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Practical Growth Performance and Nutrient Utilization of Catfish Clarias gariepinus Fed Varying Inclusion Level of Fermented Unsieved Yellow Maize

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Abstract

This study was conducted using 150 fish of *Clarias gariepinus* to investigate the growth performance and nutrient utilization of *Clarias gariepinus* fed five treatment diets containing varying inclusion level of fermented unsieved maize. The diets were grouped into CT, T1, T2, T3, and T4 with inclusion levels of 25%, 50%, 75%, and 100% of fermented unsieved maize respectively. Highest weight gain was recorded in T4 with value of 10.24 and lowest weight was recorded in CT with 9.17. High FCR were observed in T2 with value of 0.70 and lower value was observed in T4 with value of 0.62. While, T2, T3, and T4 have highest survival rates with values of 90% in each treatment CT and T1 recorded 80% and 70% respectively. There was a significant ($p < 0.05$) difference between the food conversion ratios treatment T4 with the best value and other treatments. There was a significant ($p < 0.05$) difference between the levels of fermented unsieved maize inclusion and the specific growth rate of the experimental fish. The highest value of protein level and feed efficiency were observed in T4 at significant difference level ($p < 0.05$) than other treatments. It was concluded that fermentation of maize in fish feed has positive effects on the nutritional value of the feed. It is recommend that fermented maize can replace raw maize in fish feed diet for growth performance.

Keywords: Fermentation, yellow maize, *Clarias gariepinus*, Fish, Feed

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1. Introduction

The need to intensify the culture of the fish as to meet the ever increasing demand for fish has made it essential to develop suitable diets either in supplementary forms for pond or as complete feed (Omitoyin, 2006). In addition, potentials abound in Africa to develop and expand Aquaculture (viable fish farming) but there are limitations (Jamiu and Ayinla, 2003). Water quality has for many years, been the most critical limitation to fish production. Over the past decade, aquaculture has grown in leaps and bounds in response to an increasing demand for fish as a cheap source of protein. (Akinrotimi *et.al.,* 2007). This is because production from captured fisheries has reached its limit and the catch continues to dwindle by each passing day (Gabriel *et al*., 2007). According to FAO (2006), fish supplies from capture fisheries will therefore, not to be able to meet the growing global demand for aquatic food. As aquaculture production becomes more and more intensive in Nigeria, fish feed will be a significant factor in increasing the productivity and profitability of aquaculture (Akinrotimi *et al.,* 2007). Jamiu and Ayinla (2003) opined that feed management determines the viability of aquaculture as it accounts for at least 60 percent of the cost of fish production. Maize has been a traditional energy source in formulated feeds. According to Nnam (2002) and Eyo (2004), maize is the major source of energy in most compounded diets for catfish species. This is because it is readily available and digestible.

There are various researches directed towards deriving alternative energy sources through maize in fish diets. It is equally important that more researches should be focused on finding alternative ways of increasing energy sources through maize in fish diets. Cereals such as maize, sorghum, millet, rice, are process to detoxify the anti-nutritional factors, increase palatability and improve bioavailability of nutrients; fermentation is one of the household food techniques reviewed extensively as means by which the nutritive value of plant food could be improved (Nnam, 2000; Obadina *et al,* 2008).

Non-sieved wet-milling of fermented maize has shown that the nutrient content of complementary foods can be improved by conserving the nutrient content as well as enhancing the shelf life while sieved wet-milling results mostly into nutrient losses and decreases the anti nutrient factors. The main objectives of this study is to determine growth performance and nutrient utilization of *Clarias gariepinus* fed with diet containing varying levels of fermented unsieved yellow maize at 25%, 50%, 75% and 100% inclusion.

