UNIVERSITI PUTRA MALAYSIA

UTILIZATION OF NATURAL FEED FOR GROWTH AND SURVIVAL ENHANCEMENT OF *PENAEUS MONODON* JUVENILES IN CULTURE SYSTEM AND ITS EFFECTS ON WATER QUALITY

FARSHAD SHISHEHCHIAN

FSAS 2000 24

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By

FARSHAD SHISHEHCHIAN

Dissertation Submitted in Fulfillment of the Requirements for the Degree of Doctor of Philosophy in the Faculty of Science and Environmental Studies Universiti Putra Malaysia

November 2000

UPM

Dedicated to

My parents: Esmail Shishehchian and Akram Rahnema

My wife: Roya Azimzadeh

My daughter & son: Bahar and Hamoon Shishehchian

For their Love, Support and Trust

Abstract of thesis submitted to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

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FARSHAD SHISHEHCHIAN

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Chairperson: Professor Dr. Fatimah Md. Yusoff, Ph.D

Faculty: Science and Environmental Studies

Shrimp feeds on the natural organisms such as plankton, bacteria and benthos. Problems in shrimp farming are due to pollution, diseases and poor feeding practices. There are several advantages in improving natural food in shrimp farming. First, water quality is very much improved since the oxygen evolved in photosynthesis is used in aerobic decomposition of organic matter. Moreover, ammonia in the water are reduced due to uptake by algae. Secondly, the digestibility and acceptability of natural food by shrimp have been well established. Understanding the contribution of natural foods in the shrimp culture system may help to increase the production and reduce the cost of

farming. This study was carried out to demonstrate the importance of natural food in intensive shrimp culture system. Analysis of composition and abundance of macrobenthos in shrimp culture ponds was done by sampling the sediment from six different locations of two shrimp ponds. Gut content analysis was also performed to assess the fullness of shrimp gut. A significant negative correlation ($r = -0.97$, $p < 0.05$) was also observed between the gut content and the abundance of macrobenthos in the pond bottom. There was a decline in the fullness of the shrimp foregut with the reduction of benthic populations in the pond sediments, probably indicating the importance of benthos as food for shrimp in culture system. In another field experiment the effect of bacterial product on development of benthic community in shrimp ponds, was determined. The density of polychaetes and insect-larvae was significantly ($p < 0.05$) higher in ponds with commercial bacteria products than the control, and also showed better feed conversion ratio (FCR). Laboratory experiments showed that the growth rate of *P. monodon* juvenile was significantly ($p < 0.05$) higher when fed with the combination of natural and artificial diets than other treatments. Survival rate was also significantly ($p < 0.05$) higher in those shrimp fed on natural diet compared to the others. The presence of bottom sediment significantly ($p < 0.05$) increased the survival rate of the shrimps. Shrimps fed with artificial diet showed significantly higher excretion of ammonia compare to the others. The results showed that unicellular algae could help shrimp to attain high growth and survival rates. In addition these algae control the water quality parameter such as ammonia-N and nitrite-N. Tanks without shrimp showed significantly lower ($p < 0.05$) rate of nitrogen change compared to the rest of the

treatments, indicating that most of the nitrogenous source was from the shrimp excretion. There was no significant difference among the ingestion rates of three algal species but was relatively high with *Chaetoceros calcitrans* and low with *Tetraselmis tetrahele*. The results indicated that *Penaeus monodon* juvenile was able to ingest and digest the unicellular algae. Feeding with natural feed enhanced the non-specific immune system of the shrimp. The results showed that feeding on chironomid larva significantly ($p<0.05$) increase the survival rate when shrimp was exposed to the white spot virus (WSV).

The results of this study showed that natural food play an important role in shrimp farming. The presence of suitable natural food may enhance the growth and survival of shrimps in a culture pond and improve the water and sediment quality. This study suggested that the optimum growth of shrimp could be obtained by the right combination of natural and artificial diets.

PENGGUNAAN MAKANAN NATURAL BAGI PENINGKATAN PERTUMBUHAN DAN KEMANDIRIAN JUVENIL *PENAEUS MONODON* DI DALAM SISTEM KULTUR DAN PENGARUHNYA TERHADAP KUALITI AIR

Oleh

FARSHAD SHISHEHCHIAN

November 2000

Pengerusi: Prof. Dr. Fatimah Md. Yusoff

Fakulti : Sains dan Pengajian Alam Sekitar

Udang biasanya memakan makanan yang natural seperti plankton, bakteria dan pelbagai jenis organisma bentik. Masalah yang sering dihadapi oleh industri ternakan udang adalah berpunca daripada pencemaran, penyakit udang yang merebak, dan cara pemberian makanan yang kurang baik. Terdapat beberapa kebaikan untuk meningkatkan kuatiti sumber makanan natural dalam kolam udang. Pertama ialah kualiti air dapat dipertingkatkan kerana kandungan oksigen yang dihasilkan daripada proses fotosintesis dapat digunakan dalam penguraian aerobik bahan organic. Tambahan pula, kandungan ammonia dapat dikurangkan oleh proses fotosintesis alga. Di samping itu, pencernaan dan penerimaan makanan semulajadi oleh udang telah diketahui umum. Dengan memahami sumbangan makanan semulajadi dalam perusahaan udang dapat meningkatkan pengeluaran

