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Aims and Scope

The Journal of West African Fisheries focuses on the institution s and organizations, which affect fisheries development in the African sub-regions. Attention is given to problems relating to fisheries planning and policies, fish processing, marketing and distribution; resource, fisheries technology and fishing investment, aquiculture, and bio-techololgy.

This is of particular interest to policy makers, šcholars, international agencies and private organisations involved in the fisheries industry.

UTILIZATION OF AUTOCLAVED SOLVENT EXTRACTED SESAME SEED CAKE AS A CHEAPER SOURCE OF METHIONINE SUPPLEMENTATION TO OTHER PLANT PROTEIN SOURCES IN THE FEED OF CLARIAS GARIEPINUS

OLUKUNLE, OYIN and FALAYE, A.E.

ABSTRACT

The study was designed to find the replacement value of fishmeal (Fm) by solvent extracted sesame seed cake (SSC) in relation to the amino acid supplementation. The fishmeal was replaced by SSC in five diets at 0%, 25%, 50%, 75% and 100% inclusion levels. The diets were fed to *Clarias gariepinus* fingerlings for a period of 42 days.

The trial concluded that solvent extracted sesame seed cake (SESSC) is better fed to *C. gariepinus* fingerlings supplemented at 25% level. Economically SESSC diet had the lowest incidence of cost. The fish feed production cost is reduced by at least 25% when SESSC replaces Fm in the diet of *C. gariepinus*.

Key Words: Livestock nutritionists, feed millers, aquaculturists.

Department of Wildlife and Fisheries Management, University of Ibadan.

INTRODUCTION

Groundnut cake is a common plant protein source used in the rearing of fish in Nigeria. Recently and gradually soyabean cake is being introduced into the Nigerian livestock feed pool but it is not in common use (Tewe; 1985). Soyabean cake has a higher protein content of between 40- 50% while groundnut and sesame seed cakes have between 32-40% and 34 – 57% respectively depending on the degree of oil extraction. Groundnut and soyabean cakes have methionine as the limiting amino acid (Altscul, 1958). Sesame seed cake is rich in methionine, hence, theoretically any combination of sesame seed cake with either of the two cakes should have a balanced amino acid profile for a diet.

The need of a fish for amino acid can be met if the amino acid is available. Plant proteins have lower digestibility than animal proteins in non-ruminants (Altschul, 1958). However *Clarias gariepinus* is a "chance" omnivore, as it is observed to digest both plant and animal proteins adequately.

This, study was therefore designed to utilize a cheaper source of protein than fishmeal, a source of complimentary amino acid as found in solvent-extracted sesame cake with a combination of either groundnut cake or soyabean cake.

MATERIALS AND METHODS

Experimental diets

The soyabean cake used was the blended Argentina variety. The crude protein of the soyabean cake was 44.1%. Groundnut cake was purchased from Bodija market, Ibadan. The percentage crude protein was 35.9%. The percentage crude protein of the fishmeal was 68%.

Five isonitrogenous diets were compounded to contain 40% crude protein to satisfy the dietary need of *C. gariepinus* fingerlings: Diets II, III, and IV contain 50% solvent extracted sesame seed cake added to 50% fishmeal, groundnut cake and soyabean cake proteins respectively. Diets I and V contained (40% crude protein) 100% sourced from fishmeal and solvent extracted sesame seed cake respectively.

The diets were isocaloric with 397 $\pm$ 0.45Kcal/100g of the feeds and isonitrogenous (40% crude protein). Diet I was the control (Table 1).

Experimental tanks and Experimental Animals

The feeding trial was conducted in 40.5l glass aquaria (30 x 30 x 45cm). Under gravel filters were installed in each of the tanks to remove the particulate materials. Continuous aeration was provided by a central compressor and air stones. Ninety percent of water in the aquaria was exchanged every week and replaced with preheated water at a temperature of 28 $\pm$ 2.00^{0}C.

