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Biometrics of the gastrointestinal tract of *Tor tambra* and *Tor soro* from Aceh, Indonesia

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Abstract. The gastrointestinal tract of native fish shows structural and functional diversity, which is related to different dietary requirements, feeding habits, phylogeny, age, body shape, and sex. There is some research that discusses the digestive tract of fish, but research on the digestive tract of *Tor tambra* and *Tor soro* is still limited. The purpose of this study was to describe the biometrics of the stomach and intestines of *T. tambra* and *T. soro* harvested from Leuser Ecosystem Area. This study included sample collection, sample preparation, gastrointestinal biometrics, and data analysis. The observation parameters include GaSI (Gastro Somatic Index), ISI (Intestine Somatic Index), RGL (Relative Gut Lengths), and RIL (Relative Intestine Lengths). The measurement data were tested using analysis of variance (ANOVA). The results showed that the highest GaSI, ISI, RGL and RIL values were in *T. tambra* with respective values of 0.50±0.24%, 2.46±0.58%, 44.35±5.22%, and 340.37±33.99%, while the lowest values were found in *T. soro*, whereas 0.22±0.07%, 1.57±0.55%, 32.03±14.99%, and 259.62±65.74%, respectively. The results of the statistical analysis showed that there were significant differences ($P<0.05$) in the GaSI, ISI, and RIL values, while RGL no significant differences ($P>0.05$) between the two species.

1 Introduction

The digestive tract of teleosts has attracted considerable interest in its morphological structure and function related to taxonomy and feeding habits [1]. One of the main factors, according [2][3], affecting fish survival is adequate nutrition which depends on effective ingestion,

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digestion, and assimilation of nutrients as well as the physiological competence of the fish to digest and transform ingested material. Digestion is an important process that directly affects the availability of nutrients needed for the body's biological activities; and its efficiency depends on the type and function of digestive enzymes [4]. Feeding habits are influenced by several factors, such as appetite and digestive tract structure, but are also related to the external properties of food, such as protein source and palatability [5]. Fish feeding activities and traits include herbivores that feed on plants, carnivores that consume animal component and omnivores that consume both plants and animals [6]. Diverse feeding habits and habitats affect the digestive tract in terms of structure, morphological, and physiological under various conditions [7].

The gastrointestinal tract in fish shows structural and functional diversity [8][9], which is associated with different dietary requirements, feeding habits, phylogeny, body mass, and shape, and even sex [10][11]. The main differences, observed at macroscopic and microscopic levels, include the shape, size, and structure of the stomach and intestines, the level of anatomical characteristics as well as the histological features of specific parts [7]. Many studies have examined the mechanisms of food demand, digestion and absorption in fish. In addition, it has been reported that the morphology of the digestive tract changes with different feeding habits and environments [9][12]. The shape of the cranium in each species influenced by the individual's genetics and environmental backgrounds, such as feeding habits and water quality [13]. Gill filament morphology can provide information related to the mechanical digestion process [14]. Although, there is a lot of literature discussing the digestive tract in fish, research on the digestive tract in *Tor tambra* and *Tor soro* fish is still limited. The aim of this study was to describe the gastric and intestinal biometrics of *T. tambra* and *T. soro* harvested from Leuser Ecosystem Areas. This information can provide a comparative basis for digestion, absorption and diet studies, as well as contribute to the development of fish farming of *T. tambra* and *T. soro*, which have diverse dietary needs and habitats.

2 Methods

2.1 Sample collection

T. tambra and *T. soro* were collected from river waters in Manis River, Bunin Village, Serbajadi District, East Aceh Regency, sampling in the upstream part of the river which is the habitat of *Tor* fish (97° 36' 12.391" E - 4° 29' 19.262" N). Biometric data analysis was carried out at the Aquaculture Integrated Laboratory, Almuslim University, Bireun Regency, Aceh Province, Indonesia.

2.2 Sample preparation

Fish sample in this study were obtained through direct capture or from fisherman totaling 5 fish of each species. Fish samples had an adult size with a minimum weight of 2 kg and a length of 30-50 cm. The digestive organs of the fish were separated using surgical tools, then placed in a container. Measurement of digestive organs using calipers with an accuracy of 0.01 mm starting from the stomach to the anus. Each organ was weighed using a 0.01 g digital scale. Measurement of the weight and length of the fish's digestive system includes the fish's body, stomach and intestines. Each digestive system data was documented using a digital camera (Canon EOS 400D Japan).

2.3 Digestive tract biometrics

The biometric parameters of the digestive tract in this study are GaSI (Gastro Somatic Index) and RGL (Relative Gut Lenghts) based on the formula of Bhatnagar & Karamchandani [15], ISI (Intestine Somatic Index) and RIL (Relative Intestine Lenghts) based on the formula of Wu et al [16].

$$\text{GaSI} = \frac{\text{fish stomach weight(g)}}{\text{fish body weight (g)}} \times 100$$

$$\text{ISI} = \frac{\text{fish intestine weight (g)}}{\text{fish body weight (g)}} \times 100$$

$$\text{RGL} = \frac{\text{length of fish stomach(cm)}}{\text{total length of fish(cm)}} \times 100$$

$$\text{RIL} = \frac{\text{length of fish intestine (cm)}}{\text{total length of fish (cm)}} \times 100$$

2.4 Data analysis

Biometric data analysis for each parameter was conducted using a one-way variance test. The significantly different criteria used at the 95% confidence level ($p<0.05$). Statistical analysis was conducted with SPPS ver. 22 software.

