Asian Fisheries Science **15**(2002): 357-364
ISSN: 0116-6514
https://doi.org/10.33997/j.afs.2002.15.4.007

Asian Fisheries Society, Manila, Philippines

Effect of Formulated Feeds on the Growth and Broodstock Development in *Macrobrachium rosenbergii*

V.K. VENKATARAMANI, C.B.T. RAJAGOPALSAMY* and D. RAVI

Fisheries College and Research Institute
Tamil Nadu Veterinary and Animal Sciences University
Thoothukkudi - 628 008, Tamil Nadu
India

Abstract

Experiment conducted on broodstock development in *Macrobrachium rosenbergii* by feeding formulated feeds with fish meal, squid meal or soya meal revealed that broodstock production was more than 60% in animals fed with fish meal incorporated feed. Though growth and mean growth increment were higher in conventional feed compared to formulated feeds, the per day increment in biomass was the highest in prawns fed with fish meal (102.61 g) followed by squid meal (99.62 g) incorporated feed. The study infers that formulated feeds with animal protein (47 to 54% protein) resulted in good production of broodstock in *M. rosenbergii* in 150 days. The total number of berried eggs produced was the highest in prawns fed with fish meal followed by squid meal incorporated feed.

Introduction

The freshwater palaemonid prawn *M. rosenbergii* currently offers a good potential for large-scale commercial aquaculture primarily because established techniques are available for larval rearing, the animal breeds under captivity, attains a very good growth rate within 4 or 5 mo in culture condition and shows good survival rate. Under natural condition, *M. rosenbergii* is an omnivore, feeding on various plant and animal materials (Balazs and Ross 1976). Though this species accepts a wide variety of food in captivity, it particularly prefers flesh of mollusks and crustaceans (Deshimaru and Shigueno 1972; Forster and Beard 1973). Though extensive works have been undertaken on the use of pelleted feeds (Balazs et al. 1974; Brody et al. 1980; Farmanfarmian and Lauterio 1980; Fair et al. 1980; New and Singholka 1985; Louis et al. 1994) to enhance production of *M. rosenbergii* under culture conditions, the use of quality formulated feeds to develop broodstock is yet to be accomplished. Commercially, the use of ingredients in formulated feed should be cost-effective and should be available in large quantities in areas where culture operations

**Corresponding author*

are to be carried out. Further, the prepared formulated feed should have high water stability. In the present study, three types of formulated feeds with different protein levels and a control feed were used to assess the growth and broodstock development of *M. rosenbergii* under experimental conditions.

Materials and Methods

The following formulated and control feeds were prepared to study the growth and broodstock development in *M. rosenbergii:* fish meal incorporated feed (FM), squid meal incorporated feed (SQM), soya meal incorporated feed (SBM) and control (conventional feed)

The percentage and proximate compositions of the experimental diets for all the study feeds are given in table 1. The ingredients used in the feeds were accurately weighed and the feeds were prepared following the method described by Jayaram and Shetty (1981). Biochemical analyses were also made for different feeds. Protein and fat were estimated by adopting standard procedures (Floch et al. 1956 and Oser 1971). The formulated feeds were prepared with same levels of specific protein sources (Table 1). The FM had 47% protein, the SQM had 54% protein and the SBM had 60% protein. The lowest level of protein (46%) was in the control feed (Table 1).

Juveniles of the giant freshwater prawn with the size range 1.0 to 2.6 g were acclimated in an earthen pond for 15 days and were fed with the control feed prior to the start of the feeding trial. An experiment was designed to study growth increment, broodstock development, optimal protein level to raise broodstock and fecundity.

For each circular cement tank (3.75 m diameter, 1.25 m depth), 600 nursery reared prawn seeds were stocked. The average length and weight of the specimens stocked together are given in table 2. The length was measured to the nearest mm from the eye orbit to the tip of telson.Weight was recorded

Table 1. Percentage and proximate composition of experimental feeds

Ingredients	Conventional feed	Soya meal incorporated feed	Fishmeal incorporated feed	Squid meal incorporated feed
Soyabean meal**	—	40	—	—
Fish meal**	—	—	40	—
Squid meal**	—	—	—	40
Groundnut oil cake	80	37	32	5
Rice bran	5	10	15	40
Tapioca	10	8	8	10
Vitamin - mineral mix	5	5	5	5
Protein	46	59.58	47.25	54.45
Fat	9.8	10.25	9.84	9.86
Ash	15	5.03	18.07	8.04
Moisture	12	11.5	10.6	9.5

*dry weight basis

** Solvent extracted soya meal was purchased from local suppliers of Tamil Nadu, South India. Fish meal, squid meal used for the study were prepared locally utilizing the *Leiognathus* spp. and *Loligo* spp., respectively.

after removin the excess water using tissue paper as absorbent. The increase in length and weight were used as measures of growth.

