UNIVERSITI PUTRA MALAYSIA

STUDIES ON BROODSTOCK NUTRITION OF MALAYSIAN FRESHWATER GIANT PRAWN *MACROBRACHIUM ROSENBERGII* (DE MAN)

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STUDIES ON BROODSTOCK NUTRITION OF MALAYSIAN FRESHWATER GIANT PRAWN *MACROBRACHIUM ROSENBERGII* (DE MAN)

BY

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DEDICATION

To the sacred memory of my father

NARAYAN CHANDRA DAS

who left us for ever during the

liberation period of Bangladesh

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LIST OF ABBREVIATIONS

ANOVA = Analysis of variance

AQB = Aquabind

BHT = Butylated hydroxy toluene

CAP = Calcium propionate

COP= Copra meal

DP = Digestible protein

DO = Dissolved oxygen

DHA = Docosahexenoic acid

EAA = Essential amino acids

EAAI= Essential amino acid index

EFA= Essential fatty acids

EPA= Eicosapentaenoic acid

Epgf = Egg per gram of female

FM = Fish meal

ha = hectare

HUFA= Highly unsaturated fatty acids

Kcal = Kilo calorie

LINDO = Linear interactive and discrete optimizer

MN = Mineral

MT = Matric tonne

NRC= National Research Council

NFE = Nitrogen-free extract

P/E = Protein/ Energy

P/GE = Protein/ Gross energy

% = Percent

PO = Palm oil

PER = Protein efficincey ratio

PUFA = Polyunsaturated fatty acids

P30 = Protein 30 percent

PL = Post larvae

ppm = Parts per million

RF = Relative fecundity

RM = Ringgit Malaysia

SD = Standard deviation

SE = Standard error

SEAFDEC = Southeast Asian Fisheries Development Centre

SBM = Soybean meal

VC = Vitamin C

VITP = Vitamin premix

WF = Wheat flour

Abstract of dissertation presented to the Senate of Universiti Pertanian Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

STUDIES ON BROODSTOCK NUTRITION OF MALAYSIAN FRESHWATER GIANT PRAWN *MACROBRACHIUM ROSENBERGII* (DE MAN)

by

Nitya Nanda Das

August 1995

Chairman : Dr. Che Roos Saad

Faculty : Fisheries and Marine Science

A study of the essential amino acid constraints of diets based on the egg essential amino acid content of broodstock of *M. rosenbergii* (de Man) was conducted using a linear interactive and discrete optimizer software in least cost feed formulation for the broodstock.

Four experiments using different formulation of diets under different environmental conditions were conducted and the following results were obtained: In the first experiment three types of isocaloric (400 kcal/100 g diet) formulated diets having 30% protein (P30), 40% protein (P40) and 50% protein (P50) along with a commercial control diet (30% protein with gross energy 446 kcal/100 g diet) were used to determine their suitability as feed for *M. rosenbergii* broodstock. The fecundity of prawns fed diet P30 and P40 were not significantly different ($P>0.05$) but were significantly different from prawns fed P50 and the control diet ($P<0.05$). The experimental diet P40 (with P:GE ratio of 99.33) was numerically superior to diets with P30 or P50 in terms of prawns fecundity (1354.20 eggs/g body weight) and hatching rate (86.42%).

In the second experiment 12 types of diets with various protein (P30, P35, P40) and gross energy (400 kcal/100 g diet, 440 kcal/100 g diet, 473 kcal/100 g

diet , 520 kcal/100 g diet) for each protein level along with the commercial diet were tested. The overall results obtained in assessing various protein levels in combination with gross energy levels involving 13 test diets showed that prawns fed P40 with an gross energy level of 400 kcal/100 g diet attained the highest fecundity (1354.92 eggs/g body weight) and hatching rate (90.30%). However, no significant differences were observed among the fecundity of prawns fed diets P35 (gross energy 473 kcal/100 g diet), P40 (gross energy 400 kcal/100 g diet) and P40 (gross energy 440 kcal/100 g diet). The hatching rates attained by prawn fed with diet P40 with gross energy 400 kcal/100 g diet 90.30%, P40 gross energy 440 kcal/100 g diet (82.33%) and P35 with gross energy 473 kcal/100 g diet (80.23%) were significantly higher ($P<0.05$) than those prawns fed by the other ten diets. Therefore, 40% protein diet with gross energy level of 400 kcal/100 g diet is recommended as broodstock feed for *M. rosenbergii* in view of its superior performance and cost.

