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Research Article

Effects of Dietary Wilted Water Leaf Meal on the Growth Performance of *Oreochromis niloticus* Fingerlings

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ABSTRACT

The study was carried out to determine the growth response of *Oreochromis niloticus* fingerlings fed with diet mixed with wilted waterleaf (*Talinum triangulare*). Two hundred and twenty-five fingerlings (initial mean weight 7.1±0.1g) mixed sex were treated with five diets containing maize, fishmeal, soymeal, wilted waterleaf, bone meal, lysine, methionine, vitamin premix, vitamin C, and salt in fifteen replicates and stocked at the rate of 15 fish per unit and reared for twelve weeks. Five experimental diets were formulated at varying levels of inclusion of wilted waterleaf at 0% (Diet1), 2.5% (Diet 2), 5% (Diet 3), 7.5% (Diet 4), and 10% (Diet 5) respectively. Results showed that there were significant differences ($P<0.05$) among the treatments in terms of fish mean weight gain, feed intake, feed conversion ratio, specific growth rate, protein efficiency, and mortality / survival rate. *O. niloticus* on diet 3 with 5.0% inclusion of wilted waterleaf meal had the highest weight gain (6.5 g), highest feed intake (8.86 g), and best feed conversion ratio. Wilted waterleaf meal is hereby recommended to be included in the diet of *O. niloticus* at 5.0% level of inclusion for better yield of *Oreochromis niloticus.*

Key words: *Oreochromis niloticus,* Fingerlings, Wilted Waterleaf, Growth

INTRODUCTION

Fish farming continues to make substantial contributions to animal protein intake and requirements in our diets. Globally, the sales of shellfish and finfish productions have increased tremendously from 154.0 million tonnes in 2011 to 170.9 million tonnes in 2018 (FAO, 2018). Fish production is expected to increase further to meet the demand of an increasing population in the world. This however, will require production of more fish feed. The reliance on addition of the plant-protein constituents in fish feeds has increased because of its low cost and presence of balanced amino acids in them (Naylor *et al.*, 2009).

The economic importance of Nile Tilapia (*Oreochromis niloticus)* has made it necessary for the fish culturists to develop balanced and cost effective diet for use in the aquaculture industry. Traditionally, fish meal is the major constituents of feed formulations available in the diet. Fish meal is the preferred component of fish feed due to its balanced amino acid composition, palatability and growth potential. In intensive fish culture, nothing is more important than sound nutrition and balanced feed. Nile tilapia is naturally adapted to eating plant ingredients (Keenleyside, 1991). Different scientists have reported the replacement of Fish meal in Tilapia diets such as cassava leaf meal (Ng and Wee, 1989), rapeseed (Davies *et al.*, 1990), barley and alfalfa (Belal, 1999), soybeans (Nyirenda *et al.*, 2000), ipil ipil leaf (Zamal *et al.*, 2008).

However, an increase in the cost of fish meal has forced fisheries scientists to replace it with other alternative sources. According Radhakrishnan *et al.* (2016), a limited supply of fish meal from all available resources is unable to meet an increasing demand of fish feed industry and growers therefore, protein from plant sources seems to be the most appropriate alternative for fish meal for preparation of Tilapia diet. Alternatives to fish meal can include fishery by-products, terrestrial animal by-products and plant protein sources.

Different plant sources such as oil seed meals, maize, bagasse mix are available in the country, which are produced as by-products from various industries. These sources are easily available at low or no cost. Various scientists have evaluated an efficiency and use of these sources as a partial or complete replacement of Fish meal (FM) in fish diets (Mahboob, 2014). Individually, these

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plant meals are observed to have essential amino acids, but missing one or more essential amino acids (NRC, 1993).

Waterleaf (*Talinum triangulare*) belongs to the family, Portulacea and originated from tropical Africa and extensively grown in West Africa, Asia, and South America (Schippers, 2000). Waterleaf as a vegetable has some inherent characteristics which makes it attractive to small-holder farmers and consumers. It is a short duration vegetable crop which is due for harvest between 35-45 days after planting (Rice *et. al,* 1986). Nutritionally, waterleaf has been proven to be high in crude-protein, ash, and crude fiber (Table 1), Aja *et al.* (2010). It also has some medicinal values in humans and acts as green forage for rabbit feed management (Ekpenyong, 1986).

Table 1: Proximate Analysis of *Talinium triangulare*

	Wet	Dry
Carbohydrate	10.87 ± 3.99mg/g	12.38 ± 2.76 mg/g
Steroids	106.61 ± 2.53 mg/100g	11.37 ± 1.19 mg/100g
Protein	3.52 ± 0.32%	18.75 ± 2.72%
Oil content	3.52%	1.44%
b-carotene	114.5 ± 1.49 mg/g	40.02 ± 0.50 mg/g
Crude fibre	12.00%	8.50%

Source: Aja *et al.* (2010).

