GROWTH PERFORMANCE AND NUTRIENT UTILIZATIONS OF *HETEROBRANCHUSBIDORSALIS* (GEOFFORY SAINT HILAIRE, 1809) FED FERMENTED SORGHUM BRAN MEAL DIETS

ABSTRACT

The development of fish farming is often faces high feed cost, approximately 70% of total production costs, causing declining in the profit. An attempt to increase the profit is to reduce the feed cost as minimal as possible. This study investigated the growth performance and nutrient utilizations of *Heterobranchusbidorsalis* fed fermented sorghum bran meal diets. sorghum bran was fermented at 10% moisture for seven days and samples for proximate analysis were collected on the first, fourth and seventh day. The highest crude protein was obtained in seventh day fermentation with 17.59±1.53% and the lowest was obtained in the zero day (control) with 10.53±1.53. Four isoproteic diets (40% crude protein) were formulated at 25%, 50%, 75% and 100% inclusion level to replace maize meal.The diets were fed to *H.bidorsalis* for twelve weeks. The experimental fish were fed 5% body weight throughout the experiment. The results obtained from the feeding trial showed that fish fed 100% inclusion level shows significance difference ($p<0.05$) in mean weight gain compared to fish fed other diets. The highest mean weight gain (MWG) was obtained in the fish fed 100% inclusion level diet (D_5) with 43.39±1.86g and the lowest was obtained in control diet (D_1) with 28.97±0.54g. The highest Average Daily Growth (ADG) and Specific Growth Rate (SGR) were obtained in the fish fed 100% inclusion level diet (D_5) with 0.52±0.56 and 1.07±0.64 while the lowest were obtained in the fish fed control diet with 0.35±0.51 and 0.91±0.65 respectively. The nutrient utilizations showed significant difference ($p<0.05$) in fish fed 100% inclusion level diet (D_5) compared to others. The highest feed conversion ratio (FCR) was obtained in fish fed 100% inclusion level diet (D_5) with 0.48±0.16 and the lowest was obtained in control diet(D_1) with 0.41±0.24.The highest protein intake (PI), protein rating (PR) and protein growth rate (PGR) were obtained in the fish fed 100% inclusion level diet (D_5) with 43.12±1.27, 0.52±0.72 and 1.04±0.71 while the lowest were obtained in the fish fed control diet (D_1) with 29.99±0.71, 0.35±0.45 and 1.00±0.53 respectively. The highest Protein Efficiency Ratio (PER) was obtained in the fish fed 100% inclusion level diet (D_5) with 1.01±0.07 and the lowest was obtained in the fish fed 50% inclusion level diet (D_3) with 0.95±0.62. The highest Apparent Net Protein Utilization (ANPU) and Apparent Net Lipid Utilization (ANLU) were recorded in the fish fed diet (D_5) with 23.35±0.92 and 161.22±0.26 while the lowest were recorded in the fish fed diet (D_1) with 14.68±1.05 and 131.27±0.74 respectively. This study revealed the positive effects of incorporating fermented Sorghum bran meal into the diet of *H. bidorsalis.*

Keywords: Growth performance, Nutrient utilizations, Proximate composition and *H. bidorsalis.*

INTRODUCTION

The development of fish farming is often faces high feed cost, approximately 70 to 89% of total production costs, causing declining profit [1]. An attempt to increase the profit is to reduce the

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feed cost as minimal as possible; one way to do this is to explore the source of local feed ingredients that can be used as an alternative for fish feed. In selecting the local feed ingredients, several factors should be considered. Amongst others are: the availability of the materials, the cost, the content of nutrients, and the competition with humans [2]. However, problem of high cost of feeding in aquaculture is further exacerbated due to the scare and expensive nature of some of the ingredients used in the formulation of fish feeds. In other to solve the problem of scarce and expensive feed ingredients, a number of non-conventional feedstuffs have been investigated most of which are alternative protein sources since this nutrient is considered as the most expensive nutrient [3].

Heterobranchusbidorsalis(Geoffroy Saint-Hilaire 1809)belongs to the genus *heterobranchus* and family *Clariidae*. It is one of the most cultured and economically important freshwater fish species that contributes immensely to the annual freshwater fish production in Nigeria. It is readily acceptable among Nigerian fish farmers and consumers; hence, it commands high commercial values, and is an important source of animal protein. It also serves as a model organism in research, it is cultured intensively and extensively in Africa, Europe and Asia. The economic benefits of this fish species are due to its hardiness, fast growth, large size attainable and ability to withstand changes in the environmental conditions [4].

