Effect of Low Cost Locally Available Ingredients on the Growth Performance of Juveniles Freshwater Prawn *Machrobrachium Rosenbergii* in the Laboratory

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Abstract

Fiji has a strong demand for shrimp but farmers have hard time meeting the demand due to inadequate knowledge of local ingredients. A nutritional study was conducted to evaluate the growth performances of juveniles of the freshwater prawn species *Machrobrachium rosenbergii*. The prawns were fed with low cost formulated diets using locally available ingredients. Two experiments were conducted with six different diets in each of the experiment. In Experiment 1, diets were mainly based on carbohydrate ingredients (fish meal+wheat, fish meal+meat bone meal+wheat, Fish bone+fish meal+wheat, Meat bone meal+wheat, Meat fish meal+fish meal+wheat and Meat fish meal+wheat). While diets for Experiment 2 were based protein ingredients (Fish meal+wheat, Fish meal+meat meal, Fish meal+meat meal+crest tilapia pellet, Fish meal+meat meal+copra meal, Fish meal+wheat+pea meal and Crest tilapia pellet). Each experiment (6 diets x 3 replicates) was carried out in the laboratory. Juveniles were fed twice a day for a period of three and four weeks in Experiment 1 and 2 respectively. Results indicated no significant (P>0.05) differences in water quality parameters. All nitrate, nitrite and ammonia concentrations were less than 0.2 mg/L. Fat and crude fiber contents were lowest and highest respectively in crest pellet tilapia (4.60% and 17.98%). Experiment 1 showed slight variations in growth performance. In Experiment 2, crest tilapia pellets indicated better result in weight gain (7.04 ± 2.96 mm), carapace, abdomen and body length (4.74 ± 1.94, 5.57 ± 0.62 and 5.57 ± 0.62), specific growth rate (2.38 ± 0.53) and feed intake (1.31 ± 1.19). However, no significant differences (P ≥ 0.05) were observed in either of the experiments. The costs of making each feed was almost same (0.53–0.58 Aus $/Kg). The findings indicate that the ingredient inclusion level for local ingredients available in Fiji could be quite flexible and used successfully for the growth of fresh water prawn juveniles (*M. rosenbergii*).

Keywords: Local diets; Juveniles prawn; Growth performance; Fiji

Introduction

Nutrient requirement and feed utilization can be estimated from intake (utilization) measurements, palatability and digestibility [Gonzales 1]. An ingredient inclusion trial is probably the simplest way to examine effects on feed intake [1]. An ingredient can be incorporated into a reference diet to create a test diet. Significant differences in feed intakes between the reference diet and test diets indicate the clear palatability of the test ingredients Glencross [2].

In Fiji, there is a huge concern about the farmed *M. rosenbergii* usually maturing very early (3-5 months) from the PL stage and diets have been identified as one of the reasons for this common problem. Increasing costs have resulted in the increase in price of feed. Currently, a 25 kg bag of prawns and tilapia feed, sold at Crest Feed Mill costs FJ$ 40.20 and FJ$ 31.32 respectively. Pacific Feeds Ltd is also a producer of prawn species. The prawn species used in the formulations, as some were not available in supply at the time of the experiment and obtaining those ingredients were not economical due to shipment expenditures.

Materials and Methods

Experimental set up

The experimental system was conducted at the Sea Water Wet Laboratory of the University of the South Pacific (USP) between September and December, 2010. Eighteen 100 L aquaria (58.5 x 38.5 x 44.5 cm) were connected to a temperature controlled recirculation system. All of the aquaria were kept on wooden benches to assist better observation and accessibility. Water was supplied from a 300 L sump tank with a constant water flow rate (0.3 L/min) into each aquarium. Water was circulated through a common biological filter system.

The water parameters were checked daily and maintained within the following limits:

- Temperature 29.0 ± 0.5°C, pH 6.5-7.5, DO>6.0 mg/L, ammonia<0.2 mg/L, nitrate<1.0 mg/L and nitrite<0.1 mg/L. A natural photoperiod of 12 h light and 12 h darkness was maintained throughout the experimental period.

Local ingredients

The local ingredients available in Fiji including their costs and sources are shown in Table 1. The feed ingredients were purchased in 35 kg bags and stored in the freezer at the Wet-lab. Feed stuff was analyzed at the QDPI laboratory in Brisbane, Australia. Not all of the ingredients were used in the formulations, as some were not available in supply at the time of the experiment and obtaining those ingredients were not economical due to shipment expenditures.

