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RESEARCH PAPER

Dietary Effect of *Corchorus olitorius* Seeds on Growth Performance of *Oreochromis niloticus* Fingerlings

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Abstract

Incorporating feed additives in diets of cultured fish is aimed at improving growth performance, immunity and carcass quality. Growth performance and some haematological parameters of *Oreochromis niloticus* fingerlings fed varying inclusion levels of *Corchorus olitorius* seeds were assessed in the study. *O. niloticus* fingerlings of initial mean weight 9.35±0.01g were evaluated for a period of 56 days. Five experimental diets were formulated at varying inclusion levels; 0g/100g (control), 0.5g/100g, 1.0g/100g, 1.5g/100g and 2.0g/100g of *C. olitorius* seeds. All diets were iso-nitrogenous with each treatment having triplicates. *O. niloticus* fingerlings fed 1.5g/100g diet of *C. olitorius* recorded the best growth performance in terms of weight gain, feed conversion ratio (FCR) and specific growth rate (SGR). There was a significant increase in growth and nutritional performance of *O. niloticus* fingerlings with increasing inclusion of *C. olitorius* seeds (P<0.05). Significant increase in packed cell volume, white blood cell and haemoglobin were observed in treated *O. niloticus* fingerlings and there was no adverse effect of *C. olitorius* seeds on the haematological parameters of the fish. The study showed that *C. olitorius* seed at 1.5g/100g significantly improved survival rate, weight gain and feed conversion ratio as well as reduced mortalities in the treated groups.

Introduction

In recent times, there has been a recurring problem of qualitative and affordable supply of livestock feeds which is directly related to the rising cost of conventional feedstuff which are in short supply and unavailable leading to higher cost of livestock products (Sarkiyay, 2010). In fish culture systems, feeding accounts for about 40 % - 60 % of production costs (NRC 1993; Fagbenro *et al.*, 2003) and the viability of a fish farm is largely dependent on the use of suitable feed. Feed additives as natural growth promoters are extensively researched in aquaculture because they are considered to be ecologically safer alternative to their synthetic counterparts (Isman, 2006) Medicinal plants as natural growth enhancers have been reported to significantly improve body weight, survival and feed conversion rates in fish (El Dakar, 2004; Shalaby, 2004). Feed additives in diets of cultured fish are being exploited with the aim of improving fish performance, immunity and carcass quality. A continuous search for new feed additives is therefore important for researchers in aquaculture (Cho and Lee, 2012).

The Nile tilapia (*Oreochromis niloticus*) belongs to the family Cichlidae and are widely cultivated for their ability to efficiently use natural aquatic foods, propensity to consume a variety of supplementary feeds, omnivorous food habits, resistance to diseases and handling, ease of reproduction in captivity, and tolerance to wide ranges of environmental conditions (Fagbenro, 1987). *O. niloticus* has high reproductive and growth rate, relatively disease free, scaly and hardy in nature (Satya and Timothy, 2004). Tilapia culture is widely practiced in Nigeria and contributes to food security, poverty alleviation, employment, trade and income generation (Omotosho and Fagbenro, 2005).

Corchorus olitorius belongs to the genus of about 40-100 species of flowering plant belonging to the family tiliaceae. *C. olitorious* is also known as long-fruited jute, tossa jute, jute mallow and Jew's mallow. In Nigeria, the plant is locally called Ahihara by the Igbo, Ewedu by the Yoruba and Malafiya by the Hausa (Ogunkanmi *et al.,* 2010). It is an erect, annual herb growing up to 3.5 m, an abundant agricultural product and a potential alternate feed ingredient (Tindall, 1993). It contains about 16% Crude Protein (Ndlovu and Afolayan, 2008). The leaves are widely used as a leafy vegetable in many Asian, African and European countries (Furumuto *et al*., 2002; Zeghichi *et al*., 2003). The leaves are demulcent, diuretic, febrifuge and also serve as tonic. The leaves have got attention from food and medical industry (Oyedele *et al*., 2006; Dewanjee *et al*., 2013). *C. olitorius* leaves have been reported to be very effective in the treatment of skin diseases such as measles and rashes (Mowobi *et al*., 2016).

