



The Effect of Maize Meal Replacement with Desert Panic (*Panicum Laetum*) Seed Meals in Practical Diet on Growth of African Catfish *Clarias Gariepinus*

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Received: June 6, 2020

Accepted: September, 3 2020

ABSTRACT

A 24-weeks feeding trial was conducted to investigate the effect of maize meal replacement with fermented desert panic seed meal in practical diet on growth and feed efficiency of African catfish, *Clarias gariepinus*. Fermented seeds of the desert panic were used to replace maize meal at 25-100% replacement levels. The growth response of fish significantly decreased as fermented desert panic seed meal levels in diet increased. However, there was no significant difference in growth and feed utilization of fish fed F1, F2 and F3, fish fed F2 diet had significantly higher Weight gain ($397.6 \pm 5.21\text{g}$), protein efficiency ratio (1.85 ± 0.03) and hepato-somatic index (1.74 ± 0.15) than F4 and F5 group. Furthermore, F2 diet significantly increased survival rate ($96.60 \pm 6.66\%$) of fish compared to other treatments. Nevertheless, pathological signs were absent in all treatments. Conclusively, 25% replacement of maize meal with fermented desert panic seed meal improves survival rate without deleterious effects on growth and feed efficiency in catfish. More so, fermented desert panic seed can replace maize meal up to 50% inclusion level in the diet of catfish. It is therefore recommended to use 25-50% inclusion level of FPS to replace maize meal in the diet of *C. gariepinus* fingerlings.

Keywords: *Clarias gariepinus*, Desert panic, Maize, Growth and Feed efficiency

INTRODUCTION

Nigeria aquaculture sector as made some achievements in production level through private sector driven production (Ajani, 2009; Kaleem and Sabi, 2020). In view of this, catfish farming has become popular in Nigeria and continued to attract interest. The growth of fed aquaculture production in Nigeria continued to be strong especially for the African catfish production sector, reflecting an increase trend in production over the last ten years (Amosu *et al.*, 2017). However, high costs of feed and competition for commonly used feed ingredients have continued to hamper the growth and expansion of fish farming in Nigeria. This has attracted the interest of feed expert to proffer alternative to the use of conventional feed ingredients. Cereals especially corn (maize) has been the major source of energy in fish diets and it is about 10-40% by weight in most aquafeeds (Abu *et al.*, 2010; Olurin *et al.*, 2006).

Recently, maize demand for animal and human consumption has out-weighed its supply in the global market. Maize crop yields, when negatively affected by adverse environmental conditions, increases uncertainty of maize supplies and prices (FAO, 2009). Therefore, the reliability of maize supplies for aquafeeds in the future will be influenced by climatic condition and global warming directly through its impact on crop yields, crop pests, diseases and soil fertility (Schmidhuber and Tubiello, 2007). These constraints will further increase the scarcity and high cost of maize. To mitigate against these uncertainties, previous studies have attempted replacing maize in fish diet. Iheanacho *et al.* (2017) effectively replaced maize meal with 100% melon husk resulting to improved weight gain. Aderolu *et al.* (2009) reported 50% inclusion level of sorghum in raw or fermented meal did not negatively affect African catfish. Abu *et al.* (2010) reported whole cassava root meal can replace maize meal at 100% inclusion level in the diet of *C.*

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gariepinus. It is imperative to continually evaluate more non-conventional ingredients for effective reduction in the usage of maize meal in order to sustain the fish production in Nigeria. Semi-arid grains such *Panicum* sp. could be a potential candidate replacer of maize meal. Desert Panic (*Panicum laetum*) belonging to the family Poaceae, is an upright erect or laying down then upright grass that grows in a tuft of up to 70 cm. Whole grains of *Panicum laetum* contained per 100 g: water 3.3 g, energy 1580 kJ (377 kcal), protein 9.5 g, fat 4.8 g and carbohydrate 70.8 g (Brink and Belay 2006). Desert panic seed could be a prospective substitute for maize meal as energy source, therefore investigating the substitution of maize meal with this seed may serve as a turning point in practical diet formulation for African catfish production in Nigeria. The objective of the study was to evaluate the effects of replacing maize with desert panic seed meal in diet of *C. gariepinus*.

MATERIALS AND METHODS

Animal care

The animals were cared for with strict adherence to protocols for care and use of laboratory animal in Ahmadu Bello University, Zaria in conformity to the National Institute of Health (NIH) guidelines for care and use of laboratory animals (Publication No. 85-23, revised 1985).

