Freshwater prawns are farmed in many parts of the tropical world. Unlike penaeid shrimps, freshwater prawns are grown on low protein and relatively inexpensive diets. Natural foods play an important role in the nutrition of the species in ponds.

Nutrition and Feeding in Freshwater Prawn (*Macrobrachium rosenbergii*) Farming

Gopa Mitra
Resource person, Fisheries and Aquaculture Division
Department of Zoology, Utkal University, Vanivihar,
Bhubaneswar 751004, India
Gopamitra@yahoo.com

P. K. Mukhopadhyay
Principal Scientist and Head, Wastewater Aquaculture Division
Central Institute of Freshwater Aquaculture
P.O. Rahara, Kolkata 700118, West Bengal, India

D. N. Chattopadhyay
Training Associate, KVK/TTC of CIFA
Kausalyaganga, Bhubaneswar 751002, Orissa, India

The farming of the giant freshwater prawn *Macrobrachium rosenbergii* popularly known as 'scampi' has been expanding in India recent years. Scampi farming gained momentum after the set-back in shrimp farming due to disease outbreaks and other factors. The infrastructure available to produce shrimp seed and process the shrimp was helpful in providing support to scampi farming. The existing culture system includes both monoculture and polyculture with Indian major carps in ponds. Grow out stocking densities range from 0.5-2.5 scampi per m^2 in polyculture and 1-5 per m^2 in monoculture. The culture period is 6-8 months starting at the beginning of southwest monsoon (June-July, 27-30°C). The scampi are fed with farm-made or commercial feeds. This article summarizes the nutrition and feeding of freshwater prawns (grow out), with special reference to culture conditions in India.

Freshwater prawn production depends on natural productivity in ponds, but feeds are important to profitability

Table 1: *Summary of nutrient requirements of freshwater prawn,* M. rosenbergii *based on laboratory trials*

Nutrients	Growth stages	Requirement
Protein (%)	Broodstock	38-40
	Juveniles (2nd 4th month)	35-37
	Adult (5th 6th month)	28-30
Carbohydrate (%)	For all stages	25-35
Lipid, including phospholipids (%)	For all stages	3-7
Highly unsaturated fatty acids (%)		> 0.08
Cholesterol (%)	For all stages	0.5-0.6
Vitamin- C (mg/kg)	Grow out	100
Calcium/Phosphorus		1.5-2.0:1
Zn (mg/kg)		90
Other minerals		Quantitative requirements not yet known
Energy	Broodstock	3.7-4.0 kcal/g feed
	Other stages	2.9-3.2 kcal/g feed

Nutrient Requirements

There is a fairly good amount of information on the nutrient requirements of freshwater prawn. The prawns are capable of digesting a wide range of foods of both plant and animal origin. Characterization of the activities of the digestive enzymes in the alimentary tract indicates the presence of enzymes like trypsin, amino peptidases, proteases, amylases, chitinase, cellulase, esterases and lipases. Nutrient requirements of different grow out stages of prawn are summarized in Table 1.

Proteins and Amino Acids:

Diets with about 35-40% protein and gross energy level of about 3.2 kcal/g diet and protein:energy ratio of about 125-130 mg protein/kcal are suitable for growth of *M. rosenbergii* in clear water systems that do not have any supply of natural foods. Broodstock reared in ponds having natural food (benthic micro- and macro fauna) require about 30% protein in the diet. Many commercial feeds for grow-out contain 24-32% crude protein. Protein/starch ratio of 1:1 is known to be effective for better feed efficiency and growth rate. The prawn requires the same ten essential amino acids as other crustacean and fish species, but quantitative requirements have not been determined. The amino acid composition of the prawn muscle is used to provide guidance values in feed formulation.

Carbohydrates:

The comparatively high specific activity of amylase found for *M. rosenbergii* supports the fact that the species efficiently utilizes carbohydrates as a source of energy. During fasting, energy metabolism in the prawn is dominated by carbohydrates, followed by lipids and proteins. Complex polysaccharides including starch and dextrin are more effectively utilized than simple sugars. Dietary glucosamine (an amino sugar and intermediary between glucose and chitin) facilitates molting followed by enhanced growth. Dietary protein is efficiently utilized at dietary lipid-carbohydrate ratio of 1:3-1:4. The prawns are also known to utilize as high as 30% dietary fiber.

