Bima Journal of Science and Technology, Vol. 7 (4) Dec, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i4.521

Nutritional Effects of Replacing Soybean Meal with Locust Bean (*Parkia biglobossa*) Meal on Growth and Feed Utilizations of *Clarias gariepinus*

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ABSTRACT

High cost of imported fish-meal is a major constraint to the growth of aquaculture in Nigeria. Five inclusion levels of locust bean seed meals were investigated after the seeds was boiled and fermented for two days, then sun-dried before being milled. Five iso-nitrogenous diets of 45% crude protein were formulated and the processed *Parkia biglobossa* meal was included to substitute soybean meal at 0%, 25%, 50%, 75% and 100%. The experimental diets were fed to the juveniles of *Clarias gariepinus* in an outdoor bowls for 77days to assess the growth performances of the fish to the diets. The highest mean weight gain recorded in the fish fed TD4 with 65.32±0.73G/fish and the lowest was recorded in the fish fed TD3 diet with 20.81±1.82g/fish. The highest value for Specific growth rate was obtained from the fish fed TD4 diet with 0.85±1.37% /day and the lowest was obtained in the fish fed TD3 diet with 0.43±1.27%/day. Highest final condition factor was recorded in the fish fed TD3 diet with 0.6630±1.28 and the lowest obtained in the fish fed TD1 diet with 0.5783. The highest feed conversion ratio value was recorded in the fish fed TD1 with 3.05±1.04 and the lowest value was recorded in the fish fed TD3 with 1.76±1.72. The proximate compositions of the experimental fish carcasses were better improved at the end of the experiment compared to the beginning of the experiment. The results obtained from this study implies that soybean meal could be substituted with locust bean meal in the diet of *Clarias gariepinus* to about 75% inclusion level for better and sustainable aquaculture practices.

Keyword: *Clarias gariepinus*, Locust beans, Soybean, Growth, Feed utilization.

INTRODUCTION

Recent researches in aquaculture are focused on reducing the cost of protein, the single most expensive nutrient source in practical fish feeds (Higgs *et al.,* 1990). Fish require nutrients for growth, reproduction and other normal body physiological functions just like other farm animals. These nutrients could be available in the natural aquatic environment or applied as prepared feeds (Eyo, 2003). One of the major setbacks to the fish farming systems in Nigeria is the high cost of fish feed which are mainly imported and very expensive.

Most intensive fish farming require feeding fish with supplementary diets and these constitute an important item in any fish culture operation accounting for over two-thirds of the usual cost (Lovel, 1985). The purpose of growing fish in aquaculture is to grow fish fast and economically that is, as cheaply as possible. To achieve this, it is important that fish be fed with compounded diet to get optimum production for investment within a short period of time. The compounded diet must therefore provide a balanced diet. For a source of protein to provide good growth, such protein must contain the essential amino acids (EAA) which cannot be synthesized by the fish but nonetheless are required by the fish. Fish meal contains all these essential amino acids such as lysine, leucine, arginine, methionine, valine, histidine, tryptophan, isoleucine, phenylalanine and threonine (Nose, 1975). While most plant proteins contain just about eight or less of these EAA (Olukunle, 2006). The high cost of fish meal and imported fish feed ingredients is a major problem to fish culturists in fish feed formulation in Nigeria (Madu *et al.,* 2003). Plant protein provide a ready solution to this problem; therefore, efforts are being directed at developing diets for fish in which the significant proportion of the fish meal is partially or wholly substituted by available and cheap plant sources (Eyo, 2003).

Information on the use of locust bean seeds (*Parkia biglobossa*) as a source of protein in fish feed formulation is scanty, so also is the effect of different inclusion levels on the growth and feed utilization of *Clarias gariepinus*. Locust bean (*Parkia biglobossa*) tree is commonly found growing in the wild across the North-East sub-region. Its seeds have been put to a variety of uses including ingredients in traditional dishes (daddawa) and fishing bait (Ademoroti, 1996). Therefore, this study is intended to investigate the possibility of using locust bean (*Parkia biglobossa*) seeds as an alternative source of protein in the diet of *Clarias gariepinus*.

