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Evaluation of *Telfairia occidentalis* Leaf Meal Potentials as a Possible Substitute to Fishmeal

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Abstract

The present study was designed to evaluate the acceptability and growth performance of African catfish (*Heterobranchus bidorsalis*) fingerlings treated with graded levels of *Telfairia occidentalis* leaf meal used as substitute to fishmeal. One hundred and thirty-five *H. bidorsalis* fingerlings were assigned into five treatment groups with three replicates per group. Five iso-nitrogenous diets (45% crude protein) were formulated by substituting fishmeal with *T. occidentalis* leaf meal. The control diet (T0) contained 0% *T. occidentalis* leaf meal while the other experimental diets (T10, T20, T30 and T40) contained *T. occidentalis* leaf meal at the percentage of 10%, 20%, 30% and 40%, respectively. Treatment lasted forty-two days, the experimental diets were administered at 5% of body weight two times daily (9am and 4pm). Water was changed every three days and mortality monitored daily. The acceptability indices of the diets, body weight (g) and length (cm) were measured and recorded weekly. The control diet (T0) recorded the most effective results in all parameters evaluated compared with all treatments. No significant difference ($p > 0.05$) was recorded in the water qualities tested. Conclusively, It is evident from this study that fishmeal cannot be replaced totally by *T. occidentalis* leaf meal in the diet of *H. bidorsalis* fingerlings. However, based on the non-significant difference ($p > 0.05$) observed in the growth performance of *H. bidorsalis* fingerlings fed the control diet and 10% *Telfairia*-based diet, we recommend that *H. bidorsalis* fingerling producers can substitute fishmeal with *T. occidentalis* leaf meal just at an optimal level of 10%.

Keywords: *Telfairia occidentalis* leaf meal; *Heterobranchus bidorsalis*; Fishmeal; Acceptability; Growth performance

Introduction

Aquaculture needs quality and affordable feeds in other to be successful. Fish feeds are used to maximize production and profit in aquaculture industry because they represent the highest input covering about 60% of the capital cost [1,2].

Conventionally, fish meal forms the major protein source in fish feed because of its high nutritive value and palatability. However, its cost is responsible for high cost

of fish feed leading to the increase in price of cultured fish species [3]. Consequently, there is arousing interest in developing cheaper alternatives. Therefore, growth of aquaculture to a great extent depends on development of sustainable protein sources (cheaper with regards to cost of production), to replace fishmeal in fish feed production [3]. This necessitates exploring and incorporating unconventional, unexplored, locally available and cheaper feed stuffs in fish feed production. The utilization of plant based protein feed stuffs has been found a veritable tool in the attempt to reduce artificial fishmeal cost in fish feed production [4].

In view of the foregoing, the present study aimed at ascertaining the acceptability and growth performance effects of graded levels of *T. occidentalis* leaf meal based diets using *H. bidorsalis* fingerlings as experimental animals.

Materials and Methods

Procurement and Drying of the Plant Sample

T. occidentalis leaves were purchased at Ikpa Market, Nsukka Enugu state Nigeria. The leaves were air dried at room temperature for 14 days, as stated by Oguche HEG [5]. The dried materials were milled into flour and later sieved to remove the chaff from the milled leaves.

Control Ingredient and Formulation of Experimental Diets

The control ingredient, fishmeal was obtained by milling well-dried cultured catfish which was obtained from the Fisheries Unit, Department of Animal Health and Production, Enugu State Polytechnic, Iwollo (ESPOLY). Five iso-nitrogenous diets (45% crude protein) were formulated by substituting fishmeal with *T. occidentalis* leaf meal. Whereas the control diet (T0) contains 0% *T. occidentalis* leaf meal, other experimental diets T10, T20, T30 and T40 had *T. occidentalis* leaf meal at the percentage of 10%, 20%, 30% and 40% respectively. The formulae for the diets were calculated using Pearson's Square method. The formulation was based on proximate composition of the ingredient showing the gross percentage composition of the experimental diets. All the ingredients were milled and sieved to remove chaff and ensure homogenous size profile. The ingredients for each diet were weighed and mixed thoroughly in a bowl, water added, cooked and pelletized in a manually operated pelletizer. The moist pellets were oven-dried, packaged in tagged/labelled air-tight container and stored in dry place at room temperature.

