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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 *Macrobrachium 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 meal+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 ($P \geq 0.05$) 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 tilapia and prawn pellets selling at FJ$ 25.00 and FJ$ 37.00 respectively. As part of the Fiji Islands Freshwater Aquaculture Sector Plan 2005-2010, the Government has recognized the potential in freshwater prawn farming in Fiji, and thus has emphasized its development and production expansion in the coming years. In view of this initiative, a study was undertaken to evaluate feed intakes of *M. rosenbergii* for six diet formulations that all utilized local ingredients.

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 in Experiment 2, like pea meal and wheat, had to be finely grinded using an electric blender due to the coarse nature of the ingredients.

Ingredient	Source	Price/Ton	
		FJD$	AUS$
Copra meal	Rewa Dairy Fiji Ltd, Suva	580	480
Fish meal	Pacific Fishing Company, Ltd, Suva	800	662
*Meat bone meal	Fiji Meat Industry Board, Suva	760	629
*Meat fish meal	Pacific Fishing Company, Ltd, Suva	800	662
Mill mix	Flour Mills of Fiji, Suva	350	289
Pea meal	Flour Mills of Fiji, Suva	550	455
Rice bran meal	Evergreen Rice Ltd, Navua	560	463
Wheat	Flour Mills of Fiji Ltd, Suva	825	682

*Meat bone meal and meat fish meal ingredients have no fixed proportions of its combination.

Table 1: Raw ingredients and suppliers in Fiji.

Ingredients	Control	MBM1	MBM2	MBM3	MFM1	MFM2
Fish meal	41.2	16.5	8.2	0.0	8.2	0.0
Wheat	53.8	55.6	56.2	56.8	58.2	59.3
Premix[a]	2.0	2.0	2.0	2.0	2.0	2.0
Meat-bone meal	0.0	24.7	33.0	41.2	0.0	0.0
Meat-fish meal	0.0	0.0	0.0	0.0	30.2	37.7
Fish oil	3.0	1.2	0.6	0.0	1.4	1.0
TOTAL	**100**	**100**	**100**	**100**	**100**	**100**

[a]Vitamin-mineral premix obtained from Port Stephens Fisheries Institute and supplied by Ridley Aquafeed Pty Ltd, Australia.

Table 2: Formulation (%) of the diets based on different inclusion levels (fish meal, meat bone meal and meat fish meal) tested on *M. rosenbergii* juveniles (Experiment 1).

Ingredients	WHT	MM1	MM2	CP	PM	CTP
Fish meal	44.0	44.0	35.0	30.0	40.0	Crest Tilapia pellet
Wheat	54.0	0.0	0.0	0.0	26.0	
Mill mix	0.0	54.0	38.0	23.0	2.0	
Copra meal	0.0	0.0	25.0	45.0	0.0	
Pea meal	0.0	0.0	0.0	0.0	30.0	
[a]Premix	2.0	2.0	2.0	2.0	2.0	
TOTAL	**100**	**100**	**100**	**100**	**100**	

[a]Vitamin-mineral premix obtained from Port Stephens Fisheries Institute and supplied by Ridley Aquafeed Pty Ltd, Australia.

Table 3: Formulation (%) of the diets based on different inclusion levels (wheat, mill mix, copra meal, and pea meal) tested on *M. rosenbergii* juveniles (Experiment 2).

Ingredients	Quantity/Batch (kg)
RPAN Fish Premix	8
Salt	4
Lysine	1
Choline	4
Wheat	310
Soya	218
Mill mix	490
Fish meal	320
Copra	240
Molasses	100
Pea meal	300
TOTAL	**1995**

(Source: Crest Feed Mill, Nausori, Fiji).

Table 4: Formulation of Crest Tilapia Pellet (Experiment 2).

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 EK 600H) 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 18 aquaria (3 replicates x 6 treatments-diets). For Experiment 2, juveniles were obtained from NRS and the stocking density was lower at 8 juvenile prawns for each of 18 aquaria (3 replicates x 6 treatments-diets, initial weight 6.85 ± 0.65 g and length 64.33 ± 1.15 mm). Pieces of hollow PVC were placed in each aquarium as hide outs for prawns to reduce stress.