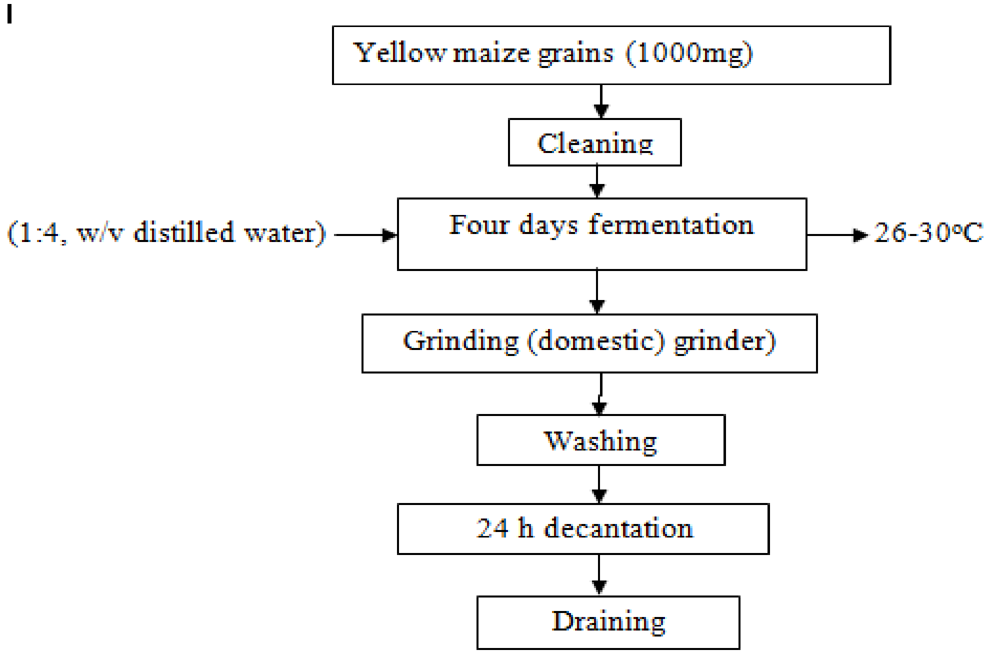

Figure 1: Flow diagram of fermented unsieved yellow maize production

2. Materials and Methods

2.1. Study site: The experiment was conducted in the Department of Aquaculture and Fisheries Management laboratory, University of Ibadan

2.2. Experimental Set Up: fermented unsieved maize was used as the feed ingredient. One kilogram of raw maize was washed with distilled water which was later decanted. Thereafter, the maize was dispersed in distilled water at ratio 1:4 w/v and allowed to undergo natural lactic acid fermentation for 4 days as described by Obizoba (1991). After four days of fermentation, the water was decanted and the fermented maize were washed with running distilled water for 10mins and milled in a domestic grinder. The fermented unsieved paste was then mix with other feed ingredients for the fish

2.3. Diet formulation and preparation: The feed ingredients were used to formulate five (5) isonitrogenous ration with 35% crude protein. Diets were formulated at 0%, 25%, 50%, 75% and 100% of fermented unsieved maize as represented as diet CT, T1, T2, T3, and T4 respectively as presented in table 2. The feed ingredients were Fishmeal, soybean meal, groundnut cake, fermented unsieved maize, raw maize, mineral premix, vitamin premix, salt and palm oil. The various ingredients were ground to a fine powdery form and thoroughly mixed in a bowl to form a homogenous mixture. Premix and water were added followed by starch as a binding agent. Experimental feeds were pelletized using the manual pelletizer, then sundried, labeled and packaged in an air tight bag stored for use thereafter.

2.4. Feeding: The experimental fish were fed with 5% of their body weight per day for 12 weeks. The fish in each bowl were batch-weighed weekly throughout the feeding trial using sensitive scale, to determine the feed adjustment based on weight gained. The fish were fed between 8-9am and 5-6pm daily.

2.5. Water Quality Parameters: The water quality parameters monitored at interval throughout the experiment were temperature, pH, and dissolve oxygen, being the most important water parameters

Table: 1: Proximate Composition of Fermented Yellow Maize.

