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Research Article

Effect of Fermented Wheat Bran on the African Mud Catfish *Clarias gariepinus* Fingerlings

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Abstract

This work is a further attempt at trying to proffer solution to the teething problem of high cost and quality fish feed for the aquaculture industry in Nigeria. Here fermented wheat bran was used to replace fish meat at four graduated levels –15%, 30%, 45% and 60% respectively. 0% substitution remained as the control. These trials feed where tested on the African mud catfish, Clarias gariepinus fingerlings for 56 days. Parameters evaluated include nutritional value, digestibility, and body composition of the fish. The results indicated that the 30% fishmeal substitution diet (FWB_2) showed superior performance in terms of the parameters used for nutritional value such as mean weight gain (2.92g) specific growth rate (7.42cm); percentage weight gain PWG (84.5) and Nitrogen metabolism (903.48) at the end of the experiment. However, the body composition indicated a high fat level and lowest fibre content compared to other treatments. The ADC values take the following trend; FWB_o (95.65)>FWB_3 (94.83)> FWB_2 (94.55)> FWB_1 (92.76) > FWB_4 (85.63). Further investigation is needed

KEY WORDS: Food value, Fermented wheat bran, digestibility, body composition, *Clarias gariepinus.*

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Introduction

In Nigeria, aquaculture has come a very long way since its introduction. It is playing an important role in meeting the fish needs of the people as well as being one of the fastest growing food producing industry in the country. Catfish production in Nigerian is expanding at a very rapid pace but in spite of this, the demand for the fish is still very

much higher than the supply due to increase in population thereby creating increasing market demand. According to a renowned ocean explorer Jacques Constean who wrote in 1973 "with earth's burgeoning human population to feed, we must turn from the sea with a new understanding and a new technology". This is exactly what is happening today among Fisheries scientists, feed technologists and fish nutritionists.

One of the areas in which the fisheries potential of Nigeria could be enhanced is through aquaculture. However the development and expansion of aquaculture is beset with a number of problems. The most challenging at present is the high cost of feed. Floating pelleted feed has become an important part of aquaculture for higher productivity, and accounted for at least 60% of the total cost of fish production in Nigeria. The viability and profitability of the fish farming enterprise depends on fish feed. At the moment, the high cost and low quality of fish feeds are major factor militating against the development of aquaculture in Nigeria. Therefore in fish nutrition research it is necessary to focus on the development of fish feed from high quality inexpensive sources for the successful commercialization of the aquaculture industry in Nigeria. This is the main focus of this work. Falaye *et al* (2001) observed that the conversion of feedstuff into high quality protein by fish for human consumption at a profit to the farmer is the main object of fish culture. Proper growth of fish depends largely on good nutrition and this is more pronounced with fish in enclosures as they require adequate nutrition (Omoruwon and Edema 2011).

A lot of work has been done in trying to proffer solutions to the high cost of fish feed by investigating unconventional sources of protein instead of fishmeal which has become so expensive due to its competitive use by other livestock industries. This investigation is yet another attempt at searching for good quality, digestible and inexpensive feed for *C. gariepinus*. Several feed ingredients have been investigated for *Clarias gariepinus*. These include cotton seed meal (Tamiyu *et al* 2013; Toko *et a*l 2008; Soybeans waste meal (Orire *et al* 2015. Sotolu and Sule 2011; Nguyen 2007; Fagbenro 2001 Davies and Fagbenro 2003) Maggot meal (Ajonena *et al* 2013, Raham 2003) Groundnut cake (Tamiyu *et al* 2013; Cook and Lockeett 2000; Oso *et al* 2013). Shrimp head waste (Fagbenro 1996; Nwanna 2003; Moreau 2004); Single cell protein (Bob-Manuel and Erondu 2010, Bob-Manuel 2013; 2016, Dabaat 2003); *Leucaena leucocephala* (Sotolu and Faturoti 2008; Falaye *et al* 2001). Agbabiaka and Isikwenu (2011) noted that protein deficit in monogastric animal is more

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critical than caloric inadequacies because protein sources for feed are expensive and in most cases consumed by humans. Also, the competing demand for fish feed stuff, such as corn, soybean, cotton seed cake, rice bran and groundnut cake has made feed production expensive (Ajonena *et al* 2013) Also Obun (2008) observed that feed ingredients that are rarely consumed by humans are highly competed for by the livestock sector.

