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DIETARY COMPOSITION AND DIGESTIVE ENZYMES OF *CHRYSICHTHYS NIGRODIGITATUS* (LACÉPÈDE, 1803) OFF IBESHE BEACH, THE LAGOS LAGOON, NIGERIA

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Chrysichthys nigrodigitatus (Lacépède, 1803) has high economic significance in coastal areas of Nigeria, especially off the Lagos Lagoon as a source of protein for locals. It is also an important component in the aquatic food web. Analysis of stomach content and digestive enzymes of 540 silver catfish from Ibeshe Beach, the Lagos Lagoon, confirmed the omnivorous diet of the species. Overall, stomachs of 10.6% of specimens were empty, while stomachs of the others were characterized by a varying degree of fullness. According to the Index of Relative Importance (IRI), the prevailing food item were diatoms accounting for 32.2%; those were followed by crustaceans, algae, and molluscs. The occurrence, distribution, and specific activities of digestive enzymes (carbohydrases, proteases, and lipases) in different gut regions of juvenile *C. nigrodigitatus* (standard length < 20.5 cm) and adult fish (SL > 20.5 cm) were assessed using a digestive enzyme assay. The activity of these enzymes, which enables the digestion of carbohydrates, proteins, and lipids, aligns with an omnivorous feeding habit. These results underscore the trophic adaptability of *C. nigrodigitatus* to its environment, especially in light of the high level of ongoing anthropogenic activity in the area, and provide insight into nutritional physiology of the silver catfish. This study is relevant in terms of the development of age-specific feed for this species, enhancing fisheries management and aquaculture practices.

Keywords: *Chrysichthys nigrodigitatus*, food items, gut, digestive enzymes, Lagos Lagoon

Water quality, human activities, and various environmental stressors are among the main factors that greatly affect the structure and functioning of aquatic ecosystems. These factors often lead to a decrease in the availability, diversity, and quality of food resources. Studies indicate that changes in the ecological niches of fish species eventually affect their diet, nutritional strategies, and even the survival of fish in the future [Kuton, Akinsanya, 2016]. The Lagos Lagoon, one of key natural and ecologically valuable brackish water systems in Nigeria, faces serious environmental threats. Major problems, such as increasing pollution, habitat destruction, eutrophication, and overfishing, remain unresolved up to now and are subjects of extensive discussion. Intense human pressure on the ecosystem can affect species composition, since it can result in local extinction and endangerment of native species, as well as in invasion by alien ones [Wilson, 1994]. Therefore, determining the feeding habits and digestive responses of fish species in such disturbed environments is an important issue to elucidate their resilience and ecological plasticity. In addition, such studies provide a scientific basis for formulating effective and feasible strategies for sustainable fishery exploitation, habitat conservation, and aquaculture development.

Chrysichthys nigrodigitatus (Lacépède, 1803) is a species of high ecological and economic value in Nigeria, especially along the Lagos Lagoon shores. This fish is a vital source of protein for locals, and it plays an essential role in the aquatic food web. Numerous studies have analyzed various aspects of its biology, particularly feeding ecology and growth patterns. Investigations of the silver catfish food and feeding habits across different aquatic systems have confirmed its omnivorous and opportunistic nature [Atobatele, Ugwumba, 2011; Kuton, Akinsanya, 2016]. Surveys on length–weight relationships and condition factor have provided insights into its growth patterns [Kareem et al., 2015; Uneke, 2015].

Stomach content analysis was pivotal in determining the species trophic position and dietary plasticity. For instance, M. Jeyol and N. Umar [2024] explored the feeding habits of the species in the Lagos Lagoon; C. Ikechukwu *et al.* [2025] examined the stomach content of *C. nigrodigitatus* in the Otuocha River; and I. Esenowo *et al.* [2017] focused on its biological characteristics in the Nwaniba River, Southeast Nigeria. All concluded that it is a voracious and flexible feeder. Earlier studies conducted by S. Fagade and C. Olaniran [1973], K. Ikusemiju [1975; 1976] / K. Kusemiju [1981; 1991], and J. Igbinosun and O. Robert [1988] also showed the dietary flexibility of this species. In [Ikusemiju, 1976; Kusemiju, 1981], foundational insights are provided into hydrobiology and ichthyofauna of the Lekki Lagoon linking feeding behavior of fish with habitat characteristics and food availability. Collectively, these surveys demonstrate that *C. nigrodigitatus* exhibits a high degree of trophic adaptability, enabling it to exploit a wide range of food resources and thrive in fluctuating environmental conditions.