Before conducting the experiments, all the animals in the cement tanks were starved for 72 hours. Fifty percent of the water in the experimental tank was changed twice a week. Water was added carefully so as not to cause stress to the stocked prawns. The stocked animals were fed with the experimental diet at 5% body weight of prawns. The feed was given at 8 am and at 4 pm. In each experimental tank, about 50 PVC pipes (2.5 cm in diameter, 8 to 10 cm length) were provided as shelter for newly moulted prawns. Fortnightly random sampling of 20 animals per tank was carried out during the experimental period (150 days). Water quality parameters such as temperature, pH, Secchi disc reading, dissolved oxygen, alkalinity, hardness, ammonia, nitrate, total soluble phosphorus and chlorophyll 'a', 'b' and 'c' were recorded fortnightly (Table 3). During sampling, maturity stages were identified based on the morphology of testis and ovary in males and females respectively to study maturation in *M. rosenbergii*. For this study, 15 specimens were sacrificed to identify the different stages of maturation. In males, 4 maturity stages namely, immature I, maturing II, matured III and spent IV were identified. In females, 5 stages namely, immature I, maturing II, maturing III matured IV and spent V were recognized. Gonadosomatic index (GSI) was calculated from the sampled population for each month for all the types of feed tested. Fecundity was calculated using gravimetric method from berried females. At the end of the experimental period, the experimental tanks were drained to collect data on the length and weight of the stocked prawns; attainment of maturity was also taken. Survival rate and biomass of *M. rosenbergii* fed with different formulated feeds and control diet were also calculated. To study the significant differences in growth increment of *M. rosenbergii* for different types of feeds, ANOVA and Student's t-test were employed; level of significance was taken at 5%.

Results and Discussion

The average growth recorded and mean growth increment attained by *M. rosenbergii* fed with different types of feeds are given in table 2. Among the formulated feeds, mean growth was highest in prawns fed the SQM feed followed by prawns fed the FM feed. The monthly average growth recorded for test animals fed with different types of feeds is given in figure 1. It was apparent that growth increment was highest in prawns fed the control feed compared to formulated feeds. However, among the formulated feeds, monthly growth increment was highest in animal fed with SQM followed by those fed with FM feed. ANOVA test analysis confirmed the prevalence of highly significant ($P<0.01$) difference existing between the average growth increment of control feed with formulated feeds (Table 4.1). The Student's t-test further revealed that the average growth increment between the control and formulated feeds were significant ($P<0.01$) and insignificant difference could be observed between prawns fed the SBM diet and SQM diet and between FM feed and SQM feed. However, significant difference in the average growth increment was seen

Table 2. Development of *Macrobrachium rosenbergii* broodstock fed with different types of feeds

Feeds	Mean stocking size		Mean growth recorded for 150 days		Mean growth increment		Attainment of maturity (Days)	Survival (%)	Production of broodstock (%)
	TL (mm)	B Wt (g)	TL (mm)	B Wt (g)	TL (mm)	B Wt (g)			
Conventional feed	59.4 (55 – 65)	1.4 (1.2 – 1.7)	166.4 (165 – 170)	56.1 (50 – 63)	107.0	54.70	150	40	45
Soya meal incorporated feed	56.4 (43 – 69)	1.75 (1.37 – 2.11)	139.7 (105 – 158)	28 (17 – 38)	83.3	26.25	150	78	50
Fish meal incorporated feed	57.3 (43 – 74)	1.85 (1.37 – 2.6)	142.5 (114 – 162)	31 (19 – 46)	85.20	29.15	150	88	60
Squid meal incorporated feed	57 (43 – 73)	1.77 (1.37 – 2.11)	155.8 (127 – 188)	32.9 (18 – 43)	98.8	31.13	150	80	53

Range is shown in parentheses

between prawns fed with SQM and FM feeds at P<0.01 level (Table 4.2). Survival rate and calculated biomass were highest in *M. rosenbergii* fed with FM feed followed by SQM feed (Tables 2 and 7).

