GROWTH PATTERN OF *Macrobrachium vollenhovenii* FED WITH VARIED CRUDE PROTEIN LEVELS OF PURIFIED AND LOCAL DIETS

AKINWUNMI, M. F.
Department of Marine Sciences, Faculty of Science, University of Lagos, Lagos, Nigeria
mfakinwunmi@gmail.com, +234 803 578 1878

ABSTRACT
Feeding trial was conducted to investigate the effect of different dietary protein on the growth of Macrobrachium vollenhovenii under laboratory conditions for 60 days. Post-larvae (average weight, 3.02 ± 0.08 g) of Macrobrachium vollenhovenii were reared on purified diets containing different crude protein (CP) levels (25%, 30%, 35%, 40% and 45%); another diet containing 40% CP served as the control in a completely randomized design (CRD). The water quality parameters such as the temperature (27 – 30 ºC), pH (6.26 - 8.09), DO (4.17 - 6.92 mg/L), salinity (2 – 5 ‰) and conductivity (65 – 354 µS/cm) were found to be within the acceptable range for aquaculture. At the end of the culture trial, the prawns that received 40% CP, compounded from local ingredients performed significantly (P < 0.05) better than the other treatments in terms of average Weight Gain (1.18g), Specific Growth Rate (0.61 %/day), Food Conversion Ratio (5.50), Protein Efficiency Ratio (0.60), Food Efficiency Ratio (0.21) and the survival rate (70.83%). The least growth performance was obtained at the 25 % and 45 % crude protein substitution. This study showed that 40% CP is adequate for the culture of Macrobrachium vollenhovenii.
Keywords: Treatments, Proximate analysis, Weight gain, Nutrient utilization, Growth performance

INTRODUCTION

Prawns of the genus *Macrobrachium* are decapods that have been identified globally in terms of its economic importance and aquaculture potentials. *Macrobrachium* species are found in most inland waters such as ponds, lakes, rivers and irrigation ditches, as well as in estuarine environment (New, 2002 and Davassi, 2011). The African river prawn is hardy as it thrives in murky waters and will survive in water with dissolved oxygen as low as 1.0 mg/L while Marioghae (1982) reported its capture from water with natural salinities of 19‰. *M. vollenhovenii*, apart from its wide distribution is also one of the largest species of *Macrobrachium* known (New, 2002). The freshwater prawns that have been cultured so far, belong to the genus *Macrobrachium*, the largest genus of the family Palaemonidae (Soundarapandian, 2008). The widespread distribution of the freshwater prawn (*M. vollenhovenii*) includes their attainment of large size, less vulnerability to disease, high market value and good taste (Marioghae, 1987; Jimoh *et al*., 2005). *M. vollenhovenii* is an omnivore with preference for animal remains and a tendency to feed on others (Marioghae and Ayinla, 1995). Mwangi (1984) showed that this species feed effectively on frog, tadpoles and the fry of *Tilapia zilli* and *Oreochromis niloticus*. Their diets also include aquatic insects and larvae, algae, detritus, molluscs and crustaceans (New, 1987; Lee *et al.,* 1980 in Obande and Kusemiju, 2008) and they depend so much on natural foods. Kurian and Sebastian (1982) also observed that adult prawns feed on plants and animal matters as well as on detritus. They are important for commercial fisheries and aquaculture, as they provide not only food but also serve as a source of income to many countries of the world (Bello-Olusoji *et al.,* 2006).

Freshwater prawn culture is an aquaculture venture designed to raise and produce prawns for human consumption. The major freshwater prawn producers are China, India, Vietnam, Thailand, Taiwan and Bangladesh. Production of this prawn in Thailand is rising gradually (New, 2005). The global annual production of freshwater prawns in 2010 was about 670,000 tons, with a total production of 615,000 tons (92%) from China (FAO, 2012).

A lot of advances has been made in the farming of shrimps all over the world and in recent years. In Nigeria, the tiger shrimp (*Penaeus monodon*) is the major species cultured and globally, it accounts for 58% of total farmed shrimp production occurring in the coastal waters (Dublin-Green and Tobor 1992; Rosenberry, 1998; Ebonwu *et al.,* 2007; Adetayo, 2008; Ayinla *et al*., 2009). The use of a purified diet became imperative because it is a single nutrient diet with no anti-nutritional factors, necessitating the use of both local and purified diet in this experiment.

