## SUMMARY

Penaeid prawn farming is being practiced in the coastal water impoundments in India to supplement the production of prawns from the capture fishery resources. Adequate seed and appropriate feed are the two important requisites for the culture of prawns. For preparing balanced and low cost feeds, knowledge on the nutritional requirements of the candidate species and the evaluation of locally available raw-materials are essential. In this context, evaluation of different sources of proteins and carbohydrates and the requirement of minerals in the diet of the prawn Penaeus indicus, an important species for culture along the entire Indian coast, has been undertaken in the present study. The data obtained are presented in four different chapters.

1. In the first chapter four purified proteins and nine natural protein sources were evaluated for the juveniles of P. indicus.

2. The purified proteins were albumen (egg), casein, fibrin (blood) and gelatin.

3. Among the natural protein sources, five were animal materials - Clam meat, fish meal, mantis shrimp (Squilla), Prawn waste, Silkworm pupa and four were plant materials - Coconut cake, gingelly cake, groundnut cake and Spirulina (single cell protein).

4. The evaluation of these proteins was carried out through standard methods of nutritional biochemistry by measuring digestibility, biological value (BV), net protein utilisation (NPU), Protein efficiency ratio (PEP) and growth, in

statistically designed feeding experiments.

5. For the first time, endogenous nitrogen excretion (metabolic faecal nitrogen) was determined for penaeid prawns, using zero protein diet. For P. indicus the metabolic faecal nitrogen was found to be on an average 324 mg N per 100 gram diet.

6. With purified proteins, four sets of experiments were conducted in which relative efficiencies of individual proteins and their different combinations were studied.

7. The influence of dietary protein level on its digestibility, BV, NPU, PER and growth was investigated.

8. Comparative studies of protein requirement in the diet were carried out using different protein sources.

9. The significance of dietary protein level in relation to faecal nitrogen, biological value and nitrogen balance was elucidated.

10. Among the purified proteins tested, fibrin and albumen had high biological value for P. indicus, followed by casein. Gelatin was found to be a poor protein source with low BV, for this prawn.

11. Biological value, NPU, PER were high at low dietary protein level and showed decreasing tendency with the increase in the dietary protein level, while the digestibility of protein in the diet tended to be low at lower levels and high at higher levels of dietary protein, though the difference was not statistically significant.

12. The requirement of protein in the diet of P. indicus was found to be 25% with albumen diets and 29% with casein diets.

13. The nitrogen balance (calculated as the difference in nitroge of the diet and the faeces) was zero at 22% dietary protein and whe it was raised a little above this level (3% in case of albumen diet and 7% in case of casein diet), the nitrogen balance was positive, at which the diet had shown the best performance.

14. In the different combination of proteins tested, the diet having all the four proteins, albumen, casein, fibrin and gelatin in equal proportions, gave the best results.

15. From the results, it was concluded that proteins having high BV only should be used for protein requirement study to obtain realistic information. A mixed protein source can be employed for protein requirement study. Albumen alone can be employed for protein requirement study. Casein alone and other combinations may be used only as alternatives.

16. Among the natural protein sources, the animal proteins were significantly superior to the plant proteins.

17. Fish meal, clam meat, prawn waste and mantis shrimp gave good results with high BV, NPU and PER in the decreasing order respectively of the ingredients. Whereas silkworm pupa was found to be a poor protein source.

18. In the plant protein sources, Spirulina and groundnut cake gave the best growth while the BV of the former was higher than that of the latter. However Spirulina diet resulted in very low survival of the prawns.

19. Coconut cake and gingelly cake showed low growth and BV, eventhough their protein had high digestibility.

20. Animal protein sources in general had low digestibility and showed higher growth, PER, NPU and BV over the plant protein sources.

21. The diet having 70% animal protein source and 30% plant protein source gave the best growth and FCR than the diets made exclusively either with animal protein or plant protein source. Under these conditions the diet with 30% protein showed best performance which is in agreement with the results obtained with casein diets.

22. The protein balance, which is the difference between the dietary protein and the protein in the faeces, was negative at lower dietary protein levels and positive at higher dietary protein level.

