INCREASING PRODUCTIVITY OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*) THROUGH ENHANCED FEEDS AND FEEDING PRACTICES

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Sustainable Feed Technology and Nutrient Input Systems/Experiment/16SFT03PU

Collaborating Institutions and Lead Investigators

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Objectives

1. To develop cost effective diets promoting fast growth based on Moringa leaf, earth worm, and maggot meals as sources of protein for Nile tilapia diets.
2. To evaluate different cost minimizing feeding strategies.

Hypothesis

1. Growth performances of Nile tilapia fed diets containing Moringa leaf meal, earth worm meal, and maggot meal as sources of protein diets do no differ significantly
2. The effects of different feeding strategies on growth performance and survival of Nile tilapia are not significantly different.

Significance

Aquaculture is the fastest growing animal food-producing sector, with fish production increasing from less than 1 million tonnes per year in early 1950s to 66.6 million tonnes by 2012 with a farm gate value of US$ 137.7 billion and accounting for almost half of the world's fish food supply (FAO, 2014). Therefore, aquaculture plays a significant role in augmenting dwindling fish supply from capture fisheries due to over-exploitation and climate change impacts. It also offers great potential for food supply, poverty alleviation and enhanced trade and economic benefits (ADB, 2005). Smallholder aquaculture with commercial orientation can potentially be very profitable and the wealth created may be a powerful tool for poverty reduction (Wijkstrom and MacPherson, 1990). Aquaculture expansion in Asian countries like Bangladesh and Thailand has led to enhanced food security among adopters and the population at large (Pant et al., 2004; De Silva and Davy, 2010; Jahan et al., 2010; Lazard et al., 2010). Furthermore, fish are a good source of animal-protein containing essential nutrients of high bioavailability which are found in limiting amounts in the human diet. These nutrients include animal protein, essential fats, minerals and vitamins. Fish is a good source of essential long-chain omega-3 fatty acid docosahexaenoic acid (DHA) that is important for optimal brain and neurodevelopment in children and eicosapantaenoic acid (EPA) that improves cardio-vascular health. Thus, improving fish production from aquaculture will increase the availability of both macro- and micronutrients required in a healthy diet.

Despite its potential for improving livelihoods, aquaculture has never developed to a significant extent in Tanzania. Chenyambuga et al., (2014) reported tilapia productivity of 5,312 kg ha^{-1} yr^{-1}. This is mostly attributed to poor feeds and feeding practices. Feeding of fish cultured in ponds of small-scale farmers depends on natural food in the ponds produced by irregular application of inadequate manure. In addition, fish farmers in rural areas provide maize brans, kitchen leftovers, and green vegetables/weeds as supplementary feeds. These feeds are of poor quality and when fed as sole diets results into slow growth

and low yield of fish at harvest. Elsewhere, it has been shown that with proper feeds and feeding practices, it is possible to attain yields of up to 19,000 kg ha^{-1} yr^{-1} (Yi and Lin, 2001). For many decades, fishmeal and soybean have been used as the main sources of protein in fish feeds (El-Sayed, 1999; El-Saidy and Gaber, 2002). However, fish farmers in Tanzania are unable to afford good quality protein sources such as fishmeal, soybean meal, and other oil cakes that can meet protein requirement required for fast growth and development of fish. Thus, there is a need to identify cheaper alternatives sources of proteins. Plant protein sources such as Moringa oleifera leaf meal can replace fishmeal, either partially or totally, in practical Nile tilapia diets (Afuang et al., 2003).

