EFFECTS OF FISH FEEDING RATE ON GREEN WATER PRODUCTION IN TILAPIA CULTURE

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DECLARATION

I declare that this dissertation is the result of my own independent work, except where otherwise stated.

20 March 2006

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ABSTRACT

An experiment was conducted to study the effect of fish feeding rate on green water production in tilapia culture. In this study, four treatments in triplicates were conducted that represented by four types of feeding rates which are 0%, 2%, 4% and 6% feeding rate of total body weight. All of the treatments were prepared in 200L fiberglass tanks where each tank was added with 5ppt green water and stocked with 300g tilapia sized between 2 to 3 inches. Feeding was given following the fixed feeding rate. The cell number of phytoplankton was counted daily for all tanks and the water quality parameters were monitored, such as dissolved oxygen (DO), pH and water temperature. The concentration of phosphate, nitrite and nitrate were also tested. The results showed that the maximum green water achieved at 4% feeding rate and the optimal growing condition for green water was up to the fifth day. However, to get constant production of green water, the feeding rate should be minimize because accumulation of the uneaten feed could cause deterioration affect the water quality. It is suggested that green water culture could be used at the fifth day, either as inoculums for higher volume or as nourishment for invertebrate animals in marine aquaculture program.

ABSTRAK

Sebuah kajian telah dijalankan untuk mengukur kesan kadar makanan yang diberikan kepada ikan terhadap penghasilan air hijau di dalam kultur ikan tilapia. Dalam kajian ini, empat rawatan dengan tiga reprikat digunakan dan ia mewakili empat jenis kadar makanan yang diberikan iaitu 0%, 2%, 4%, 6% daripada jumlah keseluruhan berat badan. Kesemua rawatan disediakan di dalam kolam gentian kaca berukuran 200L dimana setiap kolam diisikan dengan air hijau 5ppt dan kemudian dimasukkan dengan 300g ikan tilapia yang berukuran 2 hingga 3 inci. Makanan diberikan mengikut kadar makanan yang telah ditetapkan. Bilangan sel fitoplankton dikira setiap hari bagi kesemua kolam dan kualiti air juga diukur seperti oksigen terlarut (DO), pH dan suhu air. Kandungan fosfat, nitrit dan nitrat juga diuji. Keputusan menunjukkan bahawa air hijau maksimum diperolehi pada kadar makanan 4% dan kondisi pengkulturan yang optimum untuk air hijau ialah sehingga hari kelima. Namun begitu untuk penghasilan air hijau yang berterusan, kadar pemberian makanan seharusnya diminimumkan kerana pengumpulan makanan yang tidak dimakan ikan boleh menyebabkan penurunan kualiti air. Disarankan bahawa kultur air hujau boleh digunakan pada hari kelima, sama ada untuk menambahkan penghasilan ataupun sebagai makanan kepada haiwan invertebrate di dalam program akuakultur marin.

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LIST OF SYMBOLS AND ABBREVIATIONS

g	gram
L	Liter
cm	centimeter
μm	micrometer
ml	milliliter
m^3	meter cube
kg m^{-3}	kilogram per meter cube
ml min^{-1}	mililiter per minute
cells ml^{-1}	number of cells per mililiter
mil ml^{-1}	million per milliliter
kg ha^{-1}	kilogram per hectare
kJg^{-1}	kilo Joule per gram
ppt	part per thousand
h	hour
°C	degree centigrade
%	percentage
N	Nitrogen
P	Phosphorus
SL	standard length
BW	body weight
PAS	Partitioned Aquaculture System

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FA	fatty acids
ATP	Adenosine triphosphate
NPUa	apparent net protein utilization
RGRm	relative growth rate
PUFA	polyunsaturated fatty acids
HUFA	high unsaturated fatty acids
RM	Ringgit Malaysia
US$	United State Dollar

CHAPTER 1

INTRODUCTION

1.1 The importance of aquaculture

The fish production from wild captured will be limited in the future in order to maintain the population of the wild. It is as well to maintain fish sources for our next generation. As a result, the demand for fish products becomes higher than the production itself. Thus, aquaculture production is a way of covering the demand of world human population. Aquaculture is the farming of aquatic animals (fishes, mollusks and crustaceans) reared for food in fresh, brackish or marine waters (Bardach, 1997). Aquaculture was also defined by FAO (1995) as farming of aquatic organisms including fish, mollusks, crustaceans and aquatic plants.

