

PRELIMINARY OUTCOMES ON THE GASTROINTESTINAL LUMINAL IONIC CONDITIONS IN ORANGE-SPOTTED GROUPER JUVENILES

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Introduction

In fish having a stomach, the first phase of food digestion occurs in this organ by mechanical degradation, and the primary action of proteolytic and chitinolytic enzymes under an acidic environment. The second phase takes place in the intestine by the action of further proteases, phosphatases, lipases and carbohydrases under a neutral-alkaline environment. This is the general rule. However, recent studies show species-specific characteristics in gastric acidification strategies, as well as pH conditions in different intestine segments (Yúfera et al., 2012). Most of the scarce number of studied teleostean species exhibits a neutral gastric pH at fasting that declines when the food reaches the stomach, although permanent gastric acidification as in many other vertebrates has also been described (Buckling & Wood, 2009). Considering the inter-specific physiological variability in teleosteans, it is necessary to explore other species to obtain a global view of the digestive function in this zoological group and to understand the reasons for this variability. Moreover, a precise knowledge of digestion strategy will contribute to implement enhanced feeding protocols and optimize feed formulation. With this aim, we have determined changes in postprandial pH in different segments of the digestive tract in juveniles of orange-spotted grouper (*Epinephelus coioides*), a species of large commercial interest in tropical and sub-tropical waters with an increasing development in the farming industry in Asia.

Materials and methods

Orange-spotted grouper eggs were obtained from a local hatchery in Nha Trang, Vietnam. Fish larvae were reared in 3000-L tanks with a flow-through water system. After weaning, the juveniles were fed twice a day (at 08:00 and 16:00 local time) with a commercial feed by Ocialis (55% crude protein and 15% lipid). The juveniles were cultured under a light/dark cycle (12L/12D) and seawater temperatures of at 29±1°C. The gastrointestinal pH was measured in juvenile grouper at 125 days after hatching with body weight of 6-8 g. The fish were sampled at 7:00, 8:00, 9:00, 11:00 and 16:00 h (local time). Three fish were measured at each sampling point. At the day of sampling, the juveniles were fed only one meal at 8:00. pH was measured in the stomach, anterior intestine, medium intestine and posterior intestine using a pH microelectrode, as described in Yúfera et al. (2012).

Results and Discussion

The juveniles filled the stomach immediately after the morning meal. Three hours after feeding, the chymo was clearly observed in the intestine. In the afternoon, both stomach and intestine appeared full of digestive contents. In the first morning sampling, one hour before feeding, still some content was observed in the intestine. The gastric pH declined after the morning meal. Mean pH values ranged between 5.5 just before feeding and 3.4 in the last sampling in the afternoon (Fig. 1). The progressive postprandial decrease of pH values is similar to that found in other marine and freshwater fish species having the same strategy, like *Sparus aurata*, *Dicentrarchus labrax*, *Diplodus sargus*, *Tilapia redalli*, *Oreochromis mossambicus*, *Clarias gariepinus*, *Argyrosomus regius*, *Chelon labrossus* and *Amphiprion ocellaris*, (Yúfera et al., 2012; Hlophe et al., 2014; Jacob et

al., 2017), but contrasted to postprandial patterns found in *Oncorhynchus mikiss* and *Rachycentron canadum* that have a permanent acidic environment in the stomach (Bucking & Wood, 2009; Yúfera et al., 2016). A particular characteristic is that the gastric pH was already a bit acidic before feeding. More intriguing is the fact that the intestinal pH was also acidic ranging from 4.0 to 7.0 (Fig. 1). A decrease was observed after the meal probably due to the passage of gastric juice when the food reached the stomach, mainly in the anterior intestine and then again in the afternoon with the passage of the partially digested chyme. As in other fish the pH is always lower in the anterior intestine.

Although with some particular characteristics, the luminal ionic pattern observed in *Epinephelus coioides* in the present study has been found in carnivorous species, also in omnivorous thicklip grey mullet (*Chelon labrosus*) with a lower acidification capacity. The particular characteristics described in this preliminary screening need to be confirmed with a more detailed study. Beside the species, there are different sources of variations such as feeding protocols, food compositions and fish size. Moreover, the acidification strategy is also related with prey availability and encounter opportunity.

