# The Effects of Feeds and Feeding Levels on the Survival of a Prawn, *Penaeus monodon* Larvae

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## Abstract

*Penaeus monodon* larvae were grown from zoea$_1$ to mysis$_2$ stages using varying levels of single-celled *Chaetoceros* sp., baker's yeast, and a combination of the two. The effects of feeds and feeding on the survival rates of the larvae were discussed.

The highest survival rate of 76.8% was obtained when the larvae were fed on a mixture of *Chaetoceros* sp. and baker's yeast at feeding levels of $10\text{-}50 \times 10^3$ cells per ml of sea water and 1 g per ton per day, respectively. When the larvae were fed on *Chaetoceros* sp. alone, feeding level of $10\text{-}50 \times 10^3$ cells per ml of sea water seemed to give optimal survival rate. The results of the present study also suggest that baker's yeast could be applied in the mass culture of *Penaeus monodon* larvae.

## INTRODUCTION

Rearing of penaeid prawn larvae using cultures of diatoms and other planktonic organisms has been achieved successfully to some extent. In 1962, HUDINAGA and MIYAMURA[1] have concluded that the feeding density of $5\text{-}10 \times 10^4$ cells per ml of sea water of the diatom, *Skeletonema* sp., is the best for the protozoeal stage of *Penaeus japonicus* larvae. On the other hand, LIAO and HUANG[2] have reported that an optimal feeding density is $5 \times 10^4$ cells per ml of sea water for the zoeal stages of *Penaeus monodon* and *P. japonicus* using the mixed diatoms, predominantly *Skeletonema costatum* and *Nitzchia closterium*. Recently, HIRATA[3] has reported the use of a combination of soy-cake particles, baker's yeast, and *Brachionous* for the zoeal stages of *P. japonicus*, and they compared survival and growth rates with different levels of soy-cake particles, *Chaetoceros rigidus*, and a mixture of the two (HIRATA *et al.*[4]). The zoea fed soy-cake particles at the rate of 0.16 mg per zoea per day gave a survival rate of 85.9% in a zoeal period of 6 days, however growth was delayed in this group. The diatom at feeding density of $50\text{-}100 \times 10^4$ cells per ml of sea water gave high growth and the worst survival. A combination of the two gave the best result in terms of both survival and growth rates.

The authors are intending to rear the larvae of prawn, *P. monodon* under artificial control. We assumed that the knowledge on *P. japonicus* is useful, but not always adaptable for *P. monodon* living in the different environments. Therefore, the present study deals with the effects of varying feeding levels of the diatom, *Chaetoceros* sp., baker's yeast, and mixture of the two on the survival of *P. monodon* larvae.

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## MATERIALS AND METHODS

Feeding experiments were conducted in the Wet Laboratory, Aquaculture Department, Southeast Asian Fisheries Center (SEAFDEC) Philippines, using sixteen 0.5-ton round FRP (Fiberglass Reinforced Plastic) tanks. In each trial the larvae used came from one spawner. At the end of the nauplius stage ($N_6$), the larval population was divided into the sixteen tanks containing 300 liters of sea water respectively. A stocking density was ten larvae per liter of sea water. Aeration was provided using ordinary airstones. Two replicates were used in a randomized complete block design.

*Chaetoceros* sp., baker's yeast, and a mixture of the two were used as feeds from $zoea_1$ to $mysis_2$ stages. In total, five trials were conducted, however, data of the three successful trials will be reported, as the larvae were infested with *Lagenidium* and *Gregarina* during the zoeal stages causing total mortality.

The density of diatom was monitored daily with a Thoma hemacytometer and maintained at the desired level either by adjusting the volume of fresh sea water or by adding cultured diatoms. Number of larvae in each tank was estimated daily by taking four random samples of water from the tank with a 1-liter beaker. A count was made on all larvae in the four samples and the total population (by proportion) was expressed as the average number per liter of sea water.

