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# Effects of Replacing Soybean Meal with Baobab (*Adansonia digitata*) Seed Meal in the Diets of *Clarias gariepinus* (Burchell, 1822) Fingerlings

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## ABSTRACT

Utilization of plant protein sources in aquaculture has continued to produce more promising results towards alleviating high cost of feeding. This study examined the effect of partial replacement of soybean meal (SBM) with baobab seed meal (BBSM) in the diet of *C. gariepinus* fingerlings (3.66±0.37 – 4.16±0.31 and 7.03±0.33 to 7.26±0.57cm standard length). Four iso-nitrogenous (35% crude protein) diets were formulated to replace SBM with BBSM at the rates of 0, 10, 20, and 30% inclusion levels. The experimental diets were fed to fingerlings for 12 weeks in triplicates in 2 x 2 x 1.2 m outdoor concrete ponds partitioned into 4. The fish were stocked at 10 fish/1m2. The result shows that mean weight gain, Specific growth rate, Feed conversation ratio and survival were higher in fingerlings fed 10 % BBSM. However, final weight was higher in the control diet. Final weight, feed intake, food conversion ratio, specific growth rate and protein efficiency ratio values were not significantly different (p<0. 05) among the entire treatments. Baobab seed meal can therefore be used to replace soya bean meal in the diet of *Clarias gariepinus* fingerlings diet at 10% inclusion level without compromising growth and nutrient utilization.

**Keywords:** Baobab seed meal, *Clarias gariepinus*, Growth performance

## INTRODUCTION

Fish demand is increasing as a result of the increasing world population, higher living standards and the overall image of fish among consumers (Cahu*et al*., 2004). Fish as a whole has a lot of potential and can therefore be expected to provide relief from malnutrition, especially in developing countries (Ashraf *et al*., 2011). Fish like other animals requires a variety of different nutrients in sufficient quantities to flourish and maintain other bodily functions (Ashraf *et al*., 2011). *Clarias gariepinus* is one of the most popular culturable fish species commonly cultured by fish farmer in Nigeria. This is due to its ability to withstand harsh environmental conditions were most culturable species can hardly thrive. However, successful production of this Aquaculture candidate has been hampered by the high cost of feed and competition for conventional feed ingredients.

Feed is the largest single cost item for livestock, including fish production accounting for 60%-80% of the total cost (Aduku, 1993; Adegbola, 2004; Lawrence *et al*., 2008). This has been attributed to the competition that exists between man and animal for available feed resources and the growing livestock production (Robinson and Singh, 2001). This has greatly reduced profit margin and placed a great limitation on the rate of expansion of the livestock industry, including fish production in most of these industries (Oladunjeye *et al*., 2014). One of the best methods of alleviating this problem is the use of lesser known and unconventional feed ingredients.

The baobab seed meal is a non-conventional feeding stuff of great potential for inclusion into fish feed. Baobab tree (*Adansonia digitata*) is a drought and a fire resistant tree that is found in most part of Africa including the desert (FAO, 1988). This tree produces all year round in the savanna and derived savanna area of Nigeria. Though the leaves are used for soup in the drier part of Nigeria, the seeds are not usually consumed and are not subjected to any other use in the forest and derived savanna region of Nigeria. Baobab seed is rich in protein and contains a substantial amount of energy (Mwale *et al*., 2008) and the fruit pulp is rich in vitamin C (Sidibe *et al*., 1998). The use of baobab seed meal in formulating *C. gariepinus* feed will reduce to a greater extent the competition for conventional feed ingredients such

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as soya bean meal. This study was therefore carried out to evaluate the possibility of replacing soybean meal in the diets of *C. gariepinus*.

## MATERIALS AND METHODS

### Study area

The feeding trial was conducted in the experimental concrete tanks of the Department of Fisheries, University of Maiduguri, Nigeria.

### Collection of feed ingredients and formulation of experimental diet.

The ingredients used to formulate the experimental diet, which includes Baobab Seed Meal (BBSM), Soybeans, fish meal, maize and fixed feed ingredients (vitamin and mineral Premix, Lysine and methionine, salt and palm oil) were purchased from local markets in Maiduguri. The feed ingredients were separately processed and milled to a fine powder using hammer miller. The milled ingredients were kept in an airtight plastic container until required.

### Processing of baobab seed meal (BBSM)

Baobab (*Adansonia digitata*) seed was procured from a local market in Maiduguri. The seed was washed with tap water to remove the pulp and fibres and then boiled for 60 minutes at an exchange of water at 20 min interval. In each case the water was allowed to boil at $100^0$C. At the end of boiling, the hot water was decanted properly using plastic basket. Thereafter, the boiled seed was sun-dried before grinding into powder using a domestic hammer mill. The powdered BBSM was kept in an airtight plastic container at room temperature until required.

