

STATUS OF PRAWN (*Penaeus monodon*) FEED DEVELOPMENT IN THE PHILIPPINES

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INTRODUCTION

Approximately a decade ago the culture of sugpo or tiger prawn (*Penaeus monodon*) was in its infancy. Prawns were stocked alone or together with milkfish and fed mainly on natural food present in the ponds. High market prices, increased consumer demand, and availability of the seeds through artificial propagation in the last six years have brought about a shift towards more intensive culture of prawns. With the advent of monoculture and more intensive farming of sugpo has come a greater demand for an external source of food because natural food organisms in the ponds would no longer suffice to meet the dietary requirements of the prawns.

The intensive culture of prawns requires knowledge of their nutrient requirements in order to provide adequate food for growth and survival. Knowledge of their feeding habits is also important particularly in feed development. Prawn culturists and nutritionists are faced not only with problems of nutritional requirements but also practical considerations such as physical features of the diet, methods and frequency of feeding, feeding behavior and feed preferences at various stages of the life cycle, effects of the food on water quality, amount of feed and types of facilities appropriate for culture.

NUTRIENT REQUIREMENTS

We have little information on the nutrient requirements of *P. monodon*. There is likewise scarce data on the availability of protein, fats and carbohydrates. Unlike terrestrial animals, there is little information on digestible nutrient, digestible energy, and metabolizable energy for available feed ingredients. Consequently, for practical purposes, prawn feed formulations are computed in the absence of hard data for *P. monodon* using the scanty information and values derived from other species.

Supplementary feeds in the form of chicken entrails, frog meat, mussel meat, trash fish, worms and snails are available but problems related to storage and unpredictable availability of these have led to the search for other feed.

a. Protein and amino acids

We have been evaluating animal and plant protein sources. Squid meal, shrimp meal, mussel meat, fish meal, shrimp head meal and earthworm meal, have been found to be good animal protein sources (Lim et al 1979; Pascual unpub). Soybean meal and ipil-ipil (*Leucaena*) leaf meal of not more than

10% in the diet can substitute for part of the animal protein source. However, the presence of more than 0.1% mimosine in ipil-ipil leaves limits its use in prawn diets, although soaking the fresh leaves in water for 24 hours and air drying thereafter removes around 85% of the mimosine (Pascual and Penaflores 1979). Similarly, raw soybeans contain an anti-nutrient factor, trypsin inhibitor, which is rendered inactive by heating.

So far, optimum ratio inclusion of fish meal and shrimp head meal is two-thirds of the animal protein from fish meal and one-third from shrimp head meal (Pascual and Destajo 1979).

Alava and Lim (1983) used squid meal, fish meal and shrimp meal, casein and soybean meal as protein sources in diets with protein content ranging from 25 to 60% protein. Their results showed that 40% protein diet gave the best growth rate. However, comparable results were obtained with shrimps fed the 30, 35 and 45% protein diets. In another study by Pascual (manuscript), diets containing 40% protein from shrimp head meal, fish meal, earthworm meal or squid meal, and soybean meal gave survival rates almost twice that of a 32% protein diet that did not have earthworm meal or squid meal. At present, we suggest the use of 40% protein in the diet.

The amino acid pattern of the protein source is an important factor in the choice of protein sources. Furthermore, the amount of protein incorporated in a diet is partly determined by the ratio or balance of amino acids in the protein sources. Amino acids are building blocks for protein synthesis and unless they are available in the proper amounts in the diet, animal growth is retarded. Coloso and Cruz (1980) have shown that arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tyrosine and valine and probably tryptophan are essential to *P. monodon*. Other shrimps have been found to need the same amino acids. Coloso *et al* (unpublished data) have determined the amino acid pattern of PL₄₀ while Catedral and Penaflores (1977) analyzed the amino acid pattern of the muscle of wild *P. monodon*. The amino acid profile in prawn tissue protein can be used as a guide in the search for natural protein sources or a combination of these sources such that an optimal amino acid pattern could be supplied in the diet assuming that all the foodstuffs are digestible. The amino acid requirement of *P. monodon* is not yet known although the literature provides for other species such as *P. japonicus* (Deshimaru 1981).

b. **Lipid and Fatty Acids**

Lipids are necessary not only for their energy value but also for the presence of fatty acids and fat-soluble vitamins important to the growth and survival of the animals.

