UNIVERSITI PUTRA MALAYSIA

EVALUATION OF CHICKEN INTESTINE WASTE AS A FEED INGREDIENT FOR RED TILAPIA (OREOCHROMIS SP.) JUVENILES

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By

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This study was designed to evaluate the use of chicken intestine as a protein source for red tilapia juveniles (*Oreochromis sp.*). This study comprises two experiments. In experiment I, the effect of feeding two types of food each respectively containing boiled chicken intestine and raw chicken intestine on the growth of red tilapia juvenile, *Oreochromis sp.*, were studied. The results showed that the food containing boiled chicken intestine give better growth for the fish compared to the one containing raw chicken intestine when used in a 100% substitution for fish meal.

Based on the results of experiment I, the boiled chicken intestine was selected for experiment II and was incorporated into isonitrogenous (40% protein) and isocaloric (450 kcal GE/100g) diets to replace 25%, 50%, 75% and 100% substitution levels of the fish meal protein in the control diet. The test diets were fed to triplicate groups of red tilapia juveniles, twice a day, for 70 days. The

results showed that increase in the proportion of boiled chicken intestine in the diets resulted in growth retardation.

Percent total length gain was highest for fish that were fed with the control diet, followed by those fed with the diet that substituted 50% of the fish meal with boiled chicken intestine. Percent body weight gain, similarly, was highest for fish fed with the control diet, followed again by fish that were fed with the diet that substituted 50% of the fish meal with boiled chicken intestine.

The results showed that red tilapia juveniles fed with the control diet gave the best growth compared with fish that were fed others diets. Nevertheless, boiled chicken intestine could still be used as a main protein source to replace up to 50% of fish meal. Beyond and above the 50% substitution of fish meal with boiled chicken intestine clearly, resulted in stunting growth.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

PENILAIAN SISA USUS AYAM SEBAGAI RAMUAN MAKANAN UNTUK JUVENIL TILAPIA MERAH (*Oreochromis sp.*)

Oleh

KAMIL BIN LATIF

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Kajian ini telah direkabentuk untuk menilai penggunaan usus ayam sebagai sumber protein untuk juvenil ikan tilapia merah (*Oreochromis sp.*). Kajian ini melibatkan dua eksperimen. Dalam eksperimen I, kesan pemberian 2 jenis makanan yang masing-masing mengandungi usus ayam yang direbus dan usus ayam mentah ke atas tumbesaran juvenile ikan tilapia merah, *Oreochromis sp.*, telah dikaji. Keputusan menunjukkan bahawa makanan yang mengandungi usus ayam yang direbus adalah lebih baik kesannya jika dibandingkan dengan makanan yang mengandungi usus ayam mentah dalam penggantian tepung ikan 100%.

Berdasarkan keputusan experimen I, usus ayam yang direbus telah dipilih untuk eksperimen II, dan digabungkan ke dalam diet yang isonitrogenus (40% protein) dan isokalori (450 kcal GE/100g) bagi menggantikan protein tepung ikan pada kadar 25%, 50%, 75% dan 100% dalam diet kawalan. Diet ujian telah diberikan

kepada kumpulan triplikat juvenil tilapia merah, dua kali sehari selama 70 hari. Keputusan menunjukkan peningkatan kandungan usus ayam yang direbus dalam diet telah menyebabkan pertumbuhan ikan terbantut.

Peratus pertambahan panjang keseluruhan ikan adalah paling tinggi pada ikan yang diberi diet kawalan, diikuti oleh ikan yang diberi diet yang digantikan dengan 50% usus ayam yang direbus. Peratus pertambahan berat badan ikan yang tertinggi juga telah diperolehi pada ikan yang diberikan diet kawalan, diikuti oleh ikan yang diberi diet yang digantikan dengan 50% usus ayam yang direbus.

Keputusan menunjukan juvenil ikan tilapia merah yang diberikan diet kawalan memberikan tumbesaran yang baik jika dibandingkan dengan diet yang lain. Namun demikian, usus ayam yang direbus masih boleh digunakan sebagai protein utama untuk menggantikan hingga 50% tepung ikan dalam protein. Penggantian tepung ikan oleh usus ayam yang direbus yang melebihi 50% jelas membantutkan tumbesaran.