Sorghumbicolor commonly called sorghum is a grass species belonging to the family *Poaceae*which is cultivated for its edible grain. Sorghum is mostly cheaper than maize and abundantly available in most parts of the Northern Nigeria. The projected production targets of maize and sorghum in the country for the year 2012 were put at 13,388,000 and 9,859,110 metric tonnes, respectively [5]. Sorghum is similar in chemical composition to maize and has a nutritional quality comparable to other cereals [6]. However, the presence of anti-nutritional factors like tannin, phytates and cyanogenic and glucosides among others could probably have effect on nutrient utilization and growth of fish. Processing of sorghum either by fermentation removes these anti-nutritional factors [7]. The processing of sorghum produces some by-products one of which is the Fermented Sorghum. Fermented Sorghum Waste (FSW) is a by-product ~~gotten~~ obtained from the manufacture of 'ogi-baba', a common cereal gruel and staple food for several communities in Nigeria. The waste is usually discarded after the starch is obtained from the sorghum meal and feeding them to livestock and poultry. Fermented sorghum waste has a

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chemical composition that is similar to maize which therefore necessitates research into its use as a replacement for maize in the diets of fish [7].

MATERIALS AND METHODS

Experimental Location

The experiment was carried out at teaching and research fish farm of the Department of fisheries Technology, School of Sciences, Yobe State College of Agriculture, Science and Technology Gujba,Yobe State, Nigeria.

Experimental Design and Units

A Completely Randomized Design (CRD) was used in this experiment in whichfour inclusion levels of the fermented sorghum branmeal to replace maize (control). Four treatments and control in triplicate making fifteen experimental units for the experiment.

One hundred and fifty (150) *Heterobranchusbidorsalis* fingerlings of 6.16±0.21g were procured and acclimatized for seven (7) days and fed with a control diet and then the fish were stab for twenty four hours (24 hours) to empty their stomach. Subsequently, they were randomly assigned to twelve (12) treatments in triplicate each and control. Ten (10) fish fingerlings were assigned in each plastic bowl of 30 litres volume of water.

Source of Experimental Ingredients and Fish

The Maize, Soybean, Sorghum bran, Salt, Starch and Oil, were purchased from feedstuffs market in Damaturu, Yobe State. The experimental fish was procured from MBG Mega Fish Farm 6km Gujba road Damaturu, Damaturu Local Government Area of Yobe State, Nigeria while the fishmeal, vitamin premix and chromic oxide were purchased from Mike Fish Farm Maiduguri, Borno state, Nigeria for the study.

Processing of Sorghum Bran

Sorghum branwas collected in three different bowls, ground into powder, then sieved and fermented using solid fermented procedure as described by [8;9]. Each sample was solidly fermented (wet at 10% moisture and keep in container at ambient temperature) for 24 hours (1 day), 96 hours (4 days), and 168 hours (7 days). Afterward, the fermented samples were sun dried for 94 hours (4 days approximately) as described. The fermented samples were taken to the laboratory for proximate analysis and the best was used to replace maize at 25%, 50%, 75% and 100%.

Proximate Composition of the Fermented Sorghum Bran Meal and Experimental Diets

The fermented Sorghum bran at a various fermentation period and the experimental diets were analysed for crude protein, crude fibre, crude lipid, ash and a nitrogen free extracts according to [10].

Determination of Moisture

The moisture content of the samples were determined by weighing the samples and oven dried at 80^{o}C for 24 hours. The loss in weight gave the moisture content of the original sample.

Moisture (%) = Loss in Weight due to drying/Weight of Sample Take =

$$W2 - W3\ x100/W2 - W3$$

W_1 = Weight of crucible

W_2 = Weight of crucible + sample

W_3 = Weight of crucible + sample after drying

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Determination of Ash

The ash content of the samples were determined by the method described by [10].

Determination of Crude Lipid

The crude lipid was determined by the continuous solvent extraction method in a Soxhlet apparatus as described by [11].

Determination of Crude Fibre

The crude fiber was determined by the Weende method described by [10].

Determination of Crude Protein

The protein content of the samples were determined by the Kjeldhal method reported by [10]. The total nitrogen was determined and multiplied by the factor, 6.25, to obtain the protein concentration or content.

Determination of Nitrogen Free Extract

The carbohydrate content of the test samples were determined by estimation using the arithmetical difference method described by [10]. The carbohydrate content was calculated and expressed as the nitrogen free extract.

Experimental Diet Formulation

Two grams (2g) of the fermented Sorghum bran sample was collected for proximate analysis was used for moisture, dry matter, ash, crude lipid, crude fibre, crude protein and nitrogen free extract following the method of [10]. The processed Sorghum bran was used to replace maize in an iso-nitrogenous experimental diets consisting of 40.00% crude protein. The other feed ingredients making up the experimental diets comprised of fish meal, soybean meal, vitamin/mineral premix, wheat flour (binder), salt and palm oil. Five (5) diets including control were formulated using Pearson square method as shown in Table 1.