Currently, *Clarias gariepinus* is the most cultured fish in Nigeria (Ajonena and Nyamby, 2013). According to Plakas (2003), their importance in tropical aquaculture include, hardiness to adverse environmental conditions, resistance to parasites and disease, capacity to undergo aquatic and aerial respiration. In addition they exhibit reasonable growth rate in captivity and demands a high consumer preference in the market. Also, they have the ability to be raised in high density resulting in high net yields (6-16 tonnes per year). (Haylor, 1993).

Digestibility is a measure of the efficiency of digestion and absorption of various nutrients present in a food. In nutrition studies the analysis of an ingested food items is the starting point to determine its quality (Smith 2006). There are considerable variations among the different fish species in their ability to digest protein. This is due to the nature and specific activities of each species enzymes called proteolytic enzymes.

To determine the digestibility of nutrients in a feedstuff is important to enable formulation of diet that maximize the growth of cultural fish by providing appropriate amount of available nutrients and also to limit the wastes produced by the fish. Digestibility can be of help in understanding the mechanisms that determine trophic plasticity which is the ability of given fish species to use more advantageous food at the given time. The difference in protein digestibility may be due to differences in chemical composition; origin and processing of various feed ingredients; methods of faecal collection and fish species (Hata 2004). Digestibility of individual ingredients in the compounded diet is considered as one of the important factors affecting the growth of fish (Miles and Fagbenro, 2003).

Moreau (2004) obtained apparent digestibility coefficient (ADC) of 80.6-84.04 for *C. gariepinus* using fermented shrimp head waste meal. On feeding *C. gariepinus* with *Leucaena leucocephala* seed meal, Sotolu and Faturoti (2008) observed ADC Protein of

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between 66.86 and 71.93. Also Bob-Manuel and Erondu (2010) reported ADC protein of 73.25 in *Oreochromis niloticus* feed with single cell protein Bureau *et al* (2002) reported that *C. gariepinus* exhibited ADC protein of 80.20 for fishmeal, 79.92 for bone and meat meal and 71.40 for blood meal

However, Hussain *et al* (2011) observed that *Labeo rohita* fingerlings had ADC crude protein of 71.90 for blood meal, 80.20 for fishmeal and 79.92 for meat meal.

Nwanna (2003) noted that substituting fish meal with 30% fermented shrimp head waste meal did not adversely affect growth performance in *C. gariepinus*. Sotolu and Sule (2011) observed ADP = Protein of 76.14 for soyabeans meal (SBM); 65.44 for whole plant meal (WPM); and 71.28 for water hyacinth leaf meal (WLM) for *C. gariepinus*. Bob-Manuel (2013) also reported ADC – Protein of between 63.65 and 90.72 for *C. gariepinus* fingerlings fed five commercial catfish feed.

Materials and Methods

Experimental Site

The research work was carried out in the Department of Biology, Faculty of Natural and Applied Sciences, Ignatius Ajuru University of Education. Rumuolumeni. Twenty outdoor Plastic tanks with dimensions 40cm x 83cm x50cm were used to stock the fish. These were thoroughly washed and ¾ filled with clean tap water.

Experimental fish

Three hundred and fifty (350) of the African mud catfish (*Clarias gariepinus*) fingerlings were obtained from Jude Farm Limited, Ndele-Omuofo in Emuohua Local Government Area of Rivers State and transported to the experimental site in aerated bag and stocked. The fish with initial mean weight and length of 1.10g and 13.9cm respectively were allowed to acclimatize for three days. At the end of acclimation, they were randomly distributed into the experimental tanks. The experimental design was complete randomization design (CRD) with five treatment and four replicates (i.e. 5x4) = 20 experimental units. Fish samples were collected before and at the end of the experiment for proximate analysis after drying grinding and preservation in specimen bottles.

