The Thai Journal of Veterinary Medicine

Volume 42
Issue 1 *March, 2012*

Article 21

3-1-2012

Growth and Survival of Brown Shrimp (Farfantepenaeus aztecus) in a Closed Recirculation Seawater System at Different Salinities

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Short Communication

Growth and Survival of Brown Shrimp (*Farfantepenaeus aztecus*) in a Closed Recirculation Seawater System at Different Salinities

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Abstract

Growth and survival of juvenile brown shrimp (*Farfantepenaeus aztecus*) in a closed recirculation seawater system at two salinities (33 and 38‰) were evaluated during 4 weeks in experimental tanks. Although the specific growth rate (SGR) was slightly higher at the treatment of 38‰ than at 33‰, no significant differences were detected for the different time intervals analyzed; however, the growth in terms of both body weight and total length was significantly faster at 38‰. In this regard, the increase in weight and total length obtained at 38‰ were 0.33 g/week and 2.15 mm/week, respectively, whereas at 33‰ were 0.21 g/week and 1.34 mm/week. Survival was not significantly different between treatments; however, slightly higher shrimp survival (95.7±6.15%) was observed in the higher salinity treatment than in the lower one (89.1±3.07%). Results of this study suggest that the brown shrimp (*F. aztecus*) reared in a closed recirculation seawater system produce faster growth at 38 than at 33‰ salinities.

Keywords: *Farfantepenaeus aztecus, g*rowth, recirculation, survival

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บทคัดย่อ

การเจริญเติบโตและการรอดชีวิตของกุ้งบราวน์ (*Farfantepenaeus aztecus*) ในระบบการจ่ายน้ำหมุนเวียนแบบปิดที่ความเค็มแตกต่างกัน

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ทำการศึกษาการเจริญเติบโตและการรอดชีวิตของกุ้งบราวน์ระยะเล็ก (*Farfantepenaeus aztecus*) ในระบบการจ่ายน้ำหมุนเวียนแบบปิดที่ความเค็มร้อยละ 33 และ 38 เป็นเวลา 4 สัปดาห์ในถังทดลอง พบว่าอัตราการเจริญเติบโตเฉพาะ (SGR) ที่ความเค็มร้อยละ 38 สูงกว่าที่ร้อยละ 33 แต่ไม่พบความแตกต่างอย่างมีนัยสำคัญสำหรับช่วงเวลาที่แตกต่างกัน แต่การเจริญเติบโตในแง่ของน้ำหนักตัวและความยาวรวม เพิ่มขึ้นอย่างมีนัยสำคัญที่ร้อยละ 38 ค่าน้ำหนักและความยาวรวมเท่ากับ 0.33 กรัม/สัปดาห์ และ 2.15 มม./สัปดาห์ ตามลำดับ เมื่อเลี้ยงที่ความเค็มร้อยละ 38 ในขณะที่เมื่อเลี้ยงที่ความเค็มร้อยละ 33 มีค่าเท่ากับ 0.21 กรัม/สัปดาห์ และ 1.34 มม./สัปดาห์ อัตราการอยู่รอดไม่แตกต่างกันระหว่างกลุ่ม แต่พบว่าอัตราการอยู่รอดสูงขึ้นเล็กน้อย (95.7±6.15%) เมื่อเลี้ยงที่ความเค็มร้อยละ 38 เปรียบเทียบกับเมื่อเลี้ยงที่ความเค็มร้อยละ 33 (89.1±3.07%) ผลการศึกษานี้ชี้ให้เห็นว่ากุ้งบราวน์ (*F. aztecus*) ที่เลี้ยงในระบบน้ำทะเลหมุนเวียนแบบปิดมีการเจริญเติบโตได้เร็วขึ้นที่ความเค็มร้อยละ 38

คำสำคัญ: *Farfantepenaeus aztecus* การเจริญเติบโต การหมุนเวียน อัตราการอยู่รอด

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Introduction

The use of flow-through ponds for commercial aquaculture has been a traditional practice around the world for many decades. However, the culture of marine species in flow-through ponds depends on suitable coastal areas where high quality water is available (Huguenin and Colt, 2002). Moreover, in this activity a considerable amount of wastewater is generated which is usually discharged into estuaries and the sea. In fact, in some countries this has caused water pollution and deterioration of coastal ecosystems (Páez-Osuna et al., 1998; Biao et al., 2004; Das et al., 2004); consequently suitable areas for coastal aquaculture have become more limited. In addition, there is a greater risk of transmission of infectious diseases between farmed and wild aquatic animals from these traditional aquaculture practices (Murray and Peeler, 2005).

