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Original Article

Growth performance of red breasted tilapia (*coptodon rendalli*) fed maize bran and *Amaranthus hybridus* leaves under pond culture

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ABSTRACT: A study was carried out to evaluate the effect of substituting *Amaranthus hybridus* leaves for maize bran as feed on growth of juvenile *Coptodon rendalli*. Fresh chopped *Amaranthus hybridus* (100%) and dried milled maize bran (100%) and mixture of fresh chopped *Amaranthus hybridus* and maize bran (50:50) were given as different dietary treatments. The three diets were fed to triplicate groups of fish fingerlings (9.68±0.16 g) stocked in 100m^2 ponds and fed at 5% of body weight for 84 days. The diets of *Amaranthus hybridus*, maize bran and combination of *Amaranthus hybridus* and maize bran produced insignificantly differences (P>0.05) in final weight gain, where with *Amaranthus hybridus* producing average weights of 33.57 ± 1.15 g, Maize bran with average weights of 31.01 ± 1.05 g and a combination producing average weight of 34.42 ± 1.15g. The Apparent feed conversion ratios and Specific growth rates (SGR) didn’t significantly differ (P>0.05) among the treatments. There were also no significant differences (P>0.05) in total lengths at termination of (84 days) and it ranged from 120.72±0.14 mm to 124.83±0.10 mm whose stocking mean length ranged from 81.55±0.31 mm to 82.87±0.21 mm. Survival rates ranged from 98.70% to 99.96% and didn’t differ significantly (P>0.05) among treatments. These results indicate that the feeding of *Coptodon rendalli* with only *Amaranthus hybridus* or Maize bran or a combination of *Amaranthus hybridus* and Maize bran produce a similar result. The present study demonstrates that in the event that maize bran is unavailable, *Amaranthus hybridus* can substitute it as fish feed or its combination would produce similar results.

Key words: Aquaculture; *Coptodon rendalli*; *Amaranthus hybridus*; Maize bran.
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1. INTRODUCTION

Coptodon rendalli belongs to the genus Tilapia, which are the substrate spawners and guarders of the tilapia family. *Coptodon rendalli* can be identified in the field by the brighter coloration with 5-7 olive vertical bars, having bright red infusion on the throat and breast, especially male and with a distinct black spot on soft dorsal called ‘tilapia spot’ (Skelton, 2001). This fish is commonly described as the red-breasted tilapia. *C. rendalli* is indigenous and found in almost all water bodies of Malawi and is also cultured in Malawi (McMurtrie et al., 2022).

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Amaranthus hybridus leaves, popularly called "Amaranth or pigweed" is an annual herbaceous plant of 1- 6 feet high. The leaves are alternate petioled, 3 – 6 inches long, dull green, and rough, hairy, ovate or rhombic with wavy margins (Adhikary and Pratt, 2015). It is rather a common species in waste places, cultivated fields and barnyards (Yarger, 2008). Available data indicate that the plant is rich in vitamins and micro-elements required by human body to grow, develop and prevent malnutrition, disorders and diseases, hence it been used as relish in the diets (National Academy of Sciences, 2006). Ngugi et al., 2017 evaluated the nutritional characteristics and suitability of replacing FM with the amaranth (*Amaranthus hybridus*) leaf protein concentrates (ALPC) as a protein ingredient in the diet of Nile tilapia (*Oreochromis niloticus*). They demonstrate that it is possible to replace up to 80% of fish meal with ALPC without compromising the performance of *O. niloticus*. Moreover, they affirmed that although it is possible to replace a large part of fish meal with ALPC; it is not possible to eliminate it in Nile tilapia diet as an alternative protein ingredient. Maize bran is by far the most common fishpond input in Malawi (Masuda *et al*., 2004). A survey conducted on 50 fish farmers in southern region, 84% of farmers were using maize bran for feeding fish (Masuda *et al*., 2004). Maize bran is a byproduct of dry milling maize kernels when processing into maize flour. The nutritional value of maize bran varies depending on the milling process. The maize kernel is composed of four different components; husk, starch, germ, and pedicle. The main purpose of milling is to separate the starch from the kernel and grind it into flour, which is used to prepare thick porridge, the preferred staple food for Malawians (Masuda et al., 2004). Liti et al. (2006) illustrated that when Nile tilapia (*Oreochromis niloticus* L.) were fed with rice bran (RB), wheat bran (WB) and maize bran (MB) at 1.5% body weight, the results revealed that MB treatment produced the highest growth. This work aimed to evaluate the effect of substituting *Amaranthus hybridus* leaves for maize bran as feed on growth and Net yield of juvenile *Coptodon rendalli*

2. **Materials AND METHODS**

2.1 Study area

The experiment was carried out at Lilongwe University of Agriculture and Natural Resources, fish farm, in Lilongwe, Malawi, for a period of eighty-four days. Nine earthen ponds with an area of 100 m^2 each were used in the experiment. The fish ponds were filled with water from a nearby water reservoir.