Water quality

Monitoring of water quality was achieved by changing the water three times weekly to provide a fresh water environment for the fish to thrive. Dissolved oxygen was high in all treatments; pH values were generally little above 7.0. Temperature was marginally different in all treatments and ammonia level was low.

Feed formulation
Five experiment feeds were prepared by substitution bran (FWB_o – FWB_4) at different levels of substitution namely:
FWBo – Fishmeal only (o% substitution) – control
FWB_1 - 15% Fishmeal substitution with fermented wheat bran
FWB_2 – 30% Fishmeal substitution with fermented wheat bran
FWB_3 – 45% Fishmeal substitution with fermented wheat bran
FWB_4 – 60% Fishmeal substitution with fermented wheat bran
These were prepared to meet the nutritional requirement of the fish for normal growth and digestibility. 1kg of feed was prepared for each treatment.

Feeding Method
Fish were fed ad libitum twice daily at about 9.00 am and 4.00 pm. Application of feeding was done manually (by hand). Lengths and weights were taken weekly using a measuring board and a top load weighing balance respectively.

Faecal collection method
Faecal collection took place in the tanks after removing the fish, five hours after feeding. Three – quarter of the water in the tanks was first drained out. The remaining sediments at the bottom was then poured through a fine mesh cheese cloth. These settled on the mesh cloth which was transferred to fitter papers to further remove the moisture before oven drying at 60^0C. The dried faecal materials were then grinded with mortar and pistle and preserved in specimen bottles for analysis.

Proximate Analysis
Proximate analysis of fish carcass; fish feed and faeces were carried out using standard methods by AOAC (2000). The parameters considered were crude protein, fat, crude fiber, carbohydrate, moisture and ash.

Determination of nutritional value and digestibility parameters

Mean weight gain (MWG) = $(W_2 - W_1)g$
Where; W_1 – Initial mean weight (g)
W_2 - Final mean weight (g)

Specific growth rate (SGR)% (Brown, 1957)

$$\frac{\log_e W_2 - \log_2 \times 100}{T_2 - T_1}$$

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Where W_2 = Final weight (g) at time T_2 (end of experiment), W_1 = Initial weight (g) at time T_1 (beginning of experiment) and $\log_e$ = Natural logarithm.

Percentage Weight gain (PWG) %

$$\frac{\text{Mean Weight gain} \times 100}{\text{Initial Mean Weight}}$$

Nitrogen Metabolism (Nm) (Dabrowski, 1977)

$$Nm = \frac{(0.549)(b-a)h}{2}$$

Where; a = Initial mean weight of fish
b = Final mean weight of fish
h = Experimental period in days
0.549 = a constant

Apparent Digestibility coefficient (ADC) of protein was calculated using the formula reported in (NRC, 1993) as:

$$ADC = 10^2 - (10^2 \times ({}^{L_d}/_{L_f} \times {}^{N_f}/_{N_d})$$

Where, N_d = Protein in diet
N_f = Protein in faeces
L_d = % fibre in diet
L_f = % fibre in faeces

Results

Table 1. Weekly changes in standard length of *C. gariepinus* fingerlings feed with the different diets.

Weeks/diets	1	2	3	4	5	6	7	8
FWB_0	4.38	4.38	5.38	6.10	6.77	7.30	7.80	8.60
FWB_1	4.03	5.68	6.27	6.83	7.75	8.60	9.25	10.00
FWB_2	4.30	5.60	6.65	7.68	8.83	9.87	10.65	11.62
FWB_3	4.28	4.83	5.83	6.65	7.72	8.07	8.78	9.35
FWB_4	3.80	4.23	4.70	5.15	5.80	6.60	7.75	8.22

