivores.

In term of individual food items the fish prefers plants materials (phytoplankton) favored by plant grains as earlier reported by Reed *et al* (1967), though *H. niloticus* of river Kaduna flood plains do not feed on detritus, they feed on polycystic suggesting a mid-water-feeding habit than bottom were they dwell. This may also be associated to the habitat of *Heterotis niloticus* where they mostly live in glassy areas where there is a lot of grass, particularly during the breeding season as they make their nest on grasses Bard *et al* (1976).

Frequency of occurrence of food analysis showed that polycystic were the predominant food items in period of phytoplankton boom during which there was a poor zooplankton community during this period polycystic oocystis trochiscia and chlorella were dominant food items in the guts being the dominant phytoplankton in the river and the filter feeding mechanism of the fish is non selective. At certain time of the year when zooplankton community increased with more of rotifer, the fish then had preferences for the rotifers and volvox as revealed by dominance method as earlier reported. Although throughout the experiment there was no decline in phytoplankton consumption but the intake of zooplankton increase tremendously after the algae boom during the raining season and towards the end of the raining season.

Conclusion

The results suggest that the proximate composition of fish species greatly varies during the catching season. This might be due to physiological reasons and changes in environmental conditions, i.e., spawning and starvation or heavy feeding. The physiological state of *H. niloticus* species in this study might greatly affect the proximate composition. This study provides valuable information on variations in proximate composition of fish species studied in order to take necessary precautions in processing from a manufacturer point of view and to distinguish their nutritional value and make a choice based on that information from a consumer point of view.

The food and feeding habit study of the *H. niloticus* showed that the fish prefers food items that varies with time during the four months period of this study there was preference of *polycystic sp* before rotifers succeeded later.

Acknowledgement

We want to sincerely thank the chief laboratory Technologist of Department of Water Resources, Aquaculture and Fisheries Technology for the laboratory analyses of the specimens.

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Table 1: Summary of biometrics measurement, gut length and gut weight measurements of *H. niloticus* sample

Measurement	Range (cm)	Mean value
Total length (cm)	24.3 - 49.4	22.9±2.04
Standard length (cm)	20.2 - 45.0	27.7±5.0
Body weight (g)	140.0 - 900.0	265.2±145.8
Gut length (cm)	35.0 -104.0	48.8±10.6
Gut weight (g)	3.1 -32.4	6.6±4.3

Table 2: Summary of Proximate composition of *H. niloticus* sample

Months	Moisture (%)	Lipid (%)	Protein (%)	Ash (%)
May	74.91±1.32^{e}	5.01±0.58^{a}	15.52±1.57^{b}	4.54±0.17
Jun	74.52±2.53^{d}	5.22±0.33^{b}	15.46±0.56^{b}	4.66±0.22
Jul	73.59±2.16^{c}	5.51±0.41^{b}	15.48±1.32^{b}	4.71±0.55
Aug	72.91±1.07^{b}	5.89±0.34^{c}	15.47±0.78^{b}	4.73±0.43
Sept	72.65±1.13^{b}	6.61±0.76^{d}	15.26±1.12^{ab}	4.76±0.56
Oct	72.18±2.05^{a}	7.88±0.46^{e}	15.04±1.05^{a}	4.80±0.25

***Values in the same column with different superscript letters are significantly different (*P*<0.05) from each other.**

Table 3: Summary food evaluation in *Heterotis niloticus* zooplankton

Food items	Frequency of occurrence	Percentage Dominance
Cypriclopsis	4.88±1.05^{a}	8.74±0.81^{a}
Eubranchipus	4.27±1.83^{a}	8.33±1.98^{a}
Diatomus	3.84±0.37^{a}	8.39±0.63^{a}
Frontinia	4.40±1.21^{a}	8.92±0.66^{a}
Amoeba	3.37±0.82^{a}	7.06±0.50^{a}
Chilodon	5.16±1.30^{b}	8.61±1.15^{a}
Holophaya	4.14±0.56^{a}	8.91±0.88^{a}
Colpodium	3.34±0.65^{a}	8.89±2.07^{a}
Arcella	3.27±1.70^{a}	8.60±0.97^{a}
Volvox	20.16±4.38^{b}	11.76±1.15^{b}
Rotifer	43.03±4.12^{c}	11.76±1.15^{b}

***Values in the same column with different superscript letters are significantly different (*P*<0.05) from each other.**

Table 4: Summary food evaluation in *Heterotis niloticus* phytoplankton

Food items	Frequency of occurrence	Percentage Dominance
Gloecocystis	2.52±1.45[a]	5.97±1.35[b]
Ophiocytium	2.00±0.49[a]	6.38±0.62[b]
Chlorella	16.84±3.09[c]	8.32±0.38[c]
Trochiscia	18.27±2.70[c]	8.32±0.38[c]
Sceneolesmus	1.25±0.32[a]	4.52±0.95[ab]
Oocystis	8.30±4.01[b]	8.32±0.38[c]
Surivella	1.38±0.36[a]	4.98±1.32[ab]
Gomphpnema	1.24±0.42[a]	4.89±1.63[ab]
Stephanodiscus	1.36±0.19[a]	5.69±1.62[ab]
Cicconesis	1.17±0.41[a]	4.95±1.20[ab]
Rhizosolenia	1.21±0.37[a]	4.31±1.11[a]
Navicula	1.53±0.67[a]	5.16±0.89[ab]
Cyclotella	1.48±0.71[a]	4.49±0.55[a]
Coelosphaerium	1.10±0.27[a]	4.46±0.82[a]
Aphnocapsa	1.37±0.50[a]	5.58±1.14[ab]
Polycytis	37.45±3.27[d]	8.32±0.38[c]
Phormidium	1.67±0.54[a]	5.58±0.34[ab]

***Values in the same column with different superscript letters are significantly different (*P*<0.05) from each other.**