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Full Length Research Paper

Replacement of fishmeal with locally available ingredients in diet composition of *Macrobrachium dayanum*

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The effect of locally available low cost ingredients such as silk worm pupae (SWP), soyabean meal (SBM), earth worm meal (EWM) as a replacement of fish meal (FM) on growth, survival and biochemical composition, were investigated for *Macrobrachium dayanum* (0.50 g). A significantly higher rate of growth, survival and food conversion ratio (FCR) were recorded for prawns fed EWM, as compared to SWP, SBM, and FM. The proximate composition of flesh further revealed a higher level of proteins and lipids in prawns fed EWM thereby indicating EWM as a possible substitute of FM.

Key words: *Macrobrachium dayanum,* low cost ingredients, biochemical composition.

INTRODUCTION

Increasing cost of fish food ingredients (grains, fishmeal, oil cakes, etc.) has made scientists all over the world to look for cheaper and abundant substitutes. Fishmeal though highly nutritive and palatable is a relatively expensive feed ingredient as compared to other low cost protein rich ingredients such as soyabean meal, silk worm pupae, earthworm, etc. being used as protein sources for shrimps as feed. (Lim and Dominy, 1990; Davis et al., 1995; Nandeesha et al., 2000 Davis et al., 2005). Shrimp feeds mostly have high fish meal (FM) content typically ranging from 30–50% by weight (Lim and Dominy, 1990) and this account for the maximum share of the total cost input. Many wastes and by-products from agriculture, animal husbandry and industries have a good food value having low cost which can be easily processed and recycled in the form of fish food. Therefore, this study was focused to work out the efficacy of certain feeds prepared from some locally available ingredients, on the growth of a local prawn species, *Macrobrachium dayanum*.

MATERIALS AND METHODS

Prawns were collected from their natural habitat from a stream at Gho-Manhasan which is located at a distance of 20 Km/s North–West of Jammu City and brought to the Department of Zoology (Wet lab) University of Jammu, where they were kept in plastic troughs of 20 L capacity. Prawns captured, were then acclimated in plastic troughs at a temperature of about 22–25°C for about 7 days and were fed on live food.

Experimental diets and feeding

The ingredients with high acceptability were selected for feed preparation. This experiment is in continuation with earlier studies conducted by Langer et al. (2004) wherein, 40% diet was found suitable for size group under investigation. Feed was formulated by using locally available ingredients; silkworm pupae (SWP), soyabean meal (SBM), earthworm meal (EWM), fishmeal (FM), rice bran (RB) and mustard oil cake (MOC). RB and MOC were used as filler and oil source respectively. 10 prawns each were stocked in plastic tubs of 20 L capacity with proper aeration (maintained by air pumps). The experiment was conducted in duplicate. The feed was given twice a day at 3% of their body weight. The left over feed and excreta of prawns were removed once a week. Before stocking, the lengths as well as weight of the prawns were recorded. At the end of the experiment (after 90 days), prawns were observed for the length and weight increment followed by biochemical analysis.

Water quality

During the period of investigation, about 1/4th water was exchanged every alternate day. Water was well aerated with the help of air pumps to maintain the dissolved oxygen (DO) level more than 3 mg/l. Maximum and minimum water temperatures were recorded daily using mercury thermometer. Various

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Table 1. Composition of the ingredients used.

Ingredient	Protein	Fat	Moisture	Ash
Earth worm	54.7	3.9	3.1	11.2
Silk worm pupae	43.9	23.2	7.4	6.5
Soya bean	23.6	8.1	10.7	8.2
Trash fish	5.5	3.3	10.8	22.6
Mustard oil cake	46.0	14.5	10.2	5.3
Rice bran	12.6	7	10.2	19

Table 2. Formulation of experimental diets and calculated values of experimental diets.

Parameter	Diet I (SWP)	Diet II (SBM)	Diet III (EWM)	Diet IV (FM)
Silkworm pupae	40.7	0	0	0
Soya bean	0	42.025	0	0
Earthworm	0		46.05	
Fish meal	0	0	0	49
Rice bran	18.6	15.95	7.9	2
Mustard oil cake	40.7	40.025	46.025	49
Proximate composition of formulated feeds (calculated values)				
Protein (%)	39.60	39.77	39.76	40.00
Lipid (%)	14.2	14.7	10.4	11.2
Moisture (%)	11.00	11.6	9.7	11.5
Ash (%)	10.8	10.2	11.8	10.6
Dry Matter (%)	89	88.4	91.3	88.5

Table 3. Average values of abiotic parameters maintained during experiment.