Table 2 Weekly changes in weight of *C. gariepinus* fed with the various diets

Weeks/diets	1	2	3	4	5	6	7	8
FWB_0	1.12	1.45	1.64	2.15	2.47	2.82	3.14	3.47
FWB_1	1.13	1.089	2.06	2.39	2.68	2.92	3.03	3.62
FWB_2	1.93	2.14	2.45	2.72	3.02	3.45	3.74	4.02
FWB_3	1.44	1.61	1.95	2.19	2.44	2.64	2.92	3.02
FWB_4	1.32	1.59	1.99	2.19	2.39	2.67	2.89	3.15

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Table 3. Showing the mean weight gain (MWG) of the experimental fish

Weeks/diets	1	2	3	4	5	6	7	8
FWB_0	0.02	0.36	0.54	1.65	1.37	1.72	2.04	2.37
FWB_1	0.02	1.19	0.96	1.29	1.58	1.82	1.93	2.52
FWB_2	0.83	1.04	1.35	1.62	1.92	2.35	2.64	2.92
FWB_3	0.34	0.51	0.85	1.08	1.34	1.54	1.82	1.92
FWB_4	0.22	0.49	0.89	1.09	1.29	1.57	1.79	2.05

Table 4. Showing the specific Growth Rate (SGR) of *C. gariepinus*

Weeks/diets	1	2	3	4	5	6	7	8
FWB_0	1.22	2.10	3.42	3.17	4.43	5.20	5.60	6.53
FWB_1	0.30	1.14	1.48	1.18	2.43	3.21	3.49	4.32
FWB_2	1.44	2.12	3.18	4.86	5.44	6.31	6.62	7.42
FWB_3	0.12	0.16	1.36	1.12	2.32	2.91	3.27	4.11
FWB_4	0.26	0.21	1.80	2.64	2.48	3.04	3.27	4.09

Table 5. Percentage Weight Gain (PWG)

Weeks/diets	1	2	3	4	5	6	7	8
FWB_0	18.6	24.1	27.3	35.8	41.1	47.0	52.3	68.7
FWB_1	18.8	26.0	28.5	34.1	38.2	41.7	47.1	52.1
FWB_2	38.6	42.8	49.0	54.4	60.4	69.0	76.3	84.5
FWB_3	18.0	20.1	24.3	27.3	30.5	33.0	42.2	52.3
FWB_4	22.0	26.5	33.1	36.5	39.8	44.5	49.6	35.1

Table 6. Nitrogen Metabolism (N_m)

Weeks/diets	1	2	3	4	5	6	7	8
FWB_0	12.52	50.92	123.0	212.78	313.28	450.82	628.02	886.54
FWB_1	3.63	23.32	54.05	102.72	164.84	252.17	345.55	476.42
FWB_2	13.12	64.61	118.61	242.06	394.25	591.47	736.29	903.48
FWB_3	2.76	2.41	53.59	89.04	147.74	227.39	322.69	445.36
FWB_4	3.43	25.63	57.33	120.01	167.93	237.76	322.42	441.52

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Table 7. Proximate Body Composition of *C. gariepinus* before and at the end of experiment.

Sample	Protein	Carbohydrate	Lipid	Ash	Fiber	moisture
Before/ End of experiment	40.33	8.13	1.22	14.94	23.63	11.15
FWB_0	45.72	4.92	8.71	13.46	18.27	6.92
FWB_1	47.44	2.48	12.11	13.42	22.20	2.35
FWB_2	40.15	0.93	26.23	13.11	15.61	3.97
FWB_3	46.84	1.92	0.02	13,59	34.96	2.67
FWB_4	46.37	1.77	11.47	13.34	23.60	3.45

Table 8. Proximate analysis of the faeces

Sample	Protein	Carbohydrate	Lipid	Ash	Fiber	moisture
FWB_0	7.21	33.37	2.26	14.07	37.64	5.45
FWB_1	6.75	37.31	2.32	13.95	31.74	7.93
FWB_2	6.36	32.56	1.66	13.72	37.55	8.15
FWB_3	67.99	37.83	0.01	13.33	33.55	7.29
FWB_4	8.17	35.26	2.59	13.75	31.37	8.86