Chloride levels were maintained at approximately 500mg/l by the addition of 10g food – grade sodium chloride (Nacl) per tank to minimize potential effects of nitrite to fish health (Perrone and Meade, 1997). The tanks were cleaned once a week. Black polysterene plastics bags were used to cover the tanks during the night hours to give 16 : 8 hours per daylight to dark cycle (Hale and Garson, 1972). Water temperatures were regulated to give a 28 $\pm$ 2.00^{0}C; pH was 7.5 $\pm$ 0.5; ammonia 0.25 $\pm$ 0.15mg/l, dissolved oxygen 8.50 $\pm$ 1.50mg/l, water hardness 200 $\pm$ 50ppm and alkalinity 240 $\pm$ 60ppm.

Fingerlings of *C. gariepinus* of same parentage stock size 4.5 $\pm$ 1.5g were obtained and acclimated in a stock tank for six weeks until used. The fingerlings were fed on a commercial catfish pelleted diet (24% crude protein) as acclimatisation diet. Six fish were randomly stocked into each aquarium with 3 replicates. At the start of the study, individual fish weight and length were taken. (No significant difference ($P > 0.05$) occurred in the fish weights among treatment pooled). The average fish weight was 70.42 $\pm$ 0.42g. Fish were weighed weekly for four weeks and feed adjusted weekly accordingly. The fish were fed 3% of their body weight. At the start and end of the feeding trial, a number of fish were sacrificed by decapitation 6 fish at stocking and 4 fish per treatment for approximate analysis. After homogenization 2g samples was weighed and dried in a drying oven at 105^{0}C overnight for moisture determination.

Diet Preparation

Dry ingredients were first ground in a Phillips coffee mill to small particle size (approximately 1.00mm) and passed through a 250μm mesh sieve. Ingredients were thoroughly mixed with the addition of near boiling water (90^{0}C) to form a homogenous dough. The mixtures were passed through a mincer with 0.8mm diameter die to produce "spaghetti-like" strands broken up further to 0.5 – 1.00mm sizes. The pellets were steamed for 15 minutes and dried at 60^{0}C for 4 hours using Gallenkamp convectional oven. They were then cooled and packed in polystyrene bags. All diets were stored in a deep freezer at a temperature of – 18^{0}C to prevent rancidity and spoilage.

Percentage protein levels of the diets were determined by the micro-kjeldahl method (A.O.A.C., 1991). Crude lipid was determined by Bligh and Dyer technique as modified by (Henson and Olley, 1963). Digestible energy (DE) was estimated from the dietary ingredients as established for channel catfish (NRC, 1983). The diets were analysed for their amino acid composition and digestibility (Table 2). Faecal materials were suctioned, pooled and freeze-dried and stored at – 18°C till analysed.

Carcass Composition

Four fish per treatment were sacrificed for carcass composition analysis. The fish flesh were cut into slices of about 0.05cm and a sample (30g) was homogenized with 30ml of deionized water for 45 seconds in a three blade Phillips kitchen blender of HB 28111 model at 4500rpm. The homogenized flesh pulp was kept in the freezer at – 18°C until analysed for proximate composition.

Amino acid analysis

Amino acid analysis of faecal materials and diets were carried out by hydrolysis using 6m hydrochloric acid (HCl) in a kontron Chromakon 500 amino acid analyser.

Exact volumes of each acid was calculated thus:-

$$\text{Amino acid standard conc } (\mu/\text{ml}) \times \frac{\text{Area sample peak}}{\text{Area Standard peak.}}$$

Each concentration μ/ml was multiplied by 15 to give amount in μg in each 10mg sample weight.

Statistical Analysis

Growth performance and food conversion were measured in terms of daily weight gain (g), Specific growth rate (SGR, % day), food conversion ratio (FCR) and weight gain (%). Growth response parameters were calculated as follows: SGR (%/day) ($\log w_t - \log w_i/T$) x 100 where w_t is the weight of fish at time (t_i), w_i weight a fish at time = 0 and T is the culture period in days.