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LIST OF ABBREVATIONS

ANOVA	Analysis of Variance
AOAC	Association of Analytical Chemist
BW	Body Weight
BCI	Boiled Chicken Intestine
CRD	Complete Randomized Design
D.O	Dissolved Oxygen
FCR	Feed Conversion Ratio
FM	Fish Meal
G	Gram
GE	Gross Energy
Kcal	Kilo Calorie
L	Litre
NFE	Nitrogen Free Extract
PER	Protein Efficiency Ratio
RCI	Raw Chicken Intestine
S.E	Standard Error
SGR	Spesific Growth Rate
SRV	Survival Rate
TLG	Total Length Gain
WG	Weight Gain

CHAPTER 1

INTRODUCTION

Aquaculture is the cultivation of aquatic animals and plants. Its primary purpose is to produce aquatic food organisms for human consumption, but can also include other purposes such as the cultivation of ornamental and aquarium fishes (Boyd *et al.*, 1997). Aquaculture can be the best answer for some of the world's future protein needs. Aquaculture can be conducted for a number of reasons. The two most common in the U.S. are commercial motivations and recreational fishery enhancement (Stickney, 1993).

On a worldwide basis, aquaculture has tremendous potential to supplement and replace wild captured species for human consumption. To feed future world population and allow for localized production of fish and shellfish for individual consumption, aquaculture must continue to grow between 10 and 15% per year. This growth, however, will be dependent on local/country resources, their need for additional protein, and regulations that are nonrestrictive but encourage development (Martin, 2002).

When fish are cultured in a system where natural foods are absent, such as trout raceways, or where natural foods make only a small contribution to the nutrition of the fish, as in intensively stocked catfish ponds, the feed should be nutritionally complete (Lovell, 1989). However, Lovell (1989) pointed out that where abundant natural food is available, supplemental feeds need not contain all of the essential nutrients. Formulated feeds are used to either supplement or replace natural feeds in the diets of farmed fish and shrimp (Goddard, 1996). Natural food can be supplied in the form of algae, rotifers, brine shrimp, minnows, crayfish and variety of other items (Stickney, 1993).

Since feed cost accounts for over 50% of the production cost for most aquatic species, one way to increase production profitability is to reduce these costs. Protein is generally the most expensive dietary component. Therefore, finding less expensive sources of protein, which provide good growth, is advantageous for diet manufacturers and aquaculture producers alike (Coyle *et al.*, 2004).

The success of the aquaculture industry will depend in part on the reduction in fish meal used in fish feed. Fishmeal is a major and expensive source of dietary protein in fish feed (El-Shafai *et al.*, 2004) because of its high protein quality and palatability (Choi *et al.*, 2004).

Fish meal availability is limited and its supply varies because of reductions in fish stocks due to climatic factors such as the El Nino anomaly, and overexploitation and decline of ocean fisheries stocks (Olvera-Novoa *et al.*, 2002). Alternative sources of protein that are less expensive and of good quality are needed to replace or partially substitute for fish meal in aquafeeds (Catacutan and Pagador, 2004). This is because aquafeed without animal protein has been shown not being able to support an acceptable growth (Coyle *et al.*, 2004).

Waste products from slaughter houses and poultry processing plants are traditionally heat-sterilized before being used in animal feeds. Where the quantity of waste to be processed is small or irregular in supply, operating cost often prevents such preservation. As a result, these resources are not frequently being utilized, even in developing countries where there may be a local shortage of animal feed stuffs (Machin *et al.*, 1984). This study was conducted to evaluate chicken intestines as a source of protein for red tilapia (*Oreochromis sp.*) juvenile.

1.1 Objectives

The objectives of this study are:

1. To determine, the effect of feeding boiled chicken intestine (BCI) and raw chicken intestine (RCI) on the growth and body composition of red tilapia juvenile (*Oreochromis sp.*).