The GSI calculated for *M. rosenbergii* fed with different feeds is given in table 5. The GSI was found to increase in the stocked animals from the third month. The index was higher for formulated feeds than the control feed. From the sampling, it became explicit that right from the 3rd month of stocking, more matured male and berried females were collected from prawns fed with SQM and FM feeds. In the control tank, sampled specimens had maturing testes (stage III) and maturing/mature ovaries (stage III/stage IV) during the 4th (120 days) and 5th months (150 days) and the berried specimens were not recorded even in the 4th month. However, the berried females were collected from the 4th month of stock in animals fed with formulated feeds as evidenced by high GSI values (Table 5).

M. rosenbergii fed with FM feed had higher fecundity compared to control feed (Table 6). Based on observations made, it is evident that good growth registered in specimens fed with control feed (Mean: 56.1) compared to formulated feeds. The highest growth rate recorded in animals fed with conventional fed could be attributed to the lesser survival rate (40%) than the other feeds tested.

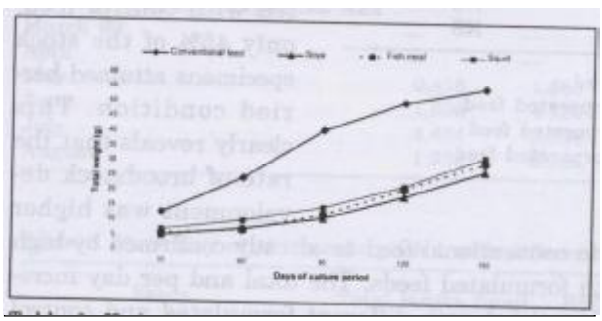

Fig. 1. Monthly average growth recorded for *M. rosenbergii* fed with control and formulated feeds

Table 3. Hydrobiological parameters recorded during the conduct of experiments

Sl. No	Parameters	Control	SBM feed trial	FM feed trial	SQM feed trial
1.	Temperature°C	28 – 30	28 – 30	28 – 30	28 – 30
2.	pH	7.5 – 8.5	7 – 8	7.5 – 8	7 – 8
3.	Secchi disc reading (cm)	30 – 35	34 – 42	40 – 42	40 – 44
4.	Dissolved oxygen (mg/l)	4 – 5.2	5.4 - 6.2	5.1– 6.4	5.3 – 6.1
5.	Alkalinity(mg/l)	38 – 56	13 – 17	11 – 18	11 – 17
6.	Hardness (mg/l)	1560-2000	1180-1910	1200-1980	1180 – 1940
7.	Ammonia (NH_3) (µg at NH_3-N/l)	7.6– 8.8	7.3 – 9.2	7.3 – 9.1	7.3 – 9.3
8.	Nitrate (NO_3) (µg at NO_3-N/l)	9.6 – 11.6	7.3 – 9.8	7.3 – 9.7	7.1 – 10.1
9.	Total soluble phosphorus (µg at PO_4-P/l)	0.2 – 0.6	1.2 – 2.1	1.2 – 2.3	1.2 – 1.7
10.	Chlorophyll (mg/m^3)				
	(a)	0.002 – 0.008	0.003-0.007	0.002-0.007	0.002-0.006
	(b)	0.003 – 0.130	0.003-0.009	0.004-0.009	0.004-0.007
	(c)	0.002 – 0.015	0.013-0.019	0.013-0.016	0.013-0.019

Table 4.1. ANOVA test analysis on the growth in weight increment in *M. rosenbergii* fed with different test feeds

Source of variation	Sum of square	Degrees of freedom	Mean sum of square	F Value (calculated)	Level of significance
Rows	1113.007	9	123.6674	2.937439	P< 0.01
Test feed	5126.716	3	1708.905	40.59116	P< 0.01
Error	1136.712	27	42.10043		
Total	7376.434	39			

Table 4.2. Students ' t ' test analysis on the growth in weight increment of *M. rosenbergii* fed with different test feeds