On the other hand aquaculture itself has benefited from nutritional trends of consumers in many developed countries. The demand for fisheries products has increased with increasing interest in personal health where fish and most shellfish are low in cholesterol and saturated fats (Nash, 1995).

The aquaculture sector fulfils many social objectives for countries, although these are currently of secondary importance. Large global production of relatively cheap freshwater fishes, for example, contributes to food security and demands for animal protein, particularly in developing countries.

The success of aquaculture and the increasing of its status to an important and valuable market-driven industry have aware by many governments and organizations to change their policies towards aquaculture. The significant contribution of aquaculture commodities to global value of fisheries is the relatively high value of some aquaculture products which are marketed fresh. On the other hand, the large volumes of capture fisheries, such as fish which are reduced for animal feeds and oils, or which can be used only after processing, are of low value (Nash, 1995).

In recent years it has been recognized that aquaculture activities also contribute to other national economies, particularly tourism. For the same reason, aquaculture enterprises have often provided a tourist attraction in themselves, as well as providing seed resources to stock recreational fisheries, or to supply directly to local restaurants with a variety of fresh farm products (Nash, 1995).

1.2 The development of aquaculture

Aquaculture has been a remarkable economic growth sector for the last decade. In 1984, the estimate of global value of cultured aquatic animals and plant (seaweed) was US$ 12 thousand million, and it has tripled to US$32.5 thousand million after ten years after that (FAO, 1995). In 2000, the global fisheries demand has been estimated to be 110-120 million t at 1988 prices. This is due to the rapid increasing in farm production and also the increasing of the prices. The value of world trade in fisheries since 1984 has more than double to a current level of about US$ 82 thousand million (Nash, 1995).

The aquaculture productions in Malaysia are mostly influenced by the production of cockles and fish from freshwater pond culture and brackish water cage culture. The total production in year 2003 was 196,874 tonnes valued at RM 1,172.30 million, which was an increase of 2.63% over the 2002 output of 191,843 tonnes (Fisheries Department, 2003). This contributed to about 13.27% of the overall fish production in the country (Fisheries Department, 2003).

The growth of aquaculture has been aided by the increase in government and private support services, and the development of manufacturing industries providing improve equipment, compound feeds, and medicines (Nash, 1995). It is easier nowadays to those who want to start involving in this sector. The decade has also seen the growth of information resources, such as journals and books of aquaculture. There were also many aquaculture websites in the internet where information is more convenient. Such activities showed that the aquaculture sector is developing rapidly.

1.3 Larval rearing

Fish larval rearing is the key stage in aquaculture. It follows directly after spawning and usually takes place in the same buildings in the hatchery. During this stage, fragile, newly hatched larvae are taken through to the early on-growing phase. Within this phase, the larvae are highly dependent on that of hatchery management and it is essential to provide a good diet which leads to high survival and growth rate.

For fresh water fish, most of them feed upon prepared diet. For example, the African catfish fry come to the surface looking for food and can be fed with pellet. But, most marine fish require live feeds during their larval development. Rotifer is the most important zooplankton and food organism for larval fish in hatcheries around the world. It is a planktonic filter feeder that feeds on organic particles which are the unicellular microalgae that provide the basis for many natural food chains. Thus, the microalgae are very essential in larval rearing.

As stated by C.E. Nash (1995), the microalgae in the larval fish culture system provide the basis for the food chain where it consists of the algae and the zooplankton such as rotifer which feed upon the algae and are in turn preyed upon by the fish larvae.

1.4 Microalgae for larval rearing

Microalgae was first isolated and maintained in 1939. There has been interest in the mass production of microalgae since the 1940s and microalgae have been used for many other purposes (Treece, 1995). But most important use is in the rotifer culture for larvae feeding.

