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Effect of Replacing Fishmeal with Baobab Seed Meal (*Adansona digitata*) on Growth, Feed Conversion and Carcass Composition for Nile Tilapia Fry (*Oreochromis niloticus*)

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ABSTRACT

The experiment was conducted at the Fish Hatchery - Department of Fisheries and Wildlife Science, College of Animal Production Science and Technology, Sudan University of Science and Technology during the period 15/07-02/09/2018 to determine the effect of replacing fishmeal with baobab seed meal in the formulation of diets for Nile Tilapia (*O. niloticus*) fish and determining effect on the growth rate. The experiment included 12 plastic aquariums, Fish were distributed randomly in aquariums and placed in each one 10 fish. Acclimatized to the hatchery conditions for 3 days, before the beginning of the experiment. The experiment included 4 treatments with 3 replicated aquariums for each. Feeds T0, T1, T2 and T3 (The diets replacing 0, 25, 50 and 75% of fish meal protein content by baobab seed meal. The results indicated that final body weight (BW), weight gain (WG) and specific growth rate (SGR) of *O. niloticus* increased with increasing level of fish baobab seed meal in diets. WG was found 20.10, 28.23 and 37.90 for T1, T2 and T3 respectively. The data were analysed by one-way analysis of variance (ANOVA, F test) and LSD for significantly different means at a significance level of 0.05 using SPSS version 16

INTRODUCTION

Fisheries and aquaculture remain important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world. Moreover, fish continues to be one of the most-traded food commodities worldwide with more than half of fish exports by value originating in developing countries. Recent reports by high-level experts, international organizations, industry and civil society representatives all highlight the tremendous potential of the oceans and inland waters now, and even more so in the future, to contribute significantly to food security and adequate nutrition for a global population expected to reach 9.7 billion by 2050 (FAO, 2016).

Aquatic animals are produced in an array of farming systems operated as extensive, semi-intensive and/or intensive production practices. Aquaculture is practiced in all aquatic environments; freshwater, brackish water and marine. Systems range from small-scale, backyard-type low technology operations to sophisticated, high technology industrial systems. Since both land and water are becoming scarce for aquaculture, almost worldwide, due to many sectors are competing for these primary resources, sustainable intensification has become the mantra for aquaculture development. The increased production per unit land, water and/or energy has become the formula for economic viability in aquaculture worldwide. This is truly reflected in the increasing trend of modernization and intensification of aquaculture, globally FAO Fisheries and Aquaculture Database (FAO, 2015).

Tilapia is the third most important cultured fish group in the world, after carps and salmonids, Tilapia culture is also one of the fastest-growing farming activities, with an average annual growth rate of 13.4% during 1970–2002. They are widely cultured in about 100 countries in the tropical and subtropical regions. As a result, the production of farmed tilapia has increased from 383,654 mt in 1990 to 1,505,804 mt in 2002, representing about 6% of total farmed finfish in 2002 (El-Sayed, 2002).

Fishmeal commercial products mostly made from fish that are not generally used for humans. The benefited of fish meal in aquaculture diet the fish meal carries large quantities of energy per unit weight and is an excellent source of protein. lipids, minerals, and vitamins (JACOBS, 2017), any complete diet to amino acid composition and digestibility, high-quality fish meal normally contains between 60% and 70% crude protein by weight, typical diets from many contain form 32% to 45% total protein by weight, fish meal used in compound feed in poultry feed and formed fish or aquaculture (Chapman, 2015).

The baobab seed and pulp were analyzed for proximate composition, mineral content, and amino acid composition. The seed oil and protein were evaluated for their fatty acid profile and protein solubility, the seed was found to be a good source of energy, protein, fat both the kernel and the pulp contain substantial, quantities of calcium potassium, and magnesium (Osman, 2004).

With the continuing growth of the aquaculture industry, more attention to fish meal fare must be given as it has significant impacts on stress response, health, and resistance to diseases, with consequences on the sustainable development of this industry (Ashley, 2007). Diets, among other factors, have strong effects on stress tolerance and health, and therefore, for adequate growth and resistance to stress and disease problems, fish must be fed adequate quantities of diets that meet all their nutrient requirements (Trichet, 2010).

