NUTRITIONAL EVALUATION OF COOKED T*amarindus indica* SEED MEAL AND PERFORMANCE OF C*larias gariepinus* FINGERLINGS

Orire, A.M[1]*., Chinenyem, F. S. [2]and Haruna, M.A.[3]
[1,2]Department of Water Resources, Aquaculture and Fisheries Technology,
Federal University of Technology Minna, Niger State, Nigeria
[3]Department of Fisheries and Aquaculture, Federal University Dutse, Jigawa State, Nigeria
*Corresponding author: abdul.orire@futminna.edu.ng; 07032552295

ABSTRACT
Attempt for alternate protein source from plant is desirable in aquaculture feed industry. This had necessitated the research into conducting a 56day feeding trial to evaluate the nutrient utilization and growth performance of *Clarias gariepinus* fingerlings mean weight 3.54±0.04g fed varying inclusion levels of cooked *Tamarindus indica* seed meal (CTM). Experimental diets were prepared at 40% crude protein at three inclusion levels (0%, 50% and 100%) as replacement for full fat soyabean meal. The weight gain, specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER), apparent net protein utilization (ANPU) determined as growth indices were found significant ($p<0.05$) for the treatments. Among of the three diets, diet three (100% CTM) performed best after the control diet (0% CTM) with significant ($p<0.05$) growth parameters values. Body carcass compositions recorded significantly high ($p<0.05$) body lipid as inclusion level of CTM increased. Therefore, cooked *Tamarindus indica* seed meal can substitute for soyabean meal in the diet of *Clarias gariepinus* without adverse effect.

Key words: catfish, tamarindus, growth, alternative protein, plant protein, soyabean

INTRODUCTION
Nigeria's fish production sector is fast growing with constraints from dwindling resource supply from capture fisheries which hardly satisfies the demand of her teeming population. This gives rise to a need to increase fish production through aquaculture but this desire seems not to be met partly due to the high cost of commercial feed (Lovell, 1981).It is no news that the highest cost in fish farming goes to fish feed, thereby making feedstuff limited in supply and expensive (Fapounda and Fagbenro, 2006; Ridha, 2006 and FAO, 2011). Globally, soybean supplies over one-quarter of the fats and oils and two-thirds of the protein concentrates for animal feeds, and is three-quarters of the total world trade in high-protein meals (Peisker, 2001; Best, 2011). However, soybean, together with maize, has been a staple food of mankind since ancient times. In human diets, soybean has been used as a protein source for over 5,000 years (Peisker, 2001). A vast array of products can be derived from soybean and these are found nowadays in more than 20,000 items on the food shelves of supermarkets worldwide. Also, nutrition of high performing animals is unthinkable without soy products (Peisker, 2001). Therefore, there is intense competition between human and animals for soybean which necessitate the need to identify other protein-rich plant resources that could be used in animal diets. The world is becoming increasingly aware of the looming food scarcity, and hence the possibility of raising animals on unconventional but easily sourced and available feedstuffs in the tropics and subtropics deserves more attention (Belewu *et al.*, 2009). Worldwide, the growing scarcity of conventional animal feed has therefore motivated nutritionists to find alternative sources of protein for livestock. The need for alternative source of protein in fish feed has become an obvious challenge in the aquaculture sector; this has given rise to various researches on how this problem can be overcome. Other conventional plant protein cotton seed, groundnut cake, bambara nut meal (Orire *et al.,* 2015) poultry meat meal, silk worm pupae, dried brewers and some unconventional sources like soyabean waste meal (Orire and Ozoadibe, (2015), *Pakia biglobosa* seed meal (Orire and Muhammad (2014), and *Tamarindus indica* (El-Siddig *et al.,* 2006) have been reported. It has been established that plant sources contain anti-nutritional factors that could be toxic to animals and the need for processing of these plant protein sources before it is used in production Gatlin *et al*. (2007). This research therefore investigated into alternative plant protein source of *Tamarindus indica* to soyabean in the diet of *Clarias gariepinus.*

METHODOLOGY
Feedstuffs sourcing
Matured and dried pods of *Tamarindus indica* were bought from Kasuwan Gwari market in Minna, Niger State, Nigeria. The tamarind pods were soaked in water for 20 minutes while 500g seeds were removed and cooked for 1 hour at 100 ºC. The cooked seeds were further washed of the seed coat and sun dried for 30 minutes. It was then milled to powder with the aid of a kitchen blending grinding machine (Ogbonna and Orire, 2015).