Microalgae species is high in omega-3 HUFAs. *Chlorella, Chaetoceros, Isochrisis, Nannochloropsis, Dunaliella* and *Tetraselmis* are the genera of algae commonly cultured for aquacultural purposes especially as feeds to the rotifer. Species from these classes and genera are usually chosen on the basis of size, nutritional value and ease of culture. For the culture of most fish larvae, it is proven that unicellular microalgae are both easy to grow and serve as excellence food source. Even though rotifers contain their own enzymes that aid fish in digesting them, rotifer usually is deficient in essential fatty acids, and possibly other nutrients. To be nutritionally adequate, they must be fed with microalgae.

The use of microalgae in aquaculture is been years and there are many products of purposely for the rotifer culture. Unfortunately these products are expensive, for example concentrated *Chlorella* imported from Japan is RM360 per liter. The cost of microalgae production is also high, mainly because the ratio of algal biomass to target species is 5-10:1 (Treece, 1995). Algae production is also labor intensive and the chemical and supply cost is high. Algae production costs using Guillard's f/2 medium (made from "scratch") is US$ 0.726 for 300 liter, or about $ 0.0091 per gallon (including shipping of chemicals to hatchery) (Treece, 1995).

Farmers especially in the poor countries are in finding solutions to have more economic way in their culture. The other way of buying such expensive products, the green water productions in tilapia are able to be good source of microalgae. The local freshwater green water contained *Chlorella vulgaris* which its size about 5 μm suitable for rotifer to consume as well to enrich its growth (Becker, 2004).

1.5 Green water

The green water is most popular in the Philippines. But most of them are for shrimp pond culture. Green water from tilapia (*Tilapia hornorum*) culture ponds is transferred to shrimp ponds as rearing water with or without tilapia (Lio-Po *et al*., 2002). There also study of the microbial and phytoplankton microbiota associated with the green water culture system of *Penaeus monodon* (Lio-Po *et al*., 2002). In their previous study, *Chaetoceros*, *Nannochlorum*, *Nitzchia*, *Skeletonema*, and *Leptolyngbia* were among the microalgal species associated with the "green water" culture of *Penaeus monodon* (Lio-Po *et al*., 2002).

The main microalga in green water of UMS hatchery is *Chlorella vulgaris. Chlorella vulgaris* a common microalgae and it is successfully used in hatcheries especially for rotifer culture. Green water production in tilapia culture is relatively inexpensive. Farmers can also save their land space as the green water production is in the tilapia culture. Additionally, the method is profitable where the green water can be used for rotifer consumption whereas the fish as well can be sold or consumed.

1.6 Objectives of study

There are environmental and nutrient factors that can effect green water production. The environmental factors are light, temperature, growth nutrient and good water condition. In this experiment, the nutrient factors will be determined by the effect of feeding of tilapia pellet to the fish. Feces that they have discharged as well the residual pellet may act as fertilizers to the green water. It is assumed that feed serves as a fertilizer (Tucker and Robinson, 1990).

Therefore, the experiment conducted will determine the effect of feeding rate on the production of green water. In this context, the objectives of the study were as below:

1. To determine the best feeding rate for optimum green water production.
2. To establish or to suggest the most appropriate system for green water production.
3. To produce cheaper, practical and profitable green water in tilapia culture.

CHAPTER 2

LITERATURE REVIEW

2.1 Microalgae for larval rearing

Marine rotifer, Brachionus plicatilis is the most important zooplankton and food organism for the mass cultivation of larval fish in hatcheries. In 1965 they were first used to feed the commercial important red sea bream. In 1967 rotifers were cultured on baker's yeast, but its use did not spread until the 1970s (Treece, 1995). Since then, many different methods for culturing the rotifer have been developed and used including microalgae culture. They are rich of nutritional compounds, especially fatty acids and sterol that are required by the larval crustaceans and finfish (Stickney, 2000).