2. To select either boiled chicken intestine (BCI) or raw chicken intestine (RCI) for further trials and to determine the effects of gradual replacement of fish meal (FM) with either RCI or BCI on the growth of red tilapia juvenile (*Oreochromis sp.*).

CHAPTER 2

LITERATURE REVIEW

2.1 Optimal Protein Requirements in Marine Fish Diets

Higher salinities demand a higher protein supply if the fish are to grow well. The increased protein demand in salt water relative to freshwater may be taken to indicate increased rates of protein synthesis and amino acid decomposition in a hyperosmotic medium (Steffens, 1985). Lazo *et al.* (1998) indicated that juvenile Florida pompano (*Trachinotus carolinus*) required a minimum of 45% protein for maximum growth and feed efficiency ration when fish meal and soybean meal are the primary source of protein.

Peres and Oliva-Teles (1999) indicated that, if the dietary protein requirement for juvenile European seabass (*Dicentrarchus labrax*) growth seems to be a diet containing 48% protein as long as temperature remain in the range between 18°C and 25°C. Red drum, *Sciaenops ocellatus* fed 45% crude protein diets had significantly greater weight gain than those fed with 35% crude protein diets (Webb Jr. and Gatlin, 2003). When the energy level of the diet is maintained at 340-375 kcal per 100g, the dietary protein level for juvenile grouper can be lowered from 50% to 44% (Shiau and Lian, 1996).

Tibaldi *et al.* (1996) suggested that a protein level of 44.3% is a suitable level for formulating practical diets for juvenile dentex, providing high quality fish meal. Pea meal has also been suggested as a dietary protein source for milkfish with an optimum level of green pea incorporation in milkfish diet suggested at 10% of the dietary protein (Borlongan *et al.*, 2003).

2.2 Optimal Protein Requirements in Freshwater Fish Diets

Proteins are defined as complex nitrogen-containing organic compounds found in all animal and vegetable cells (Perry, 1984). Protein is a very important constituent of diet (both qualitatively and quantitatively) as it is the building material for a growing animal organism and is also important for the production of enzymes, among other things (Steffens, 1985). The dietary requirement of protein is different between species and may reach 58% e.g. young trout (Huet, 1972)

A study by Giri *et al.* (2003) indicates that for maximum growth, best feed utilization and highest survival, hybrid *Clarias* catfish post-larvae require 350-400 g dietary crude protein kg^{-1} dry matter. Modern complete channel catfish rations for fingerlings in grow out facilities generally contain about 32% crude protein. Fry and early fingerlings require higher levels of protein, perhaps 50% at first feeding (Stickney, 1993).

Juvenile *Cichlasoma managuense* was found to obtain near optimal growth rates when fed 35-40% protein (Rojas and Verdegem, 1994). When applying the broken-line response method with SGR data, the protein requirement of *Cichlasoma synspilum* fry was established as 40.81% (Olvera-Novoa *et al.*, 1996). The optimum dietary protein level for juvenile *Zacco barbata* is about 30% (Shyong *et al.*, 1998). Tibbetts *et al.* (2000) indicated that juvenile American eel required approximately 47% crude protein in their diet for optimum growth and feed utilization.

A study by Khan *et al.* (1996) found that the percentage weight gain, feed conversion ratio (FCR) and protein efficiency ratio (PER) indicated that a 42% protein diet produced the maximum growth of *Mystus nemurus* under practical culture conditions. According to Chong *et al.* (2004), a minimum requirement of 30% protein is included in the diet of female swordtail brood stock. The protein content of the fish carcasses (Silver perch) increases with dietary protein levels up to 31% (Yang *et al.*, 2002). At 25°C, a diet higher in protein is more efficient in promoting growth for red tilapia than medium and low protein diets. At a lower temperature (20.9°C), the efficiency of a high protein diet decreases while a low protein diet become more efficient (Hepher *et al.*, 1983).