udang dan mengurangkan kos ternakan. Penyelidikan ini bertujuan untuk menunjukkan kepentingan sumber makanan semulajadi kultur udang intensif. Penganalisisan komposisi dan kepadatan makrobentos dalam kolam kultur udang dilakukan dengan pensampelan sedimen dari enam lokasi dalam dua kolam udang. Analisis kandungan usus juga dilakukan untuk menilai kepenuhan usus udang. Korelasi negatif yang bererti juga dapat diperhatikan di antara kandungan usus dan kepadatan makrobentos di dasar kolam. Terdapat penurunan dalam kepenuhan usus depan udang dengan pengurangan populasi bentos di dalam sedimen kolam, mungkin menunjukkan kepentingan bentos sebagai makanan udang di dalam sistem pengkulturan. Di dalam eksperimen lapangan yang lain, kesan produk bakteria ke atas perkembangan komuniti bentos di dalam kolam udang telah ditentukan. Kepadatan polychaete dan larva serangga adalah lebih tinggi dengan bererti ($p< 0.05$) di dalam kolam yang mengandungi produk bakteria komersial berbanding dengan kawalan, dan juga menunjukkan nisbah penukaran makanan (FCR) yang lebih baik. Eksperimen dalam makmal menunjukkan pertumbuhan *P. monodon* yang jauh lebih tinggi ($p<0.05$) apabila diberi makanan kombinasi semulajadi dan buatan berbanding dengan rawatan yang lain. Kadar kemandirian udang juga jauh lebih tinggi ($p< 0.05$) untuk udang yang diberi makanan semulajadi jika berbanding dengan yang lain. Kehadiran mendakan telah meningkatkan kadar kemandirian udang dengan bererti ($p<0.05$). Udang yang diberi makanan buatan menunjukkan perkumuhan ammonia yang jauh lebih tinggi daripada udang yang diberi makanan lain. Keputusan menunjukkan alga unisel boleh membantu udang untuk mencapai kadar pertumbuhan dan kemandirian

yang tinggi. Tambahan pula, alga dapat mengawal parameter kualiti air seperti ammonia-N dan nitrit-N. Rawatan yang tidak mempunyai udang menunjukkan kadar nitrogen yang jauh lebih rendah ($p<0.05$) berbanding dengan rawatan yang lain. Ini menunjukkan punca nitrogen adalah daripada perkumuhan udang. Keputusan mendapati tidak terdapat perbezaan kadar pengingesan yang bererti bagi ketiga-tiga spesies alga. Walau bagaimanapun, kadar pengingesan *Chaetoceros calcitrans* adalah lebih tinggi dan pencernaan *Tetraselmis tetrahele* adalah lebih rendah. Keputusan menunjukkan juvenil *P. monodon* dapat menginges dan mencerna alga satu sel. Makanan semulajadi juga didapati merangsang sistem imuniti udang yang bukan spesifik. Keputusan menunjukkan bahawa udang yang diberi makan larva kironomid boleh meningkatkan kadar kemandirian udang ($p < 0.05$) apabila udang didedahkan kepada virus bintik putih.

Keputusan penyelidikan ini menunjukkan bahawa sumber makanan semulajadi memainkan peranan yang penting dalam ternakan udang. Kehadiran sumber makanan semulajadi yang sesuai bukan sahaja meransangkan pertumbuhan dan kemandirian udang dalam kolam, tetapi juga memperbaiki kualiti air dan mendakan kolam. Penyelidikan ini menunjukkan bahawa pertumbuhan udang yang optimum boleh dicapai dengan kombinasi sumber makanan semulajadi dan buatan yang sesuai.

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This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy.

MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor
Deputy Dean of Graduate School
Universiti Putra Malaysia

Date:

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CHAPTER 1

INTRODUCTION

Background of Study

One of the most important cultured organisms is the marine shrimp. The history of marine shrimp culture is not well documented. Its origin traces to the earliest brackishwater and marine ponds. These primary ponds, which date back thousands of years in the Mediterranean area, and to the 15th century AD in Indonesia, were typically stocked with fish, shrimp, and other biota through passive flooding (Fast and Lester, 1992). Desirable seed, as well as unwanted predators and competitors were all carried into the pond with source waters where they grew for some time, and were then harvested. This culture method, which is called "catch and hold" culture, is still commonly used today. Where land and labor costs are low, and pond improvement costs have been largely depreciated, this approach can still be profitable with low risk (Fast and Lester, 1992).

Modern shrimp farming was born in the 1930s when Motosaku Fujinaga, a graduate of University of Tokyo, succeeded in spawning the kuruma shrimp (*Penaeus japonicus*). He cultured larvae through to market size in the laboratory and succeeded in mass-producing them on a commercial scale. For more than 40 years, he generously shared his findings and published papers in 1935, 1941,

1942 and 1967. Emperor Hirohito honored him with the title "Father of Inland Japonicus Farming" (Shigueno, 1975).

Worldwide, the majority of shrimp culture takes place in extensive, semi-intensive and intensive earthen ponds. The tiger prawn, *Penaeus monodon* (Fabricius), is the most extensively cultured crustacean in the South-East Asia. This is probably due to high growth rate capacity for adaptation to various culture system (Alava and Lim, 1983) and good response to commercial feed (Lee, 1971).

Table 1-1: World farmed shrimp production in 1995 (Hagler, 1997).

	Percent of production	Heads-on production (t)	Hectares in production	Number of farms
Thailand	31	220,000	90,000	20,000
Ecuador	14	100,000	125,000	1,900
Indonesia	11	80,000	300,000	4,000
China	10	70,000	13,000	6,000
India	8	60,000	80,000	5,000
Vietnam	7	50,000	225,000	2,000
Bangladesh	4	30,000	130,000	9,000
Mexico	2	12,000	14,000	250
Columbia	2	11,000	3,000	30
Honduras	1	10,000	11,000	36
Other	11	78,000	30,670	2,152
TOTAL	100	721,000	1,021,670	50,368

According to data received from the United Nations Food and Agriculture Organization (FAO), world shrimp production set a new record high volume in