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PRELIMINARY STUDIES ON FORMULATION AND BIOLOGICAL EVALUATION OF SUPPLEMENTAL DIET FOR *PENAEUS MONODON* AND *METAPENAEUS MONOCEROS*

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Four compounded supplemental diets (A to D) were formulated using locally available natural raw materials. The feed trials were made on juvenile *Penaeus monodon* and *Metapenaeus monoceros*, respectively. The feeds were assessed on the basis of their survival, growth and feed conversion ratios (FCR). Protein contents of the diet ranged from 19 -36%. Major protein sources were fish meal, shrimp meal and blood meal. Diet A and D gave good growth and the best FCR. During a period of 6 weeks juveniles of *P. monodon* fed diet 'A' showed a gain of 60gm and fed diet D 68.5gm with FCR values of 1.6 and 1.7, respectively. In *M. monoceros* weight gain in shrimps fed diet A was 31.5gm and in shrimps feed diet D was 38.5gm with FCR values of 1.9 and 1.6, respectively.

Key words: Formulation, Supplemental diet, *P. monodon and M. monoceros.*

Introduction

Penaeus monodon is most successfully cultured species throughout the Southeast Asia. In Pakistan, though the occurence of *P. monodon* is rare but its significantly large size, fast growth rate and hardiest survival in the local environment make it a favourite species for culture. *Metapenaeus monoceros* is also a hardy species found abundently but it is relatively slow growing and attains considerably smaller size than *P. monodon*. The initial success in shrimp farming in Indus delta has turned the shrimp farmers towards more intensification of culture methods. In an intensive aquaculture system feed costs about 50 - 80% of the total expenditure [1] and the demand and cost of feed rises with intensification of culture. Since the feed is the single largest operating cost item in the recurring expenditure of a shrimp farm, it is highly desireable to develop low cost shrimp diet, which can combine rapid growth with good survival without undue fouling the water quality, so as to make the shrimp culture a profitable venture. In the present study compounded diets have been formulated and prepared by using locally available low cost raw materials in order to avoid the import of expensive formulated feeds. Although some work has been reported on the production of low cost fish feed [2] in the country but no studies have been undertaken which may lead to the development of commercial shrimp diet. There are, however, several formulations reported in the literature [3], which were found to support the growth and survival. No such formula has been used under local conditions because the recommended feed ingredients are not available and are too expensive to use. The present communication is concerned with the development of low cost, growth promoting shrimp feed using easily available ingredients and the effect of such feed formulations on the growth and survival of shrimp in glass aquaria in the laboratory and to some extent in the experimental pond.

Materials and Methods

Four diets were formulated containing approximately 19-36% protein and 4-12% lipid (Table 1). The major sources of animal protein were fish meal, shrimp meal and blood meal. The diets had been prepared in the following manner: Dried ingredients were ground separately and known amounts mixed thoroughly. In the laboratory hot water was added to make a firm paste and thereafter extruded into 3 mm long and 2 mm diameter pellets. During large scale preparation of diet for pond trial, steam was injected before the ingredients reached to the extruder.

Feed trials were made on juvenile *Penaeus monodon* (1–3gm) and *Metapenaeus monoceros*(0.6–2gm) collected from Sandspit backwaters; shrimps were kept in 50 litres glass aquaria. Five groups of 10 prawns were reared for a period of 6 weeks for both species, four groups for test diets and one as control fed a mixture of minced fish and mussel (1:1). Feed was given twice a day at a rate of 15% of the initial body weight, half of the ration at 9 a.m. and remaining at 3.40 p.m. Feed was evaluated in terms of growth, survival and feed conversion ratio (FCR). Shrimps were weighed fortnightly and returned back to the aquaria. Proximate composition of the formulated diets was calculated using ADCP, 1983 feed compositional tables [3]. Average temperature ranged between 30 to 36° and salinity of the sea water recorded was 30°/00 throughout the study period.

Feed A was also tried in the experimental ponds of a local shrimp farmer located at Gharo Creek, where previously shrimps were reared on an imported pelleted diet, which costs

about Rs. 30/kg. There were a total of 12 ponds in operation; three ponds of 0.2 hectare, four ponds of 1.5 hectare and five of 2.5 hectare. Water was changed at a rate of 30%/day. The stocking density in the ponds was 5 animals/cubic meter. Feed was given at a rate of 10% of the body weight. Growth was monitored for a period of 4 weeks. Mean weight gain was calculated from a shrimp sample collected fortnightly by a cast net. The average temperature recorded in the ponds was a little lower than that in laboratory i.e. from 30–34°, while the salinity was the same.

