UNIVERSITI PUTRA MALAYSIA

LEAST-COST FORMULATION OF FEEDS FOR PRAWNS, WITH PARTICULAR REFERENCE TO MACROBACHIUM ROSENBERGII (DE MAN)

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FPSS 1985 2

LEAST-COST FORMULATION OF FEEDS FOR PRAWNS, WITH PARTICULAR REFERENCE TO *MACROBRACHIUM ROSENBERGII* (DE MAN)

by

Poh Yong Thong

A thesis submitted in partial fulfilment of the degree of Master of Science in the Faculty of Fisheries and Marine Science, Universiti Pertanian Malaysia.

July 1985

DEDICATION

Dedicated to the memory of my father, who passed away while this project was being undertaken.

..... and he was like a dandelion, that broadcasted its seeds in fertile valley - his efforts shall never be forgotten.

ACKNOWLEDGEMENT

The author wishes to express his appreciation to his supervisor, Dr. Ang Kok Jee and co-supervisor, Dr. Law Ah Theem for their guidance, encouragement and invaluable mentorship. Sincere appreciation is also extended to Encik Che Ross bin Saad for teaching him the rudiments of fish nutrition; to Mr. Cheah Sin Hock for invaluable discussions and encouragement; to the Dean of the Faculty of Food Science and Technology for use of the Technicon TSM Amino Acid Analyser; to Mr. Chan Tin Wan for technical assistance on amino acid analysis; to Mr. Lim Song Hok, Mr. S. Pathmasothy, Mr. Chong Kam Kin, Mr. Kenneth Chin and Mr. Kabir Ahmad for assistance in one way or another. A special word of thanks is also extended to Dr. Chan Hooi Har, for her constructive criticism. Without her encouragement and help, this thesis may not have been possible.

This project was supported by a Research Grant No. 1813-1-065 from Universiti Pertanian Malaysia, a part-time research assistantship from IDRC and the Sarawak Tunku Abdul Rahman Scholarship. The financial support of the sponsors are gratefully acknowledged.

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Linear programming was used in least-cost formulation of feeds for *Macrobrachium rosenbergii*. The constraints were: crude fat of 5 to 10%, gross energy of 4,400 cal/g, an amino acid profile similar to that of the prawn and specified amounts of crude protein of either 25%, 30%, 40% or 50%. Four pellets, P.25, P.30, P.40, and P.50, were formulated, costing M$0.72, M$0.75, M$0.81 and M$1.04 per kilogram respectively. Chemical analyses indicated that the crude protein, crude fat and gross energy content of the formulated feeds agreed closely with the given constraints. Amino acid analyses showed that the amino acid profiles (with the exception of tryosine, leucine and lysine) of the formulated feeds were remarkably similar to the amino acid profile of the prawn.

Three culture systems were designed to maintain optimal physico-chemical conditions for testing the responses of the prawn to the pellets. P.40 was shown to produce a higher growth rate of 1.15 cm per month for postlarval M. rosenbergii (0.96 - 3.08 cm post-orbital length) and 1.02 cm per month for juvenile M. rosenbergii (2.67 - 4.64 cm post-orbital length). The results indicated that the optimum protein level of the diet formulated by linear programming for best growth was 40%.

Abstrak

Abstrak tesis yang dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi sebahagian dari keperluan untuk Ijazah Master Sains.

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Programan linear digunakan untuk formulasi makanan bagi *Macrobrachium rosenbergii*. Konstrennya adalah: 5% hingga 10% lemak mentah, tenaga kasar 4,400 cal/g, profil asid amino adalah sama dengan profil asid amino udang dan peratus protein mentah yang tertentu, iaitu 25%, 30%, 40% atau 50%. Empat pelet P.25, P.30, P.40 dan P.50 diformulasikan, dengan harga M$0.72, M$0.75, M$0.81 dan M$1.04 se kilogram masing-masing. Analisa kimia menunjukkan bahawa protein mentah, lemak mentah dan tenaga kasar bagi makanan yang diformulasikan bersetuju rapat dengan konstren yang ditentukan. Analisa asid amino menunjukkan bahawa profil asid amino (kecuali tirosin, leusin dan lisin) bagi makanan yang diformulasikan adalah menyamai profil asid amino udang.

