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Evaluation of Growth Performance and Body Composition of *Clarias gariepinus* for Graded Level Inclusion of Soybean Waste

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ABSTRACTS

Soybean waste has always been treated as waste product from soybean milk or cheese production despite its high nutrient profile. It is in view of this, a feeding, trial was conducted to evaluate its (soybean waste or soymilk residue) utilization as replacement for fish meal in the diet of C*larias gariepinus* fingerlings (1.09±0.23 g). Twenty fishes were randomly distributed in 15 tanks in replicate and fed varied inclusion levels of soybean waste at 0, 25, 50, 75 and 100%. The results showed significant differences ($p<0.05$) among the growth parameters. However, diet containing 25% soybean waste gave the best growth performance in terms of mean weight gain, specific growth rate, protein efficiency ratio and food conversion ratio. The use of soybean waste meal has the potentials to improve the growth performance and body composition of fish.

Key words: Soybean waste, fish meal, *Clarias gariepinus*, growth

INTRODUCTION

The higher cost of the feed makes it impossible for the farmer to feed adequately as it accounts for 30-60% of the total variable expenses depending on the culture system (Lim and Webster, 2006). Fish meal is an indispensable ingredient in the diets of almost all aquaculture species because of the high quality and concentration of essential nutrients, especially of well-balanced amino acids, essential fatty acids and also energy content. High digestibility and palatability of fish meal serves as the benchmark ingredient in aquaculture diets due to its nutrient content (Dersjant-Li, 2002). Consequently, a concomitant increase in the demand for fish meal makes it the most expensive protein source in animal feed (Tacon, 1993). In addition, the growing rates towards the culture of premium valued carnivorous fish, which are required in high premium, high cost of fish meal remains a limitation (Hardy, 2010). Soybean meal is rated as most nutritive plant ingredients widely used in animal feed as in pig, poultry including fish feed. It is also highly resistant to oxidation and spoilage and is naturally clean from organisms, such as fungi, viruses and bacteria that are harmful to shrimp and fish (Swick *et al*., 1995). Soybean meal can be used to partially replace fish meal or animal protein in fish and shrimp diets. In general, however, at high replacement levels the growth rates of fish and shrimp are reduced this is traced to the antinutritional components in it (Olli and Krogdahi, 1994; Viola *et al*., 1983; Wilson and Poe, 1985; Abel *et al*., 1984). However, it is reported that, up to 55% of fish meal is included in fish feed which makes aquaculture a fastest growing food production sector of the world (FAO., 1997). In view of replacement of fish meal without reducing the growth performance would yield a more profitable fish production (Nguyen, 2007). Studies have revealed that soy protein concentrate can replace fish meal up to 40% in the diet of shrimp and up to 100% in fish (Nguyen, 2007). However, the antinutritional factors inherent in some plant proteins in addition to limiting in some may be improved upon with further processing (NRC., 1993).

Moreover, soybean waste which is the focus of this study has not been exploited, as possible protein source in fish feed. Soybean waste is practically an agro-waste generated when processing soybean into soy milk and cheese. The residue generated is normally fed to ruminant animals as protein supplement or at best discarded as waste. Therefore, this study seeks to investigate into the effect of feeding soybean waste as replacement for fish meal in the diet of *Clarias gariepinus* fingerling.

MATERIALS AND METHODS

The experiment was carried out in the Laboratory Department of Water Resources Aquaculture and Fisheries Technology, Federal university of technology Minna, Niger state. The experiment was conducted for 8 weeks in 24 plastic bowls, with treatments allotted in a complete randomized design. The plastic bowls been covered with nets collectively and are been fastened to the bowls with the aid of a plastic clips. The bowls was filled with water up to 12 L and the water that was used was changed daily.

Fingerlings of *Clarias gariepinus* (1.09±0.23 g) used for the experiment were purchased from a hatchery farm in Ibadan, Oyo state-Nigeria. Twenty fishes were distributed into the 15 tanks following two weeks acclimation The fishes was fed with 3% body weight daily with adjustment fortnightly for 56 days. Ten fishes were sacrificed and oven dried at 120°C for initial carcass analysis. And at the end of the experiment were called from each diet for final carcass analysis according to the method of AOAC (1998).