Our previous study showed that a diet containing a mixture of Moringa leaf meal and sunflower seed cake in equal proportions promotes higher growth rate of Nile tilapia, even better than soybean meal (Shigulu, 2012; Kitojo, 2013). Insects and other invertebrates have been shown to be cheaper sources of animal protein in tilapia diets (Omoyinmi and Olaoye, 2012). These invertebrates are abundant because of their short life cycle and ability to produce large numbers and high biomass within a short time. Our previous study showed that diets containing earthworm and maggot meals as sources of protein promote higher growth rate of Nile tilapia than the cotton seed cake based diets (Ally, 2015). Thus, the diets based on Moringa leaf meal, earthworm, and maggot meals seems to be appropriate alternative to conventional supplements as sources of protein as they have high crude protein content, abundantly available and affordable to small-scale farmers. However, these diets have not been tested under farmers' management conditions and the feed formulations have not been transferred to farmers. This study intends to transfer to small-scale farmers the technology of using Moringa, earthworm, and maggot meals as protein supplements to replace conventional fish meal and soybean meal. The aim is to enable the small-scale farmers to formulate better quality rations for Nile tilapia at an affordable cost from locally available feed ingredients.

Quantified Anticipated Benefits

The beneficiaries of this study will be various stakeholders involved in aquaculture, especially fish farmers and feed manufacturers. The expected outputs are as follows:

1. Two practical cost effective diets which promotes fast growth of tilapia developed, promoted, and adopted by fish farmers and feed manufacturers.
2. One best cost minimizing feeding strategy developed and adopted by fish farmers.
3. At least 40 fish farmers trained through workshops on feeding formulations and feeding strategies and adopt the use of the best diets and feeding strategy.
4. Two feed manufactures produce and sell the best diets developed by the project.
5. Five MSc students trained.

Research Design and Activity Plan

The study will be conducted on-farm and on-station using completely randomized design (CRD) to assign dietary and feeding strategy treatments to the experimental units.

Location

On-station studies will be conducted at the Aquaculture Research Facility, Department of Animal Science and Production, Sokoine University of Agriculture. On-farm experiments will be done in Morogoro, Dar es Salaam, Coastal, Mbeya and Iringa regions.

Methods

Experiment 1: Development of cost effective diets based on Moringa leaf, earth worm, and maggot meals as sources which promotes faster growth of Nile tilapia.

Practical and cost effective diets based on Moringa leaf, earth worm, and maggot meals as sources of protein in Nile tilapia diets will be developed based on previous studies by Shigulu (2012), Bazil (2014)

and Ally (2015). These studies evaluated suitability of Moringa leaf meal, earthworm meal and maggot meal as sources of protein in Nile tilapia diets. Five diets will be formulated based on Moringa leaf meal, earthworm meal, and maggot meal and evaluated through growth trial in comparison with existing commercial fish meal based diet. Diets 1, 2 and 3 will contain Moringa leaf meal, earthworm meal and maggot meal as sole sources of protein in the diets, respectively. Diets 4 and 5 will contain a mixture of Moringa leaf meal and earthworm meal and Moringa leaf meal and maggot meal, respectively, in equal proportions. Hence, the total number of treatments will be six. The sixth treatment will be the control and the diet for this treatment will contain fish meal as the source of protein. All diets will have hominy meal, sunflower oil, wheat flour and mineral mix. All diets will be formulated to contain 30% protein and 10% lipid. Nile tilapia fingerlings will be stocked at a density of 3/m^2 in outdoor concrete tanks of 4.5 m^2. The treatments (i.e., diets) will be allocated randomly to the tanks and each treatment will be replicated twice (PD/A CRSP, 1987, 2000). The fish will be fed at 5% of their body weight for a period of 120 days. Water quality parameters such as water temperature, dissolved oxygen, pH, total alkalinity, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen and turbidity will be measured weekly to ensure that they are within acceptable limits. Body weight and length of individual fish will be measured at the start of the experiment and then every two weeks up to the end of the experiment. Weight gain, growth rate, specific growth rate, feed utilization efficiency as well as cost effectiveness of the diets will be determined and the best diets will be identified.

