UNIVERSITI PUTRA MALAYSIA

STUDY OF SOME ASPECTS OF NUTRITION AND CULTURE OF MALAYSIAN FRESHWATER CATFISH *MYSTUS NEMURUS* (C. & V.)

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FPSS 1993 2

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DOCTOR OF PHILOSOPHY

UNIVERSITI PERTANIAN MALAYSIA

1993

STUDY OF SOME ASPECTS OF NUTRITION AND CULTURE OF MALAYSIAN FRESHWATER CATFISH *MYSTUS NEMURUS* (C. & V.)

By

MOHAMMAD SALIM KHAN

A thesis submitted in fulfilment of
the requirements for the degree of Doctor of Philosophy
in the Faculty of Fisheries and Marine Science
Universiti Pertanian Malaysia

January 1993

DEDICATION

The work is dedicated to my beloved father Alhaj T.H. Khan who passed away on 3rd June 1991

ACKNOWLEDGEMENTS

Grateful acknowledgement is due to my chief supervisor, Prof. Dr. Ang Kok Jee for his invaluable contribution, inputs and careful supervision of my doctoral programme in the Universiti Pertanian Malaysia. I am also indebted to my co-supervisors Dr. Azmi Bin Ambak, Associate Professor and Dr. Che Roos Saad, Senior Lecturer for their meaningful comments and guidance throughout the study period.

I would like to acknowledge Universiti Pertanian Malaysia for the "Graduate Assistantship" under IRPA Project 50261 which was kindly awarded to me during the tenure of my candidature as a Ph.D student. Special acknowledgement is also due to the International Foundation For Science (IFS, Grev Turegatan, Stockholm, Sweden) for awarding a research grant (No. A/1198-1) for the study of the biology and culture of tropical catfish *Mystus nemurus*. It is indeed not an exaggeration that this study would never have been possible without this financial assistance. This kind of generosity, no doubt, heralded in a new era in my life and would continue to remain as a perennial source of inspiration.

I would like to express my gratitude to the Dean of the Faculty of Fisheries and Marine Science and the Dean of Graduate Studies, Universiti Pertanian Malaysia who helped me

every possible way. I also record my appreciation to En. Abdul Aziz Bin Bahsir, Senior Assistant Registrar, Graduate Studies, UPM for his assistance. Josephine Low, staff of the Faculty of Veterinary Medicine deserves great appreciation for her kind help in typing the text of the thesis.

I would also like to extend heartfelt thanks to my friends, colleagues and well-wishers who were instrumental and have provided valuable inputs directly or indirectly in the successful completion of the project.

Last but not the least, special note of thanks is due to my wife, Norizan Ismail whose inspirational role and enthusiasm helped boost my mental strength in this tedious endeavour.

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STUDY OF SOME ASPECTS OF NUTRITION AND CULTURE OF MALAYSIAN FRESHWATER CATFISH, *MYSTUS NEMURUS* (C. & V.)

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Mohammad Salim Khan

January 1993

Chairman: Professor Ang Kok Jee, Ph.D

Faculty: Fisheries & Marine Science

Mystus nemurus (C. & V.) has enormous potential of becoming a cultured species in Malaysia. In the absence of information on important nutritional requirements of the species, aquaculture development could be considerably limited. With the objective of introducing the species to aquaculture, the following studies were conducted: i) digestibility of *M.nemurus* with potential feed ingredients, such as fish meal, soybean meal, rice bran, maize, copra meal and chicken viscera; ii) optimum dietary protein requirement of the species under tank and pond culture conditions using six isoenergetic practical diets that contained 27, 32, 37,42, 47 and 50% protein; and iii) determination of optimum stocking density of *M. nemurus* cultured intensively at six variable densities, such as 105, 195, 285, 375,465 and 555 fish/m^3 respectively.