Formulation and feed preparation

Six experimental diets were formulated to be isoenergetic,

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isoproteic and isolipidic. Diets for both experiments were prepared at the Physicochemical Laboratory facilities at the School of Marine Studies (USP). Before weighing out the quantities required, all of the dry ingredients (except the Premix) were sieved on 1.0 & 0.5 mm diameter mesh dies to remove any irregular sizes of impurities, such as small pieces of scales, hairs, grains, husk and large fragments. The dry ingredients were weighed out as per formulae (Tables 2 and 3), mixed manually and fish oil was added until a homogeneous mixture was obtained.

Water was sufficiently added in order to get a wet enough consistency to obtain dough. The mixture was then pressed through an electrical meat mincer which had die pellets of 2 mm diameter. The pellets were then dried in an electrical oven at 50°C for 24 h. The resulting pellets were then stored in labeled polyethylene plastic bags at a temperature of -10°C.

The same above procedure was done for the preparation of Experiment 2 diets. However, fish oil was not used in the second experiment in order to keep lipid levels homogenous. A few ingredients Experiment 2 diets. However, fish oil was not used in the second experiment in order to keep lipid levels homogenous. A few ingredients were not used because they were not available.

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The commercial tilapia pellet of Experiment 2 was obtained from Crest Feed Mill in pellet form and used as a reference diet, because it is widely used by Fijian farmers (Table 4).

Every ingredient and experimental diet was analyzed at the Queensland Department of Primary Industry in Brisbane (Australia). The proximate compositions of ingredients and the formulated diets were analyzed according to AOAC (2005) procedures. Nitrogen-free extract was determined on a dry weight basis by subtracting the percentage of crude protein, lipids, fibre and ash from 100 %. Gross energy content was determined by using a bomb calorimeter.

### Stocking in Aquaria
For Experiment 1, 250 *M. rosenbergii* juveniles were obtained from Dairy Farm Fiji Ltd., located in Navua. Juveniles were acclimated for 10 days. Mean total body weights and lengths were recorded with an initial weight of 3.45 ± 0.99 g using an analytical balance (A&D®, model FG 6000H) and a length of 50.27 ± 1.34 mm using an electronic digital caliper (Lufkin®). The stocking density for Experiment 1 was 10 juvenile prawns for each of 18 aquaria (3 replicates x 6 treatments-diets). Every ingredient and experimental diet was analyzed at the Queensland Department of Primary Industry in Brisbane (Australia). The proximate compositions of ingredients and the formulated diets were analyzed according to AOAC (2005) procedures. Nitrogen-free extract was determined on a dry weight basis by subtracting the percentage of crude protein, lipids, fibre and ash from 100 %. Gross energy content was determined by using a bomb calorimeter.

### Feeding and data collection
Prawns were fed twice a day (8:00 am and 4:00 pm) for a period of three weeks in Experiment 1 and four weeks in Experiment 2. At each feeding, prawns were given one hour to consume their feed ration after which uneaten feed was removed by siphoning from each aquarium using a filtration apparatus. Water replacement was made by pumping water from a reserve tank to fill up the loss due to evaporation and to account for water loss during the daily siphoning of uneaten feed. This daily collection of uneaten feed was filtered onto a filter paper on which was then rolled into a foil and stored in the fridge until drying and re-weighing the next day. The difference in weight was interpreted as feed consumed. The water parameters such as temperature, dissolved oxygen (YSI® model 85) and pH (YSI® model pH 100) were measured daily. After each experiment, the animals were re-weighed and had their lengths measured. The ammonia, nitrate and nitrite concentrations were measured using a freshwater quality test kit.

### Calculations
Weight gain (WG), total body length gain (BLG), specific growth
rate (SGR; % per day) feed conversion ratio (FCR), protein energy ratio (PER) and survival (%) were all calculated as follows:

\[ WG = \frac{\text{Final body weight (g) - Initial body weight (g)}}{\text{Initial body weight (g)}} \]

\[ BLCG = \frac{\text{Final body length (g) - Initial body length (g)}}{\text{Initial body length (g)}} \]

\[ SGR = \frac{\ln (FBW - In IBW) \times t}{100}\] where FBW is final body weight; IBW is initial body weight;

\[ \ln = \text{natural logarithmic; } t = \text{time in days} \]

\[ FCR = \frac{\text{Feed intake (g)}}{\text{weight gain (g)}} \]

\[ \text{PER} = \frac{\text{live weight gain (g)}}{\text{protein intake (g)}} \]

\[ S\% = \frac{\text{(final number of prawns-initial number of prawns)}}{\text{x 100}} \]

Means and standard deviations were calculated and expressed as mean ± SD.

