J. mar. biol. Ass. India, 1995, 37 (1 & 2) : 91 – 97

A PURIFIED DIET AND A PRACTICAL FEED FOR THE PRAWN *PENAEUS INDICUS*

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ABSTRACT

In the context of the rapid development in Penaeid prawn farming in India, nutritional research and the development of compounded feeds for feeding prawns have gained considerable importance. With the objective of evolving a reference purified diet for use in nutritional studies and a practical feed for feeding prawns, a purified diet and a practical feed were formulated based on the available information on the nutritional requirements of penaeid prawns. While the purified diet was made up of egg albumen, mixed carbohydrate, cod liver oil, vitamins and minerals, the practical feed consisted of locally available raw materials, prawn waste, mantis shrimp, fish meal, groundnut cake and tapioca. The diet and the feed were fed to the juveniles of the prawn *Penaeus indicus* for 100 days in the laboratory experiments and the results were compared with that of a conventional prawn feed, clam meat. The practical feed produced significantly ($P < 0.05$) the highest increase in length (72.2 mm) and live weight (4.69 g), followed by the clam meat (63.7 mm in length and 4.42 g in live weight) and the purified diet (54.7 mm in length and 3.83 g in live weight). The food conversion ratio obtained by the practical feed was the lowest (1.8) followed by clam meat (2.09) and the purified diet (2.37), though the differences were not statistically significant ($P > 0.05$). The possibilities of using the purified diet as the standard reference diet for nutritional studies in this region and the practical feed for the culture of penaeid prawns in the nursery and grow-out ponds are discussed.

INTRODUCTION

WITH the advent of scientific prawn farming all over the world, nutritional research and the development of compounded feeds received considerable importance. Generally, purified diets formulated using purified ingredients, are used for determining the nutritional requirements of candidate species. However, differences existed in the requirements of dietary nutrients determined by different workers within the same species. These differences are attributed mainly due to the variations in the ingredients used for formulating the research diets. Eventhough there are standard reference diets (Kanazawa *et al.*, 1977) available in literature, very often these diets could not be formulated in total in a given region as some of the diet components may not be available in that particular region. This situation necessitates the development of a purified diet, formulated using the locally available ingredients and suitable for the species that are cultured in that region. Recently, invaluable data had been obtained (Ahamad Ali, 1988) on the evaluation of different purified proteins and carbohydrates and on the mineral requirements in the diet of the prawn *Penaeus indicus*. Utilizing this information and also the other available data a standard purified diet has been evolved which can be used as a

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reference purified diet for studying the nutritional requirements of penaeid prawns in this region. Based on the nutritional requirements and also the results of evaluation of different natural protein sources (Ahamad Ali, 1988), a practical feed was formulated and tested for P. indicus. The prospects of using this practical feed for the culture of penaeid prawns are discussed.

TABLE 1. *Composition of the purified diet PDP*

Ingredients	g/100g
Albumen (egg)	35.00
Carbohydrate mix. (maltose sucrose and starch in the ratio 1:1:1)	40.00
Cod liver oil	6.00
Cholesterol	0.50
Glucosamine HCl	0.80
Vitamin mixtures*	2.70
Mineral mixture**	5.83
Cellulose	6.17
Sodium alginate	3.00
Crude protein	28.9

*Vitamin mixture : *Water soluble vitamins* : Ascorbic acid 2.0g; Choline chloride 0.12g; cyanocobalamine 0.00008g; Folic acid 0.08g; Nicotinic acid 0.04g; Pantothenic acid (calcium salt) 0.06g; Para-aminobenzoic acid 0.01g; Pyridoxine hydrochloride 0.012g; Riboflavin 0.008g; Thiamine hydrochloride 0.004g. *Fat soluble vitamins* : Biotin 0.00004g; β–carotene 0.0096g; Calciferol 0.0012g; Inositol 0.2g; Menadione 0.004g; α–tocopherol 0.029g.

**Mineral mixture : Calcium carbonate 1.3g; Potassium dihydrogen orthophosphate 4.4g; copper sulphate 0.06g; Zinc chloride 0.07g.

The author is grateful to Dr. E. G. Si and Dr. P. S. B. R. James, former Direct of CMFRI, Cochin for their encouragement carrying out this work. Thanks are due Dr. P. Vedavyasa Rao for his valuable guidan

MATERIAL AND METHODS

Purified diet : The purified diet, designated 'PDP' was formulated using egg albumen (BDH) as protein source, a mixture of sucrose (BDH), maltose (LOBA) and starch (BDH) in equal proportion, as carbohydrate source and cod liver oil (Seven Seas) as the source of lipid. The diet also contained vitamins, minerals, cellulose and other additives, the composition of which is shown in Table 1. Sodium alginate was used as the binder. The diet had 28.9% of crude protein, 40% carbohydrate, 6% lipid and 6.17% of cellulose which were found to be adequate for *P. indicus*.