RESULTS

Table 1 shows the nutrient content of the diets. The mean dietary energy was 3.97 ± 0.45kcal/g. The growth and food utilization of *C. gariepinus* fingerlings fed diets I to V are presented in Table 2. Weight gains were not significantly different ($P > 0.05$) among the *Clarias* fingerlings fed diets III and IV. Diet 1, the control had the highest daily weight gain, percent specific growth rate, food conversion ratio and protein productive value. *Clarias* fingerlings fed Diet V had the poorest food conversion ratio and total digestibility. However, Diet V recorded the best growth gain among treatments wholly fed plant proteins.

Table 3 shows that whole body proximate composition at the conclusion of the feeding trial resulted in significant differences ($P < 0.05$) in percentage moisture, crude protein among the fish fed the five diets and averaged 78.72 and 13.97% respectively. Percentage protein was significantly higher ($P < 0.05$) in fish fed diet I (100% FM protein), but there was no significant difference ($P > 0.05$) between Diets II, III and IV. Treatment V (100% sesame seed cake had a significantly higher ($P < 0.05$) protein deposited in the flesh of the fish thus fed than fish fed Diet IV (50% sesame seed cake plus 50% groundnut cake).

The lipid and ash in the carcass are significantly lower ($P > 0.05$) in all the treatments than in the initial fish used.

The levels of methionine (1.3g/100g and arginine (2.48g/100g) in diet I were lower than the levels of the same amino acid in the plant protein diets II to V, whereas the lysine level increased with the decrease of the plant protein inclusion in the diet. Diet V with (1.5g/100g) contains significantly ($P < 0.05$) thrice as much methionine as is recommended for channel catfish (0.5g/100g) (NRC, 1983).

Table 1: Feed Formulation (g/100g) and Proximate Composition of Experimental Diets

Diets	I	II	III	IV	V	Mean	SE ±
Ingredients							
Fishmeal	57.60	28.47	38.25	34.97			
Solvent – Extracted							
Sesame Seed Cake		28.47			63.52		
G-nut Cake			38.25				
Soyabean Cake				34.97			
Cod liver oil	5.00	2.50	2.50	2.50	5.00		
Corn oil		2.5	2.50	2.50			
Mineral Premix	4.00	4.00	4.00	4.00	4.00		
Vitamin Premix	2.00	2.00	2.00	2.00	2.00		
Carboxy Methyl							
Cellulose	2.50	2.50	2.50	2.50	2.50		
Chronic oxide	0.50	0.50	0.50	0.50	0.50		
Detrin	22.93	19.37	6.34	10.90	14.99		
P – Cellulose	11.47	9.69	3.37	5.35	7.49		
Nutrient – Content							
Moisture – Free Basis							
Dry Matter	89.77	87.62	93.25	93.00	88.15	90.36	
Protein %	42.91	40.81	40.00	40.00	37.87	40.32	0.32
Lipid %	10.13	9.60	22.40	8.80	10.00	13.39	
Dietary Energy	3.70	4.01	4.02	4.17	3.14	3.97	0.45
Protein – Energy Ratio	115.97	101.77	82.99	95.92	96.12	98.55	
Chronic oxide %	0.47	0.46	0.44	0.54	0.46	0.47	
Ash %	13.77	9.32	8.00	9.25	8.83	9.83	
Crude fibre %	6.00	2.00	10.00	14.00	12.00	10.00	
NFE %	26.72	37.82	13.16	27.41	24.84	25.99	

Table 2: Growth and Feed Utilization of *C. gariepinus* fed Experimental Diets

Diets	I	II	III	IV	V	SE ±	Mean
Ingredients							
Initial wt. (g)	70.41^{a}	70.50^{a}	70.40^{a}	70.62^{a}	70.15^{a}	0.42	*
Final wt. (g)	120.86^{a}	88.56^{b}	77.59^{d}	77.57^{d}	84.37^{c}	4.48	*
Daily wt. Gain g/day	1.80^{a}	0.65^{b}	0.26^{d}	0.25^{d}	0.51^{c}	0.13	
Percentage wt. Gain (%)	59.77^{a}	35.66^{b}	10.21^{d}	10.11^{d}	18.20	4.20	
Specific growth Rate SGR (%)	1.67^{a}	0.91^{b}	0.35^{d}	0.34^{d}	0.60^{c}	0.11	
Food / Conversion ratio	1.42^{a}	3.02^{b}	5.85^{d}	4.65^{c}	6.33^{e}	0.43	
Protein Eff. Ratio	0.70^{a}	0.33^{b}	0.17^{c}	0.17^{c}	0.16^{c}	0.05	
Productive Value %	18.57^{a}	18.23^{a}	13.64^{e}	15.15^{d}	15.71^{c}	0.27	16.26
Apparent Protein Digestibility	88.18^{a}	91.26^{b}	92.51^{c}	92.50^{c}	88.55^{a}	0.42	
Total Digestibility	86.72^{a}	81.60^{b}	96.92^{c}	93.52^{c}	54.90^{e}	3.33	