2.2.Experimental layout and treatment

The experiment was designed in a Completely Randomized Design (CRB) consisting of three treatments and replicated three times. Treatment 1 was *Amaranthus hybridus*, Treatment 2 was a control treatment with maize bran and Treatment 3 was a combination of *Amaranthus hybridus* and maize bran. The treatments were randomly assigned to the ponds. Nine earthen ponds measuring 100m2 and 1.5m in depth were used during the experimental study.

2.3. Pond preparation

The ponds were drained and allowed to dry for two weeks in order to get lead of aquatic organisms that may compromise the growth of the fish. All weeds were removed from the ponds before stocking to avoid excessive growth of aquatic weeds that would interfere with the natural production of food in the ponds. The removal of aquatic vegetation continued throughout the culture period and most common ones were pond weeds such as *Potamogeton ochreatus, P. crisspus, Maidema lubra,* and *Canna indica.*

2.4. Fertilization regime

The ponds were fertilized with chicken manure two weeks before the fish were stocked to ensure that production of plankton occur at an application rate of 10,000 kg/ ha/ yr. (Das *et al*., 2020).

2.5. Stocking of fish

Juvenile *Tilapia rendalli* of mixed sex with an average weight of 9.73±0.16 g and the total length of 81.55±0.56 mm were collected from breeding ponds using a seine net at Bunda fish farm. They were then kept in a large tank for a week's acclimatation period to make sure the fish are healthy before stocking. After acclimation, the fish were selected at random and stocked in each pond at the rate of 2 fish/m^2. *C rendalli* were maintained in nine earthen ponds each measuring 100m^2 and the ponds were supplied with fresh water from the nearby dam. Fish were into 9 groups (three replicates), with each pond holding 200 fish.

2.6.. Feeding regimes

The experiment continued for 84 days and the feeding rate was at 5% of the body weight per day adjusted after two weeks during sampling. The fish were fed twice per day (9 a.m. and at 2 p.m.).

2.7. Biochemical analysis of *Amaranthus hybridus* and Maize bran

Proximate analysis of *Amaranthus hybridus* and maize meal was performed for moisture, crude protein, crude fibre, ash and gross energy.The *Amaranthus* was analyzed before feeding it to the fish to determine its nutrient content (Table, 1).

Maize bran nutrient content was analyzed before feeding it to the fish (Table 2).

Table 1. Proximate composition of *Amaranthus hybridus* fed to *Coptodon rendalli* in ponds

Parameter	Concentration (% DW)
Crude protein	18.41
Crude fat	4.42
Crude fibre	7.98
Ash	14.2
Moisture	81.64
Gross energy (kJ/g)	10.71

Table 2 Proximate analysis of Maize bran fed to *T. rendalli* in ponds.

Parameter	Concentration (% DW)
Crude protein	12.6
Crude fat	9.8
Crude fibre	3.52
Dry matter	92.82
Ash	3.42
Gross energy (kJ/g)	18.24

2.8. Determination of fish growth performance

Mean weight of individual fish was determined at stocking and twenty (20) fish were randomly sampled from each pond every three weeks using a seine net to determine the growth rate. Weight (g) of each fish was measured using a digital scale and total length (cm) was measured using a vernier caliper. Mortality was recorded daily to monitor survival of the fish throughout the experimentation period.

Growth performance parameters of the harvested fish were calculated as outlined by Kang'ombe *et al*. (2007).

- Weight gain (WG, g) = final weight (g) – initial weight (g);
- Average weight gain/day = weight gain (g) / time (days);

- % Increase in mean weight = [(final mean weight – initial mean weight)/initial mean weight)] × 100
- Specific growth rate (SGR, % day^{-1}) = 100 x (ln final weight (g) – ln initial weight (g))/ time (days)
- Survival rate (%) = 100 x (initial number of fish - number of dead fish)/Initial number of fish.
- Apparent feed conversion ratio (AFCR) = Weight of food consumed by fish / Increase in weight of fish produced.
- Gross yield of fish/ha = harvested fish weight (kg)/unit area (ha)
- Net yield of fish/ha = (harvested fish weight – initial fish weight)/unit area (ha)

2.9. Determination of water quality parameters

At the beginning of the experiment, temperature, dissolved oxygen, turbidity and pH were checked using a multi-probe water checker (Horiba NTU, Tokyo, Japan). Alkalinity and ammonia were determined before application of chicken manure (Lind, 1985). This was done basically to ensure that water quality is maintained at levels that could not compromise growth of cultured fish (Boyd, 2010).