Practical feed : The practical feed 'PFP', was formulated using prawn waste (head exoskeleton, eyes, eyestalk, hepatopancreas and residual meat), mantis shrimp *(Oratosquilla nepa)*, fish meal (commercial) groundnut cake and tapioca. The ingredients composition was adjusted such that the feed was made up of 65% of animal protein material and 35% of plant protein source which was found to be necessary for better growth and feed efficiency in *P. indicus*. A commercial vitamin mixture

TABLE 2. *Proximate composition (% on dry basis) of feed ingredients and fresh clam meat*

Ingredients	Moisture	Crude protein	Lipid	Nitrogen free extract	Crude fibre	Ash
Prawn waste	81.5	35.20	6.60	0.97	14.20	23.95
Mantis shrimp *(Squilla)*	80.0	44.06	7.55	1.27	8.20	23.63
Fish meal	6.8	64.40	4.70	0.97	—	19.26
Groundnut cake	5.6	48.42	7.56	25.89	6.5	6.03
Tapioca	4.8	2.00	0.54	72.01	19.20	1.45
Fresh clam meat *(Sunnetta scripta)*	80.0	48.10	13.55	16.69	—	7.62

(Becadex), manufactured by Glaxo laboratories was included in the feed. Since the feed had adequate levels of calcium and phosphorus, these were not added. However, copper and zinc were supplemented at the required level. Tapioca was used both as carbohydrate sources and binder. While the proximate composition of the feed ingredients is given in Table 2, the composition of the feed PFP is shown in Table 3.

TABLE 3. *Composition of the practical feed PFP*

Ingredients	g
Prawn waste	14.0
Mantis shrimp *(Squilla)*	14.0
Fish meal	11 0
Groundnut cake	21.0
Tapioca	40 0
Vitamin mixture*	1.0
Copper sulphate	0.06
Zinc chloride	0.07
Proximate composition	**g/100g**
Moisture	5.60
Crude protein	28.02
Lipid	10.00
Carbohydrate (nitrogen free extract)	34.40
Crude fibre	5.18
Ash	16.80
Calcium	2.54
Phosphorus	1.23

*Vitamin mixture : (one gram of the mixture contained) Vitamin A 5000 IU : Vitamin D3 400 IU : Vitamin B1 4mg; vitamin B2 4mg; Nicotinamide 50mg; Vitamin C 60mg; Calcium phosphate 500mg.

Control feed : The fresh meat of the clam *Sunneta scripta* was used as the control feed and its composition is also given in Table 2.

Preparation of diet and feed : In the case of purified diet, all the dry ingredients were powered and passed through 500 micron sieve, mixed and homogenised with cod liver oil according to the formula. The water soluble vitamins were dissolved in water and the fat soluble vitamins in alcohol and were added to the diet mixture. The binder sodium alginate was dissolved in water (40 ml for 100 g diet) at 50-60°C and the diet mixture was added to the paste and further homogenised into a dough. It was steamed for 10 mts, extruded into pallets of 3 mm diameter and dried at 60°C for 12 hours. In the case of practical feed, the ingredients were powered in a pulverizer having 0.5 mm sieve, mixed according to the formula, homogenised and prepared into a dough with water. It was steamed, pelletised and dried as in the case of purified diet.

Feeding experiments : Hatchery reared early juveniles of the prawn *Panaeus indicus*, with an average length of 20.7 mm and an average live weight of 0.0249 g, were stocked in 3' × 2' circular plastic pools containing 200 l of a mixture of filtered (through bolting cloth No. 50) sea water and tap water. There were ten animals in each pool and there were three replicates for each treatment. The water in the pools was completely replaced once in five days and aeration was provided with the help of an air compressor. The salinity of the water was maintained between 21.2 to 25.9‰, oxygen varied from 3.81 to 4.21 ml / l, while pH and temperature ranged between 8.1 to 8.29 and 28.4°C to 30.2°C respectively.

The prawns were fed at 20% of their body weight in two divided doses in the morning and evening. The duration of the feeding experiment was 100 days.

Biochemical analysis : The ingredients, diets and the animals after the feeding experiment were analysed for proximate composition. Protein was determined by Kjeldahl method and lipid by Bligh and Dyer method. Moisture, ash and crude fibre were estimated by standard AOAC methods. While calcium was determined by titrimetric method using potassium permanganate, phosphorus was

estimated spectrophotometrically using molybdovandate reagent.

