DIGESTIBILITY AND NUTRIENT UTILISATION OF SOYBEAN BRAN-BASED DIETS IN NILE TILAPIA *OREOCHROMIS NILOTICUS*

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ABSTRACT

The digestibility and utilisation of two soybean bran-based diets and two fishmeal-based diets serving as control, at optimal (30%) and suboptimal (20%) protein levels were evaluated. These were Diet I(Control) - fishmeal based diet at 30% crude protein, Diet II(Control) - fishmeal based diet at 20% crude protein, Diet III - hydrolysed Soybean Bran based diet at 30% crude protein, Diet IV - hydrolysed Soybean Bran based diet at 20%. Dry matter digestibility differed insignificantly with variation in diets($P<0.05$). There was significant (p20.05) variation in the protein, lipid and ash digestibility. Protein was more digestible at optimum level than sub-optimum level, while lipid and ash digestibility did not vary with their inclusion levels. Variation in the utilisation of the diets was significant($P<0.05$) except for survival. It was observed that the best diet was Diet I, closely followed by Diet II with highest values of mean final weight, specific growth rate, protein efficiency ratio and the apparent net protein utilisation. The high digestibility values of Diets III and IV suggests their inclusion in fish diet to spare protein for growth.

Keywords: Digestibility, Nutrient Utilisation, Soybean Bran Hydrolysate, Diets, Nile Tilapia, *Oreochromis niloticus*

INTRODUCTION

Soybean (Glycine max) is a valuable oil seed legume with stirling nutritional qualities and now internationally acclaimed as the miracle crop, the cow of China, the Cinderella crop of the west and the Pearls of the Orient (Osho, 1991). It has high utilisation potential in human, animal and fish nutrition.

Soybean meal constitutes 50% of the diet of channel catfish in the United States - as replacer of fishmeal (Mohsen and Lovell, 1993). Utilisation of soybean fractions such as soybean bran, milk and milk products as feed in aquaculture has been an age long practice in Asia. Chen and Yi (1991) successfully utilised unicellular algae and soybean milk in the rearing of zoaea larvae of *Paenaeus penicillatus*. The larvae of *Mytilus edulis* were reared on four species of unicellular algae. They started ingesting these food materials when they still had some yolk in the body (Nie and Ji, 1980). In Africa, soybean fractions production and utilisation have been popularised through soybean production and utilisation projects of the International Institute of Tropical Agriculture (IITA, 1990) to address the problem of human malnutrition in Africa. Several whole and fraction soybean products are now common household dietary protein sources in Nigeria. Extension services on the utilisation of soybean to neighbouring West African countries of Ghana and Cote d'Ivoire were expedited (Okoruwa and Dashiell, 1997).

Ironically, most of these fractions of great nutritional potential are highly perishable materials and are therefore potential sources of wastes into the environment. A planned industrial scale production of these fractions should be backed up with a well planned waste management strategy, particularly in the developing countries with inadequate preservation and processing technologies. Bio-transformation of these materials into first class animal protein when fed as feed to fish appears to be a very effective biological method of management that converts waste into wealth.

One of such wastes is the soybean bran resulting from fractionating soybean in the course of soymilk production. Its utilisation in fish diet has been rarely reported. The use of animal wastes hydrolysate have been reported. Hardy (1991) investigated the suitability of fish hydrolysate utilization in the diets of *Onycorhynchus mykiss* and observed that partially hydrolysed fish silage was better than fully hydrolysed fish silage. This investigation is therefore aimed at studying the suitability of soybean bran in the diets of late fry of *Oreochromis niloticus* as hydrolysate, either as energy source or protein supplements.

MATERIALS AND METHODS

The standard methods of the International Institute for tropical Agriculture (IITA) was employed to produce the soybean bran (IITA, 1990). The bran was then hydrolysed at a pH of 4.0 using HCL in an oven for 24 Hrs. This was further neutralised according to Hardy(1991). The hydrolysate was allowed to dry and then incorporated into the diet- tilapia grower diets as soybean bran soluble (SBBS). The proximate composition and the amino acid profile of the solubles are shown in Table1. Four isocaloric (4.0 kcal/g) diets at suboptimal and optimal protein levels of 20% and 30% containing hydrolysed SBB were prepared, with fish meal based diets serving as control. Table 2 depicts the inclusion levels and proximate composition of the diets. 3mm pellets were prepared using a modified Bohr mill with a mounted pelleting die. They were subsequently solar-dried and kept in a dry place at room temperature. Pellets for dispensation to fish was further micronised into crumbs acceptable to the late fry.

