EFFECT OF HEAT-TREATED SOYBEAN MEAL ON GROWTH PERFORMANCE AND NUTRIENT UTILISATION OF AFRICAN CATFISH (*CLARIAS GARIEPINUS*) FINGERLINGS

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Abstract
This study evaluated the effect of heat treatments of raw soybean seed meals (RSBM) on the growth performance and nutrient utilisation of African catfish *Claras gariepinus*. Six isonitrogenous (35% crude protein) diets were formulated. A diet containing fish meal and non -heated soybean as served as control diet. Raw Soybean seeds were heated in an auto seed dryer machine at 130^0 C for 10-50 minutes represented by RSBM10, RSBM20, RSBM30, RSBM40 and RSBM50 respectively. These were used to partially replace fish meal at 18.85%. Each diet was fed to fingerlings with mean weight of 1.70g stocked 10 fingerlings/treatment in triplicate, fed twice daily for 56 days at 5% body weight. The Mean Weight Gain (MWG), Total Weight Gained (TWG), Total Feed Intake (TFI) and Protein Efficiency Ratio (PER) were determined. Data were analysed using one-way ANOVA at (α 0.05). The highest TWG, MWG of 21.79±2.00g; 2.66g were from the fish fed RSBM40 diet and the least values were from the fish fed the control diet (15.63±2.00g; 1.43g) respectively. However, the fish fed RSBM50 diet recorded the lowest TWG and MWG (16.55±20g; 1.61±006g) among the fish fed diets subjected to heat treatments. The same trends were observed in TFI and PER, where the highest value was from the fish fed RSBM40 diet (308.70±00g; 2.26±00) and the lowest value (233.10±00g; 2.14±00) was from fish fed control diet. The improved performance of fish fed RSBM40 diet, revealed that the anti -nutritional factors were denatured at the optimum temperature for effective utilisation by the fish and decreased performance of the fish fed RSBM50 diet, showed that the nutrients were denatured at higher exposure time. Therefore, it's recommended that soybeans be processed at optimum temperature for 40 minutes by farmers for the best result in culturing *C. gariepinus*.
Keywords: Heat treatment, processing, anti-nutritional factors, *Clarias gariepinus*, fish nutrition, Aquaculture

Introduction:

The world demand for sea food is increasing dramatically year by year and it is for this reason that there is a considerable move towards modernizing and intensifying fish farming. To be economically viable, fish farming must be competitive, which mean that feed cost amongst others must be carefully monitored as the fish feed constitute 60% of production cost. (Akintomide *et al.*, 2005). Due its nutritional value and palatability, fish meal still constitutes a substantial portion of fish feed formulation. However, the scarcity and consequent rising cost of fish meal has put the cost of quality feed out of the reach of the average farmers. Soybean meal has been found to be a good substitute. However, due to presence of anti-nutritional factors in soybean, it is justifiable therefore to evaluate the adequacy of heat treatment that will effectively destroy the anti-nutritional factors without affecting the nutritional quality of soybean. Studies have showed that plant protein particularly Soybean meal (SBM) is a good replacement and is the most commonly used plant protein in feed formulation for aquaculture species (Lim and Akiyama, 1991, Adewole and Owolabi, 2006). The effect of the partial or total replacement of fish meal by soybean meal (SBM) in fish diets which frequently lead to reduced growth performance and poor feed utilization efficiency (Beckmann and Pfeffer, 1989) could be attributed to a number of factors such as improper balance of essential nutrients, lower

digestibility, reduced diet palatability and most importantly the presence of anti-nutritional factors such as trypsin inhibitors (TIs) and lectins (Tacon 1994). The heat treatment applied during commercial processing of soybean meal (SBM) has been found to inactivate most of the TIs and other heat-sensitive anti-nutritional factors (Liener, 1980). However, it is suggested that this heat treatment should be kept to a minimum due to its cost and the possibility of destroying essential amino acids, such as lysine and methionine, reducing the availability of other nutrients (Qin *et al.*, 1998). Therefore, soybean meal (SBM) heat processing must be a compromise between inactivation factors and destruction/denaturation of essential nutrients. There is need to ascertain the optimum length of period at which soybean will be heated in order to inactivate the TIs in raw soybean meal without compromising its protein nutritional value. Therefore, the effect of heat-treated soybean meal diets on the growth performance and nutrient utilisation of *Clarias gariepinus* fingerlings was investigated.

Materials and Methods

Experimental location: The experiment was carried out in the Fisheries Laboratory of the Department of Animal/Fisheries Science and Management. Enugu State University of Science and Technology (ESUT), Nigeria.

Processing, formulation, preparation of the experimental diets: Raw soybean seeds were procured from Eke Market, Agbani, Enugu State. The seeds were sorted, sun dried for five days and subjected to heating processing in an automatic seed dryer **at temperature** of 130^{o}C, but for different length of time:10,20,30,40 and 50minutes respectively. After heating the content of each of the containers was crushed into dried powder with a clean, dry hammer mill and labelled (RSBM10), (RSBM20), (RSBM30), (RSBM40), (RSBM50) and the control (CONT) meals (without heat treated soybean meal). These were later used in the formulation and preparation of six experimental diets for *C. gariepinus* fingerlings containing iso-nitrogenous crude protein of 35% (Table 1) as reported by (Adewole and Owolabi, 2006).

