Studies on the Optimum Dietary Protein Requirement of Three Size Groups of Fresh Water Prawn *Macrobrachium idae* (Heller)

C. Sundaravadivel, T.A.Sethuramalingam* and K.Juliet*

*Associate Professor, Department of Zoology, Aditanar College, Tiruchendur – 628 216, Tamil Nadu, India.  
*Centre for Aqua Feed and Nutrition (CAFeN)  
Department of Zoology St. Xavier’s College. (Autonomous), Palayamkottai 627 002, Tamil Nadu, India.

**Abstract:** The Protein requirement for three different size groups of *Macrobrachium idae* viz. small, medium and large were studied. The feeding experiment was conducted for 41 days and the prawns were fed with 12 types of formulated diets containing various protein levels i.e., 21,23,25,27,29,31,35,37,39,41 and 43 % using the fish meal as major protein ingredients. The small size prawn (327.22±60 mg) reared in 40.46% dietary protein showed the best growth, while in medium size (1266.67±98 mg) at 38.27% dietary protein level and large size prawn (2968.52±13 mg) showed the best growth at 36.43% dietary protein level. Quadratic regression analysis also revealed the same protein level as their protein requirement. The specific growth rate (SGR) in all the protein level tested increased as the protein level increased in the formulated diets. Eventually, the SGR increased while the food conversion ratio (FCR) decreased and vice versa. The protein intake (PI) of the prawn showed a positive correlation with increased protein level where as the protein efficiency ratio (PER) showed variegated results. But the higher protein intake of the prawns and PER were greatly influenced by dietary protein levels.

**Keywords:** Dietary protein level, Protein requirement, size groups of *Macrobrachium idae*.

I. **Introduction**

The success of any aquaculture system depends on good quality seeds and nutritionally balanced feed which offer superior growth within a stipulated period (Ahmed Ali, 1998). The route to the economic farming of freshwater prawns lies in determining the precise nutritional requirements at all stages of development (Sethuramalingam and James Gideon, 2003) and also with the development of inexpensive artificial diet from readily available feedstuffs (Saravana Bhavan et al., 2011).

Protein is the principal nutrients in the diet of shell fishes (Ashokkumar et al., 2011) and to facilitate maximum growth and reproduction animals require an optimal level of protein in their diet (Guillaume, 1997). Nutrient requirement vary from species to species and also among different stages of development in the same species (Idulkar and Belsare, 2001). As far as freshwater prawn species is concerned the protein requirements dependent on the animal size and species (Koshio et al., 1990). It is generally believed that post larvae require a higher dietary protein level than older ones (Goddard, 1996), and in intensive nursery systems they are fed diets with high levels of protein (40-55%) (Treece and Fox, 1993). Apart from these works, relatively a few studies have been conducted towards the development of high quality diets in shell fishes (Tidwell et al., 1993) which indicate their protein requirements.

Macrobrachium species are special omnivores and most of the growth studies are done in mostly *Macrobrachium rosenbergii* only (Ramachandra Naik and Shivanandamoorthy, 2000). The availability of *Macrobrachium iade* are more in southern part of Tamilnadu especially in and around Authoro, Thoothukodi District (8° 40’ N 78° 03’ E in latitude / longitude) which farm staple food in this area. Though the size of prawns are smaller than *M. rosenbergii* the prawns shows high quality flesh. To promote the culture of *M. iade*, and disseminate the knowledge of growing this prawn needs quite a lot of information regarding the nutritional status. As nutritional studies on the prawns are scanty and more works in this aspect is needed. So, the present study was undertaken to assess the dietary protein requirement for three available size groups of *Macrobrachium iade*.

II. **Materials And Methods**

*Macrobrachium iade* were obtained from the Thamiraparani river Authoro (8° 40’ N 78° 03’ E in latitude / longitude), Thoothukudi district, Tamil Nadu and were transported to the Centre for Aqua Feed and Nutrition (CAFeN) laboratory, St.Xavier’s College, Palayamkottai and acclimatized in large cement tanks(4000 lit. capacity) for a period of 10 days. Individuals of three different sizes viz. small (231±53 to 316±11), medium (1186±64 to 1540±72), and large (1905±129 to 2990±132) mg. prawns were recruited from the stock and three prawns of same size were placed in each 36 round plastic troughs (capacity 20 lit.) and stocked. During acclimatization as well as experimental periods water temperature (28°C ± 1°C), Alkalinity (16-21 mg/lit.),
Studies on the Optimum Dietary Protein Requirement of Three size groups of Fresh water Penaeus japonicus

Salinity (0.5 to 0.7%), pH (7.2-7.5), Dissolved Oxygen (6.4-7.5 mg/lit) and Carbon dioxide (1.3 ± 0.3 mg/lit) were maintained constantly.

