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The growth and nutrient utilization of *Clarias gariepinus* (Burchell 1822) fed *Parkia biglobosa* meal based diet.

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ABSTRACT

The study investigated the growth and nutrient utilization of *Clarias gariepinus* fingerlings fed five iso-nitrogenus diets, containing fermented locust bean meal, at varying inclusion level (0%, 10%, 20%, 30%, 40%, 50%) as replacement for fishmeal. Eight weeks feeding trial was conducted using *Clarias gariepinus* fingerlings which were randomly distributed into 12 bowls at a stocking rate of 20 fish per bowl, in replicates per treatment. The experimental design was completely randomized. The fish were fed at 5% body weight, twice daily. Six isonitrogenous (35% crude protein) diets containing fermented locust beans meal at varying replacement level for fish meal designated as diet A0, B10, C20, D30, E40 and F50 were formulated and fed to the fish. All the experimental fish fed the various treatments showed increase in weight, carcass crude protein and lipid content, compared to the initial value indicating positive contribution of the various diets to growth of the fish. The results obtained indicated there was no significant difference (P>0.05) in the mean weight gain, percentage weight gain. Specific growth rate, food conversion ratio and protein efficiency ratio among the fish fed the various diets. The highest weight gain was recorded in the fish fed the control diet (2.47g) while the least was recorded for the fish fed the B20 diet (2.18g). This study revealed that locust bean seed if processed, as in fermentation, could replace fishmeal up to 50% level in the diet of C. fish. This level of inclusion would be a significant replacement for the expensive fishmeal in feed manufacturing.

Keywords: Parkia biglobossa, fermentation, growth, catfish, weight, diet

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INTRODUCTION

Aquaculture alone has the potential to supply the national requirement for fish if properly harnessed, but one of the major problems faced by fish farmers today is the provision of nutritive and cheap feed to reduce cost of production. Nigerian aquaculture industry is currently faced with the problem of inadequate supply and prohibitive cost of quality fish feed (Fagbenro and Adeparusi, 2003; Omitoyin 2005). The high cost and fluctuating quality as well as the uncertain availability of fish meal have led to the need to identify alternative protein sources for fish feed formulation.

The inclusion of plant protein sources in the ration of fish requires investigation on limiting factors in the plant ingredients such as high crude fibre content and anti-nutritional factors as earlier investigations on some plants have shown that their excessive inclusion in the feed may result in slower growth rates and general poor performance of cultured fish species (Francis *et al.,* 2001; Alegbeleye *et al*., 2001). Ordinarily, plants provide nearly two thirds of the world supply of food protein for human and animal in which 10-15% come from legumes. Among the leguminous plants used by man is the African locust bean tree (*Parkia biglobosa*). The African locust bean was found very popular use especially the fermented 'dawadawa' form, which is the product of the seeds which serves as an ingredient in the preparation of various stews, soups and sauces for the consumption of cereal and also proteinous substitute to fish (Falaye, 1992).

Parkia biglobosa is rich in protein, lipids and vitamin B_2, but deficient in the amino acid such as methionine, cystine and tryptophan. *Parkia biglobosa* is reported to be a good source of potassium and phosphorus with a high unsaturated-saturated fatty acid ratio with linoleic acid having the highest level. Unlike most other legumes, it has appreciable quantity of sulphur-containing amino acids and thus ideal for the fortification applications with various food formulations.

The utilization of locust bean in fish nutrition as replacement for a protein source i.e groundnut cake was reported to improved production performance, nitrogen retention and feed utilization, with varied results (Bridget *et al*., 2004; Alabi *et al*., 2005).

Fermentation has been reported to destroy some natural toxins which may occur in locust beans thus, improve the nutritive-value, increase digestibility and enhance growth (Bridget *et al*., 2004). Ayanwale and Ari (2002) and Dawodu (2009) found a positive attribute for fermented locust beans as against the unfermented locust bean which was said to inhibit growth of animals due to less protein quality and essential vitamins.