Aqueous extracts of the seeds of *C. olitorious* have been reported to possess peripheral, anti-inflammatory and anti-pyretic activities (Zakaria *et al,* 2006) while antibacterial activities have also been reported from its methanolic extracts (Pal *et al*., 2006). There has also been reports by Ibrahim and Fagbohun (2011) that the seed oil of *C. olitorius* possess antimicrobial properties and can potentially be used as a food preservative as well as for medicinal purposes. Oloye *et al.,* (2014) observed that *C. olitorious* seeds have largely been neglected and wasted and are primarily used for propagation. Adebooye *et al.* (2005) observed that wasting of *C. olitorius* seeds can arise as a result of the practice of leaving fruits on the plant for too long, such that some fully ripe inflorescences burst and shed their seeds. The wastage of *C. olitorius* seeds in the process of harvesting the leaves may be due to lack of popular knowledge about the nutritional content of the seeds as well as a lack of research interest (Isuosuo *et al*., 2019).

There is a dearth of information on the use of *Corchorus olitorius* in the diet of *O. niloticus*. This necessitated the present research to evaluate the effect of *C. olitorius* seed on growth, nutrient utilization and hematological parameters of *O. niloticus* fingerlings.

Materials and Methods

Formulation of Experimental Diet

Dried seeds of *Corchorus olitorius* were purchased from a local market, Oja-Oba in Akure, Ondo state, Nigeria. Identification and authentication of the seeds were done at the Department of Crop, Soil and Pest Management, Federal University of Technology Akure. The seeds were reduced to powdery form using Kenwood electric blender BL440 (UK). Amounts of 0 (control), 0.5, 1.0, 1.5 and 2.0g of *C. olitorius* seed powder per 100g of feed were taken and mixed with a basal diet (30% Crude protein), containing fish meal, yellow maize, soybean meal, fish oil, vegetable oil, vitamin premix and binder (starch). All dietary ingredients were milled. The ingredients were thoroughly mixed in a Hobart A-2007 (Hobart Ltd, London, UK) pelleting and mixing machine to obtain a homogeneous mass. The resultant mash was pressed without steam through a mixer with 2mm diameter die attached to the Hobart pelleting machine. The pellets produced were dried at ambient temperature (27-30^{0}C), broken up, sieved and kept in a cool and dry place until the start of the feeding experiment (Table 1).

Table 1. Gross Composition of Experimental Diets Expressed in g/100g.

	EXPERIMENTAL DIETS				
Ingredients	CTR	T1	T2	T3	T4
Fish meal (72%)	15	15	15	15	15
Yellow maize (10%)	25	25	25	25	25
Soyabean meal (42%)	45	45	45	45	45
Fish oil	4	4	4	4	4
Vegetable oil	6	6	6	6	6
Vitamin premix*	3	3	3	3	3
Binder (Starch)	2	2	2	2	2
Corchorus olitorius seeds	0	0.5	1.0	1.5	2.0
Proximate composition (%)					
Fish meal (72%)	15	15	15	15	15
Yellow maize (10%)	25	25	25	25	25
Soyabean meal (42%)	45	45	45	45	45
Fish oil	4	4	4	4	4
Vegetable oil	6	6	6	6	6
Vitamin premix*	3	3	3	3	3

Vitamin Premix content: Vitamin A 4,000,000IU, Vitamin D3 800,000IU, Vitamin K3 1,600mg, Vitamin B1 4,000mg, Vitamin B2 3,000mg, Vitamin B6 3,800mg, Vitamin B12 3mcg, Nicotonic acid 18,000mg, Pantothenic acid 8,000mg, Folic acid 800mg, Biotin 100mcg, Choline chloride 120,000mg, Iron 8,000mg, Copper 800mg, Manganese 6,000mg, Zinc 8,000mg, Iodine 400mg, Selenium 40mcg, Vitamin C(coated) 60,000mg, Inositol 10,000mg, Cobalt 150mg, Lysine 10,000mg, Methionine 10,000mg and Antioxidant 25,000mg.

Experimental Procedure

This study was carried out in fifteen plastic tanks (40 ×30×35cm^3) at the Teaching and Research Laboratory of the Department of Fisheries and Aquaculture Technology, Federal University of Technology, Akure. The experiment consists of five dietary treatments (CTR, T1, T2, T3 and T4) set up in triplicates at a stocking density of ten fish per tank. Fish were fed 5% body weight twice daily (between 08:00-09:00hr and 16:00-17:00hrs). All fish were batch-weighed fortnightly and feeding rates adjusted accordingly. The experiment lasted for 56 days. At the end of the feeding experiment, the following growth and nutrient utilization parameters were determined;

Weight Gain =final weight of fish-the initial weight of fish

$$\text{Percentage Weight Gain} = \frac{\text{Final mean weight of fish}}{\text{Initial mean weight of fish}} \times 100$$

$$Specific\ Growth\ Rate = \frac{100\left(\ln W_2 - \ln W_1\right)}{t}$$

Where; W_1 and W_2 are the initial and final fish weight, respectively, and t represents the duration of the feeding trial.

$$\text{Percentage survival} = N_1 / N_0 \times 100$$

Where: N_1 = Total number of fish survival in pond at end of experiments.