2.10. Data analysis

Analysis of Variance (ANOVA) was performed to test the hypothesis for any significant differences at alpha level (0.05). Data computation and analysis was performed using Excel and Scientific Package for Social Scientist (SPSS), using a Completely Randomized Design using the following statistical model:

$Yij=\mu+ \tau_i +\varepsilon ij$

Where:

Yij = j^{th} observation on i^{th} treatment

μ = overall mean

τ_i = effect of i^{th} treatment

εij = error associated with the j^{th} on i^{th} treatment

3. RESULTS

3.1 Growth performance of *Coptodon rendalli* juveniles

Results of growth of *C. rendalli* in the three treatments are presented in Table 3.

Table 3 Growth performance parameters of *Tilapia rendalli* in ponds fertilized with chicken manure and fed different supplementary diets (Mean ± SE)

Parameter	*Amaranthus hybridus*	Maize bran	*Amaranthus hybridus* and maize bran
Initial weight (g)	9.73 ± 0.16	9.94 ± 0.15	9.68 ± 0.09
Final wei ghts (g)	33.57 ± 1.15	31.01 ± 1.05	34.42 ± 1.15
Total weight gain (g)	23.84 ± 4.37	21.07 ± 3.65	24.74 ± 4.32
Weight gain/day	0.28 ± 0.05	0.25 ± 0.04	0.29 ± 0.05
Weight increase (%)	171.12 ± 22.99	156.43 ± 16.5	176.75 ± 21.85
SGR (%/day^{-1})	1.99 ± 0.27	2.02 ± 0.27	2.16 ± 0.19
FCR	1.73 ± 0.21	1.78 ± 0.21	1.48 ± 0.08
Survival (%)	99.96 ± 0.04	98.71 ± 0.74	99.58 ± 0.37
Gross yield (kg/ha)	526.31 ± 44.56	509.29 ± 32.70	330.72 ± 40.15
Net yield (kg/ha)	331.83 ± 44.61	310.56 ± 32.84	330.72 ± 40.15

Note: *Values in rows are not significantly different* (*P*>0.05)

Total length of *T. rendalli* ranged from 120.72 mm to 124.83 mm among treatments and did not differ significantly (*P>0.05*) among treatments. No significant difference (*P*>0.05) was recorded in the mean final weight, total weight gain, weight gain/day, weight increase (%), SGR (%/day^{-1}), FCR, survival (%), gross yield (kg/ha) and net yield (kg/ha) among the treatments (Table 3).

3.2. Water quality parameters

Water quality parameters measured during the experimental periods were within the range for growth of *Coptodon rendalli* in ponds (Table. 4).

Table 4 Water quality parameters measured in treatment ponds fertilized with chicken manure and supplied with different supplementary diets and stocked with *Coptodon rendalli*

Parameter	*Amaranthus hybridus*	Maize bran	*Amaranthus hybridus* + maize bran
Temp (^{o}C)	26.99 ± 0.12	26.70 ± 0.15	26.99 ± 0.12
Oxygen (mg/L)	2.84 ± 0.02	2.87 ± 0.02	2.85 ± 0.02
pH	9.12 ± 0.10	9.50 ± 0.09	9.39 ± 3.80
Turbidity NTU	146.10 ± 2.98^{a}	101.2 ± 1.66^{b}	130.97 ± 2.55^{c}
Ammonia (NH_3, mg/L)	0.010 ± 0.02	0.010 ± 0.02	0.010 ± 0.00
Alkalinity (mg/L)	98.20 ± 0.91	97.4 ± 0.80	97.467 ± 0.78

Note: *Mean values with different superscripts are significantly different (P<0.05)*

During the experimental period, the mean water temperature ranged from 26.70 to 26.99^{o}C among the treatments, which did not differ significantly (*P*>0.05) from each other. The pH ranged from 9.12 to 9.50 and did not significantly differ (*P*>0.05) from each other. Mean dissolved oxygen (DO) ranged from 2.28 to 2.87mg L^{-1} and did not significantly differ (*P*>0.05) from each treatment. Total alkalinity ranged from 97.4 to 98.2 mg L^{-1}, with a maximum mean in Treatment 1 (98.2 mg L^{-1}) followed by Treatment 3 (97.47 mg L^{-1}) and then Treatment 2 (97.4 mg L^{-1}). The control (Treatment. 2) had the lowest total alkalinity. Treatments did not differ significantly (*P*>0.05) in the levels of alkalinity. There was no significant difference (*P*>0.05) in ammonia levels from the start of the experiment up to termination among the treatments. However, turbidity ranged from 110.12 to 146.10 and significantly differed (*P*<0.05) from each treatment (Table. 4).