The high cost of fishmeal makes commercial production of Nile Tilapia capital intensive as it accounts for between 30 and 60 % of variable operating cost (Desilva and Anderson, 1995). This gave motivation to search for local and cheap alternative sources of protein that aim to reducing production cost without compromising the performance of fish, therefore, the present study was conducted to examine the effect of dietary wilted *Talinum triangulare* (water leaf) as a replacement for fishmeal on the growth performance of *Oreochromis niloticus* (Nile Tilapia) fingerlings.

MATERIALS AND METHODS

Experimental site

The study was conducted in the Aquaculture unit (wet laboratory) of Fisheries Technology Department, Lagos State Polytechnic, lkorodu campus, Lagos State.

Experimental materials

Two hundred and twenty five (225) *Oreochromis niloticus* mixed sex fingerlings were used as test animal, 20kg formulated feed from locally sourced feed ingredients with wilted *Talinum triangulare* leaf meal inclusion, weight balance scale (g) calibrated to two- decimal place, fresh water from wet laboratory overhead tank, hand-held pH meter, pump aerator, hand net, thermometer (°C), DO meter (mg/L), partitioned glass tanks for experimental design and field notebook.

Experimental technique

The experimental system consisted of five rectangular glass tanks each measuring 0.9m x 0.45m x 0.45m with water level of 0.50m from the bottom. Each rectangular glass tank was partitioned into three replicates for Complete Randomize Design (CRD) statistical computation. Each compartment was stocked with (15) mixed-sex fingerlings of *Oreochromis niloticus*, which was bred in the hatchery unit of the department. Prior to the commencement of the experiment, the fish population was acclimatized in a plastic tank for 24 hours. 12 numbers of Tilapia fingerlings each was weighed to the nearest decimeter using a digital scale and stocked in each 3 replicated glass tank.

Preparation of vegetable leaf meal

The preparation will follow the procedure of Ho Thanh Tham *et al.* (2013) with slight modification. 20kg of fresh Water leaf (*Talinum triangulare)* of 45 weeks old was harvested from arable farm of Crop Production Department, Lagos State Polytechnic, Ikorodu. The *Talinum triangulare* was identified from other species by using plant taxonomy chart. The leaves were removed from stalks and petioles and spread in 5 cm thick layer corresponding to a weight of 4 kg/m^2 on nylon sheet.

The initial dry matter (DM) content was determined and the material was sun-dried for approximately 7 hours per day for 2 days to dry matter content of 240 to 250 g/kg. The vegetable materials are turned every 30 minutes during wilting to avoid molds growth. Temperature and humidity were recorded every 30 minutes by a digital thermo-hygrometer (NJ-2099-TH, Nakata, Japan). Wilting of leaf meal was monitored according to Undersander *et al.* (1993) procedures to attain low-moisture content between 40% and 60% dry matter concentrations (NCE State Extension, 2013). The wilted leaf material was fine crushed in a grinder to form vegetable leaf meal and mix with other ingredients based on calculated percentage in fish feed formulation.

Table 2: Composition of the experimental diet

Ingredient	Diet I	Diet II	Diet III	Diet IV	Diet V
Maize	3.0	3.0	3.0	3.0	3.0
Fishmeal	3.2	2.4	1.6	0.8	0
Soya meal	2.8	2.8	2.8	2.8	2.8
G.N.C.	5	5	5	5	5
Wheat offals	6	6	6	6	6
Witted Water leaf	0.0	0.8	1.6	2.4	3.2
D.C.P.	0.2	0.2	0.2	0.2	0.2
Lysine	0.002	0.002	0-002	0.002	0.002
Methionine	0.002	0.002	0.002	0.002	0.002
Premix	0.05	0.05	0.05	0.05	0.05
Vitamin C	0.002	0.002	0.002	0.002	0.002
Salt	0.024	0.024	0.024	0.024	0.024
Calculated analysis					
Crude Protein %	35.08	33.08	31.08	29.08	27.08
Metabolizeable energy (Kcal/kg)	51434	49146	46858	44570	42282

Table 3: Growth performance of *Oreochromis niloticus* fingerlings fed with diet mixed with wilted waterleaf meal (*Talinium triangulare*)

Parameter	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SEM
Number of weeks	8	8	8	8	8	
Initial Mean Weight (g)	7.5	7.9	7.3	7.1	4.8	0.545
Weight Gain (WG) (g)	5.5	5.6	6.5	5.3	3.0	0.460
Feed intake (g)	8.8	9.1	8.6	7.7	5.5	0.652
Feed conversion ratio	1.6	1.6	1.3	1.5	1.8	0.080
Specific growth rate (% per day)	0.045	0.027	0.025	0.014	0.019	0.005
Protein efficiency ratio	0.157	0.169	0.209	0.182	0.110	0.016
Survival rate (%)	98	95	95	95	91	0.582