The diets were formulated using the Pearson's square method of feed formulation. And five isonitrogenous diets containing 50% crude protein at varying replacement level of Fish Meal (FM) and Soybean Waste (SW) were formulated thus diet 1 [0% SW/100% FM], diet 2 (25% SW/75% FM), diet 3 (50/50% SW/FM), diet 4 (75% SW/25% FM), diet 5 (100% SW 0% FM) as presented in Table 1, with their proximate compositions. The feedstuffs were mixed thoroughly with estimated quantity of water (100 g v/w of 1kg diet) to form consistent dough for each diet. The dough was then fed into a meat grinder machine for pelleting. The pelleted diets were oven dried at 60°C for 24 h and then kept in a refrigerator at -4°C.

Table 1: Formulated diets and their proximate compositions

Feed stuff (%)	Diet 1 (0% SW)	Diet 2 (25% SW)	Diet 3 (50% SW)	Diet 4 (75% SW)	Diet 5 (100% SW)
FM	68.85	28.63	21.48	14.32	0.0
Maize meal	26.15	52.00	52.00	52.00	13.3
SW	0.00	14.32	21.48	28.63	81.7
Vegetable oil	2.00	2.00	2.00	2.00	2.0
Vitamin-mineral premix	3.00	3.00	3.00	3.00	3.0
Total	100.00	99.95	99.96	99.95	100.0
Proximate compositions (%)					
Crude protein	48.61	43.40	46.88	46.88	48.61
Crude fat	11.60	11.25	10.00	11.12	10.00
Crude fibre	6.09	7.50	5.71	4.11	5.80
Ash	3.20	3.09	4.10	3.20	3.01
Moisture	4.77	4.58	4.01	4.11	3.86

SW: Soybean waste, FM: Fish meal

Table 2: Water quality parameters for the feeding trial

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Temperature (°C)	22.20	23.03	21.13	22.13	22.03
pH	6.80	6.71	6.06	6.79	6.79
Dissolved oxygen (mg mL^{-1})	2.17	2.17	2.23	2.19	2.17
Conductivity (μm g^{-1})	2.25	2.21	2.26	2.26	2.04

Water exchange were done on a daily bases by first siphoning off faeces and uneaten feed, whose values were recorded for biological analysis. The water quality parameters were taking on a weekly bases for temperature using clinical thermometer, dissolved oxygen according to the method of wrinkle's (Lind, 1979; APHA., 1980), hydrogen ion concentration (pH) were measured using a EIL 7045/46 pH meter in the Laboratory at room temperature while conductivity were monitored using conductivity meter (Table 2).

Experimental analyses and growth parameters: Final values for each group represent the arithmetic mean of the triplicates. Feed intake was monitored to measure average feed intake and their effects on growth. The growth and nutrient utilization parameters measured include weight gain, Specific Growth Rate (SGR), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER), Apparent Net Protein Utilization (ANPU) and Apparent Digestibility Co-efficient (%). The growth parameters were computed according to the methods of Maynard *et al.* (1979) and Halver (1989):

$$\text{Mean weight gain} = \text{Mean final weigh-mean initial weight}$$

$$\text{Specific Growth Rate (SGR)} = \frac{\text{Log}_e\ W_2\text{-Log}_e\ W_1}{T_2 - T_1} \times 100$$

Where:

W_2 and W_1 = Final and initial weight

T_2 and T_1 = Final and initial time (Brown, 1957):

$$\text{Feed conversion ratio} = \frac{\text{Feed fed on dry matter}}{\text{Fish live weight gain}}$$

- Protein Efficiency Ratio (PER) = Mean weight gain per gram of crude protein fed (Osborne *et al.*, 1919)
- Protein intake (g) = Feed intake×crude protein of feed

Apparent digestibility coefficient: It was also evaluated using the formula of Maynard *et al.* (1979) and Bondi (1987):

$$\text{ADC} = 100 - \frac{100 \times \text{AIA (\%) (Acid insoluble ash) of diets} \times \text{nutrient in faecal (\%)}}{\text{AIA of faecal (\%)} \times \text{nutrient in diets (\%)}}$$