Digestibility study indicated that most of the feed ingredients were fairly well digested (digestion coefficients ranged 67.93% to 97.80%) except maize and chicken viscera (digestion coefficients ranged 29.00% to 63.40%). These nutritional findings were used as specifications in the diet formulation of *M. nemurus*. Optimal solutions were found using linear programme for six variable protein diets. Catfish with a mean weight of 25.49±1.8g were fed the diets for a period of 12 weeks in controlled recirculatory water system (tank culture). It was found that weight of fish was directly proportional to protein diets upto an incorporation of 42% weight gain (final weight 63.29±0.7 g), food conversion ratio (1.4), protein efficiency ratio (1.70) and apparent net protein utilization (38.22%) invariably indicated that 42% protein diet produced the maximum growth under present experimental conditions. Fish with a mean weight of 25.89 ± 1.7 g were also fed the same six variable protein diets for a period of eight weeks. They were stocked semi-intensively in 0.032 ha ponds at the rate of 10,000 fish/ha. The experiment indicated that fish fed the 42% protein diet produced lowest FCR (1.52) and maximum standing crop (796 kg/ha), weight gain (109.89 ± 4.5 g), and PER (1.58). The experiment also revealed that naturally occurring prawn and other benthic organisms contributed approximately 20.39 to 29.42% of catfish production. Optimum stocking density of *M. nemurus* (mean weight 20.45 ± 1.5 g) fed

the 42% optimal diet lied between 285 and 375 fish/m^3 water. At 285 and 375 fish/m^3, the FCR, PER, survival and SGR (% per day) were significantly different ($P<0.05$) from those found from the stocking densities of 105, 195, 465 and 555 fish/m^3.

Overall the study indicates that *M. nemurus* is a moderately growing fish compared to channel catfish and various nutritional findings suggest that the species has potentials for aquaculture development. Further experiments on the species culture potential should be conducted.

Abstrak tesis dikemukakan kepada Senat Universiti Pertanian Malaysia sebagai memenuhi syarat untuk mendapatkan Ijazah Doktor Falsafah.

KAJIAN BEBERAPA ASPEK PEMAKANAN DAN KULTUR IKAN AIRTAWAR *MYSTUS NEMURUS* (C. & V.) DI MALAYSIA

oleh

Mohammad Salim Khan

Januari 1993

Pengerusi: Professor Ang Kok Jee, Ph. D

Fakulti : Perikanan dan Sains Samudra

Mystus nemurus (C. & V.) mempunyai potensi yang besar untuk menjadi spesis ternakan di Malaysia. Dengan ketiadaan hasil pemakanan yang penting, maka perkembangan akuakultur mungkin terhad. Dengan objektif untuk memperkenalkan spesis ini kepada akuakultur, kajian yang berikut telah dijalankan: i) bahan pemakanan yang berpotensi untuk penghadaman bagi *M.nemurus* seperti tepung ikan, kacang soya, bijirin beras, kopra dan perut ayam; ii) keperluan protin yang optimum, oleh spesis yang dikaji di dalam tangki dan kolam dengan menggunakan enam diet praktikal isoenergetik yang mengandungi 27, 32, 37, 42, 47 dan 50% protin; dan iii) penentuan densiti simpanan yang optimum bagi *M.nemurus* yang diternak secara intensif dengan enam densiti yang berbeza-beza seperti 105, 195, 285, 375, 465 and 555 ekor ikan/m^3.

Kajian-kajian penghadaman menunjukkan bahawa kebanyakan bahan-bahan yang diuji telah dapat dihadamkan oleh *M. nemurus*, (koefisen penghadaman adalah di antara 67.93% sehingga 97.80%) kecuali jagung dan perut ayam (koefisen penghadaman adalah di antara 29.00% sehingga 63.40%). Penemuan ke atas pemakanan ini telah digunakan sebagai spesifikasi di dalam formulasi diet bagi *M.nemurus*. Penyelesaian yang optimum didapati dengan menggunakan program linear bagi enam protin diet yang berbeza-beza. Ikan Baung yang beratnya 25.49 ± 1.8 g telah diberi makan diet untuk tempoh selama 12 minggu di dalam sistem kolam air berpusing yang dikawal (diternak di dalam tangki). Didapati bahawa berat ikan adalah ekoran dari penggunaan protin yang mencapai 42%. Perolehan berat (berat terakhir ialah 63.29 ± 0.7 g) nisbah pertukaran berat (1.4) kecekapan pertukaran protin (1.70) dan penggunaan protin yang sepenuhnya (38.22%) menunjukkan bahawa 42% protin telah menghasilkan pembesaran yang maksimum di bawah keadaan kajian pada masa kini. Ikan yang beratnya 25.89 ± 1.7 g juga telah diberi makanan 6 jenis protin diet yang berbeza-beza untuk selama 8 minggu. Ianya di simpan di dalam kolam yang bersaiz 0.032 ha dengan kadar 10,000 ikan/ha. Kajian menunjukkan ikan yang diberi makan 42% diet protein menghasilkan FCR terendah (1.52) dan standing crop, yang tertinggi (796 kg/ha), perolehan berat (109.89 ± 4.5g) dan PER (1.58). Kajian juga menunjukkan udang yang terhasil secara semulajadi dan lain-lain organisma benthic menyumbangkan kira-kira 20.39 sehingga 29.42% ke atas pengeluaran ikan baung.

