ISSN 1110-0354
Bull. Nat. Inst. of Oceanogr. & Fish., A.R.E., 1997. Vol. (23): 439-448

GROWTH RATES AND FEED EFFICIENCY OF THE FRESHWATER PRAWN MACROBRACHIUM ROSENBERGII FED VARYING PROTEIN AND ENERGY LEVELS

BY

A.-F. M. EL-SAYED*

*Oceanography Dept., Faculty of Science Univ. of Alexandria, Alexandria, Egypt

Keywords: Freshwater prawn, Macrobrachium rosenbergii, nutrition, aqua culture.

ABSTRACT

The present study was conducted to evaluate the effects of varying dietary protein and energy levels on the growth, feed utilization efficiency and body composition of freshwater prawn, ***Macrobrachium rosenbergii****. Juvenile prawn (0.20 g) were fed diets containing 5 protein levels (20, 25, 30, 35 or 40%) each at 2 energy levels (350 or 450 kcal GE/100 g diet) ad libitum, once a day for 90 days. Growth rates and feed utilization efficiency were significantly improved with increasing dietary protein levels up to 35%. Beyond this level, no significant improvement in prawn performance was evident. At each protein level, increasing dietary energy from 350 to 450 kcal/100 g had no effect on prawn performance, except at the lowest protein level where fish performance was improved with increasing dietary energy from 350 to 450 kcal/100 g. With the exception of lipid contents, body compositions were not significantly affected by dietary treatments. Body lipid content was increased with increasing dietary energy (lipid) levels. These results revealed that optimum growth of* ***M. rosenbergii*** *was obtained at 35% protein and 350 kcal GE /100 diet, with a protein-to-energy ratio of 100 mg protein/kcal GE. Prawn survival was not significantly affected by dietary treatments.*

INTRODUCTION

The giant freshwater prawn, ***Macrobrachium rosenbergii***, is indigenous to south and southeast Asia. However, it has been introduced into many tropical and subtropical countries of the world for aquaculture purposes (New, 1985). ***M. rosenbergii*** has a great potential for culture due to its high growth rates, tolerance to water quality changes, resistance to handling, and ability to feed on unconventional feed stuffs.

M. rosenbergii was introduced into Egypt in the late 1980's by the Ministry of Agriculture (personal communication). Its culture trials by both private and governmental sectors have been fairly successful (Sadek and El-Gayar, 1993; Sadek and Fahmy, 1996). However, information regarding their environmental requirements under local conditions is lacking. In addition, nutritional requirements of ***M. rosenbergii*** are limited and contradictory. For example, Boonyaratpalin and New (1982), Bartlett and Enkerlin (1983) reported that 15% dietary protein was sufficient for optimum growth of ***M. rosenbergii.*** On the contrary, D'Abramo and Reed (1988) found that 15% dietary protein resulted in a significantly poor performance, while 33-35% protein was optimal. Little attention has also been given to dietary energy and protein-to-energy (P/E) ratios in ***M. rosenbergii*** diets.

The present study was conducted in the Oceanography Department, Faculty of Science, University of Alexandria, Egypt, to investigate the effects of varying dietary protein, energy and P/E levels on the growth rates, feed utilization efficiency and body composition of juvenile freshwater prawn, ***M. rosenbergii.***

MATERIALS AND METHODS

Juvenile ***M. rosenbergii*** were obtained from Mariut Fish Farming Company (MFFC) on 17 October 1996. Ten individuals were randomly stocked in 35 l glass aquaria (30x30x40 cm) filled with dechlorinated tap water. The aquaria were provided with air stones, heaters, and air lifting filters. A small cylinder made of plastic netting was put in each aquarium as an artificial habitat. A commercial diet (30% cp) was fed to the prawns for a one-week conditioning period to adapt them to the test diets and laboratory conditions. At the termination of the conditioning period, the prawn in each aquarium were netted, weighed and recounted.

Ten experimental diets (Table 1) containing 5 protein levels (20, 25, 30, 35 and 40%) each at 2 energy levels (350 and 450 kcal GE/100 g diet) were prepared as described by El-Sayed (1991). The test diets were fed to duplicate groups of prawn (0.2 g) *ad libitum* once a day (at 13-14 h) as recommended by Heinen and Mensi (1991) for 90 days. The feed was given little by little, when consumed, additional amounts were provided. Feeding continued for about one hour. The feces and other wastes were siphoned daily from the aquaria immediately before feeding. In addition, about 30% of the water was siphoned and replaced by new, fresh, dechlorinated water. Water temperature was maintained at 28±1 °C throughout the study. Other water quality parameters including oxygen (mg l^{-1}), pH and ammonia (mg l^{-1}) were monitored weekly. Lighting was set at 12:12 light/dark cycle.

