UTILIZATION OF *GLIRICIDIA SEPIUM* LEAF MEAL AS PROTEIN SOURCE IN DIETS OF MOZAMBIQUE TILAPIA, *OREOCHROMIS MOSSAMBICUS* (PISCS: CICHLIDAE)

By

GEBEYEHU GEBRE-MICHAEL TEMESGEN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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DEDICATION

“THE END DEPENDS UPON THE BEGINNING”

This Thesis Is Dedicated To My Late Parents

Wro. Mulatua Haile

And

Balamberas Gebre-Michael Temesgen

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

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GEBEYEHU GEBRE-MICHAEL TEMESGEN

December 2004

Chairman: **Associate Profesor Che Roos Bin Saad, Ph D**

Faculty: **Agriculture**

A series of experiments were conducted to evaluate the use of tropical fodder legume, *Gliricidia sepium* leaf as a potential source of protein in the diet of Mozambique tilapia, *Oreochromis mossambicus.* The effect of leaf age (plant leaf harvesting time) on crude protein (CP) and crude fiber (CF) contents of *Gliricidia sepium* were determined. *G. sepium* trees were pruned and leaf samples were taken monthly for five months. Results from chemical analyses of leaves revealed that in terms of its crude protein content, *G.*

sepium leaves need to be harvested within 1-3 months after cutting. Leaves harvested from older trees tend to contain less protein.

The chemical composition and apparent protein digestibility (APD) of *Gliricidia sepium* leaves by tilapia, *O. mossambicus*, were also investigated. *G. sepium* leaf meal was found to contain high (26.0%) crude protein but low in essential amino acids such as histidine, isoleucine, leucine, phenylalanine, valine and methionine. The apparent protein digestibility was found to be about 56%. In addition, *G. sepium* has the high crude fiber content.

The optimum inclusion level of *G. sepium* leaf meal in tilapia (*O. mossambicus*) diet was also determined. Six diets containing 0%, 10%, 25%, 40%, 50% and 88% *G. sepium* leaf meal were prepared and fed at 4% per body weight per day for 27 g tilapia for 70 days. Growth performances data obtained revealed that the optimum inclusion level of *G. sepium* leaf meal is 40% of the total diet. Inclusion of *G. sepium* leaf meal above this level resulted in lower growth of *O. mossambicus*.

The effect of different feeding rate on the performance of *G. sepium* leaf meal as *O. mossambicus* diet was also evaluated. Fish were fed diet containing 40% *G. sepium* leaf meal at 2%, 3%, 4% and 5% per fresh body weight per day. Data on growth and feed utilization performances showed

that *O. mossambicus* can be fed diet containing 40% *G. sepium* leaf meal at two percent of wet body weight per day. This feeding rate resulted in statistically comparative growth and feed utilization performance by the tilapia with 3%, 4% and 5% feeding rates.

In addition to these, two processing methods of *G. sepium* leaf meal were compared. Three diets were prepared: 1) a control diet (using fishmeal as sole protein source), 2) oven-dried and 3) presoaked and dried *G. sepium* leaf meal. The diets were fed to *O. mossambicus* fingerlings for 70 days.

Growth and feed utilization performances of *O. mossambicus* showed that the three diets resulted in similar performances. It was therefore concluded that *G. sepium* leaf meal can be used as oven-dried (unsoaked) meal. This might be due to the fact that the major anti-nutritional factors found in this legume are so low in the leaf part of the plant.

Abstrak tesis yang dikemukakan kepack Senat Universiti Putra Malaysia sebagai memenuli keperluan untuk ijazah Doktor Falsafah

PENGGUNAAN MIL DAUN *GLIRICIDIA SEPIUM* SEBAGAI SUMBER PROTEIN TUMBUHAN ALTERNATIF DALAM DIET TILAPIA MOZAMBIQUE, *OREOCHROMIS MOSSAMBICUS* (PISCS: CICHLIDAE)

Oleh

GEBEYEHU GEBRE-MICHAEL TEMESGEN

December 2004

Pengerusi: Profesor Madya Che Roos Bin Saad, Ph D

Fakulti: Pertanian

Satu siri eksperimen dijalankan untuk menilai tumbuhan kekacang, *Gliricidia sepium* sebagai sumber potensi protein dalam rumusan pemakanan ikan tilapia Mozambique, *Oreochromis mossambicus.* Kesan kematangan daun (eringkat kematangan tumbuhan) ke atas kandungan protein kasar (CP) dan serat kasar (CF) ditentukan.