Feeds compared	Growth increment	
	t value	Level of significance
T 1 x T 2	10.436	P< 0.01
T 1 x T 3	7.821	P< 0.01
T 1 x T 4	7.883	P< 0.01
T 2 x T 3	- 3.020	P< 0.05
T 2 x T 4	- 2.510	NS
T 3 x T 4	- 0.505	NS

T1 - Conventional feed
T2 - Soya meal incorporated feed
T3 - Fish meal incorporated feed
T4 - Squid meal incorporated feed
NS - Not significant

Comparing the attainment of broodstock in *M. rosenbergii* fed with different feeds, it could be depicted that 60% of stocked specimens attained brood when fed with FM feed followed by SQM feed (53%) in 150 days. In animals fed with control feed, only 45% of the stock specimens attained berried condition. This clearly reveals that the rate of broodstock development was higher in formulated feeds compared to conventional feed as already confirmed by high GSI values in animals fed with formulated feeds. The total and per day increment in biomass of *M. rosenbergii* fed with different formulated and control feeds are given in table 7. Biomass was higher when the test animals were fed with formulated feeds (FM/SQM) than the control feed.

It is also interesting to note that in the harvested specimens, female specimens weighing between 30 to 35 g, fed with FM and SQM feeds were in berried condition, while in the control and SBM feeds, the broodstock made its appearance in animals weighing more than 45 g. This observation confirmed that broodstock development occurred in the early size group of *M. rosenbergii* when fed with animal protein incorporated feeds. Balazs and Ross (1976) concluded that the optimum protein level for good growth for *M. rosenbergii* was below 35%. Millikin et al. (1980) indicated that this species attains best growth at 40% protein level in feeds. Castell et al. (1989) have concluded that protein level ranging between 30 and 38% resulted in the best growth in *M. rosenbergii*. In the present study, it is evident that the protein level ranging between 47 and 54% was the best for the development of broodstock in *M. rosenbergii*. Lee et al. (1980) observed decreased growth in *M. rosenbergii* when fed with plant feeds with high levels of protein and inferred that depressed growth could be attributed to high fiber content. In the present study, animals fed with soya meal incorporated feed exhibited not only suppressed growth but also lower level of broodstock development.

Table 5. GSI of *M. rosenbergii* fed with different kinds of formulated feeds

Months	Male	Female
(i) Conventional feed		
March 99	—	—
April	—	—
May	1.179	1.893
June	1.837	3.236
July	2.090	3.830
August	1.280	4.770
(ii). Soya meal incorporated feed		
March 99	—	—
April	—	—
May	0.875	2.769
June	2.440	2.394
July	2.824	5.916
August	2.207	8.450
(iii). Fish meal incorporated feed		
March 99	—	—
April	—	—
May	1.177	2.592
June	2.070	5.200
July	2.814	4.470
August	2.231	7.660
(iv). Squid meal incorporated feed		
March 99	—	—
April	—	—
May	0.418	1.888
June	1.896	4.230
July	4.484	8.058
August	1.926	8.326

It is evident that the total biomass and per day increment in biomass were higher in animals fed with FM/SQM feeds compared to conventional and SBM feed. Between the two feeds incorporated with plant ingredients, it could be observed that biomass was higher in conventional feed than SBM feed. It is also interesting to note that biomass production obtained for the tested feeds confirmed with fecundity and percentage of broodstock developed in *M. rosenbergii*. The present study elucidates the fact that broodstock development in *M. rosenbergii* will be higher when fed with SQM and FM feeds than with feeds prepared from plant sources.

Though the mean growth increment was

Table 6. Fecundity of *M. rosenbergii* fed with different kinds of formulated feeds.

Feeds	Total length (mm)	Body weight (g)	Mean number of eggs (range)
Conventional feed	160 – 175	50 – 76	44424 42343 – 47118
Soya meal incorporated feed	160 – 175	40 – 45	58265 57782 – 58408
Fish meal incorporated feed	150 – 169	41 – 52	62114 60203 – 62826
Squid meal incorporated feed	160 – 190	40 – 55	60772 59970 – 62058

Table 7. Biomass production in *M. rosenbergii* fed with different kinds of formulated feeds

Feed	Total increment* in biomass (150 days in kgs)	Per day increment** in biomass (g)
Conventional feed	13.128	87.52
Soya meal incorporated feed	12.285	81.90
Fish meal incorporated feed	15.391	102.61
Squid meal incorporated feed	14.942	99.62

*Total increment in biomass = Mean growth increment in 150 days x survival rate x Total number of animals stocked

**Per day increment in biomass = $\frac{\text{Total increment in biomass}}{\text{Culture period in days}}$

found to be highest in the conventional feed compared to formulated feeds, the total increment in biomass was higher in FM/SQM feeds. This was mainly due to higher survival rate in the two said feeds. Therefore, it is better to compare biomass production rather than mean growth increment for this does not give a true picture of the yield in a normal culture system.

