GROWTH OF CULTURED TILAPIA (*OREOCHROMIS NILOTICUS*) ON DIETS FORMULATED FROM EARTHWORM AND OTHER LOCALLY AVAILABLE INGREDIENTS.

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ABSTRACT

A growth trial was carried out to study the effect of experimental diets containing earthworm meal and fish meal as protein sources on the body weight and length of Tilapia (Oreochromis niloticus) fingerlings. The protein concentrate portions of the five diets contained 0% 25%, 50%, 75% and 100% earthworm meal and the remaining part was made from fishmeal. The basal portion of the diets was made from copra meal, cassava, millrun and sago. All diets were formulated to contain 35% crude protein but metabolisable energy estimates ranged from 12.7 to 13.8mJ/kg. Feeding period was seven weeks and live body weight and length were measured weekly. The results showed highly significant effects of diets on body weight and length of Tilapia. The highest and lowest body weight and body length were obtained for the diet made from concentrate of 100% fishmeal and 75% earthworm meal respectively. Body weight and length of Tilapia fed on diets containing 25% earthworm meal concentrate were similar to those of Tilapia on 100% fishmeal concentrate diet. Generally growth performance of Tilapia decreased as the proportion of earthworm meal in the diets increased. The results suggest that, there is potential for using earthworms to replace up to 25% of fishmeal in the protein concentrate of farm made Tilapia diets.

Keywords: *Feeding trial, tilapia, diet, body weight, body length, fishmeal, earthworm meal, growth.*

INTRODUCTION

In Papua New Guinea, the history of freshwater fish farming dates back to the 1960s with the introduction of the trout and carp species (Smith 2007). Currently more and more farmers are venturing into small scale Tilapia (*Oreochromis niloticus)* culture in ponds. Tilapia is a hardy and prolific species that is a suitable for pond culture because they are fast growing and tolerant to poor water conditions. They also eat a wide variety of feedstuffs and can produce very good quality flesh (Fitzsimmons 2001). However Tilapia farmers, as is the case with the whole fish farming industry of Papua New Guinea, are faced with the problem of not being able to meet the optimum nutrient requirements of fish and also the high costs of farm-made fish diets (Maclean 1978). One way of minimizing these problems is by using locally available ingredients to reduce costs and using scientific procedures to properly formulate diets to meet the nutrient requirements of fish. This study was undertaken to evaluate earthworm meal as a potential source of protein to replace the high cost fish meal in Tilapia diets. The specific objectives of the study were to formulate diets which meet the nutrient requirements of Tilapia using earthworm and fishmeal as a source of protein and copra meal and cassava as a source of energy and to assess the growth performance in terms of average body weight and length of Tilapia fed on the formulated diets.

MATERIALS AND METHODS

The feeding trial was conducted under an open shed at the Papua New Guinea University of Technology Agriculture Farm. Five experimental diets called 0EW, 100EW, 75EW, 50EW and 25EW relative to the proportion of earthworm meal in the protein concentrate, were formulated using the feed formulation software of Thomson (2006). The ingredients used as well as the overall crude protein and metabolisable energy contents of the diets are shown in Table 1. Each diet was made by mixing a protein concentrate with a basal portion. The protein concentrate was made from various proportions of earthworm meal and fishmeal (from tuna) while the basal portion was made from calculated proportions of copra meal, cassava, millrun and sago. Millrun and sago were used solely to enhance the floating and binding qualities of the diets respectively. Wheat mill run consists of wheat bran, wheat shorts, wheat germ, wheat flour and the offal from the tail of the

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mill. Ground run of the mill screenings are normally added to mill run.

All diets contained a fixed level of 35% crude protein but metabolisable energy estimates ranged from 12.78mJ/kg to about 13.83mJ/kg. Earthworms were dug from the ground at a local farm. They were killed in water at 60°C, oven dried at 50 – 60°C for three to four days and then milled to a meal form. All other ingredients were milled using a hammer mill before combination. After mixing the basal and concentrate portions warm water was added at 60 – 80% and the dough resulting from further mixing was passed through a 3mm dye mincer to form pellets. The pellets were dried in an oven at 80°C for 12hrs before feeding. Each diet was replicated three times and each replicate contained five tilapia fingerlings of the GIFT variety (Dey and Gupta 2000) in a 0.17 m^3 water tank containing rain water. The mixed sex Tilapia fingerlings weighing between 5g and 7g were bought from the Highlands Aquaculture Development Centre (HAQDEC) at Aiyura. They were initially acclimatized for a period of one week on a diet of 38% crude protein then distributed randomly to the tanks.

