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EFFECT OF DIFFERENT DIETARY PROTEIN LEVELS ON GROWTH, CARCASS COMPOSITION AND SHELFLIFE OF *TILAPIA RENDALLI* (BOULENGER, 1896)

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Abstract

A grow-out experiment was designed to determine the effect of different dietary protein levels on growth, carcass composition and shelflife of *Tilapia rendalli* fingerlings as one of the common aquaculture species in Malawi. A total of 180 *T. rendalli* fingerlings with an average body weight of 23g ± 0.2 were equally divided and stocked into 9 experimental concrete tanks (20 fish /tank), representing three different experimental treatments, and three replicates each. Three experimental diets containing 25%, 30% and 35% CP were formulated. The higher significant ($P<0.05$) values of average weight gain (ADG), specific growth rate (SGR) and better feed conversion ratio (FCR) were recorded for fish fed the diet containing 35% CP. The same trend was observed for whole body tilapia content of protein (%) and lipid (%). Fish fed the diet containing 25% CP diet maintained good quality (lower sensory scores) and remained in acceptable condition up to 8 hours compared to tilapia fed the diet containing 35% CP which was nearly rejected. The results of present study suggested that *T. rendalli* fingerlings fed diets containing 30% CP for 84 days had enhanced growth performance, and fish shelf life.

Keywords: Dietary protein, Carcass composition, Shelf life, *Tilapia rendalli*

Introduction

Tilapia rendalli (Red breasted tilapia), is one of the commonest pond raised fish species by many farmers in Malawi alongside other tilapias namely, *Oreochromis shiranus, Oreochromis mossambicus* and *Oreochromis karongae*. Better growth of fish relies on efficient synthesis of dietary protein into tissue protein (Webster & Lim, 2002). Fish require protein for normal tissue function, maintenance and renewal of body protein and for growth. However, because protein sources are costly, the feed can be more cost effective when protein is largely used for tissue repair and growth and little catabolized for energy (Gauquelin *et al.,* 2007). Inadequate provision of dietary protein in the diet results into rapid reduction or cessation of growth and eventually loss of weight due to withdrawal of protein from less vital tissues to maintain the functions of more vital tissues (Halver, 1989).

On the contrary, if too much protein is included in the diet, only part of it will be used to make new proteins while the rest will be converted to energy (Alatise *et al*., 2006). Utilization of proteins for basal energy metabolism in fish is costly because one can use cheap conventional protein sparing nutrients such as fats and carbohydrates to minimize oxidation of protein (De Bruyne *et al.,* 2011). On the other hand, level of protein in fish feed influences carcass composition (Ahmad *et al.,* 2012) which later influences its shelflife (Huss, 1995). It is therefore necessary to determine optimal level of dietary protein inclusion in a diet, to balance growth of fish and carcass composition and of course save on production costs. Therefore, the present study was designed to determine the effect of different dietary protein levels on growth, carcass composition and shelf life of *Tilapia rendalli* fingerlings.

Materials and Methods

Experiment design and feed formulation

A total of 180 *Tilapia rendalli* fingerlings with an average body weight of 23g ± 0.2 were equally divided and stocked into 9 experimental concrete tanks (20 fish / tank), representing three different experimental treatments, each replicated three times. The experiment was conducted for 84 days. Three experimental diets were formulated to contents 25%, 30% and 35% CP, respectively (Table 1).

Table 1: Proximate chemical composition of different ingredients used for formulation test diets (dry weight basis)

	Proximate composition (%)				
	Dry matter	Ash	Ether extract	Crude fiber	Crude protein
Soybean	90.3±0.78	7.4±0.40	9.0±0.10	0.2±0.01	46.7±0.36
Trash fishmeal	93.3±0.46	17.1±0.10	4.4±0.01	0.3±0.02	64.0±0.25
Maize bran	89.1±0.58	3.8±0.24	12.5±0.49	10.7±0.03	13.0±0.02

Fish meal, soybean meal and maize bran used in this study were already purchased from local markets.

Table 2: Formulation of experimental diets

Ingredients	Treatment 1 (25% CP)	2 (30% CP)	3 (35% CP)
Fishmeal	16.5	22.3	28.0
Soybean	16.5	22.3	28.0
Maize bran	65.5	53.9	42.5
Minerals	0.5	0.5	0.5
Vitamin	0.5	0.5	0.5
Binder	0.5	0.5	0.5
Total	100.0	100.0	100.0

During the experimental, all fish were fed on either diet 1, diet 2 or diet 3 at 5% body weight twice a day. The chemical composition of experimental diet samples was determined according to procedures of AOAC (2000).

The following parameters were calculated as follows:

- Specific Growth Rate, (SGR) = [$\log_e$final mean weight(g) – $\log_e$ initial mean weight(g)]/[(period of culture) × 100];
- % weight gain = [Final mean weight (g) – initial mean weight(g)] / [Initial mean weight (g) × 100];
- % survival rate = (Number of fish survived at the end of experiment / number of fish stocked) × 100; and Feed conversion ratio (FCR) = Total feed given (g)/ weight gain (g).

Water physiochemical parameters

Water-quality parameters, such as temperature, dissolved oxygen (DO), pH and ammonia, were monitored to ensure that water quality remained well within the limits recommended for the fish. Water temperature, dissolved oxygen, pH, ammonia and alkalinity were measured at 09:00 and 14:00 hours according to Jha et al. (2008) using a multipurpose water checker.

