

Research Application Summary

**Effects of feeding frequency and feeding rate on growth performance, feed utilization and body composition of *Oreochromis shiranus* juvenile (Trewavas 1983) reared in laboratory condition**

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**Abstract**

Studies to investigate the effect of feeding frequency (2, 3 and 4 times/day) and feeding rate (2, 4, 6 and 8% BW/day) on growth performance, feed utilization and body composition of *Oreochromis shiranus* was conducted in a laboratory at Lilongwe University of Agriculture and Natural Resources. Nine opaque fiber glass tanks and 12 translucent circular tanks were used for feeding frequency and feeding rate studies, respectively. The experiments were carried out in a Completely Randomized Design (CRD). Results showed that feeding frequency had a significant effect ( $P < 0.05$ ) on final mean weight, specific growth rate (SGR), protein efficiency ratio (PER) and food conversion ratio (FCR). The SGR in fish fed at three times a day was  $1.179 \pm 0.7013$ g which differed by 19.6 % and 27.5% from fish fed twice a day and four times daily, respectively. Viscerosomatic and Hepatosomatic indices were not significantly different among the three treatments ( $P > 0.05$ ). In the feeding rate study, final mean weights, SGR, PER, FCR Viscerosomatic and Hepatosomatic were significantly different ( $P < 0.05$ ) among treatments. Fish that were fed on 6% Body Weight/day had the highest SGR of  $1.462 \pm 0.0837$ g ( $P < 0.05$ ) followed by fish fed on 4%, 2% and 8% with the growth of  $1.444 \pm 0.0705$ g,  $1.248 \pm 0.0753$ g and  $1.051 \pm 0.0810$  g, respectively. The studies concluded that a feeding frequency of three times and a feeding rate of 6% BW is the best for optimum growth performance, feed utilization and body composition of *Oreochromis shiranus*. These results, however, need to be validated in a pond environment.

Key words: Fish growth, Malawi, *Oreochromis shiranus*, Tilapia feeding frequency, Tilapia feeding rate

**Résumé**

Des études visant à examiner l'effet de la fréquence d'alimentation (2, 3 et 4 fois par jour) et du taux d'alimentation (2, 4, 6 et 8% PC (poids corporel)/jour) sur la croissance, l'utilisation des aliments et la composition corporelle d'*Oreochromis shiranus* ont été menées au

laboratoire à l'Université d'Agriculture et des Ressources Naturelles de Lilongwe. Neuf réservoirs en fibre de verre opaque et 12 réservoirs circulaires translucides ont été utilisés pour les études de fréquence et d'alimentation, respectivement. Les expériences ont été réalisées dans un dispositif expérimental complètement aléatoire. Les résultats ont montré que la fréquence d'alimentation avait un effet significatif ( $P < 0,05$ ) sur le poids moyen final, le taux de croissance spécifique (TCS), le ratio d'efficacité protéique (REP) et le taux de conversion alimentaire (TCA). Le TCS chez les poissons nourris trois fois par jour était de  $1,179 \pm 0,7013\%$ , contre  $19,6\%$  et  $27,5\%$  chez les poissons nourris deux fois par jour et quatre fois par jour, respectivement. Les indices visco-somatiques et hépato-somatiques n'étaient pas significativement différents entre les trois traitements ( $P > 0,05$ ). Quant à l'étude de la vitesse d'alimentation, les poids moyens finaux, TCS, REP, TCA visco-somatiques et hépato-somatiques étaient significativement différents ( $P < 0,05$ ) parmi les traitements. Les poissons nourris avec  $6\%$  de PC/jour ont eu le TCS le plus élevé de  $1,462 \pm 0,0837\%$  ( $P < 0,05$ ) suivi des poissons nourris avec  $4\%$ ,  $2\%$  et  $8\%$  avec une croissance de  $1,444 \pm 0,0705\%$ ,  $1,248 \pm 0,0753\%$  et  $1,051 \pm 0,0810\%$ , respectivement. Les études ont conclu qu'une fréquence d'alimentation de trois fois par jour et un taux d'alimentation de  $6\%$  de poids corporel sont les meilleurs pour une croissance optimale, une bonne utilisation des aliments et une bonne composition corporelle d'*Oreochromis shiranus*. Ces résultats doivent cependant être validés dans un environnement d'étang.

