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Food and Feeding Habits of Three Freshwater Fish in Jebel Aulia Reservoir, Sudan

Egbal Osman Ahmed*, El Nouman Babikir Ahmed, Alresala Abdalrhman Mahmoud, Ghada Ahmed Elhag

Department of Fish Science, AL Neelain University, Khartoum, Sudan

Abstract

This study was conducted on three commercial Nile fish to determine the type of food and their feeding habits. A total of 450 *Oreochromis niloticus*, *Labeo niloticus*, and *Schilbe mystus* samples were collected from the Jabal Aulia reservoir area, (White Nile), which lies about 40 km south of Khartoum. The looking for was made for the total& standard length, body weight, relative length to the alimentary canal, and examination of gut substance. The study indicated that *Oreochromis niloticus* feeds generally on the remains of plants, aquatic plants, phytoplankton, and a few zooplankton, and thus it can be respected as an omnivorous species. Investigation of the stomach substance of *Labeo niloticus* is essential herbivorous eating differences of plant food, which is affirmed through the proportion of intestinal length to body length, is longer 12.2 times to the standard length. The study additionally confirmed that *Schilbe* mystus are predatory carnivores that feed normally on small fish, insects, crustaceans, and molluscs. The result appeared that the length of the intestine is different, corresponding to the kind of feeding. The intestine is very long in the vegetarian species *Labeo niloticus*, and short in the carnivorous species *Schilbe mystus*, while it was medium to long in *Oreochromis niloticus* with double feeding with more vegetarianism. This considers concluded, in understanding the nature of the food,, the significance of presenting *Labeo niloticus* with plant and bottom feeder into a polyculture system in which Tilapia is the predominant fish and fundamentally based on the sort of food. It moreover concluded that the *Schilbe mystus* fish can be utilized in combating the excessive reproduction of Tilapia fish in farms.

Keywords

Feeding habits, Wight Nile Fishes, Gut Conten

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1. Introduction

Nutrition is the series of processes by which an organism takes in and assimilates nutrients for the purpose of supporting growth, reproduction, or tissue repair. Thus, any living organism, to provide all of its vital needs, must ingest food. These offer assistance to guarantee the growth, vital functions, and, also, to compensate energy losses due to foraging, migration, and reproduction activities [18]. Food is the main source of energy and is essential for growth and population grade [8]. Fish food varies from seasons to seasons since regular changes in temperature impact food consumption as well as the accessible food organisms, and from species to species [2].

Fish feeding habits are essential biological perspectives when selecting a group of fish for culturing for the right utilize of all accessible foods and to reduce competition for food [14]. The feeding habits of fish are species particular, whereas a few are known to be suspension feeders which feed on plankton and organic matter, others are described as deposit

* Corresponding author
E-mail address: egbalosman1@gmail.com (E. O. Ahmed)

feeders which feed on detritus, carnivores feeding on other animals, herbivores feeding on plants, and omnivores feeding on a variety of food items[4].

The trophic level represents the biological intelligence of a species and is used as a descriptor of the species in ecological communities [13]. Fish feeding habits, based on gastric investigations, will be widely used in fish biology as an important strategy for exploring trophic links in marine communities [16].

Investigation of substance within the gut and the characteristics of the diet provide information about food, feeding habits, and selective feeding. Therefore, the food and feeding habits of fish are determined on the basis of stomach contents and the length of the digestive tract. The research study of the food and feeding habits of freshwater fish species is the subject of ongoing research. Moreover, it forms the basis for the development of such a successful management program for fishing and fish farming [25]. An analysis of the fish's gastrointestinal tract contents provides important information about feeding types and an explanation of feeding habits [23]. Hence, the aim of this study was to provide data on the food and feeding habits of economically important freshwater fish *Oreochromis niloticus*, *Labeo niloticus*, and *Schilbe mystus* and would encourage their cultivation in order to access food and preserve these economically important fish.

2. Material and Methods

2.1. Study Site

Jebel Aulia Reservoir, 45 Km south of Khartoum located between 32° 27° E and 15° 12° N, and it arose as a result of the Jabal Aulia dam construction on the White Nile (Figure 1). Jebel Aulia reservoir is a large shallow lake in Sudan covering an estimated area of about 1246 Km^2 [9]. The construction of the dam was started in 1933 and completed in 1937 to impound water of the White Nile for irrigation purposes. Thus the dam is playing an important role in food security within Khartoum, providing agricultural products and fresh fishes to fish markets.