Processing of desert panic seeds and experimental feed preparation

One kilogram (1kg) of *P. laetum* seeds was separately soaked in 2.5 liters of water for 24 hrs, then, the water in the container was drained and the seeds were packed in an air-tight polythene bag and allowed to ferment for 3 days (72 hours). After 72hrs, the fermented seeds were washed and sundried to constant weight on a concrete floor. Then, stored in polythene bag at room temperature until use.

Experimental fish and design

African catfish was purchased from a local fish hatchery and transported to an indoor flow-through plastic tank facility at Department of Biology, Ahmadu Bello University, Zaria. After two weeks acclimatization, a total of 300 fish of average body weight (2.77 ± 0.17 g) were fasted for 24 h after randomly apportioned to 15 plastic tanks (50cm x 40cm x 100cm) in 3 replicates (20 fish / tank). Fish were fed three times daily (8.00, 12.00 and 16.00h) at 5% body weight for 24 weeks. During the feed trial, water quality parameters; dissolve oxygen, pH and Temperature were monitored.

Five (5) isonitrogenous and isocaloric were formulated by replacing maize meal with fermented desert panic seed meal (FPS) at 0, 25, 50, 75, and 100% inclusion level designated as F1, F2, F3, F4, and F5, respectively. Feed ingredients (Table 1) were finely ground, sieved and thoroughly mixed, distilled water was added to form a dough, then, the dough was pelleted into 1mm pellet size, air-dried, sieved and sorted into uniform size. The diet was later stored in plastic bags until use. The crude protein and substitution levels used were in accordance to Obasa *et al.* (2013). The proximate analysis of dietary ingredients and experimental diets were carried out according to the methods outlined by the Association of Official Analytical Chemists as described by Alagbaoso *et al.* (2015).

Growth performance and feed utilization determination

Fish from each tank were weighed periodically, morphometric data such as mean initial weight (IW) and final weight (FW) were measured. The growth and feed efficiency variables such as specific growth rates (SGR), condition factor (CF), feed conversion ratio (FCR), survival rate (SR), feed intake (FI), protein efficiency ratio (PER) and hepatic somatic index (HSI) were computed in accordance to mathematical expression described in Chen *et al.* (2012) and Liu *et al.* (2018):

- i. $SGR (\%) = 100 \times (\ln (\text{final body weight}) - \ln (\text{initial body weight}) / \text{culture days})$
- ii. $CF (\%) = 100 \times (\text{final weight}) / (\text{final body length})^3$
- iii. $FCR = \text{feed intake (g)} / \text{total weight gain (g)}$

- iv. SR (%) = $100 \times (\text{final number fish}) / (\text{initial number fish})$
 v. FI = feed intake (g dry feed consumed per fish).
 vi. PWG (%) = $100 \times (\text{final mean body weight}) / (\text{initial mean body weight})$
 vii. ER = fish wet WG/protein intake.
 viii. Condition factor (K): $\frac{W \times 100}{L^3}$ where, W = Weight of fish. L = Standard length
 ix. Net Protein Utilization (NPU): $= \frac{CPG}{DPF} \times 100$, where, CPG= carcass protein gained and DPF = dietary protein fed
 x. HSI (%) = $100 \times (\text{liver weight/whole body weight})$.

Table 1: Ingredient and mean proximate composition of experimental diets fed to *C. gariepinus* fingerlings

Ingredients	F1	F2	F3	F4	F5
Maize	34.42	25.81	17.21	8.61	0
Fishmeal	33.35	33.35	33.35	33.35	33.35
Soybean Meal	22.23	22.23	22.23	22.23	22.23
FPS	0	8.61	17.21	25.81	34.42
Binder	1.00	1.00	1.00	1.00	1.00
Palm oil	1.00	1.00	1.00	1.00	1.00
Premix	2.00	2.00	2.00	2.00	2.00
Salt	0.50	0.50	0.50	0.50	0.50
Bone meal	2.00	2.00	2.00	2.00	2.00
Methionine	1.50	1.50	1.50	1.50	1.50
Lysine	1.50	1.50	1.50	1.50	1.50
Nutrients composition (%)					
Dry Matter	96.70	96.65	95.50	95.50	95.50
Crude Protein	40.30	40.25	40.24	40.22	40.20
Crude Lipid	7.00	5.30	5.18	4.95	4.30
Crude Fibre	4.38	7.00	7.69	7.89	8.10
Ash	8.33	6.77	6.75	6.46	6.00
NFE	36.99	36.90	36.85	36.51	36.00