Parameter	Diet I (SWP)	Diet II (SBM)	Diet III (EWM)	Diet IV(FM)
Temperature (℃)	28.4	28.4	28.2	28.5
pH	8.45	8.6	8.62	8.65
DO	5.05	5.27	5.25	5.01

physico-chemical parameters were recorded using standard methods (APHA, 1975).

Chemical analysis

The ingredients used in feed formulation were subjected to chemical analysis before and after preparation of the diet (Tables 1 and 2). The flesh composition of the experimental prawns was analyzed before and after the experiment. Protein (N X 6.25), lipids by ether extract, moisture (105℃, 24 h) and ash (550℃ for 4-6 h) were determined according to the standard methods of AOAC (1995) for compounded diets and prawn flesh.

Water quality, growth and biochemical parameters were properly recorded and the data was statistically analyzed to calculate the ANOVA with the help of MS Excel 2003 and SPSS (12.0 version Inc. Chicago, USA) and mean were compared by using Duncan's multiple range test (Duncan, 1955) taking $P<0.05$ as significance level.

RESULTS AND DISCUSSION

Water quality

Various water quality parameters; water temperature, pH and dissolved oxygen (DO) were observed to be least affected by different treatment diets. The values of all the parameters, that is, water temperature, pH and DO were almost similar for all the treatment diets during the experimental period and was well within the optimal range proposed for the freshwater prawns by Boyd and Zimmerman (2000), Strauss et al. (1991) and Zimmerman (1998) respectively (Table 3).

The experiment was designed with an aim to evaluate the effect of replacement of fishmeal (FM) (Langer et al., 2004) with some locally available ingredients such as silkworm pupae (SWP), soyabean meal (SBM) and

Table 4. Studies on the effect of different locally available ingredients on growth and survival of fresh water prawn *Macrobrachium dayanum* (Hend.) by keeping protein level fixed.

Parameter	Diet I (SWP)	Diet II (SBM)	Diet III (EWM)	Diet IV (FM)
IW (g)	0.50	0.50	0.50	0.50
FWG (g)	0.65333±0.00404[b]	0.59533±0.00404[d]	0.80067±0.00057[a]	0.61500±0.004359[c]
AWG (g)	0.15000±0.01732[b]	0.09533±0.00305[c]	0.30555±0.02081[a]	0.11533±0.002082[c]
% WG	30	19	60	23
FCR	1.3333±0.020817[c]	2.24333±0.01527[a]	0.86333±0.00577[d]	1.90333±0.037859[b]
FCE	0.75000±0.02645[b]	0.44333±0.03785[d]	1.16000±0.02645[a]	0.52333±0.025166[c]
Survival (%)	80	70	90	80

Data presented above is the mean of three readings (mean ±SD). The values having same superscript do not differ significantly (P>0.05). Percentage weight gain (%WG) = (final weight – initial weight) x 100/ (initial weight); feed conversion ratio (FCR) = (weight of feed consumed)/ weight gain of fish); feed conversion efficiency (FCE) = 1/ (FCR).

earthworm meal (EWM).

Growth

The results for the growth performance of *Macrobrachium dayanum* exposed to different feeds (Table 4) clearly specified that the maximum weight gain was observed in the prawns exposed to diet III, that is, EWM. The minimum weight gain was observed in prawns exposed to diet II, that is, soya bean meal (SBM). The final average weight gain for different diets was in the order: diet III > diet I > diet IV > diet II. The weight gain values for diet II SBM and diet IV FM were similar as evidenced from the statistical analysis.

The average feed conversion ratio (FCR) for the different diets ranged between 0.8633 and 2.2433. The lowest and best FCR value was obtained for the diet III (EWM). The values of the FCR for all the diets were found to be significantly different ($P < 0.05$) from one another. The value of feed conversion efficiency (FCE) was observed to be maximum for diet III (1.160) and minimum for diet II (0.443). From the values of FCR and FCE, it can be proposed that diet III (EWM) was the best among all the dietary treatments. The prawns showed better growth with the diet that contained the animal protein as compared to plant protein. The reason may be that most plant proteins harbor anti-nutritional factors and have low biological value due to essential amino-acid deficiencies or imbalances and poor digestibility. This view is supported by Hardy (1966), Francis et al. (2001) and Jain and Srivastava, 2000). During the experimentation, the complete replacement of FM with EWM gave better growth values. These observations are supported by those made by Ramesh et al. (2001) and Sastry and Huria (2004) in *Catla catla* fry using EWM as a substitute for FM.

