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Fish offal based aqua-feed for rearing post-larvae of freshwater prawn, *Macrobrachium rosenbergii*

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Abstract

Market demand for freshwater prawn (*Macrobrachium rosenbergii*) is high in Sri Lanka. The national agencies stock 20 days old post-larvae (PL_{20}) of this prawns in minor perennial reservoirs but the yield is low due to high mortality. There is a need to develop a low-cost nursing strategy for PL_{20} before stocking. This research was conducted to evaluate the potential for nursing PL_{20} in backyard nurseries using low-cost fish offal-based aqua-feed. The trial was carried out in a backyard nursery comprising 6 cement tanks (1.73 $m^{3)}$ each.

One hundred PL_{20} were stocked in each tank (stocking density=57 $PL_{20}m^{-2}$). There were two feeding treatments each with three replicates: (1) fish offal-based aqua feed (Af), and (2) commercial prawn feed (Cf) at a rate of 5% of body weight. Af was made using a 1:1 mixture of rice bran and boiled fish-offal and Cf was purchased from the market. The feeding rate was adjusted for body weight using bi-weekly sampling and the trial was conducted for 96 days.

Average Daily Growth (ADG) of PL_{20} fed with Af on days 16, 30 and 47 were higher than the ADG of PL_{20} fed with Cf on same days but not significantly different ($p>0.05$). However, ADG of PL_{20} that fed on Af on day 85 and 96 were lower than that were fed on Cf on same days but not significantly different ($p>0.05$). Nevertheless, ADG of the PL_{20} that fed on Af on day 63 (0.0038 ± 0.0001 g day^{-1}) was significantly lower ($p<0.05$) than the ADG of PL_{20} that fed on Cf on same day (0.0072 ± 0.0012 g day^{-1}). Specific Growth Rate (SGR) in days 16, 30, 47, 85 and 96 of PL_{20} fed with Af were not significantly different from SGR of PL_{20} fed with Cf in same days. Nevertheless, SGR in day 63 in Af (5.9382 ± 0.0523) and Cf (6.2961 ± 0.0771) were significantly different ($p<0.05$). Weight Gain (WG) of PL_{20} that fed on Cf on days 16, 30, 47 and 96 were not significantly different ($P>0.05$) from WG of PL_{20} that fed on Af on same days. However, WG of the PL_{20} that fed on Cf on days 63 and 85 (0.4551 ± 0.0784 and 1.0117 ± 0.0944 g respectively) were significantly different ($p<0.05$) from WG of PL_{20} that fed on Af on same days (0.2374 ± 0.006 and0.7508 ± 0.0276 g). Percentage survival rates on days 16, 30, 47 and 63 of PL_{20} fed with Af were higher than those of PL_{20} fed with Cf on same days but not

significantly different ($p>0.05$) except the values on day 63 in Af (56.67±1.15) and in Cf (50.3±1.0). However, % survival of PL_{20} that were fed with Af on days 85 and 96 were lower than that of the PL_{20} that fed on Cf but not significantly different ($p>0.05$).

Fish offal-based aqua-feed can therefore be effectively used for nursing PL_{20} of *M. rosenbergii* for 47 days in backyard nurseries.

Keywords: *Macrobrachium rosenbergii*, fish offal, aqua-feed, low level protein diet

Introduction

Giant Freshwater Prawn, *Macrobrachium rosenbergii* is a main candidate for aquaculture in inland waters due to the attributes of becoming gravid in captivity, availability of established techniques for seed production in hatcheries and grow-out culture. Also, there are no major disease problems and has wide consumer acceptance and a high market value. This species has recently emerged as an important shellfish species for culture in south Asian countries after the significant losses observed in penaeid shrimp culture during mid-1990s due to viral diseases (Hasanuzzaman et al. 2009).