Densiti simpanan yang optimum bagi *M. nemurus* (purata berat 20.45 ±1.5g) yang diberi makan 42% diet optimum berada di antara 285 dan 375 ikan/m^3. Pada 285 dan 375 ikan m^3, FCR, PER, survival dan SGR (% setiap hari) adalah jelas berbeza ($P<0.05$) daripada yang didapati pada densiti simpanan 105, 195, 465 dan 555 ikan m^3.

Secara keseluruhan kajian menunjukkan bahawa *M.nemurus* adalah ikan yang membesar secara sederhana berbanding dengan ikan keli channel dan ia mempunyai potensi dalam bidang akuakultur. Kajian selanjutnya ke atas potensi ternakan hendaklah dijalankan.

CHAPTER I

INTRODUCTION

About three decades ago, Atz and Pickford (1959) mentioned that "In a world where the human population is increasing at a rate of 25 million each year and where half the people are already undernourished, no opportunity to improve the productivity of any important source of animal protein food can be neglected if such food can be produced in the regions where the greatest shortage of this vital component of man's diet occur". Until recently this scenario has not undergone much change.

Generally the human population are still undernourished and there is a severe shortage of proteins in many developing countries. There is an urgent need to increase the supply of proteins in order to remedy the situation.

The increase in protein production can be partly contributed by aquaculture which is widely held as an area of tremendous scope for growth - an approximate growth of 7.5%, the highest of all food sectors (ICLARM Report, 1986). Asia remains the leading aquaculture region in the world contributing more than 83% of total production (Chua, 1990). Significant changes have been brought about over the past few decades from an age-old artisanal and subsistence fishery to a modern and sophisticated fish farming system. This turning point is predominantly due to the following factors:

a) Recurrent shortfall in production from the marine capture fishery,

b) Ever increasing population,

c) Increase in demand for commercial and recreational fishery, and

d) New technology due to accelerated research effort.

In Malaysia, however, although total marine capture fisheries landings increased in 1987, 1988, 1989 and 1990 mainly due to introduction of deep sea fishing, the overall production trend from the year 1974 to 1990 shows virtually no significant increase (Annual Fishery Statistics, 1974-1990). Rapid population increase has also caused a corresponding increase in demand for fish.

Aquaculture production in Malaysia has been steadily increasing over the years from a few thousand tons to more than 50,000 metric tons in 1989 (Annual Fishery Statistics 1989). It is projected that aquaculture production in Malaysia would be increased to 206,070 metric tons by the turn of the century (Tengku Obaidullah, 1985) based on an annual growth rate of 20.8%. The actual growth rate, however, is estimated to be less than 6% (Annual Fishery Statistics 1987-1990) despite (Ong 1986) that Malaysia has been endowed with several attributes which are essential for a viable aquaculture system. They are equatorial climate, uninterrupted growth throughout the year, less natural hazards and strong consumer demand.

Ang (1988, 1990) provided the most recent review on status and future development of aquaculture in Malaysia. He reported diverse potentials of aquaculture development as Malaysia has over 570,000 hectares of mangrove forests, 17,200 hectares of disused mining pools and 200,000 hectares of impounded waters. Nonetheless, he identified a few formidable constraints which might impede the development of this bio-industry. Some of these constraints include the lack of efficient planning and management, trained personnel, aquatic pollution and marketability of fish.