It has also been reported that locust bean is rich in essential amino acids necessary for growth and development. Also present are other amino acids such as arginine and histidine (Hassan and Umar, 2005). Protein requirement is given high priority in any nutritional study because it is the single nutrient that is required in the largest quantity for growth and development and the most

The protein content of the seeds varies between 25 and 30% and has the potential to be utilized in livestock feeding (Olomu, 2011). Apart from protein, legumes provide a high proportion of complex carbohydrates, starch, edible oil and fibre (Pirman *et al*., 2001).

Parkia biglobosa contains phytate, oxalates, saponin, tannins, trypsin inhibitors and cyanogenic glycosides, which are known as secondary metabolites and are biologically active (Soetan and Oyewole, 2009). The bioavailability of the essential nutrients could be reduced by the presence of these anti-nutritional factors (Soetan *et al.,* 2014). They have been reported to limit the utilization of locust bean as feed ingredient by animals (Apata, 2003). Anti-nutritional factors can cause poor availability and/or utilization of nutrients, producing effects which include reduction in food intake, neurological effects and even death (Osagie, 1998).

This research was designed to investigate the effects of the inclusion of *P. globossa* in practical diets on the growth and nutrient utilization of *Clarias gariepinus*.

MATERIALS AND METHOD

Procurement of the Experimental Fish

Two hundred fingerlings of *Clarias gariepinus* (2.14.02 ±0.43g) was purchased from the Production farm of the Fisheries Division of the Ministry of Agriculture, Ado Ekiti, Ekiti State Nigeria. The fish were transported to the Farm house of the Department of Zoology and Environmental Biology, Ekiti State University, Ado-Ekiti. They were distributed into plastic bowls filled to one third capacity with clean water.These were acclimatized for two weeks during which they were placed on the commercial diets (Copens feed). The second phase which involves feeding the fish with the formulated feed lasted for eight weeks.

Preparation of Locust Bean (*Parkia biglobosa*) meal

2kg of fermented locust beans was purchased at the Iworoko market, Iworoko Ekiti and sun dried for two days. This was milled into a meal using a Hobart mill. It was later sundried and packed in polyvinyl bags and stored till ready for use in diet formulation.

Experimental Feed Formulation

Feedstuffs such as fish meal, maize meal, vitamin premix, methionine and lysine which were used in formulating the feed were purchased from Afe Babalola Farm located in Afe Babalola University, Ado Ekiti, Ekiti Sate, while other feedstuffs such as salt and groundnut oil were purchased in the open king’s market at Ado-Ekiti. The experimental diets were formulated using Pearson's Square method to obtain 35% crude protein diets in which fermented locust beans replaces fishmeal component of the diet in graded level (0%, 10%, 20%, 30%, 40%, 50%) . The diets were tagged diets A0, B10, C20, D30, E40 and F50 respectively. The various diets were properly mixed together and pelleted to a particulate size of 2mm. Mixing/pelleting was done in the Fishery Department of Federal University of Technology, Akure (FUTA), Ondo State. The pelleted feeds were sun dried for some days in order to prevent moulding. The dried feeds were kept inside well labelled polythene bags in the Postgraduate Research Laboratory for use. Samples of the various diets were subjected to proximate analysis in the laboratory. The feed formulation and proximate composition are shown in Table 1 and 2.

Table 1: The feed formulation and proximate compositions (% dry matter) of the various diets used to feed *C. gariepinus*.

Ingredients	A0	B10	C20	D30	E40	F50
Fish meal	43.10	38.79	34.48	30.17	25.86	21.55
Locust beans	_	4.31	8.62	12.93	17.24	21.55
Maize	51.40	51.40	51.40	51.40	51.40	51.40
Rice bran	2.50	2.50	2.50	2.50	2.50	2.50
Lysine	0.50	0.50	0.50	0.50	0.50	0.50
Methionine	0.50	0.50	0.50	0.50	0.50	0.50
Groundnut oil	0.50	0.50	0.50	0.50	0.50	0.50
Salt	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin premix	0.50	0.50	0.50	0.50	0.50	0.50

Experimental Design

The experimental fish were starved for about 24 hours after acclimatization to empty the guts, to avoid lopsided initial weight and also create appetite for the experimental diets. At the end of the acclimatization period, eighteen bowls were set up and 15 fish were randomly distributed into each bowl. The bowls were labeled accordingly. Total weight and standard length measurements were taken fortnightly. Bi-weekly, the weight (g) was taken using a Mettler top loading balance and the standard length (cm) with a graduated ruler. The fish initial weight ranged from 25.04-37.22 g with a mean weight of 31.02 ±03g. The initial mean standard length ranged from 10.13-11.27cm.

