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Histological Approach of the Digestive Tract in The Digestibility of Prey in *Hepsetus akawo* (Characiforms, Hepsetidae) in the Hydroelectric Dam Lake of Ayame 1 (Ivory Coast)

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Abstract

The present work aims to know the digestibility of the prey that make up the diet of *Hepsetus akawo* fish from monthly catches in the Ayame 1 hydroelectric dam lake. In order to provide information, the digestibility of prey, the stomach contents of 286 specimens, coupled with the histology of digestive tract were analyzed from July 2021 to June 2022. The observation and description of the digestive tract in this species revealed a developed stomach and relatively short intestine. The intestinal coefficient of between 0.94 and 1.68 made it possible to classify the species in category of Omnivorous fish. Stomach contents were analyzed using the corrected percent occurrence, weight percent and dietary index methods. It appears from this analysis that the species *Hepsetus akawo* was an Omnivore with an insectivorous tendency. Microscopically, the different areas of the digestive tract were made up of four distinct tunics, the serosa, the muscular, the sub-mucosa and the mucosa, the structure and physiology of which differ depending on the areas. The tunics of the esophageal zone contribute to its distension, those of the stomach participate in chemical and mechanical transformations of the prey, with the intestinal layers involved in the absorption of nutrients. Insects with soft cuticles were more digestible and nutrients were easily absorbed, which improves the body condition of fish in the wild or farms.

Subject Areas

Cell Biology, Histology

Keywords

Digestibility, Digestive Tract, Absorption of Nutrients, *Hepsetus akawo,* Omnivorous

1. Introduction

The African pike, *Hepsetus odoe* was initially considered until the 2010s as the sole representative of the Hepsetidae family. However, on the basis of numerous morphological and genetic studies, six different species including *Hepsetus akawo* have been identified and described [1]. *Hepsetus akawo* belonging to the Hepsetidae family was a species with tropical affinity having, like the others, a wide geographical distribution covering the tropical regions of West and Central Africa [1] [2] [3]. This common species in Ivory Coast has been identified in Bandama, Sassandra, Comoe and Bia rivers [1]. Nowadays, research work on fish fauna falls into a more global, than specific framework with the aim of having a wide range of scientific data on the theme addressed. Thus, it was time to take conservation measures which, to be effective, require perfect knowledge of the target species. To this must be added a good knowledge of the indices which characterize their distribution and level of exploitation [3] [4]. However, studies on dietary ecology relating to fish diets are of great interest. In the literature, several scientific research works relating to their feeding ecologies and the morphological diversity of the digestive tract in different species of African fish have been reported in practically all continental waterways [5] [6]. In Ivory Coast, several research studies have focused on the diet of fish [7] [8] [9]. However, the analysis of all the results of the above work only presents a simple analytical assessment of the prey consumed in comparison with other work. Such results remain very insufficient in understanding the diet. They must be completed by Histophysiology which presents the microscopic structure and structural physiology of the organ. It is in this context that the present work is undertaken. Regarding the *Hepsetus akawo* species, the literature doesn't mention scientific work on its growth, reproduction and feeding. In Ivory Coast, this species, highly prized by consumers, occupied a significant place in the landings of specimens sold on the local market [10]. This abusive exploitation was likely to profoundly modify the balance of the ecosystem's food web and lead to its disappearance in the years to come. This information was essential for understanding the biology of fish populations [10]. This lack of scientific data on growth, reproduction and food ecology constitutes a major handicap making its management and safeguarding difficult. Although it is highly prized by the local population, there are no scientific data concerning its biology and ecology. However, knowledge of fish diet coupled with the digestibility of prey would be crucial to optimizing production through domestication through fish farming. Faced with these growing concerns, it appears more than imperative to undertake the present work relating to the food ecology and digestibility of prey of the *Hepsetus akawo* species. Thus, the present work sets itself the objective of studying the functional relationships that could exist between the anatomy-histological structure of the digestive tract and the diet of the species *Hepsetus akawo*. They allow an analysis of stomach contents and the histo-physiological description of the digestive tract.

2. Materials et Methods

2.1. Materials

Study area: The Ayame 1 lake, resulting from the construction of this dam was located on Bia River. The dam was located at the entrance to the town of Ayame. Bia River was located in the South-East of the Ivory Coast, with a North latitude, North latitude between 5˚34' and 5˚37', and a West longitude extending between 3˚09' et 3˚10'. Its surface area was estimated at 9.320 km^2. The average length and width were respectively 80 and 27 km. The rainfall regime of Southeast Ivory Coast is an equatorial type of humid transition (Attiean climate) characterized by four seasons: two rainy seasons (April to July and October to November) and two dry seasons (December to March and from August to September). As part of this study, five sampling points were chosen on Lake Ayame 1 (**Figure 1**).

Sampling and dissection of biological materials: Between July 2021 and June 2022, *Hepsetus akawo* specimens were collected monthly, directly from artisanal fishermen in Ayame 1 who used nets. Immediately, the fish captured alive were kept in a cooler under ice until the laboratory. Once in the laboratory, the fish were clearly identified, measured, weighed and dissected. The standard length (LS) of the specimens was measured to the nearest millimeter using an ichthyometer. The dissection begins with the lateral incision of the abdomen of the fish, the digestive tube was highlighted in order to describe and photograph them. Finally, digestive tubes were identified, cut at their two ends going from the entrance to the esophagus to the exit from the rectum then carefully spread out to take measurements of different regions. The position of organs as well as the morphological particularities noted and described.

