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Utilization of Processed Soyabean Seeds in the Diets of *Clarias gariepinus* Fingerlings

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Abstract: Feeding trials was conducted for 12 weeks to evaluate the utilization of processed soyabeans meal on the growth and nutrient utilization of *Clarias gariepinus* fingerlings. A control diet with no soyabeans inclusion (Diet 1) and 4 others with differently processed soyabean seeds supplements were formulated i.e. (Diets 2-5). Five isonitrogenous diets (control inclusive) with 35% crude protein were compounded, in all, The diets are: (1) The control, no soyabean inclusion and no processing (2) Autoclaving and Oven Drying (AOD) (3) Autoclaving and Sun Drying (ASD) (4) Oven Drying (OD) and (5) Sundrying (SD). Ten (10) fingerlings of *Clarias gariepinus* were stocked with average mean weight range of 2.80 gm-3.60 gm in each of the experimental plastic bowls, stocked in 26.9 litres of water. Fish fed on AOD and OD diets gave the best growth performance. Processing significantly affected mean weight gain at $p<0.05$. The fourth processing method (Sundrying i.e., the fifth diet) gave the least growth performance with poor growth and nutrient utilization which thus confirms sundrying as an unacceptable form of processing soyabeans. The choice of AOD as the best diet is confirmed, since it has the highest specific growth rate SGR (0.61), Protein efficiency ratio PER (0.392), Productive protein value (PPV (0.787) and least Food Conversion ratio FCR (7.31). The OD diet (which is the second best diet) is not significantly different from AOD $p>0.05$ with SGR (0.59), PER (0.378), PPV (0.657), FCR (7.70). The third ranking diet is the control. This suggest that utilization of soyabeans for fish diets in *Clarias gariepinus* is best if the processing method involves oven- drying.

Key words: Soyabean, process, fingerlings, feeding, utilization

INTRODUCTION

According to Lovell[1], soyabean protein has one of the best amino-acid profile of all protein rich plant feedstuff for meeting essential amino-acid requirements of fish. Viola[2] was able to observe that properly treated soyabean meal with a higher energy content, reduced level of anti-nutritional factors and increased amino-acid have been used in compounding feed to obtain encouraging results and it is the most promising candidate for repacing part or all of fish meal protein in fish diets.

Despite the many uses of soyabean and its present and potential role in nutrition, its significance is being undermined by the presence of anti-nutritional factors which can inhibit growth in fish. It was established by Liener[3] that legumes synthesize a wide variety of chemical substances which are known to exert a deleterious effect when ingested. The best known of these deleterious substance is trypsin inhibitors which inhibit the action of the enzyme trypsin.

Researchers such as Goddard and Mendel[4], Liener and Pallansch[5] were able to confirm the presence of substances in legumes which are toxic. These substances known as haemagluttinnins or agglutinnings, agglutinate the erythrocytes from various animal species. Some of these toxins are Phitins, tannins, sapponins, toxic histone like protein, cyanogenic glucosides found in the Lima bean[6-8].

It should be of a serious concern to man of the presence of harmful toxin in plant proteins which serves him and other animals. The need to process and inactivate the harmful substance is essential in deriving maximum benefit from the use of soyabean and legumes in general as a useful ingredient of fish feed formulation which will support optimum fish growth and yield. Heat from friction and in some models extensively applied steam may be used to cook soyabean in order to denature the trypsin inhibitors[9], Wolf and Cowmann,[10], Janseen[11]. Improvement in nutritive value was obtained in soaked and heat treated sample than in unsoaked soyabean sample[12].

In the light of the above five isonitrogenous diets (control inclusive) with 35% crude protein were compounded as follows:

- The control, no soyabean inclusion and no processing
- Autoclaving and Ovendrying (AOD)
- Autoclaving and Sun Drying (ASD)
- Oven Drying (OD)
- Sundrying (SD) were compounded along with other ingredients (fishmeal inclusive) to monitor *Clarias gariepinus* fingerling growth in 12 weeks.