Mots clés: Croissance du poisson, Malawi, *Oreochromis shiranus*, fréquence d'alimentation du tilapia, taux d'alimentation du tilapia

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## Introduction

In Malawi fish feed constitutes about 60% of the total aquaculture production cost (IDAF, 2008). An important approach for reducing feed costs in commercial aquaculture is to develop proper feed regimes, husbandry strategies and efficient broadcasting of the predetermined ration to the culture system. Poor feeding management is one of the key constraints to the desired aquaculture production of *Oreochromis shiranus* in Malawi. Feeding frequency and feeding rate are vital in the establishment of appropriate feeding regimes. Studies show that Tilapia fingerlings fed on 3 % body weight and fed at a frequency of 4-5 times a day (FAO, 1987) grow better. However, no studies have been made to establish the optimum feeding rate and frequency of *Oreochromis shiranus* (Trewavas, 1983), a widely cultured species among small holder farmers in Malawi. As a result, farmers have no knowledge of the feed quantity and feed frequency for optimum performance of *Oreochromis shiranus*. Farmers therefore tend to either under- or over feed the fish resulting in poor growth, lowered feed efficiency and deterioration of water quality. All these factors increase production costs (Dwyer *et al.*, 2002). The objective of this study was therefore to determine the optimum feeding frequency and feeding rate that give the best growth, feed utilization and body composition of *Oreochromis shiranus*.

## Study description

A total of 600 fingerlings were acclimatised for seven days. Batches of 20 fingerlings were each stocked in 12 translucent circular glass tanks for the feeding rate study and nine

fiberglass tanks for the feeding frequency study. In both experiments the temperature was maintained at  $26 \pm 2^\circ\text{C}$  using water heaters. Four (4) feeding rates were evaluated and included 2% BW/day, 4% BW/day, 6% BW/day and 8% BW/day. These were allocated to 12 tanks in a Completely Randomized Design (CRD) with three replicates. Fish in this trial were fed twice daily. In the feeding frequency experiment, fish were fed twice daily (8:00 and 16:00 hours), three times daily (8:00, 12:00 and 16:00 hours) and four times daily (7:00, 10:30, 14:00 and 17:30 hours) in nine tanks also arranged in a Completely Randomized Design (CRD) with three replicates. Fish were sampled fortnightly by taking 10 fish from each tank. These were weighed to the nearest g; and their length measured to the nearest mm using an electric analytical balance and a measuring board, respectively. Water temperature, DO, pH, ammonia levels and nitrate nitrogen were monitored either daily or once a week using Horiba water checker and sample test chemicals.

## Results

The findings showed that feeding frequency had a significant effect on the final weight gain, specific growth rate and food conversion ratio of *Oreochromis shiranus* fingerlings. Fish fed three times daily had the highest weight gain of  $12.153 \pm 0.661\text{g}$  and differed from fish fed twice daily by  $9.128 \pm 0.751\text{g}$  and four times daily by  $8.063 \pm 0.0129\text{g}$ . Similarly SGR of fish fed three times was  $1.468 \pm 0.411\text{g}$ , followed by two times a day with  $1.179 \pm 0.7013\text{g}$  and fish fed four times daily was  $1.064 \pm 0.886$ . The highest PER ( $0.3201 \pm 0.0178$ ) was obtained from fish fed three times per day. The FCR was lowest in fish fed four times daily ( $0.994 \pm 0.239$ ) and highest in fish fed 2 times daily ( $1.63425 \pm 0.246$ ). Viscerosomatic and Hepatosomatic indices were not significantly different among three treatments ( $P > 0.05$ ) (Table 1).

