Colegio de Postgraduados

# Growth of juveniles of (*Striostrea prismatica* G.) (Ostreida: Ostreidae) under two feeding regimes in a semi-closed circulation system

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**ABSTRACT**
**Objective**: The effect of two diets on the growth of juveniles of *Striostrea prismatica* was studied.
**Design/Methodology/Approach**: The experiment consisted of tasting two diets, each with two replicates of 70 organisms. The experiments were carried out over 45 days in seawater recirculation systems. These two diets consisted of 1) 50% *Chaetoceros muelleri* B. and 50% *Tetraselmis tetrathele*, both grown in the laboratory, and 2) Shellfish Diet1800® pasta.
**Results**: The results did not show differences between both treatments. The organisms' height of those fed with the pasta was 24.7±6.42mm, and that of those fed with the live food was 24.7±7.87mm.
**Limitations on study/implications**: L'ignorance of the species' biology can limit our understanding of growth and its impact on the crop. Since the duration of the experiment, a more significant increase has been observed in the left valve, which may be due to the absence of currents or waves as occurs in natural conditions.
**Conclusions**: Therefore, it is concluded that using both diets is indistinct to cultivate *S. prismatica* juvenile in semi-closed systems.

**Keywords**: Diets, Growth, *Striostrea prismatica*, juvenile.

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## INTRODUCTION

The rocky oyster (*Striostrea prismatica* G.), a bivalve mollusk, is an essential species for fishing and the economy. It is heavily fished from Mexico's Gulf of California to Peru Mancora, which has put it under significant pressure (Arreguín-Sánchez & Arcos-Huitrón, 2011). To address this issue, domestication for cultivation is being explored. However, limited research on the species and its biology and development under laboratory conditions is poorly understood. Previous studies have focused on evaluating juvenile growth and gametogenic development in conditioning bioassays (Ríos-González *et al.*, 2018). Food plays a crucial role in the growth of organisms throughout their life cycle (Parker, 2011).

Therefore, it is essential to design diets that allow success in these early phases of development. It has been found that the growth of *Crassostrea corteziensis* and *Pinctada maxima* is influenced by the species composition and, consequently, the nutritional composition of each diet (Rivero-Rodríguez *et al.*, 2007; Haoujar *et al.*, 2022 and Yi *et al.*, 2023).

The larval and seed stages require high-quality nutrition (Marshall *et al.*, 2010), and microalgae species are commonly used to meet protein, lipid, and carbohydrate needs. Mixtures from production labs or commercial concentrates are preferred over monoalgal diets for optimal growth, and a varied diet leads to positive development outcomes (Helm, 2006).

Previous studies have tested concentrated foods and food substitutes like microparticulate food and industrial cheese whey in bivalves and invertebrates, but there is controversy surrounding their nutritional effectiveness (McCausland *et al.*, 1999; Ponis *et al.*, 2003; Enes & Borges, 2003; Espinosa & Allam, 2006; Duy *et al.*, 2016). (Duy *et al.*, 2015), evaluated the differences in the sea cucumber (*Holothuria scabra* J.) in the ingestion and digestion rate of various diets, including live food and commercial microalgae concentrate from the brand Shellfish Diet 1800© Red Mariculture, finding that both had similar results. In subsequent studies, Duy *et al.* 2016 reported that the monoalgal concentrates supplied have sufficient nutritional requirements to promote larval development, growth, and survival. Concentrated diets such as algae pastes have been used in larva and seed nurseries of marine organisms. McCausland *et al.* 1999 found that adding pastes to a natural phytoplankton diet improved growth rates in marine larvae. However, they did not observe growth differences between diets for the Pacific oyster (*Crassostrea gigas* T.). Feeding laboratory-formulated live microalgae diets did not show any difference in the growth of *Siriostrea prismatica* G. juveniles cultured in controlled systems compared to the development of juveniles fed commercial algae concentrates (pastes) in controlled systems. The present study evaluated the performance of pasta and live food feeding regimes for juvenile rock oysters in a semi-recirculating system.

## MATERIALS AND METHOD

### Experimental design

Each treatment was carried out in triplicate, giving six semi-closed recirculation systems. A pond individually integrated the semi-closed recirculation systems with a capacity of 300 L, connected to a 200 L filter with a section for sediments and sand (mechanical) and a biological filter section with perforated spheres (bioballs) that houses bacteria-denitrifying agents for the elimination of $NH_3$. The water was returned to the pond using an aquarium pump with a pumping capacity of 2000 L/h. Three replacements were made during the experiment period.