2.1.1. Analysis of Stomach Contents

In the laboratory, after the dissection, different organs of the digestive tract were removed for their description and then fixed in formaldehyde 5% in order to stop the post-mortem digestion processes. The digestive tract was unrolled and the length of the intestine (length of the intestine or LI) was measured from the pyloric valve to the anal orifice. The stomach was removed, weighed before and after incision, and the mass of the stomach contents was then determined to the nearest gram, then preserved in formaldehyde 5% for analysis of the diet.

The prey was carefully separated by category and identified either with the

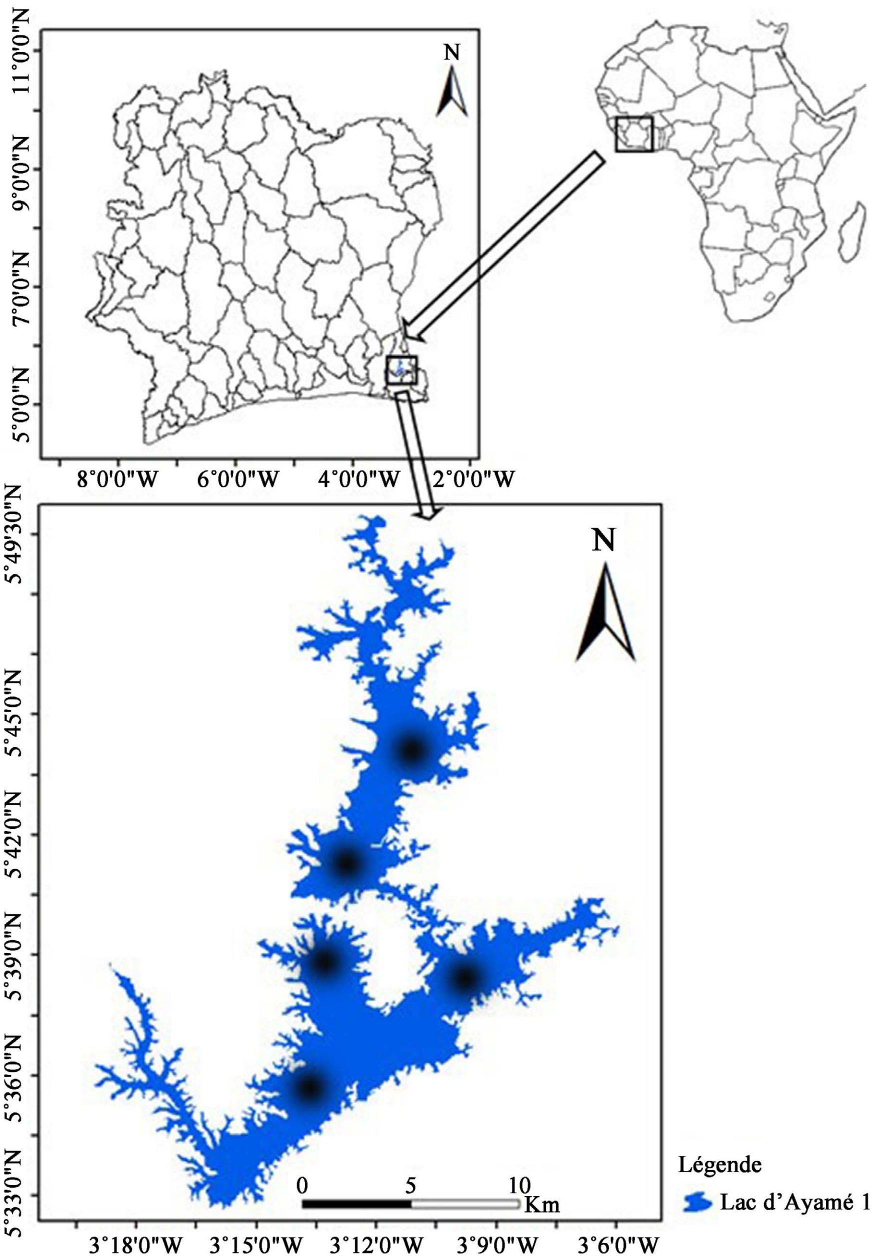


Figure 1. Localization of Lake Ayamé I of Africa. Map of Africa, A. Map of Ivory Coast, B. Extent of Lake Ayamé I, C. Sampling site.

naked eye or using a binocular magnifying glass according to their degrees of digestion and their sizes. These prey were identified using the proposed identification keys [11] [12]. For each specimen, the stomach was extracted in order to note its state of repletion, i.e., a full stomach or an empty stomach. Thus, stomachs were considered full when they filled to 1/4, 1/2 and 3/4. After opening the stomach, the stomach contents were weighed and then diluted in petri dishes containing water. Regarding the category, the prey of the same category was counted and weighed to the thousandth of a gram using a type balance SARTORIUS TE 153S. Nonwhole animals were counted based on the number of heads or abdomens present. The other parts such as the wings and legs were considered to be animal remains when the state of digestion did not allow exact identification of it through the order or family. Also, at the plant kingdom level, roots, stems, plant fiber and seeds were classified as plant debris. However, for the counting of prey such as animal and plant remains, the number 1 was assigned to their presence in a stomach regardless of quantity and weight [13].