M. Hidalgo *et al.* [1999] and W. Uys and T. Hecht [1987] explain that fish feeding and food habits are significant indicators of their digestive abilities. Understanding the digestive physiology of *C. nigrodigitatus* requires analyzing both adults and juveniles: various fish are known to undergo ontogenetic changes in their digestive enzyme activities as they mature, usually due to metabolic demands and biological processes, such as reproduction [Gisbert et al., 2018]. Few studies have investigated digestive enzymes of *C. nigrodigitatus* along the Ibeshe area of the Lagos Lagoon, leading to a serious research gap: there is a lack of comprehensive data on the distribution of digestive enzymes in the gut, and on the ontogenetic changes in the digestion of different feed components [Oghenochuko et al., 2022].

This investigation contributes to developing a species-specific and nutritionally balanced feed with reduced feed waste and an increased growth rate for *C. nigrodigitatus*, a fish of high economic and ecological importance. Understanding its digestive physiology will help the Nigerian aquaculture in creating more efficient feeding plan and reducing pressure on wild populations, especially with the rising interest in farming the silver catfish. Also, due to its resilience to environmental stressors in the Lagos Lagoon, this species is a suitable model for studying the effect of changing estuarine habitats on nutrition and digestion in hydrobionts.

This study aims to investigate the trophic adaptability and digestive efficiency of *Chrysichthys nigrodigitatus* from Ibeshe Beach, the Lagos Lagoon. The objectives of the work are to analyze the diet of the species by examining its stomach contents using numerical method, estimating frequency of occurrence, and involving volumetric method. Also, the objectives are to conduct a digestive enzyme assay to identify the catalytic proteins involved in the breakdown of major food components, to determine the distribution of these catalysts in different gut regions, to compare their activities between adult and juvenile specimens, and to measure their specific activities.

MATERIAL AND METHODS

To study *C. nigrodigitatus* diet, a total of 500 specimens were collected from artisanal fishermen that used gill nets and cast nets between July and November 2023. To prevent putrefaction, the samples were immediately preserved in ice boxes in the field and transported to a laboratory for further analysis. The standard length (SL), total length, and weight of each specimen were measured by standard morphometric techniques. The stomach of each specimen was then categorized as empty, one-quarter full (¼), half full (½), three-quarters full (¾), or full, following the established protocol for dietary studies [Hyslop, 1980].

After dissection, stomach contents were emptied into Petri dishes, and examined under a Biobase optical microscope (BMP-107B, Biobase, Shandong, China) at magnification from 40× to 400×. Food items were identified to the lowest possible taxonomic level using *Field Guide to the Commercial Marine Resources of the Gulf of Guinea* [1990]. The food habits were quantified involving three indices: frequency of occurrence (%F) as the percentage of stomachs containing a specific food item; numerical composition (%N) as the proportion of each food item relative to the total number of items; and volumetric composition (%V) as the relative volume of each food item compared to the total stomach content, estimated *via* water displacement. The Index of Relative Importance (IRI) was calculated by the formula described by E. Hyslop [1980]:

$$IRI = \%F(\%N + \%V) ,$$

where %N (percent by number) is the number of individuals of prey type *i* expressed as a percentage of the total number of all prey items in non-empty stomachs;

%V (percent by volume) is the volumetric contribution of prey type *i* expressed as a percentage of the total gut content volume [for macroscopic prey, it was estimated by wet weight (mg), while for microscopic prey (diatoms and algae) and amorphous matter (detritus and unidentified masses), %V was estimated under a microscope by the point-count method and scaled to total stomach volume];

%F (frequency of occurrence) is the percentage of non-empty stomachs in which prey type *i* occurred (empty stomachs were excluded from analysis).

IRI values were subsequently standardized to %IRI to allow comparison across prey categories:

$$\%IRI = \frac{IRI_i}{\sum IRI} \times 100 ,$$

where *i* is individual prey type.

For the digestive enzyme assay, 40 live specimens of *C. nigrodigitatus* were taken from fishermen at the Ibeshe area of the Lagos Lagoon. The sample size (20 juveniles and 20 adults) was determined based on methodological precedents in similar studies of fish digestive physiology [Gisbert et al., 2018; Hidalgo et al., 1999]. Although this sample size is below the theoretical minimum for detecting medium effect in a two-way ANOVA, it was adequate for revealing large effects. The significant differences observed across gut regions and age classes support the validity of the sample size used. Healthy individuals, showing no signs of diseases, were selected for analysis without sexual distinction. Specimens were euthanized by cervical dislocation following ethical guidelines for fish research, with approval from the relevant institutional review board. The entire gut was excised and divided into six anatomical regions: oesophagus, stomach, pyloric caeca, anterior intestine, posterior intestine, and rectum, following established protocols [Tengjaroenkul et al., 2000]. To ensure sufficient material for analysis, tissues from each gut region were pooled for juveniles and adults.