Table 1: Composition of the Experimental Diets (in 100g) fed to *Clarias gariepinus* in plastic tanks for 56 days

Treatments						
Ingredients	CONT	RSBM10	RSBM20	RSBM30	RSBM40	RSBM50
Fishmeal	27.73	27.73	27.73	27.73	27.73	27.73
Non heated RSBM	18.85	-	-	-	-	-
RSBM heated for 10 min	-	18.85	-			
RSBM heated for 20 min	-	-	18.85	-		
RSBM heated for 30 min	-	-		18.85	-	
RSBM heated for 40 min	-	-			18.85	-
RSBM heated for 50 min	-	-				18.85
Yellow maize	42.92	42.92	42.92	42.92	42.92	42.92
Bone meal	0.50	0.50	0.50	0.50	0.50	0.50
Premix	4.00	4.00	4.00	4.00	4.00	4.00
Oil	5.00	5.00	5.00	5.00	5.00	5.00
Salt	1.00	1.00	1.00	1.00	1.00	1.00
Total	100.00	100.00	100.00	100.00	100.00	100.00

Fish stocking acclimatization and experimental design: One hundred and eighty (180) of catfish fingerlings were bought from a private hatchery, Epkan Farm, Delta State, Nigeria, and acclimatized for one week. Eighteen (18) plastic bowls with diameter of 48cm and depth of 30cm as rearing tanks were used to stock the fish in a complete randomised experimental design with 10 fish per tank in triplicates, i.e. (30 fish/treatment).

Feeding Management: The fingerling fish were fed at 5% body weight twice daily between 6.30am and 6.30pm daily for 56 days (Adewole and Owolabi, 2006).

Growth measurements: Total length (cm) and total weight (g) of the fish were determined biweekly using metre rule and electronic weighing scale. The growth data obtained were used to compare the growth performance, nutrient utilisation indices and survival of *C. gariepinus* fingerlings fed the various diets as reported by (Adewole,2016). Data were analysed statistically using one-way analysis of variance (ANOVA) at (α0.05).

Results and Discussion

The result showed that all the fish used in the experiment survived, without any mortality (Table 2). This agreed with the result obtained by Helena *et al., (*2003) which reported an average survival rate of 99 percent in their work. The high survival rate obtained in this work could be as a result of good and efficient water quality management technique and reduction of stress to the fish during the feeding trials. The results at the end of the feeding trials showed that the fish responded well to the experimental diets (Table 2),there were increases in the lengths and weights of the fish from the initial total length of 3.57±9cm to 7.41±9cm from the fish fed RSBM40, while the highest Total Weight Gained (TWG) and Mean Weight Gain (MWG) of 21.79±2.00g; 2.66g were from the fish fed RSBM40, closely followed by fish fed RSMB30 (17.43±2.00g; 1.77g) and the least values were obtained from the fish fed the control diet (15.63±2.00g;1.43g) respectively. However, there was reduction in the final weight as the fish fed RSBM50 recorded the lowest weight among the diets subjected to heat treatments. The same trends were observed in the Total Feed Intake (TFI), which revealed that the highest value was from the fish fed RSBM40 (308.70±00g) and the lowest value (233.10±00g) was from the fish fed the control diet. The final condition factor (K2) showed that the highest value (6.91) was from the fish fed RSBM10 and the lowest value (1.72) was from the fish fed RSBM40.

The result obtained indicated that there was a significant reduction in both the total length, weight and feed intake of the fingerlings fed the (Control diet and RSBM10) as result of anti-nutritional factors present in the soybean which have not be inactivated to a level, that could have been utilized by fish with the heat treatment applied during the processing of soybean meal (SBM) which has led to decrease in growth performance of the fish fed with soybean based diet heated for 10minutes. This was in agreement with (Wilson and Poe, 1985; Balogun and Ologhobo, 1989) which as earlier reported that Trypsin inhibitors in soybean cause growth depression reduced feed efficiency and survival of some fish species.

Furthermore, it was observed that the fish fed RSBM20- RSBM40 diets had appreciable increased length, weight and feed intake when compared with the fish fed (Control diet, RSBM10 and RSBM50) respectively. The weight gains of fish fed heated soybean based diets increased from RSBM10 –RSBM40 and then decreased in fish fed RSBM50 as heating process progressed. This could be as a result of the gradual inactivation of anti-nutritional factors present in soybean as heating process progressed from RSBM10to RSBM30and totally destroyed at RSBM40 (40minutes of heating) to fully release the available essential nutrients for better utilization by the fish. The observed decreased after RSBM40 could be as a result of prolonged/excessive heating which Lim and Akiyama, (1991) reported can lead to destruction of these essential nutrients of the soybean, primarily lysine in non-enzymatic browning reaction and sulphur amino acid. These observations invariably agreed with Wilson and Poe, (1985) and Fowler, (1980) who had earlier reported the deleterious effect of overheating soybean on its nutritional values. This also agreed with the previous study on channel catfish that fish fed with soybean based diets heated for 40min at 130^0C increases whole body and better protein utilization (Castell and Cliplef, 1988).

Conclusion and Recommendation: It can be concluded that by heating soybean at 130^0C for 40minutes improved the growth performance and feed utilization efficiency of *C. gariepinus* fingerlings due to lowered trypsin inhibitor and other anti-nutritional factors and bioavailability of other nutrients to the fish. Therefore, processed and heat treated soybean meal is recommended as a replacement for fishmeal in the culturing of catfish in Nigeria.

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