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Vagh Sarman
Department of Fisheries Resource Management, College of Fisheries, Junagadh Agriculture University, Junagadh, Gujarat, India

Rathod Vishal
Department of Aquaculture, College of Fisheries, G. B. Pant University of Agriculture & Technology, Pantnagar, Uttarakhand, India

Dushyant Mahavadiya
Department of Aquaculture, P.G. Institute of fisheries Education and research, Kamdhenu University, Gandhinagar, Gujarat, India

Dharmesh Sapra
Department of Aquaculture, P.G. Institute of fisheries Education and research, Kamdhenu University, Gandhinagar, Gujarat, India

Correspondence
Vagh Sarman
Department of Fisheries Resource Management, College of Fisheries, Junagadh Agriculture University, Junagadh, Gujarat, India

Nutritional aspect for freshwater prawn (*Macrobrachium rosenbergii*) farming

Vagh Sarman, Rathod Vishal, Dushyant Mahavadiya and Dharmesh Sapra

Abstract
Freshwater prawn have become an important component of global aquaculture both in terms of quantity and value. It is a one of the most important species for culture due to superior cultivable attributes such as very fast growth rate, high market demand, hardiness, euryhaline nature and its compatibility to grow with cultivable fin fishes. It could be cultured almost all freshwater bodies such as ponds, tanks, canals, cage, pans, raceways. As freshwater prawn culture becomes more intensive, it also becomes less dependent on natural food and more on prepared feeds. Freshwater prawn farming is carried out by small and marginal farmers who are employing a low input level. Here we concerned on most dietary nutritional component and their effective application in aqua-farming. Various studies have shown that *M. rosenbergii* is able to utilize a higher proportion of plant derived protein. Their results provide useful perspective for managers of current prawn farming operations. The purpose of this study was to evaluate nutritional requirement of freshwater prawn in aqua-farming.

Keywords: Freshwater prawn, scampi, feed, nutrition, aqua-farming

Introduction
Fish is a vital component of food security and livelihood especially in developing countries of the world. As the world population grow, the need for more food and more fish correspondingly increased. Aquaculture, the farming and the husbandry of fish and other aquatic organisms, is now a well-established industry worldwide and fastest growing food production sector. Fish nutrition and feeding play important roles in the sustainable development of aquaculture. The efficient conversion of feed to fish is important to fish farmers because feed is the largest component of the total cost of production. Improved feed composition and better feed efficiency will result in higher fish production, lower feed cost and low waste production hence, decreased nutrient load from fish farming.

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.

Origin of modern freshwater prawn culture
Freshwater prawns have been reared in captivity, either through introducing wild-caught juveniles or by trapping them, along with other crustaceans (e.g. *Penaeus* spp. and *Metapenaeus* spp.) and fish, in tidal ponds and paddy fields, for example in the Indian sub-continent and Malaysia (Wickins 1976) [10], from time immemorial. However, modern aquaculture of this species has its origins in the early 1960s. In 1961 the first major milestone was achieved at the Marine Fisheries Research Institute in Penang, Malaysia, when the Food and Agriculture Organization (FAO) expert Shao-Wen Ling discovered that freshwater prawn (*M. rosenbergii*) larvae required brackish conditions for survival. While Ling's discoveries were fundamental, it was the work of another pioneer, Takuji Fujimura that made the commercial development of freshwater prawn culture possible.

This was the second major milestone in the history of freshwater prawn farming. Fujimura's research in Hawaii commenced in 1965, with the introduction of broodstock of *M. rosenbergii* from Malaysia (Ling & Costello 1979). Within 3 years, the activities of Fujimura and his team in the Anuenue Fisheries Research Center in Honolulu resulted in the development of mass-rearing techniques for commercial-scale hatchery production of prawn postlarvae (PL) (Fujimura & Okamoto 1972) [4]. The third important milestone in the history of freshwater prawn farming occurred when the United Nations Development Programme (UNDP) decided to fund an FAO executed project, named 'Expansion of Freshwater Prawn Farming', in Thailand.

Production status of freshwater prawn in India

Plagued by the lack of demand the scampi culture and production has failed to so any increase. The scientific monoculture of scampi has been recorded only in about 2919 Ha registering a production of about 3332 MT.