Each gut region was weighed after thawing, and homogenized in an all-glass Potter–Elvehjem homogenizer (model GPE-10, VWR International, Germany) with 10 volumes of ice-cold 1% neutralized KOH to produce a 1 : 10 homogenate. The homogenate was centrifuged at 2,500 g for 20 min at +4 °C. The resulting supernatant was collected as the crude enzyme extract and stored at −20 °C until analysis to preserve enzymatic activity, following the method of M. Furné *et al.* [2005].

Protease activity was quantified involving casein hydrolysis [Kunitz, 1947]. The reaction mixture contained 1 mL of crude enzyme extract and 1 mL of 1% casein solution (in phosphate buffer, pH 7.5); it was incubated at +37 °C for 30 min. The reaction was terminated by adding 0.5 mL of 10% trichloroacetic acid, and the mixture was centrifuged at 3,000 g for 10 min using a refrigerated centrifuge (model 5415R, Eppendorf AG, Hamburg, Germany). The absorbance of the supernatant was measured at 280 nm with a UV–Vis spectrophotometer (model UV-1800, Shimadzu Corporation, Kyoto, Japan). Lipase activity was measured titrimetrically using olive oil as a substrate [Winkler, Stuckmann, 1979]. A mixture of 1 mL of enzyme extract, 2 mL of 50 mM Tris-HCl buffer (pH 8.0), and 2 mL of olive oil was heated in a water bath at +37 °C for 60 min. After that, the mixture was titrated with 0.05 M NaOH to pink endpoint. Enzyme activity was calculated from the difference in titrant volume between the test sample and the control. Carbohydrase activity was determined in triplicate applying the dinitrosalicylic acid (DNS) method of M. Furné *et al.* [2005]. Enzyme assays were performed using starch, maltose, sucrose, and lactose as substrates.

For each assay, the reaction mixture consisted of 0.4 mL of 1% substrate solution, 0.2 mL of phosphate buffer (pH 8.0), 1.6 mL of DNS reagent, and 0.1 mL of enzyme extract. These mixtures were heated at +37 °C for 30 min, and the absorbance of the product was measured at a wavelength of 540 nm with a colorimeter (model 721 Visible Spectrophotometer, LabTex Digital, China). Enzyme activity was expressed in laboratory-specific units: proteases (trypsin and pepsin), in $\mu g \cdot mL^{-1} \cdot min^{-1}$ based on tyrosine equivalents; lipase, in $units \cdot mg^{-1} \cdot min^{-1}$ based on titration volume against NaOH; and carbohydrases (amylase, lactase, and maltase), in $mg \cdot mL^{-1} \cdot min^{-1}$ based on glucose equivalents using standard calibration curves. All enzyme activity data was normalized to the total protein concentration ($mg \cdot mL^{-1}$ of enzyme extract) to control for inconsistencies arising from differences in tissue weight and extraction efficiency.

Statistical analyses were performed involving ANOVA, with gut region and organism size as sources of variation. Post-hoc comparisons were executed using Tukey's Honest Significant Difference (HSD) test to characterize specific group differences and detect essential relationships. A *p*-value of less than 0.05 was considered statistically significant.

RESULTS

Stomach fullness analysis of 500 *C. nigrodigitatus* specimens revealed that 48.2% had full stomachs, while 10.6% had empty ones (Fig. 1). A summary of food items that constituted the diet of *C. nigrodigitatus* from the Ibeshe sampling site of the lagoon is given in Table 1. Diatoms were the dominant food item, with the value of the Index of Relative Importance (IRI) accounting for 32.2%. Those were followed by crustaceans (19.5%), algae (18.7%), and molluscs (8.9%). The presence of plant materials and fish parts (IRI of 5.5% and 5.4%, respectively) suggests an omnivorous feeding habit. IRI for detritus and unidentified materials were of 7.4% and 2.4%, respectively (Fig. 2).

