EVALUATION OF DIFFERENT SOYBEAN-BASED DIETS ON GROWTH AND NUTRIENT UTILIZATION OF *HETEROBRANCHUS LONGIFILIS* IN AQUARIA TANKS

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Abstract

In order to compare the effect of raw, cooked, toasted and extruded soybean meals on the growth and nutrient utilization of *Heterobranchus longifilis* fingerlings, 120 pure *Heterobranchus longifilis* fingerlings were purchased at the National Institute for Freshwater Fisheries Research (NIFFR) improved genetic fish hatchery and randomly allocated into four different treatments with two replicates each with 15 fingerlings in 8 aquaria tanks. Four different diets containing 40% crude protein each were compounded and fed to the fish at 5% body weight for 56 days. At the end of the feeding trials, growth performance and nutrient utilization were evaluated. The results revealed that fish fed toasted soybean-based diets had highest mean weight gain (MWG) of 16.39g, specific growth rate (SGR) of 2.03%/day, and food conversion ratio (FCR) of 2.18. The fingerlings fed the extruded soybean-based diet gave the least growth performance. It could be concluded in practice, that toasted soybean-based diet is optimal for growth of *Heterobranchus longifilis* fingerlings.

Keywords: soybean-based diets, growth, nutrient utilization, *Heterobranhus longifilis* and aquaria system.

Introduction

Fish farming is increasing rapidly in Nigeria today and if this development is sustained, then aquaculture will create a great impact on the economy and provide proteinous food for its populace. Fish is noted for high quality protein and its protein content can be as high as 60% on dry matter basis. Lack of good quality feed for economic production of fish in Nigeria adversely affects growth rate, survival rate, disease manifestation and total harvest. The value of *Heterobranchus longifilis* as cheap protein source in rural communities, its ability to adapt readily to adverse environmental conditions, resistance to disease, reasonable growth rate, acceptability of artificial diets, high conversion of artificial diets and consumer preference, make *Heterobranchus longifilis* a preferred fish species for culture in many parts of the world.

Soybean (*Glycine max*) is a leguminous crop that produces seeds containing 1400 to 2000kg/hectare. It is cultivated in many areas of the world from the tropics to the temperate regions. Soybeans also contain high nutritional values compared to other oil seed species. Its crude protein level ranged between 44-50%, Nitrogen free extract (NFE) is 40%, lipid is 15-20% and it is equally higher in essential amino acids, fatty acids, vitamins and minerals (Dabrowski and Kozak, 1979).

Unprocessed soybeans have an undesirable flavour and bitterness and they also contain toxic proteins such as haemagglutenin, tectins and trypsin inhibitors which have to be destroyed and made inactive to make the bean palatable and digestible both for human and animal consumption. Viola *et, al.*(1983), reported that raw soybeans are easily destroyed by heat and that excessive heat treatment was found to cause a reduction in the quality and quantity of the heat labile essential amino acids (EAA). Therefore, fisheries technologists, nutritionists and other food scientists need to devise different methods on how best soybean seeds can be processed to ensure high yield and good harvest in fish production. This study was therefore designed to evaluate the growth performances and the nutrient utilization of *Heterobranchus longifilis* fingerlings fed with different soybean-based diets in aquaria system.

Materials and Methods

The experiment was carried out in the Federal College of Freshwater Fisheries Technology, Fish Biology Laboratory at New Bussa, Niger State, Nigeria. *Heterobranchus longifilis* fingerlings of mean weight of 7.88±0.13g were obtained from the Genetics Improvement Laboratory of the National Institute for Freshwater Fisheries Research (NIFFR), New Bussa, Niger State, Nigeria. The fish were acclimated for three days during which they were fed on a 40% crude protein feed before the commencement of the experiment.

Eight (8) glass aquaria tanks of 60cm x 30cm x30cm were used for the experiment. The glass aquaria tanks were washed, thoroughly rinsed and filled with clean water to half of its volume and aerated using cosmos aquarium air pump 5000 model to ensure proper oxygenation of the fishes. The treatments (Treatment I: Raw soybean based diet; treatment II: cooked soybean-based diet; Treatment III: Toasted soybean-based diet and Treament IV: Extruded soybean-based diet) were replicated twice using a complete randomized design system.