2.1.2. Determination of Some Dietary Indices

The composition of diet in *Hepsetus akawo* was analyzed on the basis of the calculation of the percentages of certain dietary indices. Therefore, the food prey of each specimen was determined then quantified by calculating food indices and coefficients used by several authors. These dietary parameters were among others, the intestinal coefficient (CI), the vacuity coefficient (% CV), the corrected percentage of occurrence (% Fc), the numerical percentage (% P), the dietary importance index (% IA). The calculations of the different food parameters were made according to the following formulas.

- The intestinal coefficient (CI)

The intestinal coefficient (CI) calculated for each fish was defined as the ratio of the length of intestine to standard length of the fish [14]. Its formula is given by Equation (1),

$$\text{CI} = \frac{\text{Length of intestine}}{\text{Standard length of the fish}} \tag{1}$$

- The vacuity coefficient (% CV)

The vacuity coefficient corresponds to the percentage of empty stomachs in relation to the total number of stomachs examined. This coefficient was calculated using the formula proposed by Equation (2),

$$\%\ \text{CV} = \frac{\text{Number of empty stomach}}{\text{Total number of stomach examined}} \times 100 \tag{2}$$

The vacuity coefficient allows us to know the intensity of the feeding activity. Thus, the interpretation of the emptiness coefficient was done according to the scale proposed by [15].

$0 \le CV < 20$: Gluttonous species,

$20 \le CV < 40$: Relatively gluttonous species,

$40 \le CV < 60$: Moderate feeding species,

$60 \le CV < 80$: Relatively low feeding species,

$80 \le CV < 100$: Low feeding species.

- The corrected percentage of occurrence (% Fc)

The corrected percentage of occurrence was the percentage of the number of stomachs containing an item i compared to the number of non-empty stomachs examined or total number of full stomachs examined [13]. Its formula is given by Equation (3),

$$\%\ \text{Fc} = \frac{\text{Number of stomachs containing an item i}}{\text{Total number of full stomachs examined}} \times 100\% \tag{3}$$

- Weight percentage (% P)

The weight percentage is the percentage of the total mass of item i in grams compared to the total mass of all items in grams [16]. Its formula is given by Equation (4),

$$P = \frac{\text{Total mass of item i}}{\text{Total mass of all items}} \times 100\% \tag{4}$$

- The dietary index (IA)

The dietary index combining the dietary preferences of a species and the relative importance of prey is calculated as follows by Equation (5),

$$IA = \frac{(\%\ Fc) \times (\%\ P)}{100} \tag{5}$$

The dietary index (IA) ranges from 0 to 100. Thus,

IA < 10: This is accidental prey;

10 < IA < 25: This is significant prey;

25 < IA < 50: This is essential prey;

IA > 50: This is the main prey.

2.1.3. Histological Study Method

The preparation of histological processing was carried out by adopting standard histological techniques. The portions of the digestive tract were removed are immediately fixed by immersion in by immersion in formaldehyde at 10%. The samples were dehydrated progressively in ethanol baths of increasing degrees (70˚, 90˚ and 100˚C). The parts were then pre-impregnated in four (4) baths consisting of mixtures of 100˚ ethanol and toluene in increasing volume. The baths are successively 1/4 toluene and 3/4 100˚ ethanol, 1/2 toluene and 1/2 100˚ ethanol, 3/4 toluene and 1/4 100˚ ethanol. The actual impregnation as well the inclusion was carried out in paraffin (Parafina Para Histologia whose melting point is 58˚C and 60˚C) respectively in oven at 60˚C and in LEUCKART bars. Transverse sections of 7 µm made with a MICROM HM 310 microtome are mounted on slides previously moistened with gelatinized water. The whole successively undergoes the stages of spreading on the heating plate, spinning and drying. Before staining, the slides were collodioned to avoid possible detachment of the sections during treatments with the different baths. The slides resulting from these treatments are treated and stained with hematoxylin and eosin. The adhesion of the slats to the colored slides was done using Eukitt. The observation of the slides obtained and the microphotographs were carried out at OLYMPUS CKX 41 brand photomicroscope [10].

3. Results

3.1. General Diet Profile in *Hepsetus akawo*

This study relating to the diet of *Hepsetus akawo* focused on specimens whose standard length was greater than 180 mm. Thus, the intestinal coefficients of all the specimens in present work vary between 0.94 and 1.68. The emptiness percentage of 29.37% was obtained by taking into account the total number of stomachs examined (286) and empty stomachs (84). Careful observation of stomach contents made it possible to group the food items listed into two fractions, the animal fraction and the vegetable fraction. However, the grains of sand present in the stomachs of certain fish as well as the indeterminates have not been considered as food items. The animal fraction was classified into a large zoological group, namely Insects, Arachnids and Molluscs to which added the various remains. The class of Insects was composed of seven Orders, the Coleoptera, the Ephemeroptera, the Hymenoptera, the Lepidoptera, the Diptera, the Trichoptera and the Odonata (Table 1). The class of Arachnids and Molluscs included the Thomisidae and the Bivalves respectively. As for the plant fraction, it was represented by Macrophytes, Algae and their various remains. The classification of food items based on the corrected percentage of occurrence indicated 74.83% for Insects, 4.09% for Arachnids, 2.02% for Molluscs, 12.75% for Macrophytes, 2.44% for Algae and 3.87% for other food items. The analysis of corrected