MATERIALS AND METHODS

Collection and Processing of Locust Bean Seeds

Locust bean seeds were purchased locally from Gombe main market. The yellow powdery pulp was removed prior to processing. The seeds were boiled with firewood for 12hours, washed, fermented for two days (48hours), sun-dried, ground into fine powder, packed in labeled polyethylene bags and stored at room temperature till when needed. The fermenting was done as described by Onanuga *et al.* (2004).

Experimental Diets Composition and Preparation

Five iso-nitrogenous test diets of 45% crude protein were formulated from various ingredients such as fish meal, soybean meal, yellow maize, blood meal and locust bean meal. In the diet, locust bean meal was used to replace soybean meal as plant protein source at various inclusion levels namely 0% (control), 25%, 50%, 75% and 100%. The diets were coded TD1 (0% = control), TD2 (25%), TD3 (50%), TD4 (75%) and TD5 (100%). The diets were formulated using algebraic method along with least cost formulae (LCF) of Falayi (2003). Each proportion of the ingredients were measured using sensitive electric weighing balance (Ohauls, 2000 Model) was milled into fine particles (< 0.25mm) and mixed thoroughly in a bowl for 30minutes to ensure homogeneity of the ingredients. Starch was prepared with hot water into paste and mixed with other ingredients as binder. The dough was pelleted wet using hand pelleting machine (Kitchen hand pelleting cranker pelletizer). The pelleted dough was collected in flat trays and sun-dried to constant weight after which the feeds were crushed into crumbs with pestle and mortar (for easy ingestion by the fish). They were packed in polythene bags, labeled and stored at room temperature in the laboratory.

Proximate Composition of the Experimental Ingredients and Diets

Proximate composition of processed locust bean meal and soybean meal, fish carcasses

DOI: 10.56892/bima.v7i4.521

before and after the experiments were analyzed for crude protein, crude fibre, crude lipid, ash and moisture content according to Association of Analytical Chemist Methods (A.O.A.C. 2010).

Collection and Acclimatization of Experimental Fish

Juveniles of *C. gariepinus* used in this research were obtained from Sanhana fish farm situated at Mallam Inna Gombe. They were transported in a 50litres oxygen filled plastic jerry can of water to the laboratory of the Department of Biological Sciences, Gombe State University where the experiment was carried out. They were acclimatized for a period of one week. During this period, they were fed once a day on a commercial feed.

Experimental Units and Design

A Completely Randomized Design (CRD) was used for this study. Five experimental set up in triplicates, consequently 5 x 3 giving a total of 15 experimental units. Therefore, the experimental design consisted of 15 plastic bowls each measuring 70 litres were kept in laboratory of the Department of Biological Sciences, Gombe State University. The plastic bowls were cleaned, disinfected with saline solution and agricultural lime ($CaCO_3$) which is adjudged to be the best liming material (Bolorunduro, 2002) at an application of 100 g/m^3 as recommended by Ibiwoye (1996). The bowls were then rinsed to clear them of the lime and allowed to dry for 24hours. Thereafter, each plastic bowl was filled with 50 litres of water and covered with a net of 3mm mesh size to protect the fish from jumping out of the bowls and predators from entering into the bowls. The control diet that was coded TD1 with zero percent inclusion level of locust bean meal was assigned to the first treatment in replicates while treatment diet (TD2) 25%, (TD3) 50%, (TD4) 75% and (TD5) 100% were given to the second, third, fourth and fifth treatment respectively, all in triple replicates as shown in table 1.

Sampling and Feeding of the Experimental Fish

The fish was starved for 24 hours to empty their gastro-intestinal tracts before the commencement of feeding trials (Eyo, 2001). 24-weeks (6 Months) feeding trial was carried out in triplicate groups of 10 fingerlings each per plastic bowl. Fish was fed at 5 % of their body weight per day (2.5% in the morning 8.00 - 9.00 AM and 2.5% in the evening 5:00-6:00PM) throughout the duration of the experiment. The quantity of feeds were be adjusted based on the weight of fish for next weeks throughout the duration of the feeding trials.