While, acid insoluble ash as internal indicator (Church and Pond, 1988), which was carried out according to the method of Cockrel *et al.* (1987), the diets and feacal samples were ashed at 600°C for 6 h. After which they were boiled with 250 mL 10% HCl for 5-10 min. The solution was filtered through ash less filter paper and thoroughly washed with hot water. The filter paper include the residue on the filter paper were then put into a crucible and placed in a muffle furnace at 600°C for 2 h. The resulting acid insoluble ash were cooled and weighed as:

$$\text{Acid Insoluble Ash (AIA) (\%)} = \frac{\text{Wt. of AIA}}{\text{Wt of sample taken 1}} \times 100$$

Statistical analysis: The experimental design was a one-way anova and the data was analyses using statistical package Minitab Release 14 at 5% significant level. The mean were separated using Turkey's method (Steel and Torrie, 1980; Duncan, 1955), while graph was drawn using the Microsoft excel window 2007.

RESULTS

Table 3 shows the growth and feed utilization of *Clarias gariepinus* fed for 56 days with diet containing soybean waste meal. From the result it was observed that there were significant differences ($p<0.05$) in some cases among the diets. There were significant difference ($p>0.05$) between diets 1 (5.31) and 5 (1.37), while there were insignificant difference ($p>0.05$) between diets 2 and 3 in the Mean Weight Gain (MWG). However, diet 1 (5.31) (control diet) gave the highest Mean Weight Gain (MWG) while diet 5 exhibited the lowest Mean Weight Gain (MWG) (1.31). The Food Conversion Ratio (FCR) followed the same trend showing insignificant difference ($p>0.05$) between diet 3 (2.40) and 4 (2.37) except diets 1 and 5, which showed significant difference ($p<0.05$) between each other (Table 3). Consequently on the Specific Growth Rate (SGR), there was insignificant difference between ($p>0.05$) between diets 2 (2.32) and 3 (2.73), while there was significant difference ($p<0.05$) between diets 1 (3.10) and 5 (1.63), however, diet 1 (3.10) showed the highest Specific Growth Rate (SGR). Also observed from Table 3 that there were significant differences ($p<0.05$) between diet 1 (0.52) and diet 5 (0.31) and there were insignificant difference ($p>0.05$) between 3 (0.44) and 4 (0.44) in the Protein Efficiency Ratio (PER). However, diet 1 (0.52) showed the highest Protein Efficiency Ratio (PER) with diet 5 (0.31) gave the lowest value. The Apparent Net Protein Utilization (ANPU) there was insignificant difference ($p>0.05$) between diet 1 (68.04) and diet 3 (72.43), while there was significant difference ($p<0.05$) between diet 2 (80.23) and diet 5 (0.43) and the highest was diet 2 (80.23) of Apparent Net Protein Utilization (ANPU).

Table 4 shows the nutrients utilization of *Clarias gariepinus* fed soybean waste meal. The results also showed significant difference ($p<0.05$) between initial carcass value (35.18) and diet 5 (14.33), while there was nonsignificant difference ($p>0.05$) between diet 2 (70.00) and 3 (69.13) in the body Crude Protein (CP). However, diet 2 (70.00) was the highest while diet 5 (14.33) was the lowest in the body crude protein values (CP). Consequently, there was non significant difference ($p<0.05$) between initial body lipid value (31.09) and diet 5 (10.12), while there was

Table 3: Growth response of *Clarias gariepinus* fingerlings fed soyabean waste for 56 days

Growth parameters	Diet1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Mean initial weight (g)	1.12±0.007^{a}	1.34±0.54^{a}	1.05±0.52^{a}	1.07±0.01^{a}	0.87±0.16^{a}	0.23
Mean final weight (g)	6.44±1.08^{a}	5.09±1.736^{a}	5.06±1.68^{a}	4.13±2.50^{a}	2.25±0.60^{a}	1.51
Mean weight gain (g)	5.31±1.15^{a}	4.08±1.74^{a}	4.00±1.67^{a}	2.79±2.04^{a}	1.37±0.74^{a}	1.41
Specific growth rate (%/day)	3.10±0.40^{a}	2.32±0.68^{a}	2.73±0.55^{a}	2.17±1.03^{a}	1.63±0.74^{a}	0.65
Feed conversion ratio	1.95±0.19^{a}	2.89±1.95^{a}	2.40±0.57^{a}	2.37±0.61^{a}	3.52±1.25^{a}	1.01
Protein efficiency ratio	0.52±0.05^{a}	0.38±0.28^{a}	0.44±0.12^{a}	0.44±0.12^{a}	0.31±0.11^{a}	0.14
Mortality (%)	36.67±2.89^{b}	31.67±15.28^{b}	40.00±18.03^{b}	50.00±21.79^{1}	90.00±5.00^{1}	13.33