Table 9. Proximate composition of the experimental feed

Sample	Protein	Carbohydrate	Lipid	Ash	Fiber	moisture
FWB_0	21.46	53.83	4.81	11.90	4.88	3.12
FWB_1	17.61	53.72	5.65	14.43	6.00	3.59
FWB_2	21.58	45.20	6.98	17.09	6.96	2.19
FWB_3	16.39	62.26	8.62	6.71	3.57	2.45
FWB_4	14.26	5034	6.20	15.61	7.87	5.72

Table 10. Apparent Digestibility coefficient (ADC)

Sample	ADC
FWB_O	95.65
FWB_1	92.76
FWB_2	94.55
FWB_3	94.83
FWB_4	85.63

DISCUSSION

It was observed at the end of the 56 day experimental period that the mean weight gain (MWG) was highest for FWB_2 (2.92) which was 30% substitution of fish meal with fermented wheat bran. This value is comparable to that obtained by Bob-Manuel (2013) in feeding *Oreochromis niloticus* with SCP (2.64).

This however is contrary to the (MWG) obtained (36.63) by feeding *C. gariepinus* with commercial catfish feeds (Bob-Manuel 2012). The MWG in this work was however lower than that of Nwanna (2003) but higher than Sotolu and Faturobi (2008). The MWG follows the order FWB_2>FWB_o>FWB_4> FWB_3.

The highest PWG value recorded in this research work was 84.5 for FWB_2 the next highest was 68.7 for FWB_0. This value was higher than that recorded by Bob-Manuel and Alfred-Ockiya (2011). For *O. niloticus* and Nwanna (2003). The highest SGR was observed in FWB_2 as 7.42. This was higher than the values for Nwanna (2003) and Ogunji (2008). This was followed by FWB_0 (only fishmeal diet). The Nitrogen metabolism in this work ranged between 441.52 (FWB_1) to 903.48 (FWB_2) at the end of the 56 day experiment. The highest N_m value was obtained by FWB_2. The N_m values obtained in this work are higher than those recorded by Sotolu and Faturoti (2008) for *C. gariepinus; Bob-Manuel et al*. (2011) for *O. niloticus* and *Bob-Manuel* (2013). The proximate body composition showed anincrease in protein value over the initial value before the experiment with the exception of FWB_2 which also had the highest lipid value (26.23). The lipid content were all higher than at the start of the experiment with the exception of FWB_3 (0.02). The carbohydrate values were all lower than those before the commencement of the experiment. The ash contents were similar in all the treatments but slightly lower than that before the start of the experiment. The fibre content vary between treatments and did not give a clear cut trend, although most of the values are lower than that before the start of the experiment. The moisture content were all lower than that before the start of the experiment for all the treatments with FWB_3 having the lowest value (2.67) while FWB_0 (6.92) the highest. The ADC values were highest for FWB_0 (95.65) and lowest for FWB_4 (85.63). The ADC values recorded here surpassed those of Bureau *et al* (2002) for *C. gariepinus*; Nwanna (2003) with fermented shrimp head waste meal for *C. gariepinus*; Sotolu and Faturoti (2008) for *Leucaena leucocephala* seed meal in *C. gariepinua*; as well as those of Bob-Manuel and Erondu (2010) for *O. niloticus* and Hussain *et al*. (2011) for *Labeo rohita.* From this result, it is evident that fishmeal diet (FWB_0) was the most digestible which was closely followed by FWB_3 (94.83) and FWB_2 (94.55) respectively.

CONCLUSION

The result of the experiment indicated that diet FWB_2 (30% substitution of fishmeal with fermented wheat bran) gave the best Mean weight gain (MWG); specific growth rate (SGR); Percentage weight gain (PWG) and Nitrogen metabolism (Nm). It also exhibited one of the highest digestibility. It could therefore be inferred that fermented wheat bran can be used to replace fishmeal up to 30% without adverse effect on nutritional value, body composition and digestibility in *C. gariepinus* fingerlings.

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