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 = Final body weight (g)-Initial body weight (g)

BLG = Final body length (g) - Initial body length (g)

SGR = (In FBW-In IBW) / t x 100; where FBW is final body weight; IBW is initial body weight;

In = natural logarithmic; t = time in days

FCR = Feed intake (g) / weight gain (g)

PER = live weight gain (g) / protein intake (g)

S (%) = (final number of prawns-initial number of prawns) x 100

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

4.7. Production costs

The production costs were calculated as follows:

Initial Biomass = 0.08 g x initial number of prawns

Final Biomass = final weight (g) of prawns x final number of prawns

Product (g) = final biomass (g)-initial biomass (g)

Cost of feed (FJ$) = total feed (kg) x cost of diet (FJ$)

Cost of feed (AU$) = total feed (kg) x cost of diet (AU$)

Cost to produce 1kg prawn = FCR x 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 parameters were also analyzed using one way ANOVA.

Components	Fish meal	Meat & Fish meal	Meat Bone meal	Wheat
Dry matter	93.20	94.60	92.80	89.00
Protein	54.63	57.69	53.69	13.91
Lipid	20.50	26.10	26.50	4.40
Ash	24.50	17.30	16.90	5.40
Gross Energy (MJ/kg)	21.00	23.43	23.94	19.12
Cost (AU$/kg)	0.66	0.66	0.63	0.68
Cost (FJ$/kg)	0.80	0.08	0.76	0.83

Table 5: Proximate composition of experimental ingredients (Winfeed Stochastic Formulation % DM basis) (Experiment 1).

Components	Control	MBM1	MBM2	MBM3	MFM1	MFM2
Dry matter	93.82	93.67	92.40	91.40	93.24	94.19
Protein	30.00	30.00	30.00	30.00	30.00	30.00
Lipid	10.00	10.00	10.00	10.00	10.00	10.00
Ash	11.21	11.09	9.32	9.27	11.28	11.51
Crude Fibre	7.46	7.32	7.02	6.16	7.00	7.81
Gross Energy (MJ/kg)	19.12	19.14	19.53	19.59	19.17	19.09
Cost (AU$/kg)	0.55	0.54	0.54	0.53	0.55	0.57
Cost (FJ$/kg)	0.94	0.95	0.95	0.95	0.74	0.69

Note: MBM1, MBM2, MBM3 represent deferent meat bone meal inclusion levels. MFM1 and MFM2 represent different meat fish meal inclusion levels.

Table 6: Proximate composition of experimental diets (Winfeed Stochastic Formulation % DM basis) (Experiment 1).

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 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 ($P \geq 0.05$) 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 MFM1diet). 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 ($P \geq 0.05$).

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 PL's 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 *Liptopenaeus 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* and red drum fish [8-9]. Similarly, Forster [10] reported that replacement of fish meals by meat-bone meals above 25% reduced the growth performance of *Liptopenaeus vannamei.*

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 SGR (3.72 %/ day) of *M. rosenbergii* with diets containing 30% protein and varying amounts of trash fishmeal and groundnut oilcake (Table 7).

Water quality parameters: There were no significant ($P \geq 0.05$) differences in temperature and D.O among treatments in Experiment 1. The water temperature ranged from 27.80 ± 0.09°C to 28.07± 0.03°C, D.O from 7.14 ± 0.04 to 7.24 ± 0.01 mg/L and pH from 7.4 to 7.5. All nitrate, nitrite and ammonia levels were <0.2 mg/L (Table 8). *M. rosenbergii* can tolerate a wide range of temperature (14- 35°C) and a wide range of salinity levels (0-25 ppt). For growth, the optimal temperature is 29-31°C, the optimal pH is 7.0-8.5, and the optimal