Formulated diets of 40% crude protein was compounded from yellow maize, fishmeal, groundnut cake, soybean meal, mineral/vitamin premix, vegetable oil and starch solution serving as a binder bought from Monday Market, Ibadan Way, New Bussa. The diet ingredients were ground into fine particle using milling machines and weighed according to their percentage composition and mixed properly in a bowl. They were made into dough and pelleted with an improvised domestic pelleting machine. The pellets were later sun-dried and packaged into polyethylene bags. The percentage composition of the compound diets fed to *Heterobranchus longifilis* fingerlings in glass aquaria tanks is shown Table 1.

Table 1: Percentage composition of the compounded diets fed to *Heterobranchus longifilis* fingerlings in glass aquaria tanks.

Diet ingredient	DT1	DT2	DT3	DT4
Raw soybean meal	29	-	-	-
Cooked soybean meal	-	29	-	-
Toasted soybean meal	-	-	29	-
Extruded soybean meal	-	-	-	29
Fish meal	29	29	29	29
Groundnut cake meal	15	15	15	15
Yellow maize	21	21	21	21
Mineral/Vitamin Premix	2.0	2.0	2.0	2.0
Vegetable oil	2.0	2.0	2.0	2.0
Starch solution	2.0	2.0	2.0	2.0
Total	**100.0**	**100.0**	**100.0**	**100.0**

The experimental fish fingerlings of mean weight 7.88g were randomly stocked into the glass aquaria tanks in the early morning. The fish were fed twice daily between 7.00 8.00am and 17.00 18.00pm at the rate of 5% of their body weight per day. The compounded diet was crushed into crumbs before feeding it to the fish. The fish were sampled, for growth weekly and the diet ration was adjusted based on the weight obtained from the sampling exercise. The fish were harvested at the end of the 56-day culture period by siphoning the water in the glass aquaria tanks. All the fish inside the glass aquaria tanks were collected for mass weighing per tank and the total number of fish in each tank was counted to determine the survival rate.

During the culture period, the water quality parameters like dissolved oxygen, temperature, conductivity and pH of the water within the culture system were monitored using the standard method of the examination of water and waster water. Water temperature and dissolved oxygen (DO) concentration were measured weekly using digital can tester and oxygen meter, respectively. The pH of the water was measured using scan tester. Mortality was monitored daily and recorded accordingly. The experiment lasted for 56 days.

Analysis of Data

Growth responses and nutrient utilization parameters were calculated as follows:

(a) average daily growth rate(DGR)

$$DGR = \frac{(Wf-Wi)}{t}$$

Where: Wf= Final average weight at the end of the experiment.
Wi =Initial average weight at the beginning of the Experiment.
t= Culture period in days.

(b) specific Growth Rate (SGR) % per day

$$SGR = 100 \times \frac{(\ln Wf - \ln Wi)}{t}$$

where: Wf= final average weight at the end of the experiment.
Wi = Initial average weight the beginning of the experiment.
T = Culture period in days.

(c) Relative Growth rate (RGR) (%)

$$RGR (\%) = 100 \times \frac{(Wf-Wi)}{Wi}$$

(d) Food Conversion Ratio (FCR)

$$FCR = \frac{\text{Dry weight of diet (g)}}{\text{Total wet weight gain by fish (g)}}$$

(e) Protein efficiency ratio (PER)

$$PER = \frac{\text{Total wet weight gain by fish}}{\text{Protein intake}}$$

(f) Survival rate (S) (%)

$$SR (\%) = \frac{Ni \times 100}{No}$$

Where: Ni = total number of fingerling at the end of the experiment
No = total number of fingerling stocked at the beginning of the experiment.

Results and Discussion

The mean growth curves of *Heterobranchus longifilis* fingerling fed with different soybean-based diets are illustrated in Fig. 1. All fish fed actively and appeared healthy. Table 2 shows the proximate composition of the experimental diets fed to *Heterobranchus longifilis* fingerlings during the culture period. Diet 1 with raw soybean-based diet had the least crude protein levels of 39.27% followed by diet 2 with cooked soybean based diet (41.03%). Diet 4 with extruded soybean-based diet had 41.87% crude protein level, while the highest crude protein level of 42.00 was recorded in DT 3 with toasted soybean-based diet.

Table 2: Proximate composition of the experimental diets fed to *Heterobranchus longifilis* fingerlings.