1.1 * Average of 3 replicates

1.2 * Average of 3 replicates

Table 3 Proximate carcass composition of the fish fed the Test Diets (Dry Matter Basis) in %

Diets	Initial	I	II	III	IV	V	Mean	SE ±
Moisture	77.39	78.98	81.68	76.46	78.17	79.65	78.72	0.02
Crude Protein	8.27	16.24[a]	15.71[b]	14.09[b]	15.35[b]	14.22[c]	13.97	0.54
Crude Lipid	3.34	2.13[c]	1.76[d]	0.94[e]	2.40[b]	3.00[a]	2.26	0.16
Ash	4.00	1.00[c]	0.50[d]	2.22[a]	1.22[a]	1.00[c]	1.19	0.30

Table 4 shows that the methionine levels in all the experimental diets were more than the (NRC, 1983) recommendation for channel catfish. Diet II with an addition of 50% fishmeal had 1.79g/100g methionine which was only slightly higher than Diet V the all plant protein containing 1.51g/100g. However, the cost analysis of the ingredients indicate that it will cost less to compound diet V (two times) than to use an all fishmeal protein.

Table 4 Amino-acid Composition of SESSC-Supplemented Experimental Diets

Diets	I	II	III	IV	V
Amino Acid Types (g/100g)					
Aspartic acid	3.88	3.85	3.28	2.94	3.06
Threonine	1.80	1.78	1.51	1.34	1.38
Serine	1.91	2.00	1.77	1.63	1.82
Glutamic acid	5.31	5.93	5.61	5.47	6.47
Proline	2.13	2.21	1.96	1.51	1.71
Glycine	2.63	2.59	2.09	1.74	1.75
Alanine	3.02	2.95	2.38	1.97	1.96
Cystine	0.13	0.15	0.16	0.18	0.23
Valine	2.52	2.42	2.12	1.69	1.75
**Methionine	1.31	1.98	1.79	1.57	1.51
Isoleucine	2.16	2.01	1.67	1.51	1.63
Leucine	3.49	3.34	2.81	2.45	2.71
Tyrosine	1.47	1.38	1.21	1.18	1.63
Pheylalanine	1.82	1.74	1.53	1.47	1.71
Ammonia	2.91	2.87	2.45	2.36	2.76
**Lysine	3.84	2.97	2.12	1.52	1.03
Histidine	0.95	1.03	0.85	0.81	0.87
**Arginine	2.48	3.03	3.15	3.45	4.64
Tryptophan	-	-	-	-	-

** = Limiting amino acids for channel catfish.

The cost analysis of the feeding sesame seed cake protein in Diet II reduces the cost significantly ($P > 0.05$) when compared to the control (25.80). However, the productive protein value in the fish fed the control and diet II are similar (Table 6) but they are significantly ($P < 0.05$) different.

Furthermore, fish in treatment V fed 100% sesame seed cake protein had significantly highly ($P < 0.05$) productive protein value (15.71) than all the fish fed diets containing plant proteins (diets III, (13.64) and diet IV (15.51).