N_0 = Total number of fish in tank at the beginning of experiments.

$$\text{Feed Conversion Ratio} = \frac{\text{dry weight of feed intake (g)}}{\text{Wet weight gain by fish (g)}}$$

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Weight gain (g)}}{\text{Protein fed (g)}}$$

Haematological assessment was carried out on *O. niloticus* fed *C. olitorius* supplemented diets. Blood samples were collected through the vertebral blood vessels towards the caudal peduncle. Separate heparinized syringes treated with ethylene-diamine-acetic acid (EDTA) were used for each fish. Blood samples were collected in urinalysis bottles and taken to the Central Research Laboratory, FUTA for analyses using the methods described by Svobodova *et al*., (1991). Blood indices that were analysed are:

Red Blood Cells Count (RBC)

Haemocytometer was used in blood cell counts. Counting of the blood cells was done in the counting chamber of the haematocytometer with the aid of compound microscope and was calculated as;

RBC (Erythrocyte count)=No. of cells countedx5x10x 200 (10^6mm^3)

Haemoglobin Estimation (Hb)

Haemoglobinometer was used for Haemoglobin estimation

$$\text{Haemoglobin} = \frac{\text{Value obtained}}{100} \times 17.2\text{(gm/100ml)}$$

Mean Cell Haemoglobin Concentration (MCHC)

This was calculated by dividing the haemoglobin content in g/100ml using PCV/100 litre of red blood according to the formula:

$$\text{MCHC (g/dl)} = \frac{\text{Hb}}{\text{PCV}} \times 100$$

Mean Corpuscular Haemoglobin (MCH)

MCH was calculated from haemoglobin value (Hb) and the erythrocyte (Er); expressed in picogramme (pg)

$$\text{MCH} = \frac{\text{Hb}}{\text{RBC}} \times 10$$

Mean Corpuscular Volume (MCV)

This was calculated from the haematocrit value (PCV) % and erythrocyte (Er) 10^6/mm^3 and its being expressed in flowlitre (*fl*).

$$\text{MCV} = \frac{\text{PCV}}{\text{RBC}} \times 10$$

Packed Cell Volume (PCV) (Haematocrit)

The PCV was determined by using micro-haematocrit reader and expressed in percentage (%).

Total Leucocyte Count (TLC) or White Blood Cells

This was calculated according to the method described by Dacie and Lewis (1991)

TLC= Total number of cells in large squares x 500 (mm^3) of blood. Its expressed in cubic millimeter (mm^3).

Proximate Analyses of *C. olitorius* seeds as well as experimental diets and fish were as described by AOAC (2005).

Water quality parameters during the experiment varied as follows; dissolved oxygen, 4.93 – 6.03mg/l; temperature 26.73 – 27.10^{o}C and pH 6.63 – 6.72. These water quality parameters are within the recommended ranges for *O. niloticus* (Viveen *et al.,* 1986).

Statistical Analysis

The effect of *C. olitorius* on growth and nutrient utilization as well as haematological parameters of *O. niloticus* were analysed using one-way analysis of variance and significant differences among treatments were compared using Duncan Multiple Range Test.

Results and Discussions

The proximate composition of *C. olitorius* seeds is presented in Table 2. *Corchorus olitorius* seeds have a Crude Protein content of 19.27±0.24%, Crude fibre of 9.13±0.49%, Ash of 7.05±0.13%, Moisture content of 3.06±0.11% and Fat content of 16.76±0.31%. The result for crude protein of *C. olitorius* seeds in this study is lower than that reported by Oloye *et al.,* (2014) for wild seeds of *C. olitorius*. This suggests that *C. olitorius* seeds can be used as an additive in fish diets.

The present study showed an improvement in growth and feed utilization parameters for all fish groups fed *C. olitorius* seed powder at all levels. This indicates that the inclusion of *C. olitorius* seed powder in the experimental diets improved the fish growth positively.