Components	**DT1**	**DT2**	**DT3**	**DT4**
Moisture content	8.80	8.44	9.63	9.13
Crude protein	39.27	41.03	42.00	41.87
Crude ash	19.00	19.87	21.59	24.29
Crude fibre	9.00	8.00	9.00	7.00
Crude fat	2.30	2.20	2.50	2.20
N.F.E.	21.63	20.46	15.28	15.53

The daily growth rates of the *Heterobranchus longifilis* fingerlings fed different soybean-based diets in glass aquaria tanks for 8 weeks are shown in Table 3. The summary of results of *Heterobranchus longifilis* fingerlings receiving different soybean-based diets in glass aquaria tanks for 8 weeks as presented in Table 4, while the range and mean values of source physico-chemical parameters monitored during the experiment are shown in Table 5.

The specific growth rate (%/day) of *Heterobranchus longifilis* fingerlings fed different soybean-based diets are illustrated in Fig. 2. The feed conversion ratio (FCR) among the means of the treatments is shown in Fig. 3.

After the 56 days of experiment, the mean weight gain per day ranged between 0.069g/day to 0.293g/day with the highest growth recorded in diet 3 (toasted soybean-based diet). There was significant difference ($P<0.05$) in the mean weight gain of the fish fed different soybean-based diets. The highest specific growth rate (SGR) of 2.03%/day was recorded in diet 3, while the lowest specific growth rate of 0.69% was observed in diet 4. There was significant difference ($P<0.05$) in the mean specific growth rate of the fish fed different soybean based diets. The highest feed conversion ratio (FCR) was recorded in diet 4 with extruded soybean-based diet, having a value of 7.57 and the lowest feed conversion ratio(FCR) was recorded in diet 3 with a value of 2.21(Table 4).

Abel *et al.* (1984); Pike *et al.* (1990) also observed highest specific growth rate (SGR) in diet 3. Among the processed soybean, Diet 3 (Toasted soybean) had the highest mean growth rate and specific growth rate followed by diet 2 (cooked soybean meal), Diet 1 (raw soybean meal) and Diet 4 (extruded soybean meal) being the least among all the treatments. The survival rate of the fish during the experiment ranged from 64% - 90%. The highest survival rate of 90% was recorded in diet 3 (Toasted soybean-based diet) and the least survival rate of 64% was recorded in diet 1 (Raw toasted-based diet).

The water quality parameters varied among and within the treatments. The range and mean values of some physico-chemical parameters monitored during the experiment are presented in Table 5. Mean water temperature, dissolved oxygen, hydrogen ion concentration (pH) and conductivity were 28.66°C, 5.98mg/1, 7.54 and 223.75 µmhos/cm respectively. Among the tested diets, the fingerlings fed toasted soybean meal gave the best growth performance and food utilization as earlier reported by Eyo (1999) who confirmed that toasted soybean gave the best growth performance to *Clarias anguillaris* fingerlings compared to raw soybean, soybean residue and other heat treated soybean diets. Toasting the soybean for 30 minutes at 100°C appeared to destroy the typsin inhibitors without affecting the heat labile amino acids particularly lysine. Genetically improved *Heterobranchus longifilis* fed with cooked soybean diets did not perform as well as those fed with the toasted soybean, probably because the cooking might have damaged some of the heat labile amino acids, or the degree of heat may not have been adequate enough to destroy the trypsin inhibitors or both. The extruded soybean did give poor growth performance to the genetically improved *Heterobrancus longifilis* fingerlings, this was unexpected. Extruded soybean meal is expected to be the highest in nutritive value because the temperature of extrusion is expected to destroy the lysine inhibitor while the less retaining time was to cause less damage to the heat labile amino acids. The reason for the poor performance of the extruded soybean meal could be that the temperature of 135°C-145°C and pressure of 30-40 bars used must have been too high and therefore had adverse effect on the nutritional composition and some consistency especially the lysine component. Dabrowski and Kozak (1979) and Sadiku and Jauncey (1995) have demonstrated that prolonged heat treatment affect the nutritive value of soybean meal. Once a certain percentage of lysine is affected it creates the same percentage effect on the utilization. This significant effect of lysine however was confirmed when lysine was properly heated or slightly over heated Cowey *et al.*, (1971)

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Table 3: Daily growth rates (g/day) of *Heterobranchus longifilis* fingerlings fed different soybean-based diets in glass aquaria tanks during the 56 days.

