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Effect of Plant Proteins in Iso-caloric Feeds on Growth Performance of Freshwater Prawn *Macrobrachium idae* (Heller)

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Macrobrachium idae juveniles (0.9 - 1.3 g) were fed on eight formulated diets containing 32-42% crude protein to assess their growth performance. Prawns fed on groundnut oil cake meal (GOC) and soybean meal (SBM) showed the best growth rate (SGR) (0.46 and 0.43%.day^{-1}, respectively), food conversion ratio (FCR) (2.16 and 2.53, respectively) and protein efficiency ratio (PER) (0.84 and 0.78, respectively). *Hydrilla verticellata* (HV) and drumstick leaves (DRM) diets resulted in poor growth and decreased PER and SGR with elevated FCR. The efficiency of absorption and net conversion ranged between 84-90% and 3.81-7.8%, respectively. Increase in dietary protein content (3-8%) produced elevated growth rates and protein efficiency ratio. The dietary protein-energy ratio for maximum growth of prawns was 97.2 mg.kcal^{-1} with a digestible energy of 431 kcal.100g^{-1} of feed.

Key words: Iso-caloric feeds, growth rate, plant protein, protein-energy ratio, freshwater prawn, *Macrobrachium idae*

Feed accounts for 40-60% of the total cost in aquaculture (De Silva, 1988; Piedad-Pascual *et al.*, 1990) and among the feed ingredients, protein is most expensive. (Bautista, 1986; Tacon & Jackson, 1985). Substitution of animal protein by plant protein can often reduce feed cost (Akiyama, 1988; Ali, 1998) and inclusion of soybean meal and other plant protein in prawn and shrimp feeds has been recommended because of their nutritional quality, lower cost and wider availability (Akiyama, 1992). Only limited information is available on utilizing plant protein in feed and the effect of dietary P/E ratio on growth of prawns (Bautista, 1986). The present study was designed to find out the effectiveness of dietary plant protein and optimum protein-energy ratio required for maximum growth of the freshwater prawn, *Macrobrachium idae.*

Materials and Methods

Macrobrachium idae juveniles were collected from the perennial river Tamabaraparani near Eral and Athur, Chithambaranar District (Tamil Nadu, India). They were acclimated to laboratory conditions (temperature 28±2°C; pH 7.2 - 7.5 and Dissolved Oxygen 6.4 - 7.5 mg.l^{-1}) for a period of ten days. Individuals at intermoult (30-35 mm length; 0.9 - 1.3 g weight) were taken from the stock and three prawns were placed in each of 24 aquaria (capacity 15 l). Eight pelleted diets were formulated using groundnut oil cake (GOC) (43.9% crude protein) *Hydrilla verticellata* (HV) (17.3% crude protein), coconut oil cake (COC) (23.9% crude protein), cotton seed meal (CSM) (33.4% crude protein), soy bean meal (SBM) (41.6% crude protein), gingili oil cake (GIN) (48.8% crude protein), drumstick leaves (DRM) (21.8% crude protein) and *Chara fragilis* CHR) (36.6% crude protein), each constituting 14% and the remaining as standard ingredients *viz.*, beef slice (27%), fish meal (23%), rice bran (27%) and tapioca flour (9%). Three aquaria were assigned to each diet and each group was fed at the rate

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of 10% of body weight twice a day (10:00 h and 16:00 h). Unutilized feed and faeces were collected daily and dried in oven at 60°C for 24h and stored (Haniffa & Arulselvan, 1992). The aquaria water was changed daily in the morning before feeding the prawns. Close observation was made of moulting and the exuviae were removed and weighed immediately after moulting. The experiments were run for 41 days and at the end of the feeding trials the prawns were sacrificed and the live and dry weights were recorded (Maynard & Loosli, 1969). Carbohydrate (Roe, 1955), protein (Lowry *et al.*, 1951) and lipid (Folch *et al.*, 1957) were estimated and the ash content was determined by incinerating a known weight of dry substance in a muffle furnace at 560°C for 8h (Paine, 1964). The energy content of the ingredients and feed were estimated using a semi micro bomb calorimeter (Reis *et al.*, 1989).

Energy budget was calculated according to IBP formula (Petrusewicz & Macfadyen, 1970). (C= P+R+F+U, where C = food consumption, P= production, R= respiration, F= faeces, U=urine). Nitrogen free extract (NFE) was found out by the difference between the values obtained for the weight gained by the prawns fed on the respective diets. The results were subjected to one-way ANOVA (Snedecor & Cochran, 1967). Newman & Kuele's test was used to test the significance of difference among the means at 0.05 level.