Bio-organics Vitamin/ Mineral Premix* per Kg; Vitamin A: 10,000,000IU, Vitamin D3: 2,000,000IU, Vitamin K3: 2,000mg, Vitamin E: 23,000mg, Vitamin B1: 1,800mg, Vitamin B2: 5,500mg, Vitamin B6: 3,000mg, Vitamin B12: 15mg, Niacin: 27,500mg, Pantothenic: 7,500mg, Folic acid: 7,500mg, Biotin H2: 60mg, choline chloride: 300,000mg, Cobalt: 200mg, Copper: 3,000mg, Iodine: 1,000mg, Manganese: 40,000mg, Iron: 20,000mg, Selenium: 200mg, Zinc: 30,000mg, antioxidant: 1,250mg and Calcium Sulphate Guar gum (pellet binder).

Data Analysis

Proximate composition data were subjected to students' t-test, growth and utilization data were utilization and One-way Analysis of Variance (ANOVA). Duncan multiple range test was employed to determine the differences between treatment means at 5% confidence level (P=0.05) with the aid of IBM SPSS 20 statistical package.

RESULTS

Proximate composition of maize and fermented desert panic seed meal

The proximate composition of maize and Fermented Desert Panic Seed meal (FPS) are presented in Fig. 1. The maize meal proximate compositions were 92.72, 8.84, 1.27, 3.79, 12.15 and 66.67% while FPS had 97.60, 9.70, 2.00, 2.00, 16.90 and 67.00% for dry matter, crude protein, ash, crude lipid, crude fiber and

nitrogen free extract, respectively. There was no significant difference ($P > 0.05$) in nutrient compositions of maize and FPS meals.

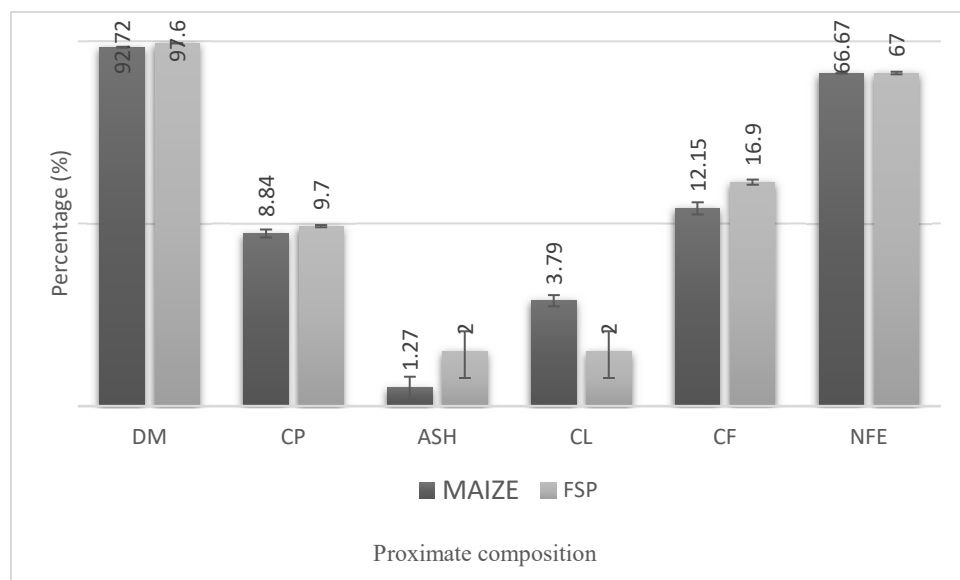


Fig 1: Mean proximate composition of fermented desert panic seed and maize meal used in feed trial.

Growth performance and feed utilization

Periodic wet weight of *Clarias gariepinus* fed fermented *P. laetum* seed meal replacing maize meal in a practical diet is presented in Fig. 2. Fish fed diet F1, F2 and F3 significantly ($P < 0.05$) increased wet weight of fish compared to those fed F5. The growth and feed efficiency parameters are presented in Table 2.