Table 1: Percentage Composition of the Experimental Diets (g/100g of Ingredients)

Ingredients (%)	TD1 (Control)	TD2	TD3	TD4	TD5
Fish Meal	30.0	30.0	30.0	30.0	30.0
Soybean Meal	37.1	27.8	18.55	9.3	0.0
Yellow Maize	18.9	18.9	18.9	18.9	18.9
Blood Meal	8.0	8.0	8.0	8.0	8.0
Locust Bean Meal	0.0	9.3	18.55	27.8	37.1
Chromic Oxide	1.0	1.0	1.0	1.0	1.0
Vitamin / Premix	2.0	2.0	2.0	2.0	2.0
Palm Oil	1.5	1.5	1.5	1.5	1.5
Salt	0.5	0.5	0.5	0.5	0.5
Starch	1.0	1.0	1.0	1.0	1.0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

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Vitamin and Minerals premix: Vitamin A - 20,00,000 I.U.; D3- 4,00,000 I.U.; E - 200,000 I.U; K -1,200mg; B1- 10,000mg.; B2- 30,000mg.; B6- 19,000mg.; B12-1,000.; Niacin-200,000mg.; Folic Acid-5,000mg.; Panth Acid-50,000mg.; Biotin-400mg.; Antioxidant 125g.; Vitamin C-150g.; Choline chloride-400g.; Manganese-30g.; Zinc-40g.; Iron-40g.; Copper 4g.; Iodine-5g.; Selenium-0.2mg.; Cobalt-0.2mg.; Calcium-600g.; Lysine- 100,000mg.; Phosphorus-4,000g.; Methionine-100g. (AGRO BAR-MAGEN NIG.LTD)

Fish Weight and Length Measurement

Measurement of the length, standard length and weight of experimental fish was done as described by Olatunde (1983). The weight was measured using a sensitive electronic weighing balance (Ohaus LS200 Model). Experimental fish were weighed at weekly intervals up till week 9.

$MWG = W_2 - W_1$ Where: W_2 = final mean body weight, W_1 = initial mean body weight

Specific Growth Rate (SGR):

$$SGR = 100 \frac{(\ln W_2 - \ln W_1)}{T}$$

Where:

W_2 = final body weight

W_1 = initial body weight

T = duration or experimental days

Ln = natural log

Condition Factor:

$$\frac{W \times 100}{L^3}$$

Where:

K= conditional factor

W= weight in grams

L= standard length in cm

Feed Conversion Ratio (FCR):

$$FCR = \frac{\text{Amount of feed fed (g)}}{\text{Fish Weight Gain (g)}}$$

Protein Efficiency Ratio (PER):

$$PER = \frac{\text{Wet weight gain by fish (g)}}{\text{Weight of crude protein fed (g)}}$$

Statistical Analysis

All data generated were subjected to descriptive statistics to determine the mean values and then subjected to analysis of variance (ANOVA) at 95% probability level where the significant differences were detected. Means values were separated using Least Significant Difference (LSD). All data were analyzed using SPSS (statistical Package for Social Sciences) version 20.0 statistical package.

RESULTS

Table 2 shows the proximate compositions of the experimental ingredients and diets

The proximate analysis of the experimental ingredients revealed that, the percentage moisture content was recorded in the locust bean meal with 9.2±1.06 and the lowest was recorded in the soybean meal with 8.9±0.54. The percentage crude protein recorded was highest in the soy bean meal with 48.25±1.26 and the lowest was recorded in the locust bean meal with 44.12±1.93. There is a significance difference (p<0.05) between the ingredients. The highest percentage crude lipid was recorded in the locust bean meal with 27.60±0.52 and the lowest was recorded in the soy bean meal with 22.31±0.82. The highest percentage ash recorded was found in the soy bean meal with 7.9±0.16 and the lowest was recorded in the locust bean meal with 6.3±0.26 while the highest percentage crude fibre was recorded in the locust bean meal with 5.1±0.54 and the lowest was recorded in the soy bean meal with 4.7±0.81. The highest nitrogen free extract was recorded in the soy bean meal with 19.1±0.74 and the lowest was recorded in the locust bean meal with 8.5±0.93. There is a significance differences between the treatments (P<0.05).