## RESULTS AND DISCUSSION

In the previous report (VILLEGAS and ESTENOR[5]) it has been shown that the use of feeding density of $1\text{-}15 \times 10^3$ cells per of *Chaetoceros* sp. for the zoeal stages of *P. monodon* resulted in almost total mortality at the end of the zoeal period. It has been observed, however, that when the diatoms were allowed to bloom up to $50\text{-}100 \times 10^3$ cells per ml, the larvae survived up to mysis stage. In the present experiment, therefore, feeding density of *Chaetoceros* sp. was increased up to ten-fold, i.e. $10\text{-}150 \times 10^3$ cells per ml.

Statistical analyses of the data obtained from each trial showed no significant difference among the types of feeds in survival rates in Trials I and II. In Trial III (see Table 2), however, the difference in the feeds affected significantly the survival rates ($p < 0.05$). Percent survival rates of the substages of the larvae are shown in Table 1. The survival rates and comparisons among treatments using Doncan's Multiple Range Test (STEEL and TORRIE[6]) are presented in Table 2. Mixture of *Chaetoceros* sp. and baker's yeast fed at the rate of $10\text{-}50 \times 10^3$ cells per ml and 1 g/ton/day, respectively, gave the highest survival rate of 74.9% followed by 1 and 3 g/ton/day of baker's yeast with 69.4% and 58.3% of survival rates. Larvae fed with *Chaetoceros* sp. alone at the rate of $100\text{-}150 \times 10^3$ cells per ml gave the lowest survival rate of 7.2%. However, no significant difference was shown among treatments at varying levels of the same feed. For instance, survival rate at 1 g/ton/day of baker's yeast is not significantly different with feeding levels of 2 and 3 g/ton/day. Also, the same results were obtained concerning the levels of the diatom, *Chaetoceros* sp..

Mean survival rates obtained from Trials I, II, and III are summarized in Table 3.

Table 1 Survival rate at the different substages of *P. monodon* larvae (Trial III)

| Diet and dietary density | Survival rate (%) | | | | |
|---|---|---|---|---|---|
| | $Z_1$ | $Z_2$ | $Z_3$ | $M_1$ | $M_2$ |
| *Chaetoceros* sp. | | | | | |
| 10-50 × $10^3$ cells/ml | 100.0 | 100.0 | 67.7 | 44.5 | 41.7 |
| 50-100 × $10^3$ cells/ml | 100.0 | 100.0 | 33.5 | 17.3 | 13.0 |
| 100-150 × $10^3$ cells/ml | 100.0 | 95.2 | 20.6 | 13.5 | 7.2 |
| Baker's yeast | | | | | |
| 1 g/ton/day | 100.0 | 96.3 | 73.7 | 69.4 | 69.4 |
| 2 g/ton/day | 100.0 | 86.2 | 86.2 | 50.2 | 25.3 |
| 3 g/ton/day | 100.0 | 93.8 | 73.4 | 58.3 | 58.3 |
| *Chaetoceros* sp. + Baker's yeast | | | | | |
| 10-50 × $10^3$ cells/ml + 1 g/ton/day | 100.0 | 100.0 | 93.4 | 84.1 | 74.9 |
| 50-100 × $10^3$ cells/ml + 1 g/ton/day | 100.0 | 91.4 | 64.0 | 40.6 | 28.4 |

Table 2 Survival rate of *P. monodon* larvae from $zoea_1$ to $mysis_2$ stages (Trial III)

| Rank | Diet | Survival rate (%)* |
|---|---|---|
| 1 | *Chaetoceros* sp. + Baker's yeast (10-50 × $10^3$ cells/ml + 1 g/ton/day) | 74.9 |
| 2 | Baker's yeast (1 g/ton/day) | 69.4 |
| 3 | Baker's yeast (3 g/ton/day) | 58.3 |
| 4 | *Chaetoceros* sp. (10-50 × $10^3$ cells/ml) | 41.7 |
| 5 | *Chaetoceros* sp. + Baker's yeast (50-100 × $10^3$ cells/ml + 1 g/ton/day) | 28.4 |
| 6 | Baker's yeast (2 g/ton/day) | 25.3 |
| 7 | *Chaetoceros* sp. (50-100 × $10^3$ cells/ml) | 13.0 |
| 8 | *Chaetoceros* sp. (100-150 × $10^3$ cells/ml) | 7.2 |

* Any two means not underscored by the same line are significantly different. Any two means underscored by the same line are not significantly different.