MATERIALS AND METHODS

Composition and preparation of experimental diets

The dietary treatments were formulated from a purified diet which was purchased from Himedia Private Limited India. It consisted of Casein, Gelatin, Dextrin, Starch soluble, Cellulose, Carboxyl Methyl Cellulose (CMC) and BHT while the control diet was formulated from locally available ingredient as shown in Tables 1 and 2 respectively. Five treatments of different CP (25 %, 30 %, 35 %, 40 % and 45 %) of 2 mm die diameter were compounded from the purified diets while a treatment of 40 % CP (2 mm die diameter) was compounded from the local diet which served as the control. The proximate composition of the experimental diets is shown in Table 3.

Table 1: Purified diets formulation at varied CP levels

INGREDIENTS	25% CP	30% CP	35% CP	40% CP	45% CP
Casein	23.90	30.00	32.10	37.50	38.40
Gelatin	5.00	7.39	8.15	9.31	11.50
Dextrin	25.00	25.00	25.00	23.00	19.00
Starch soluble	15.00	15.00	15.00	13.00	16.00
Cellulose	19.18	10.69	7.83	5.27	3.18
Carboxyl Methyl Cellulose (CMC)	1.20	1.20	1.20	1.20	1.20
Butyl Hydroxy Toluene (BHT)	0.02	0.02	0.02	0.02	0.02
Vitamin/Mineral Premix	2.60	2.60	2.60	2.60	2.60
Vitamin C	0.10	0.10	0.10	0.10	0.10
Oil	8.00	8.00	8.00	8.00	8.00
TOTAL	100	100	100	100	100

The oil used was cod-liver oil and olive oil in the ratio of 1:3

Table 2: Local diets formulation at 40 % CP levels

INGREDIENTS	40% CP (LOCAL DIET)
Fish meal (FM)	20.0
Soya bean meal (SBM)	27.6
Groundnut cake (GNC)	27.6
Maize	18.8
Vitamin/Mineral Premix	1.5
Lysine	0.5
Methionine	0.5
Binder	1.0
Salt	0.5
Palm oil	2.0
TOTAL	**100**

Table 3: Proximate composition (%) of experimental diet

Parameters	Treatments					
	T_1	T_2	T_3	T_4	T_5	Control
	25 %	30 %	35 %	40 %	45 %	40 %
Moisture Content	9.50	10.00	10.80	10.20	11.20	9.40
Crude Protein	23.19	26.77	34.79	40.94	45.06	35.80
Crude Fat	3.59	6.23	5.22	5.18	3.48	7.51
Crude Fibre	8.14	5.68	3.10	1.30	4.93	5.22
Total Ash	1.89	2.54	3.45	4.05	1.98	9.65
Nitrogen Free Extract	53.69	48.78	42.64	38.33	33.35	32.42

Experimental system

The experiment was conducted in completely randomized design in glass tanks of dimension 0.60 x 0.30 x 0.15 m^3 filled with borehole water of low brackish conditions (125L) according to varied treatments of 25% CP (T_1), 30% CP (T_2), 35% CP (T_3), 40% CP (T_4) and 45% CP (T_5) and Control diet (40% CP). Each of the treatments was triplicated and the feeding trial was conducted for 60 days. Each of the tanks was covered round with black polyethylene to conceal the prawns from light. The prawns were weighed at the start of the experiment and weekly till the end of the experiment.

Experimental animal (*Macrobrachium vollenhovenii*)

Live prawns of *M. vollenhovenii* with an average weight of 3.02 ± 0.08 g were collected from Epe Lagoon in a 100 L capacity plastic bowl, three-quarter filled with the lagoon water. The prawns were aerated using an air pump portable battery (Model: ACD - 9800) to provide them with adequate oxygen during transportation. They were then transported to the laboratory in the Department of Marine Sciences where they were gently tempered into large holding glass tanks and acclimatized in the tank for two weeks. Twenty prawns were then weighed and transferred to each of the treatment tanks filled with water and aerated.

Water quality analysis

The physico-chemical parameters (temperature, salinity, pH, dissolved oxygen and conductivity) of the water used in the culture medium were monitored daily. The temperature and pH was determined using a Horiba pH (Model: D-51). The salinity was measured using a refractometer (Model No: RHS-10). The dissolved oxygen and conductivity were measured using a pH meter (Model: HI 2210), Lutron DO meter (Model: DO 5519) and a conductivity meter (Model: EC 215) respectively.