Tiga sistem ternak telah direkabentuk untuk mengawas keadaan fiziko-kimia yang optima bagi menguji reaksi udang terhadap pelet. Keputusannya menunjukkan bahawa P.40 menghasilkan pertumbuhan superior, iaitu 1.15 sm sebulan bagi M. rosenbergii pasca-rega (0.96 - 3.08 sm panjang) dan 1.02 sm sebulan bagi M. rosenbergii juvenil (2.67 sm hingga 4.64 sm panjang). Keputusan menunjukkan bahawa peratus protein optima bagi pelet yang diformulasikan dengan programan linear untuk menghasilkan pertumbuhan terbaik adalah 40%.

CHAPTER 1

INTRODUCTION

Prawn is one of the most important high-value products in world trade and has excellent potential as an export item and foreign exchange earner for developing countries.

However, from 1977 to 1981, world prawn landings have stabilised at around 1.7 million metric tonnes (live weight) and it is thought to be close to the maximum sustainable yield (ADB/FAO INFOFISH, 1983). Any further demand for prawn will have to be supplied from aquaculture which at present is estimated to be only about 5% of total world landings (ADB/FAO INFOFISH, 1983).

In Malaysia, a similar situation prevails. In the west coast of West Malaysia, the maximum sustainable yield of 53,000 metric tonnes for marine prawn (FAO/SCSP, 1976, cited in Anon., 1981) has been surpassed. There is only a marginal stock available for exploitation on the east coast (Pathansali, 1976, cited in Anon., 1981). There is also a downward trend in the supply of the giant freshwater Malaysian Prawn, Macrobrachium rosenbergii in Malaysia (Rabanal, 1982; Ong and Pang, 1982) due to decreasing wild stocks. Increases in prawn production therefore will have to be met by prawn culture.

Many of the prerequisites of successful aquaculture enterprise can be found in Malaysia. Among the most important

are: all-year round warm climate permitting continuous production; extensive brackish water areas of 150,000 ha and freshwater surfaces of 40,000 ha (Ang, 1976); and considerable good domestic market. Many of the world's commercially important prawn species such as the tiger prawn, Penaeus monodon, the banana or white prawn, Penaeus merguiensis, the Indian prawn, Penaeus indicus and the giant freshwater prawn, M. rosenbergii, are indigenous to the seas fringing Malaysia's coastlines and its inland waters. It is possible to modify the natural environments or provide artifical habitats for aquaculture, but it is obviously more economical to make use of naturally favourable conditions. In addition, Malaysia through its long history of rubber and oil palm industry has accumulated invaluable expertise in estate management which can be adopted by the aquaculture industry. All these suggest and indicate the immense opportunity for the development of prawn culture in Malaysia. Recognising its potential, the freshwater prawn, M. rosenbergii has been selected as the top priority species for freshwater culture in Malaysia (Ong, 1983).

The giant freshwater prawn culture has been shown to be economically profitable in Hawaii (Ling and Costello, 1976; Shang and Fujimura, 1977), in Taiwan (Liao and Chao, 1982) and in Thailand (New, et al., 1982). In Malaysia, interest in prawn culture has been increasing in recent years with the establishment of prawn farms by LKIM (Lembaga Kemajuan Ikan Malaysia), Syarikat Pelihara Udang Sdn. Bhd., Ternakan Marine Sdn. Bhd., the Lion Group of Companies, and other smaller farms.

Very few of the farms however, can yet be considered successful. This situation can be attributed to a number of problems, the most important of which are: unreliable fry supply, poor management, sub-optimal water and soil conditions and a lack of cost-effective feeds. This thesis will focus on the feed problem.