Effect of dietary protein level and water salinity on spawning performances of Nile tilapia brood stock and growth of their larvae were studied and the result revealed that 40% dietary protein is required for optimum spawning performance of Nile tilapia reared at 0%, 7% and 14% salinity in clear water. It also indicated that spawning performance and larval growth were better in freshwater than at 7% and 14%, especially at low dietary protein levels (El-Sayed *et al.*, 2003). The efficiency of production of Florida red tilapia is higher on a 28% than on a 32% protein diet (Watanabe *et al.*, 1990). Al Hafedh (1999) indicated that *Oreochromis niloticus* fry (0.51g) should be reared on a practical diet containing 40% protein and larger tilapia (96-264g) on a diet containing 30% protein.

2.3 Lipid Requirements in Fish Culture

Lipids are a large, varied group of organic compounds that are insoluble in water, but soluble in organic solvents. Fats or triglycerides are the groups of lipids that are chemically important energy sources; these are esters of fatty acids with glycerol (Lovell, 1989). Differences in the lipid requirements of various species of farmed fish and shrimp reflect the natural abundance of the different lipid types found within the food chains of freshwater and marine environments (Goddard, 1996).

Generally, the protein-sparing capability of lipid increases with dietary lipid content up to 18% and decreases thereafter (De Silva *et al.*, 1991). Body protein content increases and body lipid content decreases with feed protein levels. Fish fed a 17% protein diet deposited as much as 18% lipid (Meer *et al.*, 1995). Belal and Assem (1995) indicated that varying the percentage of fat added to a practical catfish diet from 0% to 3.8%, but holding the digestible energy does not affect dressing percentage or body composition of the fed fish. The requirement for n-3 fatty acids in tilapias is known to be considerably lower than in other warm water fish and these also do not have a specific requirement for 18:3n-3 (Stickney and Hardy, 1989).

According to El-Sayed *et al.* (2005), nile tilapia broodfish reared in brackishwater require a source of dietary n-3 HUFA for optimum spawning performance, while soybean oil may meet requirements of broodfish reared in seawater. Al-Owafeir and Belal (1996) indicated that palm oil could replace soybean oil in feeds for *Oreochromis niloticus* fingerlings without any negative effect on the fish growth or body composition. Moreover, palm oil is available at low prices in many tropical and sub-tropical regions where tilapia culture is well established.

2.4 Replacement of Fish Meal in Fish Diet

Fish meal is an ideal protein source for fish and has been used as the main conventional protein source in aquaculture diets. Attempts have been made to partially or totally replace fish meal with less expensive, locally available protein sources for tilapia (Shiau, 2002). The replacement of fish meal with cheaper sources of protein has the potential to significantly reduce the cost of prepared diets for fish (Quartararo *et al.*, 1998).

Elangovan and Shim (2000) suggested that a diet containing 42% crude protein with a 2:1 mixture of fish meal protein and soybean meal protein (37% soybean meal in the diet) was adequate for normal growth in *Barbodes altus*. Webster *et* *al.* (1992) suggested that blue catfish juveniles required at least 13% fish meal in a diet containing 34% crude protein for optimal growth.

Soybean meal protein is acceptable as a replacement for up to 75% of fish meal protein in hybrid striped bass weighing over 150 g, however, in smaller fish of 5 g, only levels of 25 and 75% were acceptable, while intermediate amounts (50%) resulted in significant decreases in weight gain (Gallagher, 1994).

The highest growth rate and feed utilization was observed with 20-30% replacement of fish meal with cowpea protein concentrate, while the protein efficiency was best at 40% inclusion level (Olvera-Novoa *et al.*, 1997). Lim *et al.* (2003) concluded that dehulled soybean meal could replace fish meal up to 20% without amino acid (methionine and lysine) supplementation and 30% with amino acid supplementation in fingerling and growing Korean rockfish.

Khan *et al.* (2003) found that soybean meal was most efficiently utilized and could totally replace fish meal in the diets for fingerling *Labeo rohita,* when supplemented with methionine and fortified with minerals, under the conditions of their study. Dehulled soybean meal could replace fish meal up to 20% without amino acids (lysine and methionine) and attractant supplementation and up to 30% with AAs and/or attractant supplementation in diets for fingerling and growing olive flounder, *Paralichthys olivaceus* (Choi *et al.,* 2004).