The proximate analysis of the experimental diets revealed that, the moisture content was highest in diet TD5 with 8.63±1.25 and diet TD3 had the lowest with 8.23±1.28. Diet TD2 had the highest crude protein with 40.34±0.78 and the lowest was recorded in diet TD3 with 40.15±0.13. There is no significance differences (p>0.05) between the diets fed. The highest percentage crude lipid was recorded in diet TD5 with 11.09±1.37 and the lowest was recorded in diet TD1 with 10.05±0.82. Diet TD1 had the highest percentage ash of 8.41±1.61 and the lowest was recorded in diet TD5 with 7.64±0.93 while the highest percentage crude fibre was recorded in diet TD5 with 3.91±1.61 and the lowest was recorded in diet TD1 with 3.36±0.72. The highest nitrogen free extract was recorded in diet TD1 with 29.67±1.68 and the lowest was recorded in diet TD2 with 28.49±1.82. There is no significance differences (p>0.05) between the diets fed.

The growth and survival rate indices were shown in table 3 and figure 1 while the carcass composition of *C. gariepinus* fed experimental diets was shown in table 4.

The total initial weight and mean initial weight of the fish fed experimental diets were highest in diet TD5 with 187.6±0.83g and 18.76±1.63g and the lowest were recorded in the fish fed diet TD1 with 177.2±0.13g and 17.72±1.05 respectively. The mean initial length recorded was highest in the fish fed diet TD5 with 14.44±0.93cm and the lowest was recorded in the fish fed diet TD1 with 13.43±0.54cm. The highest mean final weight was recorded in the fish fed diet TD4 with 83.88±0.78g and lowest was recorded in the fish fed diet TD3 with 38.77±1.53g. The total final weight recorded was highest in the fish fed diet TD4 with 838.8±0.26g and the lowest was recorded in the fish fed diet TD3 with 387.7±0.92g. There is a significant difference (P<0.05) between the treatments. The mean final length recorded was highest in the fish fed diet TD4 with 23.79±1.83cm and lowest was recorded in the fish fed diet TD3 with 18.02±1.93cm. The total weight gain and the mean weight gain recorded were highest in the fish fed diet TD4 with 653.20±0.82g and 65.32±0.73g while the lowest were recorded in the fish fed diet TD3 with 208.10±1.28g and 20.81±1.82g respectively. There is a significant difference (P<0.05) between the treatments. The highest relative growth rate and specific growth rate recorded were highest the fish fed diet TD4 with 351.94±0.82% and 0.85±1.375 while the lowest were recorded in the fish fed diet TD3 with 115.87±0.625 and 0.43±1.27% respectively. The initial condition factor was highest in the fish fed diet TD1 with 0.7315±0.28 and the lowest was recorded in the fish fed diet TD3 with 0.5726±1.37 while the final condition factor recorded was highest in the fish fed diet TD3 with 0.6630±1.28 and

Bima Journal of Science and Technology, Vol. 7 (4) Dec, 2023 ISSN: 2536-6041

DOI: 10.56892/bima.v7i4.521

the lowest was recorded in the fish fed diet TD1 with 0.5783±0.73. The percentage survival rate recorded was one hundred (%) in all the treatment groups.