The feeding trial was a completely randomised block design with four diets in duplicate. Late fry of *O.niloitcus* were stocked at 10 per 20L tank in 8 tanks in a recirculatory system, at an average weight of 0.26g. They were fed at 5% body weight twice daily for 8 weeks. Wastes accumulating from the system were siphoned twice in a week. Water quality parameters were monitored at pH,6-7; temperature,30-35°C; DO, 5-6.0 mg/l; NH_3-N, 0.5-1.0; NO_3-N, 10-20 and NO_2-N, 0.4mg/l. Water flow rate was maintained at 1L/min.

Chemical analysis of the feedstuffs, diets and the method of carcass(initial and final) were performed according to the method of A.O.A.C.(1990). 10 specimens of late fry *O. Niloticus* were taken for initial carcass analysis while five from each tank for final carcass analysis. Acid insoluble ash was measured as inert material in the diets and faecal matter. Water quality parameter were analysed according to APHA (1980). Biological parameters monitored were specific growth rate(SGR), food conversion ratio (FCR), protein efficiency ratio (PER), apparent net protein utilisation (ANPU) and survival (S) (Steffens, 1989). Gross energy was calculated by using the following multiplier factors; carbohydrate, 4.1kcal/g; protein, 5.4 kcal/g and lipid, 9.5 kcal/g (Jobling, 1983). Digestibility was determined by the substitution of percentages of acid insoluble ash and nutrient in faeces and diets into the apparent digestibility coefficient equation of Maynard et al. (1979).

Analysis of variance was used to evaluate variability in the utilisation of the four diets as treatments. Multiple range analysis was used to compare means of the utilisation parameters according to Tukey (Steele and Torrie, 1960). Data transformation was done according to Zar (1984). Statgraphics package, version 3.0 was used for statistical analysis while Cricket graph package, version 1.3.1 was used for the presentation of the fish growth response to the diets.

RESULTS AND DISCUSSION

Digestibility of Hydrolysed Soybean Bran (Soybean Soluble -SBBS) Based Diets

The digestibility of these diets were evaluated. Dry matter digestibility differed insignificantly (P>0.05) with variation in diets. There was significantly variation in the protein, lipid and ash digestibility. Protein was more digestible at optimum level than sub-optimum level. This was probably due to preferential mobilisation of protein by fish for its metabolic activities creating a high demand for protein at ingestion and digestion. Fish utilise protein as source of energy (Lovell, 1991). However, Lipid digestibility was highest in Diets II and III containing lipid at levels that could be considered sub-optimal and optimal, with and without fishmeal inclusion respectively (Table 3). Lipid digestibility was relatively low as compared to protein. This negates the findings of Sargent et al. (1989) who recorded high lipid digestbility in tilapia that was attributed to high lipase activity. However, It is noteworthy that tilapia is a low lipid tolerant fish as it cannot tolerate more than 12% in its diets (Jauncey, 1982), hence, the more fishmeal in a diet, the higher the lipid content and the less its lipid digestibility. Ash digestibility was lowest in Diet I with the highest ash level. This is not unconnected with the fishmeal inclusion level. Acid digestion of ash have been reported in fish except stomachless ones. Lovell (1991) reported fish which do not have acidic stomach do not utilise mineral sources of low solubility and conversely. Digestibility of ash expected to be high in tilapia was generally low. This could be due to mineral composition of the feed being of low solubility and the physiological state of the fish as late fry.