Means on the same row carrying letter (s) with different superscript(s) are significantly different from each other ($p<0.05$)

Table 4: Body compositions of *Clarias gariepinus* fingerlings fed graded level inclusion of soybean waste for 56 days

Proximate compositions (%)	Initial body compositions (%)	Final body compositions (%) Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	SD±
Crude protein	35.18±0.01^{a}	54.91±23.00^{a}	70.00±0.01^{a}	69.13±0.01^{a}	25.29±0.01^{b}	14.33±0.01^{b}	9.43
Crude fat	31.09±0.01^{a}	25.30±0.01^{b}	23.09±0.01^{b}	14.29±0.01^{d}	17.85±0.01^{c}	10.12±0.01^{e}	0.01
Crude fibre	6.13±0.01^{b}	8.71±0.01^{a}	7.98±0.02^{a}	6.05±0.01^{b}	5.88±0.01^{b}	3.08±0.01^{c}	0.01
Ash	12.64±0.01^{a}	6.03±0.006^{b}	14.00±0.01^{a}	12.50±0.01^{a}	5.50±0.01^{b}	1.02±0.01^{c}	0.03
Moisture	16.64±0.01^{d}	85.35±0.01^{a}	49.50±0.01^{c}	58.93±0.06^{c}	64.48±0.01^{c}	79.77±0.01^{b}	0.03

Means on the same row carrying letter (s) with different superscript (s) are significantly different from each other ($p<0.05$)

Table 5: Apparent digestibility co-efficient of *Clarias gariepinus* fingerlings fed soybean waste for 56 days

Body composition parameters (%)	Diet 1 (0% SW)	Diet 2 (25% SW)	Diet 3 (50% SW)	Diet 4 (75% SW)	Diet 5 (100% SW)	SD±
Crude protein	79.57±0.01^{d}	86.40±0.01^{b}	85.74±0.01^{b}	88.20±0.01^{a}	81.43±0.01^{c}	0.01
Crude lipid	39.37±0.01^{c}	57.30±0.02^{a}	36.17±0.01^{c}	54.50±0.01^{b}	40.96±0.01^{c}	0.01
Crude fibre	12.84±0.01^{cb}	12.43±0.01^{c}	9.16±0.01^{b}	13.8±0.01^{b}	7.73±0.01^{d}	0.01
Ash	21.13±0.01^{a}	16.65±0.01^{b}	10.14±0.01^{d}	6.98±0.01^{e}	13.00±0.01^{c}	0.01
Dry matter content	69.39±0.01^{c}	86.19±0.01^{b}	87.39±0.01^{b}	91.91±0.01^{a}	86.91±0.01^{b}	0.01

Means on the same row carrying letter (s) with different superscript (s) are significantly different from each other ($p<0.05$), SW: Soybean waste

nonsignificant difference ($p>0.05$) between diets 1 (25.30) and 2 (23.09) in the body lipid values (LP). The body Crude Fiber (CF) also showed significant difference ($p<0.05$) between diets 1 (8.71) and 3 (6.05) while there was insignificant difference ($p>0.05$) between initial (6.13) and diet 3 (6.05), in the Crude Fiber (CF) values and the highest was diet 1(8.71) in the Crude Fiber (CF). In ash there is insignificant difference ($p>0.05$) between initial (12.64) and diet 3 (12.50), while there was significant difference ($p<0.05$) between initial (12.64) and diet 5(1.02) and the highest was initial (12.64) in ash value. Finally, the Dry Matter (DM) contents also exhibited significant difference ($p<0.05$) between diets 1(85.35) and initial carcass value (16.64) and insignificant difference between ($p>0.05$) between diets 1(85.35) and 5 (79.77) with diet 1 been highest in Dry Matter (DM) value.