Statistical analysis : The data obtained in the feeding experiment were subjected to analysis of variance following Snedecor and Cochran (1973).

Results and Discussion

The purified diet PDP resulted in the highest survival of 90% (Table 4) of *P. indicus* at the end of 100 days. The average increase in length of the prawns fed this diet was 54.7 mm and the average increase in weight was 3.83 g. The food conversion ratio (FCR) of the diet was 2.37. Several purified diets were formulated using casein for different species of prawns (Kanazawa *et al.*, 1970, 1981; AQUACOP, 1978; Ahamad Ali, 1982 b). In these diets the protein content varied from 15 to 80% whereas the protein co of the present purified diet was only 28.9 However, the growth obtained by the PDP in *P. indicus* compares well with growth of *P. japonicus*, *P. merguiensis* and *monodon* obtained by the other purified di On the other hand, the FCR and survival sho by PDP were superior to those obtained the other diets.

The practical feed PFP produced highest increase in length (72. 2 mm) and

Table 4. *Results of the feeding experiments conducted with diet PDP, feed PFP and fresh clam meat on* P. in *for 100 days*

Particulars	Feed		
	PDP	PFP	fresh clam m
Initial average length (mm)	20.9	20.7	20.8
Initial average live weight (g)	0.025	0.025	0.025
Final average length (mm)	75.5	92.2	88.1
Final average live weight (g)	3.86	4.72	4.45
Increase in length (mm)	54.7^{c}	72.2^{a}	63.7^{b}
Increase in live weight (g)	3.83^{b}	4.69^{a}	4.42^{a}
Food conversion ratio	2.37	1.80	2.09
Survival %	90.0	63.3	53.0
Body composition of animals after completion of feeding experiment			
Crude protein (% on dry basis)	63.9	66.53	60.40
Lipid „	18.60	13.60	21.00
Carbohydrate „	1.41	1.44	1.52
Ash „	17.23	16.93	16.81

Note : Values with different superscripts differ significantly among themselves. Increase in length and live we significant at 5% ($p < 0.05$). Food conversion ration not significantly different ($p > 0.05$).

weight (4.69 g) followed by the control fresh clam meat (63.7 mm in length and 4.4 in live weight) which were significantly hig ($p < 0.05$) than those recorded by the purif diet. The survival of the animals was 63 in the case of PFP and only 53% in the c of control feed. The growth curves (Fig had shown that for the first ten days the gro

was similar for all the three feeds. With time, the growth curves seprated out with PFP occupying the top position and the PDP taking the lower position, while the control remaining intermediate between PFP and PDP.

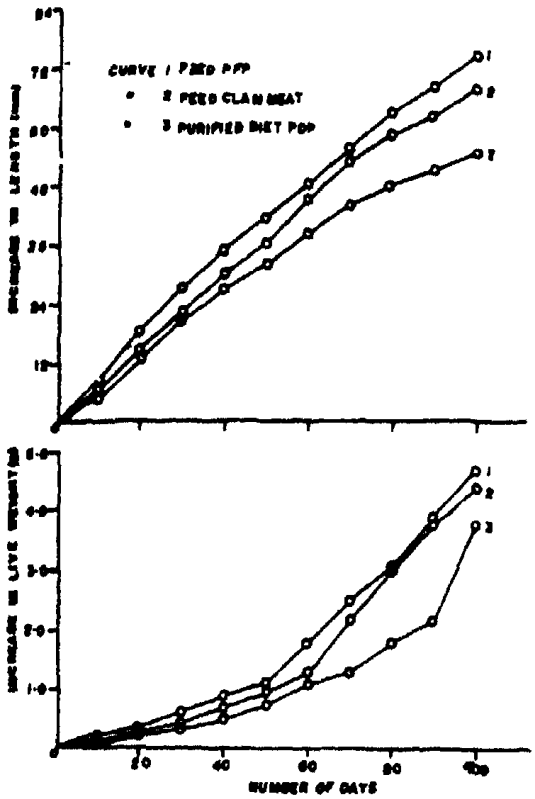

Fig. 1. Growth curves (a) weight and (b) length of *P. indicus* fed with purified diet (PDP), practical feed (PFP) and fresh clam meat.