Utilisation of Hydrolysed Soybean Bran (Soybean Bran Soluble - SBBS)-Based Diets by *O.niloticus.*

Late fry of *O.niloticus* with an average weight of 0.26g were fed with four diets (Diets I-IV) for a period of eight weeks at 5% body weight per day (Table 4). There was significant variation in utilisation of the diets by *O.niloticus* with respect to the parameters evaluated ($P<0.05$), except for survival. It was observed that Diet I recorded the best nutrient utilisation with the highest mean final weight(MFW), specific growth rate(SGR), protein efficiency ratio(PER) and apparent net protein utilisation(ANPU), and the lowest food conversion ratio(FCR). This was the control diet. Though, the fact that Diets III and IV containing the SBBS did not perform as good as Diet I and II, the relatively high digestibility of Diet III suggests its suitability for inclusion at optimal. Bran generally is more of indigestible carbohydrate and cannot be utilised readily by fish in its normal state. However, hydrolysing bran definitely improved its utilisation at optimum level to be able to provide the level of nutrient required. The growth response is depicted in Fig.1. Fish use digestible carbohydrate as energy source to spare protein (Lovell, 1991). It is therefore promising to utilise bran in its hydrolysed state to spare protein for growth in the diets of *Oreochromis niloticus* .

Carcass Composition of *O.niloticus* Fed Hydrolysed Soybean Bran (Soybean Bran Soluble – SBBS) - Based Diets

Analysis of carcass of *O.niloticus* fed SBBS showed significant variation with the diets($P<0.05$) except for protein. Fishes fed the control diets (Diets I and II) had the highest and lowest moisture and lipid content respectively, while ash was higher in the SBBS based diets than the control (Table 5). This depicted an inverse relationship between moisture and lipid already established in fish(Vlieg, 1985). It could therefore be said that the SBBS inclusion had not altered this balance. The protein in the carcass of fish fed fishmeal based diet was higher than SBBS based diets, attested to by its better net protein utilisation, as depicted in Table 3. Jauncey *et al*. (1984) postulated a direct relationship between amino acid profile in the diet and the carcass, and consequently their protein.

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REFERENCES

APHA (1980): Standard Methods of Assessment of Water and Waste Waters. American Public Health Association14edn. AHWA - WPCF . Washington D.C. pp?

A.O.A.C. (1990): *Official Methods of Analysis,* 15 edn. K. Heldrich. Association of Official Analytical Chemists, Virginia, U.S.A. pp??

Chen, B. and Yi, J. (1991): The food of larvae of *Paenaeus penicillatus* Alcock. *J. Fish.* 15(3):219-227.

Hardy, R.W.(1991): Fish hydrolysates: production and use in aquaculture feeds. Proceedings of the aquaculture feed processing and nutrition workshop. Thailand and Indonesia. Pp. 109-115

Huxley, J.S. (1932): *Problems of relative growth*. London:Methuen. pp

I.I.T.A. (1990): *Soybeans for Good Health: How to Grow and Use Soybeans in Nigeria.* International Institute of Tropical Agriculture, Ibadan - Nigeria. 23pp.

Jauncey, K. and Ross, B. (1982): *A Guide to Tilapia Feeds and Feeding*. Institute of Aquaculture, University of Stirling, Stirling. 111pp.

Jauncey, K , Tacon, A.G.J.and Jackson, A.J. (1984): The quantitative essential amino-acid requirements of *Oreochromis (=Sarotherodon) mossambicus*. In:*Proceedings of the First International Symposium on Tilapia in Aquaculture* (Fishelon, L & Yaron , Z.-eds). Tel Aviv University, Israel. Pp:328-334

Jobling, M. (1983): A short review and critique of methodology used in fish growth and nutrition studies. *Journal of Fish Biology* 23:686-703.

Lovell, R.T. (1991): Use of soybean products in diets for aquaculture species: Revised. *ASA Technical Bulletin*, (Vol./ No.) 21-90.

Maynard, L.A., Loosli, J.K., Hintz, H.F., and Warner, R.G. (1979): *Animal Nutrition*, 7th edn. McGraw-Hill, New York. pp

Mohsen, A.A. and Lovell, R.T. (1990): Partial substitution of soybean meal with animal protein sources in diets for channel catfish. *Aquaculture* 87:53-63.

Nakayama, O. and Osho, S.(1996): *Tofu: Introducing Tofu (Soy Cheese) into Traditional African Foods*. International Institute for Tropical Agriculture, Ibadan. 15pp.

Nie, Z and Ji, M. (1980). Studies on food for *Mytilus edulis* larvae.*Marine Fish. Res.* 1:85-96 pp.

Okoruwa, A.E. and Dashiell, K.E. (1997): *Soybean Utilisation in Nigeria, Ghana and Cote D'Ivoire (West Africa). IDRC/IITA Soybean Utilisation Project - Phase III*. International Institute for Tropical Agriculture, Ibadan. 103pp.