Experiment 2: Development and evaluation of cost minimizing feeding strategies
Development of feeding strategies will be based on works by Kitojo (2013) and Hasan & New (2013). Effect of feeding levels (2.5% vs 5% of body weight) and restricted feeding (daily feeding vs alternate day feeding) will be tested using the best diet identified in experiment 1 above. Nile tilapia will be stocked at a density of 3/m^2 in outdoor concrete tanks and the growth trial will last for a period of 120 days. Water quality parameters such as water temperature, dissolved oxygen, pH, total alkalinity, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen, and turbidity will be measured weekly to ensure that they are within acceptable limits. Body weight and length of individual fish will be measured at the start of the experiment and then every two weeks up to the end of the experiment. Weight gain, growth rate, specific growth rate, feed utilization efficiency as well as cost effectiveness of the diets will be determined and the best diets will be identified.

Sensitization of fish farmers and feed manufacturers to adopt the best feed formulations and feeding strategies for Nile tilapia
The best diets and feeding strategies from experiment 2 will be evaluated in an on-farm trial in two villages in Morogoro region and two villages in Iringa region. Morogoro has warm climate while Iringa has a cold climate. In each village three farmers with at least two fish ponds will be purposely selected based on the willingness to participate in the trial. The farmers' ponds will be drained, dried, limed and filled with water to a depth of 1 m before the start of the experiment. All ponds will be stocked with Nile tilapia at a stocking density of 3/m^2. For each farmer two ponds will be used, one pond will be under the best diet and feeding strategy identified in experiments 1 and 2 above and the second pond will be under normal farmer's feeding practice. The on-farm experiment will last for 180 days. Water quality parameters such as water temperature, dissolved oxygen, pH, total alkalinity, nitrate nitrogen, nitrite nitrogen, ammonia nitrogen and turbidity will be measured at monthly intervals. Body weight and length of individual fish will be measured at the start of the experiment and then every month up to the end of the experiment. Weight gain, growth rate, specific growth rate, feed utilization efficiency of fish under the two treatments will be compared.

Trainings and Deliverables
A workshop will be conducted to train farmers to formulate the best diets identified in experiments 1 and 2. During the workshop the farmers will be sensitized to use the diets to supplement fish grown in their ponds. The aim of this part will be to enable the farmers to formulate better quality supplementary diets

for feeding their fish. In addition, selected feed manufacturers will be visited in Dar es Salaam, Morogoro, Iringa, and Mbeya regions and sensitized to use the best feed formulations developed in the experiments 1 and 2. The sensitization will involve sharing of the results of experiments 1and 2 with the feed manufacturers and promotion of the developed feed formulations and feeding strategies through distribution of brochures. In summary:

1. At least 40 fish farmers trained through a workshop on feeding formulations and feeding strategies and adoption of the best diets and feeding strategy.
2. Five MSc students trained.

Schedule

Activities	2016						2017												2018	
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F
Objective 1: Development diets based on Moringa leaf, earth worm and maggot meals as sources of protein																				
Activity 1.1: Collection of feed materials																				
Activity 1.2: Formulation of six diets based on Moringa, earthworm, maggot and fish meals as sources of protein in the diets																				
Activity 1.3: Conducting on-station growth trial to evaluate the six diets																				
Activity 1.4: Data analysis and report writing																				
Objective 2: Development and evaluation of cost minimizing feeding strategies																				
Activity 2.1: Collection of feed materials and formulation of the best diet identified in objective 1																				
Activity 2.2: Conducting on-station growth trial to evaluate cost minimizing feeding strategies																				
Activity 2.3: Data analysis and report writing																				
Activity 2.4: Selection of farmers for testing the best diet and feeding strategy on farm																				
Activity 2.4: Conducting on-farm growth trial to evaluate the best diet and feeding strategy																				
Activity 2.5: Production of brochures																				

Activity 2.6: Conducting farmers' Training workshops on feed formulation and feeding strategies																			
Activity 2.7: Sharing of research results with feed manufacturers																			
Activity 2.5: Sensitization of fish farmers and feed manufacturers on the developed feed formulations and feeding strategies for tilapia																			
Activity 2.8: Report writing																			
FINAL REPORT WRITING																			