In terms of feeding rate, fish that were fed 6% per body weight resulted in the highest SGR at  $1.462\% \pm 0.0837$ , followed by fish fed 4% body weight per day with  $1.444\text{g} \pm 0.0705$ . The least performing feeding rate was 8% body weight per day with  $1.051\text{g} \pm 0.0810$ . The highest

**Table 1. Growth performances, feed utilization and body composition of *Oreochromis shiranus* fed at different feeding frequencies (means  $\pm$  s.e) after eight weeks**

Variable	2 times	3 times	4 times
Initial mean weight (g)	$9.262 \pm 0.00143^a$	$9.280 \pm 0.0146^a$	$9.273 \pm 0.0129^a$
Final mean weight (g)	$18.39 \pm 0.749^b$	$21.43 \pm 0.664^a$	$17.34 \pm 0.765^b$
Mean weight gain (g)	$9.128 \pm 0.751^b$	$12.153 \pm 0.661^a$	$8.063 \pm 0.0129^b$
Weight gain (%)	$98.6 \pm 8.124^b$	$130.9 \pm 7.086^a$	$87.1 \pm 8.353^b$
SGR (% BW/day)	$1.179 \pm 0.7013^b$	$1.468 \pm 0.411^a$	$1.064 \pm 0.886^b$
PER	$0.2413 \pm 0.0205^b$	$0.3201 \pm 0.0178^a$	$0.3089 \pm 0.0343^a$
FCR	$1.63425 \pm 0.246^a$	$1.538 \pm 0.0866^{ab}$	$0.994 \pm 0.239^b$
VSI	$8.322 \pm 0.184^a$	$6.593 \pm 0.132^a$	$6.760 \pm 0.114^a$
HSI	$1.634 \pm 0.330^a$	$0.8033 \pm 1.711^a$	$1.088 \pm 0.691^a$

\*Means followed by different letters in a column are significantly different by Duncan Multiple Range test at  $P = 0.05$ . SGR = specific growth rate, PER = protein efficiency ratio, FCR = food conversion ratio

PER was observed in fish fed 6% body weight per day with  $7.847\text{g}\pm 0.782$  and the least value was observed in fish fed 2% body weight per day with  $834\pm 0.230$ . The FCR of fish fed at different rates were significantly different ( $P < 0.05$ ) among treatment. Fish that fed on 4%, 6% and 8%. Body weight per day only requires approximately less than 1g of feed to gain 1g of weight ( $P < 0.05$ ), but it differed with fish that were fed at 2% body weight per day with 1.6g of feed to gain 1g of weight ( $P < 0.05$ ). Furthermore fish fed at different rates were significantly different ( $P < 0.05$ ) in terms of body composition. Fish fed at 6% body weight per day had the highest Hepatosomatic index of  $1.1400\pm 0.0984$  ( $P < 0.05$ ) which differed with fish fed at 8%, 4% and 2% body weights per day by  $0.9417\pm 0.232$ ,  $0.3732\pm 0.0497$  and  $0.1983\pm 0.0662$ , respectively (Table 2).

**Table 2. Growth performances, feed utilization and body composition of *Oreochromis shiranus* fed at different feeding rates (means $\pm$  s.e) after eight weeks**