Osho, S. (1991): Soybean as Food in Nigeria. Training Manual. A National *Workshopon Soybean Processing and Utilisation for Women Groups in Nigeria*. International Institute for Tropical Agriculture, Ibadan. 50pp

Sargent, J., Henderson, R.J. & Tocher, D.R. (1989): The lipids In: *Fish Nutrition*, 2nd edn (ed. by J.E. Halver), .pp153-218. Academic Press, New York, NY.

Steele, H.E. & Torrie, J.H. (1960): *Principles and Procedures of Statistics*. McGraw-Hill, New York, N.Y. pp

Steffens, W. (1989): *Principles of Fish Nutrition*. John Wiley & Sons, New York. 384pp

Vlieg, P.(1985): Statistical relationships between the moisture and oil contents of 3 New Zealand mackerel species. *New Zealand Journal of Technology*, 1:187-189

Zar, J.H. (1984): *Biostatistical Analysis*, 2nd edn. Prentice-Hall, Inc. Englewood liffs, NJ. pp

Table 1. Level of Inclusion of Ingredients in Hydrolysed Soybean Bran (SBBS) Based Diets.

Diets

Ingredients	I	II	III	IV
SBBS	-	-	46.11	24.41
FM	51.22	36.33	46.11	24.41
MM	43.78	58.48	2.78	46.19
*V/M Premix	5.00	5.00	5.00	5.00
% Proximate Composition				
(as analysed)				
Moisture	8.48	8.75	8.58	9.01
Protein	28.50	22.62	28.50	19.00
Lipid	9.87	8.37	7.98	6.46
Ash	17.00	14.60	16.18	12.71
Energy(kcal/g)	3.96	3.89	3.89	3.81

*Vitamin-mineral /kg premix: Vit. A, 4 000 000 I.U; Vit. D3 800 000 I.U; Vit. E, 10 000mg; Vit. B1, 800mg; Vit. B2, 2 000mg; Vit. B6, 1200mg; Calcium D-pantotenate, 4 000mg; Vit. H, 20mg; Vit. K3, 800mg; Vit. PP, 1 2000mg; Vit. B12, 6mg; Folic Acid, 400mg; Choline Chloride, 80 000mg; Cobalt, 100mg; Iron, 20 000; Selenium, 40mg; Iodine, 620mg; Manganese, 40 000mg; Copper, 800mg; Zinc, 18 000mg; Endox, 50 000mg.

Table 2. Digestibility of Hydrolysed Soybean Bran (Soybean Bran Soluble SBBS) in *O.niloticus*

	Diets			
ADC(%)	I	II	III	IV
Dry Matter	96.6a	97.69a	95.32a	95.70a
Protein	70.24b	51.36a	70.24b	53.93a
Lipid	51.11a	62.71b	62.71b	55.75a
Ash	12.68a	27.87b	27.87b	27.82b

Data on the same row carrying the same letter differ insignificantly from each other (P>0.05).

Table 3: Utilisation of Hydrolysed Soybean Bran (Soybean Bran Soluble-SBBS) Based Diets by *O.niloticus* Late Fry

Diets

Parameter	I	II	III	IV
MIW(g)	0.21a	0.23a	0.29a	0.29a
MFW(g)	0.79b	0.51a	0.55a	0.59a
SGR(%/Day)	2.08b	1.74ab	1.17a	1.29a
FCR	0.25a	0.26a	0.42b	0.33ab
PER	13.59b	13.45b	8.13a	8.71a
ANPU(%)	357.69b	217.50ab	122.73a	133.33ab
SURV(%)	80a	80a	75a	75a

Data on the same row carrying different letters differ significantly from each other ($P<0.05$).

Table 4: Carcass Composition of *O.niloticus* Fed Hydrolysed Soybean Bran (Soybean Bran Soluble - SBBS) Based Diets

	Diets			
% Proximate Composition	I	II	III	IV
Moisture	50.71ab	60.39b	30.79a	39.01ab
Protein	15.54a	14.79a	13.81a	12.71a
Lipid	7.10a	6.98a	22.99c	12.04b
Ash	5.33a	5.81a	9.85b	12.03b

Data on the same row carrying the same letter differ insignificantly from each other ($P>0.05$).