Manual administration of feed to the fish was done twice daily between 9:00-10:00am and 6:00-7:00pm, at the rate of 5% of the body weight per day, for 8weeks. Fifty percent water change was done every three days and complete water change carried out at the end of every two weeks.
The proximate analysis of the carcass of the experimental fish at the beginning and the end of the feeding trials were done.

Growth and Feed utilization parameters

The growth parameters were calculated as follows, using the methods of Bagenal (1978)

$$SGR = \frac{\ln W_2 - \ln W_1 \times 100}{T-t}$$

Where W_1 is the initial weight (gram at time t)

W_2 is the final weight (gram at time T).

$$FCR = \frac{\text{Weight of food consumed per fortnight}}{\text{Weight gained by fish per fortnight}}$$

Weight gain (g) was calculated as the difference between the initial and final weight of the fish:

Weight gain= Final weight - Initial weight

$$\text{Survival} = \frac{\text{Total fish number harvested X 100}}{\text{Total fish number stocked}}$$

Percentage weight gained(%WG)= Wt-Wo x 100

Where W_O = Initial Weight

Wt = weight at time t.

BIOCHEMICAL ANALYSIS

Samples of the different diets were taken to the laboratory for proximate analysis. Three fish samples were removed from the initial stock and three from each triplicate of the dietary treatments. They were filleted separately and oven dried. These were ground with mortar and pestle. From each composite fish sample; 2g was taken for proximate analysis according to the method of Association of Official Analytical Chemist (AOAC, 2006).

STATISTICAL ANALYSIS

All biological data generated from proximate analyses were subjected to a non-parametric t-test

(Mann- Whitney U-Wilcoxon Rank Sum W – test) for comparison of means within a treatment,

while the Turkey–HSD one way Analysis of Variance (ANOVA) was used for between

treatments comparison, at the 5% level of significance (Duncan 1995).

RESULTS

Table 2 shows the proximate composition of fermented locust beans. The result showed high level of protein (17.01%), fat (18.33), fibre (11.69%) and carbohydrate (21.98%).

Table 2: The proximate composition of fermented locust beans

Parameter	Composition (%)
Ash Content	3.77
Moisture Content	26.81
Crude Protein	17.01
Fat Content	18.33
Fiber Content	11.69
Carbohydrate	21.98

Table 3 shows the proximate composition of the experimental diets. The crude protein content of diet A10 (42.94) was significantly higher (p<0.05) than the control and other diets. The fat content of diet B20 and C30 (1.10) were not significantly different (p>0.05) from one another but significantly different (p<0.05) from the control and all other diets. The moisture content was higher in diet A0 (13.50) and least in diet F50 (11.64). The crude fiber content was highest in diet F50 (4.39) and least in A0 (0.39). The ash content was highest in diet A0 (10.29) and least in diet F50 (7.41). The carbohydrate content was highest in diet F50 (41.42) and least in diet A10 (33.96).