Results and Discussion

The proximate composition of the different formulated diets is presented in Table 1. The highest protein content was found in diet GOC (41.9%) whereas diet GIN had the highest content of crude fat (11.82%). The ash content ranged between 8.18% (CHR) to 11.7% (DRM). The energy values in the diets were formulated to be isocaloric (17.47-17.94 $J.mg^{-1}$). The highest feeding rate was observed with *M. idae* DRM diet (366.8 $J.g^{-1}.day^{-1}$), followed by HV diet (329.5 $J.g^{-1}.day^{-1}$) (Table 2). These values are comparable with feeding rate of 320 $J.g^{-1}.day^{-1}$ for *Macrobrachium lanchestris* fed *Tubifex tubifex* (Ponnuchamy *et al.*, 1981). The conversion rate was found to be high in GOC diet (17.7 $J.g^{-1}.day^{-1}$) and low in HV diet (9.2 $J.g^{-1}.day^{-1}$). The absorption efficiency (AE) ranged from 84.1% (GIN diet) to 89.6% (COC diet) and net conversion efficiency (NCE) ranged from 3.2% (HV diet) to 7.8% (GOC diet) (Table 2). These values were slightly lower than those obtained for *Macrobrachium nobili* fed tubifex worms (AE: 91%; NCE: 11.5-13%) (Sindhukumari & Pandian, 1987). The NCE of prawns fed 42% protein diet (GOC) was more (7.8%) than those fed the other diets and the difference was statistically significant ($p<0.05$). This result was comparable to values reported by Lim & Dominy (1990) in *P. vannamei* given soybean meal based diet (8-10%).

The present study revealed that protein efficiency ratio of *M idae* increased with increase in dietary protein level but the

Table 1. Proximate composition (wt %) and energy content ($J.mg^{-1}$) of pelleted feeds

	GOC	HV	COC	CDT	SBM	GIN	DRM	CHR
Moisture	5.4	6.8	7.2	6.5	7.0	6.9	6.2	6.7
Crude protein	41.9	34.7	36.4	40.4	36.1	40.9	32.0	35.7
Crude fat	10.8	9.3	10.3	10.5	11.5	11.8	8.8	9.3
Crude fibre	6.8	7.5	9.1	10.8	7.0	8.4	10.4	9.4
Ash	10.4	9.6	9.4	8.8	8.8	9.0	11.2	8.2
NFE	24.6	32.1	27.6	23.0	29.6	22.9	31.4	30.7
Caloric content	17.8	17.4	17.8	17.9	17.9	17.9	17.7	17.5

Table 2. The energy budget and growth performance of *Macrobrachium idae* fed on iso-caloric diets

	Feed types							
	GOC	HV	COC	COT	SBM	GIN	DRM	CHR
FR ($mg.g^{-1}.day^{-1}$)	14.76 ± 1.52^{b}	18.97 ± 0.98^{c}	17.82 ± 57^{c}	17.78 ± 1.24^{c}	16.08 ± 0.60^{b}	15.03 ± 0.63^{b}	21.12 ± 0.88^{d}	7.04 ± 1.68^{a}
FR ($J.g^{-1}.day^{-1}$)	256.36±26.41	329.48±17.02	309.51±27.27	308.81±21.54	279.28±10.42	261.05±10.94	366.82±15.28	295.96±21.48
AR ($mg.g^{-1}.day^{-1}$)	12.92 ± 1.29^{a}	16.52 ± 1.01^{b}	15.99 ± 1.51^{b}	15.62 ± 1.13^{b}	13.64 ± 0.52^{a}	12.75 ± 68^{a}	18.64 ± 0.72^{c}	15.19 ± 1.50^{b}
AR ($J.g^{-1}.day^{-1}$)	221.4±22.44	286.92±17.54	270.77±26.23	271.29±19.63	236.91±9.04	221.27±11.81	323.75±12.51	263.83±26.05
CR ($mg.g^{-1}.day^{-1}$)	1.02 ± 0.2^{a}	0.53 ± 0.05^{d}	0.76 ± 0.6^{b}	0.72 ± 0.05^{b}	0.92 ± 0.04^{a}	0.85 ± 0.04^{b}	0.61 ± 0.06^{c}	0.61 ± 0.18^{c}
CR ($J.g^{-1}.day^{-1}$)	17.72±3.47	9.21±1.86	13.22±1.04	12.51±0.86	15.98±0.69	14.76±0.64	12.83±1.04	10.59±3.13
AE (%)	87.56±0.71	86.90±0.84	89.67±0.63	87.48±0.82	84.85±0.12	84.13±1.60	88.29±0.72	89.10±0.92
NCE (%)	7.8 ± 0.84^{a}	3.22 ± 0.51^{b}	4.81 ± 0.59^{b}	4.62 ± 0.38^{b}	6.76 ± 0.34^{a}	6.67 ± 0.64^{a}	3.81 ± 0.38^{b}	4.41 ± 1.04^{b}
Initial weight (g)	3.69±0.24	0.21±0.18	3.71±0.13	3.29±0.09	3.23±0.07	3.37±0.21	3.14±0.06	3.65±0.42
Final weight (g)	4.34±0.25	3.49±0.24	4.23±0.17	3.74±0.07	3.75±0.03	3.92±0.20	3.49±0.10	4.09±0.37
PER	0.843 ± 0.03^{a}	0.32 ± 0.06^{b}	0.58 ± 0.07^{a}	0.56 ± 0.11^{a}	0.78 ± 0.10^{a}	0.68 ± 0.11^{a}	0.45 ± 02^{b}	0.57 ± 0.13^{a}
SGR	0.464 ± 0.021^{a}	0.239 ± 0.02^{c}	0.375 ± 0.02^{b}	0.366 ± 0.022^{b}	0.426 ± 0.02^{b}	0.402 ± 0.02^{a}	0.302 ± 0.02^{b}	0.325 ± 0.013^{b}
FCR	2.16 ± 0.18^{a}	5.11 ± 0.16^{d}	3.75 ± 0.56^{b}	4.24 ± 0.73^{c}	2.53 ± 0.94^{a}	3.13 ± 0.73^{b}	6.94 ± 0.25^{d}	5.35 ± 1.17^{d}
P/E (mg protein.$kcal.^{-1}$)	97.28	83.44	85.07	93.47	84.28	95.48	75.36	87.52
Digestible energy ($kcal.100g^{-1}$)	430.72	415.43	427.62	431.91	427.85	427.82	423.55	420.78
Survival (%)	94	86	89	90	92	90	89	84