2.2. Fish Sampling

A total of 450 fish samples were randomly selected from commercial fishermen. The fish that was gotten from sampling locations were identified using keys given [3, 7]. The species that were considered *Oreochromis niloticus*, *Labeo niloticus*, and *Schilbe mystus* Table 1. Total length (from mouth tip to the end of the caudal fin) and Standard Length (SL) of the fish samples were taken along the body axis using a measuring board to the closest centimeter (cm) and recorded. Moreover, the head length was taken from the tip of the mouth to the beginning of the operculum, and mouth width through opening the mouth to the greatest practical degree had been measured. The body weight was measured to nearest gram using a sensitive balance (SF-400 accuracy of 1g).

Figure 1. The lake of Jebel Aulia dam.

2.3. Gut Content Analysis

The fish intestine was carefully extricated by opening the stomach parcel of the fish with the help of a pointed nose combine of scissors. The tip of the intestine was removed from the esophagus to the end of the rectum carefully using forceps and weighed. The guts were stored in containers containing 5% formalin and transported to the faculty of the agriculture and fish sciences for analysis. Maintaining the gut in 5% formalin enhances the anticoagulant of diet ingredients for easy demonstration [6, 19].

Each intestinal substance was removed with a spoon in a glass Petri dish and inspection with two hand lenses both hand lens and stereo microscope depending on the size of food items. The distinguished components within the intestine of each specimen were numbered and the amount of a specific food item in each intestine was noted and recorded. These were included up to decide the general amount of diet components in all the guts for the purpose of knowing which food items were mostly consumed [26]. Occurrence method [22] is expressed within the formulae below.

$$Frequency\ of\ occurrence = \frac{\text{Total number of stomachs with the particular food item}}{\text{Total number of stomachs with food}}$$

2.4. Statistical Analysis

Statistical analysis was performed for mean and standard deviation (mean± SD) for the results obtained were calculated using SPSS software (Version20.0).

Table 1. Fish species studied in Jebl Awlia reservoir.

NO of samples	Family	Species	Local name
150	Cichlidae	*Oreochromis niloticus*	Bulti
150	Cyprinidae	*Labeo niloticus*	Dabs
150	Schilbieidae	*Shilbe mystus*	Schilba

3. Results

A total of 450 specimens of *Oreochromis niloticus Labeo niloticus*, and *Schilbe mysyus* were gotten. The total length and standard length ranged from 16.5 to 20.5 cm and from 14.5 to 17.5 cm, respectively in *Oreochromis niloticus* while the weight ranged between 168.3 to 100.9 g. In *Labeo niloticus*, the total and standard length ranged between 42.5 to 22.5 cm, and 35.5 to 18.5 cm, respectively while the weight ranged between 737.6.3 to 113.3 g. The total length and standard length ranged from 26.7 to 15 cm and from 23 to 12.5 cm, respectively, the weight ranged between 165.3-27.4 in *Schilbe mystus* Table 2

The alimentary canal length and its ratio to the total and standard length, and the width of the mouth to the head length were given in Tables 3&4. The alimentary canal of *Oreochromis niloticus* is longer 7 times to the total length and 8.2 times the standard length, and the ratio of mouth width to head length is 0.3 cm. While the ratio of the alimentary canal of *Labeo niloticus*, is longer 10.1 times the total length and 12.2 cm to the standard length, the ratio of the mouth width to head length is 0.1 cm. The mouth of *Schilbe mysyus* is terminal, the mouth teeth are small and thick, while the gill teeth are short and sharp. The ratio of the alimentary canal of *Schilbe mysyus*, to the total and standard length, were 1.6 and 1.8, respectively and the ratio of mouth width to head length is 0.5 cm.

Analyses of food substances found in the intestine of the three studied fish were presented in Table 5. The distinctive food items ingested by *0.niloticus*, basically on plant food items such as phytoplankton, diatoms, plant species such as leaf segments, plant tissues, dead leaves, flower buds, and a few animal food substances comprising of zooplankton, insect larvae, protozoa and detritus. The alimentary canal content of *Labeo niloticus* were aquatic plants, phytoplankton, mud, and sand. Concurring to the examination of stomach substance, *Schilbe mysyus* eat small fish, insects, crustaceans and molluscs.

Table 2. Body weight, total, and standard length of studied fish species.

Fish species	Body weight (g)			Total length (cm)			Standard length (cm)		
	Max.	Min.	Mean	Max.	Min.	Mean	Max.	Min.	Mean
Oreochromis niloticus	168.3	100.9	131.4±	20.5	16.5	18.6	17.5	14.5	15.9±0.08
Labeo niloticus	737.6	113.3	267.6±	42.5	22.5	29.4	35.5	18.5	24.4±0.43
Schilbe mysyus	165.3	27.4	55.5±	26.5	15	19	23	12.5	13.6±0.04

Table 3. Gut length & relations to the total &standard length of the studied fish species.