Feed formulation
Three experimental diets were formulated using the Pearson Square method at 40% crude protein. Diet 1

had 0% cooked tamarind; diet 2 contained cooked tamarind and soyabean at 50% each while diet 3 had 100% cooked tamarind. The feedstuffs and diets were analysed for proximate compositions according to the method of AOAC (2007) (Table 1)
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Table 1: Feed formulation and proximate composition of diets

Ingredients (%)	Diet 1 (0% CTM)	Diet 2 (50% CTM:50% SM)	Diet 3 (100% CTM)
Soyabean meal	78.20	35.90	0.00
Cooked *Tamarindus* seed meal (CTM)	0.00	35.90	57.40
Maize meal	7.90	14.20	28.60
Vitamin-mineral Premix	5.00	5.00	5.00
Shear Butter oil	9.00	9.00	9.00
	99.90	100.00	100.00
Proximate Composition (%)			
Moisture	4.5	2.17	4.03
Crude protein	40.60	40.25	40.00
Crude lipid	10.5	30.2	17.2
Crude fibre	0.5	1.9	7.15
Crude ash	4.5	1.99	1.97

CTM= cooked tamarind meal, SM= Soyabean meal

Experimental fish

The experimental fishes were obtained from Eco-Rehab Environmental Center, Kuje, Abuja, Nigeria, and were transported in a 50 litres plastic container to the laboratory of the Department of Water Resources, Aquaculture and Fisheries Technology, Federal University of Technology, Minna. Upon arrival at the laboratory, experimental fish samples were acclimatized for two weeks in one of the transitional ponds while they were sustained on maintenance ration once daily with commercial diet. At the commencement of the trial, fish were stocked in a randomized design at 20 fish per tank in triplicate.. The rearing tanks were subjected to continuous aeration by manual agitation of the water aided by the recirculatory system. The water was siphoned daily of faecal matters and uneaten feed to maintain water quality. The fishes were bulk weighed fortnightly with the aid of an electronic weighing balance (OHAUS, T2130).

Chemical analysis

The initial and final carcass were also analysed for their proximate compositions; crude protein, crude lipid, crude fibre, ash and moisture contents according to the method of AOAC (2007).

Fish growth and feed utilization estimation

Biological parameters evaluated were as according to Maynard *et al.* (1979) and Halver (1989) as described below:

Mean weight gain (g) = Mean final weigh – mean initial weight

Specific Growth Rate [SGR (%/day)] = $\frac{(Log_e W_2 - Log_e W_1) \times 100}{T_2 - T_1}$

Where, W_2 and W_1 represent final and initial weight, respectively, while T_2 and T_1 represent final and initial time, respectively.

Feed conversion ratio – Feed fed on dry matter/fish live weight gain (Brown, 1957)

Protein efficiency ratio (PER) =Mean weight gain per protein fed (Osborne *et al*., 1919).

Apparent Net Protein Utilization (ANPU) (%) = (P2 – P1) / Total protein consumed (g) x 100 Bender and Miller (1953), Miller and Bender (1955)

Where, P1=Initial carcass protein, P2=final carcass Protein intake (g) = Feed intake x crude protein of feed.

Percentage survival (%): no stocked/no left x 100

Statistical analysis

The data obtained were subjected to a one-way analysis of variance at 5% probability. The means were separated using Tukey's method while the growth curve was drawn with Microsoft excel office 2016. The statistical tool used was Minitab Release 14 (Pennsylvania, USA)

Results

The results of the 56 day feeding trial did not show significant differences ($p<0.05$) in the water quality indices among treatments. The water temperature, dissolved oxygen, pH and conductivity ranged from 24.4-27.9 °C, 4.0-6.0 mg/ l, 5.87 -7.47 and 254-325 mg/ I, respectively. However, the results on the growth parameters indicated significant differences ($p<0.05$) among treatments. Diet 1 (0% cooked tamarind meal & 100% soyabean meal) gave the best weight gain (3.78 g) followed by diet 3 (100% cooked tamarind meal) with a value of 2.74 g while diet 2 gave the lowest weight gain (1.55g). Similar trends were observed in the specific growth rate, protein efficiency ratio and apparent net protein utilization. However, the feed conversion ratio was significantly low (p<0.05) for diet 1 while there was no significant difference (p>0.05) between diets 2 and 3. Diet 3 gave the highest survival percentage as against diets 2 and 3 which were significantly low (Table 2).