Pokok *G. sepium* dicantas dan sampel daun telah di ambil setiap bulan untuk 5 bulan. Keputusan analisis kimia menunjukkan bahawa dari segi kandungan protein kasar, daun *G.sepium* perlu dituai awal selepas percantasan, paling

sesuai adalah dalam tempoh 3 bulan. Daun daripada pokok yang tua lazimnya mempunyai kandungan protein yang rendah.

Komposisi kimia dan kebolehadaman protein nyata daun *G.sepium* oleh ikan tilapia, *O. mossambicus* juga dikaji. Mil daun *G.sepium* mempunyai kandungan protein kasar yang tinggi (26%) tetapi rendah dalam asid amino penting iaitu histidine, isoleucine, phenylalanine, valine dan methionine. Kebolehan adaman protein nyata adalah 56%. Disamping itu, *G.sepium* mempunyai kadar serat yang tinggi.

Kemasukan optimum mil daun *G.sepium* dalam rumusan makanan tilapia (*O. mossambicus*) juga ditentukan. Enam rumusan yang mengandungi 0%, 10%, 25%,40%,50% dan 80% mil daun *G.sepium* disediakan dan diberi makan pada kadar 4% daripada berat badan ikan setiap hari bagi ikan tilapia seberat 27g, ini diteruskan selama 70 hari. Prestasi pertumbuhan menunjukkan yang tahap optimum bagi kemasukan mil daun *G.sepium* adalah 40% daripada rumusan pemakanan keseluruhan. Tahap yang lebih tinggi daripada ini menunjukkan pertumbuhan yang lebih rendah pada tilapia, *O.mossambicus*.

Kesan kadar pemakanan yang berbeza keatas prestasi mil daun *G.sepium* sebagai rumusan makanan *O.mossambicus* juga dikaji. Ikan diberi rumusan

yang mengandungi 40% mil ikan *G.sepium* pada kadar 2%, 3%, 4% dan 5% berat badan keseluruhan setiap hari. Data untuk prestasi tumbesaran dan penggunaan makanan menunjukkan *O.mossambicus* boleh diberi rumusan makanan yang mengandungi 40% mil daun *G.sepium* pada kadar 2% berat badan basah setiap hari. Keputusan ini menunjukkan secara statistik bahawa prestasi penggunaan makanan yang setara untuk 3%, 4% dan 5% kadar pemberian makanan diperolehi.

Selain daripada ini, 2 cara pemprosesan mil daun *G.sepium* dibandingkan. Tiga rumusan pemakanan disediakan 1) rumusan kawalan (mil ikan sebagai sumber protein tunggal), 2) daun *G.sepium* dikeringkan oleh ketuhar (oven dried) dan 3) daun *G.sepium* yang direndam. Rumusan diberi kepada anak ikan *O.mossambicus* selama 70 hari.

Prestasi kadar pertumbuhan dan penggunaan makanan menunjukkan yang ketiga-tiga rumusan memberi keputusan yang setara. Oleh itu disimpulkan bahawa mil daun *G.sepium* boleh digunakan terus tanpa sebarang rawatan. Ini kemungkinan disebabkan faktor-faktor anti nutrisi utama dalam tumbuhan kekacang ini adalah amat rendah pada daunnya.

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I certify that an Examination Committee met on---to conduct the final examination of Gebeyehu Gebre-Michael Temesgen on his Doctor of Philosophy thesis entitled "Utilization of *Gliricidia sepium* Leaf Meal as a Plant Protein Source for Diets of the Mozambique tilapia, *Oreochromis mossambicus* (Piscs: Cichlidae)" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

Halimi Mohd Saud, Ph. D.
Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Dahlan Ismail, Ph. D.
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Mustafa Kamal Abdul Sattar, Ph. D.
Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Roshada Binti Hashim, Ph. D.
Professor

University Science Malaysia
(Independent Examiner)

_____

GULAM RUSUL RAHMAT ALI, Ph. D.
Professor / Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

This thesis submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Doctor of Philosophy. Members of the Supervisory Committee are as follows:

Che Roos Bin Saad, Ph. D.
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Mohd. Salleh Kamarudin, Ph. D.
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Ridzwan Abd. Halim, Ph. D.
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Abdul Razak Alimon, Ph. D.
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

_____
AINI IDERIS, PH. D.
Professor/Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

DECLARATION

I hereby declare that this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

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GEBEYEHU GEBRE-MICHAEL TEMESGEN

Date:

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LIST OF ABBERVIATIONS

ANF's	Anti-nutritional Factors
ANOVA	Analysis of variance
CF	Crude fiber
CP	Crude protein
CRD	Completely randomized design
DM	Dry matter
DMRT	Duncan's multiple range test
DO	Dissolved oxygen
DWG	Daily weight gain
EAA	Essential amino acids
FAO	Food and Agriculture Organization
FCR	Feed conversion ratio
FM	Fishmeal
GSLM	*Gliricidia sepium* leaf meal
HPLC	High pressure liquid chromatography
LIFDC's	Low-income food deficit countries
NEAA	Non-essential amino acids
NFE	Nitrogen free extract
PER	Protein efficiency ratio
PWG	Percent weight gain
SAS	Statistical analysis system
SBM	Soybean meal
SE	Standard error (of the mean)
SGR	Specific growth rate
UPM	Universiti Putra Malaysia

CHAPTER I

INTRODUCTION

Background of the study

Fish is still a cheap source of high quality animal protein in many developing countries. According to FAO (1997), annual human demand for food fish will increase to about 110 million tonnes by the year 2010. Consequently, total world fish production from capture fisheries and aquaculture is currently the highest on record and remain very important for global food security. Today, more attention is given for fish farming because of the fact that on one hand the fisheries sector has long been dominated by the capture fisheries, and over-fishing due to improper fisheries management led to lower production. Although it is thought that potential exists in a few cases for further expansion of capture fisheries in tropical Africa, instances of water bodies being fished up to their maximum levels of sustainable yield or beyond have also been recorded (FAO,2 001; FAO, 2002). In general it has to be recognized that there are upward limits to further expansion of capture fisheries and for this reason attention has increasingly focused on the possibilities of fish farming.

World aquaculture production, including aquatic plants, reached 45.7 million tones by weight and $56.5 billion by value in 2000 (FAO, 2002). Global aquaculture production for 2001 showed a further increase to 48.2 million tones with a value of $60.9 billion. According to FAO (2002), total fish production reaches its peak 128.8

million tonnes in 2001; aquaculture contributes 37.5 million tones. Asia is by far the most important continent for aquaculture activity. China remains by far the largest producer with 71 percent of the total volume and 49.8 percent of the total value of aquaculture production.

Aquaculture contribution for global supply of fish increased from 3.9 percent of total production by weight in 1970 to 27.3 percent in 2000. It provided 20 percent of global fisheries production (and 29 percent of food fish) in 1996; and increased to 29.1 percent of global fisheries production in 2001(FAO, 2002). The share of aquaculture in the total world food fish production is set to increase from 29.1 percent in 2001 to 38 percent by the year 2010.

According to FAO (1998) aquaculture output grew dramatically during the millennium while capture fisheries production registered a slight increase. In fact, aquaculture has become the fastest growing food production sector of the world, with an average annual increase of about 9.2 percent since 1970, compared with only 1.4 percent for capture fisheries and 2.8 percent for terrestrial farmed meat production systems (FAO, 2002). Most of the world aquaculture production is carried out predominantly by low income food-deficit countries LIFDCs (FAO, 1998).

Generally in developing countries, or 'The Third World', where the problem of overpopulation is critical, it is believed that fish farming can offer one of the

solutions for the ever increasing food (protein) crisis (FAO,1997; FAO, 2001). In fact, a great deal of project activity, both past and present, has been aimed at the development of aquaculture in many African countries. Africa is well situated for aquaculture expansion; about 43% of continental Africa is assessed as having the potential for farming tilapia, African catfish and carp (FAO, 2001). However, the sector still contributes very insignificantly to national food fish supplies in the continent and remains one of the greatest development challenges of the entire tropical African region. Africa, which is home to about 12% of the world population produced an estimated 185, 817 tonnes of fish, crustaceans and mollusks, contributing about 0.6% of world aquaculture output in 1998(FAO, 2001).

Fish production and food fish supply in Ethiopia follow similar, if not worse, trend with the rest of Africa. The continuously dwindling fish stocks in many of Ethiopian fresh water lakes are threatening the already limited supply of fish to the public (LFDP, 1996; Nagelkerke, 1997). Thus the development of fish farming arises (FAO, 1997). Such interventions seem quite important for countries like Ethiopia where an ever spiraling human population combined with increasing demand for fish make good prospect for small-scale fish farming schemes to be developed among farmers. In addition the availability of immense water resources in the country; the availability of suitable farming species (predominantly the indigenous tilapia, *Oreochromis niloticus*) as well as the recently teeming government endeavor towards the development of small-scale water harvesting schemes and Ethiopia.