Table 3: Proximate composition (gm^{-100g}) of the experimental diets

	Composition %					
Parameters	A0	B10	C20	D30	E40	F50
Moisture	13.50^{a}	13.29^{a}	12.70^{b}	12.61^{b}	12.03^{b}	12.64^{ab}
Ash	10.29^{a}	9.31^{ab}	8.99^{b}	8.67^{b}	8.02^{b}	7.41^{b}
Crude Protein	40.37^{a}	42.14^{a}	38.25^{ab}	39.37^{ab}	41.19^{ab}	38.51^{ab}
Crude fibre	0.39^{a}	2.37^{b}	3.29^{b}	3.87^{bc}	3.92^{bc}	4.39^{d}
Ether Extract	1.20^{a}	0.87^{ab}	1.10^{b}	1.10^{b}	0.99^{ab}	1.07^{ab}
Carbohydrate	35.51^{a}	33.96^{a}	38.65^{b}	38.15^{b}	37.47^{b}	41.42^{b}

Note: Means with the same letter are not significantly different (P>0.05)

Table 4 shows the growth response and feed utilization of *Clarias gariepinus* fed the various diets.

The survival of the fish fed the various diets was high and not significantly different (p>0.05) from one another. The specific growth rate (SGR) of fish fed the trial diets were not significantly different (P>0.05) from one another, but significantly lower (P<0.05) than those fish fed the control diet. The percentage weight gain of the fish fed the trial diets were not significantly (P>0.05) different from one another, but these were significantly lower than those fish fed the control diet. Fish fed diet B20 had the lowest percentage weight gain (90.08%). There was no significant difference (P>0.05) in the food conversion ratio (FCR) and protein efficiency ratio (PER) of the fish fed the different diets. The FCR ranged from 1.63-1.87 and the highest value was recorded for diet F50 (1.87) while the lowest mean value was recorded in diet A0 (1.63).

Table 5: Growth performance and nutrient utilization of fish fed fermented locust beans.

Parameters	**A0**	**B10**	**C20**	**D30**	**E40**	**F50**
Mean Initial Weight (g)	2.40^{a}	2.41^{a}	2.42^{a}	2.40^{a}	2.41^{a}	2.42^{a}
Final Weight (g)	4.87^{a}	4.65^{a}	4.60^{ab}	4.69^{ab}	4.60^{ab}	4.61^{ab}
*MWG	2.47^{a}	2.24^{ab}	2.18^{b}	2.29^{ab}	2.19^{b}	2.19^{b}
% Weight Gain	102.9^{a}	92.9^{b}	90.08^{b}	95.41^{ab}	90.87^{b}	90.49^{b}
*SGR	1.58^{a}	1.56^{a}	1.55^{a}	1.54^{a}	1.49^{a}	1.53^{a}
*FCR	1.63^{a}	1.68^{a}	1.80^{ab}	1.82^{b}	1.83^{b}	1.87^{b}
*PER	0.24^{a}	0.21^{a}	0.23^{a}	0.19^{a}	0.24^{a}	0.23^{a}
% Survival	92^{a}	93^{a}	97^{b}	97^{b}	93^{ab}	97^{b}

Note: This table compares the mean of each parameter for all dietary treatments. Suffixes of different letters indicate statistical significant difference (P<0.05) among means and same letters indicate no significant difference (P>0.05). All inferences should be done along the rows. *MWG=Mean weight gain, SGR=Specific growth rate, FCR=Food conversion ratio, PER=Protein efficiency ratio

Table 6 shows the proximate composition of the carcass of the fish fed the experimental diets.

Consumption of the various diets led to increase in the crude protein contents of the carcass of the fish, when compared with the initial value (48.51%). There was no significant difference (P>0.05) between the crude protein of the fish carcass fed the different diets but the fish fed the control diet recorded the highest value while the fish fed diet D30 recorded the least. The crude lipid content of the fish fed the different diets differ and did not follow a regular pattern. However, it could be stated that the crude lipid of the carcass of the fish fed the experimental diets were significantly higher (P<0.05) than the initial sample, but significantly lower (P>0.05) than those of the fish fed the control diet. The lowest value was recorded for the fish fed the B20 diet. The initial fish had the highest moisture content (12.45%) and least was recorded fish fed diet D30 (10.61%). The highest ash content was recorded in diet C30 (11.81%) and least in control diet (9.11%).