The growth rates and feed utilization efficiency were calculated as follows:

Percent weight gain = 100 [Final weight (g) - Initial weight (g)]/ Initial weight.
Specific growth rate (% SGR) = 100[(ln final weight-ln initial weight)/ time (days))].

Feed conversion (FC) = Dry feed given (g)/Wet weight gain (g).
Protein efficiency ratio (PER) = Weight gain (g)/protein fed (g).
Protein production value (PPV) = 100(protein gain/protein fed).
Energy retention (ER) = 100(energy retained/energy fed).

At the end of the study, the prawn were netted, weighed, counted, and frozen for final body analyses. Initial body analyses were performed on a frozen subsample from the initial stock. Body water, protein, lipid and ash were determined according to the standard AOAC (1980) methods.

The results were subjected to two-way ANOVA to test for the effects of dietary protein and energy levels and their interaction on the performance of the prawn. Orthogonal polynomial test was used to compare means at 0.05 significance level (Gill, 1981).

Table (1): Composition (on as-fed basis) and proximate analyses (on dry weight bases) of the experimental diets.

Ingredient (%)	*DIETS*									
	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Shrimp meal	15	14	18	18	23	23	30	30	35	35
Blood meal	4	4	5	5	8	8	9	9	12	12
Meat & bone meal	4	4	7	7	10	10	10	10	11	11
Wheat flour	42	49	37	40	28	31	19	23	12	14
Sardine oil	2	6	2	6	1.5	5	1	5	1	5
Soybean oil	2	6	2	6	1.5	5	1	5	1	5
Starch	12	12	12	12	12	12	12	12	12	12
Vitamin & mineral mix[1]	2	2	2	2	2	2	2	2	2	2
Gelatin	3	3	3	3	3	3	3	3	3	3
Agar	1	1	1	1	1	1	1	1	1	1
a-cell	13	–	11	–	10	–	12	–	10	–
Crude protein	20.4	20.8	24.5	23.9	31.3	29.8	35.0	35.6	39.3	40.5
Crude lipid	7.0	14.9	6.8	13.9	5.5	13.0	4.4	12.7	6.6	14.5
Ash	7.0	6.6	9.0	8.7	10.2	9.7	11.1	11.4	11.7	12.2
GE (Kcal/100g)[2]	346	458	361	443	367	441	350	448	368	455
P/E ratio[3]	59	45	68	54	85	68	100	79	107	89

[1]NRC (1977).

[2]Gross energy, calculated based on 5.65, 9.5 and 4.2 kcal/g for proteins, lipids and carbohydrates, respectively.

[3]Protein-to-energy ratio = mg protein/kcal GE.

RESULTS AND DISCUSSION

The present study revealed that the performance of ***M. rosenbergii*** was significantly affected by dietary treatments. Percent weight gain, SGR and feed conversion were improved ($P<0.05$) with increasing dietary protein levels up to 35% (Table 2). Beyond this level, no significant improvement ($P>0.05$) was evident. This finding agreed well with the results of D'Abramo and Reed (1988) who found that the best performance of prawn fed isocaloric diets varying in protein levels was attained at 33-35% protein Similar results were reported by Koshio ***et al***. (1992). These authors found no significant differences in the growth rates, feed utilization efficiency and survival of ***M. rosenbergii*** juveniles reared on diets containing 30-50% protein. Therefore, they recommended that optimum prawn growth was obtained at 30% dietary protein.. In addition, Ashmore ***et al***., (1985) found that the best growth of ***M. rosenbergii*** was attained at 30-40% dietary protein depending on the source of dietary carbohydrate used. When barley was used as a carbohydrate source, 30% protein was sufficient for optimum performance, while 40% protein was suitable when wheat was used. New (1976) suggested between 27 and 35% dietary protein levels for optimum growth. However, higher protein levels (57%) were reported for maximum growth of ***M. rosenbergii*** post larvae (Heinen and Mensi ,1991).