Variable	2%BW/DAY	4%BW/DAY	6%BW/DAY	8%BW/DAY
Initial mean weight (g)	9.910 $\pm$ 0.008 <sup>a</sup>	9.840 $\pm$ 0.009 <sup>b</sup>	9.930 $\pm$ 0.013 <sup>a</sup>	9.840 $\pm$ 0.00788 <sup>b</sup>
Final mean weight (g)	20.44 $\pm$ 0.851 <sup>bc</sup>	22.56 $\pm$ 0.823 <sup>ab</sup>	23.22 $\pm$ 1.029 <sup>a</sup>	18.28 $\pm$ 0.843 <sup>c</sup>
Mean weight gain (g)	10.53 $\pm$ 0.711 <sup>bc</sup>	12.72 $\pm$ 0.881 <sup>ab</sup>	13.29 $\pm$ 0.701 <sup>a</sup>	8.44 $\pm$ 0.617 <sup>c</sup>
Weight gain (%)	106.4 $\pm$ 7.11 <sup>bc</sup>	129.3 $\pm$ 8.81 <sup>ab</sup>	133.8 $\pm$ 7.01 <sup>a</sup>	85.7 $\pm$ 6.17 <sup>c</sup>
SGR (%BW/day)	1.248 $\pm$ 0.0753 <sup>ab</sup>	1.444 $\pm$ 0.0705 <sup>a</sup>	1.462 $\pm$ 0.0837 <sup>a</sup>	1.051 $\pm$ 0.0810 <sup>b</sup>
PER	2.834 $\pm$ 0.230 <sup>c</sup>	4.429 $\pm$ 0.270 <sup>b</sup>	7.847 $\pm$ 0.782 <sup>a</sup>	6.775 $\pm$ 0.522 <sup>a</sup>
FCR	1.6380 $\pm$ 0.203 <sup>a</sup>	0.9696 $\pm$ 0.112 <sup>b</sup>	0.6693 $\pm$ 0.104 <sup>b</sup>	0.6990 $\pm$ 0.0995 <sup>b</sup>
HSI	0.3732 $\pm$ 0.0497 <sup>b</sup>	0.1983 $\pm$ 0.0662 <sup>b</sup>	1.1400 $\pm$ 0.0984 <sup>a</sup>	0.9417 $\pm$ 0.232 <sup>a</sup>
VSI	6.745 $\pm$ 0.786 <sup>a</sup>	8.830 $\pm$ 0.823 <sup>a</sup>	3.487 $\pm$ 0.855 <sup>b</sup>	9.592 $\pm$ 1.293 <sup>a</sup>

\*Means followed by different letters in a column are significantly different by Duncan Multiple Range test at  $p=0.05$ . SGR = specific growth rate, PER = protein efficiency ratio, FCR = food conversion ratio

## Discussion

The results of this study show that fish fed three times a day had highest growth rate. This was also reported for juvenile of *O. niloticus* (Riche *et al.*, 2004; Temitope *et al.*, 2013). Results also corroborates a report of Bařćýnar (2007) where growth, feed consumption and conversion ratios of Black Sea trout (*Salmo trutta labrax*) fed thrice daily had better final live weight and SGR value in comparison to other frequencies. As stated by Tsevis *et al.* (1992) and Lee *et al.* (2000), there is a limit to the feeding frequency, beyond which, fish growth becomes negligible. The optimal ration and feeding regime should reflect the interplay between feed efficiency and specific growth rate. Utilizing this model, the study has revealed that the optimal feeding frequency of *Oreochromis shiranus* is three times a day, beyond which growth of fish is limited.

The results further show that feeding the fish at 6% of their body weight per day was optimum. Similar results were reported in a study on African catfish (Yousef *et al.*, 2004) where the optimum feeding rate of juvenile catfish was 6% body weight per day. De Silva (1995) stated that an optimum feeding rate is one which gives the best growth and FCR.

Such a ration, if properly dispersed, results in minimum wastage and minimal deterioration of water quality. According to De Silva (1995), under feeding results in poor growth and production while over feeding results in wastage of feed and water quality deterioration, both of which affects fish growth. Fingerlings fed at 6% of their body weight per day had better FCR and growth than fish fed 4% body weight per day. This also provided high HSI and low VSI suggesting better utilization of energy for growth. Results reported were obtained under laboratory conditions and it is therefore recommended that these results be authenticated in pond environment studies. Nevertheless, feeding fish three times a day and at 6% body weight per day seen to be the optimum feeding regime for *Oreochromis shiranus*.

### Acknowledgements

The authors thank the Agricultural Technology Transfer project for funding the study. Thanks are also extended to staff of the Lilongwe University of Agriculture and Natural Resources, and the NEPAD Regional Fish node, Malawi for hosting the research and for the assistance rendered during this research, respectively. This paper is a contribution to the 2016 Fifth African Higher Education Week and RUFORUM Biennial Conference.

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