Twelve types of pelleted diet were formulated using fishmeal as the protein source and the rest of the ingredients as given in Table: 1 and to get graded levels of increase in dietary protein level (22 to 44%). Individuals of three different sizes viz. small (231±53 mg to 316±11 mg), medium (1186±64 mg to 1540±72 mg) and large (1905±12 mg to 2990±13 mg) prawns were recruited from the stock and three prawns of same size were placed in each of 36 round plastic troughs (capacity 20 lit.) and stocked. Each group was fed with 5% body weight of feed twice a day (9.00 am and 4.00 pm). Unfed (if any) and faeces were collected daily by manual siphoning and dried in a oven at 55°C for 24 hours and stored. The duration of the experimental period last for 41days. The water in the experimental trough was changed once in three days in the morning before first feeding of the prawns. Close observation was made for moulting after which the exuviae were removed, weighed and stored. At the end of the feeding trial, the prawns were sacrificed and the live and dry weights were recorded (Maynard and Loosli, 1969).

Carbohydrate (Hodge and Hofriter, 1962), protein (Lowry et al., 1951), lipid (Folch et al., 1957) were estimated for ingredients, feed and for prawns. The ash content was determined by incenerating a known dry sample in a muffle furnace at 560°C for 8 hours (Paine, 1964). Energy content was calculated based on the standard physiological values i.e. 4.5 Kcal/g of protein, 3.3 Kcal/g of carbohydrate and 8 Kcal/g of fat (Brett and Groves, 1979).

The results were analysed statistically using one way ANOVA (Zar, 1984) Data were subjected to student ‘t’ test, correlation, and regression analysis wherever applicable.

The growth performance of the prawns were calculated by using the following formulae (Jauncey, 1982).

\[
\text{Growth rate (GR) =} \frac{\text{Initial wet weight of prawn (mg) x duration (days)}}{\text{Wet weight gain (mg)}}
\]

\[
\text{Feed conversion ratio (FCR) =} \frac{\text{Dry food consumed (mg)}}{\text{Protein consumed (mg)}}
\]

\[
\text{Specific growth rate (SGR) =} \frac{\ln I_2 - \ln I_1}{\text{Experimental duration (days)}} \times 100
\]

\[
\text{Where,}
\]

\[
\ln - \text{natural log}
\]

\[
I_2 - \text{Final live weight (mg)}
\]

\[
I_1 - \text{Initial live weight (mg)}
\]

\[
\text{Protein intake (PI) (mg/day) =} \frac{\text{Protein consumed (mg)}}{\text{Food consumed (mg)}} \times 100
\]

\[
\text{Protein efficiency ratio (PER) =} \frac{\text{Growth (mg)}}{\text{Protein consumed (mg)}} \times 100
\]

III. Result and Discussion

The percentage composition of the ingredients used in the formulated diets and proximate composition are given in the table 1. The growth performance of M.idae (small size, medium size and large size) fed with varying protein levels in feed was reported in table 2a, 2b and 2c respectively. In small size groups the highest growth was found in prawn fed with diet 10 (485.42 mg) where as the lowest value was noticed in feed 1 (79.00 mg). In medium size groups the maximum growth was noticed in feed 10 (2139.26 mg) followed by feed 9 (2095.71 mg). In large size groups the growth was high in prawn fed with diet 8 (5110.47 mg) followed by diet 10 (3580.47 mg). As per the present study, the dietary protein in the respective diets for each group of prawn indicated that 40.46% (small), 38.27% (medium) and 36.43% (larger) respectively. Generally in freshwater prawns, it was reported that the protein requirement of prawn decrease with increasing size and age (New, 1998). Sahadevan (1992) have made simular observation in P japonicus and M.rosenbergii. This result was comparable to the decrease in growth of larger individuals of M.lancheseri and Caridina weberi observed by Ponuchamy et al., (1984). While Saravana Bhavan et al., (2011) reported that growth of prawn is normally very fast during the early stage and slows down during adult. The quadratic growth pattern noted for prawn species where growth rate either increased or decreased with increasing levels of dietary protein was reported for Penaeus japonicus (Koshio et al.,1993) and Macrobrachium species (Gomeze-Diaz et al.,1998).