Elements	**Composition**
pH	3.78
Moisture (%)	1.36
Ash	0.66
Gross Energy (Kcal/100gDM)	442.54
Crude Protein (%)	13.34
Fat (%)	4.67
Carbohydrate (%)	84.20

Table 2: Diets composition of Formulated Feeds at 35% crude protein

Ingredient	CD	T1	T2	T3	T4
Fishmeal	13.63	13.30	13.30	13.00	13.00
Groundnut Cake	27.26	26.63	26.63	26.00	26.00
Soybean meal	27.26	26.63	26.15	26.00	26.00
Maize	28.85	21.69	14.67	7.65	-
Fermented maize	-	8.75	16.25	24.35	32.00
Vitamin premix	0.50	0.50	0.50	0.50	0.50
Mineral premix	0.50	0.50	0.50	0.50	0.50
Palm oil	1.00	1.00	1.00	1.00	1.00
Total	**100**	**100**	**100**	**100**	**100**

2.6. Proximate Analysis of Experimental Feed and Fish: Proximate compositions of the fermented unsieved maize and fish carcass before and after the experiment were determined (A.O.A.C., 2005).

2.7 Growth Performance Parameters: The mean weight of the fish was estimated on weekly basis through a batch weighing of each treatment. The following growth performance was determined:

2.7.1 Mean Weight Gain: This was determined by dividing the difference in weight of fish before and after the experiment by the duration of the experiment in days

Mean Weight gain per day = $W_2 - W_1/n$

Where n = number of days

W_1 = Initial mean weight (g)

W_2 = Final mean weight (g)

2.7.2 Percentage Weight Gain (PWG): This was calculated from the relationship between the total weight gain of fish expressed as percentage of the initial weight.

$$\text{PWG} = \frac{Mean\ weight\ gain\ X\ 100}{Initial\ weight}$$

2.7.3. Specific Growth Rate (SGR): The Specific Growth Rate was calculated as follows;

$$\text{SGR} = \frac{(Log_e W_2 - Log_e W_1)}{T_2 - T_1}$$

Where W2 = Final weight at time T2 by days

W1 =Initial weight at time T1 by days

T2-T1 = Number of experimental days

Loge = Natural logarithm to base e.

2.7.4 Feed Efficiency (FE): The feed efficiency was calculated as:

$$\text{Feed Efficiency (FE)} = \frac{\text{Mean weight gain}}{\text{Mean weight of feed consumed}}$$

2.7.5 Feed Conversion Ratio (FCR): The feed conversion ratio is calculated as

$$FCR = \frac{\text{Weight of feed fed}}{\text{Weight gain}}$$

2.7.6 Gross Feed Conversion Efficiency (GFCE): This is given as the reciprocal of the food conversion ratio, expressed as a percentage.

$$GFCE = 1/FCR$$

2.7.7. Feed Efficiency (FE): The feed efficiency was calculated as:

$$\text{Feed Efficiency (FE)} = \frac{\text{Mean weight gain}}{\text{Mean weight of feed consumed}}$$

2.7.8. Protein Intake: The protein intake is given as

PI = Total feed consumed X Percentage protein

2.7.9. Protein Efficiency Ratio (PER): The protein Efficiency Ratio is given as

$$PER = \frac{\text{Mean Weight Gain}}{\text{Protein consume}}$$

2.7.10. Data Analysis: The results describing fish growth, survival rate, and weight gain and food conversion ratio were analyzed statistically using statistical analysis of variance. Mean were compared by Subjecting data to one way of analysis of variance (ANOVA) test for significance ($P< 0.05$).

3.0 Results

3.1 Proximate Composition of Experimental Feed: The result of the proximate analysis of the experimental diet is presented in table 3. Highest percentage of protein was observed in the Test diet (CT) with a value of 40.20% and the lowest value of 35.96% was recorded in Test diet 1 (T1). There was an increase in the level of crude fibre and ash content in the diets according to the percentage of unsieved fermented maize inclusion.

3.2. Proximate Composition of Experimental Fish: Results for the proximate analysis of experimental fish carcass before and after the growth trial are presented in table 4. There was an increase in crude protein composition of experimental fish carcass of treatment fed T1, T2, T3, and T4 according to the levels of fermented unsieved maize in their diets, the value observed were 51.05%, 54.84%, 58.15%, and 58.57% respectively.

