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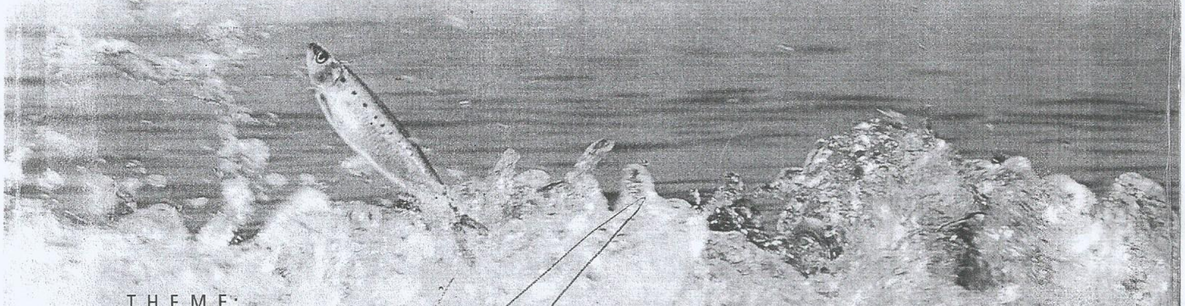
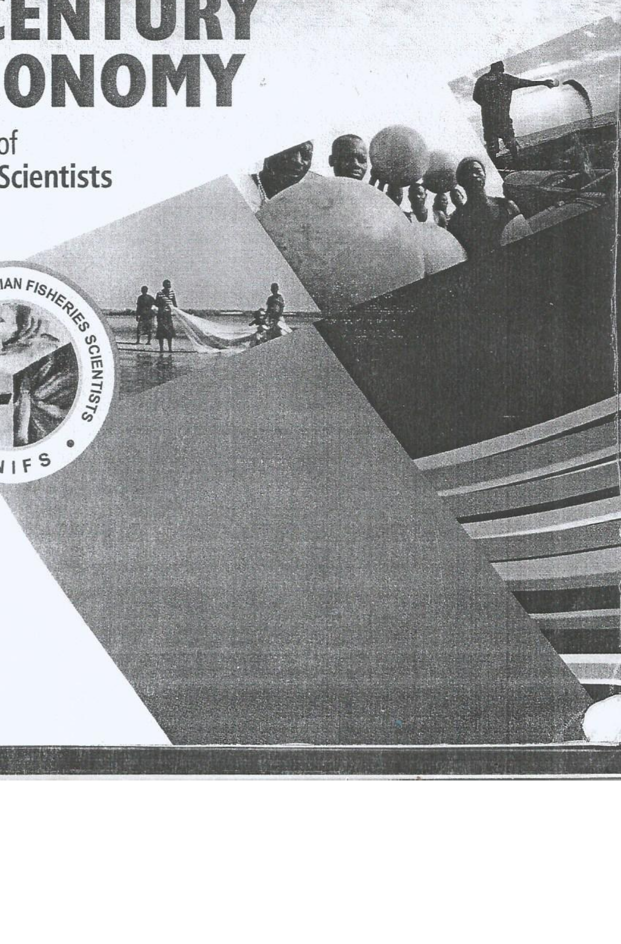


THEME:

CAPTURE FISHERIES AND AQUACULTURE RESEARCH IN THE 21ST CENTURY NIGERIA'S ECONOMY

Proceedings of the 2nd Conference of
Association of Nigerian Fisheries Scientists

July 9-11, 2019
at the Main Auditorium,
Usmanu Danfodiyo University, Sokoto



ASSOCIATION OF NIGERIAN FISHERIES SCIENTISTS
ANIFS

EDITORS:
Fagbenro, O.A.; Ipinjolu, J.K.; Ajani, E.K.; Magawata, I.; Shinkafi, B.A.; Ayoola, S.O.; Abubakar, M.Y. and Orisasona, O.