Therefore, before considering the potential benefits of diet supplementation with any specific nutrient, it is of paramount importance to ensure that are fed adequate amounts of balanced diets that meet all nutrient requirements for the specific physiological stage of development of the species under consideration proteins, carbohydrates and lipids are distinct nutrient groups that the body metabolizes to produce the energy it needs for numerous physiological processes and physical activities. However, dissolved minerals in the water may satisfy some of the metabolic requirements of fish. Vitamins Fifteen vitamins are essential for terrestrial animals and for several fish species that have been examined to date (Halver, 2002).

Explained how animal products, plant protein derivatives and single-cell proteins can be possible FM replacers in tilapia feeds, it is important to know whether these alternatives can completely replace FM without compromising production. This subject has been discussed by aquaculture nutritionists, fish biologists and fish farmers albeit with limited consensus. According to Jackson’s (2009)

The baobab is a traditional food plant in Africa but is little-known elsewhere. The vegetable has been suggested to have the potential to improve nutrition, boost food security, foster rural development, and support sustainable land care. (NRC National Research Council, 2006). In times of drought, elephants consume the juicy wood below its bark (Sheehan, 2004).

MATERIALS AND METHODS

Experimental Design and Conditions:

The experiment present study was carried in a fish hatchery at Department of Fisheries & Wildlife, College of Animal Production Science and Technology, Sudan

University of Science and Technology, one hundred and Twenty Nile tilapia frying (average weight 0.25±0.1 g) Fry of *Oreochromis niloticus* were procured from Hussien Fadoul Fish Farm, Soba-Khartoum, Sudan. These were transported to hatchery of the Department of fisheries and Wildlife Science, Sudan University of Science & Technology, Khartoum, Sudan. Fish were distributed in a flow-through system of 12 plastic aquaria acclimatized to the hatchery conditions for 3 days. Before the beginning of the experiment, weak and abnormal fish were excluded and the remaining fish redistributed on aquariums at 10 Frying/aquarium. The experiment included four treatments with three replicated aquariums for each. Feeds T0, T1, T2 and T3 (The diets replacing 0, 25, 50 and 75% of fish meal protein content by baobab seed meal.

The fish were fed by a degree of satiation two times a day. The siphoning of the water daily in aquaria by small water spout-waste and feed and the time of feeding in the day time 9:00 a.m and 4:00 p.m. in some days according of weather condition and climate particularly the temperature.

Fish were weighed and measured every seven days and feed ration was adjusted accordingly (including water quality and fish body weight in any aquaria).

Table (1): Formulation and composition of the experimental diets

Ingredients(g/ 100 g dry diet)	Control	T1	T2	T3
Fish meal[1]	40.00	30.00	20.00	10.00
Tabaldi[2]	0.00	10.00	20.00	30.00
Groundnut Cake[3]	20.00	20.00	20.00	20.00
Cottonseed Meal[4]	3.00	3.00	3.00	3.00
Wheat flour[5]	20.00	20.00	20.00	20.00
Wheat bran[6]	11.00	11.00	11.00	11.00
Vig.-Oil	3.00	3.00	3.00	3.00
Mineral premix[7]	1.50	1.50	1.50	1.50
Vitamin premix[8]	1.50	1.50	1.50	1.50
Total	**100.00**	**100.00**	**100.00**	**100.00**
Protein (%)	32.0±0.3	29.6±0.0	28.2±0.2	25.8±0.05
Fat (%)	12.87±0.3	16.83±1.5	14.56±2.1	14.71±2.3
Ash (%)	6.99±0.19	7.62±0.19	7.34±0.44	6.82±0.09
Moisture (%)	42.33±0.8	31.87±0.5	30.87±0.6	27.89±0.3
Calculated gross energy (kJ g^{-1}, dry diet)	15.22	15.07	14.91	14.76