Treatment	Replicates	7th day	14th day	21st day	28th day	35th day	42nd day	49th day	56th day
I Raw Soybean Diet	RI	1.23	0.71	0.55	0.44	0.35	0.30	0.24	0.26
	R2	1.41	0.67	0.53	0.43	0.32	0.30	0.27	0.33
	Mean	1.32	0.69	0.54	0.44	0.34	0.30	0.26	0.30
II Cooked Soybean Diet	RI	1.35	0.84	0.57	0.47	0.38	0.34	0.29	0.34
	R2	1.41	0.84	0.67	0.52	0.40	0.37	0.33	0.37
	Mean	1.38	0.84	0.62	0.50	0.39	0.36	0.31	0.36
III Toasted Soybean Diet	RI	1.32	0.81	0.59	0.55	0.48	0.47	0.39	0.47
	R2	1.19	0.64	0.55	0.41	0.37	0.37	0.34	0.39
	Mean	1.26	0.73	0.57	0.48	0.43	0.24	0.37	0.43
IV Extruded Soybean Diet	RI	1.26	0.73	0.48	0.35	0.28	0.23	0.20	0.20
	R2	1.25	0.74	0.49	0.45	0.38	0.29	0.21	0.22
	Mean	1.26	0.74	0.49	0.40	0.33	0.26	0.21	0.21

Table 4: Summary of results of *Heterobranchus longifilis* fingerlings fed Different soybean based diets in aquaria tanks for 56 days.

Treatment	Repli-cates	Average Initial Weight (g)	Average Final Weight (g)	Average Weight Gain (g)	Relative Weight Gain (%)	Average Daily Growth Rate(g)	Specific Growth Rate (%/day)	Feed intake	Food Con-Ver Sion Ratio (FCR)	**Survi-Val Rate (%)**
I Raw Soybean Diet	RI	7.53	14.41	6.88	91.37	0.123	1.16	30.21	4.39	40.0
	R2	8.09	18.45	0.36	128.06	0.185	1.47	30.63	2.96	87.0
	Mean	7.81	16.43	8.62	110.37	0.154	1.32	30.43	3.68	64.0
II Cooked Soybean Diet	RI	7.76	19.04	11.28	145.36	0.201	1.60	33.58	2.98	80.0
	R2	8.36	20.55	12.19	145.81	0.218	1.61	36.52	3.00	93.0
	Mean	8.06	19.80	11.74	145.66	0.210	1.60	35.05	2.99	87.0
III Toasted Soybean Diet	RI	7.77	26.44	18.67	240.28	0.333	2.19	39.19	2.10	80.0
	R2	7.67	21.78	14.11	183.96	0.252	1.86	32.56	2.31	100.0
	Mean	7.72	24.11	16.39	212.31	0.293	2.03	35.80	2.21	90.0
IV Extrude Soybean Diet	RI	7.81	11.08	3.27	41.87	0.058	0.62	26.41	8.08	67.0
	R2	8.03	12.27	4.24	58.80	0.075	0.76	29.91	7.05	67.0
	Mean	7.72	11.68	3.76	47.47	0.067	0.69	28.16	7.57	67.0

Table 5: Means and ranges of some physico-chemical parameter of Water in the glass aquaria tanks in which *Heterobranchus longigilis* were at different soybean based diets for 56 days.

Treatment	(0^0C) Temperature	Dissolved Oxygen(mg/L)	pH	Conductivity (µh
I	28.63 <28.0-29.0>	6.41 <5.10-8.20>	7.56 <7.0-7.67>	223.75 <200-260.0>
II	28.5 <27.0-29.0>	6.29 <5.00-8.00>	7.56 <7.0-7.6>	223.75 <200.0-260.0>
III	28.85 <28.0-29.0>	5.58 <5.10-6.00>	7.56 <7.0-7.6>	223.75 <200.0-260.0>
IV	28.75 <28.0-29.0>	5.65 <5.20-6.20>	7.45 <7.0-7.6>	223.75 <200.0-260.0>