On the contrary, about 15% dietary protein have been reported for optimum growth of ***M. rosenbergii*** (Boonyaratpalin and New 1980; Bartlett and Enkerlin 1983). These controversial results may have been related to stocking size and density, protein quality, feeding levels, ration frequencies and culture systems. Therefore, it is evident that the protein requirements of ***M. rosenbergii*** are not well established.

Increasing dietary energy in the present study from 350 to 450 kcal GE/100 g at each protein level (except at 20% protein) has not resulted in significant improvement ($P>0.05$) in prawn performance (Figure 1). At 20% dietary protein, a significant improvement in growth rates and feed efficiency was evident ($P<0.05$) when dietary energy was increased from 350 to 450 kcal/100 g. This finding may suggest that protein sparing effect by dietary energy did not occur. It may also indicate that low energy diets (350 kcal/100 g) containing high carbohydrates/low lipid levels were better digested and assimilated than high energy diets (450 kcal/100g) containing high lipid/low carbohydrate levels. The efficient utilization of dietary carbohydrates by ***M. rosenbergii*** is well documented (Lee ***et al***., 1980; Ashmore ***et al***., 1985; Matthew and Briggs 1991; Koshio ***et al***. 1992).

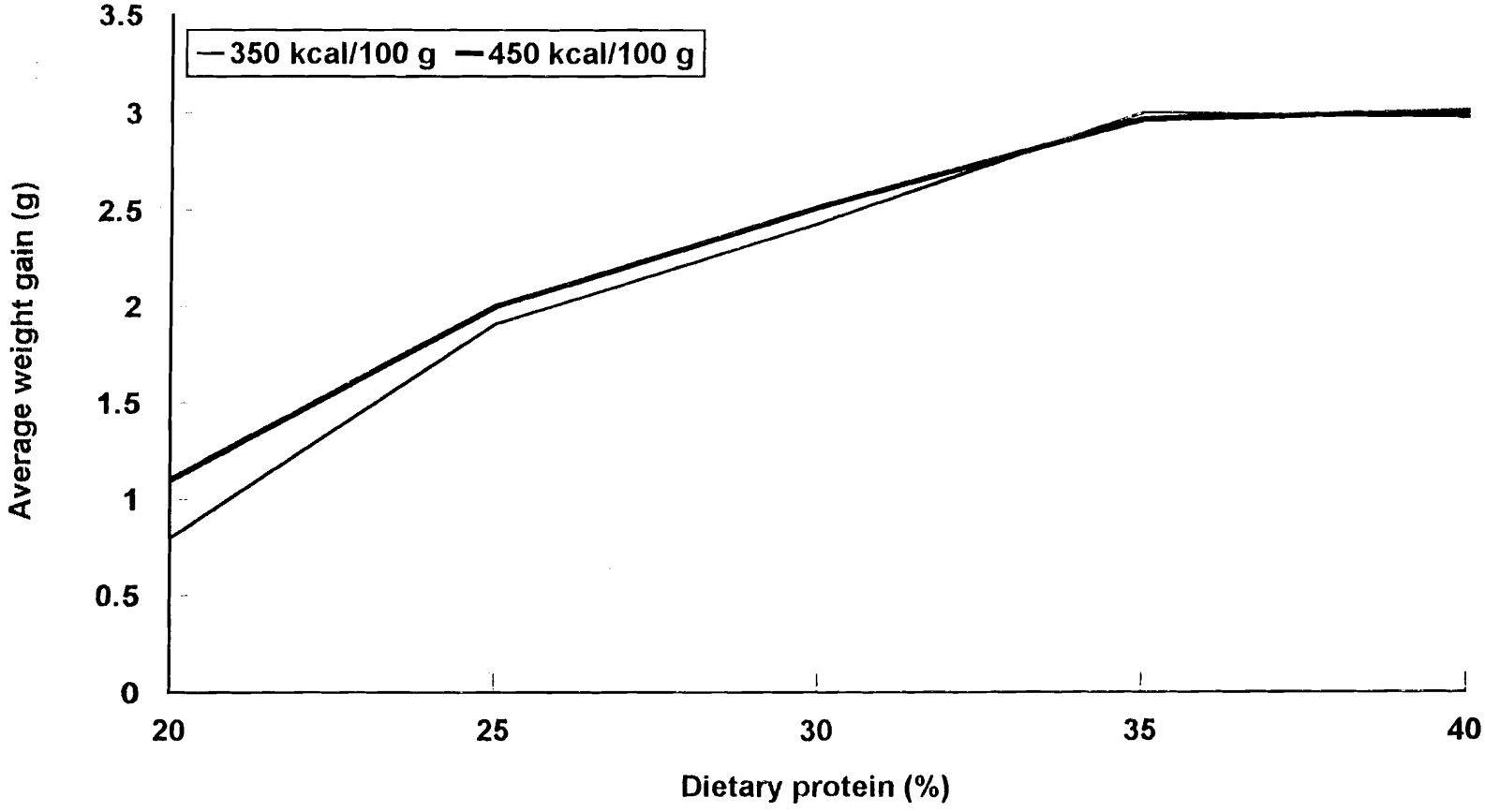

Fig. (1): Weight gain of *M. rosenbergii* fed varying protein and energy levels.

Table (2): Growth rates and feed utilization efficiency of ***M. rosenbergii*** fed the test diets. Values in the same column with the same superscripts are not significantly different. (P=0.05). Average initial weight = 0.2 g.

Diet	*FW*[1]	*% gain*	*SGR %*	*FC*	*PPV*	*ER*	*Survival %*
1	1.00	400[a]	1.79[a]	3.51[a]	26.06[a]	10.47[a]	80
2	1.31	555[e]	2.09[e]	3.24[a]	26.96[a]	9.77[a]	90
3	1.91	855[b]	2.51[b]	2.71[b]	27.21[a]	12.36[a]	85
4	2.00	900[b]	2.56[b]	2.66[b]	27.31[a]	11.31[a]	85
5	2.43	1115[c]	2.77[c]	2.41[c]	25.81[a]	14.66[b]	95
6	2.51	1155[c]	2.81[c]	2.30[c]	25.69[a]	14.21[b]	80
7	2.96	1380[d]	2.99[d]	2.00[d]	26.94[b]	18.91[c]	90
8	3.01	1405[d]	3.01[d]	1.96[d]	27.00[b]	17.40[c]	80
9	2.97	1380[d]	3.00[d]	1.88[d]	25.75[a]	19.38[c]	80
10	3.03	1415[d]	3.02[d]	1.80[d]	25.81[a]	18.92[c]	85