Table 1. General composition of the diet in *Hepsetus akawo.*

Category of food items	Corrected percentage occurrence (% Fc)	Numerical of percentage (% P)	Importance index (% IA)
Insects	**74.83**	**70.4601**	**52.7252**
Coleoptera	17.98	4.5037	0.8097
Ephemeroptera	10.54	1.6328	0.1720
Hymenoptera	3.50	1.8737	0.0655
Lepidoptera	5.84	4.4108	0.2575
Diptera	22.05	43.1703	9.5190
Trichoptera	0.94	1.8250	0.0171
Odonata	3.22	2.5487	0.0820
Rest of Insect debris	2.89	10.7621	0.3110
Arachnids	**4.09**	**4.1445**	**0.1695**
Thomisidae	2.66	1.2689	0.0337
Rest of Arachnids	1.43	2.8756	0.0411
Molluscs	**2.02**	**6.9397**	**0.1401**
Bivalves	1.24	1.9544	0.0242
Rest of Molluscs	0.78	4.9853	1.3327
Macrophytes	**12.75**	**10.4526**	**1.3327**
Fruit and plant	9.60	2.2418	0.2152
Rest of Macrophytes	3.15	8.2108	0.2586
Algae and rest of algae	**2.44**	**1.9509**	**0.0476**
Other items	**3.87**	**5.7852**	**0.2238**

occurrence percentages (%Fc) and weighted (% P) indicated a very high number of insects than the other food items in the stomach contents of the fish. This analysis of the proportions of the food indices of the different food items showed that Insects (% IA = 52.7252%) were the prey mainly consumed (**Figure 2**). However, Molluscs, Arachnids, Algae and other items were considered incidental prey.

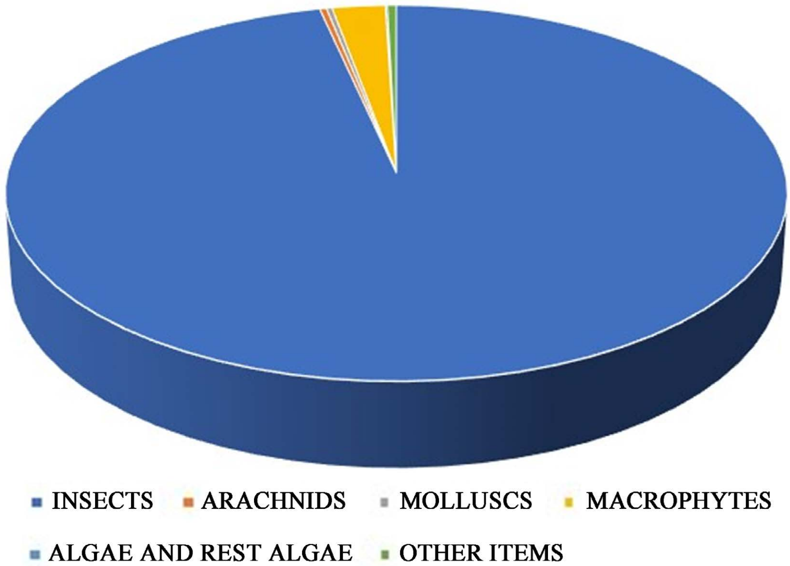


Figure 2. Proportion of items in the diet in *Hepsetus akawo*.

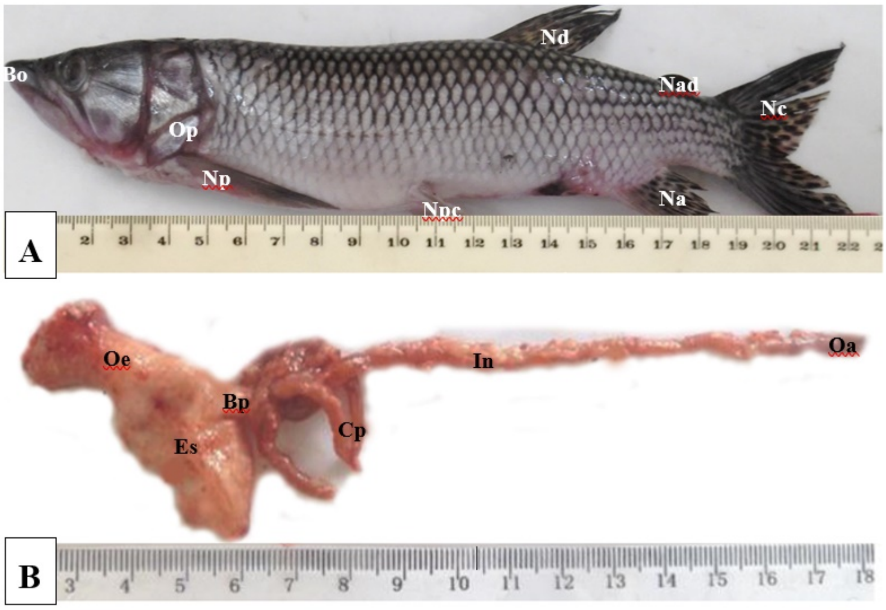
3.2. Anatomy of the Digestif Tract (Figure 3)

Following the dissection and separation of the shreds of flesh, it appears that *Hepsetus akawo* (**Figure 3A**) was a fish with small digestive glands (liver and pancreas). The observation and analysis of the digestive tract made it possible to highlight the different portions of it. It started from the oral region to the anal region. The digestive tract was made up of an oral cavity, an esophagus, a stomach and an intestine which ends at the anal orifice (**Figure 3B**). The protractile mouth opens into the esophagus which is a short cylindrical and rectilinear conduit. The stomach was a poorly developed organ in the shape of a small pouch marking the transition between the esophagus and the intestine. The intestine was in the form of a straight tube. The digestive tract was provided at the level of the pylorus with four to eight poorly developed pyloric caecum. Each portion of the digestive tract consisted of a muscular wall surrounding a lumen.