The importance of artificial feeds in fish culture to complement the rising cost of fish meal and the need for an alternative, makes this study worthwhile. The need for further research into different feeds, to achieve the noble objective of aquaculture is required. This research into fish nutrition/processing of soyabean to monitor *Clarias* gariepinus growth, can be regarded as justified in our quest for high quality feed in fish production in order to realize the aim of producing marketable fish within a limited time frame.

The basic objectives of this study are:-

- To evaluate the growth performance of *Clarias gariepinus* fingerlings fed on processed soyabean diets.
- To determine the best processing method for the utilization of soyabeans in compounded fish diets.

MATERIALS AND METHODS

Experimental diets/soyabeans processing: Five different diets were prepared using the following feed ingredients, groundnut cake, blood meal, wheat offals, yellow maize, oyster shell bone meal, vitamin premix, palm oil and processed soyabean seeds. The first diet which is the control lacks soyabeans but the groundnut cake content was doubled. All the five compounded diets were isonitrogenous and maintained at 35% crude protein (C.P) level. The processing methods used for the soyabeans seed are as follows:-

Diet 1: Control, no soyabean inclusion and no processing.
Diet 2: Autoclaved and Ovendried (AOD)
Diet 3: Autoclaved and Sundried (ASD)
Diet 4: Ovendried (OD)
Diet 5: Sundried (SD)

The ingredients were grinded and weighed out as shown in Table 1 into five big plastic bowls. The ingredients were mixed thoroughly before the addition of hot water, the starch in the yellow maize binds the ingredients together. The mixture was pelleted by extruding through a plastic sieve of about 1-2 mm diameter. The pellets were sundried and stored in polythene bags. The pellets were grinded before feeding to the fingerlings.

The processing of the soyabeans involved the division into five (i.e. the control without processing and four differently processed soyabean seed inclusions in the diet formulations). The first portion was autoclaved at 105°C for 30 min and ovendried at 60°C for 6 hrs and tagged (AOD). The second portion was autoclaved at 105°C for 30 min and sundried for 50 days tagged (ASD). The third portion was ovendried for 6 hours and tagged (OD).

The final portion was Sundried for five days (SD). There was no soyabean inclusion in Diet 1 (control) while the inclusion of processed soyabeans in diet 2, 3, 4 and 5 was constant at 24.13-24.22%. All the five diets 1, 2, 3, 4 and 5 were maintained at 35% Crude protein (C.P) level as shown in Table 1.

Experimental fish, feeding, weighing and proximate analysis: One hundred and thirty (130) advance fingerlings of *Clarias gariepinus* with a mean weight of 3.20 gm were sorted evenly and stocked at the rate of 10 fish/basin. The fish were allowed to acclimatize for 24 h before feeding commenced. The research was conducted in 10 basins (2 basins for each treatment) and water was changed daily. The fishes were fed twice daily at 5% of their body weight. The fish were weighed weekly using a sensitive accoulab weighing scale.

Proximate analysis of the fish (initial and final) and also of the experimental diets were carried out for crude protein, fat, moisture, ash, crude fibre and Nitrogen free extract (N.F.E).

Growth and nutrient utilization parameters: The following growth and nutrient utilization parameters were determined as follows:

(a) Mean Weight gain (gm/day) = $\frac{\text{Final weight } (W_2)\text{-Initial weight } W_1}{\text{Number of experimental days (n)}}$

(b) Mean Weight gain/week (gm/wk) = $\frac{\text{Mean weight gain } (W_2\text{-}W_1)}{\text{Number of experimental weeks (n)}}$

(c) Total percentage weight gain = $\frac{\text{Total weight gain}}{\text{Initial weight}} \times \frac{100}{1}$

(d) Specific Growth Rate (SGR) = $\frac{\text{Log}_e W_2 - \text{Log}_e W_1}{T_2 - T_1} \times \frac{100}{1}$

W_2 = Final weight at time T_2 days

W_1 = Initial weight at time T_1 days

(e) Total feed intake = Sum total of the amount of feed fed the fish per week.