Table 5:Cost Analysis of Feed Ingredients (₦)

Diets	I	II	III	IV	V	Mean	SE ±
Feed Ingredients							
% FM inclusion (₦)	51.60 (25.80)	28.47 (14.24)					
Plant Protein Groundnut cake (₦)			38.25 (13.39)				
Soyabean Cake (₦)				34.97 (10.49)			
Solvent Extracted Sesame Seed Cake (₦)		28.47 (5.69)	38.25 (17.65)	34.97 (6.99)	63.52 (12.70)		
Average Cost of protein inclusion (₦)	25.89	19.93	21.04	17.48	12.70	20.34	0.25

Source: Fisheries Department, Oyo State Ministry of Agriculture and Natural Resources, Ibadan, Nigeria (1997)

Table 6: Economic Evaluation of Feed

Index of Evaluation	DIETS I	II	III	IV	V	Mean	SE ±
Incidence of Cost	0.60	1.28	3.37	2.60	1.04	1	0
Profit Index	0.25	0.12^a	0.04^c	0.05^d	0.14^b	0.12	0.02
Productive Protein Value	18.57^a	18.23^b	13.64^e	15.15^d	15.71^c	16.26	0.27

Kg of fish produced = Daily weight gain/day x No. of days used in producing flesh

$$\text{Incidence of Cost} = \frac{\text{Cost of feed}}{\text{Kg of fish produced}}$$

$$\text{Profit Index} = \frac{\text{Value of fish}}{\text{Cost of feed}} = \frac{\text{Wt. of fish x cost/kg}}{\text{Cost of feed/kg}}$$

$$\text{PPV} = \frac{\text{Increment of body Protein g/day}}{\text{Protein intake (g)}}$$

DISCUSSION

The present study indicates that a 50% replacement of fish meal with solvent extracted sesame seed cake causes a depression in daily weight gain and a slight reduction in the protein productive value of the carcass. In this study growth performances and food conversions of fish fed a diet containing 100% fish meal protein were significantly better ($P < 0.05$) than fish fed 50% fish meal protein plus 50% solvent extracted sesame seed protein, or any of the other treatments that were a mixture of 50% solvent extracted sesame seed cake and 50% groundnut soyabean cake protein or even the 100% solvent extracted sesame seed cake protein.

Food conversion ratio for the control diet was similar to published values for *Clarias gariepinus* reared at similar water temperature Viveen (1986); Balogun and Ologhobo (1989). However the food conversion ratio for Diet II to V are significantly higher ($P < 0.05$) than in similar experiments (Hossein and Jauncey 1989). The somewhat higher FCR values may be due to the breaking of the diet pellets rapidly. Small particles of diets were lost in the underground filters and removed as the tanks are cleaned weekly thus skewing FCR values upwards. Thus observation is similar to Webster *et al.* (1992) where channel catfish was fed soybean and distilled grains for partial or full fishmeal and skewing of FCR values.

The depression in growth, high FCR, poor digestibility would not recommend an all plant protein. Even though Altschul, (1958) and Lyon (1971) reported in Olukunle (1996) had shown solvent extracted sesame seed not to contain proteolytic enzyme inhibitors that have an adverse effect on growth of poultry or swine, egg production and egg quality. However, *S. indicuum* has an outer skin (hull) containing a high level of oxalic acid which reacts with calcium known to be in high concentration in the seed to form oxalate. Johnson *et al.* (1988) reported that oxalic acid is present in highest concentration in the hull of sesame seed cake (14.93%), hence dehulling of sesame seed in this study. Johnson *et al.* (1979) further suggested that the modern concepts of calcium metabolism and homeostatus should be undertaking in the animal under study to know the effects of oxalate in food acceptability. The high FCR in Diets II to V may be due to lower acceptability when compared to the control diet. The results of the present study Table 2 indicate that a diet containing 50% Sesame seed cake protein will produce nearly a productive protein in carcass of *Clarias* gariepinus as a 100% fish meal protein diet. Since fishmeal is one of the most expensive feed ingredients in a prepared diet, use of less expensive plant protein sources may allow ingredient flexibility in least cost diet formulation and possible increase profits for producers. Further, research to evaluate calcium metabolism and homeostatis; and the toxicity of oxalates in diets of *Clarias gariepinus* should be conducted to establish the correct processing techniques, and inclusion levels of sesame seed cake protein.

Further research to evaluate diets containing sesame fishmeal protein partial or total replacement for fish meal will form a core of another research project.

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