Table 1: A state-wise detail of scampi production during 2011-12 & 2012-13

S. No	State	2011-12			2012-13		
		Area under culture (Ha)	Estimated production (MT)	Productivity in (MT/Ha/Year)	Area under culture(Ha)	Estimated production (MT)	Productivity in (MT/Ha/Year)
1.	West Bengal	4358.00	2906.00	0.66	1520.00	2446.00	1.61
2.	Odisha	743.00	513.00	0.69	886.00	592.00	0.67
3.	Andhra Pradesh	485.00	475.00	0.98	280.00	174.00	0.62
4.	Tamil Nadu	437.00	285.00	0.65	136.00	54.00	0.40
5.	Kerala	161.00	52.00	0.32	48.00	6.00	0.13
6.	Karnataka	0.00	0.00	0.00	0.00	0.00	0.00
7.	Goa	0.00	0.00	0.00	0.00	0.00	0.00
8.	Maharashtra	33.00	38.00	1.15	49.00	60.00	1.22
9.	Gujarat	0.00	0.00	0.00	0.00	0.00	0.00
Total		6244.00	4269.00	0.68	2919.00	3332.00	1.14

Source: Marine Product Export Development Authority (MPEDA), Kochi

*Production from Aquaculture farms this data provides production from monoculture farms only and does not include production from village ponds, reservoirs etc.

Feeds in Aquaculture

Aquatic animals, like any other living organisms, need essential nutrients or substances for growth, tissue repair and maintenance, regulation of body functions, and to maintain health. As freshwater prawn culture becomes more intensive, it also becomes less dependent on natural food and more on prepared feeds. A nutritionally-balanced feed and adequate feeding are important factors that help maximize freshwater prawn production and profitability. Inappropriate feeds could result in disease outbreaks, poor growth, and high mortality of prawn in the farm. Good quality feed coupled with appropriate feeding management has been shown to result in improved feed conversion efficiency, lower costs of production, and reduced levels of environmental degradation.

A good quality and nutritionally-adequate feed can be ineffective unless proper feeding practices are used. Emphasis must also be given to good feeding management and improved feed performance. An effective feeding management requires answers to questions of what, how much, when, how often, and where, to feed the freshwater prawn. The feeding regime used should match the feeding behavior and digestive cycle of the freshwater prawn in order to maximize feed utilization. Any reduction in food wastage will have a significant impact on freshwater prawn production costs and the quality of the culture environment.

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 2.

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. 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 -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.

Table 2: Nutrient requirements of freshwater prawn, M. rosenbergii

S. No	Nutrients	Growth stages	Requirement
1.	Protein (%)	Broodstock	38-40
		Juveniles (2^{nd} 4^{th} month)	35-37
		Adult (5^{th} 6^{th} month)	28-30
2.	Carbohydrate (%)	For all stages	25-35
3.	Lipid, including phospholipids (%)	For all stages	3-7
4.	Lipid, including phospholipids (%)		> 0.08
5.	Cholesterol (%)	For all stages	0.5-0.6
6.	Vitamin- C (mg/kg)	Grow out	100
7.	Calcium/Phosphorus	-	1.5-2.0:1
8.	Zn (mg/kg)	-	90
9.	Other minerals	-	Quantitative requirements not yet known
10.	Energy	Broodstock	3.7-4.0 kcal/g feed
		Other stages	2.9-3.2 kcal/g feed

Source: MitraGopa *et al*. 2005.

Mechanism of Nutrition

The process of nutrition involves three stages-ingestion, digestion and egestion.

Ingestion

Prawn is omnivorous, i.e., eats all kinds of foods. It feeds actively at dusk and in the morning on algae, decaying vegetables and small insects. Food is procured by the chelate legs and brought near the mouth cavity by following appendages – maxilla, maxillulae, Mandibbles and maxillipeds. These appendages allow animal to bring food closer to mouth. Mandibles help to fragment the food into smaller bits and the molar processes of the mandibles inside the buccal cavity crush the food. Entrance of food within the cardiac stomach is assisted by the peristaltic motion of the esophageal wall.

Digestion

Within the cardiac stomach the food is churned by the action of cuticular plates on the inner wall, finer particles of food filtered by the complete come within lateral grooves from where it is guided into the ventral chamber of pyloric stomach. Digestion takes place within the pyloric stomach by the action of digestive juices which come from the hepatopancreas. All the enzymes for the breakdown of carbohydrate, protein and lipid are present in the juice.

The digested liquid food is strained by the filtering apparatus in the ventral chamber of pyloric stomach and enters within dorsal chamber and then to the hepatopancreas. The residual part of the food passes within the mid gut. After certain amount of absorption the residual matter enters within dorsal chamber and then to the hepatopancreas. The residual part of the food passes within the hind gut.

Egestion
From intestine the residual part of the food enters within the rectum and is temporarily stored there for some-time. Finally it is ejected through the anus.

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.

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