Acknowledgment

The authors express their gratitude to the Dean, Fisheries College and Research Institute, Tamilnadu Veterinary and Animal Sciences University Thoothukkudi, India for providing the facilities for the conduct of the present study and to ICAR, New Delhi for providing the financial assistance for this study.

References

Balazs, G.H. and E. Ross. 1976. Effect of protein source and level on growth and performance of the captive freshwater prawn, *Macrobrachium rosenbergii*. Aquaculture, 7: 299–313.

Balazs, G.H., E. Ross, C.C. Brooks and T. Fujimura. 1974. Effect of protein source and level on growth of the captive freshwater prawn, *Macrobrachium rosenbergii*. Proceedings World Mariculture Society, 5: 1 –14.

Brody, T., D. Cohen, A. Barnes and A. Spector. 1980. Yield characteristics of the prawn *Macrobrachium rosenbergii* in temperate zone Aquaculture. Aquaculture, 21(4): 375–385.

Castell, J.D., J.C. Kean, L.R. D'Abramo and D.E. Conklin. 1989. A standard reference diet for crustacean nutrition. I. Evaluation of two formulations. Journal of World Aquaculture Society, 20 (3) : 93 – 99.

Deshimaru, O. and K. Shigueno. 1972. Introduction to the artificial diet for prawn, *Penaeus japonicus*. Aquaculture, 1: 115 – 133.

Fair, P.H., A.R. Fortner, M.R. Millikin and L.V. Sick. 1980. Effects of dietary fiber on the growth, assimilation and cellulase activity of the prawn *Macrobrachium rosenbergii*. Journal of World Mariculture Society, 11: 369 – 381.

Farmanfarmaian, A., T. Lauterio. 1980. Amino acid composition of the tail muscle of *Macrobrachium rosenbergii* - comparison to commercial feed pellets. Proceedings of World Mariculture Society, 11: 454 – 462.

Folch, J. H.Less and G.H. Solana Stanley. 1956. A simple method for the isolation and quantification of total lipid from animal tissues. Journal of Biological Chemistry, 226: 497-509.

Forster, J.R.M and T.W. Beard. 1973. Growth experiments with the prawn, *Palaemon serratus* fed with fresh and compounded foods. Fish Invet. Ser. 27 (7):16.

Jeyaram, M.G. and H.P.C. Shetty. 1981. Formulation, processing and water stability of two new pelleted fish feeds. Aquaculture, 23: 355-359.

Lee, P.G., N.J. Blake and G.E. Rodrick. 1980. A quantitative analysis of digestive enzymes for the freshwater prawn *Macrobrachium rosenbergii*. Proceedings of World Mariculture Society, 11: 392 – 402.

Louis, R., D'Abramo and Shyn-shinsheen. 1994. Nutritional requirements, feed formulation and feeding practices for intensive culture of the freshwater prawn *Macrobrachium rosenbergii*. Reviews in Fisheries Science, 2(1): 1- 21.

Millikin, M.R., A.R. Fortner, P.H. Fair and L.V. Sick. 1980. Influence of several dietary protein concentrations on growth, feed conversion and general metabolism of juvenile prawn (*Macrobrachium rosenbergii)*. Proceedings of World Mariculture Society, 11: 382–391.

New, M.B. and S. Singholka. 1985. Freshwater prawn farming- A manual for the culture of *Macrobrachium rosenbergii*. FAO Fishery Technology Paper (225) Rev. 1, 118 pp.

Oser, B.L. 1971. Hawk's Physiological Chemistry 14th Ed. TATA McGraw – Hill Publishing Co. Ltd., 1210 pp.

Manuscript received 21 January 2002; Accepted 30 August 2002