Effect of Substituting Animal Protein Sources with Soybean Meal in Diets of *Oreochromis karongae* (Trewavas 1941)

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Abstract

Three diets were formulated using locally available feed ingredients in Malawi to test the effect of replacing animal protein (fish meal, meat and bone meal) with soybean meal (10:0, 5:5, 0:10 % of diet) as the protein source on growth and feed conversion of *Oreochromis karongae*. There were no significant differences in growth rate (GR), specific growth rate (SGR) and feed conversion ratios (FCR) among the three diets. It can be concluded that more expensive and limited animal protein sources can totally be replaced by cheaper soybean in order to get similar growth rates in *O. karongae*.

Introduction

Increasing demand, high costs and uncertain availability of fish meal, together with risk factors associated with diseases from animal protein sources, have resulted in nutritionists studying alternative sources for inclusion into the diets of freshwater and marine species. Of these sources soybean is the most promising source (Boonyaratpalin et al. 1998). Many studies have been carried out on the partial replacement of dietary fishmeal and other animal protein with soybeans in diets of teleost fishes, but there are only a few reports written on the utilisation of soybean products as the sole protein source (Watanabe and Pong-maneerat 1993; Kaushik et al. 1995).

The lack of suitable fish species for culture continues to be one of the bottlenecks to the development of aquaculture in Malawi. Results reported during the Agricultural Sciences Committee (ASC) annual conference in 1997 (Kaunda et al. 1997) indicated that, based on growth, ability to breed, withstand stress, and marketing value, *Oreochromis karongae* (Chambo), *Dinotoperus* spp (Bombe), *Oreochromis shiranus* (Makumba) and *Tilapia rendalli* were the potential species for both commercial and small scale farmers in Malawi. Results from experiments on diets have shown that *O karongae* can be reared in semi-intensive culture systems and on plant protein sources (Msiska 1998).

This article summarises the study that was carried out to test if substitution of animal protein sources with a less expensive plant protein source (soybean meal) would have an effect on the growth of *O. karongae.*

Materials and Methods

The study was conducted at Bunda College Fish Farm, Zomba, Malawi. Fingerlings of *O. karongae* were collected from Mangochi about 400 km south of Bunda College. Fingerlings (4-5 g) were stocked in nine 3 m^2 concrete tanks at a rate of 3 fish/m^2. Three diets, using local ingredients purchased from various sources in Malawi, were formulated using a BLP88 computer package. No soybean meal was added to diet 1. In diet 2 fish meal was replaced by soybean and diet 3 did not have any protein source of animal origin i.e. not even bone meal (Table 1). Each diet was supplied to three replicate tanks.

Ingredients were analysed for approximate composition (Table 2), using standard methods for dry matter, crude protein, ether extract, crude fibre and ash content (AOAC 1995).

Fish were fed twice a day at 09:00 and 14:00 hours at 5% body weight, adjusted fortnightly. Feed was made into pellets, crushed into smaller sizes and spread on the water surface slowly by hand. Fish were weighed every 14 days for 10 weeks. The individual fish in each tank were weighed to the nearest 0.01g. using a digital scale.

Data analysis

The growth rate (GR) was determined using linear regression:

$$y_t = a + bx_t$$

where

- y_t is total weight (g) of fish at time t
- a is the average weight (g) of fish at the start of the experiment
- b is growth rate in g/day
- x_t is the number of days at time t

and specific growth rate (SGR):

$$SGR\ (\%) = \frac{\ln(Wt_2) - \ln(Wt_1)}{t_2 - t_1} x100$$

where

Wt_1 and Wt_2 are weights at respective time t_1 and t_2 and the difference of t_2-t_1 is the time duration (in days) considered between W_2 and W_1.

Table 1. Test diets.

Ingredient (%)	Diet 1	Diet 2	Diet 3
Fish meal	5	0	0
Meat and bone meal	5	5	0
Soy bean meal	0	5	10
Cotton seed cake	7.5	7.5	7.5
Sunflower cake	20	20	20
Peanut germ	17	20	20.5
Hominy chop	15.5	12.5	12.0
Maize meal	10	10	10.0
Wheat offal	20	20	20
Diet cost (US$/kg)	0.09	0.08	0.07

The data was subjected to analysis of variance (ANOVA). The following model was used:

$$Y_{ij} = \mu + T_j + e_{ij}$$

where

- Y_{ij} is the response obtained for the jth observation of treatment j;
- μ is the overall mean; T_j is the jth treatment effect; e_{ij} is the random error associated with the ith observation of the jth treatment

To find the cost effectiveness of each of the three diets, a "K" value was obtained by subtracting the total costs of feed from the total revenue from each diet. It was assumed that all other costs (e.g. labour) were constant in each of the diets, and hence the difference in costs is a reflection of how effective the diet was at achieving growth.

Results and Discussion

No significant differences were found in growth rate (GR), specific growth rate (SGR) and feed conversion ratio (FCR) between diets (Table 3).

This may partially be explained by the fact that *O. karongae* is said to prefer feeding on plants such as periphyton growing in marshy areas (Tweddle, 1981) and hence lack of animal protein in the diet did not affect growth. However, Mwanyama (1993) reported that *O. karongae* is both phytophagous and zoophagus, switching from one to the other depending on size and abundance.

A SGR of 2.30 % obtained from formulated diets was close to 2.27% reported for mirror carp (*Cyprinus carpio*) by Msiska et al. (1991) and

Table 2. Source of locally available ingredients and their chemical composition (%).

Ingredients	Source	Dry matter	Crude protein	Ether extract	Crude fibre	Ash
Fish meal	Maldeco Fisheries (Mangochi)	97.3	63.5	11.2	0.9	1.4
Meat & bone meal	Cold Storage (Blantyre)	98.7	55.6	25.3	0.1	14.7
Cotton seed cake	National seed Company (Blantyre)	99.9	19.5	10.4	8.2	3.7
Sunflower	Mbado Enterprise (Blantyre)	98.5	25.3	15.3	22.9	5.3
Maize meal	Grain and Milling Company (Blantyre)	91	9.7	4.9	1.8	1.4
Wheat bran	Grain and Milling Company (Blantyre)	94.2	10.6	4.2	8.9	2.3
Hominy chop	Grain and Milling Company (Blantyre)	95.1	10.6	7.8	3.0	2.3
Peanut germ	Tambala Food Products	95.1	28.3	42.2	5.7	4.9
Soya beans	Afela Moyenda Enterprise (Blantyre)	94.2	52.9	1.4	4.0	6.7

Table 3. Specific growth rate (SGR), growth rate (GR), feed conversion ratio(FCR), yield and "K" value.

Diet	SGR (%)	GR (g/day)	FCR	Yield (t/ha/yr)	"K" (US$)
1	2.10	0.22	2.32	3.44	3455.10
2	2.15	0.23	2.27	3.46	3476.97
3	2.30	0.25	2.03	3.80	3824.38

FCR : dry feed intake/wet weight gain

much higher than earlier values of 0.96 % for *O. karongae* (Maluwa et al. 1995). The former species was introduced into Malawi from Israel in the 1980s but was banned for culture by the Malawi government in 1991 for fear that it might have detrimental effects on the indigenous species if specimens accidentally got into natural water bodies. The results indicate that *O. karongae* does not rely on expensive sources of protein to achieve good growth.

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