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

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Abstract: *The Protein requirement for three different size groups of Macrobrachiun 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 Macrobrachiun 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 feedstuff (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 idae* are more in southern part of Tamilnadu especially in and around Authoor, Thoothukodi Disrict (8º 40´ N 78º 03´ E in latitude / longitude) which farm stiple 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 .idae,* 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 idae.*

II. Materials And Methods

Macrobrachium idae were obtained from the Thamiraparani river Authoor (8º 40´ N 78º 03´ E in latitude / longitude), Thoothukudi district, Tamil Nadu and were transported to the Centre for Aquafeed 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 (28ºC ± 1ºC), Alkalinity (16-21 mg/lit.),

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 55ºC 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 560ºC 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) .

$$\text{Growth rate (GR)} = \frac{\text{growth (mg)}}{\text{Initial wet weight of prawn (mg) x duration (days)}}$$

$$\text{Feed conversion ratio (FCR)} = \frac{\text{Dry food consumed (mg)}}{\text{Wet weight gain (mg)}}$$

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

Where,

In - natural log

I_2 - Final live weight (mg)

I_1 - 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 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 smillar 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 1nd 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.

S.No.	Ingredients	Protein (%)	Carbohydrate (%)	Lipid (%)	Ash (%)	Energy value (j/mg)
1	Fish meal (FM)	51.50	1.40	15.70	26.30	21.27
2	Groundnut Oil cake (GOC)	48.90	6.70	10.70	11.50	17.81
3	Rice bran (RB)	15.70	20.40	13.40	12.50	15.36
4	Corn flour (CF)	08.47	67.00	4.59	6.27	14.38
5	Soyabean meal (SBM)	49.56	8.85	1.37	18.64	18.46
6	Tapioca flour (TF)	14.90	43.70	0.10	8.90	11.62

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

Ingredients	Feed Types											
	1	2	3	4	5	6	7	8	9	10	11	12
Fish Meal (FM)	17	19	20	22	26	28	30	32	34	44	46	48
Groundnut oil Cake (GOC)	23	25	28	20	21	22	20	18	16	16	14	12
Rice bran (RB)	28	24	20	22	17	14	16	14	12	8	8	8
CornFlour (CF)	8	8	8	10	10	10	10	10	12	8	8	8
Soyabean flour (SBM)	14	14	14	16	16	16	14	16	16	14	14	14
Tapiocaflour(TF)	8	8	8	8	8	8	8	8	8	8	8	8
Vitamin / Mineral Mix*	2	2	2	2	2	2	2	2	2	2	2	2
Protein (%)	22.12	24.31	26.08	28.47	30.06	32.33	34.13	36.43	38.27	40.46	42.91	44.81
Carbohydrate(%)	21.30	23.10	19.30	18.70	16.30	15.20	13.10	14.80	15.60	13.70	11.90	9.70
Lipid (%)	4.90	4.80	4.70	5.10	4.80	4.90	5.70	5.60	5.70	5.70	5.80	5.80
Energy (K.cals/g)	2.45	2.68	2.74	2.88	2.91	3.38	3.41	3.72	3.83	3.89	3.94	3.99
Ash (%)	7.61	7.83	7.96	8.30	8.74	8.81	8.93	8.98	9.41	10.62	10.62	10.79

*Supradyn Tablets – Nicholas Pharma, Pithampur, Mathya Pradesh, India.