Experimental Diets Preparation

The milled feed ingredients were weighed according to the formulated proportion calculated based on Pearson square method and mixed in a bowl. Warm water was added to make the mixture moist forming homogenous dough. The resultant dough was extruded through pelleting machine in to suitable size pellets. The pellets were sun-dried. The dried pelleted feeds were broken into smaller sizes, packaged and stored in cellophane bag to avoid spoilage. The sample of each diets was analyzed in the laboratory for proximate compositionfollowing standard methods of analysis [10].

Feeding of Experimental Fish

The fish was starved for 24 hours to empty their gastro-intestinal tracts before the commencement of feeding trials [12]. 24-weeks (6 Months) feeding trial was carried out in triplicate groups of 10 fingerlings each per plastic bowl. Fish was fed at 5 % of their body weight per day (2.5% in the morning 8.00 - 9.00 AM and 2.5% in the evening 5:00-6:00PM) throughout the duration of the experiment. The quantity of feeds were be adjusted based on the weight of fish for next weeks throughout the duration of the feeding trials.

Growth Performance and Nutrient Utilization

The weight and quantity of feed per each setting was recorded on weekly basis. Therefore, the following growth and nutrient utilizations parameters were calculated as follows:

Weight Gain

The total and mean weight gain was calculated for each replicate and treatment as follows:

Weight gain/fish (g/fish) = $Wf - Wi$

Mean weekly weight gain (g/week) = $\boldsymbol{Wf - Wi/N}$

Where Wf = final weight of fish at the end of the experiment

Wi = initial weight of fish at the beginning of the experiment

N =number of weeks.

Average Daily Growth (ADG)

The average daily growth was determined using the following formula

ADG= $Wf - Wi/t$

Where Wf = final weight of fish at the end of the experiment

Wi = initial weight of fish at the beginning of the experiment

T= Rearing period

Relative Growth Rate (RGR)

This is the percentage ratio of the weight gained to the initial body weight which was determined according to [13].

RGR (%) = $Wf - Wi/Wi\ x\ 100$

Specific Growth Rate (SGR)

This is the percentage daily weight gain was computed according to [14].

SGR (%/day) = $LogWf - LogWi/t\ x\ 100$

Where log Wf= logarithm of the fish final weight

log Wi= logarithm of the fish initial weight

t = experimental period in days.

Survival (SR)

The percentage survival rate was calculated according to [13].

SR (%) = $Nf/Ni\ x\ 100$

Where Ni=Number of cultured animal/fish stocked at the beginning of the experiment

Nf = Number of cultured animal/fish alive at the end of the experiment.

Feed Intake (FI)

This was taken as the addition of the amount of feed supplied during the experimental period.

Feed Conversion Ratio (FCR)

This is a numerical value used to measure the utilization of feed for growth [15].

Food conversion ratio was calculated following [16].

FCR = $Weight\ gaing/Feed\ intake\ (g)$

Protein Intake (PI)

This is the numerical value of the quantity of protein present in the feed fed to the fish during the experimental periods and was determined following [17].

PI (g of protein in 100 g diet/fish) = Total feed intake x % crude protein in the diet.

Protein Efficiency Ratio (PER)

This index uses growth as a measure of nutritive value of dietary protein. It was determined from [18].

PER= $Mean\ weight\ gaing/Mean\ protein\ intake\ (g\ of\ protein\ in\ 100g\ of diet/fish)$

Protein Rating

This is a measure of the daily protein intake efficiency in the fish feed and was determined using method reported by [19].

Protein rating = Daily protein intake x PER.

Protein Growth Rate (PGR)

This measured the relativeness of the daily protein gain by the fish and was calculated using [17].

PGR (%) = $\frac{LogP2-LogP1}{n}x100$

Where Log P1= initial logarithm of the fish carcass protein content

Log P2 = final logarithm of the fish carcass protein content; n =number of weeks

Gross Protein Value (GPV)

This is a commonly used biological method for evaluating proteins quality in a feed. This was determined using [20].

GPV = $\frac{A}{Ao}$

Where: A= Weight gain of the fish fed test diet (g)/

Protein intake of test diet (g of protein in100g of diet/fish)

Ao = Weight gain of the fish fed control diet (g)/

Protein intake of control diet (g of protein in 100g of diet/fish)

Apparent Net Protein Utilization (ANPU)

ANPU expresses the percentage of ingested protein that is retained by deposition in the carcass when no correction for endogenous nitrogen losses is made. This was calculated following [21].

ANPU (%) = $P2 - P1/P1\ x\ 100$

Where: P1 = Protein in fish carcass (g) at the beginning of the experiment

P2 = Protein in fish carcass (g) at the end of the experiment

PI = Protein intake (g of protein in 100g of diet/fish)

Apparent Net Lipid Utilization (ANLU)

ANLU expresses the percentage of ingested lipid that is retained by deposition in the carcass when no correction for the endogenous lipid losses is made. This was calculated following [21].