In the third experiment three types of isonitrogenous (P40) diets with gross energy levels 350 kcal/100 g diet, 375 kcal/100 g diet and 400 kcal/100 g diet along with a commercial diet were tested. The study showed that prawns fed the diet P40 with gross energy level of 400 kcal/100 g diet had the highest fecundity (1377.12 eggs/g body weight), hatching rate (92.10%) and they were significantly different in all the treatments ($P<0.05$).

In the fourth experiment four types of diets with protein and gross energy levels of P35 with gross energy 473 kcal/100 g diet, P40 with gross energy level of 350 kcal/100 g diet, P40 with gross energy level of 375 kcal/100 g diet and P40 with gross energy level of 400 kcal/100 g diet along with a control were tested under pond condition. Prawns fed with P35 diet (473 kcal/100 g diet) attained the highest fecundity (1372.10 eggs/g body weight) and highest hatching rate (85.42%), which were significantly different in all the treatments ($P<0.05$). Prawns fed the diet P40 (400 kcal/100 g diet) had the second highest fecundity

(1336.20 eggs/g body weight) and hatching rate 82.36%, and thirdly P40 diet (375 kcal/100 g diet) had 1278.57 eggs/g body wt and hatching rate of 71.50% , followed by P40 (350 kcal/100 g diet) had a fecundity of 1105.35 eggs/g body wt and hatching rate of 60.85%. Lastly the prawns fed the control diet had a fecundity of only 1069.45 eggs/g body weight with a hatching rate of 56.30%.

The essential amino acids index (EAAI) were calculated and were found to be a possible method of evaluating the broodstock diet of *M. rosenbergii* as a higher index indicates higher egg production in water recirculating system. In pond condition however, higher EAAI does not indicate higher egg production which might be due to different envoronmental conditions and different food items. Studies of fatty acids showed that 20:5n-3 fatty acids gave the highest correlation for fecundity. Similarly, 22:6n-3 fatty acids gave the highest correlation for hatching rate. In pond condition 20:5n-3 fatty acids gave the highest correlation for both fecundity and hatching rate. Considering in view of its superior performance and cost factor, a P40 with an energy level of 400 kcal/100 g diet for the water recirculating system and a P35 with an energy level of 473 kcal/100 g diet for the pond culture system are recommended as broodstock feed for *M. rosenbergii.*

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KAJIAN PEMAKANAN INDUK UDANG GALAH *MACROBRACHIUM ROSENBERGII* (DE MAN) DI MALAYSIA

Oleh

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Ogos 1995

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Satu kajian keperluan asid amino dalam makanan yang berasaskan kepada jumlah keperluan asid amino dalam telur induk *M. rosenbergii* (de Man) telah dilakukan dengan menggunakan perisian pengoptimum interaktif linear dan diskret dalam perumusan makanan kos terendah untuk induk udang galah.

Empat kajian dengan menggunakan perumusan makanan yang berbeza dan keadaan persekitaran yang berlainan telah dilakukan dan hasil yang didapati adalah seperti berikut: Dalam kajian pertama, tiga jenis makanan yang berisokalorik (400 kcal/100g diet) telah disediakan yang mana mengandungi 30% protein (P30), 40% protein (P40) dan 50% protein (P50) bersama-sama satu makanan komersil sebagai makanan kawalan (30% protein dan tenaga gros 446 kcal/100 g diet) telah digunakan untuk mengetahui kesesuaian sebagai makanan untuk induk udang galah (*M. rosenbergii*). Tidak terdapat perbezaan yang bererti ($P>0.05$) bagi fekunditi dan kadar penetasan telur untuk udang yang memakan makanan P40 dan P30, tetapi terdapat perbezaan yang bererti ($P<0.05$) bagi kedua-dua rawatan ini dengan udang yang memakan makanan P30 dan P50. Walaubagaimanapun, udang yang memakan makanan P40 (dengan nisbah protein:tenaga gros sebanyak 99.33)

adalah lebih baik daripada udang yang memakan makanan P30 kerana ia memberikan fekunditi yang tertinggi (1354.20 telur/g berat badan) dan kadar penetasan telur yang terbaik (86.42%) untuk induk udang galah.