Freshwater prawn is an omnivore (Balazs and Ross 1976) and can be grown using low cost aqua-feed (Mitra et al. 2005). Freshwater Prawn grows well even with 15% protein feeds in ponds with sufficient natural food. Trials of Freshwater Prawn culture have been conducted in Sri Lanka by Hettiarachchi and Kularatne (1988).They indicated that the low survival rates in their trials were due to the stocking of PL_{20} stage and suggested that stocking of older PL is necessary to improve the survival rates. National Aquaculture Development Authority (NAQDA) also has stocked *M. rosenbergii* larvae of PL_{20} stage in 9 minor perennial reservoirs and has obtained poor survival (J.M. Asoka, Pers. Comm. 2007).To improve the survival and production in *Macrobrachium* culture it appears that there is a necessity to rear *Macrobrachium* larvae of PL_{20} for a further period of more than 20 days in backyard nurseries before stocking in aquaculture systems. In the present study, an attempt was made to rear the *Macrobrachium* larvae in nursery systems for a period of 96 days using a low cost feed prepared incorporating fish offal.

Materials and Methods

The trial was carried out in the Regional Research Centre of National Aquatic Resources Research and Development Agency (NARA) in Rekawa, Tangalle in Hambantota district. PL_{20} of *M. rosenbergii* were obtained from Freshwater Prawn Hatchery in Pambala, North-Central province in Sri Lanka. One hundred PL_{20}were stocked in backyard nursery comprising 6 cement tanks (1.73 m^3). The stocking density used was 57 PL_{20} m^{-2}.

There were two feed treatments with three replicates: In treatment (1) prawns were fed with fish-offal based aqua-feed (Af), and in treatment (2) with commercial

prawn feed (Cf). In both treatments prawn larvae were fed at a rate of 5% of body weight. Total ration was divided into two parts; about 1/3 of the total feed was given at 10^{th} hr and the remaining amount at 19^{th} hr. Af was made using a 1:1 mixture of rice bran and boiled fish offal and Cf was purchased from Gold Coin Feed Mills (Lanka) Ltd, Colombo, Sri Lanka. The feeding rate was adjusted for body weight using bi-weekly sampling and the trial was conducted for 96 days.

The proximate compositions of Af and Cf were determined according to the standard methods given in APHA (1985). Percentage moisture content was determined by oven drying weighed samples in porcelain crucibles at 105 ºC for 24 hours. The total volatile matter lost at this temperature was taken as the moisture content. Percentage ash content was determined by incinerating the dried samples overnight in a Muffle furnace at 550ºC. Percentage protein (N×6.25) was estimated by semi-micro Kjeldahl digestion, distillation and titration. Percentage fat content was determined through chloroform method (Bligh and Dyer 1959).

Sampling was carried out in each tank on the days 16, 30, 47, 63, 85 and 96.Randomly selected 20 juveniles were taken as a sample from each tank in each occasion. The initial and subsequent weekly weight gains (g) were recorded on a sensitive top loading balance (Precisa 120 A).

The growth performances of the *Macrobraccium* larvae that were fed on 2 different diets were assessed using Specific growth rate (SGR), Average Daily Growth (ADG), Condition Factor (K), Weight Gain (WG) and % Survival. These were calculated using standard definitions from Ricker (1979) and Fasakin et al. (2001).

Means and standard deviations were calculated and expressed as mean ±SD. Student's t-test (Graph PadPrism Software www.graphpad.com) was employed to compare the growth performance of post-larvae that fed on Af and Cf.

Results

The Average Daily Growth (ADG) and Specific Growth Rate (SGR) of the Freshwater prawn that fed on fish-offal based aqua-feed (Af) and commercial feed (Cf) within the 96 days of rearing period are shown in Fig.1. The ADG of the larvae fed on Af and Cf were not significantly different in the day 16, 30, 47, 85 and 96 but significantly different in day 63 respectively. The SGR of the larvae fed on Af and Cf were not significantly different in the day16, 30, 47, 85 and 96 but significantly different in day 63 only. After the day 47, the ADG of the PL fed on Af has shown a slight increase, which was recorded as 0.0038±0.0003 and on the day 63 ADG was 0.0038±0.0001 g day^{-1}. After day 63, it has increased but lower than the ADG of the PL fed on Cf.