Table 2: Growth parameters for *Clarias gariepinus* fingerlings fed cooked *Tamarindus indica* meal for 56 days.

Growth Parameters	Diet 1 (0% CTM)	Diet 2 CTM/50% SM)	Diet 3 (100% SM)	Mean SD
Initial weight (g)	3.64^{a}±0.35	3.51^{a}±0.16	3.78^{a}±0.18	0.14
Final weight (g)	7.41^{a}±1.67	5.04^{c}±0.83	6.52^{b}±0.40	1.10
Mean weight gain(g)	3.78^{a}±1.63	1.55^{c}±0.54	2.74^{b}±0.58	1.07
Feed conversion ratio	0.79^{a}±0.28	1.54^{b}±0.75	1.56^{b}±0.43	0.52
Specific growth rate(%/day)	1.25^{a}±0.39	0.64^{c}±0.28	0.97^{b}±0.28	0.25
Protein efficiency ratio	3.34^{a}±1.18	1.85^{c}±0.91	2.56^{b}±1.03	1.05
Apparent net protein utilization (ANPU) (%)	2.05^{a}±0.68	1.44^{c}±1.05	1.93^{b}±1.11	0.97
Survival rate (%)	33.33^{b}±0.00	36.67^{b}±14.14	80.00^{a}±18.85	13.61

Data in the same row with different superscript letters are significantly different (p<0.05) from each other.
Mean in the same column with same letter are not significantly different (p>0.05)
CTM =cooked tamarind meal; SM = soyabean meal

Table 3: Proximate Composition of *Clarias gariepinus* fingerlings fed experimental diets for 56 days

Composition (%)	Initial	Final			
		Diet 1 (0% CTM)	Diet 2 CTM/50% SM)	Diet 3 (100% SM)	SD±
Moisture	15.41^{a}±0.01	13.7^{b}±0.39	7.35^{c}±1.56	7.60^{c}±0.85	1.04
Crude protein	57.76^{b}±0.01	59.68^{b}±0.25	63.00^{a}±7.43	60.38^{b}±1.24	4.35
Crude lipid	12.26^{c}±0.01	13.25^{b}±0.78	14.00^{b}±2.12	15.45^{a}±0.21	1.31
Crude ash	14.53^{a}±0.01	13.62^{a}±0.28	4.55^{b}±0.78	5.75^{b}±1.34	0.91

Mean in the same row with different letters are significantly different (p<0.05) from each other.

Figure 1 depicts the growth response of the test diets as *Clarias gariepinus* fingerings exhibited best growth curve on diet 1 followed by diet 3 while diet 2 gave the lowest response.

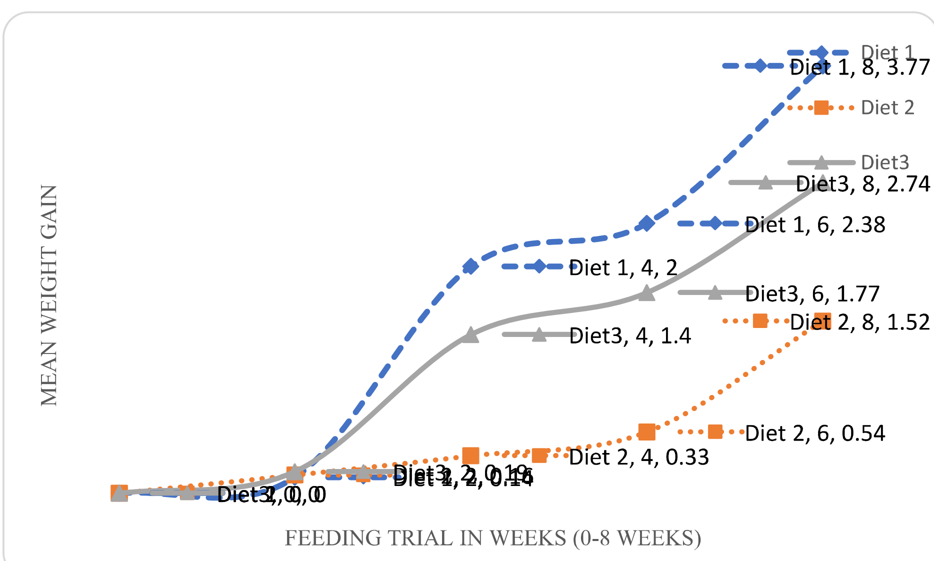

Figure 1. Growth response for *Clarias gariepinus* fingerlings fed experimental diets

