

## Effect of High Salinity Water on Growth and Survival of Penaeid Postlarvae from the Red Sea at Different Stocking Densities

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**ABSTRACT.** A study undertaken to assess the effect of high salinity water on the growth and survival of *Penaeus monodon*, *P. indicus* and *P. semisulcatus* postlarvae in cylindrical 5000-l fibreglass tanks for 60 days under monoculture in saline water from the Red Sea. Three different stocking densities tested were 50, 100 and 200 postlarvae/m<sup>2</sup> with initial weight of 0.09 g. The highest net weight gained, survival rates and feed conversion ratio were obtained in the lowest stocking density (50 postlarvae/m<sup>2</sup>) in all three species. High salinity caused an effect on the growth, survival rates, and feed conversion ratio of the penaeid postlarvae.

### Introduction

Penaeid shrimps are one of the most important resources of the coastal fisheries in Saudi Arabia. Shrimp culture is still in its infancy stage in the Kingdom of Saudi Arabia and shrimp culture practices are not or not often documented. In recent years, developments have been made in shrimp's aquaculture all over the world. Different ranges of salinity have been reported to support the survival and better growth of *P. monodon*<sup>[1-5]</sup>. A high rate of survival and good growth of *P. monodon* in a freshwater lake has been reported from the Philippines<sup>[6]</sup>. Monoculture of *P. monodon* in rivers, irrigation channels and ground water has been successfully accomplished in Thailand<sup>[7]</sup>. However, there is little information available on monoculture of *P. monodon*, *P. indicus* and *P. semisulcatus* in higher salinities of 38 to 39‰. Hence the present study was undertaken to assess the growth and culture potential of *P. monodon*, *P. indicus* and *P. semisulcatus* in saline water under monoculture in Jeddah, Saudi Arabia.

## Materials and Methods

The culture system consisted of 18 cylindrical 5000-l fibreglass tanks. Three tanks were used for each species with two replicates for each density. The system was located outdoor in an aerial space at the Faculty of Marine Science (FMS), King Abdulaziz University, Obhor Campus. The experiment was conducted from October 26<sup>th</sup> to December 25<sup>th</sup> 1998. In this trial three stocking densities per species namely 50, 100 and 200/m<sup>2</sup> postlarvae were used. The postlarvae (PL30) have mean weights of 0.09 g. They were obtained from the Fish Farming Center (FFC) of the Ministry of Agriculture (Jeddah). Experimental duration was 60 days for each trial. Shrimp was fed with 40% protein at the rate of 30%, 25%, 20%, and 10% of the shrimp biomass every fifteen days. The diet was given four times daily. Ten percent of the shrimp stocked was sampled every two weeks for the purpose of adjusting feed requirement of the organism. Water exchange rate for the system was approximately 40% of the water volume per day. Continuous aeration was provided. Salinity, water temperature, pH and dissolved oxygen were measured daily.

## Results

The mean values of the different water quality parameters along with standard deviation are presented in Table 1. The Red Sea has relatively high salinity values. In the present investigation, postlarvae of *P. monodon* exhibited a growth rate of 0.067, 0.056 and 0.051 g/day and attained a total of 4.02, 3.36 and 3.06 grams at the end of the culture experiment (60 days) with 80, 68 and 59% survival for the stocking density of 50,100 and 200 postlarvae/m<sup>3</sup> respectively. Average feed conversion rate was 2.77 for the three densities (Table 2).

TABLE 1. Mean values with standard deviation of water quality parameters recorded during the culture operation.

Parameters	Values
Water level (m)	1.5 ± 0.08
Temperature (°C)	30.1 ± 1
pH	8.06 ± 0.5
Dissolved oxygen (mg/l)	5.57 ± 1.2
Salinity (ppt)	38.5 ± 0.5

TABLE 2. Weight gain, Feed Conversion ratio (FCR), and survival rates of the three penaeid species at three different stocking densities.

Species	Stocking density / m <sup>2</sup>	Weight gain (g/day)	FCR	Survival rate (%)
<i>P. monodon</i>	50	0.067	2.63	80
	100	0.056	2.71	68
	200	0.051	2.97	59
<i>P. indicus</i>	50	0.051	2.38	78
	100	0.044	2.60	68
	200	0.042	2.85	60
<i>P. semisulcatus</i>	50	0.052	2.47	48
	100	0.046	2.54	39
	200	0.043	2.98	37

Postlarvae of *P. indicus* got a growth rate of 0.051, 0.044 and 0.042 g/day (Tables 1+2), and attained 3.06, 2.64 and 2.52 grams at the end with a survival rate of 78, 68 and 60% for the 3 different stocking densities respectively. Average feed conversion rate was 2.61 for the three stocking densities.

Postlarvae of *P. semisulcatus* gained a growth rate of 0.052, 0.046 and 0.043 g/day and attained 3.12, 2.76 and 2.58 grams after 60 cultured days with a survival rate of 48, 39 and 37% for the different stocking densities respectively. Average feed conversion rate was 2.66 for the three densities.

