Innovations in Agriculture

Innovations in Agriculture 8: 1–4
doi: 10.3897/ia.2025.140594

RESEARCH PAPER

Comparative morphological study of the gastrointestinal tract of *Eutropius niloticus* and *Oreochromis niloticus* from lower river Benue, Nigeria

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Academic editor: R. Subramanian ♦ **Received** 30 October 2024 ♦ **Accepted** 28 January 2025 ♦ **Published** 25 February 2025

Abstract

This study investigates the gastrointestinal tract (GIT) morphology of *Eutropius niloticus* and *Oreochromis niloticus* which are two economically important fish species from Lower River Benue. Fifty specimens of each species were sampled monthly for a period of three months (November, 2022 – January, 2023) to determine their body and gut measurements. Results revealed that *Eutropius niloticus* had a mean total length of 24.15±1.90 cm, gut length of 18.00±1.32 cm, and gut weight of 6.09±0.95 g in November, indicating a digestive system enhanced for rapid transit during the period. Conversely, *Oreochromis niloticus* showed a highly coiled intestine, with a mean gut length of 79.75±9.59 cm and a gut weight of 3.99±1.19 g, suggesting a digestive system adopted to prolonged digestion. Both species showed a significant correlation between body weight and gut length, with r^2 values of 81.67% and 69.65%, respectively. These findings contribute to the understanding of the feeding strategies and adaptive digestive mechanisms of these species to the dry season fluctuations of River Benue.

Keywords

Gastrointestinal Tract (GIT) Morphology, *Eutropius niloticus*, *Oreochromis niloticus*, Lower River Benue, Fish Nutrition

Introduction

Fish shows diverse adaptations in their gastrointestinal tract (GIT) morphology, which reflect their diet, ecological niche, and evolutionary history. These adaptations ensure optimal digestion, nutrient absorption, and physiological regulation (Leander et al. 2013). Carnivorous fish tend to have shorter intestines to support rapid digestion, while herbivorous species exhibit longer, coiled intestines to facilitate the breakdown of complex plant materials (Kalhoro et al. 2017). Additionally, factors such as body shape, sex, and size can influence GIT morphology (Canan et al. 2012). Understanding these morphological differences is crucial for managing fish populations in natural habitats and optimizing their nutrition in aquaculture systems (Germano et al. 2017).

The GIT of fish shows diverse adaptations that reflect their evolutionary history, dietary habits, and ecological roles (Wilson and Castro 2010). While carnivorous fish, such as *Eutropius niloticus*, possess shorter and more linear intestines suitable for rapid digestion of protein-rich diets, herbivorous and omnivorous species, like *Oreochromis niloticus*, possess longer and more coiled intestines that accommodate plant-based diets, facilitating the breakdown of complex carbohydrates (Qu et al. 2012). Variations in GIT morphology are also influenced by environmental conditions and resource availability, underscoring the dynamic relationship between physiology and habitat (Santos et al. 2015). Studies have indicated that gut morphology in *Eutropius niloticus* is also influenced by environmental factors such as water quality and seasonal changes, which affect feeding behaviour and digestive efficiency (Djaelani et al. 2023). The histology of its GIT, characterized by epithelial cells and mucus layers, supports nutrient assimilation.

Eutropius niloticus and *Oreochromis niloticus* are important species in African fisheries, valued both for their ability to exploit the food resources in African aquatic systems. While *Oreochromis niloticus*, commonly known as Nile tilapia, has been extensively studied due to its widespread use in aquaculture (Samanta et al. 2016), research on the digestive morphology of *Eutropius niloticus* remains limited. As aquaculture continues to expand, particularly in sub-Saharan Africa, a deeper understanding of the digestive anatomy of these fish is essential for optimizing feeding practices and improving growth performance (Baroiller 2015).

The Lower River Benue, has undergone significant ecological alterations due to climate change and anthropogenic activities. These changes are expected to impact the availability of prey and other food resources, potentially causing dietary shifts among fish populations. There is limited research focusing on the GIT morphology of *Eutropius niloticus* in the context of habitat alterations. This study examines the morphological adaptations of the GIT in *Eutropius niloticus* in comparison to *Oreochromis niloticus*. This research provides information on the capacity of *Eutropius niloticus* to adapt to such dietary changes comparative to *Oreochromis niloticus*, which has a well-documented GIT structure suitable for mixed diets.

Materials and methods

200 samples of each of the fish species were obtained from the local fishermen at the Wadata landing site. The morphometric measurements of the fish samples were taken after which they were gutted. The standard length, total length and gut length were measured using a meter board while body and gut weight were taken on a precision weighing scale (Mettler Toledo). Data obtained from these measurements were subjected to 1-way Analysis of variance (ANOVA) to determine the variations across the sampling months. Simple linear regression of between body weight and gut length were conducted for each of the species studied.