The proximate analysis of the experimental fish carcass as shown in table 4 revealed that, the moisture content was highest in the fish at initial before the commencement of the experiment with 75.85±0.26 and the lowest was recorded in the fish fed TD4 diet with 74.03±0.64. There is no significant difference (P>0.05) between the treatment groups. Fish fed TD5 diet had the highest crude protein with 64.08±0.46 and the lowest was recorded in the fish at initial with 59.95±1.74. There is no significance differences (p>0.05) between the treatments. The highest percentage crude lipid was recorded in the fish fed TD1 diet with 14.36±1.64 and the lowest was recorded in the fish at initial with 14.10±0.53. The percentage ash recorded was highest in the fish at initial with 0.75±1.83 and the lowest was recorded in the fish fed TD3 diet with 0.50±0.45 while the highest percentage crude fibre was recorded in the fish fed TD3 diet with 20.59±1.36 and the lowest was recorded in the fish at initial with 20.37±0.28. The highest nitrogen free extract was recorded in the fish at initial with 5.13±1.35 and the lowest was recorded in the fish fed TD4 diet with 0.25±0.82. There is a significant difference (P<0.05) between treatments.

The feed acceptability and nutrient utilizations indices of the fish fed experimental diets are shown in table 5.

The total feed intake, mean feed intake, weekly feed intake and daily feed intake recorded were highest in the fish fed TD4 diet with 300.3.±0.27g, 30.03±0.41g, 27.20±1.38g and 3.90±1.06g while the lowest were recorded in the fish fed TD3 diet with 118.4±0.52g, 11.84±1.64g, 10.76±0.73g and 1.54±1.93g respectively. There is a significant difference (P<0.05) between the treatments. Fish fed TD1 experimental diet had the highest feed conversion ratio (FCR) of 3.05±1.04 and the lowest was recorded in the fish fed TD3 diet with 1.76±1.72. The protein intake (PI) recorded was highest in the fish fed TD4 experimental diet with 12.01±1.37 and the lowest was recorded in the fish fed TD3 experimental diet with 4.74±0.87. The Protein efficiency ratio (PER) and gross protein value (GPV) recorded were highest in the fish fed TD1 with 7.62±0.26 and 1.00±0.23 while the lowest were recorded the fish fed TD3 with 4.39±0.62 and 0.58±1.73. Protein rating (PR) recorded was highest in the fish fed TD4 diet with 0.85±0.52 and the lowest was recorded in the fish fed TD3 diet with 0.27±0.08. the apparent net protein utilization (ANPU) recorded was highest in the fish fed TD1 experimental diet with 75.57±1.54 and the lowest was recorded in the fish fed TD4 diet with 38.55±1.94. There is a significant difference (P<0.05) between the control and other diets.

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Table 2: Proximate Compositions (% Dry weight) of Soybean Meal, Locust Bean Meal and Experimental Diets

Nutrient	Substituted Ingredients		Experimental Diets				
	Soybean Meal	Locust Bean Meal	TD1	TD2	TD3	TD4	TD5
%Moisture	8.9±0.54^{a}	9.2±1.06^{a}	8.30±0.64^{a}	8.48±1.64^{a}	8.23±1.28^{a}	8.45±0.82^{a}	8.63±1.25^{a}
%Crude Protein	48.25±1.26^{a}	44.12±1.93^{b}	40.21±1.73^{c}	40.34±0.78^{c}	40.15±0.13^{c}	40.23±1.47^{c}	40.16±0.58^{c}
%Crude Lipid	22.31±0.82^{b}	27.60±0.52^{a}	10.05±0.82^{c}	10.68±1.23^{c}	10.81±1.37^{c}	10.95±0.73^{c}	11.09±1.37^{c}
%Ash	7.9±0.16^{a}	6.3±0.26^{a}	8.41±1.61^{a}	8.21±0.18^{a}	7.92±0.29^{a}	7.87±1.63^{a}	7.64±0.93^{a}
%Crude Fibre	4.7±0.81^{b}	5.1±0.54^{a}	3.36±0.72^{c}	3.80±0.82^{c}	3.82±1.46^{c}	3.87±1.72^{c}	3.91±1.61^{c}
%NFE	19.1±0.74^{b}	8.5±0.93^{c}	29.67±1.68^{a}	28.49±1.82^{a}	29.07±0.27^{a}	28.63±0.26^{a}	28.57±1.73^{a}

Data on the same row with difference superscripts ($p < 0.05$) are significantly different