TABLE 1. PERCENTAGE COMPOSITION AND PROXIMATE ANALYSIS OF THE DIETS (IN AQUARIUM TANKS).

Feed ingredients	Diet A	Diet B	Diet C	Diet D
Fish meal	38.0	42.0	-	30
Shrimp head	-	14.0	42	20
Maize flour	-	25.0	-	-
Rice husk	4.0	12.5	21.5	-
Cotton seed cake	2.5	-	-	10
Sunflower oil	-	3.5	3.5	-
Rice bran	2.5	-	-	15
Blood meal	10.0	-	-	-
Wheat flour	37.0	-	-	5
Wheat bran	-	-	30.0	15
Guar gum	1.0	2.0	2.0	2.0
Vit/Min. mix	5.0	1.0	1.0	3.0
Total	100.0	100.0	100.0	100.0
Protein	36.440	29.589	19.344	31.765
Lipid	4.073	11.439	12.73	6.979
NFE	41.559	32.292	27.748	31.643
Moisture	7.4	8.4	10.1	9.2
Ash	10.563	18.280	30.635	20.413

Results and Discussion

Survival. No mortality was observed in any species in the laboratory experiment. The survival was 100%.

Growth. All the four compounded diets produced health growth. The total weight increment and percent growth for *P. monodon* and *M. monoceros* is given in Table 2 and 3 respectively. During a period of 6 weeks approx. a 2 - 4 fold increase was observed in total weight of shrimps fed on formulated diet. As far as the increase in weight is concerned, all the four diets had the same effect on both the species; no specific difference was found. The maximum growth was observed in shrimps fed on diet D followed by diet A,B and C. In *P. monodon* the total weight increment in the shrimps fed diet B (39.84gm) and C (32.11gm) is a little less than half of the increment produced by diet A (60.05gm) and D (68.56gm) (Table 2). However, the difference was less pronounced in *M. monoceros*, where the shrimps fed on diet A and D produced total average weight of 31.5gm and 38.5gm, respectively as compared to 26.8 and 23.8gm produced by diet B and C respectively (Table 3). The growth of the control group in both species was poor as compared to shrimps fed on diet A and D but is better than shrimps fed diet B and C.

TABLE 2. GROWTH AND FOOD CONVERSION RATIO OF *P. MONODON* FED FORMULATED DIET. (IN AQUARIUM TANKS).

Diet	Mean weight (gm)			Food consumed (gm)	FCR	% Growth
	Initial	Final	Increment			
A	1.591±0.70	7.596±0.55	6.005	10.024	1.669	377
B	1.624±0.70	5.608±0.43	3.984	10.232	2.568	245
C	1.769±0.70	4.980±0.36	3.211	11.145	3.470	181
D	1.659±0.72	8.515±0.72	6.856	11.712	1.708	413
Control	1.636±0.62	5.931±0.77	4.295	9.677	2.253	262

TABLE 3. GROWTH AND FOOD CONVERSION RATIO OF *M. MONOCEROS* FED FORMULATED DIET (IN AQUARIUM TANKS).

Diet	Mean weight (gm)			Food* consumed (gm)	FCR	% Growth
	Initial	Final	Increment			
A	0.970±0.47	4.122±0.40	31.52	6.111	1.938	324
B	1.059±0.39	3.744±0.46	26.85	6.672	2.484	253
C	1.041±0.44	3.429±0.50	23.88	6.559	2.746	229
D	1.001±0.34	4.858±0.40	38.57	6.307	1.635	385
Control	1.083±0.50	3.962±0.57	28.79	6.823	2.369	265

* Food presented.

Growth observations in the ponds. The survival was 70% during a period of 4 weeks. Growth observations on shrimp fed diet A are summarized in Table 4.

TABLE 4.

Date	No. of shrimps sampled (N)	Average wt. (gm)	% Increase in weight
14.4.90	63	14.75	—
3.5.90	55	20.00	35.6
15.5.90	47	27.00	35.0
			70.6

After a period of 4 weeks, 70.6% increase was observed in total weights of shrimps. The utilization of natural feed in ponds or possible competition by small crabs and occasionally fishes has not been evaluated. The growth rates of the shrimps fed diet A and those of fed imported diet were found almost similar (i.e., with the imported pelleted diet the percent increase in the total weight was 68.6% for the same period.