Significantly highest weight gain, specific growth rate, survival as well as the best FCR were observed in fish group fed diet containing 1.5g/100g *C. olitorius* seed powder (T4) while the least values for weight gain, SGR and the poorest FCR were recorded in fish fed control diet (T1). These results agree with those reported by Dada *et al*., (2019) in *C. gariepinus* fed diets supplemented with *C. olitorious* seed powder. Similar results were also reported by Afe *et al.,* (2019) in *Heterobranchus bidorsalis* fed dietary *Ocimum gratissimum* leaf powder. Dada and Abiodun (2014) also reported similar result in *Oreochromis niloticus* fingerlings fed dietary fluted pumpkin (*Telfaria occidentalis*) extract which showed significantly improved growth performance and feed utilization indices over the control group. The reports of Turan (2006) also align with those of the present study when *Trifolium pratense* was used as a growth-promoter in the diet of *Oreochromis aureus*. This study showed that *C. olitorious* supplementation in the diets of *O. niloticus* generally enhances nutrient utilization, as reflected by the improvements in weight gain, food conversion ratio, specific growth rate and protein efficiency ratio. This suggests that supplementation of fish diets with *C. olitorious* optimized protein use for the growth which can decrease the quantity of feed necessary for fish growth and hence, production costs.

The proximate composition of the experimental fish prior to feeding is presented in Table 4. *O. niloticus* fingerlings used in the experiment has a crude protein content of 52.15±0.03%, ash content of 29.97±0.15% and fat content of 5.27±0.15%. The proximate composition of the experimental fish fed the experimental diets is presented in Table 4. Significantly higher values (P≤0.05) were observed for crude protein in fish fed *C. olitorius* seeds supplemented diets over the control group (T1). The highest protein content 59.33±0.13% was recorded in fish fed diet containing 1.0g/100g *C. olitorius* seeds (T3) while the lowest protein content (57.58±0.01%) was recorded in fish fed control diet (T1). The highest ash content (23.03±0.01%) was recorded in fish fed control diet (T1) and the lowest ash content (20.32±0.02%) was recorded for fish fed 1.0g/100g of *C. olitorius* seed supplemented diet (T3). Crude lipid was found to be highest (16.01±0.01%) in fish

Table 2. Proximate compositions of *Corchorus olitorius* seeds

Parameters	Percentage composition (%)
Moisture content	3.06±0.11
Ash	7.05±0.13
Crude lipid	16.76±0.31
Crude fibre	9.13±0.49
Crude protein	19.27±0.24
NFE	44.73±0.72

NFE: Nitrogen free extract

Table 3. Growth Performance and Feed Utilization of *O. niloticus* Fingerlings Fed with Experimental Diets

	TREATMENT				
Parameters	T1	T2	T3	T4	T5
Initial mean weight(g)	9.35±0.01	9.35±0.00	9.35±0.01	9.35±0.00	9.35±0.01
Final mean weight (g)	12.73±0.01[a]	12.82±0.01[a]	13.57±0.02[b]	14.30±0.01[c]	13.46±0.04[b]
Mean weight gain (g)	3.38±0.01[a]	3.47±0.01[a]	4.23±0.01[b]	4.95±0.01[c]	4.11±0.03[b]
SGR (%)	0.55 ±0.00[a]	0.56 ±0.00[a]	0.67 ±0.00[b]	0.76±0.00[c]	0.65±0.01[b]
FCR	1.40±0.00[b]	1.40±0.00[b]	1.35±0.00[a]	1.32±0.00[a]	1.40±0.00[b]
PER	0.61±0.00[a]	0.64±0.00[b]	0.76±0.00[d]	0.86±0.00[e]	0.73±0.01[c]
Survival (%)	86.45±0.22[ab]	84.22±0.22[ab]	86.67±0.00[b]	89.67±0.85[b]	79.78±0.22[a]

SGR = Specific growth rate, FCR = Feed conversion ratio and PER = Protein efficiency ratio. Figures on the same row having the same superscripts are not significantly different (P>0.05)

Table 4. Proximate Composition of the Experimental Fish Fed *C. olitorius* Supplemented Diets (on dry matter basis)

	TREATMENTS					
Parameters	Initial	T1	T2	T3	T4	T5
Moisture	6.50 ±0.17	4.86±0.04^{b}	4.87±0.04^{b}	4.02±0.01^{c}	3.41±0.01^{d}	5.03±0.01^{a}
Ash	29.97±0.15	23.03±0.01^{d}	22.99±0.01^{d}	20.32±0.02^{a}	21.29±0.01^{b}	21.97±0.01^{c}
Crude lipid	5.27±0.15	14.30±0.02^{a}	14.06±0.03^{a}	16.01±0.01^{b}	16.01±0.01^{b}	14.31±0.01^{a}
Crude protein	52.15±0.03	57.58±0.01^{a}	57.96±0.06^{b}	59.33±0.13^{c}	59.20±0.14^{c}	58.15±0.01^{b}
NFE	6.12±0.32	0.23±0.07^{ab}	0.12±0.02^{a}	0.32±0.15^{ab}	0.43±0.20^{ab}	0.54±0.04^{b}