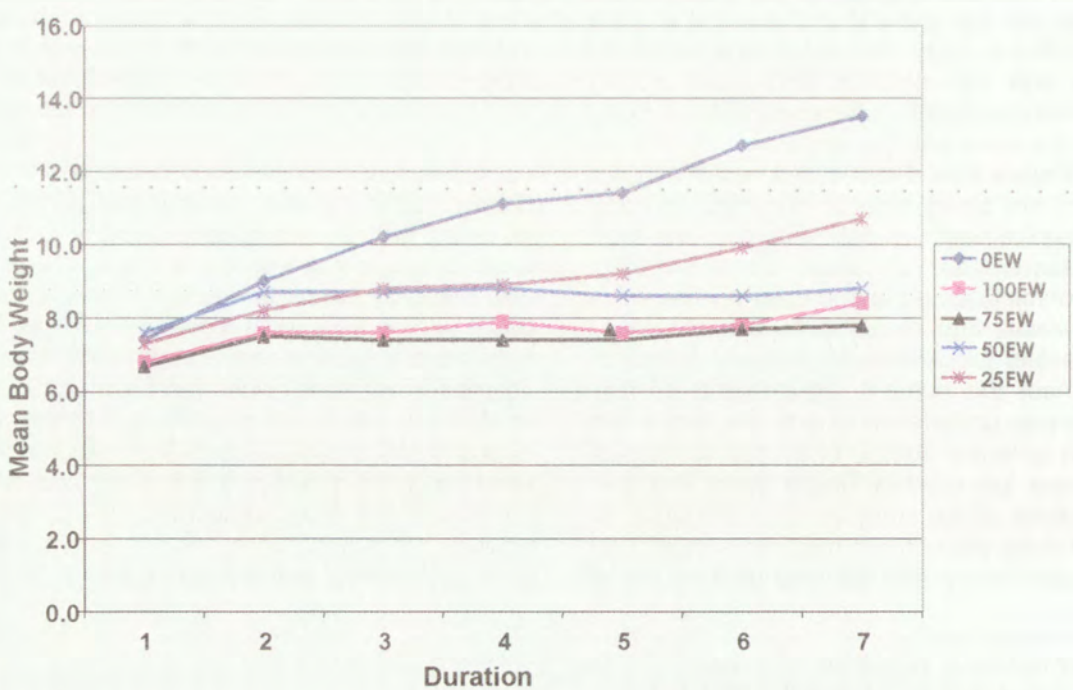
A complete randomized experimental design was used whereby the 15 treatments and replicates were randomly distributed to tanks located in a grid pattern under the shed. A compressor was used for aerating the tanks via small air hoses. The water in the experimental tanks was changed weekly.

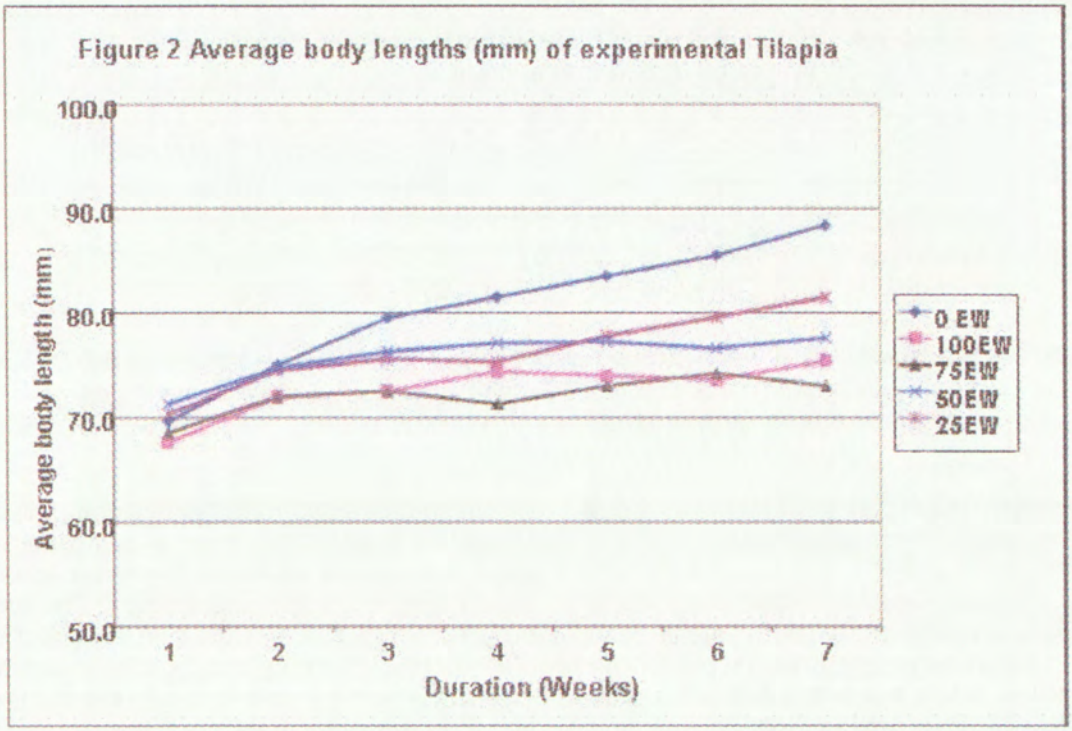
The fish were fed twice a day at a rate of 10% of their body weight adjusted on a weekly basis. Measurements made were weekly average live body weight and body length for seven weeks. Analysis of variance (ANOVA) was carried out on the two measured variables to study the effect of diets on body weight and body length of the fish.