T. MAMMAN
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Growth Response and Carcass Composition of Catfish *(Clarias gariepinus)* Fingerlings Fed Varying Inclusion Levels of Toasted Wild Groundnut *(Calapogonium muccuniodes)* Seed Meal

[1,2]Bake, G. G.*, [1]Ogbonnaya, C.C., [1]Yusuf, J., [3]Adam, A., [4]Gana, A. B., [5]Nwangwu, D. C. and [1]Sadiku, S.O.E.

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Abstract

A feeding trial was conducted for 56 days to evaluate the suitability of toasted wild groundnut (*Calapogonium mucuniodes*) seed meal (TCMS) inclusion in practical diet of catfish (*Clarias gariepinus*) fingerlings through their growth performance and body composition. *C. gariepinus* fingerlings (initial mean weight 1.46±0.02 g) were fed with experimental diets containing different inclusion levels of TCMS and were designated as D1 (0% TCMS), D2 (10% TCSM), D3 (20% TCSM), D4 (30% TCSM) and D5 (10% Raw *calapogonium muccuniodes* seed meal, RCSM)). 15 net hapa (0.5x0.5x1m) were suspended in two outdoor concrete tanks (8mx5mx1.5m) with the aid of kuralon twine tied to plastic poles. The concrete tanks were filled to 5/6 of its volume (40m^3) with filtered and dechlorinated tap water, 20 fish were stocked in each hapa. Each treatment was randomly allocated to three hapa. The results of the growth performance showed that fish fed with D3 had the highest final weight (FW), weight gain (WG), specific growth rate (SGR) and feed intake (FI), and these were significantly different from other fishes fed with other experimental diets. D5 was significantly lower than the other experimental diets ($P<0.05$), although there was no significant ($P>0.05$) difference between fish fed with D1 and D2, however they were significantly higher than D4. Except for D3 with a higher significant value of feed efficiency (FE) and protein efficiency ratio (PER), fish fed with D1, D2 and D4 were not significantly different from each other but were significantly higher than fish fed D5. Whole body proximate composition of fish fed all diets showed that inclusion of TSOM influenced moisture and lipid contents. This study showed that toasted *C. muccuniodes* seed meal would be a potential suitable ingredient for *C. gariepinus* fingerlings and that it may be included in a diet up to 20 %.

Keywords:
Toasted *Calapogonium muccuniodes,* Catfish, Growth performance.

Introduction

One major concern in aquaculture production is the high cost of feed and heavy reliance on fish meal and fish oil as the primary protein and energy source in this feed. Fish meal is very palatable and has exceptional nutritional value including an excellent balance of essential amino acids and essential fatty acids, which closely meet the requirements of most farmed fish. It also provides an excellent source of digestive energy and vitamin (Tacon, 1993). However, cost in fish meal production and unpredictability of availability has led to a search for an alternative replacement. Plant protein source such as soybean, wheat bran, corn gluten meal, cassava leaf meal, barley and rapeseed has often been used as cheaper alternative feedstuffs (Devies *et al.*, 1990; Olvera-novoa *et al.*, 1990; Wu *et al.*, 1995; El-sayed, 1998; Maina *et al.*, 2002; Abelghany, 2004). However, the scarcity and competition from other sectors for these conventional crops for livestock and human consumption as well as industrial use make their costs too high and put them far beyond the reach of fish farmers or producers of aquafeed (Fasakin *et al.*, 1999).

Therefore, in order to attain a more economically sustainable and viable production, research interest has been redirected towards the evaluation and use of unconventional plants protein sources (Siddhuraju and Becker, 2001; Bake *et al.*, 2009). Although, plant proteins (PP) may be cost-effective, their use is usually limited by deficiencies in essential amino acids and minerals, and the presence of anti-nutritional factors (ANFs) as well as complex carbohydrates (National Research Council (NRC), 1993; Vielma *et al.*, 2003). In view of this, research work has shifted towards unconventional ingredients like leguminous seed meals, leaves, etc., and the use of some food processing techniques to reduce the effect of anti-nutritive factors. Toasting or the use of dry heat is a simple and cheap method to reduce the anti-nutritional factors and crude fibre contained in plant by-products.