Source: Field Exp., 2018

Table 4: Mean values of essential water quality parameters

Parameter	T1	T2	T3	T4	T5 SEM
pH	6.70	6.70	6.72	6.70	6.75 0.010
Dissolved Oxygen (mg/L)	3..00	3.10	3.04	3.10	3.15 0.026
Temperature (^oC)	26.50	26.80	26.75	26.80	26.85 0.062

Source: Field Experiment, 2018.

Experimental diets, feeding regime and routing management

20kg of experimental diets was formulated for five treatments (Table 2) which included maize, fish meal, soya meal, bone meal, vitamins and mineral, premix and salt that were obtained from a local market in lkorodu, Lagos. The water leaf was wilted to remove the water content for ease of grinding and mixing and to retain the nutritive value. The wilted water leaf was pulverized together with other feed ingredients and pelleted based on calculated percentage inclusion. The ingredients were used to formulate five different experimental diets using 35% crude protein. The wilted water leaf was included with other feed ingredients at 0%, 2.5%, 5%, 7.5%, and 10% levels of inclusion. The fish fingerlings were fed twice daily, between 7.00-8.00hrs and 14.00-15.00hrs at 5% body biomass during the experimental periods. The diet was adjusted every two weeks when new mean weights of fish for the various experimental units were determined. The water in the glass tank was changed twice in a week and fresh water was supplied to the glass tank to improve water quality and avoid pollution from uneaten food and metabolites. During the experiment, the water quality was monitored. The temperature of the water was measured with thermometer calibrated in degree centigrade (^oC), the dissolved oxygen was determined by using the digital hand-held oxygen meter and pH of the water was also measured with pH meter.

Data collection and evaluation

Data on fish growth and performance characteristics were taken every week. The weight of individual fish was determined with an electronic scale called Ohaus Scout Pro Balances, model SP-601. Fish weight gain, feed conversion ratio, specific growth rate and survival were computed according to the following growth indices as cited by Babalola *et al.* (2016).

Mean Weight Gain (WG) = Final weight of fish - Initial weight of fish)

Specific Growth Rate (SGR) (% per day) = (Log_e W2-Log_eW1)/T2-T1x100

Where W2 is weight of fish at time T2 (final) and W1 is weight of fish at time T1 (initial)

Feed Conversion Ratio (FCR = Total feed consumed by fish (g)/Weight gained by fish (g)

Protein Efficiency Ratio (PER) = Wet weight gain / Protein fed)

Mortality rate (M) = (N_o-N_tx 100%/N_o)

Where, N_o is the number at the start of the experiment and N_1 is the number at the end of the experiment.

Statistical analysis

The data collected were subjected to one-way analysis of variance (ANOVA) The experimental design used was complete randomized design (CRD) with multiple comparison test for the means at a significance level (Duncan, 1955).

RESULTS

The growth performance characteristics of *Oreochromis niloticus* fingerlings in response to dietary treatment of *Talinum triangulare* leaf meal in the feed formulation over 12 weeks period is shown in Table 3 with the growth indices such as weight gain, feed intake, specific growth rate, protein efficiency ratio, survival rate (%) and feed conversion. Fishes on diet 3 with 5.0% inclusion of wilted waterleaf meal had the highest weight gained (6.5 g), highest feed intake (8.86 g), and ideal feed conversion ratio (1.3) while fishes on diet 5 (10% wilted waterleaf meal) had the lowest weight gained (3.0 g), highest feed intake (5.5 g), and feed conversion ratio (1.8). All these growth parameters differ significantly at ($P<0.05$). The survival rate ranged between 90% and 98% which is within expected 5% mortality rate.

Table 4 below shows mean values of essential water quality parameters necessary for the culture of *O. niloticus*. The pH ranged was 6.70 – 6.5, Dissolved oxygen during the experimental period falls between 3.00mg/l and 3.15mg/l while Temperature ranged was 26.50-26.85°C. All the parameters are not significantly different ($P>0.05$).

DISCUSSION

This study demonstrates that fish need energy in the food to maintain basic metabolic activities and to support growth, reproduction, activity, and health. Proteins,

carbohydrates, and lipids and other macronutrients provide this energy. Fish require essential amino acids in proteins for growth, tissue repair, general health, and reproduction. Protein quality affects fish performance. The amount and types of amino acids in a protein source determine its quality. Some protein sources like fish meal are high quality but also very expensive. Less expensive protein sources such as leaf meal may be used if they meet the meet protein requirements of the fish as explained in the work of Lochmann and Phillips (2009).