Dalam kajian kedua , 12 jenis makanan yang mengandungi tiga paras protein (P30, P35 dan P40) bersama-sama tenaga gross (400 kcal/100 g diet, 440 kcal/100 g diet, 473 kcal/100 g diet dan 520 kcal/100 g diet) untuk setiap paras protein dan satu makanan komersil telah diuji. Keputusan menunjukkan induk udang yang diberi makanan P40 bersama kandungan tenaga 400 kcal/100 g diet, dapat memberikan fekunditi yang tertinggi (1354.92 telur/g berat badan) dan kadar penetasan telur yang tertinggi (90.30%). Walaubagaimanapun, analisis statistik menunjukkan tiada perbezaan bererti untuk fekunditi diperolehi bagi udang-udang yang menerima makanan P35 (tenaga 473 kcal/100 g diet), P40 (tenaga 400 kcal/100 g diet) dan P40 (tenaga 440 kcal/100 g diet). Kadar penetasan yang tinggi dan bererti ($P<0.05$) didapati dalam tiga jenis kombinasi makanan iaitu P40 dengan tenaga gros 400 kcal/100g diet (90.30%), P40 dengan tenaga gros 440 kcal/100 g diet (82.33%) dan P35 dengan tenaga gros 473 kcal/100 g diet (80.23%), jika dibandingkan dengan sepuluh makanan yang lain. Makanan mengandungi 40% protein dengan tahap tenaga 400 kcal/100 g disyorkan sebagai makanan yang sesuai untuk induk udang galah kerana ia memberikan pretasi yang terbaik dan kos yang terendah.

Kajian makanan dengan menggunakan isonitrogen protein (40%) dengan tiga tahap tenaga 350 kcal/100 g diet, 375 kcal/100 g diet dan 400 kcal/100 g diet menunjukkan udang yang diberikan makanan dengan tahap tenaga 400 kcal/100 g menghasilkan fekunditi tertinggi (1377.12 telur/g berat badan) dan kadar penetasan telur tertinggi (92.10%) ($P<0.05$).

Kajian dalam kolam dengan menggunakan empat rumusan makanan iaitu P35 dengan tahap tenaga 473 kcal/100 g diet, P40 dengan tahap tenaga gros 350 kcal/100 g diet, P40 (375 kcal/100 g diet) dan P40 (400 kcal/100 g diet telah dilakukankan. Udang galah yang memakan P35 (473 kcal/100 g diet) telah menghasilkan fekunditi tertinggi ($P<0.05$) iaitu 1372.10 telur/g berat badan dan kadar penetasan telur yang tertinggi (85.42%). Udang yang memakan makanan P40 (400 kcal/100 g diet) memberikan fekunditi kedua tertinggi iaitu 1336.20 telur/g berat badan dan kadar penetasan telur sebanyak 82.36% dan ketiga oleh udang yang memakan makanan P40 (375 kcal/100 g diet) dengan 1278.57telur/g berat badan dan kadar penetasan telur sebanyak 71.50% dengan diikuti oleh udang yang memakan makanan P40 (350 kcal/100 g diet) memberikan 1105.35telur/g berat badan dan kadar penetasan telur sebanyak 60.85%. Udang yang memakan makanan kawalan menduduki tempat terakhir dengan memberikan 1069.45 telur/g berat badan dan kadar penetasan telur hanya 56.30% sahaja.

Indek asid amino yang perlu (EAAI) juga telah dikira dan didapati bahawa kaedah ini boleh digunakan untuk penilaian dalam penghasilan telur *M. rosenbergii*i di dalam sistem air berpusing. Di dalam kolam, nilai EAAI yang tinggi tidak menunjukkan penghasilan telur yang tinggi, ini mungkin kerana faktor sekitaran dan juga makanan semula jadi yang terdapat dalam kolam. Kajian asid lemak menunjukkan terdapat korelasi yang tinggi di antara asid lemak 20:5n-3 dan fekunditi. Korelasi yang tinggi juga terdapat bagi asid lemak 22:6n-3 dan peratus penetasan dalam sistem air berpusing. Di dalam kolam, asid lemak 20:5n-3 memberikan korelasi yang tinggi untuk fekunditi dan juga kadar penetasan telur. Mengambil kira faktor kos, makanan mengandungi 40% protein dengan tahap tenaga sebanyak 400 kcal/100 g diet adalah disyorkan untuk ternakan induk udang bagi sistem air berpusing dan makanan mengandugi 35% protein dengan tahap tenaga 473 kcal/100 g diet adalah disyorkan bagi pengkulturan induk *M. rosenbergii* di dalam kolam.