Calapogium mucuniodes otherwise called wild groundnut is a wild leguminous plant, which produces tonnes of pods containing seeds in the fruiting season (Pizarro, 2001). These seeds are left unutilized since they are neither consumed by any animal nor utilized for any other medical purpose. Catfish (*Clarias gariepinus*) belongs to the family of Claridae, they are the most cultured fish in Nigeria. They are characterized by their ability to grow on a wide range of artificial and natural feed. They grow fast and have a high potential hardness and tolerance to low dissolved oxygen and other aquaculture routines (Idodo-Umeh, 2003). Hence emphasis has been on the increase on how to improve the productivity of catfish.

Although data about the potential and nutrient composition of *Calapogonium mucuniodes* seed are available, the data regarding the inclusion levels of toasted *Calapogonium mucuniodes* seed meal (TCMM) in the diet of *C. gariepinus* fingerlings is still limited. Hence, it is against this background that this view that this research was conducted to evaluate the growth response and carcass composition of *C. gariepinus* fingerlings fed TCMM-based diet.

Materials and Methods

Diet Formulation and Preparation

The feeding trial experiment was carried out at the Old Research School of Agriculture and Agricultural Technology Farm, Federal University of Technology, Bosso Campus, Minna, Niger State. *Calapogonium mucunoides* was collected behind the Information Technology Service Department (ITS), Gidan Kwano Federal University of Technology Minna, while some were collected at Rafin Yashin Village Bosso Local Government Area. The seeds were collected by manually opening the pods. The viable seeds were sun-dried and later toasted within the temperature range of 70°C to 80°C to reduce the effect of anti-nutritional factor using a frying pan. After toasting, the seeds were allowed to cool, and later grounded to homogeneous powder. The fish meal used for the experimental diet was purchased from Sauki Fish Farm Km 16 Minna –Zungeru Road, Niger State. Soybean and groundnut cake were obtained from Kure Market Minna, Niger State. The soybean was then toasted using a frying pan and allowed to cool before milling with the aid of a grinding machine. All the ingredients used were separately milled and fortified with vitamin and mineral premix. Each experimental diet was thoroughly mixed starting from the less quantity ingredients in a plastic bowl and later mixed with water. The moist mixed ingredients were made into dough and pelleted with manual pelleting machine at the Laboratory Unit of the Department of Water Resources, Aquaculture and Fisheries Technology with 2mm dye. The pellets were sun-dried and preserved in polythene bags.

Based on the nutritional requirements of *Clarias gariepinus*, five iso-nitrogenous and iso-lipid diets were formulated at 40% protein and 9.0% lipid, containing varying inclusion levels of TCMM at (0%, 25%, 35%, 45% and 55%) and were designated D1(0% inclusion), D2 (25% inclusion), D3 (35% inclusion), D4 (45% inclusion), and D5(55% inclusion).