3.3. Histology of the Digestive Tract in *Hepsetus akawo*

- **Esophagus (Figure 4)**

The cross section of the initial part of the digestive tract the esophagus revealed a lumen of the esophagus and set of characteristic layers forming the muscular wall (**Figure 3A**). The lumen of organ was lined by stratified epithelium. The muscular wall of approximately 350 μm ± 10 μm in diameter was



Mouth, Bo; Operculum, Op; Pelvic fin, Np; Pectoral fin, Npc; Anal fin, Na; Dorsal fin, Nd; Adipose fin, Nad; Caudal fin, Nc. Esophagus, Oe; Stomach, Es; Pyloric branch, Bp; Pyloric caecum, Cp; Intestine, In; Anal orifice, Oa.

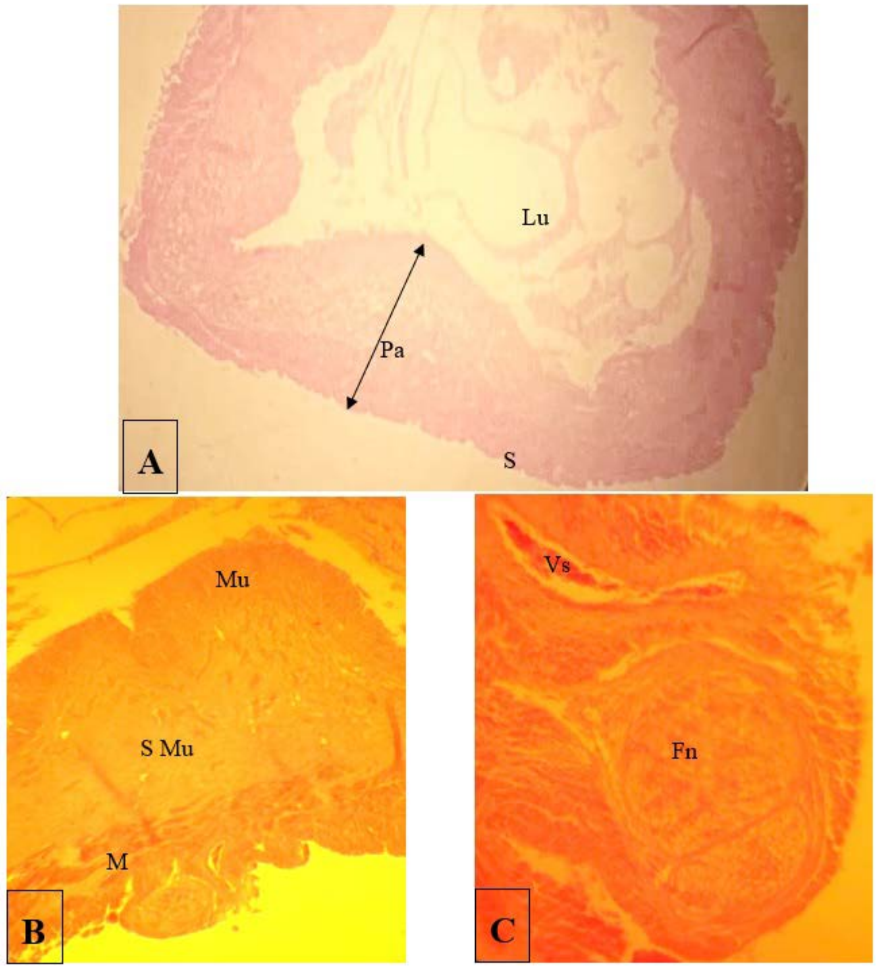
Figure 3. Morphology of a specimen and the digestive tract. A. External morphology of the specimen of *Hepsetus akawo*; B. Anatomical aspect of the digestive tract.

made up of four (4) layers of variable thickness which are the serosa, the muscularis, the submucosa and the mucosa (Figure 4B). The serosa, well individualized was a thin connective subepithelial layer that limited the esophageal wall. The muscularis adheres to serosa. The muscular tunic was composed of two under-layers, the external longitudinal undercoat and the internal circular undercoat. The external longitudinal sublayer is presented in places of blood vessels and esophageal glandular regions (Figure 4C). The difficult-to-observe submucosa was an intermediate layer between the muscular and mucous tunics.

The mucosa appears in the form of an esophageal rim and consists of a surface epithelium bordering the lumen of a cellularized connective chorion.