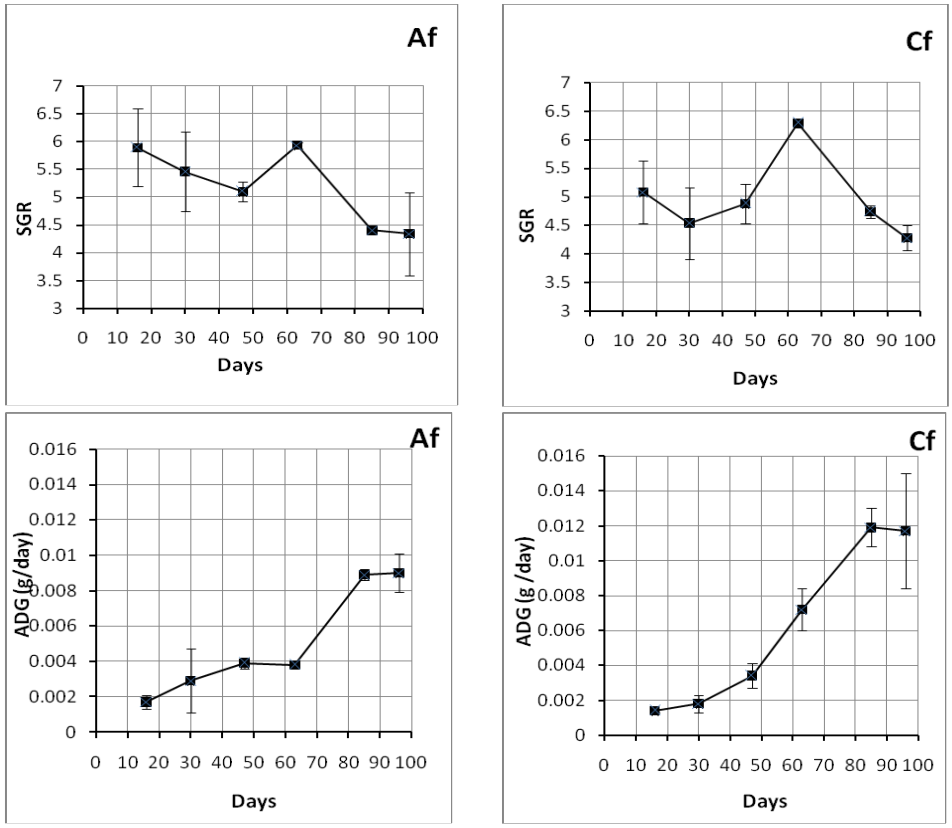

Figure 1. Specific Growth Rate (SGR) and Average Daily Growth (ADG) of the freshwater prawn (*M. rosenbergii*) that fed on commercial feed (Cf) and fish offal substituted aqua-feed (Af) during the 96 days of rearing period.

The weight gain (WG) of the post-larvae fed with Af has shown higher values than that of these fed with Cf up to day 50. After that the values through commercial feed went up and the values through aqua-feed was decreased (Fig.2).

Percentage survival rates of the larvae that fed on Af on days 16, 30 and 47 were (87.7±2.08, 70±2.0 and 63.3±3.51) higher than those of the larvae that fed on Cf (82.3±2.52, 65.3±5.77 and 58.7±1.53). However, these values were not significantly different ($p>0.05$). Nevertheless, % survival rates of the larvae that fed on Af and Cf (56.67±1.15 and 50.3±1.0) on the day 63 were significantly different ($p<0.05$). Although, % survival of the larvae that fed on Cf were higher in day 85 and 96 (50.33±8.39 and 44.1±3.61) than the larvae that fed on Af (47.0±2.65 and 42.3±4.04) these were not significantly different ($p>0.05$) (Table 1).