Experimental System and Fish

The experimental fish, pure-bred *C. gariepinus* fingerlings, with an initial mean weight of (1.42- 1.45g) were purchased from Tagwai fish hatchery of Ministry of Livestock and Fisheries Development, Minna, Niger State. The fish were transferred in a well-oxygenated water plastic container from the hatchery to the Department of Water Resources, Aquaculture and Fisheries Technology Experimental Fish Farm, Federal University of Technology, Minna, Bosso Campus where the feeding trial was conducted. Upon arrival, they were acclimatized in a transitional tank in the farm for four days and were fed commercial feed (Coppens®) at 40% crude protein once a day before the experiment commenced. Fifteen hapa nets (0.5x0.5x1m) were suspended in two outdoor concrete tanks (8mx5mx1.5m) with the aid of kuralon twine tied to plastic poles. The concrete tanks were filled to 5/6 of its volume (40m^3) with filtered and dechlorinated tap water. Twenty (20) fish were accommodated in each hapa and each treatment was randomly allocated to three hapas. Photoperiod depends on the natural light, and the water temperature was monitored daily. The water quality parameters in the system were monitored weekly. The temperature ranged between 24°C and 29°C while the concentration of dissolved oxygen ranged between 6.5 and 8.4 mg/l and the pH values of the treatments ranged from 7.16 - 7.64. No critical values were detected for nitrite and nitrate. The fish were fed three times daily at 5% of body weight at 09:00 am, 12:00 pm and 16:00 pm for 56 days. Feeding rate was subsequently adjusted according to their growth rates per hapa. The uneaten and faecal matters were siphoned out of the hapa every morning before feeding, and 45 minutes after the fish have been fed. The fish were denied feed 24 hours prior to sampling. Five fish were randomly sampled on a weekly basis, and weights were measured using a digital electronic weighing balance (CITIZEN MP-300: Model).

Biochemical Analyses

About 10g initial sample and 15g of final samples from each hapa were pooled separately and then homogenized using laboratory mortar and pestle. The major ingredients used for the diet, the formulated diet and the fish body samples were subjected to chemical analysis. The proximate composition analysis was determined according to AOAC procedures (AOAC, 2002). Moisture content was determined by drying samples at 105±2°C until a constant weight was obtained. Dried samples were used for determination of crude fat, protein and ash contents. Crude fat was measured by solvent extraction method in a soxhlet system where n-hexane was used as a solvent. Crude protein content was calculated by using nitrogen content obtained by the Kjeldahl method. A conversion factor of 6.25 was used for calculation of protein content according to AOAC (2002).

Evaluation of Growth Parameters

Growth performance was analysed in terms of weight gain (WG), specific growth rate (SGR), and feed intake (FI). The following formulas were used:

Weight gain (%) = (final weight (g) - initial weight (g)) × 100 / initial weight (g)
Survival (%) = 100 × (final number of fish/ initial number of fish).
Specific growth rate (%) = [ln final weight (g) - ln initial weight (g)) / feeding period (day) ×100
Feed intake (mg/fish/day) = dry feed (mg) fed / number of fish / feeding period (day)

Statistical Analyses

Data were analysed using one-way analysis of variance (ANOVA) using Statistica 8.0 (Stat-Soft, Inc., Oklahoma, USA). Differences between treatments were compared by Tukey's test. Level of significance was tested at $P<0.05$.

Results

The proximate composition of the major ingredients used for the formulation of the experimental diets is presented in Table 1. The result showed that the fish meal had the highest crude protein (67.84%) and 12.59% crude lipid, while toasted *Calapogonium mucuniodes* meal (TCMS) had (37.83%) crude protein and (2.85%) crude lipid.

Table 1: Proximate composition of the major ingredients used in the formulation of the experimental diet for *Clarias gariepinus* fingerlings

Ingredients	Fishmeal	Soybean meal	Maize meal	Millet meal	RCMM**	TCMM***
Proximate composition						
Moisture (%)	5.82	3.19	4.66	3.22	3.19	4.28
Crude protein (% d.b.*1)	67.84	43.63	9.32	12.9	28.00	37.86
Crude lipid (% d.b.*1)	12.59	7.00	4.20	4.36	1.78	2.85
Ash (% d.b.*1)	12.18	8.15	3.22	2.33	12.35	7.34
Crude fibre (% d.b.*1)	0.03	5.00	3.40	2.60	9.82	6.28

Source: Field Survey
d.b = dry basis
RCMM** = Raw Calapogonium mucuniodes seed meal
TCMM***= Toasted Calapogonium mucuniodes seed meal

Table 2: Gross and proximate composition of the experimental diet for hybrid catfish fingerlings (g/kg)