Table 3: Proximate Composition of Experimental Diets

Parameters (%)	Test Diets				
	CD	TDI	TD2	TD3	TD4
Crude protein	37.42	35.96	36.42	38.25	40.20
Crude Fibre	4.20	5.53	5.51	5.60	5.58
Crude Fat	4.36	4.98	5.24	5.46	6.66
Crude ash	15.78	15.88	16.02	15.95	16.22
Moisture	9.96	9.78	9.89	9.93	9.88
Nitrogen Free Extract	28.45	28.20	27.30	24.92	22.63

Table 4: Proximate Composition of Experimental Fish before and after the Feeding Trial

Parameters	Initial	CT	T1	T2	T3	T4
%CP	40.44	53.24±0.60	51.05±0.10	54.84±0.93	58.15±0.61	58.57±0.54
%CF	4.6	6.19±0.04	5.91±0.01	7.26±0.055	8.02±0.032	6.16±0.095
%CF	0.12	1.11±0.01	1.06±0.03	1.06±0.012	1.25±0.01	1.15±0.035
% Ash	10.5	12.75±0.06	12.70±0.02	13.06±0.097	13.55±0.050	12.91±0.058
% Moisture	2.12	3.75±0.01	3.72±0.02	3.75±0.025	3.63±0.030	3.63±0.030

3.3. Water Chemistry of Experimental Fish Tanks: The result of the water quality parameters analyzed during this study is presented in table 5, the result showed no significant variation in all the parameters measured and no deviation from the normal water quality parameters for fish culture.

Table 5: Mean Value of Water Quality Parameters observed during the study

Parameters	CT	TD1	TD2	TD3	TD4	Mean	SD
Temperature	26.40	26.72	27.70	27.90	26.96	2.45	0.13
pH	6.90	7.00	6.50	6.70	6.50	6.72	0.23
Dissolved O_2	5.60	5.90	5.85	5.66	5.65	5.73	0.13

3.4. Growth Performance:

3.41. Mean Weight Gain: The growth response of *Clarias gariepinus* fed with various inclusion levels of fermented unsieved maize in their diet is presented in table 6. The mean weight gain varies from 6.19g± 0.02 to 4.98g ±0.02 and there was a significant ($p< 0.05$) difference in the mean weight gain. The highest mean weight gain was recorded in T4 with a value of 6.19g and the lowest 4.98g in T1.

3.42. Food Conversion Ratio and Gross Feed Conversion Efficiency: The highest food conversion ratio is 0.70 ± 0.99 and was recorded in T2. T3 had the best food conversion ability with a lowest value of FCR. There was a significant ($p< 0.05$) difference between the food conversion ratio of the treatments. The gross feed conversion efficiency was lowest in the T1 with 16.78± 1.01 and highest in T2 with 20.27 ± 1.67.

3.4.3. Specific Growth Rate: The results of the specific growth rate of the experimental treatments are present in table 6. The highest SGR value of 1.10 ± 0.05 was recorded in T4 .While the lowest was in T1 with 0.95± 0.03. There was a significant ($p< 0.05$) difference between the level of fermented unsieved maize inclusion and the specific growth rate of the experimental fish.

Table 6: Growths and Nutrient Utilization of Experimental Fish

Parameters	CT	T1	T2	T3	T4
Experimental periods (days)	84	84	84	84	84
No of fish per treatment	10	10	10	10	10
Mean initial weight	4.03±0.02	4.06±0.02	4.06±0.01	4.05±0.03	4.05±0.02
Mean final weight	9.17±0.28	9.04±0.08	10.19±0.34	10.13±0.12	10.24±0.1
Mean weight gain	5.14±0.04	4. 98±0.02	6.13±0.04	6.08±0.02	6.19±0.05
Percentage weight gain	127.50±7.11	122.60±3.06	150.90±8.01	150.10±3.08	152.80±4.62
Mean feed intake per week	3.36±0.31	3.41±0.15	4.34±0.02	4.18±0.12	3.86±0.02
Feed efficiency	1.52±0.05	1.46±0.08	1.41±0.13	1.45±0.04	1.60±0.05
Feed conversion ratio	0.65±0.49	0.68±0.86	0.70±0.99	0.68±0.26	0.62±0.34
Gross feed conversion Efficiency	17.47±0.06	16.78±1.01	20.27±1.67	19.57±0.47	20.18±0.62
Protein efficiency ratio	0.52±0.02	0.50±0.03	0.56±0.04	0.56±0.01	0.55±0.01
Protein intake (g/day)	9.70±0.89	9.87±0.45	10.92±0.05	10.82±0.36	11.17±0.06
Specific growth rate	0.97±0.08	0.95±0.03	1.09±0.08	1.09±0.03	0.94±0.05
Survival rate (%)	80	70	90	90	90

