REPLACEMENT OF COMMERCIAL TILAPIA, *Oreochromis niloticus* DIET WITH PLANT PROTEIN

LIEW SIT FUN

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(TANDATANGAN PENULIS)

Alamat Tetap: P.O. Box 61, 91007 Tawau, Sabah

Tarikh: 12 April 2007

Disahkan oleh

(TANDATANGAN PUSTAKAWAN)

Dr. Sujat Al-Azad

Nama Penyelia

Tarikh: 12 April 2007

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

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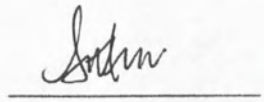

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Signature

1. SUPERVISOR

(DR. SUJJAT AL-AZAD)

2. CO-SUPERVISOR

(DR. SITTI RAEHANAH BINTI MUHAMAD SHALEH)

3. EXAMINER 1

(MR. MUHAMMAD ALI SYED HUSSEIN)

4. EXAMINER 2

(MR. KENNEDY AARON AGUOL)

5. DEAN

(ASSOC. PROF. DR. SHARIFF A. KADIR S. OMANG)

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ABSTRACT

This study was undertaken to formulate diet with the replacement of animal protein using plant protein. Growth rate and survival rate was monitored in Red Tilapia, fed with commercial pellet and formulated diet. Changes in water quality parameters were recorded. Experiment conducted with nine 200L tanks each filled with freshwater with aeration system. Each tank stocked with 180 tails measured juvenile tilapia fish. Crude palm kernel meal, crude soybean meal, crude palm oil, crude glutinous rice flour, minerals and vitamins premix were used as ingredients to formulate diet. Tilapia diets were formulated with 32% dietary protein level. Commercial pellet act as diet 1 (control diet), formulated pellet as diet 2 and 50% commercial pellet plus 50% formulated pellet as diet 3. The result indicated that, Diet 2 and Diet 3 showed significant differences ($p<0.05$) in weight, but no significant differences ($p>0.05$) in length. Better in specific growth rate and protein efficiency ratio were observed when tilapia fed with Diet 3. However, feed efficiency ratio was better when tilapia fed with Diet 2. Diet 3 was observed that ammonia concentration is the lowest among 3 Diets.

ABSTRAK

Experiment ini dijalankan bertujuan untuk menggantikan protein haiwan dengan protein tumbuhan dalam pemprosesan makanan tiruan. Kadar pertumbuhan serta kadar kematian diperhatikan pada Ikan Tilapia merah yang dipelihara dengan makanan tiruan buatan sendiri serta makanan tiruan komersial. Perubahan dalam kualiti air diperhatikan dan dicatat. Experiment dijalankan dengan sembilan 200L tanki yang berisi dengan air tawar. Sebanyak 180 ekor ikan tilapia disimpan dalam setiap tangki. "Crude palm kernel meal, crude soybean meal, crude palm oil, crude glutinous rice flour, minerals dan vitamins premix" digunakan sebagai bahan dalam formulasi makanan tiruan. Formulasi makanan untuk Ikan Tilapia mengandungi 32% protein. Makanan tiruan komersial digunakan sebagai pengimbang, makanan tiruan buatan sendiri sebagai diet 2 dan campuran kedua-dua makanan tiruan sebagai diet ke-3. Keputusan jelas menunjukan bahawa diet 2 serta diet 3 mempunyai perbezaan secara significant ($p<0.05$) dalam berat badan, dan tiada perbezaan dalam panjang saiz badan ($p>0.05$). Diet 3 menunjukkan SGR serta PER yang lebih baik manakala Diet 2 menunjukkan FCR yang lebih baik. Bagi kepekatan ammonia, Diet 3 juga didapati nilai ukuran yang terendah.

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°C	Celcius
%	percent
g	gramme
kcal	kilocalorie
mg/kg	milligramme per kilogramme
ppm	part per million
L	litre
cm	centimetre
NFE	Nitrogen Free Extract
mg/L	milligramme per litre
kg	kilogramme

CHAPTER 1

INTRODUCTION

1.1 Tilapia (*Oreochromis niloticus*)

Tilapias are native to variety of areas in Africa (David and Christopher, 1989). Tilapias included *Oreochromis,* which are microphagous and mouthbreeders (Halver, 1989; Pillay, 2003). However, there are three types of *Oreochromis* species which are *Oreochromis mossambicus*, *Oreochromis niloticus*, and *Oreochromis aureus* (Halver, 1989; Pillay, 2003).