Ingredients	D1	D2	D3	D4	D5
FM	518.40	378.90	323.10	267.30	211.50
SBM	50.00	50.00	50.00	50.00	50.00
GNC	50.00	50.00	50.00	50.00	50.00
TCMM	0.00	250.00	350.00	450.00	550.00
MM	27.50	27.50	27.50	27.50	27.50
Millet	27.50	27.50	27.50	27.50	27.50
Starch	20.00	20.00	20.00	20.00	20.00
Cellulose	273.10	151.90	103.40	54.90	6.30
Vitamin premix	15.50	15.50	15.50	15.50	15.50
SBO	2.50	13.20	17.50	21.80	26.20
Mineral	15.50	15.50	15.50	15.50	15.50
Total	1000.00	1000.00	1000.00	1000.00	1000.00
Moisture (%)	4.78	4.32	4.66	4.54	4.38
Crude protein (% d.b.*1)	37.22	37.28	37.45	37.55	37.43
Crude lipid (% d.b.*1)	9.15	9.65	9.79	9.94	9.57
Ash (% d.b.*1)	9.15	9.21	9.46	9.89	9.35
Crude fibre (% d.b.*1)	6.14	6.25	6.66	6.93	6.36

d.b = dry basis
FM= Fishmeal; SBM= Soybean meal; GNC= Groundnut cake meal;
TCMM= *Toasted Calapogonium mucuniodes seed meal;* MM= Yellow Maize: SBO= Shea butter oil

Table 2 shows the ingredient profile and nutrient composition of the five experimental diets. All the diets were similar in all the nutrient composition. Table 3 shows the growth performance indices of the fish fed the experimental diets for 56 days. The result showed that fish fed with D3 (35% inclusion) had the highest final body weight and was significantly different from other fish fed other experimental diets. Fish fed D5 had the lowest final body weight and was significantly different from fish fed other experimental diets. There was no significant difference between fish fed D1 and D2, however they were significantly higher than fish fed D4 and D5. The percentage weight gain and specific growth rate followed the same pattern as final weight gain. Except for fish fed D5, the survival rate of the fish fed experimental diets showed that there was no significant difference (P>0.05) among all of them.

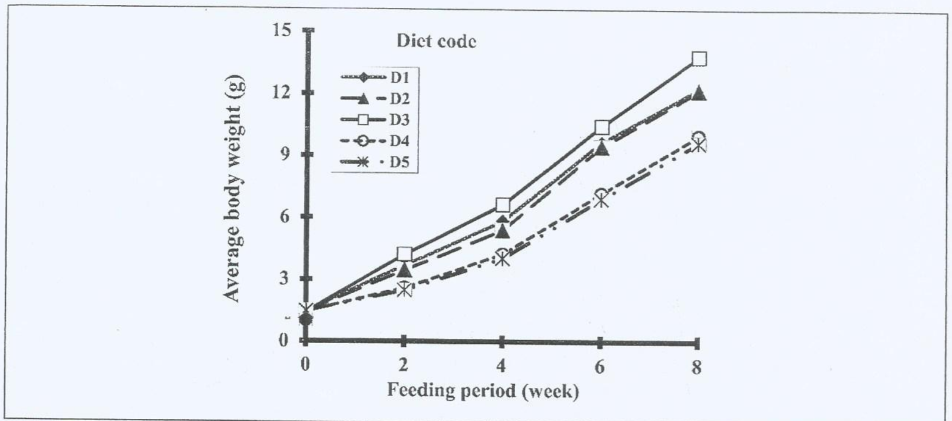

Figure 1: Growth of *C. gariepinus* fingerlings fed the experimental diets

Table 3: Growth performance indices of *Clarias gariepinus* fingerlings fed experimental diets for 56 days

Diet code	Body weight (g)		Weight gain (%)	Survival rate (%)	Specific grow rate (%)
	Initial	Final			
D1	1.46±0.04	12.25±0.31^{b}	738.81±17.67^{b}	98.50±2.14^{a}	3.80±0.51^{b}
D2	1.44±0.07	12.15±0.52^{b}	743.98±15.48^{b}	98.52±2.12^{a}	3.81±0.24^{b}
D3	1.42±0.06	13.79±0.22^{a}	871.36±26.51^{a}	98.66±2.21^{a}	4.06±0.36^{a}
D4	1.45±0.02	9.98±0.64^{c}	588.38±28.55^{c}	98.42±2.15^{a}	3.44±0.48^{c}
D5	1.46±0.04	9.63±0.64^{d}	559.59±24.33^{d}	95.22±2.37^{b}	3.37±0.48^{d}

Values in the same column with same letters are not significantly different ($p>0.05$).