- **Stomach (Figure 5)**

Structural microscopy of the stomach showed an organization almost similar to that of the esophagus, that was to say a lumen surrounded by a gastric wall (Figure 5A). The gastric wall with a thickness of approximately 500 µm ± 25 µm in diameter on average was made up of several clearly visible layers with very significant variations (Figure 5A). This gastric wall was made up of four tunics characteristic of the digestive tract, namely, the serosa, the muscular, the submucosa and the mucosa (Figure 5B). The external serosa was thin, irregularly contoured protective layer that surrounded or covered the gastric wall. The muscular tunic of the stomach was strongly developed and composed of two well-individualized underlayers, the external one with a longitudinal arrangement and the internal one with a circular arrangement (Figure 5B). The submucosa was characterized by the presence of connective tissues, arteries and lymph node regions similar to



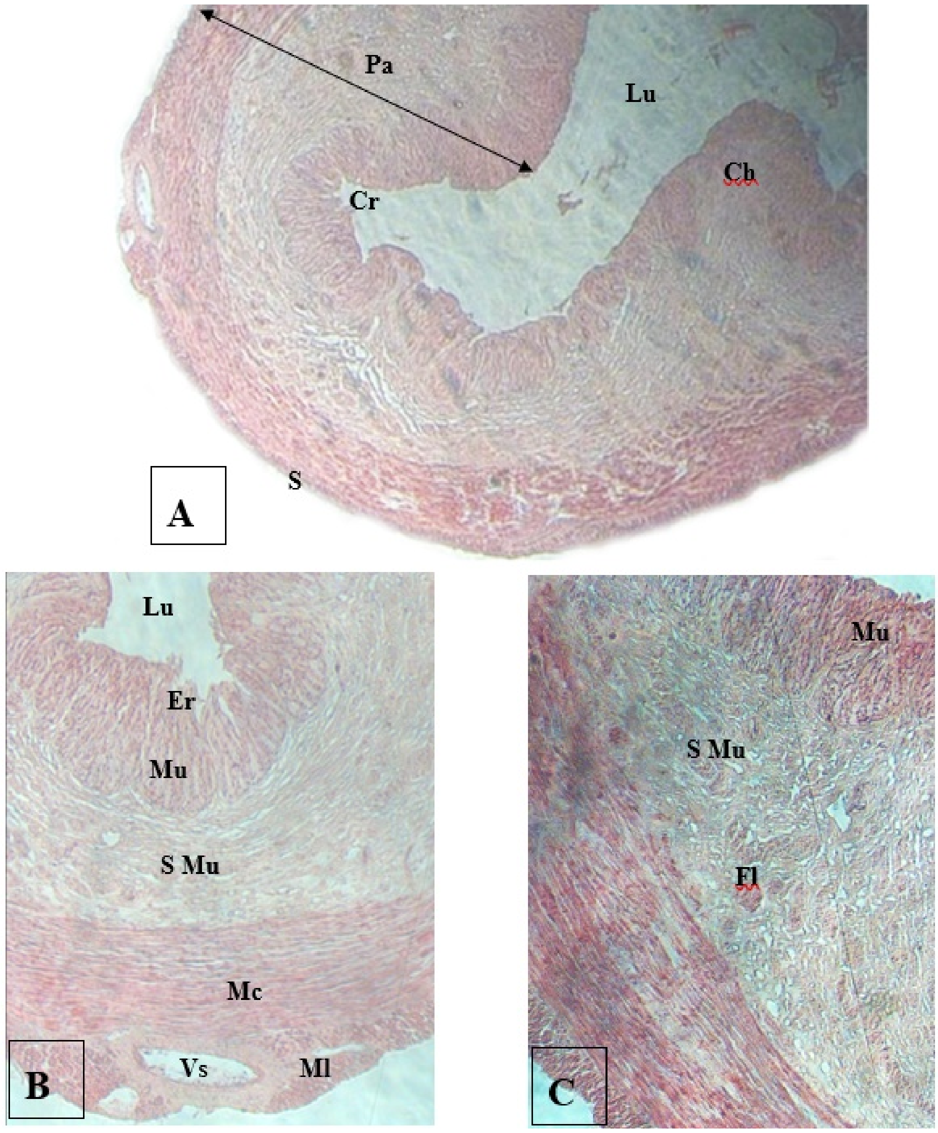
Lumen, Lu; Wall, Pa; Bundles of nerve fibers, Fn; Serous, S; Blood vessels, Vs; Mucosa, Mu; Submucosa, S Mu; Muscular, M.

Figure 4. Cross section of the esophagus of *Hepsetus akawo.* A. General view of the esophagus; B. Portion of wall; C. Localization of glandular regions and blood vessels in the muscular; Coloring: Hematoxylin and Eosin; Magnification: (A) ×40; (B) ×100.

Auerbach's plexus. The gastric mucosa had numerous deep folds or folds allowing great distention of the organ. It was formed of covering epithelium with a more irregular appearance represented by invaginations and more or less significant depressions called crypts (Figure 5A). The crypts which were narrower than deep, constituting a particularity of the stomach, made it possible to obtain a greater stomach light. Below the folds were the connective tissues of the chorion containing the lymphoid follicles similar to vacuoles and more or less rounded blood capillaries (Figures 5B and 5C).