### Collection and preparation of organisms

From "El Tizate," Nayarit, 420 juvenile oysters between 7 and 45 mm/length (average 22.33±6.24 mm) (attached to rocks) were collected and transported in 40 L seawater reservoirs to Laboratory Water Quality and Aquaculture from the Centro Universitario de la Costa (LACUIC), they were cleaned with a wire brush and fresh water to eliminate epibionts. In each replica, the rocks were placed with 70 oysters, and the total height was recorded (they were not detached from the rock since this caused severe damage to the organism).

The bioassay lasted 45 days, from December 19, 2015, to February 4, 2016. To determine the organism's growth in both feeding regimes, the total height was recorded at the beginning and end of the bioassay.

**Feeding regimens**

The diets for each treatment consisted of Diet 1) 50% (*Tetraselmis tetrathele* B.) and 50% (*Chaetoceros muelleri* L.) (cultivated in the LACUIC).

**Microalgae cultivation**

Tow strains of microalgae, *T. tetrathele* and *C. muelleri*, were cultivated. The Northeast Biological Research Center (CIBNOR) strains acquired the strains. They were maintained in standard batch cultures in 19l jugs and cultivated with the following procedure:

The jugs were sterilized with 2% sodium hypochlorite (NaClO) at 1 ml for every 10 ml of water. Then, the NaClO was neutralized with sodium thiosulfate ($Na_2S2O_3$). Finally, to avoid contamination, the jugs were covered until inoculation.

Seawater was treated using a sand and carbon filter and then placed in 40 L containers with 2% NaClO for disinfection. It was covered, left to rest for 12 hours, and neutralized with sodium thiosulfate, ensuring its safety and cleanliness. These cultures were scaled consecutively from 500 ml flasks to 2 L glass flasks to 19 L capacity glass jugs. The seawater was enriched with an F/2 culture medium PROLINE brand. In the case of diatoms, sodium metasilicate pentahydrate was added.

The jugs with the culture were kept in a light regime of 12 hours of light and 12 hours of darkness at an intensity of 1800 lux, with constant aeration to avoid self-shading. The cultivation temperature was 20 °C, and they were harvested in the exponential phase of their growth.

Diet 2) commercial Shellfish Diet1800® microalgae concentrate (Reed Mariculture®) containing *Tisochrysis lutea* (T-ISO) B & P., *Pavlova* sp., *Tetraselmis* sp., *Thalassiosira weissflogii* F., *Chaetoceros calcitrans* & H., *T. pseudonana* H & H. and *Chaetoceros calcitrans* T.

The food ration was calculated with a sample of 3 organisms per treatment. The total height, total length, total weight, and wet weight of the tissue were recorded. In each treatment, the food ration was calculated differently. In the case of Treatment 1, live food (AL), the method proposed by FAO 2006 (Helm, 2006) was considered, which consisted of 2% of the live weight of the organism following the formula (based on a mixture of 50% *T. tetrathele* and 50% *Ch. muelleri*.

$$V = (S * 0.2) / (7 * W * C)$$

Where $V$ is the volume of microalgae (l) required for daily feeding, $S$ is the weight of the live organisms, $W$ is the weight of one million cells supplied (the weight of the cells was considered according to Helm *et al*., 2006. $C$ is the cell density of microalgae in the culture.

Treatment 2 utilized commercial microalgae paste (PCM) for seeding, following the company's recommended protocol of adding 5% of the product based on the organisms' live weight. The ratio had to be reduced to 4% due to microalgae remaining in the water after 12 hours.

The organisms were fed once a day after removing the feces and excess sedimented organic matter. The recirculation system was kept off for 12 hours to ensure the organisms were fed adequately. Aeration in ponds continued with two Elite model 802 aerators, and then the circulation system restarted. The feed portion was adjusted three times during the experiment. For adjustment, a sample of three organisms was taken from each pond, of which the total height and wet weight were recorded. With the latter, the portion was calculated using the formulas mentioned in the previous paragraphs.

The physicochemical variables of the water (temperature, salinity, dissolved oxygen, and pH) of each recirculation system were recorded once a day.