Feed utilization of the fish fed experimental diets is shown in Table 4. Fish fed D3 had a higher feed intake (FI) and was significantly different ($P<0.05$) from other fishes fed with other experimental diets; while fish fed D5 was significantly lower than the other fish fed experimental diets ($P<0.05$). Although, there was no significant ($P>0.05$) difference between fish fed with D1, and D2, however, they were significantly higher than those fed D4. Except for D3 with a higher significant ($P<0.05$) level, the value of feed efficiency (FE) and protein efficiency ratio (PER), fish fed with D1, D2 and D4 were not significantly different from each other but were significantly ($P<0.05$) higher than fish fed D5.

Table 4: Feed utilization of *Clarias gariepinus* fingerlings fed experimental diets for 56 days

Diet Code	Total Feed Intake (g)	Feed Efficiency	Protein Efficiency ratio	Protein Retention (%)
D1	14.08±0.52^{b}	0.77±0.41^{b}	2.01±0.57^{b}	38.11±0.27^{b}
D2	14.04±0.46^{b}	0.76±0.62^{b}	2.01±0.45^{b}	37.94±0.76^{b}
D3	15.83±0.36^{a}	0.78±0.28^{a}	2.09±0.24^{a}	38.47±0.42^{a}
D4	11.29±0.64^{c}	0.76±0.39^{b}	2.02±0.26^{b}	37.48±0.26^{c}
D5	10.86±0.64^{d}	0.75±0.39^{c}	2.01±0.26^{c}	37.27±0.24^{d}

Values in the same column with same letters are not significantly different ($p>0.05$).

The proximate composition analysis of whole-body *C. gariepinus* fingerlings (wet basis) fed experimental diets for 56 days is shown in Table 5. The whole body composition of the fish fed the experimental diets revealed that there was no significant difference in the crude protein of the fish fed experimental diets. However, the inclusion levels of TCMS influenced the moisture and carcass lipid composition of the whole body of the fish fed the experimental diets. Hence, D5 had the highest carcass lipid although not significantly different from fish fed D4. Fish fed D1 had the lowest, however it was not significantly different from fish fed D2. The carcass lipid increased with increase in the inclusion level of TCMS, while the moisture reduced with an increase in the inclusion level of TCMS.

Table 5: Proximate composition analyses of whole-body C. *gariepinus* (wet basis) fed experimental diets for 56 days

Component (%)	Initial	Final*1				
		D1	D2	D3	D4	D5
Moisture	77.65	73.25±1.2^{a}	73.18±0.8^{a}	72.32±1.4^{b}	71.51±1.5^{c}	71.25±0.4^{c}
Protein	13.10	17.88±1.5^{a}	17.89±1.3^{a}	17.84±1.1^{a}	17.79±1.2^{a}	17.84±1.5^{a}
Lipid	3.89	4.25±0.2^{c}	4.45±0.5^{c}	4.85±0.6^{b}	6.13±0.4^{a}	6.65±0.4^{a}
Ash	4.01	4.13±0.3^{a}	4.14±0.7^{a}	4.18±0.3^{a}	4.15±0.5^{a}	4.12±0.4^{a}

Values in the same column with same letters are not significantly different ($p>0.05$).