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

Initial weight (mg)	Final Weight(mg)	Growth(mg)	Growth Rate (mg)/day (GR)	Specific Growth Rate (SGR)	Food Conversion Ratio (FCR)	Protein Intake (PI)	Protein Efficiency Ratio (PER)
233.71±62	312.71±34	79.00±24	1.92±0.13	$0.70±0.09^{c}$	$3.72±0.17^{c}$	$16.74±0.70^{a}$	$0.62±0.10^{c}$
239.68±71	338.38±30	98.70±30	2.40±0.24	$0.84±0.02^{c}$	$3.73±0.06^{c}$	$17.32±0.52^{a}$	$0.69±0.66^{d}$
316.11±11	492.53±52	176.42±21	4.30±0.13	$1.07±0.05^{c}$	$3.20±0.10^{b}$	$17.89±0.44^{a}$	$0.87±0.18^{d}$
231.82±53	372.38±33	140.56±24	3.42±0.32	$1.16±0.01^{c}$	$3.40±0.82^{b}$	$18.12±0.48^{a}$	$0.87±0.38^{c}$
242.37±44	448.37±36	206.00±15	5.02±0.17	$1.50±0.07^{b}$	$3.17±0.78^{bc}$	$19.48±0.78^{a}$	$1.15±0.78^{b}$
253.16±63	501.34±24	248.18±18	6.05±0.08	$1.66±0.03^{b}$	$3.25±0.62^{b}$	$21.09±0.28^{b}$	$1.12±0.68^{b}$
286.84±72	556.21±58	269.37±24	6.57±0.37	$1.62±0.04^{b}$	$3.31±0.17^{a}$	$22.46±0.38^{b}$	$1.24±0.52^{a}$
237.43±56	486.65±32	249.22±18	6.07±0.25	$1.75±0.07^{ab}$	$3.42±0.32^{ab}$	$26.77±0.48^{b}$	$1.18±0.34^{b}$
276.43±41	578.08±23	301.65±18	7.35±0.15	$1.80±0.12^{a}$	$3.39±0.65^{ab}$	$26.77±0.67^{b}$	$1.16±0.38^{b}$
327.22±60	762.64±34	485.42±16	9.40±0.10	$1.89±0.09^{a}$	$2.68±0.72^{a}$	$24.73±0.76^{b}$	$1.34±0.51^{b}$
289.11±75	592.76±42	303.65±19	7.40±0.27	$1.74±0.08^{b}$	$3.22±0.17^{b}$	$28.43±0.81^{bc}$	$1.00±0.47^{a}$
271.48±58	545.48±41	274.21±19	6.68±0.30	$1.70±0.06^{ab}$	$3.25±0.26^{ab}$	$28.61±0.35^{bc}$	$0.92±0.72^{a}$

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.

Initial weight (mg)	Final Weight (mg)	Growth (mg)	Growth Rate/day (mg)(GR)	Specific Growth Rate (SGR)	Food Conversion Ratio (FCR)	Protein Intake (PI)	Protein Efficiency Ratio (PER)
1335.32±11	1842.73±73	507.41±16	12.37±0.35	$0.78±0.08^{d}$	$4.03±0.19^{d}$	$30.05±0.67^{a}$	$0.66±0.23^{d}$
1326.36±10	1895.27±66	569.41±23	13.87±0.27	$0.87±0.12^{d}$	$3.43±0.15^{c}$	$33.60±0.60^{a}$	$0.86±0.26^{c}$
1268.64±69	1980.71±10	712.44±19	17.36±0.45	$1.08±0.09^{c}$	$2.65±0.42^{b}$	$32.25±0.40^{a}$	$1.06±0.27^{b}$
1540.49±72	2698.22±49	1157.73±53	28.23±0.42	$1.36±0.15^{c}$	$3.23±0.57^{c}$	36.90±0.71a	$0.51±0.21^{d}$
1466.62±11	2824.34±34	1357.60±17	33.11±0.38	$1.59±0.17^{b}$	$3.50±0.35^{c}$	$36.30±0.82^{a}$	$0.78±0.20^{c}$
1290.86±10	2702.11±64	1411.25±19	34.42±0.21	$1.80±0.07^{d}$	$2.46±0.67^{b}$	$42.89±0.85^{a}$	$0.94±0.21^{a}$
1186.44±64	2533.23±64	1347.23±42	32.85±0.13	$1.85±0.16^{d}$	$2.60±0.66^{b}$	$49.71±0.71^{b}$	$0.61±0.22^{d}$
1215.52±82	2923.26±49	1707.74±53	41.65±0.23	$2.10±0.22^{ab}$	$2.04±0.76^{a}$	$53.73±0.70^{b}$	$0.91±0.23^{a}$
1266.67±98	3362.38±33	2095.71±26	51.11±0.47	$2.38±0.30^{a}$	$1.96±0.90^{a}$	$39.49±0.65^{b}$	$0.90±0.29^{a}$
1309.91±94	3448.26±10	2139.26±58	52.17±0.52	$2.36±0.28^{a}$	$2.11±0.21^{a}$	$51.01±0.47^{b}$	$0.92±0.24^{a}$
1246.87±11	2662.33±67	1415.46±83	34.52±0.17	$1.85±0.13^{b}$	$2.57±0.32^{b}$	$55.39±0.30^{b}$	$0.14±0.26^{d}$
1408.82±86	2972.42±82	1563.60±77	38.13±0.19	$1.82±0.27^{b}$	$2.49±0.40^{b}$	$60.19±0.35^{b}$	$0.66±0.25^{d}$