Table 5 shows the Apparent Digestibility Coefficient (ADC %) parameters. Where crude protein observed showed a significant difference ($p<0.05$) between diets 4 (88.19) and 5 (81.43), while there was nonsignificant difference ($p>0.05$) between diets 2 (86.42) and 3 (85.74). The Crude Fiber (CF) showed significant difference ($p<0.05$) between diet 1 (12.84) and diet 5 (7.74), while there were no significant difference ($p>0.05$) in the crude fiber digestibility of diets 1 (12.84) and 2 (12.44) with diet 3 having highest value (19.17). Consequently, there was a significant difference ($p<0.05$) between diets 2 (57.32) and diet 3 (36.17) of the Crude Lipid (CL) digestibility while, there was insignificant difference ($p>0.05$) in diets 1 (39.05) and 5 (40.96) of crude lipid the highest was diet 2 of the Crude Lipid (CL) value (57.32). In ash content, there was a significant difference ($p<0.05$) between diets 1 (21.14) and 4 (6.98) and there was insignificant difference ($p>0.05$) between diets 3 (10.15) and 5 (13.00) of ash digestibility while, the highest was diet 1 (21.14).

DISCUSSION

From the findings, diet 1 which had the 100% fish meal gave the best growth parameters results in terms of Mean Weight Gain (MWG), Food Conversion Ratio (FCR), Specific Growth Rate (SGR) and Protein Efficiency Ratio (PER). This is as a reflection of a good utilization of the diet. Diet 2 which had 75% fish meal and 25% soybean waste meal inclusion resulted in reduced growth performance, which could be as a result of substitution of fish meal with soybean waste meal. Andrews and Page (1974) reported that, substitution of fish meal with soybean meal in fish diet resulted in reduced growth and feed efficiency. Diets 2 (25%) and 3 (50%) soybean waste, respectively showed insignificant difference ($p>0.05$) in their performances which was very close in performance to diet 1 (control), which is an indication of positive contribution to growth of the fish as opined by Mambrini *et al*. (1999) who reported that, soy protein concentrate could replace 50% of dietary protein from fish meal in rainbow trout. The poor values observed in the Food Conversion Ratio (FCR), Specific Growth Rate (SGR), Protein Efficiency Ratio (PER) and Mean Weight Gain (MWG) in the diets 2, 3, 4 and 5 were indication of inefficient utilization of diets, this is not good enough especially at fingerling stage, when the fish is still going through the lag phase. The slow down in growth could be attributed to the high fiber content of the soybean waste, as observed in the apparent digestibility value, which is significantly lower than the control diets. Krogdahl (1989) reported, improvement in the utilization of soyabean meal when oligosaccharides was removed in the diet of salmon and rainbow trout. Furthermore, the depressant growth observed can also be linked to anti-nutritive factors as reported in salmon (Olli and Krogdahi, 1994), rainbow trout (Sandholm *et al*., 1976), carps (Viola *et al*., 1983; Abel *et al*., 1984), nile tilapia (Wee and Shu, 1989) and in channel catfish (Wilson and Poe, 1985; Olli and Krogdahi, 1994; Dersjant-Li, 2002). *Clarias gariepinus* has been reported to have a very poor handling of high fiber in its diets (Orire and Sadiku, 2014). Moreover, the study revealed that the fingerlings of *Clarias gariepinus* could tolerate up to 25% soybean waste meal in its diet beyond which there is decline in growth and survival. There are some relationships that featured in the carcass composition showed in Table 5 where protein, lipid, ash and dry matter showed significant difference ($p<0.05$) to the initial values. The performance of the diet is strongly in agreement with the work of Lin and Shiau (1995) who stated that carcass composition should reflect the diets.

CONCLUSION

From the experiment *Clarias gariepinus* fingerlings will tolerate up to 25% inclusion level of soybean waste thereby reducing the inclusion level of fishmeal to 75% for growth without any adverse effect which therefore, can be recommended to aquaculturists and feed manufacturers.

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