1. Feeds and Nutrition of Prawns

In the semi-intensive and intensive prawn culture systems, feed cost accounts for a substantial portion of the total operational cost. In South Carolina, feed costs for freshwater prawn was 42% of total costs (Roberts and Bauer, 1978); in Hawaii, it was estimated to be 27% of the operating expenses (Shang and Fujimura, 1977; Weidenbach, 1982); in Taiwan it was the largest item of outlay in freshwater prawn farming, constituting at least 30% of the total costs (Liao and Chao, 1982). A computer model of production economics in intensive penaeid shrimp grow-out indicated that feed is the single highest cost factor ranging from 30 to 35% of the total annual operating expenses (Hanson and Goodwin, 1977).

With feed costs constituting a high proportion of the operating expenditure in prawn culture, feeds offer more opportunity for reducing production cost through their refinement. Perhaps, prawn farming should emulate the highly successful poultry industry, the evolution of which as stated by Schaible (1970), was attributed more to the formulation of cost-effective feed than any other single factor.

In the natural environment, prawns are able to satisfy their

nutritional requirements from a variety of animal and vegetable sources. Ling (1969) reported that the giant freshwater prawns, M. rosenbergii is in nature omnivorous, feeding on aquatic worms, aquatic insects, insect larvae, small molluscs and crustaceans, flesh and offal of fish and other animals, grains, seeds, nuts, fruits, algae and tender leaves and stems of aquatic plants. Studies on the food and feeding habits of the tiger prawn P. monodon, have been accomplished by Hall (1962), Thomas (1972, cited in Motoh, 1981) and Marte (1980, cited in Motoh, 1981). These studies indicated that P. monodon is also an omnivore, feeding on crustaceans, vegetable matter, molluscs, polychaetes, insects and fish.

Traditional prawn culture in Malaysia has long relied on natural productivity of the pond and to a lesser extent on supplemental feeds from one or more of the following:- a) unprocessed agricultural wastes such as copra cake, rice bran, groundnut cake; b) grains such as rice, soya bean, maize; c) trash fish; and d) commercial poultry pellets.

Agricultural wastes and grains by themselves are not nutritionally balanced and thus cannot support a more intensive culture system. Although trash fish has been used with considerable success in M. rosenbergii farming in Taiwan (Chao, 1979), it is messy to handle, requires refrigeration for storage, inconsistent in supply in monsoon-affected regions and, as pointed out by New et al. (1982), poses potential pollution problems in the ponds. Broiler chicken pellets is widely used as feed for M. rosenbergii in Thailand (New et al., 1982). It is

however, not water-stable, thus quickly becoming unavailable to the prawns.

Frieda Taub, in opening the Nutrition Workshop of the 1972 World Mariculture Society Meeting, characterised approaches to aquacultural nutrition as tending towards three categories: 1) imitation of natural diets; 2) trial and error experimentation with formula feeds formulated for other organisms and 3) controlled (formulated) feeds with chemically defined diets. Much work has been done in the first two categories as reviewed by New (1976) and Biddle (1977). The present study adopts the last approach.

The problem of prawn feed formulation is rather formidable. The prawn nutritionist has to deal with a multivariate phenomenon because there are at least eleven major variables, all of which interact with one another (Hanson and Goodwin, 1977).

These are (1) stage of growth, (2) species of prawns, (3) water quality and temperature, (4) feed stability (binder dependant), (5) presentation (whether pellet form, paste or meal), (6) percentage and derivation of lipids, (7) percentage and derivation of carbohydrates, (8) percentage and amino acid composition of protein, (9) health of prawn, (10) effects of natural feed in the rearing environment and (11) feeding rates. In addition, concrete information in dietary requirements of prawn is very limited despite considerable research in prawn nutrition.

The nutritional requirements of prawn for lipids, protein or