ANPU (%) = $L2 - L1/L1 \ x\ 100$

Where: L1 = Lipid in fish carcass (g) at the beginning of the experiment

L2 = Lipid in fish carcass (g) at the end of the experiment

LI = Lipid intake (g of lipid in 100g of diet/fish)

Apparent Digestibility Coefficient (ADC) of dry Matter

This was calculated according to the method used by [22].

ADC (%) =$100 - (100(\%Chromic\ oxide\ in\ diet/Chromic\ oxide\ in\ \ feces))$

Statistical Analysis

All data generated were subjected to descriptive statistics to determine the mean values and then subjected to analysis of variance (ANOVA) at 95% probability level where the significant differences were detected. Means values were separated using Least Significant Difference (LSD). All data were analyzed using SPSS (statistical Package for Social Sciences) version 20.0 statistical package.

Table 1: Gross Ingredient Composition (g/100g) of the Experiment Diets

S/N	Ingredients (g/kg)	Inclusion Levels				
		0% Diet 1	25% Diet 2	50% Diet 3	75% Diet 4	100% Diet 5

1	Fish Meal	33.33	33.33	33.33	33.33	33.33
2	Soybean Meal	30.34	30.34	30.34	30.34	30.34
3	**Maize Meal**	**31.33**	**23.50**	**15.67**	**7.83**	**0.00**
4	**FSBM**	**0.00**	**7.83**	**15.67**	**23.50**	**31.33**
5	Vitamin premix	1.50	1.50	1.50	1.50	1.50
6	Starch	1.50	1.50	1.50	1.50	1.50
7	Salt	0.50	0.50	0.50	0.50	0.50
8	Oil	1.00	1.00	1.00	1.00	1.00
9	Chromic oxide	0.50	0.50	0.50	0.50	0.50
Total		100	100	100	100	100
Calculated % Crude Protein		40.00	40.400	40.00	40.00	40.00

Key: FSBM = Fermented Sorghum Bran Meal
Vitamin and Minerals premix: Vitamin A -20,00,000 I.U.; D3- 4,00,000 I.U.; E - 200,000 I.U; K -1,200mg; B1- 10,000mg.; B2- 30,000mg.; B6- 19,000mg.; B12-1,000.; Niacin-200,000mg.; Folic Acid-5,000mg.; Panth Acid-50,000mg.; Biotin-400mg.; Antioxidant 125g.; Vitamin C-150g.; Choline chloride-400g.; Manganese-30g.; Zinc-40g.; Iron-40g.; Copper 4g.; Iodine-5g.; Selenium-0.2mg.; Cobalt-0.2mg.; Calcium-600g.; Lysine- 100,000mg.; Phosphorus-4,000g.; Methionine-100g. (AGRO BAR-MAGEN NIG.LTD)
*Calculated gross energy = Protein x 23.6kJ/100g + Lipid x 39.5kJ/100g + NFE x 17.2kJ/100g (Blaxter, 1989)

RESULTS

Proximate Composition of the Fermented Sorghum Bran Meal Diets and Fish *Carcass*

The fermented sorghum bran meals diets shows that, the percentage moisture content recorded was highest in the diet D_5 with 11.53±0.78 and the lowest was recorded in diet D_1 with 10.00±0.34. Diet D_1 had the highest percentage dry matter of 90.00±1.34 and diet D_5 had the lowest content with 88.47±1.06. The percentage ash content recorded was highest in diet D_1 with 5.42±0.43 and the lowest was in diet D_5 with 3.85±0.67. Diet D_1 had the highest fibre content of 6.64±1.42 and the lowest was recorded in diet D_5 with 4.33±0.66. Diet D4 had the highest percentage crude lipid of 7.80±1.54 and the lowest was recorded in diet D_5 with 5.80±1.35. The highest percentage crude protein was recorded in diet D_5 with 45.06±1.54 while the lowest was recorded in diet D_1 with 40.44±1.43. There is no significance differences ($P<0.05$) between diet D_1 and D_2. However, there is a significance differences ($P<0.05$) between control and diet D_5. The percentage nitrogen free extract recorded was highest in diet D_2 with 32.54±1.54 and the lowest was recorded in diet D_4 with 29.230.74. There is a significance difference between the diets fed.

The proximate composition of the experimental fish carcass shows that, fish fed diet D_5 had the highest percentage moisture content of 9.76±0.63 and the lowest was recorded in the fish fed diet D_2 with 8.62±0.84 while the highest percentage dry matter was recorded in the fish fed diet D_2 with 91.38±1.48 and the lowest was recorded in the fish fed diet D_5 with 90.24±1.92. The percentage ash and crude fibre recorded were highest in the fish at the initial stage before subjecting them to experimental diets with 5.42±0.32 and 6.64±0.53 while the lowest were recorded in the fish fed diet D_5 with 3.14±0.65 and 3.39±0.73 respectively. The percentage crude lipid and crude protein recorded were higher in the fish fed diet D_5 with 21.89±1.58 and 52.35±1.44 while the lowest were recorded in the fish at the initial with 8.38±1.38 and 42.44±2.54 respectively. There is a significance differences ($P<0.05$) between the treatments. The nitrogen free extract recorded was highest in the fish at initial with 28.12±1.76 and the lowest was recorded in the fish fed diet D_5 9.47±0.67.