Table 3: Growth and Survival Rate Indices of *Clarias gariepinus* Juveniles Fed Locust Bean Substituted Meal Diets

Indices	Experimental Diets				
	TD1 (Control)	TD2	TD3	TD4	TD5
Inclusion levels (%)	0	25	50	75	100
Total initial weight (g)	177.2±0.13^{b}	183.2±0.53^{b}	179.6±1.05^{b}	185.6±0.27^{b}	187.6±0.83^{a}
Mean initial weight (g/fish)	17.72±1.05^{a}	18.32±1.74^{a}	17.96±0.37^{a}	18.56±1.92^{a}	18.76±1.63^{a}
Mean initial total length (cm/fish)	13.43±0.54^{a}	13.72±1.83^{a}	14.28±1.04^{a}	14.27±1.83^{a}	14.44±0.93^{a}
Mean final weight (g/fish)	52.42±1.82^{b}	43.90±1.64^{c}	38.77±1.53 ^{c}	83.88±0.78^{a}	57.40±1.47^{b}
Total final weight (g)	524.2±1.39^{c}	439.0±1.92^{d}	387.7±0.92^{e}	838.8±0.26^{a}	574±1.64^{b}
Mean final length (cm/fish)	20.85±0.92^{a}	18.80±1.06 ^{b}	18.02±1.93^{b}	23.79±1.83^{a}	21.22±1.92^{a}
Total weight gain (g)	365±0.91^{c}	255.8±0.96^{d}	208.10±1.28^{e}	653.20±0.82^{a}	386.40±0.72^{b}
Mean weight gain (g/fish)	36.5±1.93^{b}	25.58±1.04^{c}	20.81±1.82^{d}	65.32±0.73^{a}	38.64±1.83^{b}
Relative growth rate (%/fish)	205.98±1.09^{b}	139.63±1.94^{c}	115.87±0.62^{d}	351.94±0.82^{a}	205.97±1.95^{b}
Specific growth rate (%/day)	0.61±0.73^{b}	0.49±0.64^{c}	0.43±1.27^{d}	0.85±1.37^{a}	0.63±0.63^{b}
Initial Condition Factor (K_1)	0.7315±0.28^{a}	0.7094±1.38^{a}	0.5726±1.37^{c}	0.6387±1.06^{b}	0.623±1.82^{b}
Final Condition Factor (K_2)	0.5783±0.73^{b}	0.6605±0.28 ^{a}	0.6630±1.28^{a}	0.6251±0.63^{a}	0.6012±0.17^{ab}
Number Stocked	10	10	10	10	10
Number Cropped	10	10	10	10	10
Survival (%)	100	100	100	100	100

Data on the same row with difference superscripts ($p < 0.05$) are significantly different

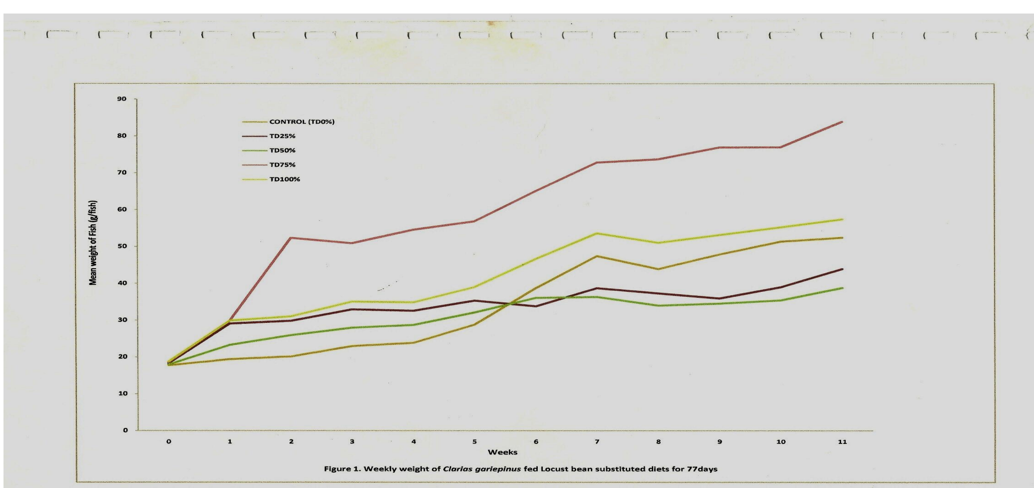

Figure 1. Weekly weight of *Clarias gariepinus* fed Locust bean substituted diets for 77days