Food conversion ratio (FCR) showed a variation among the three different size of M.idae fed with formulated diets viz., small size groups fed diet 10 exhibited the low FCR (2.68), where as in medium size groups showed the lowest (1.96). The large size groups showed FCR of 2.14 when fed with diet 8. From this study it could be presumed that irrespective of the size groups, the protein level in feed was found to influence the prawn significantly i.e., as the protein level in the feed increased the FCR level decreased to a certain point and then increased. The protein levels of each size groups of prawns which showed the lowest FCR were as...
follows i.e., small – 40.46%, medium – 38.27% and larger ones 36.43% respectively. This protein level was comparable to the reports of Frechienicht, (1988) who noticed a better growth of post-larvae of *M. rosenbergii* at (30.3%) and (51.2%) protein level with FCR of 1.86 and 2.18 in the diet. Law et al., (1992) reported maximum growth in post larvae of *M. rosenbergii* when fed with (40%) protein diet as against (24%, 30% and 50%) protein levels which had FCR of 2.48, 1.81 and 1.89 respectively. While Jeyalakshmi and Natarajan (1994) reported a feed conversion ratio of 2.8 to 4.1 for *Macrobrachium idella* fed with diet containing varied protein levels (30–45%).

Table 2. Proximate composition and energy value of selected ingredients used in the formulated feed.

All the values are given in percentage dry weight except the energy value.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Ingredients</th>
<th>Protein (%)</th>
<th>Carbohydrate (%)</th>
<th>Lipid (%)</th>
<th>Ash (%)</th>
<th>Energy value (j/mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fish meal (FM)</td>
<td>51.50</td>
<td>1.40</td>
<td>15.70</td>
<td>26.30</td>
<td>21.27</td>
</tr>
<tr>
<td>2</td>
<td>Groundnut</td>
<td>48.90</td>
<td>6.70</td>
<td>10.70</td>
<td>11.50</td>
<td>17.81</td>
</tr>
<tr>
<td>3</td>
<td>Rice bran (RB)</td>
<td>15.70</td>
<td>20.40</td>
<td>13.40</td>
<td>12.50</td>
<td>15.36</td>
</tr>
<tr>
<td>4</td>
<td>Corn flour (CF)</td>
<td>08.47</td>
<td>67.00</td>
<td>4.59</td>
<td>6.27</td>
<td>14.38</td>
</tr>
<tr>
<td>5</td>
<td>Soyabean meal (SBM)</td>
<td>49.56</td>
<td>8.85</td>
<td>1.37</td>
<td>8.90</td>
<td>11.62</td>
</tr>
<tr>
<td>6</td>
<td>Tapioca flour (TF)</td>
<td>14.90</td>
<td>43.70</td>
<td>0.10</td>
<td>8.90</td>
<td>11.62</td>
</tr>
</tbody>
</table>

Table 1–Percentage composition of ingredients and proximate analysis of formulated feed.

<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Protein (%)</th>
<th>Carbohydrate (%)</th>
<th>Lipid (%)</th>
<th>Ash (%)</th>
<th>Energy value (j/mg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish meal (FM)</td>
<td>51.50</td>
<td>1.40</td>
<td>15.70</td>
<td>26.30</td>
<td>21.27</td>
</tr>
<tr>
<td>Groundnut</td>
<td>48.90</td>
<td>6.70</td>
<td>10.70</td>
<td>11.50</td>
<td>17.81</td>
</tr>
<tr>
<td>Rice bran (RB)</td>
<td>15.70</td>
<td>20.40</td>
<td>13.40</td>
<td>12.50</td>
<td>15.36</td>
</tr>
<tr>
<td>Corn flour (CF)</td>
<td>08.47</td>
<td>67.00</td>
<td>4.59</td>
<td>6.27</td>
<td>14.38</td>
</tr>
<tr>
<td>Soyabean meal (SBM)</td>
<td>49.56</td>
<td>8.85</td>
<td>1.37</td>
<td>8.90</td>
<td>11.62</td>
</tr>
<tr>
<td>Tapioca flour (TF)</td>
<td>14.90</td>
<td>43.70</td>
<td>0.10</td>
<td>8.90</td>
<td>11.62</td>
</tr>
</tbody>
</table>

Table 3 a : Growth performance of small size *Macrobrachium idae* fed with varying protein levels in feed.

Values of same superscripts in each column did not differ significantly (P < 0.05)

Table 3 b : Growth performance of medium size *Macrobrachium idae* fed with varying protein levels in feed.