[1]FW is the average final weight (g/prawn).

The 4.5-7% lipid contained in low- energy diets may have met the lipid requirements of prawn, while high lipid (13-15%) contents of high-energy diets may have suppressed their growth rates, as has been reported by Sheen & D'Abramo (1989). Those authors found that the best growth of ***M. rosenbergii*** fed varying lipid levels (0-12%) was obtained at 6% level, while levels above 10% have resulted in a significant reduction in weight gain. Similar protein, energy and lipid requirement of another freshwater prawn species, ***M. nipponense*** has been reported by Bingru and Shen (1990). They found that juvenile prawn required 36.8-42.3% protein, 6-12% lipid and 300-356 kcal/100 g for optimum performance.

It should be mentioned that PPV were not significantly affected (P>.05) by dietary treatments. In the mean time, energy retention was increased with increasing dietary protein up to 35% and leveled off afterwards. Prawn survival was not affected (P>0.05) by dietary treatments.

With the exception of lipid contents, body composition was not significantly affected (P>0.05) by dietary treatments (Table 3). At each dietary protein level, body lipid content was increased with increasing energy level from 350 to 450 kcal/100 g.

In conclusion, the present study revealed that a diet containing 35% protein and 350 kcal GE/100 g with a P/E ratio of 100 mg protein/kcal GE produced the best performance of ***M. rosenbergii*** juveniles.

Table (3): Body composition (on dry weight basis) of ***M. rosenbergii*** fed the test diets. Values in the same column with different superscripts are significantly different (P=0.05).

Diet	***Body composition (%)***			
	Water	**Protein**	**Lipid**	**Ash**
Initial	72.54	63.65	7.55	15.23
1	71.51	64.42	8.24^{a}	16.05
2	71.92	64.39	9.92^{b}	15.95
3	72.27	64.87	8.65^{a}	16.69
4	72.14	65.17	10.46^{b}	16.84
5	73.00	65.54	9.22^{ba}	17.12
6	72.64	65.34	11.74^{c}	16.72
7	71.36	65.56	8.97^{a}	16.87
8	70.68	66.06	11.93^{c}	17.21
9	71.55	66.48	10.00^{b}	16.86
10	70.82	65.88	12.37^{c}	17.17

REFERENCES

AOAC (Association of Official Analytical Chemists), 1980. Official Method of Analysis, 12th edition, Washington DC.