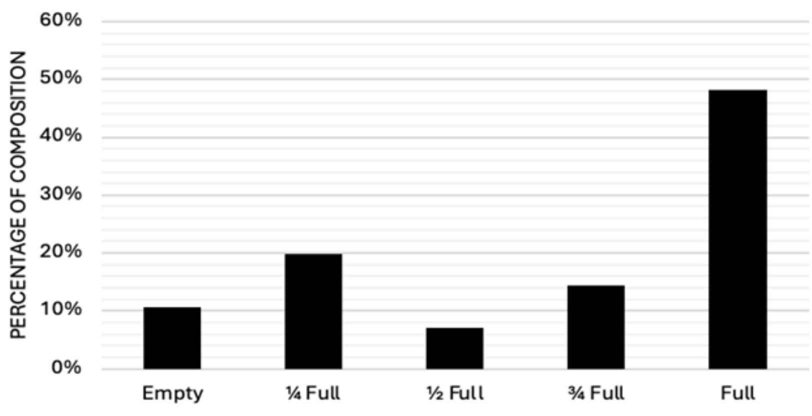

Fig. 1. Stomach fullness of 500 *Chrysichthys nigrodigitatus*

Рис. 1. Наполнение желудков 500 особей *Chrysichthys nigrodigitatus*

Table 1. Share (%), occurrence, and volume of food items in *Chrysichthys nigrodigitatus* stomachs

Таблица 1. Доля (%), количество и объём пищевых объектов в желудках *Chrysichthys nigrodigitatus*

Food item	Numerical method		Occurrence method		Volumetric method	
	N	%N	F	%F	V	%V
Diatoms	5,652	37.7	252	56.4	850	17.0
Algae	4,761	31.7	237	53.0	100	2.0
Crustaceans	2,344	15.6	219	49.0	1,125	22.5
Molluscs	1,229	8.2	192	43.0	575	11.5
Plant materials	499	3.3	179	40.0	490	9.8
Fish parts	523	3.5	149	33.3	600	12.0
Detritus	–	0	157	35.1	1,010	20.2
Unidentified mass	–	0	205	45.9	250	5.0

Note: %F is a number of stomachs containing prey item ÷ total of non-empty stomachs ($n = 447$). Empty stomachs ($n = 53$) were excluded.

Примечание: %F — количество содержащих добычу желудков ÷ общее количество непустых желудков ($n = 447$). Пустые желудки ($n = 53$) исключены.

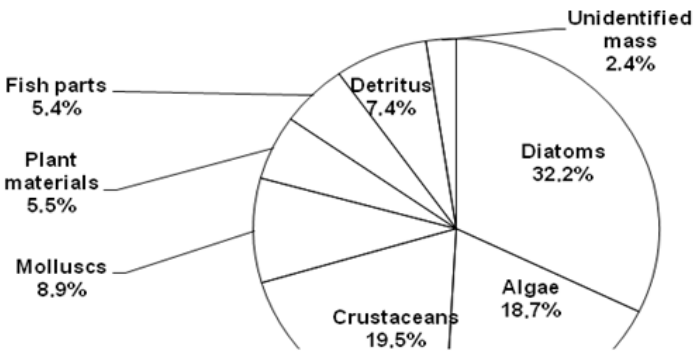

Fig. 2. The Index of Relative Importance (%) of food items in stomachs of *Chrysichthys nigrodigitatus* from Ibeshe Beach, the Lagos Lagoon

Рис. 2. Относительная значимость (%) пищевых объектов в желудках *Chrysichthys nigrodigitatus* у пляжа Ибеше, лагуна Лагос

The digestive enzyme profiles of *C. nigrodigitatus* juveniles and adults revealed consistent activity of proteases (trypsin and pepsin), lipases, and glycosidases (amylase, lactase, and maltase) across all gut regions (Tables 2, 3, Figs 3–5). In juveniles (SL < 20.5 cm), trypsin and pepsin activities were the highest in the anterior intestine: (0.75 ± 0.015) and (0.76 ± 0.010) $\mu g \cdot mL^{-1} \cdot min^{-1}$, respectively. Lipase activity ranged from (0.54 ± 0.10) $units \cdot mg^{-1} \cdot min^{-1}$ in the pyloric caeca to (0.78 ± 0.10) $units \cdot mg^{-1} \cdot min^{-1}$ in the stomach, indicating a capacity of lipid digestion throughout the gut.

Glycosidase activity was the highest in the pyloric caeca: (3.07 ± 0.021) $mg \cdot mL^{-1} \cdot min^{-1}$ for maltase and (1.31 ± 0.081) $mg \cdot mL^{-1} \cdot min^{-1}$ for lactase. Strong activity was also observed in the posterior intestine for both lactase [(2.70 ± 0.081) $mg \cdot mL^{-1} \cdot min^{-1}$] and maltase [(2.81 ± 0.015) $mg \cdot mL^{-1} \cdot min^{-1}$] reflecting intensive carbohydrate digestion in midgut and hindgut sections.