- **Intestine (Figure 6 and Figure 7)**

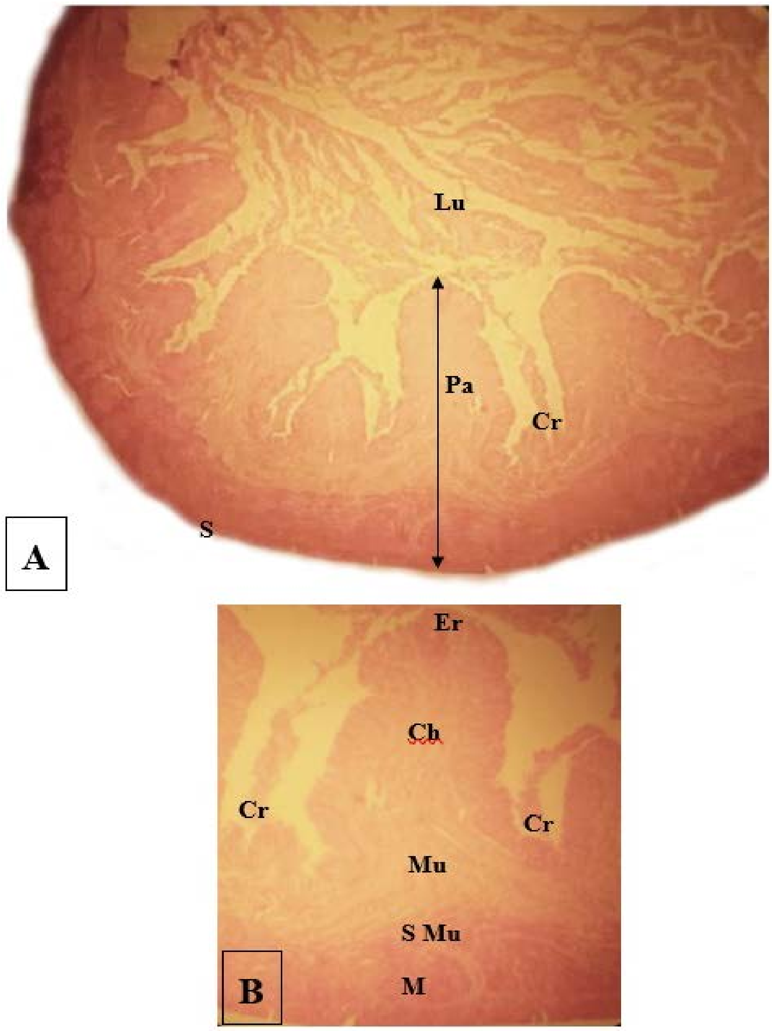
The histological section of the intestine revealed the presence of a muscular wall around a large lumen. It was made up of four very distinct tunics which are from the outside to the inside, the external serosa, the muscular, the submucosa and the mucosa (Figure 6A). The serosa, a very thin layer was made up of connective tissue and poorly vascularized. Arrangement and structure of the



Lumen, Lu; Wall, Pa; Serous, S; Blood vessels, Vs; Mucosa, Mu; Submucosa, S Mu; Circular muscular tunic, Mc; Epithelium, Er; Longitudinal muscular tunic, Ml; Lymphoid follicles, Fl;: Crypts, Cr; Chorion, Ch.

Figure 5. Micrograph of the cross-section stomach of *Hepsetus akawo.* A. Overview of the stomach; B. Detailed view of a portion of the stomach; C. Localization of lymphoid follicles and cardiac glands; Coloring: Hematoxylin and Eosin; Magnification: A. ×40; B. ×100.

muscular tunic were similar to those of the stomach with less thickness. The submucosa was characterized by the presence of loose connective tissues and the absence of blood vessels. The mucous membrane, the thickness of which was double the three previous layers, presented a very characteristic size, structure and arrangement favoring very significant distension during digestion (Figure 6B). The mucosa was made up a set of folds of variable size. Folds formed large, fairly deep crypts as well as villi. The villi lined by simple prismatic epithelium composed of exocrine glandular ones and numerous goblet cells (Figure 6B).



Lumen, Lu; Wall, Pa; Serous, S; Mucosa, Mu; Submucosa, S Mu; Epithelium, Er; Crypts, Cr; Chorion, Ch; Mucosa, Mu; Muscular, M.

Figure 6. Micrograph of the cross-section intestine of *Hepsetus akawo*. A. Overview of the intestine; B. Detailed view of a portion of intestine. Coloring: Hematoxylin and eosin; Magnification: A. ×40; B. ×100.

4. Discussion

Morphology of digestive tract and general diet profile in *Hepsetus akawo*

Macroscopic observation of the digestive tract in *Hepsetus akawo* revealed the presence of a poorly developed muscular stomach and a short intestine (0.94 and 1.68). In fact, on the basis of intestinal coefficients obtained and comparison of the results of previous work, *Hepsetus akawo* appears to be an Omnivorous species [14] [17]. The present results agree with those obtained at *Pomadasys jubelini* and *Parachanna obscura* [17] [18]. In literature, work on the morphology of digestive tract in particular on the digestibility of prey is function of the length of intestine reflected a specific dietary base [14] [19]. There is a correlation between food type and the relative length of intestine to the body length of fish. Generally, it is accepted that the intestine was short in Carnivorous species, that is to say that in its fish was less than 1 while in Herbivorous species, the intestine was long, of one relative length greater than 3 that of fish [20] [21]. However, in fish with an intermediate diet, *i.e.*, Omnivorous, the relative length of intestine was between 1 and 3.