So far as silkworm pupae meal is concerned, it ranked second (%WG=30%) in growth results when compared with fish meal (%WG=23%). Earlier studies based on replacement of FM with SWP in common carp (Nandeesha et al., 1990), catla and rohu, Jayaram and Shetty (1980) have shown the best growth of carps at 30% pupae inclusion, been the highest level tried up till that time. However, Begum et al. (1994) recorded significantly better specific growth rate (SGR), FCR and protein efficiency ratio (PER) for rohu fed with a diet having 50% of its protein contributed by SWP when compared to FM based diet. Similarly, the study conducted by Nandeesha et al. (2000) indicated that non-defatted pupae can be profitably used up to 50% in carp diet by completely replacing FM and even reducing the level of other costly inputs like groundnut oil cake. In this experiment, the complete replacement of fishmeal with SWP yielded better growth results in terms of WG, SGR, FCR and survival rate. These observations get support from the findings of Nandeesha et al. (2000) who have suggested that the net protein retention increases with increasing levels of pupae in the diet.

The growth recorded for soyabean based diet was minimum as also recorded by many other authors (Forster and Beard, 1973; Fenucci and Zein- Eldin, 1976; Fowler, 1980; Lim and Dominy, 1990; Davis et al., 2005; Zhou et al., 2005). According to Storebakken et al. (2000), the poor growth performance of fish fed soyabean meal as compared to FM could be due to lower digestibility of nitrogen and energy, the presence of non-digestible oligosaccharides, amino acid deficiencies and anti-nutritional factors.

The biochemical composition of the flesh of prawns fed the four experimental diets was estimated in terms of moisture, protein, total lipids and ash (Table 5). The moisture content of the prawns before culture was estimated to be 81.74% and had a decrease after the experimental period as 79.94, 80.56, 79.85, and 80.12% in diet I (SWP), diet II (SBM), diet III (EWM) and diet IV (FM), respectively ($P < 0.05$). The protein content before culture was 14.50%. After culture, its value was analyzed as 15.40% in diet I, 14.83% in diet II, 15.63% in diet III and 15.46% in diet IV. The value of protein for all treatments did not differ significantly ($P>0.05$). Diet III showed the highest protein value of prawns. The

Table 5. Biochemical composition of the flesh of *Macrobrachium dayanum* before and after culture.

Parameter	Before culture	After culture			
		Diet II (SWP)	Diet III (SBM)	Diet III (EWM)	Diet IV (FM)
Moisture (%)	81.74±0.003[a]	79.94±0.047[d]	80.56±0.052[b]	79.85±0.035[e]	80.12±0.025[c]
Protein (%)	14.50±0.200[c]	15.40±0.030[a]	14.83±0.02[b]	15.63±0.208[a]	15.46±0.020[a]
Lipids (%)	2.14±0.020[ab]	2.23±0.041[ab]	2.10±0.20[b]	2.28±0.020[a]	1.72±0.025[c]
Dry matter (%)	18.25±0.003[e]	20.04±0.020[b]	19.44±0.025[d]	20.13±0.020[a]	19.88±0.025[e]
Ash (%)	2.53±0.25[b]	2.87±0.030[a]	3.03±0.030[a]	1.95±0.036[c]	3.07±0.017[a]

Data presented above is the mean of three readings (mean ± SD). The values having same superscript do not differ significantly (P>0.05). Percentage weight gain (%WG) = (final weight – initial weight) x 100/ (initial weight); feed conversion ratio (FCR) = (weight of feed consumed)/ weight gain of fish); feed conversion efficiency (FCE) = 1/ (FCR).

non-significant difference in protein content of prawns fed different diets could have been due to isonitrogenous quality of these diets despite having variable protein sources. Ali and Sahu (2002) made similar observation in *Macrobrachium rosenbergii* juveniles, wherein three isocaloric and isonitrogenous diets prepared from fishmeal, acid fish silage and fermented fish silage did not affect the carcass crude protein. Gupta (2005) also came forward with similar observations in the case of protein value while studying some alternative practical feeds for freshwater prawn *M. rosenbergii*. Before culture, the lipid content of the prawn flesh was recorded to be 2.14% while after the culture period, the lipid content of the prawns fed with diet I, diet II, diet III and diet IV was found to be 2.23, 1.90, 2.28 and 1.72% respectively. Diet III, that is, EWM gave the highest value of the total lipid content compared to the other three diets which suggest the efficiency of Diet III. The total lipid content of the prawns fed with diet II (SBM) was low as compared to diet III (EWM) and diet I (SWP). This gets support from the observation of Du et al. (2003) who reported that the carcass dry matter, crude fat and energy value declined with increasing SBM inclusion. However, contrary to the findings of this study, Gupta (2005) reported that the diet with soya bean meal as major protein source resulted in higher carcass lipid content.

This study, therefore clearly revealed better growth, FCR, FCE and survival for *M. dayanum* (of particular weight group selected) fed earthworm meal than the rest three diets used.

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