**Statistical analysis**

Data were tested for normality with a Kolgomorov-Smirnov test (Daniel, 2010). The average growth was calculated, and subsequently, an $X^2$ was performed to determine the existence of statistical differences between the treatments.

## RESULTS AND DISCUSSION

The recirculation system model used in the experiment had the appropriate physicochemical conditions for maintaining the contained biomass since the variations of the monitored physicochemical parameters remained constant, with salinity and pH being the parameters that were controlled with the addition of Sodium Bicarbonate ($NaHCO_3$) and freshwater depending on the parameter to be controlled (Table 1.); nevertheless, McCausland *et al.*, 1999, suggests that variations between experiments may be a factor that influences the composition of diets and the response to growth.

The mortality rate was 4.76%, but growth was possible. This suggests that systems (RASs) are viable for breeding and conditioning bivalve mollusks to maximize production and maintain water quality. Previous studies by Frías & Segovia (2010) and Kamermans *et al.* (2016) have used RASs for seed conditioning and growth, demonstrating their ability to maintain the conditions for experiment success.

The average growth with PCM was 24.67±6.4mm, and with AL, 24.76±6.47mm. No significant statistical differences were recorded in oyster growth between feeding regimes ($X^2$0.8862, $\alpha$=0.5, df=1) (Table 2). This is consistent with the findings of Yi *et al.*, 2023, who tested the effects on the growth of juvenile *Pinctada maxima* J., with live microalgae

**Table 1**. Average of the physicochemical parameters during the experimental period. PCM commercial microalgae paste, AL live food.

| Diet | T (°C) | O.D. (mg $L^{-1}$) | pH | S (UPS) |
|---|---|---|---|---|
| Commercial food PCM | 22.1±1.8 | 5.6±0.4 | 7.4±0.10 | 35.4±2.3 |
| Live cultivation al | 22±1.6 | 5.7±0.4 | 7.4±0.4 | 35.4±2.7 |

**Table 2**. Average growth of juvenile rock oysters in semi-recirculating systems. PCM commercial microalgae paste, AL live food.

| Organism size | Commercial food (PCM) | Live cultivation (AL) |
|---|---|---|
| Average starting size | 22.33±6.24 | 22.33±6.24 |
| Average final size | 24.67±6.40 | 24.76±6.47 |

and spray-dried algae powder and didn't find significant differences in larval growth; however, they found differences in spat growth.

Oyster growth didn't show differences between the diets administered maybe because they were a species mix. Rivero-Rodríguez *et al.*, 2007 explain that the most successful diet for *Crassostrea corteziensis* H. spat was a monospecific dietary compound just for *Chaetoceros calcitrans* P., which gave sufficient nutrients to perform spat growth.

Microalgae production offers benefits and drawbacks when feeding bivalve mollusk larvae and seeds. Due to the food's immediate availability, the nutritional value of the product provided to the organisms during their production can be determined. However, because of the high cost of production and labor requirements for this activity, scientists and production farms have been employing food supplements or substitutes such as dehydrated microalgae, microalgae concentrate (pastes), grain flours, and other by-products like whey. There is a lot of debate about whether pasta is a nutritious food. Some scientists believe that when pasta is frozen or stored for a short period, it loses its nutritional value. Studies by Enes *et al.* (2003) and Espinoza *et al.* (2006) have explored this issue.

Espinosa *et al.* (2006) found that bivalve mollusks grow better when fed live microalgae than commercial products. Commercial food undergoes degradation during freezing, storage, and transportation, leading to lower nutritional quality. This highlights the importance of considering the food source for optimal growth (McCausland *et al.*, 1999).

Experiments with concentrated foods in laboratories show varying efficiencies in shelf life and concentration methods. These concentrates effectively feed larval and seed stages of Brown bivalve mollusks (Ponis *et al.*, 2003).

Duy *et al.* (2015) found that concentrates like Shellfish Diet 1800 are essential for the growth and survival of sea cucumber larvae. However, not all species of microalgae included in the concentrate may be fully digested within 24 hours, potentially leading to incomplete consumption by the larvae. This suggests the need for further research on optimal feeding strategies.

## CONCLUSIONS

The effectiveness of pastes or microalgae for cultivation is inconclusive. Further research is needed to determine if culture systems impact growth rates.

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