The general profile of the *Hepsetus akawo* diet obtained through a qualitative analysis of stomach contents showed a very diverse dietary spectrum consisting of Insects, Arachnids, Molluscs, Macrophytes, Algae and plant and animal debris. In addition, the analysis of stomach contents following the quantitative component revealed that Insects constituted the dominant prey in the diet. However, Arachnids, Molluscs, Macrophytes and Algae were rarely consumed prey. These results give this predatory species an Omnivorous diet with an Insectivorous tendency. The explanation could be linked to the abundance and preferences of these prey over Plants and Arachnids. The results indicate that this diet was essentially composed of Coleoptera, Ephemeroptera, Hymenoptera, Diptera, Trichoptera and Odonata. The present results were similar to those obtained by several authors in different species in more or less different environments [8] [18]. These results differ from some work done on the diets of certain species showing a diet dominated by Benthic prey, Fish, Crustaceans and Molluscs [8] [17] [22]. The different diets of Fish can be explained by the availability of different food sources in their natural environments. Also, the variation in diet would be linked to the differentiation of the digestive system and habitat used [17]. Concerning the percentage of emptiness, it was 29.37% in the present work. This value obtained makes it possible to classify *Hepsetus akawo* species among the relatively gluttonous species. The high rate of this parameter would be linked to predatory fish. This high rate could be explained by an increase in the genital glands exerting strong pressure on the digestive tract, which causes the fish to eat little or not at all during the reproduction period. Also, the physiological state of fish and the availability food in the natural environment could influence feeding activity in fish [9] [23]. In fact, it seems that prey of Animal origin has a faster digestion than that of Plant origin [17] [24]. Therefore, variation in diet would likely by explained by the structural organization of digestive tract.

Microscopic structure

In general, and in the present work, light microscopy of the digestive tract of the species *Hepsetus akawo* showed the existence of a wall made up of four tunics which were, serosa, muscularis, submucosa and mucosa. Lumen of the digestive tract was a simple transit of the food bolus of the anal orifice. However, in literature, work relating to the digestive tract of fish remains very few and dates from the 1980s. Such a structural organization was recently observed in *Seriola dumerili* [25]. These results differ from those of previous work carried out in *Trachurus trachurus* which had obtained two tunics, the mucosa and the muscularis at the level of the esophagus compared to three on the side of the stomach [26]. The tunics of the different regions of digestive tract also present a functional distinction.

Histophysiology

Hepsetus akawo was a predatory species with an Omnivorous tendency whose prey ingested in the oral cavity underwent predigestion before passing through the esophageal area. Once in the mouth, the prey was immobilized, disarticulated and crushed by pharyngeal apparatus. After that, they were directed toward the esophagus. In esophagus, the esophageal lining cells were involved in the mechanical protection of the underlying cells with the friction of food bolus. Also, they constituted a barrier to the exchange of digestive materials. In fact, when food bolus resulting from predigestion, descended into the esophagus, the shallow longitudinal folds of the esophageal mucosa temporarily disappeared, increasing the lumen of the esophagus thanks to the distension of the wall. In addition, the secretion of mucus by the lining epithelial cells lubricated the esophageal wall and facilitated the progression of luminal contents. However, the food ingested exerted very little pressure on the esophageal walls. From the above, the esophagus would be a simple propulsive conduit of the food bolus from the oral cavity to the stomach. Once the food bolus was in stomach, the powerful contractions of the muscular tunics continued the transformations through the mechanisms of crushing and grinding the consumed products. Structurally, the presence of muscularis helps to strengthen the gastric wall, promoting its consolidation, its rigidity and preventing its rupture to the extent that the food ingested stays long enough in the stomach. Also, the presence of food caused a succession of actions on stomach wall, among other things, strong pressure, strong distension and an increase in gastric volume which could lead to the bursting of the gastric wall. As for the cells lining stomach mucosa, they include longitudinal folds distension allowing the obtaining of significant lumen. The mechanical action of muscular tunic pushes gastric secretions from glandular epithelial cells into the lumen of stomach. This mechanical action associated with the secretion of mucus and hydrolysis products would contribute to the complete and total transformation of organic matter from food chyme before their passage into the intestinal zone. In the case, *Hepsetus akawo,* species, the stomach would be the place of temporary storage and the seat of mechanical and chemical transformations. After, total transformation, the food chyme passes into the intestinal area. In the intestinal area, the presence of much higher longitudinal folds coupled with the presence of villi would contribute to good absorption of nutrients from gastric digestion. However, indigestible materials were evacuated through the anal orifice in from of droppings in the natural environment.

In summary, the esophageal mucosa facilitates movements of luminal contents. As for the stomach muscularis and the intestinal mucosa, they respectively optimize the digestibility and absorption of nutrients contributing to the increase in the body condition of the fish. Insects with rigid cuticles stay longer in the stomach than Insects with soft cuticles. In insects, the stiffer the cuticles, the longer the digestibility and residence time in the stomach. Consequently, fish with very good digestibility reaches commercial size and the size of first sexual maturity more quickly.

5. Conclusion

During the present work, the anatomo-histological aspect made it possible to know and justify the existing relationship between diet and the anatomical and microscopic structure of the digestive tract. The apical mouth allows easy harvesting of foods of various kinds. The esophagus is a tube that allows food to pass easily and directly into the stomach. The stomach constitutes an area for mixing and storing food before it passes into the intestine. The intestine serves as an area of nutrient absorption. Analysis of the stomach contents of *Hepsetus akawo* showed a diet composed of insects, arachnids, macrophytes, molluscs and algae. Insects are the majority of the diet and constitute the main and preferential prey of this species. Histologically, the four functional layers are identically arranged throughout the digestive tract. Knowledge of the diet coupled with digestibility through histophysiology should allow domestication of this target species. Therefore, the fish breeder should choose insects with soft cuticles that have high digestibility and optimal absorption. It would be desirable to continue this work by integrating other parameters, size and physiological states.

Conflicts of Interest

The authors declare no conflicts of interest.

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