Parameters	Control	MBM1	MBM2	MBM3	MFM1	MFM2	F	P value
Initial weight (g)	4.00 ± 0.20	4.01 ± 0.07	3.08 ± 0.24	3.57 ± 0.11	3.14 ± 0.55	2.86 ± 0.19	3.20	0.05
Final weight (g)	5.28 ± 0.30	4.77 ±	3.70 ± 0.24	4.82 ± 0.35	4.25 ± 0.71b	3.48 ± 0.20	3.26	0.04
Weight gain (g)	1.27 ± 0.48	0.28	0.55 ± 0.43	1.24 ± 0.26	1.11 ± 0.16	0.62 ± 0.03	0.91	0.51
Carapace length gain (mm)	3.65 ± 0.52	0.75 ± 0.35	2.61 ± 0.57	3.22 ± 0.14	3.58 ± 1.42	2.27 ± 0.11	1.04	0.44
Abdomen length gain (mm)	4.42 ± 0.71	1.99 ± 0.37	4.85 ± 1.00	5.45 ± 0.49	6.72 ± 0.72	5.21 ± 0.76	1.04	0.44
Total Body length gain (mm)	8.08 ± 1.06	5.06 ± 0.84	7.47 ± 1.54	8.67 ± 0.52	10.30 ± 2.03	7.49 ± 0.65	0.86	0.53
Survival (%)	63.33 ± 8.82	7.06 ± 1.18	86.66 ± 13.33	86.66 ± 6.67	70.00 ± 10.00	80.00 ± 0.00	1.74	0.20
SGR (%/day)	1.31 ± 0.49	63.33 ± 3.33	0.88 ± 0.60	1.41 ± 0.23	1.45 ± 0.08	0.94 ± 0.06	0.64	0.67
Feed Intake (g/day)	1.09 ± 0.05	0.81 ± 0.36	0.78 ± 0.09	1.19 ± 0.04	0.91 ± 0.14	0.79 ± 0.03	5.377	0.07
FCR	0.86 ± 08	1.08 ± 0.021. 44 ± 2.53	1.42 ± 4.35	0.96 ± 0.21	0.82 ± 0.03	1.27 ± 0.08	0.84	0.55

Table 7: Mean growth performance, survival and feed intake of *M. rosenbergii* fed six different diets of varying inclusion levels of meat bone meal and meat fish meal for 21 d (n = 10). Values (Mean ± SE) (Experiment 1).

Diets	Temperature (ºC)	D.O (mg/L)
Control	27.80 ± 0.09	7.14 ± 0.04
MBM1	27.93 ± 0.02	7.18 ± 0.01
MBM2	27.87 ± 0.03	7.17 ± 0.01
MBM3	27.93 ± 0.03	7.20 ± 0.02
MFM1	27.98 ± 0.04	7.22 ± 0.01
MFM2	28.07 ± 0.03	7.24 ± 0.01
F-value	3.95	2.77
P value	0.20	0.07

Table 8: Average water temperature and dissolved oxygen different diets for 21 d (Experiment 1).

Components	Wheat	Copra meal	Pea meal	Mill mix
Dry matter	89.00	97.30	90.00	87.50
Protein	16.47	23.19	18.50	17.63
Lipid	1.90	13.20	1.50	4.10
Ash	1.70	5.70	2.80	4.20
Gross Energy (MJ/kg)	18.52	19.95	18.76	19.28
Cost (AU$/kg)	0.68	0.48	0.46	0.29
Cost (FJ$/kg)	0.83	0.58	0.55	0.35

Table 9: Proximate composition of ingredients (Winfeed Stochastic Formulation % DM basis. (Experiment 2).

Components	WHT	MM1	MM2	CP	PM	CTP
Dry matter	88.26	91.75	92.54	89.72	89.20	89.10
Protein	30.00	30.00	30.00	30.00	30.00	31.00
Lipid	10.00	10.00	10.00	10.00	10.00	4.60
Ash	12.03	11.98	12.13	13.55	11.38	11.20
Crude Fibre	4.16	5.94	6.25	3.49	9.18	17.98
Gross Energy (MJ/kg)	17.79	17.92	17.18	17.13	17.60	18.30
Cost (AU$/kg)	0.79	0.58	0.59	0.62	0.72	0.89
Cost (FJ$/kg)	0.96	0.71	0.72	0.75	0.87	1.08

Note: MM1 and MM2 represent different mill mix inclusion levels. CP and PM represent copra meal and pea meal inclusion level respectively, CTP refers to Crest Tilapia Pellet.

Table 10: Proximate composition of experimental diets (Winfeed Stochastic Formulation % DM basis (Experiment 2).