Adult fish (SL > 20.5 cm) exhibited elevated overall enzyme activities. Trypsin and pepsin activities reached the highest values in the posterior intestine: (1.17 ± 0.021) and (0.98 ± 0.010) $\mu g \cdot mL^{-1} \cdot min^{-1}$, respectively. Lipase activity was uniformly distributed along the gut, peaking in the rectum: (0.82 ± 0.15) $units \cdot mg^{-1} \cdot min^{-1}$. Glycosidase activity was concentrated in the pyloric caeca [(2.99 ± 0.006) $mg \cdot mL^{-1} \cdot min^{-1}$ for maltase and (1.96 ± 0.025) $mg \cdot mL^{-1} \cdot min^{-1}$ for lactase] and anterior intestine [(2.74 ± 0.036) $mg \cdot mL^{-1} \cdot min^{-1}$ for maltase], confirming active digestion of carbohydrate-rich diets in these gut regions.

Table 2. Specific activity of enzymes in the gut of *Chrysichthys nigrodigitatus* juveniles (standard length < 20.5 cm) (with Tukey's HSD superscripts) off Ibeshe Beach, the Lagos Lagoon, Nigeria (mean ± *SD*)

Таблица 2. Удельная активность ферментов в кишечнике молоди *Chrysichthys nigrodigitatus* (стандартная длина < 20,5 см) (со средним Тьюки) у пляжа Ибеше, лагуна Лагос, Нигерия (среднее значение ± *SD*)

Gut region	Proteases, $\mu g \cdot mL^{-1} \cdot min^{-1}$		Lipid, $units \cdot mg^{-1} \cdot min^{-1}$	Glycosidases, $mg \cdot mL^{-1} \cdot min^{-1}$		
	Trypsin	Pepsin	Lipase	Amylase	Lactase	Maltase
Oesophagus	0.70 ± 0.01*	0.59 ± 0.01*	0.72 ± 0.10**	0.47 ± 0.02*	0.09 ± 0.01*	2.54 ± 0.02**
Stomach	0.44 ± 0.01*	0.35 ± 0.01*	0.78 ± 0.10**	0.51 ± 0.02*	0.77 ± 0.02*	2.16 ± 0.04**
Pyloric caeca	0.52 ± 0.02*	0.17 ± 0.01*	0.54 ± 0.10**	0.24 ± 0.01*	1.31 ± 0.08**	3.07 ± 0.02**
Anterior intestine	0.75 ± 0.02*	0.76 ± 0.01*	0.74 ± 0.15**	0.42 ± 0.02*	0.91 ± 0.02*	1.37 ± 0.02**
Posterior intestine	0.57 ± 0.01*	0.48 ± 0.01*	0.62 ± 0.15**	0.30 ± 0.02*	2.70 ± 0.10**	2.81 ± 0.01**
Rectum	0.61 ± 0.02*	0.86 ± 0.02*	0.71 ± 0.02**	0.28 ± 0.02*	0.43 ± 0.01*	2.34 ± 0.03**

Note: * and ** mark significant differences within the same row among different enzymes (Tukey's HSD, $P < 0.05$).

Примечание: * и ** — значимые различия в пределах одного ряда среди разных ферментов (среднее Тьюки, $P < 0{,}05$).

Table 3. Specific activities of enzymes in the gut of *Chrysichthys nigrodigitatus* adults (standard length > 20.5 cm) (with Tukey's HSD superscripts) off Ibeshe Beach, the Lagos Lagoon, Nigeria (mean ± *SD*)

Таблица 3. Удельная активность ферментов в кишечнике взрослых особей *Chrysichthys nigrodigitatus* (стандартная длина > 20,5 см) (со средним Тьюки) у пляжа Ибеше, лагуна Лагос, Нигерия (среднее значение ± *SD*)