Growth Performances and Nutrients Utilizations

The growth performances and nutrients utilizations of *H.bidorsalis* fed experimental diets are shown in table 5 and 6.

The mean initial weight was highest in diet D_5 with 6.25±0.63g and the lowest was in diet D_3 with 6.04±0.75g. Fish fed diet D_5 had the highest total final weight with 397.88±1.67g while the lowest was recorded in diet D_1 with 303.91±2.24g. The mean final weight was highest in diet D_5

with 49.74±0.17g and the lowest was recorded in diet D_1 with 35.05±1.86g. The total weight gain was highest in diet D_5 with 335.35±1.68g and the lowest was recorded in diet D_1 with 243.10±0.65g. The mean weight gain recorded was highest in diet D_5 with 43.49±1.86g and lowest was recorded in diet D_1 with 28.97±0.54g. There is a significance differences ($P<0.05$) between the treatments. The values for average daily growth (ADG), specific growth rate (SGR) and relative growth rate (RGR) was highest in fish fed diet D_5 with 0.52±0.56g, 1.07±0.64g and 695.84±0.14g and the lowest value recorded was recorded in diet D_1 with 0.35±0.52g, 0.91±0.65g and 476.48±1.05g respectively. There is a significance differences ($P<0.05$) between the treatments. The mean final length measured was highest in the fish fed diet D_5 with 18.2±0.71cm and the lowest was recorded in diet D_1 with 16.3±1.03cm. The condition factor (K) recorded was highest in the fish fed D_4 and D_5 with 0.83±0.03 each and the lowest was recorded in diet D_3 with 0.79±0.81. The percentage survival rate recorded in the fish exposed to the experimental diets was highest in diet D_2 with 90±0.19% and the lowest was recorded in the fish fed diet D_5 with 80±0.36%. There is a significant difference ($P<0.05$) between the fish fed different experimental diets. The mean feed intake recorded was highest in fish fed D_5 with 89.84±0.27g and the lowest was recorded in the fish fed diet D_1 experimental diet with 71.41±0.54g. Fish fed diet D_5 experimental diet had the highest feed conversion ratio (FCR) of 0.48±0.16 and the lowest were found in the fish fed diet D_1 experimental diet with 0.41±0.24. There is a significance differences ($P<0.05$) between the treatments. The protein intake and protein efficiency ratio recorded was highest in the fish fed diet D_5 experimental diet with 43.12±1.27 and 1.01±0.07 while the lowest were found the fish fed diet D_1 experimental diet with 29.99±0.71 and 0.97±1.28 respectively. The gross protein value (GPV) and protein rating (PR) recorded were highest in the fish fed diet D_5 with 1.04±0.71 and 0.52±0.72 while the lowest were found the fish fed diet D_1 (Control) with 1.00±0.53 and 0.35±0.45 respectively. There is a significance differences ($P<0.05$) between the treatments. The protein growth rate recorded was highest in the fish fed treatment D_5 diet with 0.76±0.26 and the lowest was recorded in the fish fed treatment D_1 diet with 0.49±0.65. The apparent net protein utilization and apparent net lipid utilization recorded were highest in the fish fed diet D_5 with 23.35±0.92 and 161.22±0.26 and the lowest were recorded in the fish fed diet D_1 with 14.68±1.05 and 131.27±0.74. The apparent digestibility coefficient of dry matter recorded was highest in the fish fed diet D_5 with 62.50±0.73 and the lowest was recorded in the fish fed diet D_1 28.57±0.82.

Table 2: Proximate Composition of the Fermented Sorghum Bran Meal Diets

	D_1 (Control)	D_2	D_3	D_4	D_5
Inclusion levels %	0	25	50	75	100
Moisture	10.00 ± 0.34^{c}	10.52 ± 1.03^{c}	10.57 ± 1.53^{c}	11.33 ± 1.54^{b}	11.53 ± 0.78^{a}
Dry Matter	90.00 ± 1.34^{a}	89.48 ± 0.65^{b}	89.43 ± 1.54^{b}	88.67 ± 1.82^{c}	88.47 ± 1.06^{c}
Ash	5.42 ± 0.43^{a}	4.32 ± 0.54^{b}	4.54 ± 0.54^{b}	4.64 ± 1.54^{b}	3.85 ± 0.67^{c}
Crude Fibre	6.64 ± 1.42^{a}	4.55 ± 1.54^{b}	4.78 ± 1.29^{b}	4.67 ± 0.93^{b}	4.33 ± 0.66^{c}
Crude Lipid	7.38 ± 0.13^{a}	6.53 ± 0.54^{c}	7.34 ± 1.04^{b}	7.80 ± 1.54^{a}	5.80 ± 1.35^{c}
Crude Protein	40.44 ± 1.43^{e}	40.54 ± 1.76^{d}	41.56 ± 0.23^{c}	42.33 ± 1.75^{b}	43.06 ± 1.54^{a}
NFE	30.12 ± 1.54^{a}	33.54 ± 1.54^{a}	31.21 ± 1.65^{b}	29.23 ± 0.74^{c}	31.43 ± 0.43^{b}

Means in the Same Row with Different Superscripts are Significantly Different ($P<0.05$)

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Further, when you want to replace protein as nutrient rather than maize soybean or fish meal would be better.