The study of crustacean nutrition is much more recent as compared to fish. An awareness of this subject has increased rapidly during the last two decades due to the rapid expansion of aquaculture. Qasim [4] was the first who describe the use of various ingredients from both plant and animal sources into a compounded diet. Work on feed formulation and evaluation suggests that suitability of a shrimp diet depends upon various factors such as composition, stability, feed conversion ratio and cost effectiveness. In general, the dietary requirements vary widely, particularly with respect to protein level from species to species. Further it is not only the level of protein which effects the growth and survival, the protein source also have the same effect, which is due to the presence or absence of certain amino acids in the source. In fact, the presence of certain amino acids, particularly the essential amino acids determine the suitability or otherwise of a particular protein. The plant proteins, though less expensive, lack some essential amino acids and, therefore, have to be supplemented with animal proteins to get a balanced protein ration.

Destajo and Dejarme [5] tried many protein sources of animal and plant origin. Such as fish meal, shrimp meal, soybean meal, meat and bone meal, ipil-ipil (*Leucaena leucocephala*) leaves and seeds in the diet of *P. indicus* and found that a combination of proteins from different sources is more suitable for growth in shrimps. Sick and Andrews [6] showed soybean meal as best protein source for *P. duorarum.* Lim *et al.* [7] reported that squid meal and shrimp meal are good protein sources for *P. monodon* juveniles. He further explained that these two ingredients were superior to fresh brown mussel meat, casein and spirulina.

The feeding habit of a shrimp changes progressively from planktivorous to an amnivorous level as it reaches from postlarval to the juvenile stage. It has been concluded that diets containing both plant and animal proteins produce good growth [8–11]. Our studies demonstrate that diet containing a combination of protein sources (i.e., diet A and diet D) showed better growth and FCR values than those having protein only from one major source, (i.e. diets C and D). Colvin [12], Pascual and Destajo [13] also showed that combination of fish meal and shrimp meal is superior to either fish meal or shrimp meal alone. He also assessed that a ratio of 60% fish meal to 40% shrimp meal is best for growth. This is in agreement with findings of present study where the diet D having similar ratio proved to be the most effective. Least growth was observed with diet C, in which only 19% protein was incorporated.

The optimal dietary level of protein (predominantly fish meal protein) as is reported by Andrews *et al.* [14] for *P. setiferus* is 28-32%. They observed significant reductions in growth of shrimps fed 40 and 52% protein, which they attributed to protein imbalance and increase in the level of lipid and other fish meal components. The optimal protein level of *P. meguiensis* ranged from 34.0 to 42.1% of the diet [15]. The protein requirement level for *P. monodon* as studied by Lee [16] is 45-50% while Alava and Lim [17] reported it within the range 40-45%, which shows an increased protein requirement in *P. monodon.* In the present study the diet A had 36.4% protein which is below the described optimal level for *P. monodon* but no adverse effect on growth was observed.

The level of lipid is also important for growth. Certain lipids are known to have positive effect on maturation of ovary in captivity. Bautista [18] concluded that *P. monodon* juveniles need from 5-10% lipid in their diet, while Mendoza [19] reported that dietary lipid level of nearly 12% was required by *P. monodon* juveniles for maximum growth, efficient FCR and optimum survival. Fat free diets supplemented either by carbohydrates or casein to keep isocaloric condition produced good weight gain, but a low length growth rate in *P. japonicus* [20]. In crab *Carcinus meanus* fat free diet prolonged the intermould period, high amount of lipids resulted in reduced growth and survival [21]. The lipid level in the present study ranged from 4-12% (Table 1), although the maximum growth was obtained at 4 and 6% level, the reduced growth of shrimps at 11 and 12%, lipid level (indiet B and C), may not be attributed solely to high lipid level, it may possibly be a result of diet deficiency of linoleic and linolenic acid, because in shrimps it is not only the lipid level, which is important, it is the fatty acid profile which is more important and shrimp showed a higher requirement for HUFA'S. The reduced growth may be due to inadequate protein level.

The cost of the formulated diets i.e., from A to D ranged from Rs. 6 to 10/gm which is much lower than the imported feed which costs Rs. 30/kg.

The study may further be extended to determine the optimal nutritional requirements of the indigenous species under local climatic conditions.

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