### Experimental design

Different Baobab seed meal (BBSM) replacement levels of soybean meal (SBM); 0 (control), 10, 20, and 30 % were coded as D1, D2, D3, and D4, respectively were incorporated into the experimental diet (Table 1).

Table1: Composition of the experimental diet

| **Feed ingredients (%)** | **Baobab seed meal inclusion level (%)** | | | |
|---|---|---|---|---|
| | **0** | **10** | **20** | **30** |
| BBSM | 0.00 | 7.82 | 15.62 | 23.43 |
| Soybean meal | 31.25 | 31.25 | 15.62 | 7.82 |
| Fish meal | 31.25 | 31.25 | 31.25 | 31.25 |
| Maize | 34.48 | 34.48 | 34.48 | 34.48 |
| Premix | 0.50 | 0.50 | 0.50 | 0.50 |
| Methionine | 1.00 | 1.00 | 1.00 | 1.00 |
| Lysine | 0.50 | 0.50 | 0.50 | 0.50 |
| Vegetable oil | 0.30 | 0.30 | 0.30 | 0.30 |
| Lysine | 0.50 | 0.50 | 0.50 | 0.50 |
| Salt | 0.20 | 0.20 | 0.20 | 0.20 |
| Starch | 0.50 | 0.5 | 0.50 | 0.5 |
| Total | 100 | 100 | 100 | 100 |
| **Proximate Composition** | | | | |
| Dry matter | 96.00 | 97.00 | 97.00 | 96.00 |
| Protein | 35.31 | 34.58 | 35.40 | 35.29 |
| Fiber | 12.16 | 7.83 | 9.66 | 9.50 |
| Fat | 7.33 | 8.00 | 8.33 | 8.33 |

This was followed by continuing mixing until homogenous products were achieved. A dough was formed by the addition of water and thorough mixing for each treatment. The dough was pelleted into different containers using manual pelleting machine through 1mm diameter dice. Triplicate samples of each experimental diet were analysed for proximate composition using the AOAC (2000) standard.

The BSM based diets were allocated to 10 fish/m$^2$ (concreted fish tank partitioned into 4 with 1mm net) in a complete randomized design (CRD). Prior to the commencement of the experiment, all fish were starved for 24 hours. This practice is to eliminate variation in weight due to residue food in the gut and also to prepare the gastrointestinal tract for the experimental diets, while at the same time to increase the appetite of the fish. During the experiment, fish were fed at 5% of their body weight twice daily with half the daily ration fed in the morning and the other half fed in the evening. The fish were weight twice monthly to adjust their feed. The fingerlings were reared for a period of 12 weeks. At the end of the culture period, final weight (g), final length (cm), the mortality rate and total feed consumed (g) were recorded. The following growth parameters were determined:

a) Weight gain: WG = $W_2$ -$W_1$, where $W_2$= final weight (g) and $W_1$ = initial weight (g)
b) Mean daily weight gain (g/day) = $W_2$ -$W_1$/t, where $W_2$= final weight (g) and $W_1$ = initial weight (g), t = rearing period.
c) Specific Growth Rate (SGR %/day) = Ln$W_2$-Ln$W_1$/t (day) × 100, Where Ln = base of natural logs, $W_2$= final weight (g) and $W_1$ = initial weight (g), t = culture period
d) Survival (%) = Number of fish harvested/Number of fish stocked × 100
e) Feed Conversion Ratio (FCR) = feed fed/weight gain
f) Protein Efficiency Ratio (PER) = Weight gain (g)/Protein intake (g)
g) Condition factor (k) = $(W/L^3) \times 100$

**Water quality parameters**

Water quality parameters were monitored every week throughout the feeding trial. Water temperature (°C) and pH were measured daily with a combined digital pen meter, while Dissolved oxygen (mg/l) was measured using the DO meter.

**Statistical analysis of data**

Data obtained from the experiment were subjected to one-way analysis of variance (ANOVA). Duncan's multiple range test (Duncan, 1995) were used to determine the significant differences between the means at 95 % confidence level (p = 0.05) with the aid of SPSS version 20.