### 4.7. Production costs

The production costs were calculated as follows:

\[ \text{Initial Biomass} = 0.08 \times g \times \text{initial number of prawns} \]

\[ \text{Final Biomass} = \text{final weight (g)} \times \text{final number of prawns} \]

\[ \text{Product (g)} = \text{final biomass (g)} - \text{initial biomass (g)} \]

\[ \text{Cost of feed (FJ$)} = \text{total feed (kg)} \times \text{cost of diet (FJ$)} \]

\[ \text{Cost of feed (AUS)} = \text{total feed (kg)} \times \text{cost of diet (AUS)} \]

\[ \text{Cost to produce 1kg prawn} = \text{FCR} \times \text{cost of diet (FJ$)} \]

### Statistical analysis

The data obtained was statistically analyzed by performing analysis of variance (ANOVA). The effect of different diets on FBW, WG, SGR, FCR, PER and S (%) were carried out using one way ANOVA. Water temperature is 29-31°C, the optimal pH is 7.0-8.5, and the optimal temperature is 29-31°C. The results are presented in Table 6. The water temperature ranged from 27.80 ± 0.09°C to 28.07 ± 0.20°C (the highest value was observed for MBM1 diet). Survival ranged from 63.33 ± 3.33 to 86.66 ± 13.33 % with highest value of survival seen in prawns fed with MBM3 diet. The feed intake, among all treatments, presented no significant differences (P ≥ 0.05).

Generally, the protein quality of dietary ingredients affects growth performance. Protein quality of dietary protein sources depends on the amino acid compositions and their digestibility. Deficiency of an essential amino acid leads to poor utilization of the dietary protein and thus reduces growth and decreases feed efficiency. Hardy [3], Hossain [4] found out that PLs of *M. rosenbergii* raised in a recirculation system for 60 days and fed a commercial shrimp nursery diet (30 %) achieved survival rate of 76 % and SGR of 3.28 %/day. The use of different protein sources in various combinations has been found to be more effective than that of a single source in the substitution of fishmeal in feeds because it prevents the high inclusion level of any single anti-nutrient in the diet. Hossain [5], Yang [6] on *Macrobrachium nipponense* and Zhu [7] on *Liptopeneus vannamei* juveniles reported no significant differences in growth with diets having varying inclusion levels (0-60%) of two protein sources e.g. fish and meat-bone meal. Growth rate was negatively affected by meat-bone meal when the fish meal replacement levels were above 14% and 17% respectively in *M. rosenbergii* [4]. Generally, the protein quality of dietary ingredients affects growth performance. Protein quality of dietary protein sources depends on the amino acid compositions and their digestibility. Deficiency of an essential amino acid leads to poor utilization of the dietary protein and thus reduces growth and decreases feed efficiency. Hardy [3], Hossain [4] found out that PLs of *M. rosenbergii* raised in a recirculation system for 60 days and fed a commercial shrimp nursery diet (30 %) achieved survival rate of 76 % and SGR of 3.28 %/day. The use of different protein sources in various combinations has been found to be more effective than that of a single source in the substitution of fishmeal in feeds because it prevents the high inclusion level of any single anti-nutrient in the diet. Hossain [5], Yang [6] on *Macrobrachium nipponense* and Zhu [7] on *Liptopeneus vannamei* juveniles reported no significant differences in growth with diets having varying inclusion levels (0-60%) of two protein sources e.g. fish and meat-bone meal. Growth rate was negatively affected by meat-bone meal when the fish meal replacement levels were above 14% and 17% respectively in *M. rosenbergii* [4]. Generally, the protein quality of dietary ingredients affects growth performance. Protein quality of dietary protein sources depends on the amino acid compositions and their digestibility. Deficiency of an essential amino acid leads to poor utilization of the dietary protein and thus reduces growth and decreases feed efficiency. Hardy [3], Hossain [4] found out that PLs of *M. rosenbergii* raised in a recirculation system for 60 days and fed a commercial shrimp nursery diet (30 %) achieved survival rate of 76 % and SGR of 3.28 %/day. The use of different protein sources in various combinations has been found to be more effective than that of a single source in the substitution of fishmeal in feeds because it prevents the high inclusion level of any single anti-nutrient in the diet. Hossain [5], Yang [6] on *Macrobrachium nipponense* and Zhu [7] on *Liptopeneus vannamei* juveniles reported no significant differences in growth with diets having varying inclusion levels (0-60%) of two protein sources e.g. fish and meat-bone meal. Growth rate was negatively affected by meat-bone meal when the fish meal replacement levels were above 14% and 17% respectively in *M. rosenbergii* [4].

### Results and Discussion

#### Experiment 1

**Proximate analyses:** The proximate analyses of the experimental ingredients are shown in Table 5. The crude proteins ranged from 13.91% to 57.69% (dry weight) with meat fish meal showing the highest crude protein content and wheat showing the lowest. The crude fat content ranged from 4.40% to 26.50% with meat fish meal showing the highest crude fat content and wheat showing the lowest. The gross energy ranged from 19.12MJ/kg to 23.94 MJ/kg with meat bone meal showing the highest gross energy and wheat showing the lowest.