The body compositions also exhibited significant differences ($p<0.05$) among treatments. The body moisture was significantly high ($p<0.05$) for diet 1 than diets 2 and 3 that are not significantly different ($p>0.05$) from each other. The body crude protein was significantly high ($p<0.05$) for fishes fed diet 2 while there were no significant differences ($p>0.05$) between diets 1 and 3. However, diets 3 was significantly high ($p<0.05$) in body crude lipid while there were no significant differences ($p>0.05$) between diets 1 and 2. Moreover, the body ash content was significantly high ($p<0.05$) for fishes fed diet 1 while there were no significant difference ($p>0.05$) between diets 2 and 3.

Discussion

The proximate composition of ingredients revealed soyabean meal having the highest Crude protein and Ash content value (Table 1). Cooked *Tamarindus* seed meal (CTM) had the highest value of crude lipid and crude fibre.It also showed the proximate composition of experimental diets, with diet 1 having the highest moisture content and subsequently reduced as the inclusion level of CTM increased indicating that moisture content reduces with increase in plant material. This finding agrees with Fagbenro (1999) and Francis *et a*l. (2001) who reported that anti-nutrients in plant protein sources may be reduced by processing to enhance its palatability and nutrient utilization for growth in fish. Cooked tamarindus seed meal was an acceptable source of protein in the diets for *Clarias gariepinus* fingerlings within the conditions of this experiment.

The ingredient was used at various inclusion levels in the experimental diet without adverse effect on the growth and survival rate as presented in the Table 2. The growth performance has been shown to vary among fish species and experimental conditions owing to the suitability of the inclusions of the diet (El-Sayed, 1999). The best performance was shown by fish fed diet 1 (0% inclusion of CTM) which is the control for the experiment, followed by diet 3 (100% inclusion of CTM) and the least performed was fish fed diet 2 (50% inclusion of CTM) (figure 1). A reduction in all the growth and nutrient utilization parameters measured was observed in the fish fed CTSM diet 2. This may be attributed to the presence of anti-nutritional factors from soyabean and tamarind (Azzaza *et al*., 2011; Akande, 2010; Reddy and Pierson, 1994; Aderibigbe *et al*., 1997 and Abo-state *et al*., 2009) where the authors reported that anti-nutrients render some major nutrients inactive, by the distortion of the digestive process or metabolic utilization of feed which exerts some effect contrary to optimum nutrition as observed in this study with respect to diet 2. Feed was better converted in diet 1 and protein efficiency was higher in diet 1 while diet 3 showed the fish effectively utilized the protein in the ingredients from the diets which also signified the digestibility of the test ingredient (Abo-sate *et al*., 2009 and Hajos *et al*., 1995).

There was a higher survival rate in diet 3 (100% inclusion of CTM) than the other experimental diets (soybean based-diets) which is in agreement with previous workers (El-Sayed, 1999; Francis *et al.,*2001) who reported that soybean meal does contain some anti-nutritional factors (such as trypsin, lectins, anti-vitamins, phytic acid, saponins and phytoestrogens) which could have been harmful to the fish, hence their survival rate of 33.33% and 36.67% for diets 1 and 2 respectively. The proximate composition of the whole body of the fish fed the experimental diet in this study agrees with Ogbonna and Orire (2015) and Orire *et al*. (2015) in nutrients utilization in terms of body fat which was inversely related to body moisture content.

CONCLUSION AND RECOMMENDATION

This study demonstrated that growth performance and nutrient utilization of this study gave an overall better result in diet 1 (100% soyabean meal) and diet 3 (100% cooked *Tamarindus indica* seed meal, while diet 2 (50% CTM) performed poorly. Therefore, cooked *Tamarindus indica* seed meal can be included in fish feed up to 100% as replacement for soyabean.

RECOMMENDATION

Further experiment should be conducted to establish best inclusion level of *Tamarindus indica* meal as replacement for soyabean meal in the diet of *Clarias gariepinus* fingerling.

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