**RESULTS**

Growth performance of *C. gariepinus* fed baobab seed meal is shown in Table 2. The highest mean final weight was observed in the fingerlings fed the control diet, followed by 20 % BBSM based diet. There was no significant difference (p>0.05) between the final weight values of the fish fed controlled diet compared to the entire treatments. The mean weight gain was higher (23.06±0.23) in fingerlings fed with 10% BBSM replacement, followed by the controlled and fish fed 20 % BSM replacement (21.20±2.55 and 20.26±0.88, respectively) diet. No significant variation was observed between the weight gain values of fish fed 10 % BBSM based diet compared to the other diets.

The specific growth rate was observed to be higher (1.47±0.34 %/day) in fish feed 10 % BBSM. There was no significant difference (p>0.05) between the SGR values in treatment 2 compared to the entire treatments. The mean survival rate ranged from 60% to 100%. However, was significantly (p<0.05) higher in fish fed 10 % BBSM replacement, followed by those fed the control diets.

The mean total feed intake by the experimental fish ranged from 21.33 to 26.56g, with the highest value (26.56g) recorded in the control. The lowest fed intake (21.33g) was recorded in treatment4. There was a significant difference (p<0.05) the feed intake values of fish fed the control diets compared with the entire treatments.

Feed conversion ratio was between 1.00±0.00 and 1.26±0.23. With 10% BSM replacement having the highest FCR value of 1.00, followed by fish fed 20 and 30% BBSM with the same value of 1.16, respectively. There was no significant (p>0.05) difference between the FCR values of the control compared to the entire treatments. The protein efficiency ratio (PER) ranged from 2.20±0.10 to

2.76±2.33. The PER was highest at 10% replacement level of BSM. No significant difference (p<0.05) was observed between the PER values of fish fed the control diet compared to the rest of the experiments.

The condition factor ranged from 0.85 to 1.20. Condition factor was not significantly different (p>0.05) between the fingerlings fed control diet compared to fingerlings fed 10% and 20%BBSM diet. But was significantly different (p<) in fish fed 30% BBSM.

Table 2: Mean (±SE) Growth performance of *Clarias gariepinus* fed baobab based diets

| **Parameters** | **Baobab seed meal inclusion level of (%)** | | | |
|---|---|---|---|---|
| | **0** | **10** | **20** | **30** |
| Initial length (cm) | 7.20±0.32[a] | 7.03±0.33[a] | 7.13±0.50[a] | 7.26±0.57[a] |
| Final length (cm) | 13.70±0.75[a] | 13.13±0.31[a] | 13.50±0.10[a] | 13.46±0.20[a] |
| Initial weight (g) | 4.06±0.17[a] | 4.03±0.17[a] | 4.16±0.31[a] | 3.66±0.37[a] |
| Final weight (g) | 25.30±2.72[a] | 27.13±0.13[a] | 24.40±0.52[a] | 21.06±2.17[a] |
| Weight gain (g) | 21.20±2.55[ab] | 23.06±0.23[a] | 20.26±0.88[ab] | 17.36±1.81[b] |
| Feed intake | 26.56±1.68[a] | 23.40±0.03[a] | 25.63±0.03[a] | 21.33±2.17[a] |
| Specific growth rate (%/day) | 1.40±0.61[a] | 1.47±0.34[a] | 1.36±0.73[a] | 1.35±0.41[a] |
| Food conversion ratio | 1.26±0.23[a] | 1.00±0.00[a] | 1.16±0.06[a] | 1.16±0.33[a] |
| Protein efficiency ratio | 2.30±0.40[a] | 2.76±2.33[a] | 2.20±0.10[a] | 2.30±0.05[a] |
| Survival rate (%) | 60.00±15.27[b] | 100.00±0.00[a] | 93.33±3.33[a] | 86.66±6.66[ab] |
| Condition factor | 0.99±0.11[ab] | 1.20±0.90[a] | 0.98±0.00[ab] | 0.85±0.06[b] |

Means with same superscripts on the same row are not significantly different (P>0.05)

### Water quality parameter

Table 3 shows the some water quality parameters recorded during the experiment. Water quality parameters recorded in this experiment were within the recommended values of Boyd (1979). The mean water temperature in the experiment tanks ranged from 27.80ºC to 29.50ºC, while dissolved oxygen varied from 5.10mg/l to 6.10mg/l and pH value ranged from 7.5 to 8.0.