DOI: 10.56892/bima.v7i4.521

Table 4: Carcass Composition (% Dry weight) of *Clarias gariepinu* Fed Locust Bean Meal Supplemented Diets

Compositions Inclusion Levels	Initial	TD1 (0%)	TD2 (25%)	TD3 (50%)	TD4 (75%)	TD5 (100%)
% Moisture	75.85±0.26^{a}	74.29±1.38^{a}	74.63±1.92^{a}	74.32±1.36^{a}	74.03±0.64^{a}	74.88±1.37^{a}
% Crude Protei	59.95±1.74^{b}	63.57±0.47^{a}	62.90±1.71^{a}	63.30±0.18^{a}	64.58±1.75^{a}	64.08±0.46^{a}
% Crude Lipid	14.10±0.53^{a}	14.36±1.64^{a}	14.29±1.32^{a}	14.34±1.37^{a}	14.16±0.26^{a}	14.34±1.26^{a}
% Ash (%)	0.75±1.83^{a}	0.53±0.45^{a}	0.53±0.36^{a}	0.50±0.45^{a}	0.51±0.63^{a}	0.54±0.82^{a}
% Crude Fibre	20.37±0.28^{a}	20.70±0.36^{a}	21.46±1.73^{a}	21.59±1.36^{a}	20.50±1.26^{a}	20.44±1.42^{a}
%Nitrogen Free Extract	5.13±1.35^{a}	0.84±0.26^{b}	0.82±1.41^{b}	0.27±0.74^{b}	0.25±0.82^{b}	0.60±1.72^{b}

Data on the same row with difference superscripts (P< 0.05) are significantly different

Table 5: Feed Acceptability and Nutrient Utilizations Indices of *Clarias gariepinus* Juveniles fed Locust Bean Substituted Meal Diets

Indices	Experimental Diets				
	TD1 (Control)	TD2	TD3	TD4	TD5
Inclusion Levels (%)	0	25	50	75	100
Total Feed Intake (g)	119.7±1.92^{d}	128.0±1.93^{c}	118.4±0.52^{d}	300.3±0.27^{a}	200.9±0.63^{b}
Mean Feed Intake (g of feed/fish)	11.97±0.25^{c}	12.80±0.64^{c}	11.84±1.64^{c}	30.03±0.41^{a}	20.09±1.07^{b}
Weekly Feed Intake (feed / week)	10.88±1.03^{c}	11.64±0.28^{c}	10.76±0.73^{c}	27.20±1.38^{a}	18.26±0.62^{b}
Daily Feed Intake (g/fish/day)	1.55±1.48^{c}	1.66±0.63^{c}	1.54±1.93^{c}	3.90±1.06^{a}	2.60±1.05^{b}
Feed Conversion Ratio (FCR)	3.05±1.04^{a}	2.00±1.02^{b}	1.76±1.72^{c}	2.18±0.28^{b}	1.92±0.93^{c}
Protein Intake (g/100g of diet/fish)	4.79±0.28^{c}	5.12±0.82^{c}	4.74±0.87^{c}	12.01±1.37^{a}	8.04±0.26^{b}
Protein Efficiency Ratio	7.62±0.26^{a}	5.00±1.83^{b}	4.39±0.62^{c}	5.44±0.81^{c}	4.81±1.73^{c}
Gross Protein Value	1.00±0.23^{a}	0.66±0.92^{b}	0.58±1.73^{b}	0.71±1.04^{b}	0.63±1.15^{b}
Protein Rating	0.47±0.43^{a}	0.33±1.82^{a}	0.27±0.08^{a}	0.85±0.52^{a}	0.50±0.18^{a}
Apparent Net Protein Utilization (%)	75.57±1.54^{a}	57.62±0.82^{b}	70.68±1.54^{a}	38.55±1.94^{d}	51.37±0.38^{c}