Values of same superscripts in each column did not differ significantly (P < 0.05)
Studies on the Optimum Dietary Protein Requirement of Three size groups of Fresh water...

Table 3c: Growth performance of large size *Macrobrachium idae* fed with varying protein levels in feed.

<table>
<thead>
<tr>
<th>Protein Level</th>
<th>Initial Weight (g)</th>
<th>Final Weight (g)</th>
<th>Growth Rate (g/day)</th>
<th>Specific Growth Rate (SGR)</th>
<th>Food Conversion</th>
<th>Protein Intake</th>
<th>Protein Efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed 1</td>
<td>102.3</td>
<td>144.0</td>
<td>11.64</td>
<td>1.91</td>
<td>4.05</td>
<td>0.93</td>
<td>0.73</td>
</tr>
<tr>
<td>Feed 2</td>
<td>102.3</td>
<td>144.0</td>
<td>11.64</td>
<td>1.91</td>
<td>4.05</td>
<td>0.93</td>
<td>0.73</td>
</tr>
<tr>
<td>Feed 3</td>
<td>102.3</td>
<td>144.0</td>
<td>11.64</td>
<td>1.91</td>
<td>4.05</td>
<td>0.93</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Fig. 1. Quadratic regression analysis of small size group of *M. idae* for three different dietary protein levels

Contrary to the report of FCR, the specific growth rate (SGR) showed a reverse trend i.e., the increase of SGR with increase in dietary protein up to a particular point and decrease thereafter shows an inverse trend with FCR. In small size groups a maximum specific growth rate was noticed in feed 10 (1.89), medium size
groups was higher in feed 9 (2.38), where as in large size groups the highest specific growth rate was observed in feed 8 (2.710). Among the feed tested, the SGR was significant (P<0.05) at 40.46% dietary protein level for small size, 38.27% in medium size and 36.43% for large size prawns. The quadratic regression analysis (Fig.1) of the three size groups of *M. idae* also confirms the same levels for three size groups. This result explicitly proves that the dietary requirement gradually decreased as the size of the prawn increased. This report coincides with the report of Seema Langer et al., (2004) in *Macrobrachium dayanum* that (SGR) increased with increase in dietary protein from 25-45% and the FCR decreased accordingly.

The protein efficiency ratio (PER) for three different size groups ranged from 1.41 to 4.66) in smaller size, (0.14 to 1.06) in medium size and (0.58 to 3.77) in large size and protein intake (PI) in smaller size groups 16.74 to 28.61 (mg/day), in medium size groups 30.05 to 60.19 (mg/day) and in large size groups 27.74 to 57.41 (mg/day). PER showed a varied effect as the protein level increased. Initially upto 30.06% the PER decreased from 3.77 to 0.58 and then showed a decreased trend as the protein level increased. Elevated PI was observed upto 30.06% protein diet and after which the value showed no significant change. PI increased with increase of dietary protein level. Similar observations were made by James et al., (1992) and reported that PER decreases with the increasing dietary protein levels. Dabrowski (1979) reported different patterns of changes in PER in relation to dietary protein levels and found that the relationship between dietary protein and PER differs from species to species. Jauncey (1982) also reported FCR and PER decreasing with increasing dietary protein content. Felix and Prince Jayaseelan (2006) reported that PER was high in low protein diet (15%) and as the dietary protein levels increased, decline the PER values were observed. They also reported that 40% protein diet to achieve better growth performance in *Macrobrachium rosenbergii* in nursery phase expecting high PER. The 15% protein diet in the present study did not show good growth performance the intake of food showed narrow variation with respect to different protein levels (15–45%). This result was comparable with the optimum level of dietary protein determined to be within the range of 52-57% for *P. japonicus* (Deshimaru and Yone, 1978) and later revised not to exceed 42% (Koshibo et al., 1993), 40-44% for *P.monodon* (Shiau et al.,1991), and 36% or higher for *P. vannamei* (Smith et al.,1985) and later revised to 30% (Cousin et al.,1993) and 15% (Aranyakananda,1993). Sethuramalingam and James Gideon (2003) reported that 40-41% dietary protein was good enough to sustain optimal growth of *Macrobrachium idae* juveniles.

In the present study a best growth was obtained in smaller size (40.46%), in medium size also (38.27%), whereas large size showed a maximum growth in (36.43%) of protein which conforms their protein requirement at these stages of prawns.

References

Studies on the Optimum Dietary Protein Requirement of Three size groups of Fresh water...