Table 3: Proximate Composition of *Heterobranchusbidorsalis* Carcass Fed Fermented Sorghum Bran Meal Diets

Parameters	Initial	D_1 (Control)	D_2	D_3	D_4	D_5
Inclusion Levels %	0	0	25	50	75	100
Moisture	9.00±0.54^{b}	8.91±0.23^{c}	8.62±0.84^{c}	9.25±0.62^{b}	9.47±1.73^{a}	9.76±0.63^{a}
Dry Matter	91.00±2.43^{a}	91.09±1.64^{a}	91.38±1.48^{a}	90.75±1.38^{b}	90.53±1.26^{b}	90.24±1.92^{b}
Ash	5.42±0.32^{a}	3.33±1.56^{b}	3.98±1.36^{b}	3.76±0.71^{b}	3.56±0.81^{b}	3.14±0.65^{b}
Crude Fibre	6.64±0.53^{a}	4.86±0.75^{b}	4.01±0.82^{b}	3.95±0.24^{c}	3.64±0.62^{c}	3.39±0.73^{c}
Crude Lipid	8.38±1.38^{c}	19.38±2.86^{b}	21.09±2.04^{a}	21.38±1.27^{a}	21.52±1.37^{a}	21.89±1.58^{a}
Crude Protein	42.44±2.54^{d}	48.67±2.76^{c}	51.08±1.48^{b}	51.78±1.36^{b}	52.11±1.53^{a}	52.35±1.44^{a}
NFE	28.12±1.76^{a}	14.85±1.85^{b}	11.22±1.52^{c}	9.88±0.92^{d}	9.70±1.45^{d}	9.47±0.67^{d}

Means in the Same Row with Different Superscripts ($P<0.05$) are Significantly Different

Table 4: Growth Performance of *Heterobranchusbidorsalis* Fed Fermented Sorghum Bran Meal Diets for 84 Days

	Experimental Diets				
	D_1 Control	D_2	D_3	D_4	D_5
Inclusion Levels %	0	25	50	75	100
Total Initial Weight (g)	60.81±0.21^{c}	62.05±0.54^{a}	60.35±1.17^{b}	62.21±1.26^{a}	62.53±0.72^{a}
Mean Initial Weight (g/fish)	6.08±0.37^{a}	6.21±0.54^{a}	6.04±0.75^{a}	6.22±1.02^{a}	6.25±0.63^{a}
Total Final Weight (g)	303.91±2.24^{e}	366.40±1.82^{c}	356.97±1.72^{d}	388.62±0.89^{b}	397.88±1.67^{a}
Mean Final Weight (g/fish)	35.05±1.86^{e}	40.71±1.38^{d}	41.17±1.05^{c}	46.65±1.83^{b}	49.74±0.17^{a}
Total Weight Gain (g)	243.10±0.65^{e}	304.35±1.83^{d}	296.62±1.86^{c}	326.41±0.28^{b}	335.35±1.68^{a}
Mean Weight Gain (g/fish)	28.97±0.54^{e}	34.50±1.82^{d}	35.13±0.65^{c}	40.43±1.74^{b}	43.49±1.86^{a}
Average Daily Growth (%/fish)	0.35±0.51^{b}	0.41±0.68^{c}	0.42±0.52^{b}	0.48±0.17^{a}	0.52±0.56^{a}
Specific Growth Rate (%/day)	0.91±0.65^{b}	0.97±0.53^{b}	0.99±0.56^{b}	1.04±0.08^{a}	1.07±0.64^{a}
Relative Growth Rate (%/fish)	476.48±1.05^{e}	555.56±1.26^{d}	581.62±0.92^{c}	650.00±1.38^{b}	695.84±0.14^{a}
Mean Initial Length (cm/fish)	4.4±0.32^{a}	4.4±0.52^{a}	4.4±0.12^{a}	4.3±0.43^{a}	4.3±0.15^{a}
Mean Final Length (cm/fish)	16.3±1.03^{c}	17.2±0.32^{b}	17.3±0.25^{b}	17.8±0.65^{b}	18.2±0.71^{a}
Condition Factor (K)	0.81±0.65^{c}	0.80±0.17^{a}	0.79±0.81^{a}	0.83±0.53^{a}	0.83±0.03^{a}
Percentage Survival Rate	86.67±1.37^{a}	90.00±0.19^{a}	86.67±0.25^{b}	83.33±0.63^{c}	80.00±0.36^{d}

Means in the Same Row with Different Superscripts are Significantly Different (P<0.05)

Comment [W4]: Initial weight before experiment should be non-significant. Then only you can compare in successive weeks.