(f) Food Conversion Ratio (FCR) = $\frac{\text{Food intake}}{\text{Weight gain}}$

(g) Gross Food Conversion Efficiency (GFCE) = $\frac{1}{FCR} \times \frac{100}{1}$

(h) Protein Intake (P.I) = Feed intake × % Protein in diet

(i) Protein Efficiency Ratio (PER) = $\frac{\text{Mean weight gain}}{\text{Protein intake (g)}}$

(j) Productive Protein Value (PPV) = $\frac{\text{Increment of body protein (g)}}{\text{Protein intake (g)}}$

Table 1: Gross composition of experimental diets (% ingredients)

	Rations				
	1	2	3	4	5
Groundnut cake	42.77	24.21	24.13	24.13	24.17
Blood meal	7.13	8.07	8.04	8.04	8.06
Soyabeans	-	24.22	24.13	24.13	24.17
Wheat offal	20.80	17.50	17.60	17.60	17.55
Yellow maize	20.80	17.50	17.60	17.60	17.55
Oyster shell	1.50	1.50	1.50	1.50	1.50
Bone meal	1.50	1.50	1.50	1.50	1.50
Vitamin premix	1.50	1.50	1.50	1.50	1.50
Oil	4.00	4.00	4.00	4.00	4.00
Total	100.00	100.00	100.00	100.00	100.00

Water quality assessment: The following water quality parameters were monitored on a weekly basis according to the principles of Boyd[13].

- Dissolved oxygen of water samples from each basin for each treatment using Winklers method.
- Temperature was determined by placing a mercury thermometer at a depth of 10-15 cm below water surface and the value read.
- pH-The hydrogen ion concentration was measured weekly using a pH meter.

Statistical analysis of data: The experimental results were subjected to statistical analysis using Ott Lyman[14] method. Analysis of variance (ANOVA), correlation and regression analysis were carried out. The level of significance in the test diets were determined using Least Significant Difference (LSD) for post mortem analysis of the data collected.

RESULTS

Table 2 shows that the processing method used did not affect the proximate composition of the processed soyabeans. As shown the crude protein is within the range of 38.40-38.70%, fat 9.83-10.13%, moisture content from 15.60-16.40% and Ash from 9.95%-10.20% (i.e., all within very narrow ranges).

Table 3 shows the crude protein of 5 compounded diets ranging between 34.40-35.20%, fat 17.00-19.64% and moisture from 17.40-18.04%. The proximate composition of the final fish in all the 5 diet treatments which ranged from 60.20-63.20% for crude protein increased more than the initial fish crude protein of 58.80%. Also fat content range of 6.42-7.20% increased far more than the fat content of the initial of 5.74%. However the crude fibre value of 4.62% for the initial fish the initial fish was much higher than the crude fibre of the final fish (i.e. final fish of the 5 treatments which ranged from 2.15-2.67%. Also the moisture content of the initial fish 10.30% was much higher than in the final fish which were within a range of 7.25-8.14%.

Table 2: Proximate composition of soyabeans processed in different forms

Soyabean processing method	Crude protein	Fat	Crude fibre	Ash	Moisture content	N.F.E.
Unprocessed soyabean (Control)	38.40	22.80	9.83	10.12	16.00	2.85
Autoclaved and Ovendried (AOD)	38.70	23.20	9.86	9.95	15.80	2.49
Autoclaved and Sundried (ASD)	38.70	23.40	9.93	10.20	15.60	2.17
Ovendried (OD)	38.60	22.90	10.13	10.17	16.20	2.00
Sundried (SD)	38.40	22.90	9.95	10.18	16.40	2.17

Table 3: Proximate composition of experimental diets

Experimental diet	Crude protein	Fat	Crude fibre	Ash	Moisture content	N.F.E.
Unprocessed (Control)	35.20	19.64	11.42	13.32	17.62	2.80
Autoclaved and Ovendried (AOD)	34.90	17.20	12.95	14.69	18.04	2.22
Autoclaved and Sundried (ASD)	34.50	16.85	13.84	15.25	17.42	2.14
Ovendried (OD)	24.40	17.00	13.78	15.13	17.43	2.26
Sundried (SD)	34.40	18.73	12.69	14.11	17.40	2.67

