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Research Application Summary

The effect of dietary incorporation of cockroach meal as protein source of *Oreochromis shiranus* (Trewavas 1983) diet

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Abstract

A study was conducted at Lilongwe University of Agriculture and Natural Resources Aquaculture farm from 15 February 2018 to 11 May 2018 to determine the effect of dietary incorporation of cockroach meal as protein source in Oreochromis shiranus diets on the growth rate and survival, and their effect on water quality. There was a significant (P<0.05) difference in total weight gain of fish among the treatments. The fish fed on the 25% replacement of soybean meal by cockroach meal resulted in higher weight gain of 24.17±0.98g compared to other treatments. This was followed by the 20% replacement meal (20.94±1.45). The control treatment (soybean meal only as a protein source) resulted in the least weight gain (18.29±1.10 g). The mean apparent feed conversion ratio (AFCR) of 4.2 was recorded in 25% cockroach meal replacement. The mean water pH taken in the morning and in the afternoon ranged from 6.0 to 7.5 and from 6.84 to 6.85, respectively. The dissolved oxygen ranged from 5.96 mgL-1 to 6.26.mgL-1 while ammonia ranged from 0.06 to 0.73 mgL-1 across the treatments. It can be concluded that replacing soybean meal with 25% of cockroach meal is possible for better growth performance of Oreochromis shiranus without affecting the water quality.

Key words: Cockroaches, feed conversion, locally available ingredients, Oreochromis shiranus, protein source, survival

Résumé

Une étude a été menée à la ferme aquacole de l'Université d'Agriculture et des Ressources Naturelles de Lilongwe du 15 février 2018 au 11 mai 2018 afin de déterminer l'effet de l'incorporation alimentaire de tourteau de cafards en tant que source de protéines dans les régimes d'Oreochromis shiranus sur le taux de croissance et la survie, ainsi que leur effet sur la qualité d'eau. Il y avait une différence significative (P <0,05) dans le gain de poids total des poissons entre les traitements. Les poissons nourris au remplacement de 25% du tourteau de soja par le tourteau de cafards ont entraîné un gain de poids plus élevé de 24,17 ± 0,98 g par rapport aux autres traitements. Cela a été suivi de l'alimentation résultant du remplacement à 20% (20,94 ± 1,45). Le traitement témoin (tourteau de soja uniquement comme source de protéines) a entraîné le gain de poids le plus faible

(18,29 ± 1,10 g). Le rapport apparent moyen de conversion alimentaire (RACA) de 4,2 a été enregistré dans 25% de substituts de repas à base de cafards. Le pH moyen de l'eau pris le matin et l'après-midi variait de 6,0 à 7,5 et de 6,84 à 6,85, respectivement. L'oxygène dissous variait de 5,96 mg/l1 à 6,26 mg /l, tandis que l'ammoniac variait de 0,06 à 0,73 mg/l dans les traitements. On peut en conclure que le remplacement de la farine de soja par 25% de la farine de cafards est possible pour améliorer les performances de croissance d'Oreochromis shiranus sans affecter la qualité de l'eau.

Mots clés: cafards, conversion alimentaire, ingrédients disponibles localement, Oreochromis shiranus, source de protéines, survie

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Introduction

Nutrition requirements for growth, reproduction and normal physiological functions of fish are similar to other animals, but fish have much higher requirements for protein than carbohydrates and lipids, so diets with 25 to 45% crude protein are mainly used in fish production. Given that the general aim is a global increase of aquaculture production, there is a need for introduction of different components in feed mixtures and their maximal utilization (Tacon, 2005). Different animal and plant components are used in the production of fish feed. From the nutritional aspects, the components of animal origin mainly fish meal have the best nutritional potential but are expensive and competes with humans, thus affecting fish production. Ingredients of plant origin such as soy bean meal have reasonable prices and are continuously available on the market (Storebakken *et al.,* 2000).

Soya bean meal is the most important feed of plant origin in the feed industry. It is a source of biologically valuable proteins that are very similar in the structure of amino acids to proteins of animal origin (Watanabe, 2002). Insects are natural food sources for fish and have 64 – 65% crude protein (Olaleye, 2015). Cockroaches are some of the common insects with potential of good source of protein for fish. This experiment was conducted to evaluate the effect of dietary incorporation of cockroach meal in the formulated diet as amino acids source on growth performance of *Oreochromis shiranus* with the aim of exploring alternative protein sources.

Materials and methods

Study area. The experiment was conducted from 15 February to 11 May 2018 at Lilongwe University of Agriculture and Natural Resources (LUANAR) fish farm in nine concrete tanks measuring 1.4 m by 1.9 m by 1 m for 84 days. Each tank was stocked with 15 fingerlings with initial average weight ranging from 11.9 to 12.3 g. These fingerlings were sourced from Bunda fish farm. Acclimatization was done for one week before applying treatments. The experimental diets with different levels of cockroach meal were then randomly allocated to each tank.