3 Results and discussion

Biometric studies of fish digestive systems can determine water environmental pollution and potential dangers in an aquatic habitat [17]. The highest GaSI value is found in *T. tambra* reach of 0.50±0.24%*,* while the lowest value is found in *T. soro* reach of 0.22±0.07%. The results of statistical analysis showed significant differences in GaSI values between the two species ($p<0.05$). The highest ISI value was found in *T. tambra* while the lowest value was found in *T. soro*, which reach of 2.46±0.58% and 1.57±0.55%, respectively. The results of statistical analysis showed significant differences in ISI values between the two species ($p<0.05$) (Table 1). Some species of fish are omnivorous when small and then adopt herbivorous eating habits as their size increases [17]. RGL and GaSI values can indicate that herbivorous fish can change their feeding intensity according to their sexual cycle [18]. Catfish in nature which are carnivorous have a GaSI reaching 36.53% higher than cultivated catfish (29.29%) [17][19].

Table 1. Digestive tract biometric parameters of *Tor tambra* and *Tor soro*, while stars symbol "*" indicate significant differences.

Parameters	*Tor tambra*	*Tor soro*
GaSI	$0.50 \pm 0.24^{*}$	$0.22 \pm 0.07^{*}$
ISI	$2.46 \pm 0.58^{*}$	$1.57 \pm 0.55^{*}$
RGL	44.35 ± 5.22	32.03 ± 14.99
RIL	$340.37 \pm 33.99^{*}$	$259.62 \pm 65.74^{*}$

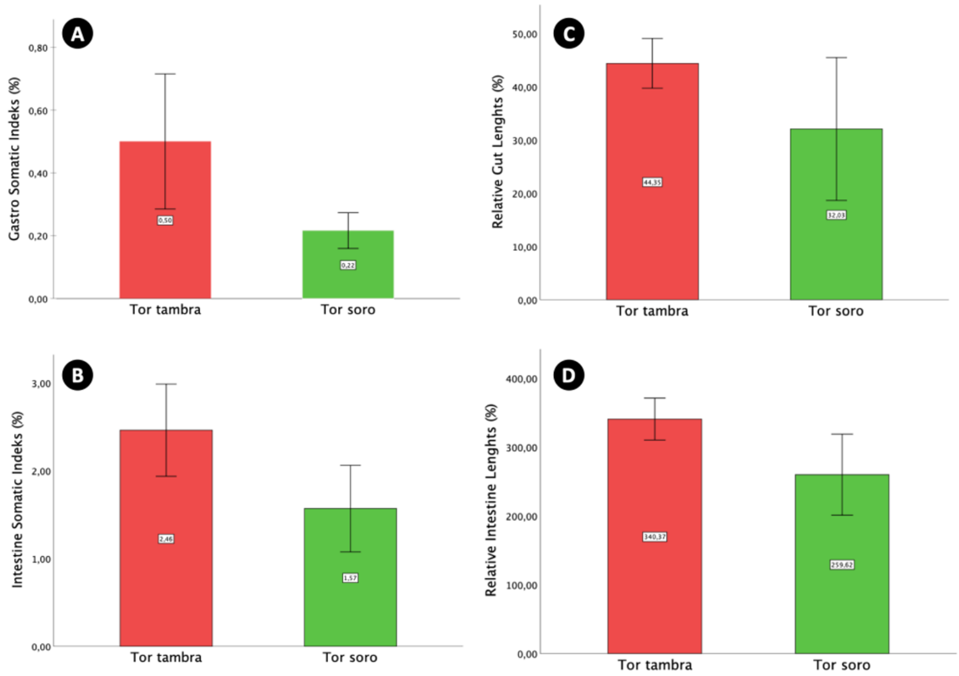

Fig. 1. Digestive tract biometrics of *Tor tambra* and *Tor soro* fish. Description: (A) Gastro Somatic Index, (B) Intestine Somatic Index, (C) Relative Gut Lenghts, (D) Relative Intestine Lenghts.

The highest RGL value was found in *T. tambra* reach of 44.35±5.22% while the lowest value was found in *T. soro* 32.03±14.99%. Statistical analysis showed that there was no significant difference in RGL values between the two species ($p<0.05$). The highest RIL value was found in *T. tambra* (340.37±33.99%) while the lowest value was found in *T. soro* (259.62±65.74%) (Fig. 1). The results of statistical analysis showed significant differences in ISI values between the two species ($p<0.05$). *T. tambra* and *T. soro* feeding habits are omnivorous. *T. tambra* predominantly feed herbivorous-omnivorous food sources, while *T. soro* is predominantly carnivorous-omnivorous. RGL and GaSI values can indicate carnivorous-omnivorous and herbivorous-omnivorous feeding habits [20]. It is clear that the RGL ratio of herbivorous and carnivorous fish decreases gradually, forming a continuum from herbivorous to carnivorous fish [18]. This can be expressed as the angle formed by the constant of the ratio of body length to gut length for each species and in the long run it is possible to know the feeding habits of any species just by plotting its RLG against body length [21]. The research results of Muchlisin et al. [22] strengthens the conclusion that *T. tambra* has an omnivore feeding habit with herbivorous tendencies.

4 Conclusion

The results showed that the highest GaSI, ISI, RGL, and RIL value were found in *T. tambra* while the lowest value were found in *T. soro* which each value of 0.50±0.24%, 2.46±0.58%, 44.35±5.22%, and 340.37±33.99% for *T. tambra* and 0.22±0.07%, 1.57±0.55%, 32.03±14.99%, and 259.62±65.74% for *T. soro*. The results of statistical analysis showed significant differences in the values of GaSI, ISI and RIL while the value of RGL had no significant difference between the two species ($p<0.05$).

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