[1]Fishmeal 45% CP; [2]baobab17%; [3]Groundnut Cake43.7% CP; [4]Cottonseed Meal 38%; [5]Wheat Middling 17% CP and [6]Wheat bran 13.7%.[7]Mineral mixture (g/100g dry diet) calcium biphosphate 13.57; calcium lactate 32.69; ferric citrate 02.97; magnesium sulphate 13.20; potassium phosphate (dibasic) 23.98; sodium biphosphate 08.72; sodium chloride 04.35; almunium chloride.6H_2O 0.0154; potassium iodide 0.015; cuprous chloride 0.010; mangnous sulphate H_20 0.080; cobalt chloride. 6H_2O 0.100; zinc sulphate. 7H_2O 0.40 (Halver, 2002). [8]Vitamin mixture (g/100 dry diet) choline chloride 0.500;inositol 0.200; ascorbic acid 0.100; niacin 0.075; calcium pantothenate 0.05; riboflavin 0.02; menadione 0.004; pyridoxine hydrochloride 0.005; thiamin hydrochloride 0.005; folic acid 0.0015; biotin 0.0005; alpha-tocopherol 0.04; vitamin B_{12} 0.00001; LobaChemie, India (Halver, 2002).

Water Quality Measurement:

Temperature, pH, dissolved oxygen (DO) and ammonia were estimated by aqua sol kits during the experimental period according to APHA (1995).

Growth and Feed Utilization:

Initial body weight (IBW), final body weight (FBW), specific growth rate (SGR), feed intake (FI), feed conversion ratio (FCR), survival rate, protein efficiency ratio (PER), protein productive value (PPV) and energy retention (ER) were measured using the following equations:

Weight gain (g) = final weight – initial weight;

Weight gain % = 100 x weight gain / initial weight;

Specific growth rate (SGR; %/day) =100 (Ln final weight – Ln initial weight) / days;

Feed intake (g fish/day) = $\frac{total\ feed\ intake\ per\ fish}{number\ of\ days}$

Feed conversion ratio (FCR) = feed intake (g) / weight gain (g)

Survivor Rate % = $\frac{initial\ number\ of\ fish\ stocked - mortality}{number\ of\ days} \times 100$

Moisture Content Determination:

The samples were first weight (Initial weight) then dried in an electric oven at 1050C for 24-30 hours to obtain a constant weight. The moisture content was calculated as follows:-

Moisture content (%) **=** Initial weight – Dry weight× 100/ Initial weight

Crude Protein Determination:

The Kjeldal method for the estimation of nitrogen was applied. Nitrogen content was converted to protein percentage by multiplying by 6.25 as follows:

Protein % = (Va – Vb) x N x14 x 6.25 x 100 /1000 x Wt

Whereas:

Va = volume of HCL used in titration

Vb = volume of sodium hydroxide of known normality used in back titration

14 = conversion factor of ammonium sulfate to nitrogen

6.25= conversion factor of nitrogen to protein

Wt= weight of sample

N= normality of NaoH

Crude Fat Determination:

The fat content of each sample was determined according to Soxhlet method by ether extract using 2 gm of fish samples. Extraction continued for 5 hours at 100^0C before finding the weight of the extracted fat. Fat percentage was then calculated as follows:

Fat % = Extracted fat weight x 100 / Sample weight

Ash Content Determination:

Ash was determined by heating 1 gm at 5500C in muffle furnace until a constant weight was obtained. Ash content percentage was given by the following formula:

Ash % = Ash weight x 100 / Sample weight

Statistical Analysis:

The data were analyzed by one-way analysis of variance (ANOVA, F test) and LSD for significantly different means at a significance level of 0.05 using SPSS version 16.

RESULTS

Parameters for growth performance and survival rate of Nile tilapia are presented in table 2. Growth performance it had to differ (P>0.05) between tilapia fed with the control diet and the diet with (BSM) in terms of final weight, Highly weight gain (WG T_1 37.90) low weight gain (WG T_3 20.10), Highly specific growth rate (SGR T1 6.16) low specific growth rate (SGR T3 4.97), diets had significant highly ($P<0.05$) Highly final weight(WG T_1 40.40)and low final weight(WG T_2.T_3 30.73), weight gain, specific growth rate compared to the control diet. The values of feed conversion ratio high (FCR $T_1$2.67) and low (FCR T_3 5.02) showed had significant difference ($P>0.05$) between the dietary treatment fed to the fish, also had significant difference ($P>0.05$) between the dietary treatment fed to the fish in protein efficiency ratio (PER) and life weight gain (LWG).