Consumption of fish is widespread amongst all ethnic races in Malaysia as it supplies over 60% of the required animal protein (Ang, 1990). While the Government of Malaysia is actively planning for an accelerated development of aquaculture (Pathansali and Zainol, 1976; Ong 1986) there is an urgent need to identify and introduce potential indigenous species. Traditionally freshwater fish species that are cultured in Malaysia are mostly exotic species which have been introduced to Malaysia in the early 19th century. Important cultured species are Javanese carp, *Puntius gonionotus*; grass carp, *Ctenopharyngodon idella*; bighead carp, *Aristichthys nobilis*; tilapia, *Oreochromis* spp.; silver carp, *Hypophthalmichthys molitrix*; and rohu, *Larbeo rohita*. The detrimental effects of some exotic species are well-documented (Welcomme, 1988) and, as such, suitable indigenous species are generally encouraged for aquaculture.

Malaysia is endowed with stocks of potential indigenous species of which *Mystus nemurus* (Cuvier & Valenciennes) has enormous potential of becoming a cultured species (Khan *et al*., 1990). The species has wide distribution ranging from the Indochina to the Asiatic mainland in Malaya and Thailand (Smith, 1945). Important baseline study of its biology has indicated many favourable biological characteristics which could lead to the mass culture of the species (Khan, 1987). The species has the following characteristics:

a. Stout, sturdy and scaleless body with high dress-out percentage,
b. Ability to breed naturally in confined water body,
c. Abundant in certain lakes, rivers and reservoirs,
d. Successful artificial spawning, and
e. Ability to withstand relatively low pH and dissolved oxygen.

The species is one of the popular and demanded freshwater fishes for its delicacy particularly in the state of Perak, Malaysia. *M. nemurus* constitutes one of the dominant species in reservoir fishery (Khan, 1987). It can grow to a significant size and weights between 0.4 and 1.5 kg. were common in Chenderoh reservoir, Malaysia (Khan, 1987). The Department of Fisheries, Ministry of Agriculture, has identified the species as potential catfish for aquaculture (Ismail, Pers. Comm.).

The species is essentially a carnivore although it feeds extensively on a variety of food items (Khan *et al*., 1988). It is generally a bottom feeder and thus it can effectively utilize benthos as food in ponds, lakes and reservoirs. Under wild condition, it was generally found to be slow growing species.

Different catfish species are cultured in many parts of the world: channel catfish, *Ictalurus punctatus* in USA (Beleau, 1985); walking catfish, *Clarias batrachus* and *C. macrosephalus* in Thailand (Arerat, 1987); African catfish, *Clarias gariepinus* in some countries of Africa (Viveen *et al*. 1985); and walking catfish, *C. batrachus* and *Heteropnuestes fossilis* in India (Sinha, 1988). However, the aquaculture potentials of *M. nemurus* in Malaysia still remains to be realised.

Recently interest in the intensive and extensive domestication of this species has been intensified. Extensive form of cage culture was reported in Chenderoh reservoir (Khan, 1987). Farmers have reported that in traditional pond culture, *M. nemurus* are stocked extensively at less than 2000 fish/hectare. Growth of fish at this low stocking density is dependent on pond's natural productivity (Schroeder, 1983). In a few instances, commercial fish pellets, trash fish and agricultural wastes such as rice bran and copra meal, are used as supplementary feed by local farmers. These ingredients by themselves are not nutritionally balanced and thus they are not suited as diets for intensive culture of *M. nemurus*.

Protein is the building block of animal tissue and is also the most expensive ingredient in animal feeds. As culture practices continue to intensify, *M. nemurus* will rely heavily on prepared feeds; but its nutritional needs are largely unknown.

Intensive research has been devoted to studies on optimum dietary protein requirements of various cultured catfish species. The optimum protein requirement values are already known for a number of species, for example, channel catfish, 25-45% protein diet (Robinson and Wilson, 1985); walking catfish, *Clarias batrachus*, 30% (Chuapoehuk, 1987); Siamese river catfish, *Pangasius sutchi*, 30% (Aizam *et al.*, 1980) and African catfish, *Clarias gariepinus*, 30-35% (Viveen *et al.*, 1985). Rearing strategies for those species ranged from the flow-through and controlled recirculatory to static pond water systems.

It was, therefore, important to determine the optimum dietary protein requirement of *M. nemurus* in different aquatic environments. Experiments were thus designed to determine that requirement in both controlled recirculatory and static pond water systems.