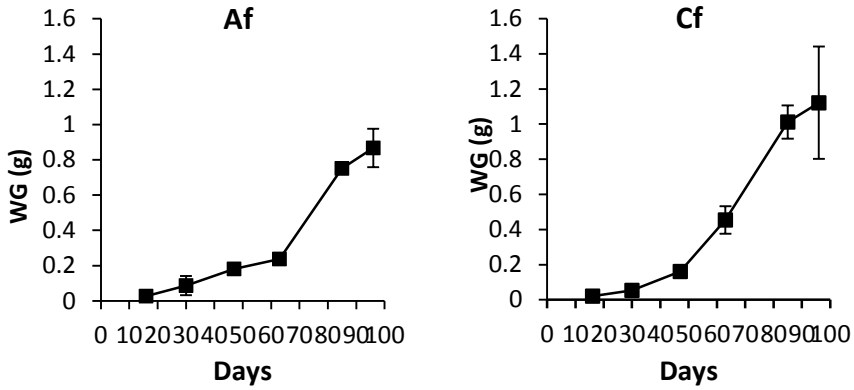

Figure 2. Weight gain (WG) of the freshwater prawn (*M. rosenbergii*) that fed on commercial feed (Cf) and fish offal substituted aqua-feed (Af) within the 96 days of rearing period.

Table 1. Percentage survival of the freshwater prawn (*M. rosenbergii*) larvae (PL_{20}) fed on Commercial feed (Cf) and fish offal substituted aqua-feed (Af) within the 96 days of rearing period.

Feed	Mean % Survival					
	Day 16	Day 30	Day 47	Day 63	Day 85	Day 96
Cf	82.3 ± 2.5^{a}	65.3 ± 5.8^{b}	58.7 ± 1.5^{c}	53.1 ± 1.0^{d}	50.3 ± 8.4^{f}	44.0 ± 3.6^{g}
Af	87.7 ± 2.1^{a}	70.0 ± 2.0^{b}	63.4 ± 3.5^{c}	56.7 ± 1.2^{e}	47.0 ± 2.6^{f}	42.3 ± 4.0^{g}

Values in the same column with different superscripts are statistically different 0.05% level.

The proximate composition of the fish offal substituted aqua-feed (Af) and the commercial prawn feed are shown in Table 2. Commercial prawn feed is nutritionally complete feed for prawn and consist with 36.32% protein. Nevertheless the aqua-feed consist with 18.63% protein which is lesser than the % protein in commercial prawn feed.

Table 2. Proximate compositions of fish offal substituted aqua-feed (Af) and commercial prawn feed (Cf).

	%Moisture	%Dry matter	%Ash	% Protein	% Fat
Aqua-feed (Af)	49.1±4.6	50.9±4.5	2.1±0.8	18.6±0.8	10-12
Commercial Feed (Cf)	10.3±0.03	89.7±0.03	10.5±0.07	36.3±0.2	4-6

Water quality levels observed throughout the experimental period (Table 3) were found to be within the acceptable levels (Boyd 1979).

Table 3. Mean±SD values of water quality parameters observed in the tanks where *Macrobrachium rosenbergii* PL_{20} fed on commercial feed (Cf) and fish offal substituted aqua-feed (Af) within the 96 days of rearing period. The ranges are given in parentheses.

Parameter	Af	Cf
Temperature (°C)	28.0±0.1(26-29.5)	28.1±0.2(26-29)
pH	8.5±0.1(8.0-9.2)	8.4±0.0(8.1-8.9)
Dissolved oxygen (mg L^{-1})	9.4±0.02 (8.1-10.5)	9.5±0.3 (8.3-10.5)

Discussion

Results indicate that further rearing of PL_{20} could be done using fish offal-based aqua-feed. Based on SGR and ADG, the proposed length of the rearing period is less than 47 days and 47-50 would be the most suitable. Accordingly, this information has to be disseminated to farming communities involved in freshwater prawn culture. This information can also be used to increase the survival and production of the freshwater prawn reared in minor perennial reservoirs. Further, these developments can be used to enhance the profitability of *M. rosenbergii* culture in ponds and minor perennial reservoirs and will generate self-employment for rural communities.