Table 2: Comparison of the weekly weight of all treatments for seven weeks (g/fish)

Treatment	Control	T1	T2	T3	Sig
Initial weight(g/fish)	2.50±0.10	2.50±0.10	2.50±0.20	2.40±0.34	NS
W1	$5.93±0.55^a$	$4.96±0.64^b$	$4.36±0.23^b$	$3.84±0.28^b$	*
W2	$8.43±0.45^a$	$7.33±1.42^b$	$6.53±0.90^c$	$5.50±0.70^c$	*
W3	$13.33±0.49^a$	$11.46±1.61^b$	$8.53±0.40^c$	$7.20±1.12^c$	**
W4	$17.20±1.41^a$	$16.76±2.70^b$	$11.93±1.02^c$	$9.80±1.70^c$	*
W5	$23.53±1.79^a$	$22.93±3.93^b$	$17.43±1.58^c$	$13.66±2.12^c$	*
W6	$13.26±3.49^a$	$33.70±7.01^a$	$24.90±2.40^b$	$18.36±3.09^b$	*
W7	$36.83±7.29^b$	$40.40±6.51^a$	$30.73±2.36^c$	$22.50±3.93^d$	*

*The mean difference is significant at the 0.05 level

Table (3): Growth performances of different treatments fed with feed contain difference level of Tebaldi seed meal:

Treatments Parameters	Control	**T1**	**T2**	**T3**	SIG
IW(g/fish)	2.50±0.10	2.50±0.10	2.50±0.20	2.50±0.34	NS
FW(g/fish)	$36.83±7.29^b$	$40.40±6.51^a$	$30.73±2.36^c$	$30.73±2.36^c$	*
WG (g)	$34.33±7.25^b$	$37.90±6.60^a$	$28.23±2.20^c$	$20.10±3.59^d$	*
FCR	$2.97±0.67^b$	$2.67±0.51^a$	$3.52±0.28^c$	$5.02±0.82^d$	*
SGR	$5.95±0.43^b$	$6.16±0.85^a$	$5.49±0.20^b$	$4.97±0.09^c$	*
PER	$0.33±0.07^{ab}$	$0.39±0.07^a$	$0.32±0.03^{ab}$	$0.26±0.04^b$	*
LWG (%)	$1.73±271.16^b$	$1.52±310.34^a$	$1.25±383.13^c$	$8.35±35.58^d$	*
Survivor rate	93%	100%	93%	90%	*

$^{a.b.c.d}$ Means in the same row with superscript are significantly different at level (p<0.05

The results from the water quality monitoring are presented in table (4). The parameters d, pH, and nitrite were measured bi-weekly throughout the experiment. The water temperature was recorded every week, showing no vital difference in temperature between weeks or tanks, after the initial period the water temperature was only measured once a week only. The water parameters did not reflect any differences among the treatments, also no significant differences in nitrite, nitrate, and pH during the experimental period.

From the above table (5) the highly dry mater in (T_2 26.81) and low dry mater in treatment (T_0 25.72). Highly crude protein in treatment (T_0 70) and low crude protein in treatment (T_3 55.13) highly fat in treatment (T_3 14.81) and low fat in treatment (T_0 6.41). Highly ash in treatment (T_3 7.69), and low ash in treatment (T_2 3.70).

Table (4) Hydro chemical parameters of water quality of different treatments

Treatments Parameters	Control	T1	T2	T3	SIG
Temperature	27.0±1.63	27.0±1.63	27.0±1.63	27.0±1.63	NS
pH	8.11±0.10	8.07±0.09	8.10±0.10	8.15±0.07	NS
NO_2	30.0±14.14	30.0±14.14	30.0±14.14	30.0±14.14	NS
NO_3	0.00±0.00	0.00±0.00	0.00±0.00	0.00±0.00	NS
DO	5.55± 2.29	4.06±0.33	5.09±1.63	5.42±1.90	NS

NS: no significant differences

Table (5). CarcassComposition of *Oreochromis niloticus* fed with different level of Babab Seed Meal

Experimental diets				
	Control	T_1	T_2	T_3
DM%	25.72±0.31	26.49±0.40	26.18±0.20	26.81±0.30
Fat%	6.41±0.42	9.33±0.75	14.81±0.34	6.90±0.90
CP%	70.0±0.23	69.65±0.50	55.13±0.50	62.20±0.80
Ash	5.926±0.45	5.71±0.20	7.69±0.57	3.70±0.17

Means in the same row with different superscripts are significantly ($P<0.05$) different.