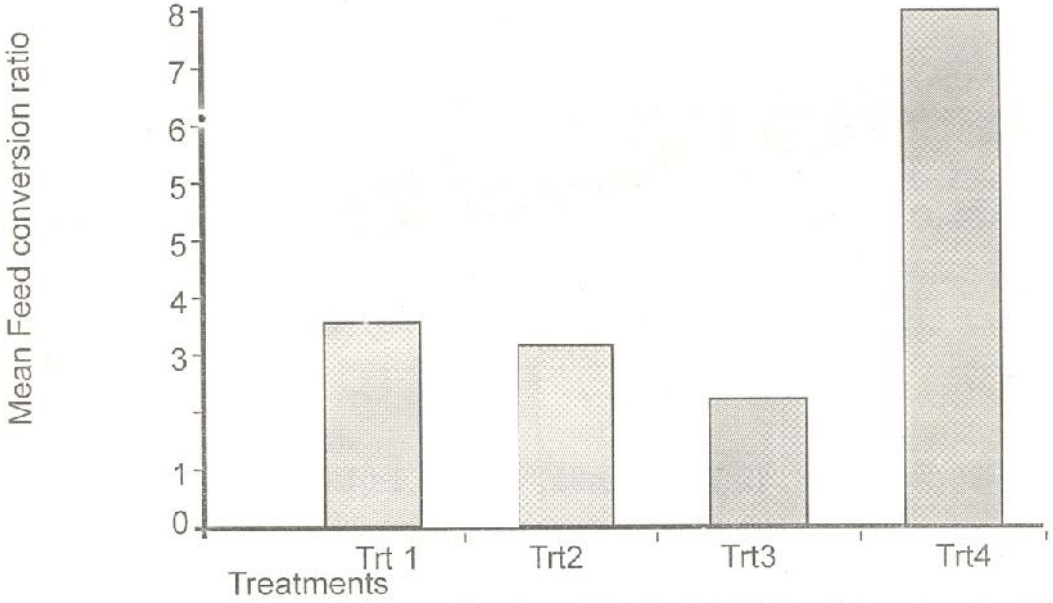

Figure 3: Mean Feed conversion of *Heterobranchus logifilis* fingerlings fed with different soyabean based diets

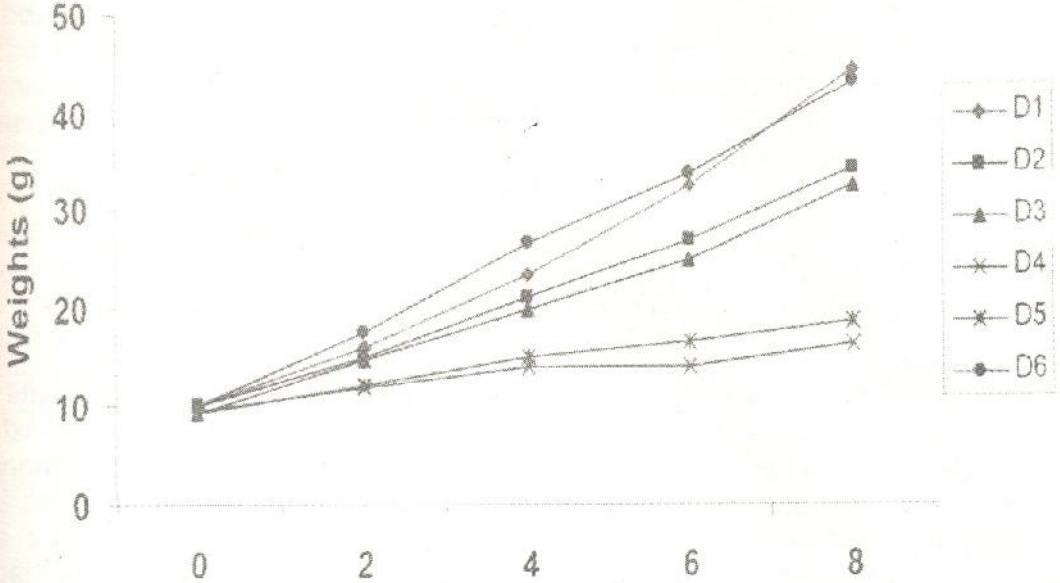

Fig. 1: Cumulative Weight increases of C. gariepinus fed fingerlings experimental diet for 8 weeks.