Table 2: Mean (\pm SD) growth performance and feed utilization of *C. gariepinus* fed fermented desert panic replacing maize

Parameters	F1	F2	F3	F4	F5
IW (g)	2.43 \pm 0.31	3.10 \pm 0.25	2.70 \pm 0.78	2.93 \pm 0.15	2.71 \pm 0.25
FW (g)	420.0 \pm 12.98 ^a	397.65 \pm 5.44 ^a	382.4 \pm 8.14 ^a	366.3 \pm 16.31 ^{ab}	321.3 \pm 30.83 ^b
WG(g)	417.2 \pm 12.94 ^a	397.6 \pm 5.21 ^a	374.3 \pm 8.24 ^a	363.3 \pm 16.47 ^{ab}	316.64 \pm 29.33 ^b
SGR (g/d)	1.29 \pm 0.25 ^a	1.27 \pm 0.173 ^{ab}	1.25 \pm 0.013 ^{ab}	1.24 \pm 0.023 ^{ab}	1.21 \pm 0.013 ^b
FCR	1.28 \pm 0.60 ^b	1.34 \pm 0.14 ^b	1.43 \pm 0.11 ^{ab}	1.44 \pm 0.10 ^{ab}	1.64 \pm 0.33 ^a
CF	1.23 \pm 0.13 ^a	0.99 \pm 0.22 ^{ab}	0.86 \pm 0.04 ^b	0.81 \pm 0.05 ^b	0.79 \pm 0.21 ^b
FI (g)	533.76 \pm 23 ^a	532.70 \pm 4.39 ^a	535.25 \pm 38.51 ^a	522.72 \pm 28.37 ^{ab}	515.8 \pm 39.73 ^b
PER	1.94 \pm 0.06 ^a	1.85 \pm 0.03 ^a	1.74 \pm 0.01 ^{ab}	1.73 \pm 0.04 ^{bc}	1.52 \pm 0.07 ^c
NPU (%)	28.48 \pm 0.02 ^a	28.00 \pm 0.05 ^a	28.45 \pm 0.03 ^a	26.34 \pm 0.03 ^b	26.12 \pm 0.05 ^b
SR (%)	73.60 \pm 3.33 ^b	96.60 \pm 6.66 ^a	74.0 \pm 6.66 ^b	76.6 \pm 3.33 ^b	76.6 \pm 3.33 ^b
FCE (%)	78.16 \pm 4.97 ^a	74.62 \pm 1.20 ^{ab}	69.92 \pm 3.65 ^b	69.48 \pm 0.84 ^b	61.02 \pm 6.15 ^c
HSI	1.96 \pm 0.25 ^a	1.74 \pm 0.15 ^a	1.46 \pm 0.24 ^{ab}	1.43 \pm 0.15 ^b	1.20 \pm 0.34 ^b

Values (means \pm Standard error) across a column with different superscript varied significantly ($P < 0.05$).

Key: IW=Initial Weight, FW= Final Weight, WG= weight Gain, SGR= Specific growth rate; FCR= feed conversion ratio; CF= condition Factor; Feed fed; PER= Protein efficiency ratio; SR = Survival rate, FCE= Feed conversion efficiency; HSI= Hepatosomatic index and NPU= Net Protein Utilization

After 24 weeks feeding trial, diets F1, F2 and F3 significantly ($P < 0.05$) increased final weight of fish as compared to F5 group. However, all treatments increased weight of fish in relation to their initial weight. Diet F1 induced the highest weight gain in fish ($417.2 \pm 12.94\text{g}$), however, was not significantly different from fish fed F2, F3 and F4 with weight gain values 397.60 ± 5.21 , 374.30 ± 8.24 and $363.30 \pm 16.47\text{g}$ respectively. Furthermore, F1, F2 and F3 significantly influenced specific growth rate, feed conversion ratio, feed intake, protein efficiency ratio, net protein utilization, feed conversion efficiency and hepatosomatic index when compared to fish fed F5. The survival rate of fish was significantly ($P < 0.05$) increased by F2 diet compared to F1, F3, F4 and F5 group.