Red tilapia, *Oreochromis niloticus* was selected for my study because it is a popular food fish in Malaysia. Tilapias reveal best growth rates when they are fed with balanced diet consist proper mixture of protein, carbohydrates, lipids, vitamins, minerals and fiber. Tilapia can utilize meal-type foods well while most fish count not (Brown and Gratzek, 1980). Larger tilapia can consume pelleted diet more efficiently and the wasted food can benefit in assisting the production of pond organism.

According to Jauncey and Ross (1982), El-Sayed and Teshima (1991) and Stickney (1996), tilapia below 0.02g require diet higher in protein in range of 45 - 50 % for growth, 0.02 – 2.0g of tilapia need 40% of protein, 2.0 – 35 g of tilapia need 35% of protein, and harvest type tilapia need 30 – 32 % of protein.

1.2 Plant protein supplements

Shortage and imbalance of essential amino acids (EAA) or indigestibility and toxic factors of protein sources are the cause of low nutritive value of dietary proteins for fish (Teshima and Kanazawa, 1988). Plant materials was the second most heavily consumed food (Chapman and Fernando, 1994). The most important protein supplements of plant origin are oilseed meals. These are included soybean meals, peanuts, sunflower seeds, coconuts, canola, cottonseed, and others.

In general, animal proteins are more expensive than plant proteins, and most of the commercial pellets are made with proteins that are from animal origin. Also, animal protein feedstuffs are expensive, so to search for cost effective alternatives in plant protein sources is needed (Liti *et al.*, 2006). Therefore, it is obligatory to replace animal protein with plant protein.

The most important requisite for a successful fish production consist of the use of least cost, nutritionally balance diet and good feeding management. To benefit the aquaculture fields itself, it is important to study the best feed that can boost the growth rate for cultured tilapia. Little work has been done to replace commercial diet with

plant protein ingredients, study was undertaken with aims to formulate diet using plant protein.

1.3 Objectives

The major objective of this experiment is to evaluate the growth and survival of tilapia fed with commercial pellets and own formulated diet (the diet formulated with replacement of animal protein by plant protein).

The specific objectives are:

1. To formulate tilapia diet using plant protein as main ingredients
2. To evaluate growth rate and survival fed with commercial and formulated diet
3. To determine the changes in water quality parameters
4. To produce a low cost formulated diet

CHAPTER 2

LITERATURE REVIEW

2.1 Soybean meal

Soybean is one of the most important oil seed crops. Unlike the groundnut, soybean has relatively low oil content. Because of this, the seeds can be flaked by crushing easily. The oil removal of flaked soybean is carried out through solvent extraction. And the residue is very low in fat, but high in protein.

Even though soybean meal is generally considered to be one of the best readily available plant protein sources, its protein quality and essential amino acids profile (with the exception of Methionine), but it also like other plant proteins does contain a variety of endogenous antinutrients which require removal or inactivation through processing prior to usage within aqua feeds (Tacon, 1995). There are several antinutritional factors contained in soybeans such as trypsin inhibitors. Trypsin inhibitors can be destroy or inactivated by processing (Halver, 1989). However, studies had been conducted to use processed soybean meal as a fish meal replaced within tilapia feeds (Tacon, 1995).

Ng (2003a) stated that, it is suitable for culture of lower value fish species such as catfish, tilapia and carps. There is great to reduce costs by using locally available feed ingredients within the animal feed industry (Ng, 2003a).

According to Halver (1989), soybean meal is a good source of essential amino acids (EAA) and rich in lysine in one of very few plant sources. In recent years, soybean meal has been increasingly used as a substitute for more expensive fish meal in compound fish feeds.

2.2 Kernel and palm oil

The growth of *Oreochromis nilotícus* fingerlings (2.5g body weight) was fed 60% palm kernel protein was reported that of fish fed a fish meal based diet (Omoregie and Ogbemudia, 1993). After the oil extraction of macadamia nut kernels, that has also been found to have great potential for use as a protein source for tilapia. For example, Fagbenro (1993) found that monosex *Tilapia guíneensís* fed macadamia cake (33.4% crude protein) grew at a similar rate to fish fed a commercial diet (35.5% crude protein).

On the other hand, when macadamia cake was used as a replacement for soybean meal at levels exceeding 50% in feeds for *Oreochromis nilotícus* fingerlings, fish growth and protein digestibility were not adversely affected feed efficiency (Balogun and Fagbenro, 1995). However, the low price of macadamia cake makes it

an excellent alternative plant protein source for tilapia (Balogun and Fagbenro, 1995). Ng, *et al*. (2002b) have been reported, the higher levels of palm kernel meal could be included in the diets of hybrid tilapia, and this can reduce the impact of rising costs in feed.