Table 6: The proximate composition of the carcass of *C. gariepinus* fed the experimental diets

Parameter	Initial	A0	B10	C20	D30	E40	F50
Crude lipid	9.17	12.66	11.32	10.29	11.51	12.22	12.70
Crude Protein	52.51	63.20	60.21	60.30	58.92	62.51	64.40
Moisture	12.45	11.76	10.95	10.81	10.80	10.61	11.62
Ash	9.11	9.60	10.32	11.81	9.53	11.14	10.84
Nitrogen Free Extract	2.76	5.33	7.20	6.79	4.26	3.52	3.44

DISCUSSION

From the results shown above, fermenting seeds of the African locust bean seeds increased the crude protein than that obtainable in the raw seeds. The crude protein of the fermented locust bean (17.01%) was considered high, but this figure is much lower than recorded by some previous workers (Ibrahim and Antia, 1986; Fetuga *et al*., 1973; Olaniyi *et al*., 2010). Raw locust bean seeds have been shown to contain some anti-nutritional factor; high tannin, saponins, cyanide, oxalate and phytic contents. These elements are capable of retarding growth in animals by impairing digestion, and subsequently leading to mortality. Processing African locust bean must have reduced these anti-nutritional factors, as high level of survival was recorded.

The crude protein contents of the experimental diets (38.15% - 42.14%) were within the range recommended in *C. gariepinus* formulated test diets and it met the protein requirements (30% - 40%) recommended as being optimum for growth in *C. gariepinus* culture.

All the experimental fish fed the various treatments showed increase in weight, which indicates that the fish samples were able to convert the feed protein to extra muscles. The performance was an indication of positive contribution to growth of the fish. Data on gross body composition of an animal provides specific information on its development and physiological state (Adewumi, 2005). The fish carcass crude protein was generally higher than the initial fish carcass protein. The weight gained could be attributed to protein synthesis of new tissues which ultimately led to increase in body carcass protein.

The ability of *Clarias gariepinus* fingerlings to readily accept the experimental diets as shown by the nutrient utilization parameters and high rate of survival, is an attestation to hitherto known ability of this fish to utilize varieties of food items, an attribute that endears it to aquaculture (Adewumi, 2012). Weight gain and species growth rate are usually considered as the most important measurement of productivity of diets (Adesina *et al*., 2013). That there was no significant difference (P>0.05) in the food conversion ratio (FCR) and protein efficiency ratio (PER) of the fish fed the different diets is a reflection of the fact that the locust beans contains nutrients that were adequately utilized by the fish. However, the output of the trial diets were lower than those fish fed on control diet. This can be explained by the fact that diets containing *P. biglobossa* had high fibre content. Clarias has been reported to have poor handling of high level of fibre in diets (Jauncey, 1998).

Protein requirement is given high priority in any nutritional study because it is the single nutrient that is required in the largest quantity for growth and development and also the most expensive ingredient in diet formulation (Lovell, 1989; NRC, 1993). Dietary lipids function as a ready source of energy for fish and also provide essential fatty acids which are needed for fish growth and survival. Fish generally require omega-3 fatty acids rather than omega-6 fatty acids in contrast to terrestrial animals which require omega-6 fatty acids (Kanazawa, 2000).

Cruz (1975) stated that carcass composition should reflect the diet fed to fish. From the results of this study, it was discovered that fermented locust bean meal (*P. biglobosa*) could replace fishmeal to a level of 50% without any deleterious effect on the fish. This is in agreement with some previous workers (Olaniyi *et al*., 2010; Mohammed and Mohammed, 2014). Mohammed and Mohammed (2014) stated that fermented locust bean meal could economically replace fish meal up to 100% in the diet of *Clarias gariepinus* fingerlings, without any adverse effect on growth and blood profiles.

CONCLUSION

Fermentation improved the nutrient composition of the locust bean seeds as was observed in this work. Feeding processed African locust bean seeds does not adversely affect the fish as there was improved growth performance of Clarias fed these diets even up to 50% fishmeal replacement level. This level of inclusion would be significant replacement for the expensive fishmeal in feed manufacturing. Locust bean is a readily available agricultural product that can be utilized for sustainable feed production, compared with fish meal.

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