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

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

Initial weight (mg)	Final Weight (mg)	Growth(mg)	Growth Rate (mg)/day (GR)	Specific Growth Rate (SGR)	Food Conversion Ratio (FCR)	Protein Intake (PI)	Protein Efficiency Ratio (PER)
2900.32±13	4345.26±11	1444.94±94	19.81±0.35	0.98±0.08^{c}	3.05±0.19b^{c}	41.71±0.67^{b}	3.77±0.23^{b}
2565.24±12	4632.17±10	206746±63	50.41±0.27	1.43±0.12^{c}	3.87±0.15^{c}	37.52±0.60^{a}	1.45±0.26^{a}
2232.62±11	3862.62±10	163023±23	39.75±0.45	1.36±0.09^{c}	2.86±0.42b	40.70±0.40^{b}	1.06±0.27^{a}
2335.39±11	4117.44±110	1882.41±52	45.90±0.42	1.42±0.15b^{c}	2.60±0.57^{b}	29.74±0.71^{a}	0.78±0.21^{c}
2103.21±12	4503.38±11	2400.64±63	60.97±0.38	1.86±0.17^{b}	2.80±0.35^{b}	31.89±0.82^{a}	0.58±0.20^{d}
2968.52±13	6880.81±11	3912.81±82	95.41±0.21	2.10±0.07^{b}	3.00±0.67^{bc}	30.69±0.85^{a}	1.50±0.21^{b}
2328.67±13	5901.42±96	3573.27±98	87.15±0.13	2.26±0.16^{ab}	2.42±0.66^{a}	46.88±0.71^{b}	1.10±0.22^{a}
2402.91±11	7984.57±10	5110.47±83	124.63±0.23	2.71±0.22^{a}	2.14±0.76^{a}	49.25±0.70^{b}	2.04±0.23^{b}
2015.34±10	5497.36±86	3482.52±56	84.93±0.47	2.42±0.30^{a}	2.36±0.90^{c}	52.70±0.65^{c}	1.24±0.29^{a}
1905.44±12	5002.29±92	3097.71±72	75.54±0.52	2.40±0.28a	2.10±0.21^{a}	54.98±0.47^{c}	1.16±0.24^{a}
2324.12±11	5964.47±11	3540.29±68	86.34±0.17	2.29±0.13ab	3.98±0.32^{ab}	52.48±0.30^{c}	2.09±0.26^{b}
2246.61±12	5826.86±11	3580.47±59	87.32±0.19	2.33±0.27ab	2.19±0.40^{a}	57.41±0.35^{c}	1.26±0.25^{a}

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

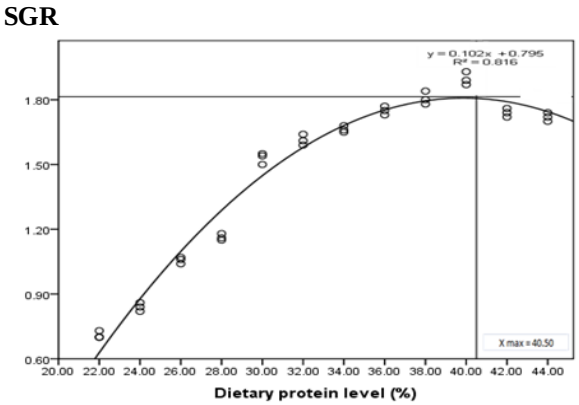

Fig. 1. Quadratic regression analysis of small size group of *M. idae* for three different dietary protein levels

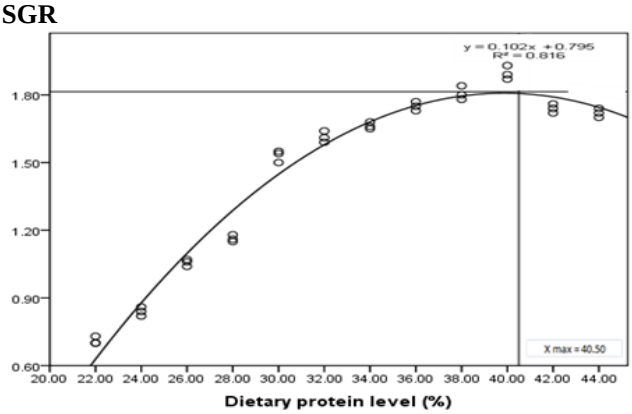

Fig. 2. Quadratic regression analysis of medium size group of *M. idae* for three different dietary protein levels