4.DISCUSSION

There were no significant differences (*P>0.05*) between the growths (weight gain) of fingerlings fed on diets containing *Amaranthus hybridus*, maize bran and a combination of *Amaranthus hybridus* and maize bran in ponds fertilized with chicken manure. the means of SGR in this study was in the same range with those reported by Kang'ombe et al. (2007) for *C. rendalli* (1.87% day^{-1}) raised in ponds fertilized with chicken manure and fed on maize bran. Survival of the fish was generally high in all the treatments and did not differ significantly (*P>0.05*) from each other.

The high survival rates observed may have resulted from the good acceptability of the feed by the fish. This means that tilapias can thrive on *Amaranthus hybridus* as on maize bran. The survival rates in this study were higher than those reported by Kang'ombe *et al.* (2007) for *Coptodon rendalli* in concrete ponds fertilized with chicken manure supplemented with maize bran. The feed conversion ratio (FCR) recorded was in the range which was obtained by Kang'ombe et al., (2007) for *C. rendalli* (1.64 day-1) which increased in the fertilized ponds with chicken manure and fed on maize bran. The gross and net yields among the treatments were within the range of yields reported by Kang'ombe *et al*. (2007) of *Coptodon rendalli* raised in ponds fertilized with chicken manure and fed on maize bran. In this study based on treatments, average temperatures (26.70 ^{o}C to 26.99 ^{o}C) were within the recommended range for tilapia growth and high yield (Lucas & Southgate, 2003). Josiah *et al*. (2014) also observed that the optimum range for growth and food conversion was 21- 28^{o}C. Although the levels of DO in the morning were below 5.0 mg L^{-1} among the treatments, SGR was higher because the levels were still above 1 mg L^{-1} considered critical (Popma & Masser, 1999). Tilapia has a low oxygen demand and can survive low oxygen levels (Siddiqui, *et al*., 1989). The means of DO were within the optimum limits for tilapia species (Ridha and Cruz, 2000). The pH ranged from 8.12 – 9.50 among all the treatments and the pH range in this study was ideal and was within the recommended range between 6.7 and 9.5 (Santhosh and Singh (2007). Bryan et al. (2011) recommended that, most fish species does better in ponds with a pH near 7.0 and that ponds with a pH less than 6.0 may result in stunting or reduced fish production.

The levels of ammonia were generally low because some NH_3 were used up by algae and other aquatic plants as a nitrogen source for protein synthesis. In earthen ponds, ammonia is not a problem as it is quickly used by phytoplankton and aquatic macrophysics (Knud-Hansen, 1998). Levels of un-ionized ammonia (NH_3) around 1.0 mg L^{-1} are considered toxic to fish and ionized ammonia (NH_4^+) values ranging from 0.2 to 2 mg L^{-1} are considered favorable for fresh water fish (Barker *et al*., 2003). In this study, NH_3 was ideal for propagation of plankton and growth of fish, and was within the range as reported by (Brummett, 2000). There was a decrease in total alkalinity in all the treatments, which could be attributed to the uptake of HCO_3 by phytoplankton and competition for carbonates and carbon by snails, which were observed in all the treatments. The snails incorporate calcium carbonates in their shells there by lowering total alkalinity of water (Knud-Hansen, 1998). However, total alkalinity in this study was within the recommended range of 50 to 300 mg $CaCO_3$ L^{-1} (Boyd *al.*, 2016).

5. CONCLUSION

As indicated by this research, there were no significant differences in the overall performance of *Amaranthus hybridus* and maize bran-based supplements on the growth performance of *Coptodon rendalli*. *Amaranthus hybridus* has demonstrated that it can be combined with maize bran to produce a supplement feed that can improve growth than using maize bran or *Amaranthus hybridus* exclusively in ponds fertilized with chicken manure. The use of Amaranthus can be promoted in fish farming to reduce the production cost. This is because it is normally treated as weed by many farmers in their fields. Amaranthus is very much available in rainy season at a time when maize bran becomes scarce due to human use as food in this lean season, hence can reduce competition. Therefore, *Amaranthus hybridus* can substitute maize bran as a supplement feed especially that maize bran cost is high as compared to *Amaranthus hybridus* which is available all year round and can easily be cultivated.

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