Results

The morphometric parameters and GIT measurements for both fish species varied significantly over the three-month study period. The morphometric measurements of *Eutropius niloticus* are summarized in Table 1.

Table 1. Mean measurements of body and gut parameters of *Eutropius niloticus*.

Measurements	Months			
	November, '22	December, '22	January, '23	Overall
Total Length (cm)	24.15±1.90	11.41±1.08	24.84±1.87	19.92±1.20
Standard Length (cm)	20.63±1.53	9.54±0.89	19.01±1.21	16.16±1.06
Body Weight (g)	91.60±12.70	12.28±5.81	87.60±20.20	62.30±10.10
Gut Length (cm)	18.00±1.32	12.12±1.47	12.88±1.44	14.13±0.90
Gut Weight (g)	6.09±0.95	1.05±0.30	5.95±0.82	4.27±0.56

In November, the mean total length (24.15±1.90 cm) and body weight (91.60±12.70 g) were at their highest, suggesting the peak feeding activity of the species. Gut length was also longest in November (18.00±1.32 cm), indicating a possible increase in digestive capacity to handle higher food intake during this period. However, both gut weight (6.09±0.95 g) and body weight decreased markedly in December to 1.05 g and 12.28 g, respectively, possibly due to seasonal changes impacting food availability. By January, body and gut parameters began to recover, with a mean total length of 24.84 cm and a gut weight of 5.95 g.

These variations suggest that *Eutropius niloticus* may exhibit seasonal feeding behaviour, with a peak during the early dry season (November) and reduced activity towards the end of the year, as food resources become scarce. The strong regression between body weight and gut length (r^2 = 81.67%) (Fig. 1) supports the hypothesis that GIT morphology in *Eutropius niloticus* adjusts to accommodate seasonal dietary changes.

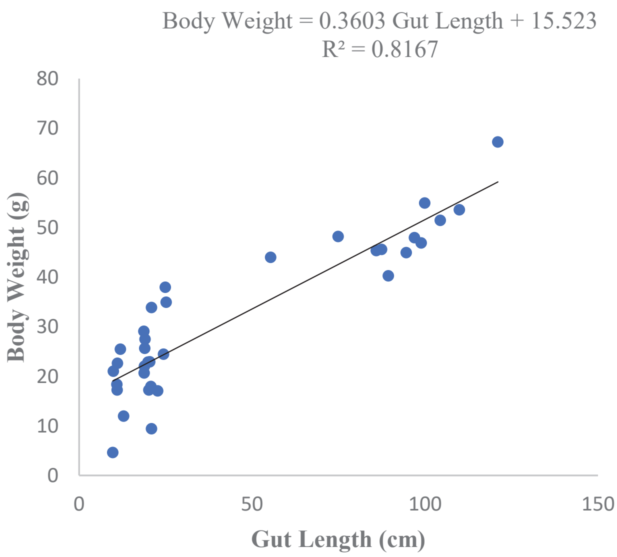

Figure 1. Regression relationship between body weight and gut length of *Eutropius niloticus*.

The morphometric trends observed in *Oreochromis niloticus* are presented in Table 2. This species showed a distinct pattern of growth, with the highest mean body weight recorded in December (115.10 g). The gut length

Table 2. Mean measurements of body and gut parameters of *Oreochromis niloticus*.

Measurements	Months			
	November, '22	December, '22	January, '23	Overall
Total Length (cm)	16.56±2.25	14.95±3.93	12.55±0.57	14.3±1.28
Standard Length (cm)	13.53±1.85	12.28±3.19	10.33±0.53	11.77±1.04
Body Weight (g)	73.40±19.90	115.10±65.00	32.56±3.12	67.00±19.20
Gut Length (cm)	79.75±9.59	43.60±11.10	17.60±1.14	42.22±5.63
Gut Weight (g)	3.99±1.19	7.52±3.26	2.66±0.28	4.39±0.99

was longest in November (79.75 cm), suggesting that gut development increased with feeding activity.

The coiled intestinal structure of *Oreochromis niloticus* likely facilitates the digestion of a mixed diet of detritus, algae, and plant material, which requires prolonged processing. Gut weight also peaked in December (7.52±3.26 g), coinciding with the highest recorded body weight, indicating that the fish may optimize digestion and nutrient absorption during this period.

The regression analysis revealed a significant relationship between body weight and gut length, with an r^2 value of 69.65% (Fig. 2).