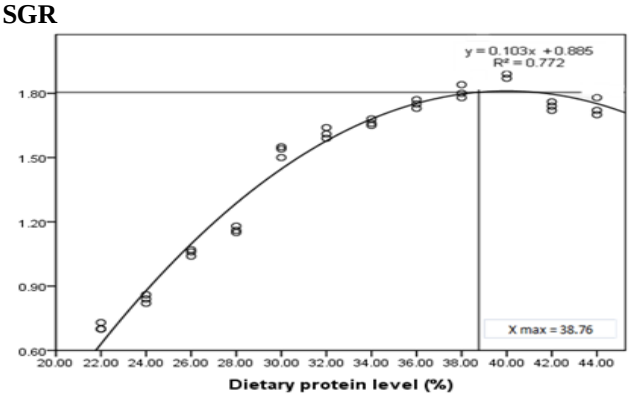

Fig. 3. Quadratic regression analysis of large size group of *M. idae* for three different dietary protein levels

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 upto 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 groups16.74 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 feed 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 *Macrbrachium 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% (Koshio *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 *Macrburachim 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

[1]. Ahmed Ali,S.1998**.** Farm-made feed in Aquaculture. The technologies to reckon with in rural development. pp. 452-460. In : M.S.Hameed and B.M.Kurup (Eds.). *Technological Advancement in Fisheries*. Publn. No.1. School. Indl. Fish. Cochin Univ. of Science and Technology, Cochin.

[2]. Aranyakananda,P.1993. Dietary protein and energy requirements of *Penaeus vannamei* and the optimal protein to energy ratio. Ph.D . Dissertation, Taxas A & M universlty, College station, Texas, U.S.A.

[3]. Ashokkumar,S.,Mayavu,P.,Ramesh,S., and Sugesh,S. 2011.Effect of different protein levels on the juveniles prawn with special reference to *Penaeus indicus*. *World Journal of Fish and Marine sciences* 3 (1):37-43.

[4]. Brett,J.R and T.D.Groves.1979.Physiological energetic. In: W.S.Hoar, D.J.Randall and J.R. Brett (eds.). *Fish physiology*. Vol.8. Academic Press. London. pp.280-344.

[5]. Cousin,M.,Cuzon,G.,Blanchet,E.,Ruelle,F.,AQUACOP.,1993. Protein requirements following an optimum dietary energy to protein ratio for *Penaeus vannmei* juveniles. In:*Proceedings of the Aquaculture feed Processing and Nutrition Workshop: Fish Nutrition in Practice* (Kaushik,S.J. & Luquet,P. eds.), pp. 599-606. INRA, Paris, France.

[6]. Dabrowski,K., 1979. Feeding requirements of fish with particular attention to common carp. A review. *Pol.Arch.Hydrobiol*. 26 : 135 – 158.

[7]. Deshimaru,O., Yone,Y., 1978. Optimum level of dietary protein from prawn. *Bull. of the Jpn.Soc.Fish*.,44,1395-1397.

[8]. Felix,N.,Prince Jeyaseelan,M.J.,2006. Effect of different protein diets on growth and feed conversion ratio of post larvae of *Macrobrachium rosenbergii* (Deman).*Indian J. Fish*.,53(2) : 175-180.

[9]. Folch,J., Less,J.M. and Sione Stanley,G.W., 1957. A simple method for the isolation and purification of total lipids from animal tissues. *J.Biol.Chem*., 226 : 497 – 507.

[10]. Goddard,S.,1996. Feed management in intensive Aquculture. Chapman and Hall, New York, U.S.A.

[11]. Gomez,D.G.H., Nakagawa and S.Kashwara. 1998. Effect of dietary/starch ratio and energy level on growth of the giant freshwater prawn *Macrbrachium rosenbergii*. *Nippon swisan Gakkaishi*, 54: 1401-1407.

[12]. Guillaume,J., 1997. Protein and aminoacids in crustacean nutrition (D`Abramo,L.R. Conklin,D.E. and Akiyama,D.M.,eds.). The *Aquaculture World-69- Society*. Baton Rouge. pp:26-50.

[13]. Hodge,J.E. and B.T.Hofriter. 1962. Determination of reducing sugars. In: R.L.Whister and M.L. Wolfrom (eds). Methods for carbohydrate chemistry. Academic Press. New York, 1 : 388-389.

[14]. Indulkar,S.T. and Belasre,S.G. 2001. Growth and survival response of *Macrobrachium rosenbergii* post-larva to various indigenous feed ingredients. *Journal of Applied Fisheries and Aquaculture*.,1 (3) : 367-371.

[15]. James, T. Sherief, P.M., Nair,C. and Thamby,D.M., 1992. Evaluation of *Spirulina fusiformis* as

[16]. a protein source in the diet of the post-larva of *Macrobrachium rosenbergii*. Pp 234 – 237. In: Fresh water prawn E.G.Silas (Ed.)., Kerala Agricultural University, Thrissur, India.