The effect of various oils like corn oil, soybean oil, beef tallow, pork lard and fish oil on the growth of *P. monodon* juveniles has been studied (Mangalik 1979). Fish oil is the best, followed by beef tallow, soybean oil, copra oil, corn oil and pork lard, in descending order. In a recent study by Mendoza (1982) the diet containing 11.7% lipid gave maximum growth, efficient feed conversion and protein efficiency ratio, and optimum survival rate.

She also reported that the total body fat increased with increasing levels of dietary lipid.

Fatty acid composition of postlarvae is generally related to the fatty acid pattern of the diets. Total body lipid was found to be higher than that of the pre-experimental animals (Yashiro 1982). The study concluded that cooked mussel meat is a good feed in place of *Artemia* as it is cheap and readily available.

Preliminary data gathered from an on-going study by Millamena (pers. comm.) on the fatty acid profile of the ovaries, hepatopancreas and tail muscle of wild *P. monodon* indicate that there is a predominance of higher long chain polyunsaturated fatty acids of arachidonic acid (20:4 ω 5), eicosa-pentaenoic acid (20:5 ω 3) and docosahexaenoic acid (20:6 ω 3) in prawn broodstock.

Results from a study by Nalzaró (1982) with a practical formulation indicate that a total cholesterol level of around 1% is required for maximum growth, high feed conversion, high protein efficiency and survival rate and maintenance of constant level of body cholesterol.

c. **Carbohydrates**

Carbohydrates in prawn diets are not only useful for their energy value but also for their binding properties. Carbohydrates and fats are known to be protein spacers and provide part, if not most, of the energy needed in the diet. Among the carbohydrates that have been studied are sucrose, dextrin, maltose, glucose, molasses, cassava starch, cornstarch and sago palm starch. Sucrose and sago palm starch 10% in the diet were found to give better survival rates than the other carbohydrates tested at the same level. However, changes in the hepatopancreatic cells were observed (Pascual *et al* 1983).

d. **Vitamins and Minerals**

We have not done work on vitamins and minerals. We rely on commercial poultry vitamin-mineral mixes or use those figures published in the literature such as those of Deshimaru (1981).

e. **Energy Requirement**

There are indications that prawn juveniles need between 3,100 to 3,300 kcal/kg of diet but this has not been confirmed (Bautista unpub.).

DIET DEVELOPMENT

Aside from nutritional requirements, practical problems related to the physical features of the diet have to be solved. Water stability, attractability, size, shape, density and texture are some of these considerations.

The prawn is a slow eater and nibbles its food so that a water stable pellet is necessary. A 34 hour stability is preferred. Use of a finely ground feedstuff and a good binder gives water stable pellets. We have tried a number of binders: sweet

potato starch, cassava starch, extract of shark fins, *Gracilaria*, gum arabic, alginate, glutinous rice, carboxymethyl cellulose, carrageenan, corn starch (Pascual *et al* 1978; Pascual and Tabbu 1979; Murai *et al* 1981; Pascual and Sumalangcay in press), and sago palm starch (Lim and Destajo 1979). Sweet potato starch causes pellets to mold easily and has poor binding capacity. Other binders are either too expensive or not commercially available. We have found sago palm starch, cornstarch and alpha potato starch as acceptable for laboratory use at 5% level in the diet. Alginate and carboxymethyl cellulose are good but expensive binders. Carrageenan is a potential binder. Another procedure essential for making a water stable pellet is gelatinization of the starch before the addition of dry ingredients. Steaming the pellet during or after extrusion adds to stability.