Values in the same row with same superscript are not significantly different at 0.05 level

FR : Feeding rate; AR : Absorption rate; CR : Conversion rate; AE : Absorption efficienty; NCE : Net conversion efficiency; PER : Protein efficiency ration; SCR : Specific growth rate; FCR : Feed conversion ratio; P/E : Protein-energy ratio

difference was not statistically significant ($p>0.05$) except for HV and DRM fed prawns, in which there was a significant decrease in PER and SGR (Table 2). Similar relationship of dietary protein with elevated PER and SGR was reported in *P. monodon* (Alava & Lim, 1983) and *P. vannamei* (Lim & Dominy 1990) fed soy bean based diets containing up to 42% protein. The best growth and survival were recorded in *M. idae* with GOC diet followed by SBM and GIN diets (Table 2). HV, DRM and CHR fed prawns showed poor growth. Presence of high fibre content and imbalance in essential amino acids (Tacon & Cowey, 1984; Cho & Kaushik, 1990; De Silva *et al.*, 1990), low digestibility (Lall, 1991; Kaushik, 1995) etc. result in poor growth and these may be the reasons for the poor performance of these diets. The GOC diet produced the best (low) FCR but DRM diet fed prawns showed high FCR (6.94). Lim & Dominy (1990) reported FCR ranging between 1.73 and 2.87 for *P. vannamei,* fed on diets containing various levels of soybean meal. Pieded-Pacaul *et al.* (1990) reported FCR between 5 and 7.3 for *P. vannamei* which were given diets containing defatted soybean. Cruz-Saurez *et al.*, (1993) formulated diets with shrimp meal (3-16%) and reported FCR between 1.29 and 2.32 for the same species. Indrajasmine (1996) used plant protein (40-48%) and obtained FCR values ranging between 1.46 and 2.25 for *P. indicus.*

The present study indicated that the GOC diet was superior to other diets for *M. idae.* The protein-energy ratio (P/E) of GOC diets (97.2) showed the maximum growth whereas diets with P/E ratio of 75.36 (DRM), 83.44 (HV) and 87.52 (CHR) resulted in poor growth. The maximum growth for *P. monodon* was obtained on diets having P/E ratio of 120-174 and energy content of 285-370 kcal. $100g^{-1}$ of feed (Bautista, 1986) which was found to be higher than the values obtained for *M.idae* in the present study. Hajra *et al.* (1988) also reported that higher P/E ratio of 102 and energy value of 358 kcal.$100g^{-1}$ resulted in better growth of *P. monodon.*

For optimum growth of prawn, it is important to have a balance between dietary protein and energy or an optimum P/E ratio in diets. It is obvious that the P/E may differ according to the type of ingredients (De Silva *et al.*, 1990) and a P/E ratio lower or higher than optimum may lead to the reduction in growth of prawn (Akiyama, 1992). From the present study it appears that a diet with P/E ratio of 97.2 and energy content 431 kcal.$100g^{-1}$, with 42% protein was optimum for best growth of *M. idae.* The present study also demonstrated that the GOC and SBM with the required energy levels in the diets yielded best results and this formulation could be used to reduce the feed cost and enhance protein conversion for *M. idae.*

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