Feeding Procedure

M. vollenhovenii were fed at the rate of 3 % of their body weight throughout the culture period. The total amount of feed for a day was divided in to two equal proportions and fed at 0900 and 1600 hours daily. Uneaten feed and faeces were removed by siphoning from the tank bottom immediately prior to morning and evening feeding.

Determination of growth and nutrient utilization parameters

At the end of the experiment, the growth indices including specific growth rate, food conversion ratio and food efficiency ratio were calculated according to Parsons (1988).

- Weight Gain: Weight gain was determined from the final weight and initial weight of the experimental prawn.

$$Weight\ Gain\ (WG) = Final\ weight\ (W2) - Initial\ weight\ (W1)$$

- Percentage Weight Gain: The percentage weight gain was determined as the difference between the final weight and initial weight of the experimental prawn.

$$Percentage\ Weight\ Gain\ (PWG) = \frac{Mean\ weight\ gain}{Mean\ weight\ initial}\ X\ 100$$

- Specific Growth Rate: This is the percentage rate of change in the logarithmic body weight.

$$Specific\ Growth\ Rate\ (SGR) = \frac{Ln\ W2 - Ln\ W1}{t}\ X\ 100$$

Where Ln = natural log, W_2 = mean weight at the end of the culture period, W_1 = mean weight at the beginning of the experiment and t = time in days for the experimental period.

- Food Conversion Ratio: This is the ratio of the total dry feed fed and the total wet weight gain of the experimental prawn.

$$Food\ Conversion\ Ratio\ (FCR) = \frac{Total\ feed\ consumed}{Wet\ weight\ gained}$$

- Food Efficiency Ratio: This is the reciprocal of the food conversion ratio of the experimental prawn.

$$Food\ Efficiency\ Ratio\ (FER) = \frac{1}{FCR}$$

- Protein Efficiency Ratio: This is relationship between the increment in the weight of the prawn (weight gain in the prawn) and the protein consumed.

$$Protein\ Efficiency\ Ratio\ (PER) = \frac{Weight\ gain}{Protein\ intake}$$

Proximate Analysis of Experimental Diets

The proximate analysis of the experimental diets was done following standard methods (AOAC, 1990).

Statistical Analysis

Statistical comparison of data from the feeding trial was analyzed using a one-way analysis of variance (ANOVA) as described by Gomez and Gomez (1984). Mean differences between treatments

were tested for significance ($P < 0.05$) using Duncan's Multiple Range Test (Duncan, 1955).

RESULTS

The ranges of the physico-chemical parameters and their respective mean and standard error were recorded. The temperature ranged between 27 and 30 ºC (mean: 28.29 ± 0.10), salinity ranged from 2 – 5 ‰ (mean: 3.54 ± 0.15), pH ranged from 6.26 - 8.09, dissolved oxygen ranged between 4.17 and 6.92 mg/L (mean: 5.84 ± 0.11), conductivity ranged between 65 and 354 µS/cm (mean: 147.59 ± 17.53).

The growth and nutrient utilization parameters of *M. vollenhovenii* cultured in glass tanks are shown in Table 4. The result showed that there was no significant difference ($P > 0.05$) among the average weight gain values which ranged between 0.51 and 1.18. However, the highest weight gain was observed for control treatment. There were no significant differences ($P > 0.05$) in the SGR, FER and survival in the different treatments which ranged from 0.25 – 0.61, 0.10 – 0.21 and 41.67 – 70.83 respectively. The highest values however were observed for the control. There was no significant difference ($P > 0.05$) between the FCR values in treatments T_1 and T_2 and these values were significantly higher than in T_3, T_4 and control. There was no significant difference ($P > 0.05$) between the FCR values in T_3, T_4 and control.

There was significant difference ($P < 0.05$) between the FCR values in treatments T_5 and the other treatments, which had the highest FCR value. There was no significant difference ($P > 0.05$) among the PER values in T_2, T_3, T_4 and control while there was significant difference ($P < 0.05$) between the PER values in T_1 and T_5.