3.4.4 Protein Intake and Protein Efficiency Ratio: The highest protein levels were observed in T4 and lowest in CT treatment. There was a significant difference at $p < 0.05$ between the protein intake levels.

3.4.5. Feed Efficiency: The feed efficiency values were recorded as follows CT 1.52 ± 0.05, T1 1.46 ± 0.08, T2 1.41 ± 0.13, T3 1.45±0.04 and T4 1.60± 0.05. T4 has the highest feed efficiency and there was a significant difference at $p < 0.05$ within the treatment.

3.4.6. Survival Rate: The highest level of mortality was record in T1 with 70% survival rate while other treatments showed 80% and above. T2, T3, and T4 gave the highest survival rate of 90%. Highest rate of mortality occurred in the third week and no mortality was record in the rest of weeks of the experimental period.

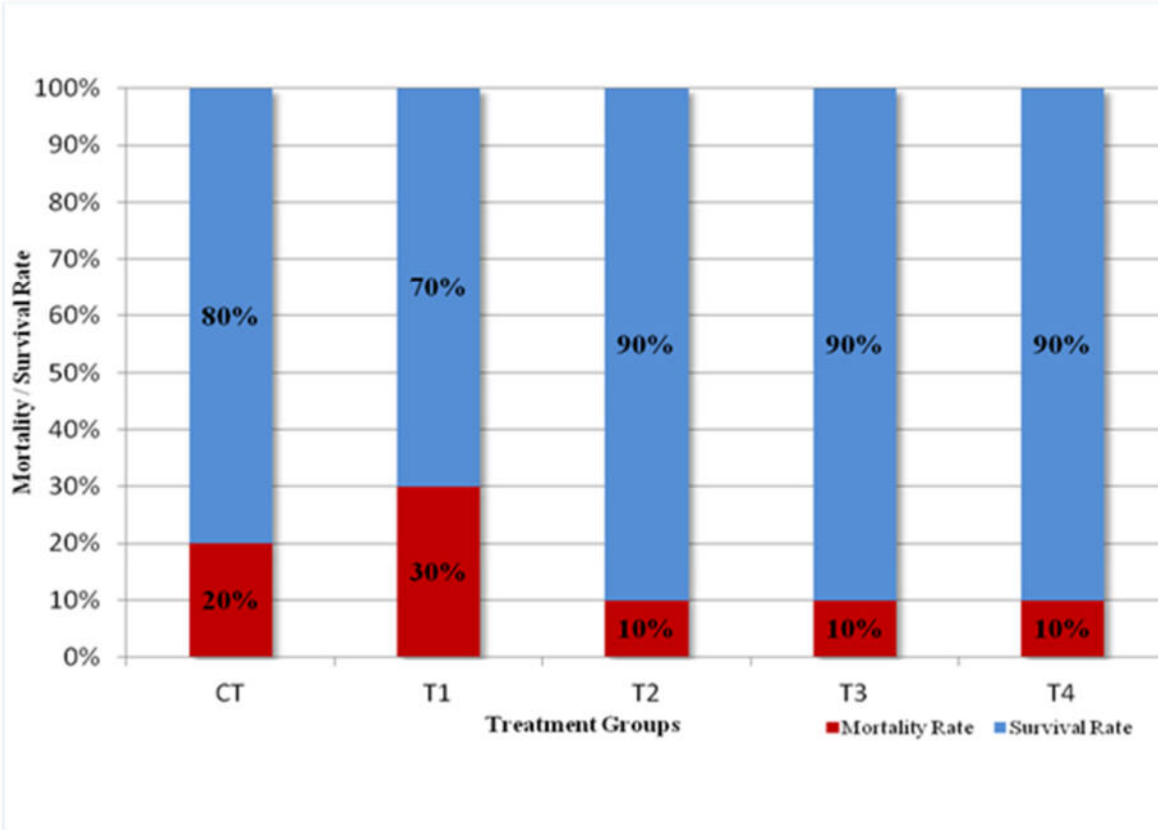

Figure 2: The survival rate of the experimental fish during the study

4.0 Discussion

4.1 Proximate Composition of the Diet and Fish: The proximate analysis of the experimental test diet showed a difference in composition among the treatments which no significance difference, which may be attributed to the various inclusion levels of fermented unsieved maize in the diets. The range of crude protein observed in the experimental diets was in accordance with the work of Akinrotimi et al. (2007), who recommended 35-40% protein levels in *Clarias gariepinus* diet; the highest levels of crude fibre recorded in the inclusion of 100% fermented unsieved maize (T4), which may be due to high fibre contents present in fermented unsieved maize. There was an increased in the value of the proximate composition of all the treatments between the initial values and the final values of the experiment. This shows that all the formulated diets were nutritional adequate and can be used for feeding catfish.

4.2.Water Quality: The mean temperature value recorded in this experiment agreed with Idodo (2003) that reported a temperature range of 25-28oC, for optimum growth of catfish and Tilapia. Boyd and Licthkoppler (1989) recommended a temperature range of 25-32C for best growth of warm water fish and Aderolu and Sogbesan (2010), who recorded a temperature range of 27.5-29.5C for *Clarias gariepinus* fed with graded level of cocoyam. The mean PH value recorded was in accordance with that obtained by Omitoyin (2006) for intensive fish culture. Dissolved oxygen value obtained met the optimal range of 2 mg/litre - 5 mg/litre recommended for tropical warm water fish species by Boyd and Tucker (1998).