The availability, lower cost, low polyunsaturated fatty acids (PUFA) content and high vitamin E concentration of palm oil make it the choice for the formulation of fish feeds in tropical countries (Ng *et al.*, 2003b).

2.3 Nutrient requirements

To achieve the maximum healthy growth rate in fish, the fish must receive all of the essential nutrients in balanced quantities (Brown and Gratzek, 1980). These nutrients included protein, lipid, vitamins and minerals.

2.4 Protein and amino acids

Protein is the main organic material of the fish body so generous dietary supply is needed for rapid growth (Brown and Gratzek, 1980; Halver, 1989). It is making up about 65 to 75% of the total on a dry-weight basis (Halver, 1989). Fish do not have true protein requirement, but they need a well-balance mixture dispensable and indispensable amino acids (Pillay, 2003). Fish consume protein to obtain amino acids, and the protein is digested or hydrolyzed and released free amino acids (Halver, 1989).

These amino acids are used by the tissues to synthesize new protein and repair the tissue for maintenance.

Protein is more expensive than carbohydrate or fat (Brown and Gratzek, 1980). Therefore, the amount of protein in diet should be limited. Because of protein is needed for growth and tissues repair, and the energy should come from cheaper sources. If too much protein is supplied in the diet, there only part of it will be used to make new proteins whereas the remainder will be converted to energy (Halver, 1989).

2.4.1 Dietary protein requirement in tilapia

Fish require a higher percentage of protein in their diet if compare to warm-blooded animals. There are several factors that influenced optimum percentage of protein in fish diets such as size of fish, physiological function, protein quality, nonprotein energy in the diet, feeding rate, natural foods and economics (Brown and Gratzek, 1980).

The size of fish like land animals which needed higher protein requirement during early life than during later phase of growth (Brown and Gratzek, 1980). It is because protein requirement of fish will decrease with increasing size and age. Halver (1989) have reviewed studies on Tilapia and concluded that fish require 35% to 50% protein if fish less than 1g, for fish from 1g to 5g require 30% to 40% protein, from 5g to 25g require 25% to 30% protein and more than 25g require 20% to 25% protein.

Brown and Gratzek (1980) conducted that there is less protein is needed in a maintenance diet than in one fed for a rapid growth rate in physiological function. For the protein quality, that is a balance essential amino acids produce better growth rate than deficient in one or more essential amino acids (Brown and Gratzek, 1980).

Protein quality is influence by amino acid composition and made up of 20 to 25 amino acids (Brown and Gratzek, 1980). Ten of the amino acids (known as amino acids) cannot be synthesized by tilapias as other fish's body so that must be provided in the diet (Brown and Gratzek, 1980). These essential amino acids (indispensable) are included arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine (Brown and Gratzek, 1980). There is other non-essential (dispensable) amino acids that fish can synthesize consist of alanine, asparagine, aspartic acids, cysteine, cystine, glutamic acid, glutamine, glycine, hydroxyproline, proline, serine and tyrosine (Webster and Lim, 2002).

Brown and Gratzek (1980) stated that fish will use part of the protein to meet energy needs if the diet is deficient energy. This will reduce the amount of dietary protein available for growth. Besides, fish will benefit from diets containing higher percentages of protein than fed for at satiation (Brown and Gratzek, 1980). The protein level in diet may be reduced if natural aquatic organisms contribute to daily food intake of fish (Brown and Gratzek, 1980). That is important to determine how much protein to be used in commercial diets. Thus, the cost and availability of protein sources is a major factor.

2.4.2 Evaluation of protein in formulated diet

Because of the major function of dietary protein is to supply amino acids for maintenance and growth or production, so that nutritional value of protein is related to amino acids (Halver, 1989). A well-balanced protein would have high nutritional value, but an imbalanced protein would have low nutritional value.

2.4.3 Protein efficiency ratio

Protein efficiency ratio (PER) is probably widely used method for evaluating protein quality in fish. The usefulness and limitations of this method have been reviewed by Halver (1989). It is assumes that all protein is used for growth and no allowance for maintenance (turnover) is made (Webster and Lim, 2002). PER is defined as the total weight gain of fish divided by the total protein intake over the feeding trial (Webster and Lim, 2002).

$$\text{Protein efficiency ratio (PER)} = \frac{\text{total weight gain of fish}}{\text{total weight gain of crude protein fed}}$$

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