Attractiveness of the diet to the prawn is also necessary. Several attractants have been tested by incorporating shrimp, mussel, squid, fish extract, mussel extract in purified diets (Pascual 1980). Murai *et al* (in press) used krill meal, earthworm meal, glycine, sucrose and mussel water as attractants in a practical diet. Addition of krill meal, earthworm meal and sucrose improved attractability to a certain extent. Glycine supplement and mussel significantly improved attractability. Furthermore, dietary groups supplemented with any type of attractant showed better average weight gain than those fed the diet without attractant. Prawns fed the diet with earthworm meal had the best growth rate. Best feed conversion was also achieved with the diet containing earthworm (Murai *et al* in press). Perhaps diet attractability, *per se*, may be a vital factor in determining the quality of compounded feed for prawn, and that earthworm meal as an attractant in prawn diets significantly improves growth, survival and feed efficiency of *P. monodon* juveniles.

FOOD AND FEEDING HABITS

Much information on dietary requirements can be extracted from food intake studies in the natural habitat. Marte (1980) reported that around 85% of the ingested food of *P. monodon* caught from the wild in Makato, Aklan consisted of crustaceans (small crabs and shrimps) and molluscs. The remaining 15% was composed of fish, polychaetes, ophiuroids, debris, sand and silt. Furthermore, about 95% of food is transported from the foregut four hours after feeding. Results showed that *P. monodon* feeds on slow moving benthic organisms. Crustaceans appear to be the "staple" food while molluscs contributed the largest bulk; the undigestible shell fragments may have been retained longer in the gut. Wild prawns from Makato showed significant monthly variations in the feeding activity.

DIET FORMULATIONS

There is one formulation that we have continued to improve as we get more information on the nutritional requirements. There are several commercial companies that are producing feeds while a few fishfarmers prefer to prepare their own feeds. All ingredients or feedstuffs should be finely ground (around 425 microns) and homogenous. The starch is first gelatinized before adding to the dry previously

mixed ingredients when feed is prepared under laboratory conditions. Unlike fish diets, prawn diets have to be conditioned with steam. All of these procedures are necessary for the production of compact, water stable pellets.

A formulation has been published and used as the basis for some of the commercial feeds in the market. It stands to be improved. Some fishfarmers have consulted us with regards to the diet formulation and have made their own feeds using our extension manual (1983) as a guide in feed preparation. The local commercial companies that manufacture prawn feeds, to my knowledge, are Robina, Vitarich, San Miguel, First Farmers and Techno Dynamics.

Four diets have been tried in ponds twice and results show that feeding does increase survival and provide for better growth (Tabbu *et al* unpublished) than without feeding. However, feed conversion ratios (FCR) were inconsistent in two runs. Our SEAFDEC formulation had an FCR of 1.8 in the first run and 6.1 in the second run. Although commercial feeds are now available and supplemental feeding has been found necessary in semi-intensive and intensive cultures there is no one ideal formula. All of these rations do provide for "better" growth and survival although we have not been able to determine a good growth rate. Feed is only one of the factors for increasing growth and survival rates. Proper water management and the use of healthy animals are just as necessary.

Cost of feedstuffs has escalated as with other items in the market. However, one would have to do his own feasibility study as to whether it is cheaper to make one's own feed or to buy them. Supplementary feeding is needed when stocking density is more than 1-2/sq m and the choice of feed as to whether it is moist or pelletized will also depend on the availability of fresh trash fish, chicken entrails, frog meat, etc, and proper storage facilities. There is more thiaminase, an enzyme that destroys the vitamin, thiamine and other nutrients are also destroyed in deteriorated fish. One advantage of dry pelletized over moist or wet feed is that its quality can be controlled. Furthermore, storage space with refrigeration is needed for keeping wet diets from deteriorating fast. Likewise, dry pelletized feed should also be stored properly to prevent the growth of fungi that produce toxins.

LARVAL DIETS

Artificial feeds for larvae remains a puzzle. Natural food like phytoplankton and zooplankton - *Tetraselmis*, *Chaetoceros*, *Skeletonema*, *Brachionus* and *Artemia* - seem to be the choice although egg yolk, finely ground squid and mussel are now being used in prawn hatcheries. There are flaked as well as micro-encapsulated diets being tested in some laboratories here and abroad (Kanazawa *et al* 1982). One of the problems with artificial larval feeds is the need to always have feed in the water column but not to the extent of polluting the water. Thus a feed that can remain in the water for a certain period with minimal leaching out of nutrients has to be developed.