Feed formulation and source of ingredients. Cockroaches were obtained from the Cockroach Breeding Programme at LUANAR. They were boiled at 105˚C to inactivate harmful bacteria, viruses and other microorganisms like *Escherichia coli* and Coliform but also to preserve them. Then, they were sundried to about 10% moisture content and milled into powder. The feed ingredients were mixed manually and water added to it slowly to form a thick, malleable mixture. Pellets were made using a pellet making machine and then dried. The feed was formulated using Pearson's square at 30% crude protein where cockroach meal replaced soy bean meal at 0%, 20% and 25%. The treatment composition of the diets tested during the experiment was as summarized in Table 1.

Table 1. Percentage (%) ingredients inclusion levels in diets formulated

Parameter	Treatment 1 0% cockroach meal	Treatment 2 20% cockroach meal	Treatment 3 25% cockroach meal
Soy bean	57.52	45.76	39.75
Maize bran	39.97	39.97	39.97
Cockroach meal	-	11.75	17.63
Vitamin premix	0.50	0.50	0.50
Mineral	0.50	0.50	0.50
Binders	1.50	1.50	1.50
Total	100	100	100

Experimental design.The experiment was laid out in a completely randomized design (CRD). The treatments were randomly allocated to experimental units using random numbers. The fingerlings of *Oreochromis shiranus* of mixed sex were stocked in each concrete tank. A sample of 7 fish representing about 50% of the fish stocked in each tank were weighed (g) and measured (mm) using an electric balance and a measuring board containing a fixed ruler on it, respectively. Sampling was done every two weeks. Sampled fish were returned in the tanks soon after taking measurements.

The fish were fed twice a day between 8:00-9:00am and between 15:00-16:00pm at the rate of 5% of the total body weight of the fish. The dry pellets were broadcasted over the water surface of the tank. The amount of feed was adjusted every fortnight according to weight of fish. Tank cleaning was done every two weeks during the time of sampling.

Water quality parameters were also determined. These were dissolved oxygen, ammonia, temperature and pH. Dissolved oxygen and ammonia were analyzed in the laboratory. Thermometer and pH probe were used to collect data on temperature and pH, respectively. These were determined every day at 09:00hours and 14:00hours.

Data collection and analysis. Fish were sampled every two weeks. Seven fish from each tank were caught using the hand net. The body weight and length of each individual fish were measured using an electronic scale and measuring board, respectively. Thereafter growth rate, survival and feed utilization were calculated. The data collected were analyzed using one-way analysis of variance (ANOVA) at a probability level of 5%. Turkey test was further performed where significant

differences occurred among the treatment means. This data analysis was performed using IBM SPSS version 20 software. The ANOVA showed a significant difference when Tukey test was performed. Below is the statistical model that was be used.

$$Yij = \mu + \tau i + \varepsilon ij$$

Where Y = jth observation on ith treatment; μ = overall treatment mean, τi = effect of the ith treatment and εij= error component association with jth unit on the ith treatment.

Results and Discussion

Growth performance of fish. The initial weights of fish did not differ significantly (P<0.05) among the treatment means (Table 2). Significant (P<0.05) differences started showing up during the second week of the study (Figure 1). There was a significant (P<0.05) difference in total weight gain of the fish among the treatments (Table 3). The fish in 25% cockroach meal + maize bran + soya bean showed higher weight gain (24.17±0.98) as compared to other treatments and it was followed by a treatment given 20% cockroach meal + maize bran + soy bean which showed higher weight gain of 20.94±1.45g and then the treatment given maize bran + soya bean which showed the lower gain weight of 18.29±1.10g.

Specific growth rate also differed significantly (P<0.05) among the treatments. The mean specific growth rate was 1.09% day^{-1} for maize bran + soya bean, 1.72% day^{-1} for 20% cockroach meal + maize bran + soya bean and 1.31% day^{-1} for 25% cockroach meal + maize bran + soya bean as illustrated by Table 2 (mean growth gain). This slightly higher growth may be due to higher profile for amino acids which play a remarkable role in the fish's growth. Matanda (2014) also reported a high growth rate of 1.9±2.5 in *Clarias gariepinus* fingerlings fed on cockroaches. Borthakur and Sarma (1998) also reported a high growth rate in *Clarius gariepinus* fingerlings fed insects Significant (P<0.05) differences occurred in apparent feed conversion ratio across the treatments (Table 2).