Gut region	Proteases, $\mu g \cdot mL^{-1} \cdot min^{-1}$		Lipid, $units \cdot mg^{-1} \cdot min^{-1}$	Glycosidases, $mg \cdot mL^{-1} \cdot min^{-1}$		
	Trypsin	Pepsin	Lipase	Amylase	Lactase	Maltase
Oesophagus	0.54 ± 0.01*	0.51 ± 0.02*	0.73 ± 0.15**	0.24 ± 0.02*	0.05 ± 0.01*	0.53 ± 0.03**
Stomach	0.56 ± 0.01*	0.50 ± 0.01*	0.71 ± 0.10**	0.26 ± 0.01*	0.02 ± 0.01*	2.51 ± 0.04**
Pyloric caeca	0.97 ± 0.01*	0.93 ± 0.01*	0.77 ± 0.20**	0.44 ± 0.01*	1.96 ± 0.03**	3.00 ± 0.01**
Anterior intestine	0.81 ± 0.01*	0.83 ± 0.01*	0.78 ± 0.15**	0.34 ± 0.01*	0.41 ± 0.01*	2.74 ± 0.04**
Posterior intestine	1.17 ± 0.02*	0.98 ± 0.01*	0.81 ± 0.10**	0.41 ± 0.02*	0.70 ± 0.03*	2.10 ± 0.06**
Rectum	0.71 ± 0.01*	0.59 ± 0.01*	0.82 ± 0.15**	0.55 ± 0.02*	1.20 ± 0.01*	2.40 ± 0.01**

Note: * and ** mark significant differences within the same row among different enzymes (Tukey's HSD, $P < 0.05$).

Примечание: * и ** — значимые различия в пределах одного ряда среди разных ферментов (среднее Тьюки, $P < 0{,}05$).

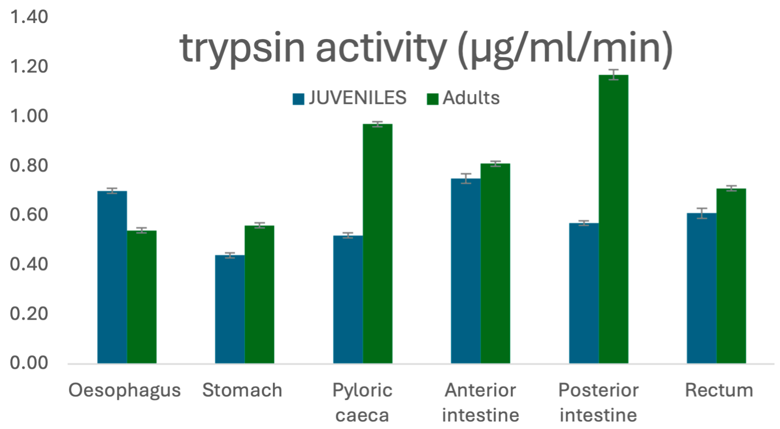

Fig. 3. Trypsin activity in different gut regions of *Chrysichthys nigrodigitatus*

Рис. 3. Активность трипсина в различных отделах кишечника *Chrysichthys nigrodigitatus*

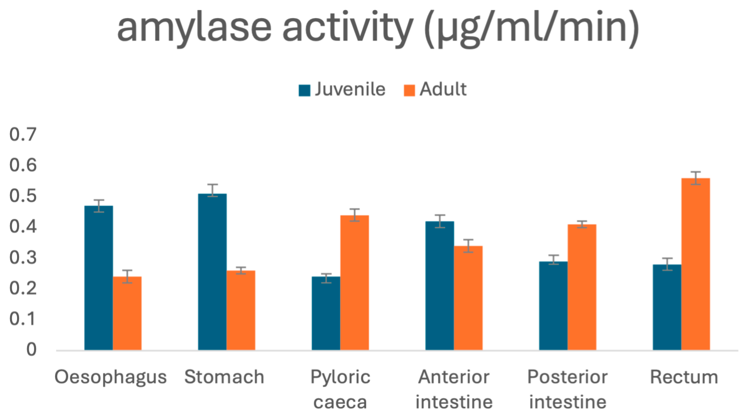

Fig. 4. Amylase activity in different gut regions of *Chrysichthys nigrodigitatus*

Рис. 4. Активность амилазы в различных отделах кишечника *Chrysichthys nigrodigitatus*

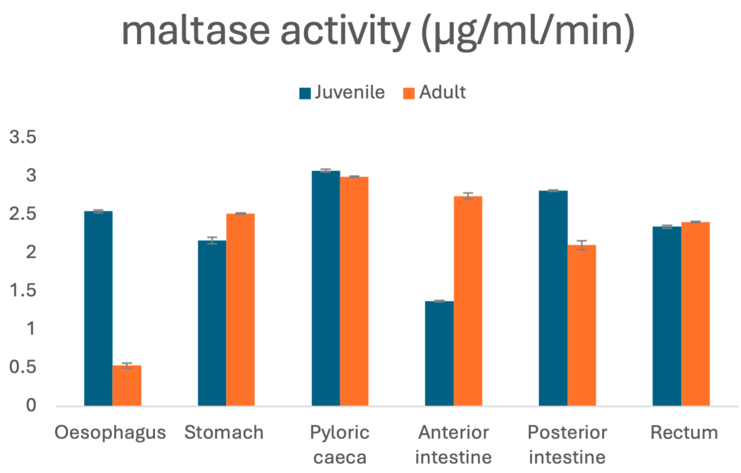

Fig. 5. Maltase activity in different gut regions of *Chrysichthys nigrodigitatus*