The proximate analyses of the experimental diets are shown in Table 6. The crude protein content was 30 % and the crude fat content was 10% for all the diets. The crude fibre ranged from 6.16% to 7.81%; with MFM2 showing higher levels and MBM3 showing the lowest. The gross energy ranged from 19.09 MJ/kg to 19.59 MJ/kg with MBM3 showing highest t and MFM2 showing the lowest gross energy content.

**Growth performance, survival rate and feed intake:** There was no difference (P ≥ 0.05) with regard to animal performance. Weight gain ranged from 0.55 ± 0.43 to 1.27 ± 0.48 g. In terms of value, highest weight gain was achieved by prawns fed with control diet. Total body length gain ranged from 7.06 mm ± 1.18 mm to 10.30 mm ± 2.03 mm (the highest value was observed for MBM1 diet). Survival ranged from 63.33% ± 3.33 to 86.66 ± 13.33 % with highest value of survival seen in prawns fed with MBM3 diet. The feed intake, among all treatments, presented no significant differences (P ≥ 0.05).

The specific growth rate (SGR) for prawns with different treatments ranged from 0.81 ± 0.36 to 1.45 ± 0.08%/day. Hari [11] obtained the highest levels at 0.81 ± 0.36 to 1.45 ± 0.08%/day. For the optimal temperature, the optimal temperature is 29-31°C, the optimal pH is 7.0-8.5, and the optimal temperature is 29-31°C.
salinity is 0-10 ppt New [12]. The effects of pH, temperature and salinity on the oxygen consumption and nitrogen excretion on *M. rosenbergii* have been studied by Nelson [13] and Chen [14]. *Enterococcus* infection in *M. rosenbergii* is exacerbated by high pH (8.8-9.5) and high temperature (33-34º C), but reduced by low salinity (5-10ppt) Cheng [15].

**Experiment 2**

**Proximate analysis:** The proximate analyses of the experimental ingredients are shown in Table 9. The crude protein and crude fat ranged from 16.47% to 23.19 % (dry weight) and 4.10% to 13.20% respectively. Highest and lowest crude protein was observed in Copra meal and wheat while highest and lowest crude fat was found in copra meal and mill mix. The gross energy ranged from 18.52 MJ/kg to 19.95 MJ/kg with copra meal showing the highest gross energy and wheat showing the lowest.

The proximate analyses of the experimental diets are shown in Table 10. The crude protein and fat content was 30% and 10% for all of the diets. The crude fibre ranged from 3.49% to 17.98% with Crest Tilapia Pellet (CTP) and Copra (CP) showing the highest and lowest.
Fiji showed no significant differences in the intake levels for the two ammonia levels were <0.2 mg/L (Table 12).

The water temperature ranged from 27.88 ± 0.04°C to 27.99 ± 0.03°C; D.O. from 7.15 ± 0.03 mg/L to 7.22 ± 0.01 mg/L and pH from 7.3 to 7.5. All nitrate, nitrite and ammonia levels were <0.2 mg/L (Table 12).

Therefore, the findings of these two experiments indicated that the ingredient inclusion level for selected local ingredients available in Fiji showed no significant differences in the intake levels for the two batches of selected local ingredients. The omnivore nature of freshwater prawns permits the use of a wide variety of locally available ingredients including commercial by-products, as ingredients in formulated feeds. This suggests that inclusion levels for formulation of diets for freshwater prawn *M. rosenbergii* could be quite flexible.

### Conclusions and Recommendations

The present commercially available feeds are inconsistent in supply and costly for farmers to purchase. The idea was to produce a diet using locally available ingredients which could be easily prepared by farmers as “on farm- feeds” and in the future, suggested to commercial feed companies to produce and supply. Locally available ingredients were identified as fish meal, meat bone meal, meat fish meal, copra meal, wheat, mill mix, rice meal and pea meal. The assessment of selected ingredients locally available in Fiji showed that the inclusion of feed ingredients for the formulation of diets for the giant freshwater prawn is flexible. Commercially, the use of ingredients in formulated feed should be cost- effective and should be available in large quantities in areas where culture operations occur. It is not always necessary that the best diet will be the cheapest one. However, it will produce better growth and lower FCR values which will be more economical in the long-term. A limited number of ingredients are used in the formulation of feeds in aquaculture in Fiji. When formulating a diet for freshwater prawns permits the use of a wide variety of locally available ingredients including commercial by-products, as ingredients in formulated feeds. This suggests that inclusion levels for formulation of diets for freshwater prawn *M. rosenbergii* could be quite flexible.

### References

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