BROODSTOCK DIETS

Knowledge of the characteristics of a good broodstock diet is scanty. Results

from the study of Marte (1982) indicate that there are certain nutrients in molluscs and fish which are required for gonad development because during the appearance of spawners, these feeds are found abundantly in the gut of the prawns.

Molluscs occur in the gut more frequently than crustaceans in August, December, March, April and June while fish remains appear in more prawns in August, January, and March. According to Motoh (pers. comm.) preliminary data indicate that peak season of *P. monodon* spawners in the same area occur around April, August and November. This suggests that prawns feed on food like molluscs and fish which they would need for gonad development (Marte 1982). The study of Millamena *et al* (in progress), as previously stated, showed higher polyunsaturated fatty acids in tissues of wild prawn broodstock which are also present in molluscs and fish liver oils. Primavera *et al* (1979) fed broodstock with mussel meat alone or in combination with pellets and got higher survival and better reproductive performance from those fed mussel meat alone or in a combination with pellets than those that were not offered any mussel meat.

THE FUTURE

Many questions remain unresolved. Are we feeding the prawns or are we feeding the pond? What are the changes that occur in the food before it is eaten by the prawn? How much of the nutrients are lost? How sure are we that the feed is really available to the prawns? How do stocking density, oxygen concentration, temperature and salinity and exposure to disease relate to the quality and quantity of the feed being tested?

The researcher is often faced with the problem of quality control in feedstuffs. The lack of standardized quality local ingredients makes it difficult for the researcher to duplicate his study, and the need to analyze every batch of feed ingredients used in the study adds to the cost of research and development. Many of the locally available feedstuffs are not of high quality so that duplication of the same feed and of experimental results is difficult to obtain. One often resorts to the use of imported feedstuffs for reasons based on quality. However, due to lack of proper storage of imported feedstuffs, the researcher is also faced with the problem of poor quality by the time the feed reaches the laboratory. The presence of pesticide residues in some of the local feeds like rice bran or tikitiki has also to be resolved because this can cause mass mortality. Some pesticides used in plants and taken in by insects have been found to prevent chitin formation, one possible reason for soft shelling in prawns.

Perhaps some kind of legislation or assistance from the industry and fish-farmers' organizations is needed to hasten the solution of these problems..

We do not know the requirements for minerals and vitamins, specific fatty acids and amino acids. Larval feeds and broodstock diets have yet to be developed. Diets developed for grow-out in the laboratory have to be tried under various pond conditions, and this takes time. When fishpond owners agree to cooperate, certain inputs are necessary and should be met before or during the experimental runs, otherwise interpretation of data collected becomes very difficult.

The problems are tremendous but a collective and well directed effort may eventually lead to the solution of many of these problems.