Table 2. Mean and standard errors for growth parameters, survival rate and AFCR of *O. shiranus*

Parameter	Treatment 1 0% cockroach meal	Treatment 2 20% cockroach meal	Treatment 3 25% cockroach meal
Initial weight (g)	11.88±0.29^{a}	12.34±0.34^{a}	11.92±0.19^{a}
Final weight (g)	30.19±1.14^{a}	33.33±1.3^{ab}	36.24±0.94^{b}
Mean weight gain (g)	18.29±1.10^{a}	20.94±1.45^{ab}	24.17±0.98^{b}
Specific growth rate (%/day)	1.09±0.48^{a}	1.72±0.64^{b}	1.31±0.38^{a}
AFCR	5.28±0.34^{a}	5.07±0.37^{b}	4.18±0.18^{b}
Percentage survival (%)	82.22±1.40^{a}	84.44±0.70^{a}	82.57±0.66^{a}

Note: Means (±SE) in the same row having different superscripts are significantly different (P<0.05). AFCR stands for Apparent Feed Conversion Ratio and SE for Standard Error.

From these results, it was noted that every 4.2 g, 5.1 g and 5.3 g of treatment diets fed to fish produced 1g of fish biomass. This shows that feed utilization in 25% cockroach meal + maize bran + soya bean treatment was relatively better compared to other treatments. These were higher than those reported by De Silva (2001) for fish fed on carefully prepared diets. However, Olaleye (2015) reported a higher feed conversion ratio of 2.14, 2.26, and 2.32 when *Clarias gariepinus* fingerlings were fed on insects as an alternative source of protein. Percent fish survival was high (82 % - 84%) but no significant between treatments (Table 2). The high percentage survival were attributed to favorable conditions for growth.

Water quality parameters. During the experimental period, all water quality parameters were within the required range of growth of the experimental fish (*Oreochromis shiranus*). The water quality parameters were not significantly (P>0.05) different across treatments (Table 3).

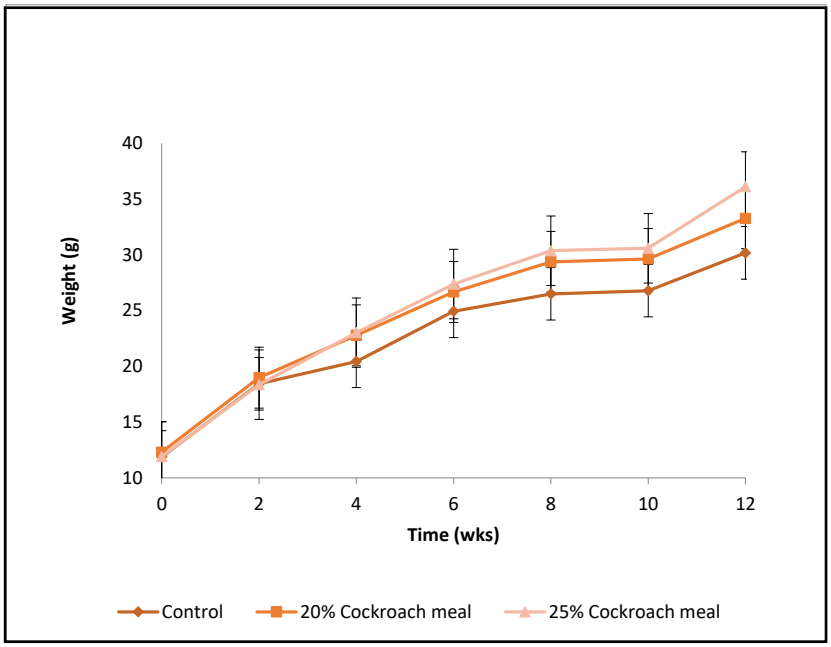

Figure 1. Mean weight (±se) of *Oreochromis shiranus* over the experimental period.

Table 3. Water quality parameters measured in treatment tanks stocked with *O. shiranus*

Parameter	Treatment 1 0% cockroach meal	Treatment 2 20% cockroach meal	Treatment 3 25% cockroach meal
Temp (°C) AM	24.34±0.08	24.32±0.08	24.32±0.07
Temp (°C) PM	27.12±0.06	27.13±0.07	27.23±0.08
Oxygen (mg/L)	6.26±0.19	5.96±0.22	5.74±0.02
pH range AM	6.82±0.02	6.85±0.022	6.80±0.02
pH range PM	6.86±0.02	6.77±0.02	6.84±0.02
Ammonia (mg/L)	0.06±0.01	0.73±0.01	0.07±0.01

Water quality is important in the culture system as it regulates the biology and physiological activities within the body of fish. Water quality should be kept high for good performance (Brummet and Noble, 1995). In this study, water quality parameters across treatments were within the recommended levels for growth of tilapias (*Oreochromis shiranus*) (Balarin, 2006).

Conclusions

The study has demonstrated that incorporating cockroach meal in the fish diet significantly improved growth performance (weight gain and specific growth rate) of *Oreochromis shiranus*. Cockroach meal therefore has potential to make considerable contribution to production of *O. shiranus.*

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