Table 5: Nutrients Utilizations of *Heterobranchusbidorsalis* Fed Fermented Sorghum Bran Meal Diets for 84 Days

	Experimental Diets				
	D_1 Control	D_2	D_3	D_4	D_5
Inclusion Levels %	0	25	50	75	100
Total feed intake (g)	659.42 ± 2.54^{e}	739.15 ± 1.84^{b}	736.88 ± 1.92^{b}	798.99 ± 2.61^{a}	796.55 ± 1.52^{a}
Mean feed intake (g)	71.41 ± 1.54^{e}	76.84 ± 1.04^{d}	80.71 ± 0.93^{c}	87.10 ± 1.64^{b}	89.84 ± 0.27^{a}
Feed conversion ratio (FCR)	0.41 ± 0.24^{b}	0.45 ± 0.18^{a}	0.42 ± 0.67^{b}	0.46 ± 0.82^{a}	0.48 ± 0.16^{a}
Protein intake (g/100gdiet/fish)	29.99 ± 0.71^{d}	34.58 ± 0.26^{d}	37.13 ± 1.93^{c}	40.94 ± 0.67^{b}	43.12 ± 1.27^{a}
Protein efficiency ratio (PER)	0.97 ± 1.28^{b}	1.00 ± 0.21^{a}	0.95 ± 0.62^{b}	0.99 ± 0.23^{b}	1.01 ± 0.07^{a}
Gross protein value (GPV)	1.00 ± 0.53^{a}	1.03 ± 0.52^{a}	0.98 ± 0.82^{b}	1.02 ± 0.71^{a}	1.04 ± 0.71^{a}
Protein rating (PR)	0.35 ± 0.45^{b}	0.41 ± 0.72^{b}	0.42 ± 0.61^{b}	0.49 ± 0.02^{a}	0.52 ± 0.72^{a}
Protein growth rate (PGR)	0.49 ± 0.65^{b}	0.67 ± 0.15^{b}	0.72 ± 0.64^{a}	0.74 ± 0.17^{a}	0.76 ± 0.26^{a}
Apparent net protein utilization (ANPU)	14.68 ± 1.05^{c}	20.36 ± 0.18^{c}	22.01 ± 1.74^{b}	22.79 ± 0.65^{b}	23.35 ± 0.92^{a}
Apparent net lipid utilization (ANLU)	131.27 ± 0.74^{b}	151.67 ± 1.93^{b}	155.13 ± 0.65^{b}	156.80 ± 0.63^{b}	161.22 ± 0.26^{a}
Apparent digestibility Coefficient (ADC) of dry matter	28.57 ± 0.82^{e}	37.50 ± 1.03^{d}	50.00 ± 1.07^{c}	57.14 ± 0.46^{b}	62.50 ± 0.73^{a}

Means in the Same Row with Different Superscripts are Significantly Different ($P<0.05$)

DISCUSSION

The result obtained from the proximate composition of the fermented bran meal diets revealed that, one hundred (100%) percent in inclusion level of the fermented sorghum bran meal diet had the best percentage moisture content, crude lipid and crude protein level and the lowest crude fibre compared to others. The variation observed from the values often exists during the process of chemical analysis of experimental ingredient and diet as reported by [23]. This was a result of fermentation level which improve the protein composition and reduced crude fibre content of the fermented bran meal and diets. This result is in line with findings by [3] who reported 33.45% crude protein in Mucuna soaked in water with ash for 72 hours. The results agreed with the findings of [7;24] who reported that, fermentation increase protein level of the feed ingredients and [25] who reported increase in moisture content, protein content level of fermented sorghum by-product meal at seven days fermentation period. Nitrogen free extract (NFE) values recorded from this study was lowest in diet containing highest inclusion level of fermented sorghum bran meal. This result is comparable with the values reported by [26]. The NFE values of the treatment diets with growth promoters decreased with increasing inclusion levels compared with that of the control diet. This result is in agreement with the findings of [27] who reported a reduction in the NFE values of fish diet with growth promoters. The study also agreed with [28] who reported decrease in nitrogen free extract in the diet of *Clariasgariepinus* fed fermented coconut waste at varying inclusion levels. It is also agreed with [29] who reported that fermentation decreases fibre and carbohydrate level of Pumpin and Sorghum.