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 (33-34° 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

Parameters	WHT	MM1	MM2	CP	PM	CTP	F	P value
Initial weight (g)	5.30 ± 0.69	5.40 ± 0.85	6.46 ± 1.21	9.15 ± 0.47	8.43 ± 1.15	6.73 ± 0.90	2.98	0.05
Final weight (g)	7.46 ± 1.16	7.63 ± 1.49	10.73 ± 1.18	12.42 ± 0.52	11.8 ± 0.98	13.77 ± 3.70	2.01	0.14
Weight gain (g)	2.16 ± 0.54	2.24 ± 0.66	4.26 ± 2.37	3.27 ± 0.06	3.37 ± 0.30	7.04 ± 2.96	1.28	0.33
Carapace length gain (mm)	0.47 ± 0.27	1.39 ± 0.53	2.60 ± 1.83	1.37 ±0.50	2.31 ± 0.59	4.74 ±1.94	1.48	0.26
Abdomen length gain (mm)	3.46 ± 2.01	1.64 ± 0.71	5.03 ± 3.94	2.39 ±0.46	2.97 ±1.15	5.51 ± 0.62	0.66	0.65
Total Body length gain (mm)	4.76 ± 2.24	3.04 ± 1.21	7.63 ± 5.73	3.76 ± 0.58	5.28 ± 1.45	10.25 ± 2.47	0.85	0.53
Survival (%)	58.33 ± 23.20	66.66 ± 8.33	54.16 ± 22.05	79.16 ± 8.33	54.16 ± 18.16	62.50 ± 25.00	0.25	0.92
SGR (%/day)	1.20 ± 0.16	1.20 ± 0.15	1.91 ± 1.12	1.09 ± 0.03	1.25 ± 0.24	2.38 ± 0.53	1.00	0.46
Feed intake (g/day)	0.53 ± 1.13	0.67 ± 0.32	0.70 ± 1.04	1.75 ± 0.22	1.09 ± 0.65	1.31 ± 1.19	0.32	0.88
FCR	0.25 ± 0.04	0.30 ± 0.05	0.16 ± 0.14	0.54 ± 0.04	0.32 ± 0.11	0.19 ± 0.09	2.61	0.08

Values (Mean ± SE). (Experiment 2).

Table 11: Mean growth performance, survival and feed intake of *M. rosenbergii* fed four different diets of copra meal, mill mix and pea meal for 28 d.

Diets	Temperature (ºC)	D.O. (mg/L)
WHT	27.93 ± 0.03	7.15 ± 0.03
MM1	27.91 ± 0.02	7.18 ± 0.003
MM2	27.94 ± 0.05	7.20 ± 0.01
CP	27.89 ± 0.02	7.22 ± 0.01
PM	27.88 ± 0.04	7.21 ± 0.01
CTP	27.99 ± 0.03	7.21 ± 0.02
F value	2.74	2.54
P value	0.07	0.08

Table 12: Average temperature and dissolved oxygen for the *M. rosenbergii* fed six diets for 28 d (Experiment 2).

amount. The gross energy ranged from 17.13 MJ/kg to 18.30 MJ/kg. CTP indicated highest gross energy while CP content showed the lowest gross energy.

Growth performance, survival rate and feed intake: There were no significant differences ($P \geq 0.05$) with regards to growth performance, survival rate and feed intake among the treatments. Weight gain ranged from 2.16 ± 0.54 g to 7.04 ± 2.96 g. Total body length increased between 3.04 ± 1.21 mm to 10.25 ± 2.47 mm. Survival rate ranged from 54.16 ± 18.16% to 79.16 ± 8.33 %. Increasing carbohydrate in the diet enhanced growth rate to a point. This is attributed to the protein sparing effect of carbohydrate in which the higher levels of carbohydrate in the diet provided more energy for metabolic activities of the animal, while sparing more protein for growth. The protein sparing effect of carbohydrate in diets occurs at 30% in *Penaeus aztecus* Andrews [16]. Sick and Andrews [17] found that 40% corn starch in casein-based diets produced faster growth in *P.duorarum.* Furthermore, at lower protein levels, energy may be partly derived from protein, thus accounting for lower growth rate even if protein and lipid levels in the diets at lower and higher carbohydrates were the same.

The feed intake (Table 11) among all treatments did not show significant differences ($p \geq 0.05$). Although, in terms of value, higher feed intake was seen for prawns fed with CP diet. The specific growth rate (SGR) for prawns in the different treatments ranged from 1.09 ± 0.03% to 2.38 ± 0.53 %/day.

Water quality parameters: In Experiment 2, all water parameters showed no significant differences ($P \geq 0.05$) for temperature and dissolved oxygen among the treatments. 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, it is recommended that ingredients be chosen based on nutritional value taking into account the potential anti-nutritional factors, rather than on the basis of cost per unit alone. There is also the need to further train farmers on how to formulate and produce nutritionally balanced feeds. In addition, Government should subsidize the cost of locally fabricated machines to make them affordable to farmers.

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