Table 4: Proximate composition of experimental fish before and after the experiment

Experimental fish	Crude protein	Fat	Crude fibre	Ash	Moisture content	N.F.E.
Initial fish	58.80	5.74	4.62	18.70	10.30	1.84
1	62.10	6.85	2.59	19.50	8.14	0.82
2	63.20	7.20	2.64	18.40	7.83	0.73
3	61.90	6.42	2.67	20.00	7.64	1.37
4	62.80	6.92	2.15	20.10	7.25	0.78
5	60.20	6.66	2.57	20.80	8.14	1.63

Table 5: Growth and nutrient utilization of *Clarias gariepinus*

	Diet 1 Control	Diet 2 AOD	Diet 3 ASD	Diet 4 OD	Diet 5 SD
Experimental period (days)	84	84	84	84	84
No. of fish stocked	10	10	10	10	10
Survival rate (%)	80	80	80	80	80
Mean Initial weight (g)	3.15	3.27	3.10	3.20	2.90
Mean final weight (g)	5.14	5.46	4.81	5.26	3.41
Mean weight gain (g)	1.99	2.19	1.71	2.06	0.51
Mean daily weight gain (g/day)	0.024	0.026	0.020	0.025	0.006
Mean weekly weight gain (g/wk)	0.1658	0.1825	0.1425	0.1717	0.0425
Total percentage weight gain (%)	63.17	66.97	55.16	64.43	17.59
Specific growth rate	0.583	0.61	0.52	0.59	0.19
Total feed intake (TFI) (g)	168.67	160.07	137.32	177.14	114.45
Mean total feed intake (g/fish)	16.867	16.007	13.762	17.714	11.445
Weekly mean feed intake (g/wk)	14.06	13.34	11.47	14.76	9.54
Daily mean feed intake (g/day)	2.01	1.91	1.64	2.11	1.36
Feed Conversion Ratio (FCR)	8.48	7.31	8.05	7.70	22.44
Gross food Conversion efficiency (%)	11.79	13.68	12.42	12.99	4.46
Total Protein Intake (TPI)	59.40	55.90	47.50	60.90	39.40
Protein Intake (g/fish)	5.94	5.59	4.75	6.09	3.94
Daily protein intake (g/day)	0.071	0.067	0.057	0.073	0.047
Weekly protein intake (g/wk)	0.495	0.466	0.396	0.508	0.328
Protein Efficiency Ratio (PER)	0.335	0.392	0.360	0.378	0.129
Productive Protein Value (PPV)	0.556	0.787	0.653	0.657	0.355
Mortality	-	-	-	-	2

Table 6: The relationship between growth nutrient utilization parameters and mean weight gain

X	Y	Prediction Eq. (Y = a + bx)	r	r^2	Remarks
SGR	MWG	Y = -0.27+4.03X	0.99	0.987	S
Food intake	"	Y = - 2.20+0.26X	0.92	0.846	S
F.C.R	"	Y = 2.93-0.11X	- 0.99	- 0.980	S
G.F.C.E	"	Y = - 0.36+0.19X	0.99	0.980	S
P.I	"	Y = - 0.27+4.03X	0.99	0.980	S
PPV	"	Y= - 0.649+3.971X	0.877	0.769	S

Table 7: Anova for mean weekly mean weekly weight gain of *Clarias gariepinus*

Source of Variation S.V.	Degree of freedom D.F.	Sum of squares S.S.	Mean square M.S.	Fcal	Ftab
Treatment	12	20.38	1.698		
Error	52	20.10	0.387	4.39	1.92
Total	64	40.48			
Fcal > Ftab, therefore p<0.05					

Diet 2 treatment (Autoclaved and ovendried soyabean compounded diet) gave the best growth and nutrient utilization parameters of highest specific growth rate SGR (0.61). Protein efficiency ratio PER (0.392), Productive protein value PPV (0.787) and least food conversion ratio FCR (7.31). This is followed by Diet 4 (ovendried soyabean compounded diet) with SGR (0.59), PER (0.378), PPV (0.657) and FCR (7.70).