Lipids and Fatty Acids:

In freshwater prawn that uses dietary carbohydrate efficiently as energy source, protein sparing by lipids is not considered to be crucial. The dietary lipid level in prawn diets can be as low as 5 % provided the lipid source contains sufficient levels of essential fatty acids. There is a dietary requirement for highly unsaturated fatty acids (HUFA) although in very small quantities. Both n-3 and n-6 HUFAs at dietary levels of 0.075% are known to increase weight gain and feed efficiency remarkably. In addition both 18:2n-6 and 18:3n-3 are also required.

M. Rosenbergii, like other crustaceans, is unable to synthesize cholesterol due to the absence of the enzyme 3 hydroxy 3 methylglutaryl CoA reductase. The dietary requirement for cholesterol is approximately 0.3-0.6% in diet. Substitution with 0.6% ergosterol or stigmesterol is generally not so effective compared to 0.6% cholesterol. However, a mixture of phytosterols (sitosterol, campesterol and dihydrobrassi-casterol) has been found to be as effective as cholesterol. So, unlike in penaeid shrimp feeds, there is no need to add high levels of purified cholesterol in freshwater prawn feeds provided the ingredients contain sufficient levels of phytosterols.

Farmer showing difference in claw sizes between individual prawns

Low level of dietary cholesterol in broodstock diet is known to adversely affect egg quality resulting in inferior quality of seed production The cholesterol content in the eggs and hepatopancreas, and total lipid content in the ovary and hepatopancreas of pond reared broodstock fed with a diet containing 30% crude protein and 5% lipid was significantly lower when compared to the eggs from wild broodstock collected from the lower reaches of the river Brahmini in Orissa, India. Higher levels of lipids and cholesterol are probably key factors in egg maturation and egg quality.

The freshwater prawn also has limited ability to biosynthesize phospholipid (PL) *de novo*. A basal level of 0.8% dietary PLs is required to meet the demand of the scampi broodstock. A dietary source of phosphatidylcholine (PC) in the form of soy-lecithin is essential for larval growth and survival. Supplementation of larval diets with 5% soy-lecithin along with 1 % cod liver oil and 1% groundnut oil improved growth rate by164%. In the absence of sufficient levels of bile salts during development, dietary PC may also enhance the assimilation of ingested fats by acting as temporary emulsifier.

Vitamins:

Vitamin requirements of *M. rosenbergii* are probably similar to other crustaceans and fish species. The prawn requires 60-150mg vitamin C/kg diet. Levels of 60mg ascorbic acid and 300 mg α-tocopherol per kg diet are considered sufficient for proper reproduction and offspring viability in prawn broodstock. However, feeding female prawn with higher levels of both these vitamins (each around 900 mg/kg) might improve larval quality including higher tolerance to ammonia stress. It has been reported that vitamin E at 200 mg/kg diet modulated some of the antioxidants defense system by decreasing lipid peroxidation in the hepatopancreas.

Minerals:

Information on quantitative mineral requirement of freshwater prawn is limited. Dietary supply of calcium seems to improve growth of freshwater prawn. Performance of the prawns were better when calcium was provided at 3% level in soft water (Calcium concentration at 5 ppm). Even when the calcium concentration was higher at 74 ppm, performance improved when calcium was provided at 1.8%. The optimum level of zinc is at 50-90mg/kg diet. Growth and feed conversion efficiency declined at higher dietary doses (> 90mg/kg) of zinc.

Feeds

Natural food items:

Zooplankton and oligochaete worms play a very important role in the nutrition of freshwater prawns grown in ponds. Even juveniles larger than 2g can utilize live zooplankton. Earthworm and insect larvae are also natural food items for the prawns. Enhancement of macroinvertebrate production in ponds is extremely important in the production of freshwater prawns as it would improve feed efficiency considerably. The use of good quality feeds, however, is important when biomass in the ponds increase as the animals grow. Moreover, more uniform production of large prawns is achieved when feeds are used (Tidwell et al. 2004).

Market-size prawns grown in ponds

Feed ingredients:

Prawn head meal, chicken offal, clam meat, silk worm pupae, meat and bone meal, fish meal, crustacean meal, squid meal and mussel meat meal are some of the excellent ingredients used in prawn feed trials. Various cereal grains, oil seed cakes (ground nut oil cake, soybean cake, sunflower oil cake), rice bran and several other animal husbandry and agro by-products available have also been used as ingredients in test diets. Many of the ingredients are also used in the on-farm and commercial feeds made in India.