Fish species	Gut length (cm)			Relation to total length	Relation to standard length
	Max.	Min.	Mean	Mean	Mean
Oreochromis niloticus	161.5	90.0	131.2±0.35	7.0±0.07	8.2±0.09
Labeo niloticus	459.7	227.7	299±1.67	10.1±0.03	12.2±0.02
Schilbe mysyus	46.5	21	30.0±0.82	1.6±0.21	1.8±0.21

Table 4. Feeding habits & mouth width relative to head length of studied fish specie.

Fish species	Head length (cm)			mouth width(cm)			Relative to head length	Feeding habit
	Max.	Min.	Mean	Max.	Min.	Mean	Mean	
Oreochromis niloticus	5.0	4.3	4.7±0.65	1.4	1.2	1.3±	0.3±1.34	Omnivore
Labeo niloticus	6.5	3.8	4.9±0.65	1.7	0.4	0.7±	0.1±1.22	Herbivore
Schilbe mysyus	4.5	2.5	3.2±0.53	2.4	1.2	1.7±	0.5±1.12	Carnivore

Table 5. Food types of studied fish species.

Food content		Fish species		
Animal food	**Types**	***Oreochromis niloticus***	***Labeo niloticus***	***Schilbe mysyus***
Fish	Fragments of fish body, scales, bones, others	-	-	+
Aquatic Insect	Adult, Larvae, legs, head	+	-	+
	Crayfish	-	-	+
Crustaceans	Decapod	-	-	
	Daphnia	+		
Molluscs	Gastropod (snails)		-	+
Roterifer	Brachionus	+	-	+
Copepods	Cyclopoid	+	-	+
Ostracods	Cyclopoid Cypris		-	+
Cladocera	Bosmina	+	-	+

Food content		Fish species		
Animal food	**Types**	***Oreochromis niloticus***	***Labeo niloticus***	***Schilbe mysyus***
Protozoa	Neries sp	-	-	+
Plant food	Item			
Plant remains	leaf parts, plant tissues, dead leaves, flower buds	+	+	_
	Pleurococcus	+	-	-
	Euglena	+	+	-
	Spirogyra species	+	+	-
	Chlorella	-	+	-
Algae	Gloeocapsa	-	+	-
	Volvox	+	-	-
	Lyngbya	+	-	-
	Diatoms	+	-	-
			-	-
Mud and sand particles	mud and sand particles	+	+	-

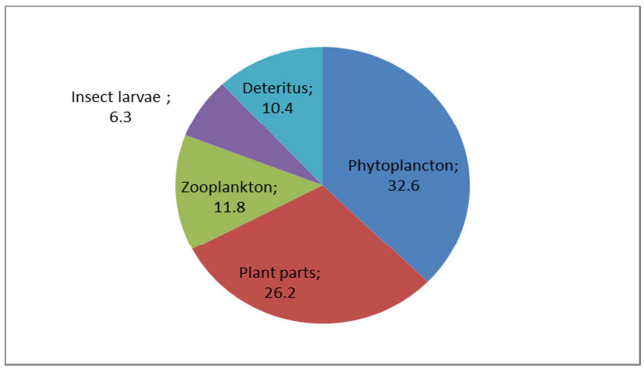

Figure 2. The proportions of food types in the stomach of *Oreochromis niloticus.*