NFE: Nitrogen free extract.
Figures on the same row having the same superscripts are not significantly different (P>0.05)

Table 5. Some Haematological Parameters of *O. niltoticus* Fingerlings fed *C. olitorious* Seed supplemented Diets

	TREATMENT				
Parameters	T1	T2	T3	T4	T5
PCV (%)	24.00±0.12^{a}	24.20±0.17^{b}	24.27±0.12^{b}	25.20±0.12^{c}	24.23±0.15^{b}
HB (g/dl)	8.03±0.09^{a}	8.17±0.09^{b}	8.20±0.09^{cb}	8.33±0.09^{c}	8.13±0.09^{ab}
WBCx10^{3} (mm^{3})	7.20±0.12^{b}	8.40±0.12^{c}	8.13±0.09c	8.90±0.06^{d}	6.20±0.06^{a}
RBC x10^{6}(mm^{3})	2.65±0.00^{a}	2.75±0.00^{c}	2.75±0.00^{c}	2.75±0.00^{c}	2.68±0.02^{b}
MCV (fl)	90.57±0.44^{a}	88.00±0.68^{a}	88.25±0.57^{a}	91.63±0.42^{a}	90.32±1.09^{a}
MCHC (pg)	33.47±0.29^{a}	33.76±0.52^{a}	33.78±0.34^{a}	33.07±0.47^{a}	33.57±0.56^{a}
MCH (%)	30.31±0.33^{a}	30.32±0.35^{a}	29.93±0.35^{a}	30.30±0.32^{a}	30.31±0.22^{a}

Means in a given column with the same superscript letter were not significantly different at P<0.05.
Keys: PCV=Packed Cell Volume, Hb=Haemoglobin Estimation, WBC=White Blood Cell Count, RBC=Red Blood Cell Count

fed fed 1.0g/100g and 1.5g/100g *C. olitorius* seed supplemented diets (T3 and T4). respectively. The significant increase observed in crude lipid and crude protein contents of fish fed diets containing *C. olitorius* seed powder in this study suggests improvements in protein synthesis attributable to the presence of *C. olitorious* seed powder in the diet.

The haematological parameters of *O. niltoticus* (Table 5) showed significant differences (P≤0.05) in packed cell volume (PCV), red blood cell (RBC), haemoglobin (Hb) and white blood cells (WBC) concentrations in all the treatments. The PCV of 24.00 - 25.20% falls within the range of 20 – 50% reported by Pietse *et al.* (1981). This agrees with the reports of Adegbesan *et al*. 2018 where significantly higher of heamatological parameters were observed in *Clarias gariepinus* fed *Aloe barbadensis* leaf diets. The increment observed in WBC in fish fed 1.0 -1.5g/100g *C. olitorious* diet could indicate increased production of leucocytes in the liver tissues (Adegbesan *et al.*, 2018). The range of RBC (2.65-2.75 x10^{6}mm^{3}) recorded in this study is comparable with 2.07-3.47 x10^{6}mm^{3} reported by Ibidunni *et al.* (2017) when *C. gariepinus* was fed with *Zingiber officinale* root supplemented diets. Reduction in the RBC observed in fish fed T5 (2.0g/100g *C. olitorius*) could be due to higher concentration of ant-metabolites especially tannin (Ibidunni *et al.,* 2018). There were no significant variations observed in MCH, MCV and MCHC in fish fed *C. olitorius* seed powder.

Conclusion

The results from this present study suggest that *C. olitorius* seeds can be considered as a dietary supplement at an inclusion level of 1.5g/100g in the diet of *O. niloticus* to enhance growth performance and blood parameters.

Ethical Statement

The *Oreochromis niloticus* fingerlings used for the study were humanely handled in accordance with the ethics and regulations guiding the use of research animals as approved by the university.

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No funding information is available.

Author Contribution

OEA and AAD suggested, planned, and designed the study, MLS performed the experiments. The supervision of the experiments and report writing was performed by OEA. OEA wrote and edited the manuscript. AAD corrected and approved the final manuscript.

Conflict of Interest

The authors declare that they have no known competing financial or non-financial, professional, or personal conflicts that could have appeared to influence the work reported in this paper.

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