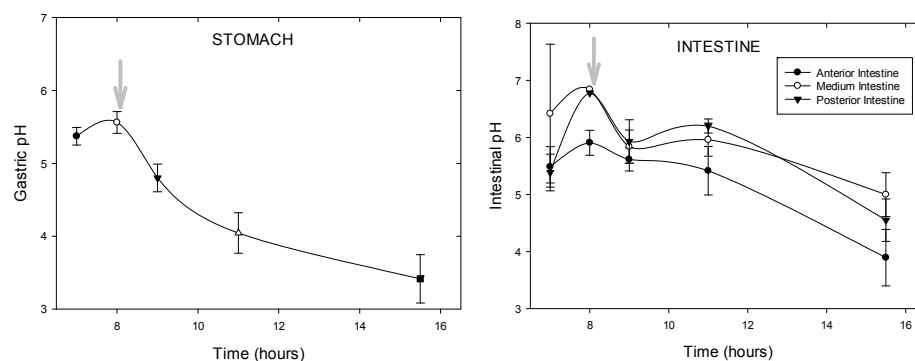



Fig. 1. Gastric (left) and intestinal (right) luminal pH (mean \pm SEM) recorded in juvenile orange-spotted grouper. Arrow indicates the meal time.


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ABSTRACT

This study examines the postprandial pH changes in the digestive tract of orange-spotted grouper early juveniles reared at 29 °C.


The gastric pH declined after the morning meal. Mean pH values ranged between 5.5 just before feeding and 3.4 in the last sampling in the afternoon. Interestingly, intestinal pH was also acidic ranging from 7.0 to 4.0, particularly the anterior intestine. A decrease was observed after the meal probably due to the passage of gastric juice. A similar gastric pattern was described in most of teleost examined so far. The intestinal pattern has been only describe in some of the studied species.

INTRODUCTION

- Orange-spotted grouper (*Epinephelus coioides*) is a species with large commercial interest with a high voracity and growth rate.
- A better knowledge of its digestive functionality will help to implement appropriate feeding protocols and formulate optimal feeds.
- The aim of this study was to examine the postprandial pH changes in the different sections of the digestive tract in early juveniles during diurnal period.


MATERIALS AND METHODS

JUVENILE REARING



29 °C
33 g L⁻¹ salinity
Photoperiod: 12L : 12D

SAMPLING

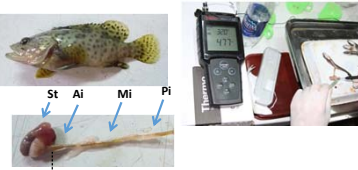


Set of 5 samples during the diurnal time

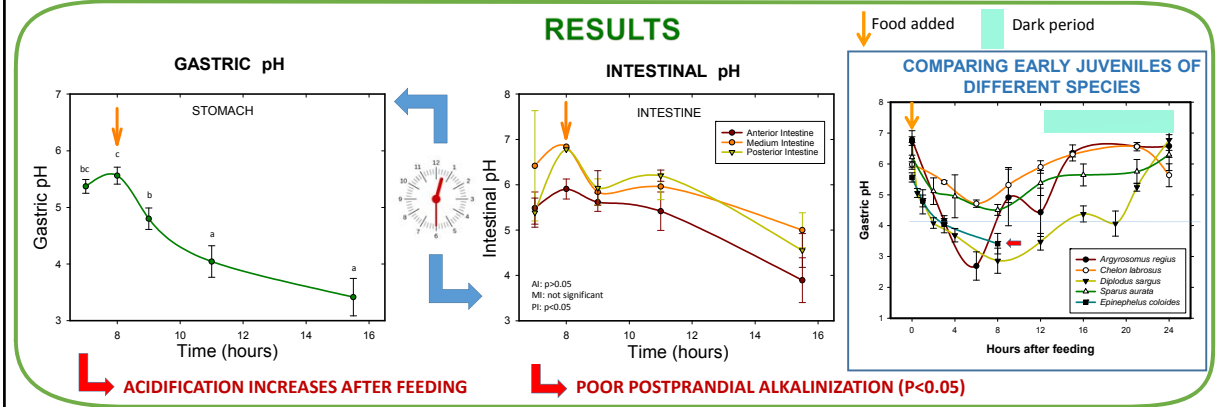
07:00 08:00 09:00 11:00 15:30

body weight: ca. 6-8 g

pH DETERMINATION



St Ai Mi Pi



DISCUSSION

- Most of the analyzed teleostean exhibit the neutral gastric pH during fasting [1] that declines after feeding; only *Oncorhynchus mikiss* [2] and *Rachycentron canadum* [3] have been described to maintain a permanent gastric acidification. Orange-spotted grouper showed the first strategy
- At resting gastric pH is slightly acidic decreasing after feeding in the range 5.5 to 3.4
- Intestinal pH was also acidic (7.0 to 4.0), particularly the anterior intestine. The luminal pH was slightly acidic during the first hours after feeding and decreased afterwards. This intestinal pattern has been also described in some few species

CONCLUSIONS

- Orange-spotted grouper juveniles exhibits a slight acidic gastric luminal pH at resting
- The digestion in the lumen of the intestine seems to occurs also under a relative acidic environment

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