The inclusion of wilted waterleaf (*Talinium triangulare*) in the diet of *Oreochromis niloticus* fingerlings shows significant effect on their performance characteristics. The gradient levels of inclusion of wilted waterleaf meal in the diet shows the ideal percentage inclusion that will provide require protein and nutrients needed by *Oreochromis niloticus* fingerlings in their formulated diet for optimum performance, this findings support the report of Falaye (1992) on nutritional requirement of *Oreochromis niloticus* . The obvious trend in the growth of *Oreochromis niloticus* fingerlings in the experiment could also be as a result of the endogenous and exogenous changes in the fishes vis-a-vis the culturing environment as reiterated by Reginald, (2013).

Weight gain, specific growth rate, and food conversion ratio are not correlated with the increase in dietary food intake. This phenomenon could be established with the fact that wilted waterleaf is low in crude protein being plant protein source with 18.75±2.72% CP (Aja *et al.,* 2010) when compared with the crude protein requirement for Nile Tilapia fingerlings which in the range of 28-35% CP (FAO, 2018) according to Fakorede (1999) on fish nutrition this however, disagreed with the report of Mohammed (2009) on weight gain and specific growth rate which increases significantly with increase in dietary intake.

The fishes that had the best feed conversion ratio are the fishes on diet 3 with 5.0% level of inclusion of wilted waterleaf meal. The detoxification of waterleaf to remove ant-nutritive factors to enhance its nutrient bioavailability in *Oreochromis niloticus* fingerlings at that specific level of inclusion in the diet could be reason for the best feed conversion ratio recorded this agreed with the report of Oladunmoye (2007) and the findings of Audu *et al*. (2004) on the effect of substituting fishmeal diets with varying quantities of plant protein on the growth responses and food utilization of *O. niloticus*.

The lowest feed conversion ratio reported in diet 5 (FCR=1.8) could be the lack of fishmeal which supply essential amino acids in the diet of fish. Typical dietary proximate composition of Nile Tilapia fingerlings required 28-35% CP in their diets which is lacking in the diet 5 (FAO, 2018). This clarifies the reason for high specific growth rate (SGR) observed in diet 1(0.045g/fish) that had fishmeal without wilted waterleaf meal in the diet that supplies required crude protein for fish growth.

Fishes on diet 3 (5.0 % wilted waterleaf meal) had the highest protein efficiency ratio (0.209). Tilapias are generally known as herbivores, feeding mainly on plant materials. According to Opuszynski and Shireman (1995), the digestive tract of Nile tilapia is at least six times the total length of the fish, providing abundant surface area for digestion and absorption of nutrients from its mainly plant-based food sources. This specialized food and feeding habit of Nile Tilapia make the fish an excellent food converter when plant-based protein is mixed with their diet.

The highest food intake reported in diet 2 (2.5% wilted waterleaf meal) could be the aroma and flavor given by wilted leaf meal and fish meal combined at that specific percentage inclusion in the fish diet as cited by Babalola *et al.* (2016) together with specialized food and feeding habit of Nile Tilapia that makes plant-based protein their choice of food. Obviously, lack of fishmeal in diet 5 (10% wilted waterleaf meal) that will complement the palatability and flavor of the diet for appetite enhancement was responsible for the lowest food intake recorded in fishes on diet 5.

The mortality reported during the experimental period could be from exogenous changes in the fishes and the culturing environment respectively (Reginald, 2013). However, the diets with wilted waterleaf meal inclusion recorded the consecutive mortality compared to diet 1. The residual phytochemical in the wilted waterleaf meal that dissolved in the culturing water could be responsible for the recorded mortality (Ng and Wee, 1989).

The essential water quality parameters measured falls within the culturable range for *O. niloticus* as cited by Babalola *et al.* (2016). The fluctuations in the readings from all the treatments are suspected to be the exogenous effect of the culturing environment and the effect of pollution from uneaten experimental diets and from the fishes' metabolites (Reginald, 2013).

In conclusion, the application of wilted waterleaf meal in the diet of *O. niloticus* showed that there was significant difference ($P<0.05$) in the weight gain, feed intake and feed conversion ratio. Moreover, diet 3 performed better than other treatments from the view point of weight gain and feed conversion ratio at 5.0% level of inclusion of wilted waterleaf meal in the diet.

This study evidently showed that wilted waterleaf meal could be used at recommended level of 5.0% inclusion in the diet of *O. niloticus* by serving as a good plant protein supplement that can be used to augment fish meal in their diet. This experiment should be repeated in ponds to see if better results could be obtained outside laboratory.

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