## Discussion

The Red Sea has relatively high salinity values, when compared with the optimal salinity for shrimp<sup>[8]</sup>. Stocking density of 50 postlarvae/m<sup>2</sup> gave the highest average net weight gain among the cultured species. Growth rates obtained in the present experiment seem to pass the growth rates reported for *P. monodon* by<sup>[9]</sup>. Sultan *et al.*<sup>[10]</sup> obtained higher average daily increment from 0.15 to 0.194 g in nylon cages at stocking density of 6 per square meter as compared to the present study with 0.04 to 0.06 g/day. The results obtained by<sup>[11-13]</sup> was good, but the results of the present study are higher comparable to the data they obtained. Although shrimps could be grown in a wide range of salinities, it was believed that the result of low weight increment is due to the higher salinity (38 to 39‰). Raj and Raj<sup>[14]</sup> working on the same species, obtained the highest mean weight gain of 0.048 g per day at 25‰ and 0.010 g per day at 45‰ for *P. monodon*, while our findings showed a better weight increment per day of 0.067, 0.056 and 0.051 g for the 50, 100 and 200 postlarvae/m<sup>2</sup>, respectively.

The monitored salinities were at the upper tolerable limit of the shrimps and may cause stress for the shrimp. Aside from growth as a function of diet, a great proportion of energy is diverted to osmo-regulation<sup>[15]</sup>.

The growth values recorded in this present study are better than that of 0.044 g/day experienced by<sup>[16, 17]</sup> obtained lower growth increment in 25‰ of 0.029 and 0.025 mg in 50‰ for brown shrimp (*P. aztecus*). Overall results of the different treatments in this study show a higher daily growth increment than 0.039 g/day reported by<sup>[18]</sup> for *P. rnonodon* cultured in pond at stocking density of 20.000 juveniles per hectare for 80 days.

The result of the study indicates that high survival rate occurred with low stocking density. It was observed that death of *P. semisulcatus* and *P. rnonodon* was due to post molting. Ponce<sup>[19]</sup> reported that cannibalism in the intensive culture of shrimp is natural even with enough natural and supplementary feeds in grow-out ponds. This occurrence however was not observed in *P. indicus*. The obtained survival rate in this study is a little lower than the survival rate reported by<sup>[18]</sup>. But survival rates recorded for both *P. rnonodon* and *P. indicus* in the present study are better than that of 58% experienced by<sup>[20]</sup> with *P. rnonodon* at very low stocking density of 1.5 m<sup>2</sup>. However, the percentage recovery in the present study confirms the view of<sup>[21]</sup> who reported that survival rates of 60% to 80% was to be expected under suitable rearing conditions. The stocking density and the kind of environment play a vital role in the survival of the stock. It was observed that due to the very high stocking density in the present study (50 to 200 postlarvae/m<sup>2</sup>) and higher salinity (39‰), rearing in tanks, cannibalism increased during molting stages. In pond with stocking density of only 20,000 per hectare used by<sup>[18]</sup>, the shrimp has a greater possibility of hiding from predators during molting.

Feed conversion ratio (FCR) was influenced by the survival rate. The result shows that the best FCR was obtained from the highest survival rate. The FCR pattern is similar to the different treatments, for the three species. As survival rate increases, there would be more individuals that would eat the food given, and more flesh to be produced. The reflected higher values for FCR for the *P. monodon* is attributed to its bigger size that would need more food as compared to the smaller species. *P. indicus* and *P. semisulcatus*<sup>[16, 17]</sup> attained higher FCR of 1.25 for 25‰ and 1.52 for 50‰ for brown shrimp (*P. aztecus*) with feeding levels similar to ours when compared to all our results of 2.43, 2.44 and 2.98 for high salinity concentration of 38.9‰.

In all treatments, the lowest stocking density (50 larvae/m<sup>2</sup>) registered the highest survival rate. Even with high stocking density and low survival rate, results indicate that the three penaeid species showed high potential for commercial production along at the higher salinity of the Red Sea water.

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## تأثير الملوحة العالية على نمو وحياة يرقات ربيان عائلة البينيدي من البحر الأحمر في كثافات تخزينية مختلفة

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المستخلص. لقد تمت الدراسة لمعرفة تأثير الملوحة العالية لمياه البحر الأحمر على نمو ونسبة بقاء ثلاثة أنواع من يرقات ربيان عائلة البينيدي، بينيس مونودن و بينيس إنديكس وبينيس سيميسالكاتس في مرحلة ما بعد اليرقة. لقد تم تربيتها في أحواض من الفيرجلاس سعة ٥٠٠٠ لتر لمدة ٦٠ يوماً بطريقة الزراعة الموحدة في مياه عالية الملوحة من البحر الأحمر، وتم وضع ثلاثة كثافات مختلفة وهي ٥٠، ١٠٠، و ٢٠٠ يرقة في المتر المربع. وبلغت أوزان هذه اليرقات البدائية ٠,٠٩ جم. لقد أظهرت النتائج أن أعلى وزن مكتسب ونسبة بقاء وتحول غذائي كان في الكثافات التخزينية الأقل (٥٠ مابعد اليرقة/ م<sup>٢</sup>). كما أظهرت الدراسة بأن الملوحة العالية كان لها التأثير الواضح على معدلات النمو ونسبة البقاء والتحول الغذائي ليرقات الربيان (مرحلة ما بعد اليرقة).