Рис. 5. Активность мальтазы в различных отделах кишечника *Chrysichthys nigrodigitatus*

These results demonstrate that *C. nigrodigitatus* possesses a full complement of digestive enzymes at both life stages, supporting its omnivorous feeding habit. The enzyme distribution shows ontogenetic adaptation: juveniles increased activity of carbohydrase, while adults increased protease and lipase activity, reflecting a dietary shift with growth.

DISCUSSION

Food and feeding habits of fish are crucial for aquaculture and provide valuable insights into habitat characteristics, ecological productivity, and environmental heterogeneity. *C. nigrodigitatus* feeds on a variety of food items in the lagoon. In its diet, 8 major items were recorded, of both plant and animal origin: diatoms, algae, crustaceans, molluscs, plant materials, fish, detritus, and unidentified mass. These observations are consistent with *prior* studies by M. Lawal *et al.* [2010], T. Edem and C. Odey [2019], and J. Dada and P. Araoye [2008]. Quantitative analysis revealed that diatoms, a plant component, were the prevailing food item, constituting 37.7% by number and 56.4% by frequency of occurrence. Plant materials were also reported as a major food for this species in Asa Dam [Dada, Araoye, 2008]. I. Udosen and O. Rufus [2018] reported six main food groups, including plant ones (phytoplankton) and animal ones (crustaceans, insects, molluscs, and worms), as well as unidentified matter; this indicates that *C. nigrodigitatus* is an omnivorous feeder. A similar report on this species published by N. Inyang and C. Nwani [2004] suggested that it fed on both plants and animals, but animal components predominated in its food. This contradicts the results of the present study, in which diatoms were the prevailing food item. Such a discrepancy could be the result of an unspecialized mode of fish feeding, which can be explained by differences in food availability between various habitats. O. Oghenochuko *et al.* [2022] confirmed the overlapping and omnivorous feeding nature of *C. nigrodigitatus*, linking it to opportunistic behavior. This conclusion was supported by O. Atobatele and O. Ugwumba [2011], as well as B. Uneke [2014]. R. Welcomme [2001] also reported that unspecialized feeders consume items like insects, zooplankton, detritus, and plant matter based on their relative abundance in the environment.

We recorded high glycosidase activity, which indicated that *C. nigrodigitatus* can effectively digest carbohydrates. Apparently, starch digestion starts in the esophagus and continues in the posterior intestine. In adults, high glycosidase activity in the pyloric caeca (1.96 $mg \cdot mL^{-1} \cdot min^{-1}$ for lactase and 2.99 $mg \cdot mL^{-1} \cdot min^{-1}$ for maltase) and anterior intestine (2.74 $mg \cdot mL^{-1} \cdot min^{-1}$ for maltase) ensures the complete digestion of carbohydrates in these regions. The strong specific activity of the amylase enzyme observed in the stomach suggests that the digestion of carbohydrates, which starts in the anterior segment (esophagus), intensifies as food moves into the stomach. This fact provides evidence that the digestion of carbohydrate is largely concluded in these parts of the alimentary canal [Oghenochuko et al., 2022]: a finding consistent with that in the paper of D. Odedeyi and O. Fagbenro [2010]. Lipase activity was detected uniformly throughout the entire gut of *C. nigrodigitatus*, and a similar pattern was reported for *Heterotis niloticus* (Cuvier, 1829) by O. Fagbenro *et al.* [1993]. As noted by R. Buddington [1985], the presence or absence of specific digestive enzymes in fish depends on its diet and feeding habits, and also on the functional morphology of gut regions. The occurrence of various glycosidases, proteases, and lipases in *C. nigrodigitatus* gut correlates with its omnivorous diets. Furthermore, the digestive enzyme activities were higher in adults than in juveniles, supporting conclusion of C. Tramati *et al.* [2005] that the digestive processes in *Diplodus puntazzo* (Walbaum, 1792) are correlated with body size and dietary composition.