Better growth, molting frequency and survival occurs by feeding animal proteins sources such as mussel meat meal, squid meal, shrimp meal, fishmeal and earthworm meal than plant protein sources such as various oil seed cakes. Best growth performance with least feed conversion ratio (FCR) and highest protein efficiency ratio can be achieved by feeding prawn meal as source of protein than either mussel meat meal or combination of prawn meal and mussel meat meal in a 1:1 ratio. Meat and bone meal and squilla meal can be used as a replacement of fishmeal for the preparation of efficient practical diets of prawn. Distillers Dried Grains and Solubles (DDGS), an inexpensive ingredient, relatively high in protein (29%), is suitable for use in practical diets at up to 40% of the total formula. Fishmeal can be partially or totally replaced with soybean meal and distillers' by-products in diets. In addition to the more conventional animal feed ingredients, many other materials (moist pressed brewers' grains, corn silage, beef liver, orange flesh, peeled sweet potatoes, frozen peeled bananas, turnip greens and carrot tops) can suitably be used for inclusion in prawn diet.

A feed formula using locally available ingredients such as groundnut oil cake, fish meal, soybean meal, rice bran, and vitamin and mineral premix has been developed at CIFA, Bhubaneswar for commercial grow-out of freshwater prawns in ponds. This formula is helpful for small and marginal farmers who do not use commercial feeds and instead prepare a farm made feeds using mixtures of rice bran, oil cakes and fish or crustacean meal. Chitin supplementation in prawn diet is beneficial for the formation of new shells during molting. Dry sugarcane yeast, *Saccharum officinarum*, a by-product of alcohol production from sugarcane, could be supplemented up to 20% in a 30% protein diet for grow-out stages.

Addition of several chemo attractants such as taurine, betaine, glycine and proline in diets enhances voluntary feed intake and growth of juveniles. Betaine added to the water has been shown to induce a burst of food searching behavior leading to further intake resulting in a 17% increase in prawn growth at juvenile stages. Cadaverine at 0.2 % inclusion was the best attractant when compared to other biogenic amines such as putrescine, pheromones (crab urine and freshwater prawn green gland extracts) and squid extracts. However pheromones exhibited good results only with males indicating that these may be more suitable in all-male culture of prawns.

Feeding practices

Freshwater prawn is omnivorous and coprophagous. They have been shown to utilize natural food in preference to artificial feeds. Fertilization, therefore, plays an important nutritional role in pond culture of freshwater prawn. Generally no exogenous feed is required until the prawn biomass reach 18 g/m^2 in the pond. Beyond this point natural productivity can no longer sustain growth and feed supply becomes mandatory as a direct source of nutrients. For grow-out culture of prawns feed are initially given at 5-8% of the body weight/day. The feeding rate declines as the animals grow and reach about 1.5-2% bwd when the animals are about 20 g in size. Broodstock are fed with balanced artificial formulated pelleted feed at 3-5% of the body weight twice daily during morning and evening. Farmers generally feed the cultured prawn twice daily with feeds that contain protein levels ranging from 20 to 35%. However, the species grows well even with 15 % protein feeds in ponds with sufficient natural food.

Summary

The prawn is one of the high value aquaculture product emerging from Asia. At present feed is the largest single cost item, as it constitutes 40-60% of operational cost in prawn production. Hence feed to attain higher growth and more efficient feed conversion ratios needs to be developed . In this context, the use of feeding attractants will have relevance in improving feed intake and feed efficiency and to minimize feed wastage and water pollution.

Dr Gopa Mitra teaches postgraduate programs in Fisheries and Aquaculture at the Department of Zoology, Utkal University, Bhubaneswar, Orissa, India. Her area of research is the improvement of the nutritive value of natural fish food organisms through bioenrichment. She also works on larval nutrition and physiology of Indian major carps, catfish and prawns.

Dr P.K. Mukhopadhyay is currently Head, Wastewater Aquaculture Division, Central Institute of Freshwater Aquaculture (CIFA). His research interest is in nutritional biochemistry of Indian major carps, catfish and freshwater prawn. He has several publications on fish nutrition in peer-reviewed journals. He was a Post Doctoral Fellow in the University of Stirling during 1992, and Visiting Scientist at INRA, St-pee Sur Nivelle during 2000.