Data on the same row with difference superscripts (p< 0.05) are significantly different

DISCUSSION

This study revealed that, increase in weight was recorded in all the treatments was an indication of positive responses of the fish to all the diets and that the protein content in the experimental diets was adequate enough to provide for growth and dietary energy supply of the fish, these confirmed the work reported by (Fagbenro and Arowosoge, 1991).

The quadratic equation pattern observed in this experiment for specific growth rate agrees with the pattern noted for *Heterobranchus longifilis* fed termite meal diets by Sogbesan and Ugwunba (2008) and for *C. gariepinus* fed cocoyam meal (Aderolu and Sogbesan, 2010). Similar observations agreed with Hassan *et al.,* (1995) who reported on *Cirrihinus mrigala* fingerlings and fry fed diets of different protein contents.

The condition factor of fish varies according to the physiological factors and fluctuates according to different stages of development agreed with Odedeyi *et al.,* (2007). This statement could justify the reason for variations in the initial and final condition factors for fish in the same treatment.

In this study, the inclusion levels of locust bean meal appeared to be an important factor in influencing growth, feed utilization and nutrient utilization of feeding *C. gariepinus*. The growth in terms of weight gain and specific growth rate increased with increase in the inclusion levels of locust bean meal as a complementary protein to 75% inclusion. These results is in conformity with Osuigwe

(2003) who reported on feeding *Heterobranchus longifilis* with raw and boiled mucuna. Those fed boiled mucuna performed better. The reason being that treatments given to legumes reduced the effect of the anti-nutritional factors. The negative effects of some of these anti-nutritional factors had been reported by Sogbesan *et al.* (2006).

The 75% inclusion level reported in this study which gave the best mean weight gain and specific growth rate indicates that locust bean cannot fully replace soybean meal in fish diet rather it can only be used as a complementary source of proteins. This observation is in agreement with that reported by Alegbeleye *et al.* (2001). Some essential nutrients (amino acids / fatty acids) needed for optimum growth by *C. gariepinus* are not fully present in locust bean meal rather could be shared when soybean meal is included (Eyo and Olatunde, 2001). Hossain and Jauncey (1989) had earlier reported that a mixture of protein sources was much more effective than single source of protein.

Desilva and Anderson (1995) reported that, protein efficiency ratio is a measurement of protein effectiveness to provide the essential amino acids needed by the fish. They also reported that this index has also been associated with fat deposition in the fish muscle and that higher protein efficiency ratio is an indication of diet that produces fatty fish. The protein efficiency ratio range of 4.39±0.62 and 7.62±0.26 recorded in this study favour fat deposition. This could also be the scientific reason for low apparent net protein utilization in fish fed 75% locust bean meal (TD4) which had the highest feed intake and protein rating. The effect of the crude lipid in the diet might be responsible for sparing effect on the protein contents of the diets.

The crude protein reported for each diet is in accordance with the optimum dietary protein 40.0% required by *C. gariepinus* for better growth and development as reported by Eyo and Olatunde (2001). Zeitler *et al.* (1984) documented that protein is the basic nutrient that cannot be compromised in the choice of ingredient and since each diet was adequately utilized by fish, it reflected that they contained the optimum required nutrient. The lipid content of each diet increased with increase in the inclusions level of locust bean meal. This lipid may have a sparing effect on the dietary protein and complements its utilization (Okoye *et al.,* 2001).

Conclusion

The results obtained from the experiments indicate that locust bean meal could be used to supplement soybean meal or totally replace, but the best result will be from 75% inclusion level of locust bean for sustainable aquaculture. This shows that locust bean meal could do better than soybean meal in fish feed. Different processing methods could be used if they will improve the nutrient value of *Parkia biglobossa* and utilization by fish.

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