As stated by N. Papandrulakis (1999), important microalgae are used in the larval rearing for sea bream (*Sparus aurata*) as in that for other species, use of the important microalgae. The microalgae are both a key for quick restoration of rotifer cultures, a basic condition for preserving prey quality during high density stocking prior to distribution, and a requisite for creating the efficient (high growth rate and survival) green water rearing medium used for larvae culture. The development of two rearing methods, the so called green (by endogenous bloom) and pseudo green (by daily addition) water techniques, and their industrial repercussions confirm this important role.

2.2 Nutritional value

Even though zooplankton such as rotifer contains their own enzymes that aid fish in digesting them, rotifers are deficient in essential fatty acids and possibly other nutrients (Treece, 1995). Microalgae in aquaculture possess the essential nutritive constituents where they are abundant high quality protein, essential fatty acids (FA), sources of PUFA and vitamins (Becker, 2004).

Larval fish nutritional requirements are more specific. Watanabe *et al.* (1990) determined, that highly unsaturated fatty acids (omega-3 HUFAs), especially 20:5 ω3, were essential for survival and growth of marine finfish larvae. While some species can synthesize long-chain HUFAs from short-chain HUFAs, many marine fishes cannot. This is why certain feeds containing HUFAs can be valuable as rotifer feed (Treece, 1995).

A valuable asset in microalgae used in aquaculture is the protein content, which may amount to more than 60% of dry weight. The protein content per cell, considered as one of the major factors determining the nutritional value of microalgae as feed in aquaculture, was found to be more susceptible to medium induced variation than the other cellular constituents (Becker, 2004).

For the lipids, the various polyunsaturated fatty acids (PUFAs) synthesized by algae are important for the growth of fish. The deficiency in PUFAs is the major cause of the low survival rates often encountered. Although there are marked differences in the compositions of the microalgal classes and species, protein is always the major organic constituent, followed usually by lipids and carbohydrates (Becker, 2004).

2.3 Green water

Green water occurs in a pond where tilapia and other fish species are grown, but the principle behind the success of the greenwater culture technique has not been established (Tendencia, and Pena, 2002). It is found out that the system is low cost, easy to manage, environment friendly, and may reduce the use of antibiotics and other chemicals in shrimp ponds which cause environmental deterioration. (Tendencia and Pena, 2002).

With the recent development of the "green water" grow-out culture of the tiger shrimp *Penaeus monodon*, occurrence of infections attributed to luminous *Vibrio* can be prevented (Paclibare *et al*., 2002). Using this method, water from jewel tilapia (*Tilapia hornorum*) culture ponds is transferred to shrimp ponds as rearing water with or without tilapia stocked in cages in polyculture with shrimp (Lio-Po *et al*., 2002).

Pure cultures of *Chaetoceros calcitrans*, *Nitzchia* sp., *Skeletonema costatum* *Nannochlorum* sp., and *Leptolyngbia* sp. were obtained from the Phycology Laboratory, SEAFDEC, Phillippines. These are phytoplanktons associated with the "green water" culture system for *P. monodon*. In addition, *Leptolyngbia* sp. was isolated from the "green water" culture pond and maintained in the laboratory. Phytoplankton estimation, characterization, and identification followed the key of Yamaji (1991). Count estimates were made with standard methods using a hemacytometer counting chamber.

2.4 Tilapia

Nile tilapia is an attractive species for aquaculture because of fast growth, large size at reproduction, low feeding trophic level and low production costs. Juvenile and adult Nile, *Oreochromis niloticus*, blue, *O. aureus*, and Mozambique, *O. mossambicus*, tilapia are reported to filter phytoplankton (McDonald *et al.*, 1985). Most studies of phytoplanktivory in tilapia have concentrated on descriptions of dietary preferences. There have been some quantitative studies on filter feeding of phytoplankton in tilapia, but most of them have mainly focused upon adult tilapia. Since Nile tilapia use algal protein including cyanobacteria, raising tilapia on foods at lower trophic level can be a cost-efficient culture method (Turker *et al.*, 2002).

Tilapia *Oreochromis niloticus* is known to change its diet and feeding mode from carnivorous to omnivorous feeding at a standard length (SL) of 2–3 cm, and changes again to being a phytoplanktivorous filter feeder at about 6–7 cm SL in its natural habitat (Getachew, 1987).