The recent interest in improving biosecurity in aquaculture has increased the development and utilization of closed recirculation water systems, which have been successfully used for the culture of fish and crustaceans in tanks, improving water efficiency and reducing effluent discharges (Otoshi et al., 2003; Delabbio et al., 2004). Previous studies regarding growth and survival of penaeid shrimp in closed recirculation seawater systems have been performed on species such as *Penaeus monodon* (Tseng et al., 1998) and *Litopenaeus vannamei* (Barón-Sevilla et al., 2004). Although the reproductive performance and larval rearing of *Farfantepenaeus aztecus* (brown shrimp) in a closed recirculation system have been examined (Gandy, 2004), there are few studies regarding growth and survival of *F. aztecus* in these type of systems. This is of utmost importance because *F. aztecus* is a species that could be of interest for aquaculture, in part because it is a native shrimp species of this region (Gulf of Mexico). This species supports an important fishery in the Northwestern Gulf of Mexico (Arreguín-Sánchez and Castro-Meléndez, 2000); however, its culture in shrimp farms in the Gulf Coast of Mexico is absent. Brown shrimp is abundant in coastal lagoons along the Gulf, including the Laguna Madre of Tamaulipas (Mexico) and Texas (USA), with extensive suitable habitats for shrimp where salinity is frequently close to or higher than 35‰ (Tunnel and Judd, 2002). Particularly, in Laguna Madre of Tamaulipas the mean salinity in shrimp nursery habitats is approximately 38‰ (Pérez-Castañeda et al., 2010). Therefore, the purpose of this study was to evaluate the growth performance and survival of juvenile brown shrimp (*F. aztecus*) in a closed recirculation seawater system at two salinities (33 and 38‰), similar to those encountered in its natural habitat in coastal lagoons from this region.

Materials and Methods

The experiment was performed in four 160-l circular fiberglass tanks with 120 l of well seawater. The natural seawater used in the experiment was obtained from a larvae production laboratory located on the coast of the Gulf of Mexico and transported to the closed recirculation water system situated about 200 km inland. An activated charcoal biofilter was placed in each experimental tank which was also provided with airlift filters, air stones, and a system of seawater supply of 5 ml/sec. Water was maintained at constant temperature (25^{0}C) and dissolved oxygen at 5 mg/l.

Juvenile brown shrimp (*Farfantepenaeus aztecus*) were taken from a brackish pond in Almagre lagoon (23° 48' N, 97° 48' W) and transported to the laboratory. Before the beginning of the experiment, the shrimp were acclimatized to conditions of feeding and management in laboratory for two weeks.

The experiment was performed by duplicate in two salinity groups (33 and 38‰). In this study, 38‰ was regarded as the control group because it is the mean salinity in nursery habitats of *F. aztecus* during its juvenile phase in coastal lagoons from this region. Salinity treatments were prepared by adding appropriate quantities of rock salt or dechlorinated freshwater. Changes in salinity were performed at a rate of 1 ‰/hour. Each replicated tank was stocked with 23 shrimp with an individual weight (mean±SD) of 4.25±1.6 g. The duration of the trial was 4 weeks. The shrimp were fed two times per day, at 9:00 and 14:00 hour, at a rate of 6-10% of body weight. Commercial pelleted fed (Purina) with a 35% protein level was utilized. If dead shrimp were present, they were bagged and stored frozen for future incineration. The shrimp were weighed and measured (total length) weekly. In order to compare growth performance, weekly mean weight and total length were fitted by linear regression for each treatment, analyzing differences between slopes (F test). Specific growth rate (SGR, % per day) and survival percentage for each tank were also calculated. Differences in SGR and survival between the two salinity treatments were analyzed using student's *t*-test.

Results and Discussion

At the beginning of the experiment (i.e. week 0), body weight and total length of the brown shrimp (*F. aztecus*) did not show significant differences between treatments. Mean weight (W) over time (week) was fitted by linear regression for each salinity treatment (**W=4.33+0.33 week** and **W= 4.26+0.21 week** for 38 and 33‰, respectively) showing significant differences between slopes ($F_{1,6}$= 13.08, *p* =0.01, Fig 1). Shrimp reared in high salinity (38‰) exhibited a faster growth (higher slope: 0.33 g per week) than in 33‰ (lower slope: 0.21 g per week). Indeed, when the experiment ended, shrimp reared at 38‰ reached a mean weight of 5.55 g (±0.20), while that of shrimp at 33‰ was 5.10 g (±0.47) (Fig 1). With respect to total length (TL), linear functions of the form **TL= 76.76+2.15 week** and **TL=76.94+1.34 week** were fitted for 38 and 33‰, respectively; exhibiting significant differences between slopes ($F_{1,6}$= 19.10, p<0.01, Fig 1). In this regard, growth in terms of total length also was significantly faster at 38‰ (higher slope: 2.15 mm per week) than at 33‰ (1.34 mm per week).