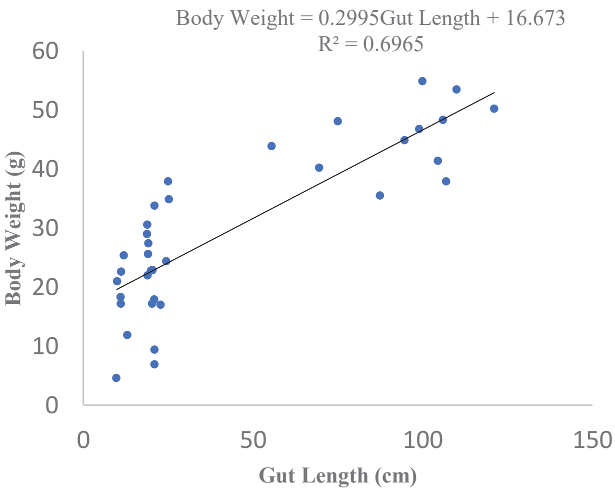

Figure 2. Regression relationship between body weight and gut length of *Oreochromis niloticus*.

The comparison between the two species reveals distinct adaptations in their GIT morphology, relative to their dietary preferences and feeding strategies. *Eutropius niloticus* had a shorter but linear intestine, adaptive to carnivorous feeding, while *Oreochromis niloticus* had a longer and coiled intestine, for the digestion of plant-based material. The relationship between body weight and gut length was more prominent in *Eutropius niloticus* (r^2 = 81.67%), suggesting a stronger relationship between growth and digestive capacity. In contrast, *Oreochromis niloticus* showed a slightly lower correlation (r^2 = 69.65%), indicating a more complex digestive demand. The study also observed that environmental factors and seasonal changes influenced the gut morphology of both species. Peak values in November for gut length and weight in both fish suggests increased food availability during the post-rainy season, with higher feeding activity.

Discussion

The results of this study report the distinct digestive adaptations in *Eutropius niloticus* and *Oreochromis niloticus* and emphasize the influence of their natural diets on GIT morphology. The relatively simple, straight intestine observed in *Eutropius niloticus* is in agreement with its carnivorous feeding habit, which requires rapid digestion of high-protein prey (Canan et al. 2012). The well-developed stomach, with pyloric ceca, further facilitates the breakdown of complex protein structures, optimizing nutrient uptake (Germano et al. 2017). This finding further agrees with previous research showing that carnivorous fish tend to have shorter intestines to expedite food transit and nutrient absorption (Leander et al. 2013). In contrast, *Oreochromis niloticus* had a highly coiled intestine and a muscular stomach, adaptations that support the digestion of plant material, algae, and detritus (Samanta et al. 2016). This coiled intestinal structure increases the residence time of food, enhancing the breakdown of complex carbohydrates and fibers. Previous studies have also noted similar adaptations in herbivorous and omnivorous fish species, emphasizing the role of gut morphology in dietary specialization (Banerjee and Ray 2018).

Seasonal variations in gut morphology further confirms the impact of environmental factors on fish physiology. The longer gut length and increased gut weight observed in November suggest that both species optimize their digestive capacity in response to increased food availability during the early dry season. This finding is in agreement with previous research which confirmed the influence of seasonal food availability on GIT development and growth performance in fish (Tran-Ngoc et al. 2016). The relationship between body weight and gut length, as evidenced by the regression analysis, indicates that digestive morphology is closely related to growth performance in both species. The stronger regression observed in *Eutropius niloticus* suggests that this species relies more heavily on digestive capacity to support growth, while *Oreochromis niloticus* may employ additional physiological mechanisms to maintain growth under varying environmental conditions. The observed variations in fish body and gut measurements during the dry season (November to January) can be attributed to the physiological responses of *Eutropius niloticus* and Oreochromis niloticus to the environmental conditions associated with the harmattan season in Nigeria. In November, receding water levels in the River Benue also concentrate food resources, leading to increased feeding activity and higher gut measurements in Eutropius niloticus and *Oreochromis niloticus*. This period of resource abundance likely supported the optimal nutrient intake and growth in these species. Maimuna et al. (2024) reported that *E. niloticus* is had high index of relative importance of common food items in the dry season in River Benue. However, as the dry season progressed into December and January, food availability declined due to resource depletion and unfavourable water occasioned by lower water volume. These fish species achieved greater biomass during this period in River Benue due to the peaks in food surplus as earlier reported by Mariño et al. (2021). This caused reduced gut weight and body size parameters, which reflect shifts in feeding activity and energy allocation. The observed changes in digestive morphology are presumably driven by short-term resource dynamics in the water quality and environmental conditions. Water quality parameters, such as dissolved oxygen and nutrient concentrations, are critical during the dry season, influencing the overall health and growth of fish and other aquatic species (El-Hack et al. 2022). The adaptive capacity of these fish species to cope with fluctuating food availability during the dry season.

Conclusion

This study proved that the GIT morphology of *Eutropius niloticus* and *Oreochromis niloticus* reflects their respective feeding strategies and ecological roles. *Eutropius niloticus* is adapted for rapid digestion of carnivorous diets, while *Oreochromis niloticus* has developed a coiled intestine suited for plant-based diets. These morphological adaptations are further influenced by seasonal changes in food availability, emphasizing the importance of environmentally informed management practices in aquaculture.

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