REFERENCES

Bardach, J. E., 1997. *Sustainable Aquaculture: Fish as Food and the Case for Aquaculture*. John Wiley & Sons, New York.

Becker, W., 2004. Microalgae for Aquaculture- The Nutritional Value of Microalgae for Aquaculture. In: Richmond, A., 2004. *Handbook of Microalgal Culture-Biotechnology and Applied Phycology*. Blackwell Publishing, UK. p281-383

Billard, R.,1995. *Carp biology and Culture*. Springer, Paris. p16-18

De La Cruz, F. L, Espinoza E. V, Millan-Nunez, R., Trees, C.C., Angel, E. S., and Nunez-Cebrero, F., 2005. *Nutrient uptake, chlorophyll a and carbon fixation by Rhodomonas sp. (Cryptophyceae) cultured at different irradiance and nutrient concentrations*. Elsevier B. V., New York.

FAO, 1995. *Code of Conduct for responsible fisheries. Food and Agriculture Organization of the United Nations*. Fisheries Department, Italy.

Falkowski and Raven, 1997. *Aquatic Photosynthesis*. Blackwell Science, Inc., Malden, MA. p375

Feuga A. M., 2004. Microalgae for Aquaculture, The Current Global Situation and Future Trends. In: Richmond, A., 2004. *Handbook of Microalgal Culture Biotechnology and Applied Phycology*. Blackwell Publishing, UK. P362

Fisheries Department, 2003. Annual Fisheries Statistic 2003. Jilid 1. p18.

Fogg, G. E and Thake, B., 1987. *Algal Cultures and Phytoplankton Ecology*, The University of Wisconsin Press. p259

Getachew, T., 1987. A study of an herbivorous fish, Oreochromis niloticus L., diet and its quality in two Ethiopian Rift Valley lakes. In: Awasa and Zwai. J., 1987. *Fish Biology Vol.* 30, p 439–449.

Ghosh, S. K., Mandal, B. K. and Borthakur, D. N., 1984. *Effects of feeding rates on production of common carp and water quality in paddy-cum-fish culture*. Elsevier B. V., Amsterdam.

Huebner, J.D. and Langton, R.W., 1982. Rate of gastric evacuation for winter flounder, Pseudopleuronectes americanus. In: Can. J., 1982 *Fish Aquatic Science* Vol 39, p356–360.

Jabatan Perikanan Malaysia, 2003. *Annual fisheries statistic 2003*. Jilid 1. p18

Knud-Hansen, C.F., 1998. *Pond fertilization: ecological approach and practical applications. Pond Dynamics/Aquaculture Collaborative Research Support Program*. Oregon State University, Corvallis, OR p125

Lio-Po, G. D., Leano, E. M., Penaranda, M. D., Villa Franco, A. U., Sombito, C. D. and Guanzon, N. G. Jr., 2002. *Anti-luminous Vibrio factors associated with the 'green water' grow-out culture of the tiger shrimp Penaeus monodon*. Elsevier B. V, Amsterdam.

Lio-Po, G. D., Leano, E. M., Usero, R. C. and Guanzon, N. G, 2002 G.D. Lio-Po, E.M. Leaño, R.C. Usero and N.G. Guanzon, *Vibrio harveyi and the 'green water culture' of Penaeus monodon*. In: Y. Inui and E.R. Cruz-Lacierda, Editors, *Proceedings of the SEAFDEC-OIE Seminar Workshop on Disease Control in Fish and Shrimp Aquaculture in Southeast Asia-diagnosis and Husbandry Techniques, 4–6 Dec 2001, Iloilo City, Philippines*, SEAFDEC Aquaculture Department, Philippines (2002), p97–106.

McCarthy, J. J., 1981. The Kinetics of Nutrient Utilization. In: Platt, T., 1981. *Bases of Phytoplankton Ecology*. P210

McDonald, M. E.,1985. *Carbon Budgets for a Phytoplanktivorous Fish Fed Three DifferentUunialgal Populations.* p246–249.