Discussion

This study investigated the possibility of utilizing toasted *Calapogonium mucuniodes* meal in the diet of *Clarias gariepinus* fingerlings. Fish mortality was low and relatively uniform in all the treatments. Furthermore, all the experimental fish remaining in the tank were morphologically normal at the end of the feeding trial. In this present study, the water temperature which was between 24±0.5°C and 29± 0.7°C and the dissolved oxygen 6.5 to 8.4mg/l were within the acceptable range for *Clarias gariepinus* fingerlings culture (Huet, 1979; Mary *et al., 2017)*. The proximate composition of toasted *Calapogonium mucuniodes* meal in this study reveals that the crude protein content was 37.86% and was higher than the raw *Calapogonium mucuniodes* meal at 28.00%. The differences might be attributed to the processing technique employed. Fagbenro (1999) and Frances *et al.* (2001) reported that heat treatment substantially reduced and inactive levels of secondary compounds in the legume seed meals, subsequently boosting the nutrient profile of the meal. In this present study the result from the nutrient profile of the seed tend to agree with this report.

The sustainability of including alternative ingredients in aquafeeds in terms of growth performance has been reported to vary highly among fish species and experimental conditions (Elsayed, 1999; Bake *et al.,* 2009). The percentage survival was excellent throughout the experimental period. This could be attributed to good handling, good water quality management and proper processing as well as suitability of toasted *Calapogonium mucuniodes* meal inclusion in the diets of *C. gariepinus*. The fish adapted to the experimental diets within 3 – 4 days of commencement of feeding trial. However, the acceptability of the diets varied significantly as evident in their growth performance. The best growth response was obtained from *C. gariepinus* fingerlings fed D3 (35% inclusion of TCSM). Proper processing of ingredients has been reported to have effect on the texture, palatability, and taste of the experimental diet and are related to the level of plant material incorporated into the diet. This in turn affects the acceptability of feed and may consequently retard the growth of the fish when in high quantity (Fagbenro, 1999; Francis *et al.,* 2001). The digestibility of individual ingredient in feeds according to Bake *et al.* (2014) has been known also to influence growth performance in fish. In this study, growth rate decreased significantly with an increase in the inclusion level of TCMS above 35% inclusion. The decrease in growth in groups fed high levels of TCMS agreed with the earlier works of Fagbenro *et al.* (2003), Ogunji *et al.* (2008) and Bake *et al.* (2013). They reported that high inclusion of plant protein in fish diet usually results in depressed growth as a result of poor palatability which results to low acceptability and utilization of the diet by the fish.

Lipid content of the fish fed experimental diets increased with an increase in the inclusion level of TCMS. This indicated that the fish fed experimental diets were able to effectively utilize the lipid in the experimental diets. It also showed that higher level inclusion of toasted *C. mucuniodes* seed meal in the diet of *C. gariepinus* fingerlings has the potential in increasing lipid deposition in its carcass. This result agrees with the findings of Abd – El-Hakim *et al.* (2003) that plant protein in the diet of fishes has the potential to increase its lipid deposition in the carcass of the fish fed plant protein. In this study, moisture was indirectly proportional to the lipid. This agrees with the works of Sadiku and Oladimeji (1991) and Bake *et al.* (2012, 2013) that in most semi fatty freshwater fish species, muscle lipid content shows inverse proportionality to its water content. The analysis from this study also indicated that the crude protein content of carcass was not significantly different among all the fish fed the experimental diets.

Conclusion

The findings of this study revealed that the optimum inclusion level of toasted *Calapogonium mucuniodes* seed meal in the diet of *C. gariepinus* is 35%, beyond this would bring about a decline in growth performance. It can also be concluded that catfish (*C. gariepinus*) can utilize toasted *C. mucuniodes* meal at an inclusion level of 35% in diet without any adverse effect on the growth performance. This development can make toasted *C. mucuniodes* meal an alternative protein source in catfish (*C. gariepinus*) diet, thereby minimizing the competition on fish meal demand as a protein source in fish feed production. However, more work needs to be done on the amino acid profile of *C. mucuniodes* and its uses for other aquaculture fish species.

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