Fish sampling and determination of shelf life

All stocked fish from each tank were sampled every 3 weeks by measuring total weight (g). At the end of the experiment, fish were harvested and kept at ambient temperature to determine its shelflife. A sensory panel of 6 people described sensory quality changes in the fish using the quality index method (QIM) (Martinsdóttir *et al*., 2001) for 8 hours using a 4 hour interval. Changes in appearance, odour, gills colour and mucus, eye cornea and texture were scored between 0 and 3 demerit points where zero represented very fresh fish (at harvest) and increasing scores meant more fish spoilage.

Determination of carcass composition

The proximate chemical composition of the fish (crude protein, crude fat, dry matter and ash) was analysed before and after the experiment following the standard methods of analysis developed by the Association of official analytical chemists AOAC (2000).

Data analysis

Data were statistically analyzed by analysis of variance using SPSS Statistical Software Program Version 16. Least Significant Difference (LSD) multiple range test was used to compare differences between treatment means when significant F values were observed at 5% level of significance (Mansour, 1998).

Results

All conditions of the experimental evaluation in the present study were apparently satisfactory, and fell under the optimal standards defined for nutritional evaluations in *Tilapia rendalli*. Water quality parameters monitored during this study were within the tolerable limits for tilapia production .

Water temperature ranged from 27°C to 29°C, dissolved oxygen from 7.1 to 8.7 mg/l and pH from 7.2 to 7.9. The higher significant ($P<0.05$) values of, average weight gain (ADG), specific growth rate (SGR) and better feed conversion ratio (FCR), were recorded for fish fed on the diet containing 35% CP, while the fish fed on diet containing 25% CP recorded the lowest values.

Table 3: Water quality parameters for different experimental

Parameter	Treatment 25% CP	30% CP	35% CP
pH (range) am	7.21-6.73	7.67-6.8	7.81±6.89
pH (range) pm	7.68-7.29	7.93-7.32	7.89-7.47
DO (mg/l) am	7.13±0.03[a]	7.13±0.30[a]	7.19±0.40[c]
DO (mg/l) pm	8.35±0.29[a]	8.71±0.31[b]	8.71±0.28[b]
Temp (°C) am	26.96±0.14[a]	26.96±0.16[a]	26.96±0.3[a]
Temp (°C) pm	29.1±0.18[a]	29.1±0.19[a]	29.09±0.19[a]
Ammonia (mg/l)	0.19±0.05[a]	0.19±0.04[a]	0.19±0.05[a]

treatments (mean ± SE)

Fish fed on diet containing 25% CP diet maintained good quality (lower sensory scores) and remained in acceptable condition up to 8 hours. On the contrary, tilapia fed on a diet containing 35% CP was nearly rejected by the sensory panel after 8 hours of ambient

storage.

Discussion

Results for the present study agree with earlier reports by Ahmad *et al.* (2012) that growth of fish increases with increasing levels of dietary protein. Dietary protein requirements for tilapia species vary considerably from fry, juveniles to brood stock. El-Sayed & Teshima (1992) and Bahnasawy (2009) determined the range for dietary protein requirements of tilapia species between 20 and 56%. The minimum dietary protein requirements for non-spawning and spawning *Oreochromis niloticus* reported by Wee & Tuan (1988) was 27.5% and 35%, respectively. Adewolu & Adoti (2010) also reported high growth rates in *Clarias gariepinus* fed at 35% dietary protein. Feed conversion ratio (FCR) increased with increasing dietary protein levels with the 35% CP diet scoring the lowest FCR of 2.6 compared to 3.3 and 3.1 for 25% CP and 30% CP, respectively. The FCR was higher and not good probably because the feed was not palatable and also the form of the feed such that the fish could not take much of it. These results are in agreement with previous studies on tilapia species (Siddiqui *et al*., 1988; Abdel-Hakim *et al.,* 2001).

The highest FCR values observed with the highest dietary protein level (35%) in this study were earlier reported by Wee and Tuan (1988). Optimal dietary protein for different tilapia species reported among authors may be dissimilar. Sumi *et al*. (2011) and Khattab *et al*. (2000) found the optimum dietary protein level range from 35% CP to 37% CP in *O. niloticus*, while Santiago *et al*. (1982) reported that the optimum dietary protein level for *O. niloticus* fry was between 35 and 40%. Ahmad *et al*. (2004) attributed these variations to differences in fish size and age, stocking density, protein quality, hygiene and environmental conditions or other unknown factors which mask the standardization of the parameters.

From nutrition point of view, this study showed that fish fed on diet containing 35% CP had higher energy content compared to other experimental diets, which is consequently converted into fish body fats and high fat accumulation reduces shelf life of the fish due to rancidity (Huss, 1995). A positive correlation between dietary energy and body fat retention were recorded in various fish species (De Silva & Anderson 1995). High fat content in fish also makes the muscle more soft and susceptible to digestive enzymes (Huss, 1995). This could probably explain why fish fed on 35% CP spoiled faster than fish fed on 25% CP in this study. The present study results demonstrated that increased dietary protein levels consequently increased amount of crude fat in the fish resulting into its reduced storage life due to the breakdown of the fats, an observation previously reported by Huss (1995).

Based on the growth performance and shelf life results in this study, the optimal dietary protein of *T. rendalli* should be 30% CP. This recommendation is reached due to the fact that though fish grew better on 35% CP diet its shelf life was the lowest whilst growth of fish fed on 25% CP diet was the lowest but with highest shelf life. Fish fed on a 30% CP diet would therefore give an optimum growth rate and shelf life resulting into better economic returns to the farmer.

Tilapia rendalli is commonly raised by small scale fish farmers in Malawi with low incomes hence unnecessary costs incurred due to inclusion of more dietary protein in feed would be counter-productive. Therefore, due to many factors that influence optimal dietary protein inclusion in fish feed, this study recommends that a similar study should be conducted in earthen ponds to simulate real field situation.

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