4.3. Growth Performance: The mean weight gain observed in the treatment indicates that all the formulated experimental diets are nutritionally adequate. The mean weight gain of the fish of T1 gave the lowest growth performance and these may be attributed to the poor acceptability of the T1 by the fish. The specific growth rate recorded was similar to the 0.87% obtained by Aderolu and sogbesan (2010) for *Clarias gariepinus*. fish fed with 100% fermented unsieved maize inclusion levels gave the best growth performance and nutrient utilization in terms of Mean Weight Gain (MWG), Specific Growth Rate (SGR), Feed Conversion Ratios (FCR), and Protein Efficiency Ratios (PER). 25% replacement levels gave the poorest performance. This has shown that usage of fermented unsieved maize of 100% as replacement for maize yielded a result that agrees with the result of Falaye *et al*. (2012), that growth performance of *Clarias gariepinus* increases as the levels of cowpea hull meal increases as a replacement of maize which also disagrees with the results of Falaye *et al.* (2010), that the replacement of fishmeal using 30% of dietary poultry offals yielded the best growth performance in *Clarias gariepinus* compared to higher increase of the poultry offals.

4.4.Nutrient Utilization: The protein efficiency ratio is the rate at which protein intake is utilized for growth, the value obtained were very close to the recommended value of Aderolu and sogbesan (2010) who obtained 0.62 - 0.21 for fish fed 37% crude protein level. The total feed intake increases with the inclusion levels; this is due to different weight gain as fish are fed based on 5% of their body weight throughout the experimental period. The feed conversion ratio recorded is comparable to that of (Agbebi et. al., 2009) when fishmeal is substitute for blood meal in the diet of *Clarias gariepinus*

5. Conclusion

The replacement of raw maize with fermented unsieved maize in the diet of Clarias gariepinus at inclusion levels of 0%, 25%, 50%, 75%, and 100% as studied. Showed that fish fed with 100% fermented unsieved maize inclusion levels gave the best growth performance and nutrient utilization.

6. Recommendation

The above results has shown that fermentation of maize can therefore be recommended for total substitution for raw maize in the diets of Clarias gariepinus, as it has digestibility and enhances growth performance and apparent digestibility coefficients of energy.

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