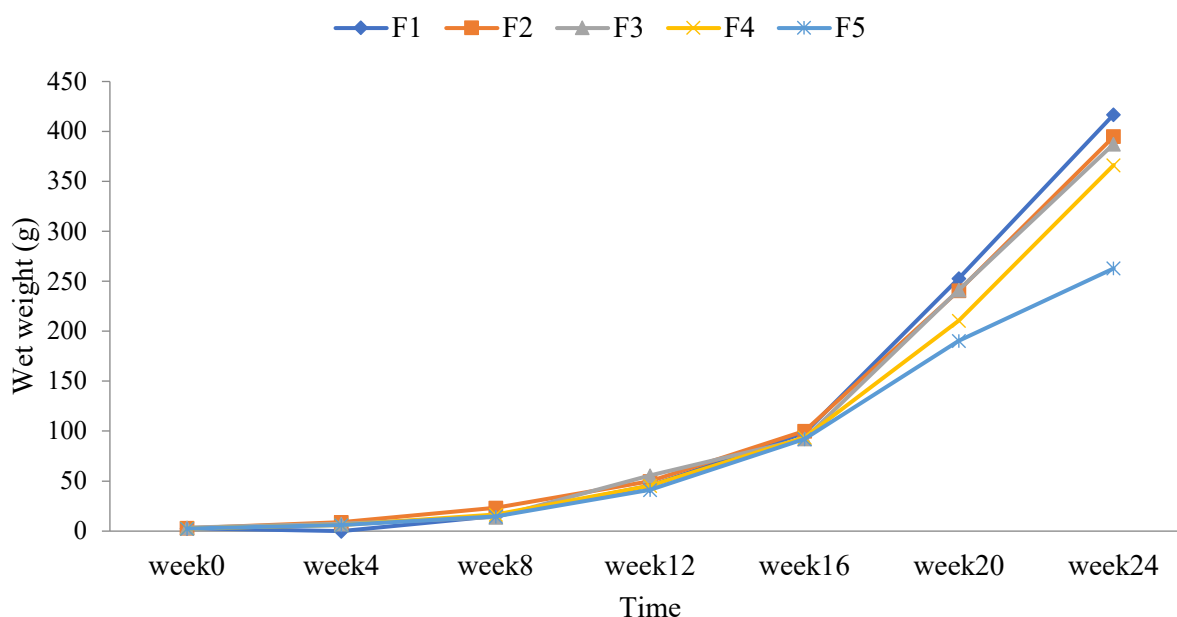


Fig 2: Mean periodic wet weight of *C. gariepinus* fingerlings fed *P. laetum* seed replacing maize meal.

DISCUSSION

Maize meal serves as a major energy source in fish diet. However, its demand has out-weighted supply, this prompted the present study involving the replacement of maize meal with fermented desert panic seed meal. The replacement of maize meal with FPS did not affect water quality parameters monitored during feed trial. The nutritional quality of maize meal and FPS was not statistically different when values were subjected to t-test, buttressing FPS usage as a good replacer for maize meal. The nutrition values of FPS obtained in this present study corroborates desert panic seed nutrient value reported by Brink and Belay (2006).

Previous studies have used non-conventional energy sources to replace maize meal. Sorghum meal up to 50% inclusion level in raw or fermented meal form can enhance growth and feed efficiency without a negative effect on catfish (Aderolu *et al.*, 2009). Melon husk meal inclusion in diet of African catfish up to 100% enhanced growth and feed utilization (Iheanacho *et al.*, 2017). Whole cassava root meal at 66% inclusion level gave optimal growth performance in hybrid catfish (Abu *et al.*, 2010). Also, 25% replacement of maize meal with cocoyam meal was recommended for growth and economic benefit to sustain *C. gariepinus* production (Aderolu and Sogbesan, 2010). Iheanacho *et al.* (2018) reported increased growth of Nile tilapia (*Oreochromis niloticus*) juveniles fed melon husk-based diet. Orire and Ricketts

(2013) also reported better growth performance and feed efficiency in *O. niloticus* fed melon husk diet. Nwanna *et al.* (2009) documented poor feed utilization of potato peel diet as dietary carbohydrate source in the diet of *C. gariepinus*.

Weight gain is known to be the most important criterion for measuring fish responses to experimental diets and a very reliable indicator of growth (Lovell, 1989; Jegede and Fagbenro, 2008). The decrease in weight gain as replacement level increased could be due to superiority of Maize protein over FPS and the residual anti-nutrients that might affect the bioavailability of FPS nutrients for digestion and assimilation by *C. gariepinus*. Similarly, Orire and Sadiku (2013) observed inability of *C. gariepinus* to utilize carbohydrate of complex nature. Carbohydrate, either of cereal or tuber in fish feed has been reported to act as both structural and energy component which have some influences on the growth rate of fish, provided all other physiological requirements are satisfied (Carter *et al.*, 2003). Also, Tihamiyu *et al.* (2016) reported decreased growth performance of *C. gariepinus* at higher inclusion of *Sorghum bicolor* as a replacement for Maize.