Mischke, C. C. and Zimba, P. V., 2003. *Plankton Community Responses in Earthen Channel Catfish Nursery Ponds under Various Fertilization Regimes*. Volume 233, Issues 1-4, Elsevier B. V. UK. P219-235

Nash, C. E., 1995. Introduction to the Production of Fish. In: Nash, C. E. (1995) *World Animal Science (C8) - Production Of Aquatic Animals (Fishes)*. Elsevier Science B. V, Amsterdam. p1-10

Negros Prawn Producers Marketing Cooperative Inc. (NPPCMI), 2000. *Successful Prawn Culture Management Techniques in Negros*. p57.

Paclibare, J. O., Usero, R. C., Somga, J. R. and Visitacion, R. N., 2002. *Visitacion, Integration of finfish in shrimp (Penaeus monodon) culture: an effective disease prevention strategy*. In: Y. Inui and E.R. Cruz-Lacierda, Editors, *Proceedings of the SEAFDEC-OIE Seminar Workshop on Disease Control in Fish and Shrimp Aquaculture in Southeast Asia-diagnosis and Husbandry Techniques, 4–6 Dec 2001, Iloilo City, Philippines*, SEAFDEC Aquaculture Department, Philippines (2002), p151–171

Papandroulakis, N., 1999. *Comparative value of live and frozen marine Chlorella for sea bream Sparus aurata larviculture with the pseudo green water technique*. Elsevier Science B. V. L.A.

Riche, M. A., 2000. *Effect of Phytic Acid on Nitrogen Retention in Tilapia (Oreochromis niloticus)*. Dissertation, Michigan State University, East Lansing, Michigan, USA, p166.

Seymour, E.A., 1989. *Devising optimum feeding regimes and temperatures for the warmwater culture of eel, Anguilla anguilla L. Aquac. Fish. Manage.* **20**, p311–323.

Smith, D. W., 1988. *Phytoplankton and catfish culture*. Volume 74, Issues 3-4. Elsevier Science B. V. UK. p167-189

Stickney, R. R., 2000. *Encyclopedia of Aquaculture*. John Wiley and sons Publishing. Canada. p520-521

Tendencia, E. A., 2002. *Investigation of some components of the greenwater system which makes it effective in the initial control of luminous bacteria*. Elsevier B. V., Amsterdam. p115-119

Treece, G. D., 1995. *The Production of Live-Food Organisms for Fishes*. In: Nash, C. E. (eds) *World animal science (C8) - Production of aquatic animals (Fishes)*. Elsevier Science B. V, Amsterdam. p369-375

Tucker, C.S. and Robinson, E.H., 1990. *Channel Catfish Farming Handbook*. Van Nostrand Reinhold, New York, p454

Turker, H., Eversole, A. G. and Brune, D. E., 2000. Effect of flow rate and temperature on the algal uptake rate by Nile tilapia, Oreochromis niloticus. In: *Book of Abstracts, Aquaculture America, New Orleans,* LA, USA (2000), p333.

Turker H., Eversole, A. G. and Brune, D. E., 2002. *Filtration of green algae and cyanobacteria by Nile tilapia, Oreochromis niloticus, in the Partitioned Aquaculture System* Elsevier B. V., New York. p93-101

Uusitalo, J., 1996. *Algal carbon uptake and the difference between alkalinity and high pH ("alkalization"), exemplified with to pH drift experiment, Sci. Mar.* Elsevier B. V., New York. p129–134.

Watanabe, W. O., Clark, J. H., Dunham, J. B., Wicklund, R. L. and Olla B. L., 1990. *Culture of Florida red tilapia in marine cages: the effect of stocking density and dietary protein on growth.* Elsevier Science B.V., Amsterdam. p123-134

Yamaji, I., 1991. *The Marine Plankton of Japan.* Hoikusha Publishing Co. Ltd, Japan.

Zonneveld, N. and Fadholi, R., 1991. *Feed intake and growth of red tilapia at different stocking densities in ponds in Indonesia.* Elsevier Science B. V., New York.