Table 4: Growth and nutrient utilisation parameters of *Macrobrachium vollenhovenii* for the 60 days culture trial

PARAMETERS	TREATMENTS					
	T_1	T_2	T_3	T_4	T_5	Control
Average Initial Weight (g)	3.00±0.09^{ab}	3.07±0.03^{ab}	2.89±0.16^{ab}	3.32±0.14^{a}	3.11±0.01^{ab}	2.73±0.29^{b}
Average Final Weight (g)	3.85±0.33^{ab}	3.97±0.33^{ab}	3.78±0.09^{ab}	4.41±0.01^{a}	3.44±0.07^{b}	3.74±0.24^{ab}
Average Weight Gain (g)	0.88±0.21	0.94±0.31	0.89±0.11	1.10±0.12	0.51±0.02	1.18±0.41
Feed fed (g)	5.17±0.41	5.51±0.30	5.19±0.32	6.18±0.22	5.19±0.18	5.44±0.33
Protein fed (g)	1.29±0.10^{c}	1.65±0.09^{b}	1.81±0.11^{b}	2.47±0.09^{a}	2.33±0.08^{a}	2.18±0.13^{a}
SGR (%/day)	0.42±0.08	0.44±0.13	0.45±0.07	0.48±0.06	0.25±0.01	0.61±0.23
Food Conversion Ratio	6.47±1.36^{ab}	6.82±1.48^{ab}	6.12±1.18^{b}	5.69±0.44^{b}	10.19±0.15^{a}	5.50±1.32^{b}
Protein Efficiency Ratio	0.72±0.13^{a}	0.62±0.17^{ab}	0.50±0.09^{ab}	0.43±0.03^{ab}	0.22±0.01^{b}	0.60±0.18^{ab}
Food Efficiency Ratio	0.17±0.03	0.17±0.05	0.18±0.03	0.18±0.01	0.10±0.00	0.21±0.07
Survival (%)	54.17±15.02	54.17±4.17	41.67±11.02	56.25±6.25	54.17±8.33	70.83±11.02

Data are mean values ± standard error.

Means with the same superscript alphabet along the row are not significantly different ($P > 0.05$)

DISCUSSION

The results of the water quality analysis during culture were observed to be within the permissible limit for aquaculture. This is in agreement with the work of FAO (2002), Mamun *et al.* (2010) and Akinwunmi *et al*. (2014).

The control diet (40% CP) gave the best compared to other treatments used. It had the highest AWG, SGR, FER, lowest FCR and the highest survival rate. This agreed with the work of Mahmood *et al*. (2005) on *Penaeus monodon*. The result of FCR in this study was similar to the work of Manush *et al.* (2006) with a FCR values ranging from 3.7-5.6. Akinwunmi *et al*. (2014) also reported a FCR of 1.04 which was observed to be lower than that reported in this study.

In this study, the survival rate ranged between 41.67 and 70.83% which was observed to be lower than that observed by Ayinla *et al*. (2012). Hossain and Islam (2006) and Chowdhury *et al*. (2008) in their findings, reported that the survival rate of prawns ranged from 68 to 78% and 62 to 76% respectively while Mamun *et al.* (2010) recorded a survival rate that ranged between 80 and 83%.

The comparatively low growth and high FCR in the case of the purified diets might be due to non-attractive odour and non-palatability of the diets. Thus, the prawn did not respond well to the feeds. Ahamad-Ali (1995) reported low growth and high FCR in an experiment for *Penaeus indicus* using purified diet and indicated that it might be due to the non-palatability of the purified diets as they are prepared with purified materials and chemicals. Ahamad-Ali (1982) posited that the growth of prawns using purified diets was low compared to the growth obtained in the laboratory experiments for *P. indicus* with feeds compounded with natural ingredients. Also, Kanazawa *et al*. (1970), Sick *et al*. (1972), Deshimaru and Kuroki (1974, 1975 a and b) cited in Ahamad-Ali (1982) reported similar inferior growth in prawns fed with purified diets prepared using casein, amino acid mixtures and peptides. The use of cellulose powder as a non-nutrient filler in purified diets appeared to affect the palatability of the diets for prawns (Ahamad-Ali, 1980).

The protein introduced in the diet was well utilized and made available for the prawns. This was observed in the initial crude protein to be 16.28 and an increase in CP after which the experimental trial had been terminated with values that ranged between 16.69 and 19.41. The findings posited that there existed an inverse relationship between crude protein / carbohydrate and between crude protein / crude fat which was in conformity with the report of Dinakaran *et al*. (2009).

CONCLUSION

African river prawn (*Macrobrachium vollenhovenii*) was subjected to laboratory culture to determine the best crude protein requirement for further culture. It was revealed that the control diet of 40% crude protein had the best performance compared to other treatments having the best Average Weight Gain, Specific Growth Rate, Food Conversion Ratio, Food Efficiency Ratio and highest survival rate. Therefore, the species is culturable in confinement as against their occurrence in natural environment. This will help to supplement the supply of fishes and to increase the protein intake of the general populace.

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