Table (6): Amino acid Profile of the diets

	Control	T1	T2	T3
Arginine, %	2.43	3.16	3.35	3.8
Histidine, %	2.22	1.27	1.31	1.36
Isoleucine %	0.78	1.36	1.74	1.86
Leucine %	2.52	2.81	3.13	3.45
Lysine %	17.74	2.53	2.6	2.68
Methionine %	0.78	1.73	0.68	0.64
Cystine %	0.38	1.48	0.58	0.69
Phenylalnine %	9.44	2.59	1.77	1.96
Tyrosine %	1.05	2.03	1.00	0.92
Threonine %	1.43	1.58	1.73	1.79
Tryptophan %	2.42	0.31	0.25	0.74
Valine %	0.88	7.5	2.5	1.23

Table (6) showed that the highest level of Arginine, Isoleucine, Leucine, Lysine, Threonine and Valine in T3 (75% replacement), as fellow 3.8,1.86,3.45, 2.68, 1.79 and 1.23 g/100 respectively.

DISCUSSION

The selection of feed ingredients is one of the most important factors for the formulation and commercial production of supplemental quality feed for any aquatic species (Zamal *et al.*, 2008; Koumi *et al.*, 2009).

These differences might be due to different environmental conditions such as soil type, local varieties, and processing methods. All the experimental feeds were actively fed upon and accepted by the Animal throughout the experimental period which could be a result of palatability of the feed indicating that the levels of incorporation of baobab did not affect the palatability of the diets. Besides this, the availability of fish meals is decreasing day by day due to its high demand in other than aquaculture industries like livestock, poultry, etc. The decreased supply of fish meals in future will dramatically affect fish production. Considering this, it is essential to partially reduce or eliminate fish meal in fish diet. One approach to reduce fish meal from fish diets is to replace it with alternative less expensive and easily available plant protein, which will allow for continued expansion of aquaculture. In view of this, a number of plant protein source has been evaluated for the replacement of fishmeal (Alceste and Jory, 2000; Yue and Zhou, 2008; Francis *et al.*, 2001).

The result of feeding graded levels of baobab seed meal (0, 25, 50, 75%) on the performance of Nile tilapia (*O. niloticus*) are presented in table (3). The results showed that there were significant differences in the total feed intake, this finding was agreed with those of (Ayoub *et al.*, 2017*)*, they found that there were significant differences in the total feed intake of broiler chicks. Chimvuramahwe., *et al*.,(2011) found results conflating with this result they noticed the inclusion of baobab seeds meal on broiler reduced the broiler chicks performance.

The total weight gain (g), final body weight (g), and feed conversion ratio (g feed/g gain), protein efficiency ratio (g weight gain/g protein intake) and specific growth rate (SGR) were significantly ($p<0.05$) effected by the inclusion of baobab seed meal, its improved by feeding of the baobab seed meal, so that the best results were obtained by fish fed 10% baobab seed meal followed by those fed the other tested diets Table (3). These results were agreed with those of (Ayoub *et al.*, 2017). They reported the birds fed graded levels of baobab seed meal were recorded significant improvement in weight gain, final body weight, and feed conversation ratio. These results were agents those of (Chimvuramahwe *et al.*, 2011) who reported that the inclusion of baobab seeds meal on broiler reduced the broiler chick's performance.

The results showed that there were significant differences include protein content between tested groups were the control recorded highest protein content. The fat content was significantly affected by the inclusion of baobab seeds mail were T2 recorded high-fat content flowed by T1. The results showed there were significant differences Ash content were T2 recorded high ash content flowed by T1. The results showed there were no significant differences in dry matter content.

Conclusion:

Fish fed different level of baobab seed meal exhibited numerically good growth performance and better feed utilization efficiency moreover, diets with baobab seed meal were comparable to the positive control diet, as these were found to be efficiently utilized by *O. niloticus* fry as well .therefore, baobab seed meal may pose as a potential candidate ingredient for fish meal replacement in *O. niloticus* feeds.

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