The high protease and lipase activities in adults indicate that a protein- and lipid-rich diet would enhance the growth rate of fish in a culture system, and this aligns with recommendations established for omnivorous species [Cahu, Zambonino Infante, 2001]. Conversely, the high carbohydrase activity in juveniles suggests that a plant-based diet is both cost-effective and nutritionally suitable during the earlier stages of cultivation [Francis et al., 2001]. Consequently, this investigation provides a basis for formulating stage-specific feeds, reducing the reliance on expensive animal-based feed ingredients, thereby lowering costs and enhancing the sustainability of culturing the silver catfish.

This study shows that *C. nigrodigitatus* is a promising species for both wild capture and aquaculture due to its omnivorous and opportunistic feeding habits, which make it resistant to constantly changing environmental conditions. The dietary and enzymatic activity data provided in this investigation can be integrated into fisheries management strategies, supporting the species economic potential, particularly in regions like Ibeshe, where it serves as a vital source of protein for locals, while also helping to maintain ecological balance. However, realizing this potential requires regular monitoring of population dynamics and ecosystem health, especially in the face of anthropogenic threats like pollution and the habitat degradation from ongoing sand mining in the Lagos Lagoon [Wilson, 1994].

Conclusions. This study provides crucial insights into the feeding ecology and digestive physiology of *Chrysichthys nigrodigitatus*: a species of ecological and economic importance in coastal and estuarine systems of West Africa. The identification of a diverse range of dietary items, particularly diatoms, algae, crustaceans, and molluscs, alongside the distribution of carbohydrases, proteases, and lipases throughout the gut, underscores the species trophic adaptability and omnivorous feeding strategy. Such physiological and dietary flexibility is likely to contribute to resistance of the silver catfish to anthropogenic pressures and fluctuating environmental conditions in habitats like the Lagos Lagoon.

The observed ontogenetic variation in digestive enzyme activity reflects an adaptive physiological response to changing dietary needs across life stages. This insight can be directly applied to design nutritionally efficient, age-specific diets, thereby improving feed formulation, optimizing growth, and reducing production costs in aquaculture. From a fisheries management perspective, understanding the species ecological role as both a consumer of diverse food resources and a key contributor to energy transfer in the aquatic food web is vital for developing effective conservation strategies to wild populations.

Given its ecological plasticity and economic importance, *C. nigrodigitatus* should be a priority species in ecosystem-based management plans. Further in-depth studies are recommended to investigate how environmental stressors, seasonal dynamics, and habitat changes affect feeding ecology of the silver catfish, its reproductive success, and long-term population stability. Such research will enhance our capacity to balance aquaculture development with the conservation of natural stocks and ecosystem functions.

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СОСТАВ ПИЩИ И ПИЩЕВАРИТЕЛЬНЫЕ ФЕРМЕНТЫ В КИШЕЧНИКЕ *CHRYSICHTHYS NIGRODIGITATUS* (LACÉPÈDE, 1803) У ПЛЯЖА ИБЕШЕ, ЛАГУНА ЛАГОС, НИГЕРИЯ

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Chrysichthys nigrodigitatus (Lacépède, 1803) имеет большое экономическое значение для прибрежных районов Нигерии, особенно лагуны Лагос, как источник белка для местного населения, а также как важный компонент морской пищевой цепи. Анализ содержимого желудков, а также пищеварительных ферментов 540 особей сома *C. nigrodigitatus*, выловленных у пляжа Ибеше в лагуне Лагос, свидетельствует о всеядности этого вида. У 10,6 % рыб желудки были пустыми, а у остальных особей степень наполненности различалась. Согласно значениям индекса относительной значимости (Index of Relative Importance, IRI), доминирующим пищевым объектом были диатомовые водоросли — 32,2 %; за ними следовали ракообразные, водоросли и моллюски. У молоди *C. nigrodigitatus* (standard length < 20,5 см) и взрослых особей (SL > 20,5 см) с помощью ферментативного анализа установлено распределение пищеварительных ферментов (карбогидраз, протеаз и липаз) в различных отделах кишечника и определена их удельная активность. Способность разновозрастных особей этого вида переваривать углеводы, белки и жиры отражается в активности пищеварительных ферментов, что подтверждает всеядность сома. Полученные результаты подчёркивают его трофическую адаптивность к условиям среды обитания и к уровню антропогенной нагрузки, давая представления о физиологии пищеварительного процесса этого вида. Результаты исследования важны для разработки возрастспецифических кормов для *C. nigrodigitatus* в целях совершенствования управления рыбными ресурсами в регионе и оптимизации аквакультуры.

Ключевые слова: *Chrysichthys nigrodigitatus*, пищевые объекты, кишечник, пищеварительные ферменты, лагуна Лагос