FCR is universely proportional to mean weight gain. The negative r value (- 0.99) is an indication of appreciable growth rate with a slight increase in feed intake. This implies a high efficiency of feed utilization to promote growth in the shortest possible period.

N.B:

MWG = Mean Weight gain
r = regression
r^2 = coefficient of determination
G.F.C. = Gross food conversion efficiency
P.I. = Protein intake
PPV = Production protein value
S = Significant at $p<0.05$
X = Independent variable
Y = Dependent variable
SGR = Specific growth rate

That is there is significant differences $p<0.05$ in all the diet treatments which resulted in the significant differences in the mean weight gain of the fish during the 12 week experimental period.

Water quality assessment: The mean dissolved oxygen concentration ranged from 6.4 mg/litre to 7.56 mg/litre. The mean pH value recorded was between 7.21-8.22. The mean temperature for the water samples ranged from 26.4°C-28.5°C.

DISCUSSION

The proximate composition of the processed soyabeans used in diet formulation shows that processing does not affect the crude protein of the soyabeans when compared with the unprocessed sample as shown in Table 2, the crude protein in all the diet treatments are within the same range. Also the crude protein values of the five compounded diets are close as shown in Table 3 which corresponded with the optimum levels required for maximum growth of *Claras gariepinus*.

The final proximate analysis of the fish samples indicates a range of crude protein of 60.20% in fish fed Diets (SD) to 63.20% in fish fed Diet 2 (AOD) which in all cases were higher than the initial crude protein of 58.80 for the initial fish Table 4. The highest total percentage weight gain of 66.97% was recorded in Diet 2 (AOD) while diet 5 (SD) gave the least total percentage weight gain of 17.59%. This implies that sundrying (SD) is not a good

processing method for soyabean utilization in *Clarias gariepinus* diets.

Increment in weight obtained in fish fed Diets 2, 3 and 4 agrees with the work of Kaushik[15,16] that soyabeans has to be processed before appreciable growth can be observed. Some of the processing methods adopted by them are cooking, toasting and extrusion. The growth performance as shown in Table 5 shows that artificial heat (AOD and OD) was better for use in processing than natural heat (SD).

Also the highest Specific Growth Rate (SGR) value of 0.61 was recorded for AOD and the least SGR of (0.19) recorded in the fish fed SD diet (Diets). Also Table 5 shows that Diet 2 (AOD) has the best and the least FCR value of 7.31, while the highest FCR value was recorded for Diet 5 (S.D) with a value of 22.44, hence the poor growth performance of fish fed SD diets.

The fish fed AOD diet which had the highest SGR, also had the highest PER of 0.392. hence fish fed Diet 2 (AOD) lay more flesh than those fed on other diets. The least PER of 0.129 recorded for SD Diet fed fish further shows that sundrying of soyabeans is not a suitable processing method. The similar trend followed by the Protein Productive Values (PPV) of 0.787 and 0.657 respectively further confirms suitability of AOD and OD diets and the unsuitability of SD.

The result of the water quality parameters observed was in accordance with that expected for fish culture. It is in line with what was stated by Boyd[13]. The following ranges were obtained and was in accordance with what was expected, dissolved oxygen range of 6.41 mg/l-7.56 mg/l, pH 7.21-8.22 and temperature ranged from 26.4°C-28.5°C.

CONCLUSION

This study demonstrated the effectiveness of processing soyabeans as a means of releasing the nutrients and probably inactivating trypsin inhibitors and other antinutritional factors. It also shows the enhancement of the nutritive value and utilization of soyabeans by ovendrying, since Autoclaved and Ovendried (AOD) and Ovendried (OD) diets gave the best growth performance in this study. Fish feed manufacturers should endeavour to incorporate ovendrying facilities in their processing line for effective utilization of soyabeans for fish feed.

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