Specific growth rate was higher in shrimp reared at 38 than at 33‰. However, these differences were not significant (Table 1). During the first two weeks of the experiment, no mortalities were recorded in the rearing tanks; however, survival of

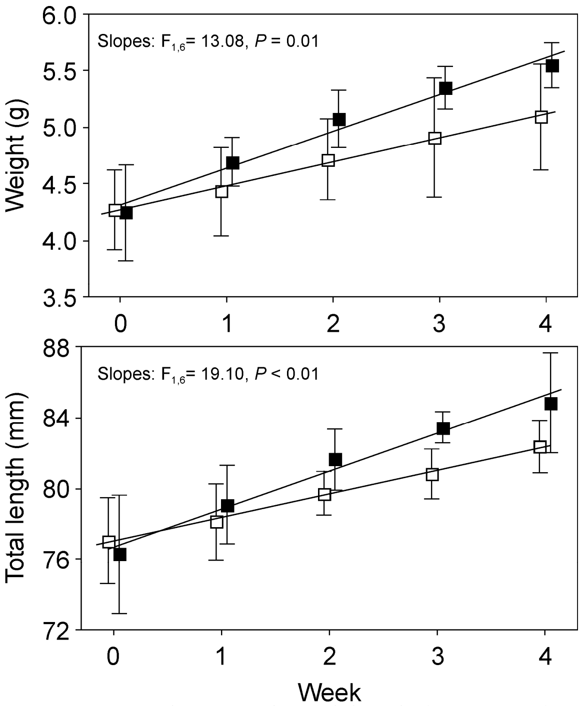

Figure 1. Growth in weight and length (mean ± SD) of juvenile *F. aztecus* maintained in a closed recirculation system at two salinities, 33‰ (□) and 38‰ (■). Linear functions of the form ***Y=a+bX*** were fitted, and significant differences between slopes were found.

Table 1 Mean (± SD) specific growth rate (SGR) of *F. aztecus* juveniles in a closed recirculation system at different salinities. No significant differences between treatments were observed at any time interval (*p*>0.05).

Weekly interval	SGR (% per day)	
	33‰	38‰
0-2	0.62 (± 0.04)	1.13 (± 0.31)
2-4	0.55 (± 0.11)	0.64 (± 0.11)
0-4	0.59 (± 0.03)	0.90 (± 0.22)

Table 2. Survival percentage (mean±SD) of *F. aztecus* reared in a closed recirculation system at different salinities. No significant differences between treatments were observed at any time (*p*>0.05).

Week	**% Survival**	
	33‰	**38‰**
0	100.0 (± 0.00)	100.0 (± 0.00)
1	100.0 (± 0.00)	100.0 (± 0.00)
2	100.0 (± 0.00)	100.0 (± 0.00)
3	97.8 (± 3.07)	95.7 (± 6.15)
4	89.1 (± 3.07)	95.7 (± 6.15)

juvenile *F. aztecus* at the end of the trial was 89.1% (±2.17) and 95.7% (±4.35) at 33 and 38‰, respectively. Although shrimp survival was slightly higher (particularly at weeks 3 and 4) at the salinity of 38‰, no significant differences were detected (Table 2).

Our results suggest that brown shrimp (*F. aztecus*) grows better at higher salinity, as indicated by the increase in body weight and total length over time, which were significantly higher at 38 than at 33‰. The mean weight per week of juvenile shrimp calculated in our study (0.21 to 0.33 g per week) was close to the values reported for laboratory-reared *F. aztecus* of a similar size, which was from 0.22 to 0.28 g per week (Zein-Eldin and Corliss, 1976).

Small juveniles of *F. aztecus* held at low salinities grew significantly better at the upper limit of salinity utilized, i.e. 8-12‰, in an experiment performed by Saoud and Davis (2003) indicating that low salinities are suboptimal for growth of *F. aztecus* juveniles. Similarly, a positive influence of salinity on growth has also been reported in *Penaeus chinensis* juveniles (Chen et al., 1996) and postlarvae of *P. semisulcatus* and *F. paulensis* (Soyel and Kumlu, 2003; Tsuzuki et al., 2003). In contrast, studies of growth in *L. vannamei* juveniles at different salinities (5 to 49‰) revealed bigger growth rates of shrimp maintained at the lowest salinities tested (Bray et al., 1994).

Higher salinities seem to improve shrimp survival, as seen in the results of this trial where shrimp maintained at 38‰ showed higher survival percentage than at 33‰; however, such differences were not significant. Indeed, a previous experimental study with *F. aztecus* indicated lower survival of postlarvae (PL-10 and PL-13) when salinity decrease from 26 to 12‰; however, survival of early juveniles (weight 0.2 g) was not significantly affected when maintained during 4 weeks at different salinities although slightly higher survival percentages (c.a. 3-5% higher) were recorded at 8 and 12‰ than at 2 and 4‰ (Saoud and Davis, 2003). A positive influence of salinity on survival of *P. semisulcatus* postlarvae was also noted which was significantly higher at 30-40‰ than below 25‰ (Soyel and Kumlu, 2003). In conclusion, growth performance of *F. aztecus*, in terms of body weight and total length over time, was significantly faster at 38 than at 33‰ without significant differences in survival.

Acknowledgements

We are grateful for support from PROMEP Mexico (grants 103.5/04/1405 and 103.5/05/3156).

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