Table 1. **Composition of experimental diets for Tilapia.**

Diet	Composition of concentrate portion of diet	Crude protein (%)	Metabolisable energy (mJ/kg)
0EW	100% fish meal	35	12.78
100EW	100% earthworm meal	35	13.83
75EW	75% earthworm meal + 25% fish meal	35	13.59
50EW	50% earthworm meal + 50% fish meal	35	13.33
25EW	25% earthworm meal + 75% fish meal	35	13.06

Figure 1 Average body weights (g) of experimental Tilapia





RESULTS

Trends in average body weight and body length of Tilapia fed the different treatment diets are shown in Figures 1 and 2 respectively. Fish on 0EW (crude protein mainly from fishmeal) had higher weekly average body weights and body length compared to all the other diets throughout the feeding period while fish on 75EW and 100EW diet had the lowest weekly average body weight and body length. It appears that as the proportion of earthworm meal increased (corresponding to a decrease in the proportion of fish meal) in the diet, tilapia tended to perform poorer in body weight and body length.

Results of analysis of variance of body weight and body length are shown in Tables 2 and 3 respectively. These results show that diet had statistically significant effect on both body weight and body length.

The results of mean separation using the least significant difference at $P<0.05$ are shown in Table 4.

The overall mean body weight and length were 8.47g and 75.13mm respectively. Tilapia on 0EW (only fishmeal in the diet) had the highest mean body weight and body length (10.37g and 80.83mm respectively) while Tilapia on 75EW

Table 2. Analysis of variance of mean body weights (g) of Tilapia on experimental diets.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F value	P-value
Treatment	4	17.57	0.39	5.45	0.014
Residual	10	8.06	0.81		
Total	14	25.63			

Table 3. Analysis of variance of mean body length (mm) of Tilapia on experimental diets.

Source of variation	Degrees of freedom	Sum of squares	Mean squares	F value	P-value
Treatment	4	157.61	39.40	4.63	0.022
Residual	10	85.03	8.50		
Total	14	242.63			

Table 4. **Estimated mean body weights and body lengths of Tilapia on experimental diets**

Treatments diets	Mean Body Weight (g)	Mean body length (mm)
0EW	10.37^{a}	80.83^{a}
25EW	8.73^{ab}	75.53^{ab}
50EW	8.40^{b}	75.3^{b}
100EW	7.57^{b}	72.33^{b}
75EW	7.30^{b}	71.67^{b}

Legend: Within each column, values with different superscript are significantly different from each other (P<0.05) but those with the same superscript are not significantly different from each other.

had the lowest mean body weight and body length (7.3g and 71.67mm respectively).

Results of the mean separation show that, Tilapia fed on 25EW had statistically similar mean body weight and mean body length as Tilapia fed on 0EW. However Tilapia fed on the remaining diets had significantly lower mean body weight and length than fish on the 0EW diet. Tilapia on 25EW diet had similar body weights and lengths as those on the diets containing earthworm meal (i.e. 50EW, 75EW and 100EW). Generally it appears that as the percentage of earthworm meal in the diet increased, performance of the fish became poorer in terms of both body weight and body length.

DISCUSSION

The findings from this study clearly show that growth of Tilapia, in terms of body weights and lengths, was influenced by the protein sources used in their diets. Tilapia on diets containing 25% earthworm meal and only fishmeal (0EW) concentrate had similar growth performance. This suggests that although fish meal could be the best protein source for fish diets, earthworm meal could potentially be used to replace fish meal if added up to 25% or less in the concentrate. However if the amount of earthworm meal concentrate in the diet is increased above the 25% level then growth performance of the fish are likely to be adversely affected in comparison with a diet formulated solely from fishmeal.

The similarity in performance of Tilapia for body weight and body length are not surprising because both variables are measures of growth.

The generally better performance of Tilapia fed fishmeal diets may be explained in terms of the quantity and quality of protein in the diet. The quality of dietary protein depends on the amino acid profile. The amino acid profile of fish meal most closely meets the amino acid requirements of fish compared to that of earthworm (Miles and Chapman 2006). Thus from a nutritional stand point, fishmeal is often the preferred source of protein in diets for fish and shrimps. The addition of fish meal to fish diets can be expected to increases feed efficiency and growth through better digestion, nutrient uptake and utilization compared to earthworm meal.

One significant finding from this study is that 25% or less of fishmeal concentrate can be replaced by earthworm meal concentrate in the diets for Tilapia. The main advantage of using earthworms to replace fishmeal in diets for Tilapia raised by small scale farmers would be its relatively low cost and availability in even remote communities in the country compared to fishmeal. Farmers could harvest naturally existing earthworms or culture them from domestic and farm garbage and residues for this purpose. It can therefore be proposed that the process of developing earthworm meal for feeding cultured Tilapia be investigated to better understand and apply the techniques of using earthworms in Tilapia diets.

Some factors which need further investigation include the method of processing earthworms into meal, digestibility and inclusion rates of earthworm meals. Furthermore the free choice feeding system using whole earthworms could also be investigated because it is known that fish readily consume whole earthworms and this feeding system, if successful, will remove the need to process earthworms into meal.

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