23. The protein balance in the practical diets was zero at 26% protein and the optimum protein requirement shown by the prawn was just 3.7% above the dietary protein level, where the protein balance was zero.

24. In the second chapter, seven different carbohydrates - three monosaccharides, glucose, fructose, galactose; two disaccharides, maltose, sucrose; two polysaccharides, glycogen and starch, were evaluated by measuring the digestibility, growth and food conversion ratio (FCR).

25. Only disaccharide, maltose and polysaccharide starch were efficiently utilised by P. indicus. Glucose, fructose and galactose gave poor results while the results of the diet with sucrose were slightly superior to that of the monosaccherides.

26. Using a mixed carbohydrate - sucrose, maltose, starch (in equal proportions), which gave the best results, the effect of dietary carbohydrate level on digestibility, growth survival and FCR was studied.

27. The role of carbohydrate level in the diet at constant protein, at constant lipid and at constant protein and lipid was investigated and discussed.

28. The diet with 22.5% carbohydrate produced the best performance at constant protein (34.8%), while at constant lipid (6%), the dietary carbohydrate showed protein sparing action and the diet having 53% carbohydrate and 22% protein gave the highest growth and best FCR. High lipid (16.8%) and low carbohydrate (8.44%) produced low growth and high FCR. Only the diet with 6% lipid and 33% carbohydrate gave the best performance.

29. The results had shown that, the carbohydrate is preferable over lipid for increasing the calorific value of the diet. High energy - Low Protein feeds are more economical without compromising with the performance of the feed.

30. Further, cellulose was found necessary for the efficient utilisation of the diet. Best FCR was obtained with diet having 10% cellulose than the diet having zero percent cellulose. It is concluded that cellulose can be used upto 10% in the diet.

31. The faeces of animals fed with zero carbohydrate diet had considerable amount of carbohydrate. The excretion of carbohydrate in the faeces varied from 50 to 116 mg/g of dry diet consumed. Further investigations are needed to establish whether this is metabolic faecal carbohydrate similar to the metabolic faecal nitrogen.

32. The third chapter deals with the studies on the requirement of six minerals - Calcium, phosphorous copper, zinc, magnesium and manganese, in the diet of P. indicus.

33. The Prawns were fed with diets prepared with different levels of selected minerals and their growth, FCR and survival were measured. The effect of each mineral level in the diet on the body mineral level in animal was investigated.

34. 0.53% of calcium was required in the diet of P. indicus for best growth and FCR.

35. Phosphorous was essential in the diet of P. indicus and it was required at 1.05% level in the diet for the best growth and FCR.

36. The food conversion ratio of the diet was the best when the diet contained 13.6 mg copper per 100 gram diet.

37. The best growth and FCR were obtained by the diet having 23.6 mg of zinc per 100 g. Higher level of zinc in the diet depressed the growth.

38. Magnesium was not found to be required in the diet. Addition of magnesium in the diet decreased growth and increased FCR.

39. The control diet had 0.21 mg of manganese per 100 gram diet which gave the best results. Addition of manganese to the diet depressed growth and increased FCR.

40. Using the information obtained on the nutritional requirements of P. indicus and also the ingredients evaluated in the present study, a purified diet and a practical feed were formulated.

41. While the purified diet was made up of albumen (egg), mixed carbohydrate (sucrose, maltose, starch, in 1:1:1 ratio), cod liver oil, vitamins and minerals, and other additives, the practical feed consisted of prawn waste, mantis shrimp, fish meal, groundnut cake and tapioca, fortified with vitamins. These were fed to P. indicus in long term feeding experiments

in the laboratory and the results were compared to those of the conventional feed, clam meat.

42. The practical feed produced the highest growth and the best FCR, followed by the control feed and the purified diet. However, the purified diet resulted in the highest survival of animals among the three diets tested.

43. The possibilities of using the purified diet as standard basal diet for nutritional studies on prawns in this region, and the practical feed for the culture of penaeid prawns in the nursery and grow-out systems were discussed.