Freshwater prawn larvae are opportunistic feeders (Jiménez-Yan et al. 2006). They can digest and absorb most of the nutrients contained in the feed. In this trial, freshwater prawn larvae have shown comparatively higher growth when fed with Af than Cf over the period of 47 days until they become PL_{67}.This proposes that the amount of nutrients is sufficient enough to achieve acceptable growth from PL_{20}–L_{67}.These larvae can then be used for further rearing in grow-out ponds, which will contribute towards better survival and better production rates in aquaculture and culture-based fisheries.

In the preparation of feed for rearing the PL_{20} of freshwater prawn up to PL_{67}, fish offal can be used as the main protein provider instead of fishmeal. According to Balios (2003), fish offal contains all the essential amino acids (EAA) that require for the growth of juvenile prawns (Table4).

The formulated feed had a high level of carbohydrate which was estimated as 70%. Carbohydrate is an inexpensive and immediate source of energy in fish diets (Erfanullah and Jafri 1998). It serves as a precursor for the various intermediary metabolic functions. As such, in the presence of carbohydrate in fish diets the expensive protein component is not used as energy source for the functions that could cover by carbohydrate. Accordingly, larvae fed with this diet can utilize the available carbohydrate for their energy requirement and can spare protein for their growth. Wilson (1994) has shown the presence of carbohydrate in fish diets has a protein-sparing effect similar to that of lipid. It may be the reason for higher growth of PL_{20}

up to PL_{67} when fed with fish offal based aqua-feed. Mitra et al. (2005) has reported that freshwater prawn can grow well with 15% protein diet in ponds with natural foods. Accordingly, the prepared Af with 18.6% protein may be sufficient for PL_{20} rearing up to PL_{67} (Table 2).

Table 4. Essential amino acid profile (% in dry weight basis) of the fish offal (Adopted from Balios 2003) and other protein ingredients that are mainly used in fish feed formulation, i.e., fishmeal (Herring) and oil extracted soybean meal. (Adopted from Kai Li et al. (2009).

	Protein ingredients		
	Fish-offal	Fishmeal (Herring)	Soybean meal
Arginine	1.92	3.87	3.15
Isoleucine	2.22	2.95	2.05
Histidine	0.98	2.40	1.34
Leucine	3.24	4.94	3.36
Methionine	1.11	1.98	0.38
Phenylalanine	1.67	2.81	2.27
Threonine	1.83	2.89	1.81
Trytophane	0.37	2.15	1.50
Lysine	2.28	6.01	2.78
Valine	2.62	3.06	1.93
Cysteine	0.51	0.31	0.26
Tyrosine	1.32	2.15	1.50

The increase of ADG of the PL fed on Af as well as those fed on Cf after day 63 may be due to the molting of PL. Lee and Wickins (1992) have recorded that the external shell (exoskeleton) of crustaceans is capable only of limited expansion and that growth occurs through molting intervals throughout life. The decreased growth of PL that were fed on Af after day 47 (PL_{63}) may be due to inadequate essential amino acids and protein that could be provided through fish offal.

However, Hasanuzzaman et al. (2009) have reported the highest weight of prawn when fed on diet where 80% fishmeal protein was replaced by extracted Soybean meal (SBM). As SBM is an expensive protein ingredient in Sri Lanka, it could not be used in low-cost feed preparation. The formulated Af had 18.6% protein which was lower than that of Cf. However, faster growth rate of PL was observed with Af until the day 47. Mitra et al. (2005) has obtained similar results for freshwater prawn grown with 15% protein in ponds with sufficient natural food. In this trial too, certain amounts of natural food may have been produced in culture ponds.

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