The highest survival of 76.8% was obtained when the larvae were fed with a mixture of *Chaetoceros* sp. and baker's yeast at feeding levels of 10-50 × $10^3$ cells per ml and 1 g/ton/day, respectively. This dietary combination consistently produced high survival rates. Increasing the density of *Chaetoceros* sp. to 50-100 × $10^3$ cells per ml at the same supplementary feeding of 1 g/ton/day of baker's yeast resulted in a low survival rate of 57.4%.

*P. monodon* larvae on *Chaetoceros* sp. on baker's yeast alone resulted in low mean survival rates compared with their mixture. For diatom feeding the highest survival rate was obtained at feeding density of 10-50 × $10^3$ cells per ml with an average survival rate of 53.4%. Increasing the feeding levels up to 100-150 × $10^3$ cells per ml resulted

Table 3 Mean survival rate of *P. monodon* larvae in Trials I, II and III

| Rank | Diet | Mean survival rate (%) |
|---|---|---|
| 1 | *Chaetoceros* sp. + Baker's yeast ($10\text{-}50 \times 10^3$ cells/ml + 1 g/ton/day) | 76.8 |
| 2 | *Chaetoceros* sp. + Baker's yeast ($50\text{-}100 \times 10^3$ cells/ml + 1 g/ton/day) | 57.4 |
| 3 | *Chaetoceros* sp. ($10\text{-}50 \times 10^3$ cells/ml) | 53.4 |
| 4 | Baker's yeast (2 g/ton/day) | 41.8 |
| 5 | Baker's yeast (3 g/ton/day) | 41.7 |
| 6 | *Chaetoceros* sp. ($100\text{-}150 \times 10^3$ cells/ml) | 34.3 |
| 7 | Baker's yeast (1 g/ton/day) | 28.4 |
| 8 | *Chaetoceros* sp. ($50\text{-}100 \times 10^3$ cells/ml) | 16.8 |

in low survival rate of 34.3%. A feeding rate of $10\text{-}50 \times 10^3$ cells per ml of *Chaetoceros* sp. for the zoeal stages of *P. monodon* seemed to give optimal survival rate.

Survival rate on baker's yeast alone ranged from 28.4 to 41.8%. Higher mean survival rates were obtained when the larvae were fed on larger amounts of baker's yeast, while low mean survival rates were observed when small amounts were given (Table 3). The lowest survival rate was found in the larvae that received the minimum amount of baker's yeast (1 g/ton/day). Treatments with the maximum level of baker's yeast (3 g/ton/day) did not give the best survival rate although there was no great difference from feeding level of 2 g/ton/day. It was observed that growth was the slowest in this group with a delay of one day to reach the mysis stage as compared with those fed with *Chaetoceros* sp. alone and combination of diatom and baker's yeast.

HIRATA *et al.*[4] have reported that in *P. japonicus*, the feeding of soy-cake particles at the rate of 0.16 mg per zoea per day gave a survival rate of 85.9% at 6th day of zoeal period of *P. japonicus*. In their subsequent experiment the effect of soy-cake particles was compared with those of diatoms and a mixture of diatom and soy-cake. Zoea fed with soy-cake particles alone had the best survival but the lowest growth rate. Diatoms alone gave the best growth but the lowest survival rate. A mixture of the two produced the best result in terms of both survival and growth rates.

Results obtained in the present study were consistent with their findings. Based on the results of this experiment, a mixture of diatom and baker's yeast or other suitable planktonic organisms might provide an efficient diet for the mass culture of penaeid prawn larvae.

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