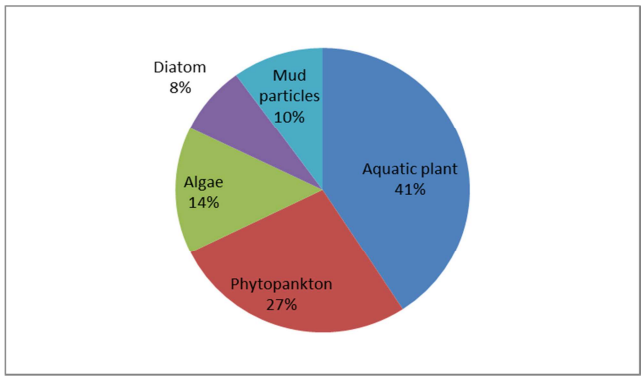

Figure 3. The proportions of food types in the stomach *Labeo niloticus.*

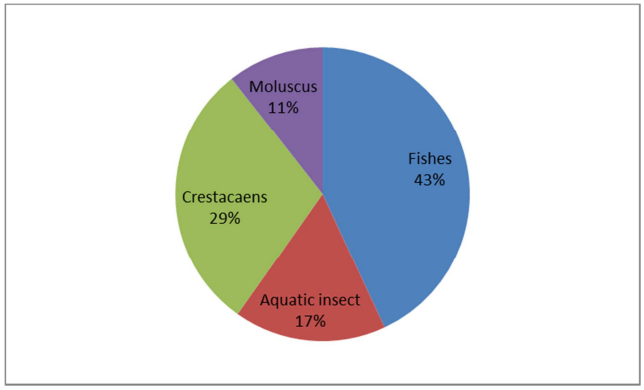

Figure 4. The proportions of food types in the stomach of *Schilbe mysyus.*

4. Discussion

Studies on fish biology are indispensable for preserving fish biodiversity and managing the sustainability of production [30]. One of the most important biological aspects of fish that needs to be studied for a successful aquaculture program is the habit of feeding. The evaluation of the stomach substance of a fish reduces Intra and inter-specific competition for biological specialty because it is crucial in giving straightforward models of stomach substance and feeding dynamics [29]. It has been identified the type of food and feeding habits during the study period on the basis of the percentage of the type of food in the stomach and the relative length of the digestive tract.

Concurring to the feed type, there are three types of fishes; carnivores (eat only meat), omnivores (eat both plants and meat), and herbivores (eat only plants) [24]. *Oreochromis niloticus* is omnivorous feeding behavior [12]. Its diet composition may vary within a wide range of seasonal and spatial conditions of the environments. The food composition may too shift depending on the size of the fish, maturity, environmental condition and habitat types [20]. In this study, *O. niloticus* is mainly omnivorous and eats various elements of plant and animal food Figure 2. Feed primarily on the remains of plants, aquatic plants, phytoplankton, aquatic insect and some zooplankton Table 5. These results confirmed by the large ratio of intestinal length 7 & 8.2 times to the total, and the standard length respectively, which characterizes usually omnivorous [1, 21, 27, 28].

Examination of the stomach substance of *Labeo niloticus* of the herbivorous species that feed on different types of plant foods Table 5. Most food types are aquatic plants, their debris and their remnants, phytoplankton, algae in expansion to mud and sand Figure 3. Similar observations were obtained that *labeo niloticus* in Jebel Aulia Reservoir is herbivores fish, depending on phytoplankton, diatoms, algae plants remains and organic debris [5]. The current study emphasizes the

nature of the bottom-feeding of sucker. *L. niloticus* that eat at the bottom which explains the presence of quantities of mud that was rinsed from the bottom during feeding and possibly to extract aquatic plant debris and organic materials from it. As well as the gill teeth of *L. niloticus*, which are thin, thick, and near together, so make a difference within the productive sifting of phytoplankton. Also, the structure of the buckle cavity, gills, and pharynx are fitted with an advanced filter-feeding system [15]. Concurring to this study mentioned, that *L. niloticus* is mostly herbivorous, which is confirmed by the ratio of intestinal length to body length, is longer 12.2 times to the standard length.

The nature of the bottom-feeding of *L. niloticus*, qualifies to be utilized within the polyculture system, which includes Tilapia species as the main fish *L. niloticus*, will contribute to harvesting the natural bottom food that is wasted in the case of monoculture of Tilapia. Moreover will increase the total productivity of fish in cultivation ponds without influencing the efficiency of the main fish (Tilapia).

Fish are predators that feed on a single group of animals other than plant material or detritus [17]. The presence of animal food items within the stomach of *S. mystus* could be due to the predatory nature of the fish [2]. *S. mystus* feed mainly on the aquatic insects, young and larvae of the fish, thus S. *mystus* from Jebl Awlia can be classified as a predator feeder. The results appeared that the food items comprised of fish, insects crustacean, and molluscs, in addition to the width of the mouth, and the shortening of the digestive tract [10]. The feeding habits of *S. mystus* in Jebel Aulia lakes agreed with observations that *S. mystus* from Oyan and Asejire lakes feed mainly of three major groups, fish, insects, and crustacean [4]. Depending on the predatory nature of feeding, *S. mystus* can be utilized in polyculture to combat the overbreeding of tilapia species in the ponds as an elective carnivorous fish.

5. Conclusion

According to the obtained results, the intestine substance in *Oreochromis niloticus* comprises the plant, as well as an animal types, mainly food substance, is plants, so *Oreochromis niloticus* omnivorous. *Labeo niloticus* are Herbivorous species, feeding on a great variety of plant and bottom-feeding fish. The food items within the stomach of *Schilbe mysyus* consisted of fish, insects crustaceans, and molluscs, in this way classified as predator feeders.

The nature of the bottom-feeding of *L. niloticus*, and the predatory feeding of *S. mystus* can be utilized within the polyculture system, which includes Tilapia species as the main fish. *L. niloticus*, will contribute to harvesting the natural bottom food that is wasted in the case of monoculture of Tilapia and *S. mystus* combat the overbreeding of tilapia species as an alternative carnivorous fish.

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