LITERATURE CITED

- Alava, V.R. and C. Lim. 1983. The quantitative dietary protein requirement of *Penaeus monodon* juveniles in a controlled environment. *Aquaculture*. 30 pp. 53-61.
- Catedral, F. and V. Peñaflores. 1977. Amino acid analysis of *P. monodon* muscle. SEAFDEC AQD Quart. Res. Rep. 4th Qtr. (Oct.-Dec.) Vol. I No. 4 p. 1.
- Coloso, R.M. and L.J. Cruz. 1980. Preliminary studies in some aspects of amino acid biosynthesis in juveniles of *Penaeus monodon* Fabricius Bull. Phil. Biochem. Soc. 3(1&2): 12-22.
- Deshimaru, O. 1981. Studies on nutrition and diet for prawns, *Penaeus japonicus*. Memoirs of Kagoshima Prefecture Fisheries Exptl. Station, No. 12. p. 7.
- Kanazawa, A.S. Teshima, H. Sasada and S. Abdel Rahman. 1982. Culture of the prawn larvae with micro-particulate diets. Bull. Jap. Soc. Fish. 48 (2): 195-199.
- Lim, C. and W.H. Destajo. 1979. Effects of crude semi-purified and purified starch of sago (*Metroxylon sagu Rotto*) on the water stability of pelleted shrimp diets. Fish. Res. J. Phil. Vol. IV No. 1 pp. 19-23.
- Lim, C., Suraniranat P. and Platon R.R. 1979. Evaluation of various protein sources for *P. monodon* postlarvae. *Kalikasan Phil. S. of Biology*. 8: 29-36.
- Mangalik, Arthur. 1979. Effects of various lipid sources on the growth and survival rates of *Penaeus monodon* Fabricius from postlarvae to juveniles in a controlled environment. M.S. Thesis. College of Fisheries Univ. of the Phil. 65 pp.
- Marte, C.L. 1980. The food and feeding habit of *Penaeus monodon* collected from Makato River, Aklan, Philippines. *Crustaceana*. 38 (3): 225-236.
- Marte, C.L. 1982. Seasonal variation in food and feeding of *Penaeus monodon* Fabricius (*Decapoda natantia*) *Crustaceana*. 42 (3) p. 250-255.
- Mendoza, E.C. 1982. Quantitative dietary lipid requirement of *P. monodon* juveniles in a controlled environment. M.S. Thesis. College of Fisheries, Univ. of the Phil, in the Visayas. 33 pp.
- Murai, T., A. Sumalangcay and F.P. Pascual. 1981. The water stability of shrimp diets with various polysaccharides as binding agents. Quart. Res. Rep. April-June, 1981. Vol. V, No. 2 pp. 18-22. SEAFDEC AQD Tigbauan, Phil.
- Murai, T., A. Sumalangcay and F.P. Pascual. Supplement of various attractants to a practical diet for juvenile *Penaeus monodon* Fabricius. In press.

- Nalzaró, G.G. 1982. Quantitative dietary cholesterol requirement of *Penaeus monodon* juveniles. M.S. Thesis College of Fisheries, Univ. of the Phil. in the Visayas. 47 pp.
- Pascual, F.P. 1980. Attractants in purified diets. SEAFDEC AQD Quart. Res. Rept. 2nd Quart. (April-June) Vol. IV, No. 1 p. 7.
- Pascual, F.P. 1983. Nutrition and feeding of *Penaeus monodon*. Extension Manual No. 2, 3rd ed. p. 5.
- Pascual, F.P., L. Bandonil and W.H. Destajo. 1978. The effect of different binders on the water stability of feeds for prawn. Quart. Res. Rep. 1st Quart. Jan.-Mar. Vol. pp. 31-35.
- Pascual, F.P., R. Coloso and C. Tamse. 1983. Survival and some histological changes in *P. monodon* Fabricius juveniles fed various carbohydrates. Aquaculture. 31 pp. 169-180.
- Pascual, F.P. and W. Destajo. 1979. Growth and survival of *Penaeus monodon* post-larvae fed shrimp head meal and fish meal as primary animal sources of protein. Fish Res. Journal of the Phil. Vol. IV No. 1. p. 29.
- Pascual, F.P. and V. Penaflores. 1979. The extraction of mimosine from ipil-ipil leaves (*Leuceana leucocephala*) by soaking in water. Quart. Res. Rept. 3rd Quart. (July-Sept.) Vol. III. p. 4.
- Pascual, F.P. and Sumalangcay, A. Jr. Gum arabic, carrageenan of various types and sago palm starch as binders in prawn diets. In press.
- Pascual, F.P. and M. Tabbu. 1979. Fishwater and agar as binders in a prawn diet. Quart. Res. Rept. 1st Quart. (Jan.-Mar.) Vol. 3 No. 1 p. 1.
- Primavera, J.H., C. Lim, C. and E. Borlongan. 1979. Feeding regimes in relation to reproduction and survival of ablated *Penaeus monodon* Fab. Kalikasan. Philipp. J. Biol. 8: 227-235.
- Yashiro, R.H. 1982. The effects of *Artemia* fed with different diets on the growth and survival of *Penaeus monodon* Fabricius postlarvae. M.S. Thesis. College of Fisheries, Univ. of the Phil, in the Visayas.