[17]. Jauncey, K., 1982. The effects of varying dietary protein level on the growth, food conversion, protein utilization and body composition of juvenile Tilapia (*Sarotherodon mossambicus*). *Aquaculture*, 27: 43-54.

[18]. Jeyalakshimi,B. and Natarajan,P.1994. Growth, Conversion efficiency and moulting frequency of *Macrobrachium idella* fed on different artificial feed.*J.Aquq.Trop*., 9: 193-200.
[19]. Koshio,S.,Teshima, S.,Kanazawa, A., Watase, T.1993. The effect of dietary protein content on growth, digestion efficiency and nitrogen excretion of juvenile kuruma prawns, *Penaeus japonicus*. *Aquaculture*, 113, 101-114.
[20]. Law,A.T.,Poh,Y.T. and Ang,K.J.,1992. Least-cost feed formulation for juvenile *Macrobrachium rosenbergii* by using the linear programming technique. In: *Abstracts of the 3rd Asian Fisheries Forum*, 26 – 30 October, 1992, Singapore. Pp188 (Abstract PN05). Asian Fisheries Society, Manila, Philippines.
[21]. Lowery, O.H., Rosebrough, N.J. Farr, A.L. and Randall, R.J. 1951. Protein measurement with folin phenol reagent. *J. Priol. Chem*. 193 : 265-275.
[22]. Maynard,L.A. and Lossli,J.K.1969.Animal Nutrition, sixth edition, Grew Hill, New York., pp.613.
[23]. New,M.B., 1998 A review of dietary studies with shrimp and prawn. *Aquaculture*. : 101 -144.
[24]. Paine,R.T.1964. Ash and caloric determinations of sponge and opisthobranch tissues. *Ecology*. 45 : 384-387.
[25]. Ponnusamy,R., Katre,S. and Reddy,S.R., 1981. Preliminary investigation on the utilization of Tubifed worms by the post larvae of *Macrobrachium lanchestri* (De man). *Hydrobiol*. 76 : 65 – 78.
[26]. Ramachandra Naik,A.T. and Shivanandamoorthy,H. 2000. Organoleptic evealuation of flesh of prawn and carps fed plant and animal based protein diets. *The Ind.J.Nutr.Dielet*.,37:91– 94.
[27]. Sahadevan,P. 1992. Protein requirement of the post larva and juveniles of *M.rosenbergii* (deman). M.F.Sc. Thesis. *Kerala Agric.Univ.College of Fisheries*. Panangad. Cochin.
[28]. Saravana Bhavan,S.Radhakrishnan and C.Seenivasan. 2011.Growth performance of the monsoon river prawn *Macrobrachium malcolmsonii* on formulated feeds with combinations of pulses and cereals along with groundnut oilcake and soya meal. *J.of Ecobiotechnology*, 3(1) : 14-23.
[29]. Seema Langer, Tajinder Kour of Rajesh Chalotra. 2004. Effect of different dietary protein level on the growth of post larvae of the freshwater prawn *Macrobrachium dayanum*. *Applied Fisheries and Aquaculture*.vol.IV (1).pp: 34-36.
[30]. Sethuramalingam, T.A. and James Gideon, K. 2003. Evaluation of some animal and plant protein sources in the diets of juvenile fresh water prawn, *Macrobrachium idae* (Heller). *Journal of Advanced Zoology*. 24(1&2) : 13-18.
[31]. Shiau,S.Y., Kwok,C.C.,Chou, B.S.,1991. Optimal dietary protein level of *Penaeus monodon* reared in seawater and brackishwater. *Nippon Suisan Gakkaishi*, 57, 711-716.
[32]. Smith,L.L., Lee,P.L., Lawrence,A.L, Strawn,K.,1985. Growth and digestibility by three sizes of *Penaeus vannamei* Boon: effects of dietary protein level and protein source. *Aquaculture*. 46, 85-96.
[33]. Treece,G.D., Fox,J.M.,1993. Design, Operation and Training Manual for an Intensive Culture Shrimp Hatchery. Texas A & M University Sea grant College Program.TAMU-SG-93-505. College Texas, USA.
[34]. Tidwell, J.H., Webster, C.D., Yancey, D.H. and D'Abramo, L.R. 1993. Partial and total replacement of fish meal with soybean meal and distillers by-products in diets for pond culture of the fresh water prawn (*Macrobrachium rosenbergii*). *Aquaculture*, 118 : 119-130.
[35]. Wilson, R.P., 1989. Amino acids and proteins. In; J.E. Halver (ed.) Fish Nutrition. Academic press, London. 111-149.