Table 3: Some (±SEM) water quality parameters recorded during the experiment.

| **BBSM inclusion level (%)** | **Temp. (ºC)** | **Dissolved oxygen (mg/l)** | **pH** |
|---|---|---|---|
| 0 | 28.5 ± 0.23 | 5.1 ± 0.28 | 7.6 ± 0.6 |
| 10 | 27.8 ± 0.54 | 5.3 ± 0.01 | 7.5 ± 0.5 |
| 20 | 29.0 ± 0.30 | 5.5 ± 0.05 | 7.6 ± 0.1 |
| 30 | 29.5 ± 0.18 | 6.1 ± 0.06 | 7.5 ± 0.1 |

Means having in the same column have similar superscript are not significantly different (p>0.0)

In the present study, there was a general increase in weight gain in all treatments, thus indicating that the fish were able to convert feed protein in extra muscles. Weight gain and specific growth rate are usually considered as the most important measurement of productivity of diets (Hossain*et al*., 1995; Omitoyin and Faturoti, 2000). The increase in weight gain reported in all the treatments indicated that the fish responded positively to all the diets and that the protein contents of the experimental diets adequately enhanced growth and dietary energy supply of the fish. The highest mean weight gain from the experiment (23.06g) was recorded in fish fed 10% BBSM based diet. Mean Weight Gain (MWG) generally followed progressively a decreasing pattern with an increase in the inclusion levels (from 10% to 30%), thus exhibiting an inverse relationship. The present study agrees with the findings of Anene*et al*., (2012) who reported decreased weight gained by juvenile *C. gariepinus* with increased level of baobab seed meal in replacement for soybean meal. In a related study Mwale*et al*., (2008) observed a decrease in the weight gain of guinea fowl keets at 15% and 25% inclusion level of the baobab seed meal. The decrease in the MWG of fish at 30% BBSM could be attributed to the presence of anti-nutritional factors in the seeds and the higher levels of inclusion. Fagbenro *et al*. (2010) reported depressed growth in *C. gariepinus* fed raw sunflower and sesame seed meals at levels above 10% inclusion due to the effect of anti- nutritional factors. However, at lower inclusion levels, fish have been reported to have a physiological mechanism that could compensate for the presence of anti-nutrients, hence their negative effect may not be felt, but at higher levels of inclusion, when the limit might have been exceeded, then the negative effect of these anti-nutrients will be well pronounced. Specific growth rate (SGR) was highest (1.47g) in 10% BBSM and the least (1.35g) fingerling fed with 30% BBSM replacement. This result contradicts the report of Khan *et al*. (2003) whose values of SGR were higher than those obtained in this study.

The condition factor ranged between 0.85 and 1.20. The robustness and general well- being of the fish fed graded levels of boiled baobab seed meal diets are expressed by the condition factor (K), the values differ significantly differs from the control (Table 2)**.** However, the values are within the range (0.5 to 1.0) reported by Lagler (1956) as good for healthy fish. The survival rate was more than 50% in all treatments. The highest value (100.0%) was recorded in 10%BBSSM and least (60.0%) in 0% BBSM. Fish mortality recorded in some treatments might be attributed to the effect of some extraneous factors. In related experiments Alegbeleye (2005) reported that mortality might not be attributed to the presence of anti-nutrients in the diets alone but also to any other extraneous factors such as stress resulting from handling.

The best (1.00±0.00) feed conversion ratio recorded for fish at 10% BBSM indicated a superior level of utilization of the BBSM diet by the fish. The lower the FCR, the better the feed utilization by the fish (Adikwu 2003; Shabbir *et al*., 2003; Jabeen *et al*., 2004). In the present study, the lowest FCR value indicated better feed utilization by the fish and this obviously accounted for the better growth performance of *C. gariepinus* fed 10% BBSM diet among other diets. Protein Efficiency Ratio (PER) is known to be regulated by the non-protein energy input of the diet and is a good measure of the protein-sparing effect of lipid and/or carbohydrate (Lie *et al*., 1989; Tibbets *et al*., 2005). PER recorded in this study exhibited no significant difference. The importance of feed intake of fish as a determinant of fish performance has been strongly emphasized (Preston and Leng, 1987; Faturoti, 1989; Pillay, 1990). While other studies (Anderson *et al.*, 1984; Keembiyehetty and De-Silva, 1993) pointed out the possibility of protein sparing effects of other nutrients in a feed, that is as more energy was supplied for metabolism through other nutrients, more protein is available for fish growth and tissue development. The increased in feed intake in this study could be attributed to the probable palatability of the baobab seed meal included in the diets. The results obtained in this study is in agreement with that of Mwale *et al*. (2008) who reported an increase in the feed intake of guinea fowl keets fed graded level of baobab seed meal The significantly higher PER value (2.76±2.33) obtained at 10% BBSM indicated maximum utilization of inherent nutrients in the diet at this level which was not possible at higher inclusion levels (>10%).

## Conclusion

The study revealed that up to 10% baobab seed meal can be included in the diet of C. *gariepinus* without compromising fish growth and nutrient utilization.


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