Ashmore, S.B., Stanley, R.W., Moore, L.B. and Malecha, S.R., 1985. Effect on growth and apparent digestibility of diets varying in grain source and protein level in ***Macrobrachium rosenbergii.*** J. World Maricult.Soc., 16:205-216.

Bingru, Y and Shen, H., 1990. On the appropriate contents of protein, fat and calorie-protein ratio in the diet of freshwater shrimp (Macrobrachium nipponense). J. Fish China Shuichan Xuebao, 14:321-327.

Bartlett, P. And Enkerlin, E., 1983. Growth of the prawn ***Macrobrachium rosenbergii*** in asbestos asphalt ponds in hard water and on a low protein diet. Aquaculture 30:353-356.

Boonyaratpalin, M. and New, M.B., 1982. Evaluation of diets for ***Macrobrachium rosenbergii*** reared in concrete ponds. In: Giant prawn farming. (ed. by M.B. New), pp. 249-256. Elsevier, Amsterdam.

D'Abramo, L.R. and Reed, L., 1988. Optimal dietary protein level for juvenile freshwater prawn ***Macrobrachium rosenbergii***. Paper presented at the 19th Annual Meeting of the World Aquaculture Society, Honolulu, Hawaii, January 2-9, 1988.

El-Sayed, A.M., 1991. Protein requirements for optimum growth of ***Liza ramada*** fry Mugilidae) at different water salinities. Aquatic Living Resources, 4:117-123.

Gill J.L., 1981. Design and analysis of experiments in animal and medical sciences. Vol. 1. Iowa State University Press. Ames, IA, 409 pp.

Heinen, J.M. and Mensi, Jr. M.J., 1991. Feeds and feeding schedules for indoor nursery of postlarval freshwater prawn ***Macrobrachium rosenbergii***. J. World Aquacult. Soc., 22(2):118-127.

Koshio, S., Kanazawa, A. and Teshima, S., 1992. Nutritional evaluation of dietary soybean protein for juvenile freshwater prawn ***Macrobrachium rosenbergii***. Nippon Suisan Gakkaishi, 58(5):965-970.

Lee, P.G., Blake, N.J. and Rodrick, G.E., 1980. A quantitative analysis of digestive enzymes for the freshwater prawn ***Macrobrachium rosenbergii***. Proc. World Maricult., Soc. 11, 392-402.

Matthew, R. and Briggs, P., 1991. The performance of juvenile prawns, ***Macrobrachium rosenbergii***, fed a range of carbohydrate sources in semi-purified diets. Paper presented at the 22nd Annual Confer. & Expo. of the World Aquaculture Society, San Juan, Puerto Rico, June 16-20, 1991.

NRC (National Research Counsel), 1977. Nutrient requirement of warmwater fishes. National Academy of Science, Washington, D.C., 78 pp.

New, M.B., 1976. A review of dietary studies with shrimp and prawns. Aquaculture, 9:101-144.

New, M.B., 1985. Freshwater prawn farming. A manual for the culture of ***Macrobrachium rosenbergii.*** FAO Fisheries Technical Paper 225, Revision 1, 118 pp.

Sadek, S.S. and El-Gayar, F.M.H., 1993. Production of the giant freshwater prawn ***Macrobrachium rosenbergii*** in brackishwater ponds (Egypt). Proceedings of Aquaculture Symposium: Technology and Investment Opportunities. 11-14 April 1993, Riyadh, Saudi Arabia. p. 296-302.

Sadek, S.S. and Fahmy, M. 1996. The Egyptian experiment in culturing freshwater prawn, ***Macrobrachium rosenbergii*** (in Arabic). Fisheries Research, 14:75-82.

Sheen, S-S. and D'Abramo, L.R., 1989. Estimation of the optimal dietary lipid level for juvenile freshwater shrimp ***Macrobrachium rosenbergii.*** Paper presented at the 20th Annual Meeting of the World Aquaculture Society, Los Anglos, California, February 12-16, 1989.