The proximate composition of the experimental fish carcass revealed that, the crude protein content of the initial fish carcass was lower than at the end of the experiment. The results obtained from this study revealed that fish fed 100% inclusion level of fermented sorghum bran meal diet had the higher the protein content compared to others. This result is in line with [30] who reported considerable high crude protein in *H. bidorsalis*, *Clariasgariepinus* and their inter-generic crosses with commercial feed. This observation is consistent with [7] who reported significant increase in crude protein level in Heteroclarias carcass fed fermented sorghum waste meal diets. The result is in agreement with [31] who reported that feeding *Heterobarnchusbidorsalis* with garden snail and replacement to fish meal significantly increase crude protein of the carcass.The carcass crude lipid increase of the fish fed diet with 100% inclusion level was higher compared to others. This translate the lipid composition of the

experimental diets. The present study is in agreement with the findings of [7] who similarly reported increased values of crude fat in the final carcass of Heteroclarias fed fermented sorghum waste meal diets. The observation is agreement with [31] who reported that feeding *Heterobarnchusbidorsalis* with garden snail and replacement to fish meal significantly increase crude lipid of the carcass. The nitrogen free extract was higher in the fish sample before the commencement of the experiment and reduces with increase inclusion levels. Nitrogen-free extract (NFE) in the initial fish reduced significantly in the final carcass values among the treatment diets.This result is in line with [31; 32] who reported that nitrogen free extract content of African catfish reduces if fed with butterfly pea seed meal.

The results obtained from this study of Growth performance and Nutrients utilizations revealed that, fish fed 100% inclusion level diet had the best mean final weight, mean weight gain, average daily growth rate, specific growth rate and relative growth rate compared to other fish fed treatments diets and control as well. The result obtained from this study is in agreement with [25] who reported better growth performance in African catfish *Clariasgariepinus* (Burchell, 1822) fed fermented sorghum by-product meal diets. The result also is in line with the findings of [33] who reported increase in weight gain, specific growth rate, average daily growth and survival rate of *Clariasgariepinus* (Burchell, 1822) fed varying levels of *Albizialebbeck* (Benth) leaf meal. It also agreed with [24] who reported increase in growth performance in *Clariasgariepinus* fed fermented sorghum at varying levels with best at 100% inclusion level. The result obtained from this study is in agreement with [4] who reported increase in growth parameters with *Hetrobranchusbidorsalis* fed *Eucalyptusglobulus* leaf supplemented diets. The result obtained on condition factor (K) revealed that fish fed diet containing 100% inclusion level had the best condition factor compared to others. The result also agreed with [34] who reported the range of 0.8 to 1.4 in length-weight relationship of *Hetrobranchusbidorsalis* diploid and triploid progenies raise under the same environmental condition. This result is in line with [33] who reported that, good condition factor in *Clariasgariepinus* fed varying levels of *Albizialebbeck* leaf meal. The results on nutrients utilization obtained from this study revealed that fish fed diet containing 100% inclusion level had best feed intake, feed conversion ratio, protein intake, protein efficiency ratio, gross protein value, protein rating and protein growth rate compared to others fed treatment diets and control. The results obtained from this study revealed that the experimental fish utilized the diet very well as observed in the results presented. The

result obtained is in line with [35] who reported that, in sex reversed Red Tilapia (*Oereochromisniloticus* x *Oreochromismossambicus*) fed fermented palm kernel meal as protein source. The results obtained also is in line with [36] who reported better feed conversion ratio, protein efficiency ratio and protein conversion ratio in African catfish fed fermented Bambara nut meal as substitute of fishmeal. The results also agreed with [37] who reported better feed utilization in African catfish *Clariasgariepinus* fingerlings fed *Lauceraleucocephala*. The result also agreed with the findings of [38] who reported efficient nutrient utilizations in African catfish fed varying inclusion level of fermented un-sieved yellow maize. The result obtained also agreed with [25] who reported good feed conversion ratio and protein efficiency ratio in *Clariasgariepinus* fed fermented sorghum by-product meal diets.

The apparent net protein utilization, apparent net lipid utilization and apparent digestibility coefficient of dry matter obtained were best in fish fed diet containing 100% inclusion level. This is as a result of feeding the fish with a good diet and water quality management. The result obtained from the study is in agreement with the result obtained by [33] who reported increase in growth and better net protein utilization in *Clariasgariepinus* fed varying levels of *Albizialebbeck* leaf meal diet. The result obtained also agreed with [39] who reported better protein efficiency ratio, apparent digestibility coefficient of crude protein, apparent digestibility coefficient of crude lipid and apparent digestibility coefficient of crude fibre in hybrid catfish fingerlings fed graded levels of germinated Sword Beans (*Canavaliagladiate*) seed meal.

CONCLUSION

This study revealed the positive effects of incorporating fermented Sorghum bran meal into the diet of *H.bidorsalis*. The study also revealed that, solid state fermentation of Sorghum bran improves proximate composition of the bran and diets. Feeding of *H.bidorsalis* with diets incorporated with fermented Sorghum bran meal at 100% inclusion levels will improve the growth performance and nutrient utilizations thereby making it viable to the farmers.

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