The comparatively low growth and high FCR in the case of PDP are expected as it is a synthetic diet. Such inferior results with synthetic purified diets were not uncommon and were reported by many (Sick *et al.*, 1972; Deshimaru and Kuroki, 1974, 1975 a, b; Ahamad Ali, 1982 b; Teshima *et al.*, 1986). This might be due to the non-palatability of the purified diets as these are prepared with purified materials and chemicals. Nevertheless, the use of purified diets is essential in nutritional studies as the effect of particular nutrient could be clearly understood, without the interference of extraneous factors only through purified diets. These are primarily meant for studying the nutritional requirements of candidate species. However, Purified diets can also be used for practical feeding purposes by incorporating appropriate feed attractants such as squid extract, mussel mantle and shrimp extract. The high survival resulted by the present purified diet indicates that the diet is nutritionally balanced. Taking this into account and also the comparative growth performance of PDP, it can be used as standard purified diet for studying the nutritional requirements of penaeid prawns in this region.

Clam meat is conventionally used for feeding prawns in culture systems. In the present study the growth of prawns was low and the FCR was high compared to the practical feed. The survival was also low. Similar results were reported in *P. indicus* with fresh clam meat by Colvin (1976) and Ahamad Ali (1982 a), especially it resulted in high mortality and cannibalism. Contrary to these findings, Kanazawa *et al.* (1970) reported superior growth in *P. japonicus* fed with the meat of short-necked clam (*Tapes philippinarum*). Similar observations were made by Forster and Beard (1973) in the prawn *Palaemon serratus*. However, clam meat by itself may not be considered as a nutritionally balanced feed for prawns. Besides, it is relatively expensive (6 to 9 rupees per kilogram of fresh meat with 80% moisture) and is used for human consumption. Further, the availability of clam meat in adequate quantity for feeding large scale culture of prawns is not assured. It may, however, be used as supplementary feed for

prawns wherever it is available at competitive price.

The FCR obtained (1.80) by the practical feed PFP in the present study is superior to the FCRs obtained by certain compounded feeds tested for *P. indicus* by Raman *et al.* (1982). However, one of the feed combinations (fish meal, rice bran and tapioca in the ratio 1:1:1) reported by these authors gave a FCR of 1.69 which was slightly better than the value recorded by the feed PFP. The FCR of PFP is also superior to the FCRs of some formulated feeds (with frog flesh waste) recorded by Mohammed Sultan *et al.* (1982) in *P. indicus* (3.01 – 4.96) and *P. monodon* (5.87 – 8.21). Colvin (1976), while studying the growth, digestibility and FCR of some diets formulated with fish meal and shrimp meal reported 2.72 as the lowest FCR in *P. indicus* which is higher than the value obtained by PFP for this prawn.

The performance of the present feed PFP compares well with some of the feeds formulated for other penaeid prawns. In cage culture experiments with *P. monodon* in Philippines (SEAFDEC, 1981), the FCR recorded by a practical feed was 4.8. In a semi-intensive culture experiment with the same prawn (SEAFDEC, 1983) a commercial prawn feed with 45% protein and an experimental feed with 35% protein produced FCRs of 3.4 to 4.6 and 6.1 respectively. Certainly, the FCR (1.80) shown by PFP in *P. indicus* is much lower than the values presented above. Further, in pond culture experiments with *P. monodon* in the Philippines, Liu and Mancebo (1983) used a commercial formula feed developed by the President Enterprises Corporation, Taiwan and obtained a FCR of 1.78. The FCR of PFP is practically comparable with these results.

From the above discussions it is clear that the performance of the present practical feed PFP is comparable to that of many of the standard formula feeds and it is superior to the performance of some of the locally formulated feeds. Moreover, the material cost of the present feed is found to be Rs. 4.7 per kilogram, based on the existing retail prices of the ingredients (prawn waste Rs. 3/- kg, mantis shrimp Rs. 3/- kg; fish meal Rs. 8/- kg, tapioca Rs. 3/- kg) including the cost of vitamin and mineral mixture (which is equivalent to Rs. 1 per kg of the feed). If we add Rs. 1.2 towards the cost of preparation, the total cost of the feed will be Rs. 6/- kg. With a food conversion ratio of 1.80, the cost of the feed to produce one kilogram of prawns is only Rs. 10.80 which can be considered as very economical. The performance of the feed is expected to be much better in a dynamic environment such as a culture pond compared to the results shown in the laboratory experiments.

The feed ingredients listed in the formula of PFP are locally available in considerable large quantities. Recently Wood and Coutts (1988) estimated the potential availability of prawn head meal (2200 t/annum), fish meal (110000 t/annum) squilla meal (10000 t/annum), groundnut cake (1.4 million t/annum) and tapioca (5.6 million t/annum) for making prawn feed in India, which is very encouraging. Taking into account the good performance of the feed, its low cost, the adequate availability of raw materials, the detailed information available on the techniques of preparation of water stable pellets, the practical feed PFP can be recommended for the large scale culture of penaeid prawns in general and *P. indicus* in particular.

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