In the present study, FPS could replace maize meal up to 50% without negatively affecting *C. gariepinus*. However, growth of fish was FPS dependent, reflecting that FPS cannot 100% replace maize meal. Furthermore, optimum growth and survival of *C. gariepinus* could be achieved at 25% FPS level. The findings of the study are in congruent with that of Aderolu *et al.* (2009), Orire and Ricketts (2013) and Aderolu and Sogbesan (2010). However, Iheanacho *et al.* (2017) and Iheanacho *et al.* (2018) successfully replaced maize with melon shell and seed meal at 100% in the diet of *C. gariepinus*. Falaye *et al.* (2012) reported an increased growth performance of *C. gariepinus* with increasing levels of cowpea hull meal as a replacement of maize. The aforementioned difference with previous reports may probably be due to dissimilarity in nutrient content of melon shell meal and FPS, fishmeal and maize meal proportion/composition and differences in digestibility of FPS and melon shell meal. The inclusion level at 25% FPS significantly enhanced survival in *C. gariepinus*, this could be attributed to the composition of secondary metabolites such as flavonoid and alkaloids that may be present in desert panic seed.

Despite the isocaloric and isonitrogenous nature of the diets, differences in the growth of fish may be linked to superiority of protein quality (Yusuf *et al.*, 2016). However, the growth in fish fed F2 and F3 were not statistically different from the F1 group, but the aforementioned groups differed significantly ($P < 0.05$) to fish in F5 groups. Specific growth rate is the most commonly used biological parameter to express growth response to diet. The trend exhibited by fish in this study suggests efficient nutrient utilization and assimilation of those diets by the fish. Characteristic feed utilization efficiencies and consequent growth rates has earlier been attributed to dietary protein quality by Cho *et al.* (2013) and Sotolu and Faturoti, (2009).

The decreased in the acceptability of diets F4 and F5 in this study is an indication of poor palatability (Glencross *et al.*, 2007; Falaye *et al.*, 2015; Lawal *et al.*, 2011 and Jimoh *et al.*, 2014; Mukhopadhyay and Ray, 2001). Meanwhile, the reduction in the palatability of 100% replacement of FPS diet could be manipulated through suitable feed stimulant additive (De Oliveira and Cyrino, 2004; Hirt-Chabbert *et al.*, 2012).

The similarities of HSI among the treatments indicate that FPS meal had no hazardous effect on the fish. The HSI is a useful biomarker to detect hazardous effects of environmental stressors (Sadekarpawar and Parikh, 2013; EPD, 2015). It also provides an indication on status of energy reserve in an animal. In a poor environment for instance, fish usually have a smaller liver (with less energy reserved in the liver). The values recorded for *C. gariepinus* in this study are slightly higher than those reported by Bbole *et al.* (2016).

Condition Factor (CF) has been correlated to growth or health conditions of fish. The condition factors values (0.79 – 1.23) recorded in this study showed decreased trend compared to the control diet. This could be due to the residual antinutrients in the feed and relatively poor feed utilization which resulted in high fecal matter in the culture media, affecting water quality and wellbeing of the fish. A high condition factor reflects good culture environmental quality; while a low condition factor reflects poor environmental quality (Boyd, 1981).

The increase in the FCR with an increase in the FPS level replacing maize level could be as a result of poor digestibility of the diets probably due to the residual antinutrients and high fiber content commonly reported in plant ingredients. However, the FCRs recorded were all within the economic range recommended for *C. gariepinus* diets by Sahza *et al.* (2006). Although, the NPU at 50% FPS diet is significantly higher than the control. The NPU reported in this study are better than those reported by Olukunle *et al.* (2007) in *C. gariepinus* fed sweet potato-based diets. In addition, there was a general decrease in FCR and increase in PER for fish fed the control diet compared to the FPS fed fish. Such observation may be related to the fact that FCR decreases, while PER increases with increased feeding rate and growth (Chakraborty *et al.*, 2011). The values of PER and NPU recorded in this study are similar to those reported by Cho *et al.* (2013).

Conclusion

Fermented *P. laetum* seed meal is a nutritive energy source and a good replacement for maize meal at 25% inclusion level in a practical diet for growth and survival of *C. gariepinus*.

Acknowledgment

We thank Department of Biology, Ahmadu Bello University, Zaria and Department of Fisheries, University of Maiduguri for providing the space and facilities used for this study.

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