CHAPTER 1

INTRODUCTION

Background of the study

The long-legged Malaysian freshwater prawn *Macrobrachium rosenbergii* (de Man) locally known as udang galah, a decapod caridean crustacean which is apparently evolving"out of the sea" (Johnson, 1960), is indigenous to South and South-East Asia, together with northern Australia and the Western Pacific Islands (New, 1990).

Modern farming of the freshwater prawns, *Macrobrachium rosenbergii* , began in the early 1970 following the development of hatchery techniques by Ling (1962) and the subsequent establishment of mass larval rearing techniques by Fujimura (1966), Ling (1969a), Fujimura and Okamota (1970, 1972). However, in the coastal areas of the Indo-Pacific region, catches of *Macrobrachium rosenbergii* have been supporting small fisheries for hundreds of years (Holthuis, 1980).

Out of over 100 species of the genus *Macrobrachium* known to exist, *Macrobrachium rosenbergii* is the most commonly used species in commercial farming and has been introduced in many other countries (New, 1990 ; New, 1995). This is because the species is large and possesses various favourable characteristics; it has a high economic importance both as an item of food (source relatively wide range of temperatures from a minimum of 15°C to a maximum of 35°C, with maximum growth occurring at temperatures near 31°C (Shang and Fujimura, 1977); it is a fast growing omnivore, feeding on both animal and plant materials; the female carries and cares for her eggs, thus resulting in a relatively high hatching rate (Shang, 1981). It is resistant to common disease problems (Ling, 1969a, 1969b; Wickins and Beard, 1974; Balazs and Ross ,1976; Johnson, 1982). It is, however, unfortunate that the significant level of development in the late 70's (Wickins, 1976) in respect to large scale expansion of commercial freshwater prawn farming is yet to be achieved.

A sound global commodity market is of great concern in the development of industrial scale prawn farming. However, an increasing trend of prawn production and its exports in recent years in many Asian countries have demonstrated not only the existence of a global market, but also an ample scope and opportunity for further development. In 1987-88 Southeast Asia alone shared about 92.4% of the total global aquaculture production of *Macrobrachium rosenbergii,* comprising 44% (11,839MT) in Thailand, 32% (8,600 MT) in Vietnam, 17% (4,500 MT) in Taiwan, 0.2% (55MT) in Japan, 0.04% (10MT) in Israel and 0.02% (5 MT) in Malaysia (New, 1990). In fact, some other countries in this region also export a substantial quantity of freshwater prawn every year; for example, Bangladesh exported 2,028 MT in the year 1988-89 (Bangladesh, 1989). From the point of view of importance of export, *Macrobrachium rosenbergii* ranks second only to *Penaeus* in Bangladesh (Karim,1992). The high price (US$ 5.30-7.55) of headless freshwater prawn in Europe and other markets (INFOFISH, 1992) has further raised the demand for this commodity. However, to ensure a stable local as well as international market, a reliable and constant production of high quality cultured prawns in large quantities is a prerequisite which depends on efficient broodstock management of prawns.

Statement of the problem

Increased exploitation and better means of catching has greatly reduced stocks in many areas (Rabanal, 1982). More radical changes reducing stocks, however, occur in places where man-made changes in the environment have been introduced. Pollution from population centres and newly established industries were noted to have reduced the stocks in the Palembang river systems in South Sumatra, Indonesia. The building of new multipurpose dams in a river system can change the normal migration route and radically adversely affect the fishery as in the case of the Dakatia dam in the Gangetic river system in Bangladesh. Pollution occurring downstream and damming upstream has drastically decimated the giant prawn fishery in the Chao Phrya and other rivers in Thailand. Mine pollution and silting have greatly reduced the prawn population in the Agno river system in Central Luzon, Philippines (Rabanal, 1982).

The trend appears to be general and inevitable , leading to a rapid or gradual reduction of prawn fisheries in natural waters. There may be two ways to approach the problem: (1) to preserve and maintain the environmental quality by designating sanctuary areas and formulating conservation measures for the natural fishery and (2) promoting the programme for the culture of the cultivable species of this group. The first measure is good but there are instances when the idea has to be subordinated to other pressing needs. For instance ,the discovery of oil resources in a prawn fishery area will result in abandoning the fishery in favour