Procurement and Acclimatization of Experimental Fish

One hundred and thirty-five (135) *H. bidorsalis* fingerlings of average weight of 1.19g and average length of 4.57cm were obtained from Freedom Fisheries, University Market Road Nsukka, Enugu State and transported to the Zoological Garden, Department of Zoology and Environmental Biology, Faculty of Biological Sciences, University of Nigeria, Nsukka. Thereafter, the fish were acclimatized in the experimental plastic aquaria (23cm depth and 47.5cm diameter) for fourteen days prior to the experimental period. During this period, the fish were fed 0.8–1.2 mm standard commercial catfish diet (Coppens) with nutrient composition shown in Table 1.

Proximate composition of major feed ingredients					
Parameters (%)			Feed ingredients		
			FM	TOLM	MM
Moisture			4.36	4.48	3.36
Crude protein			65	25.66	8.28
Crude lipid			19.42	6.84	4.62
Crude carbohydrate			8.63	57.86	72.89
Crude fibre			1.08	2.34	6.73
Ash			1.77	2.84	4.13
Proximate composition of experimental diets					
Parameters (%)	T_0	T_{10}	T_{20}	T_{30}	T_{40}
Moisture	4.89	5.15	5.45	4.67	5.22
Crude protein	45.31	45.12	45.03	45.21	45.01
Crude lipid	11.23	11.34	11.31	12.15	11.02
Crude fibre	3.87	3.99	3.45	3.79	3.77

Ash	2.55	2.76	2.57	2.99	2.33
Composition of experimental diets					
Ingredients (g)	T_0	T_{10}	T_{20}	T_{30}	T_{40}
FM	60.5	58.4	55.9	53	49.8
TOLM	0	7	15	24.5	36
MM	32.3	27.5	21.9	15.3	7
Bone meal	3	3	3	3	3
Groundnut oil	2	2	2	2	2
Fish vitamin plus	1.5	1.5	1.5	1.5	1.5
Phosphate additive	0.7	0.7	0.7	0.7	0.7

Note: FM = Fish meal; TOLM = *Telfairia occidentalis* leaf meal; MM = Maize meal; (T0) – 0% *Telfairia occidentalis* leaf meal
T10 - 10% *Telfairia occidentalis* leaf meal; T20 - 20% *Telfairia occidentalis* leaf meal; T30 - 30% *Telfairia occidentalis* leaf meal
T40 - 40% *Telfairia occidentalis* leaf meal

Table 1: Proximate composition of major feed ingredients, proximate composition of experimental diets & composition of experimental diets.

Experimental Design and Conditions

One hundred and thirty-five *H. bidorsalis* fingerlings were assigned into five treatment groups (The control diet (T0) contained 0% *T. occidentalis* leaf meal while the other experimental diets (T10, T20, T30 and T40) contained *T. occidentalis* leaf meal at the percentage of 10%, 20%, 30% and 40%, respectively), replicated three times with nine fish per replicate. Water was changed every three days. All the experimental fish were fed the experimental diets at 5% of body weight [6] two times daily (9am and 4pm) for forty-two (42) days. Mortality was monitored daily.

Physico-Chemical Parameters

The water temperature was determined with a mercury-in-glass thermometer; pH was determined with a portable field pH meter while dissolved oxygen was determined by means of the Wrinkler's method.

Determination of Proximate Composition of Feed Ingredients: The proximate composition (moisture, crude protein, crude lipid, and crude fiber and ash contents) of the dried *T.occidentalis* leaf meal, maize meal, and fishmeal before the experiment were determined using the methods of the Association of Analytic Chemists [7].

Determination of Acceptability Index: The acceptability of the experimental diets by the *H. bidorsalis* fingerlings was assessed using the "time to strike index" [8].

Determination of Weight Gain and Feed Conservation Ratio (FCR) & Survival Rate: Weight gain, feed conservation ratio and survival rate were determined following the method of [9].

Determination of Specific Growth Rate (SGR): The specific growth rate was determined following the method of Ricker WE [10].

Statistical Analysis

The statistical analysis was performed with R statistical package (Version 3.4.1). The data describing Growth Performance (Acceptability indices, feed intake, length, weight, weight gain specific growth rate, and feed conversion ratio), dissolved oxygen, temperature and pH were analyzed statistically using one-way analysis of variance (ANOVA) ($p < 0.05$) and comparisons among means were made by Least Significant Difference (LSD). 5% level of significance was used in all the analyses.

Result

Effects of the Experimental Diets on Acceptability (A), Body Weight (B), Body Standard Length (C), Weight Gain (D) and Specific Growth Rate (E) Of *H. bidorsalis* Fingerlings

The results on the effects of the experimental diets on acceptability (A), body weight (B), body standard length (C), weight gain (D) and specific growth rate (E) of *H. bidorsalis* fingerlings are shown in Table 2. The results as observed in all parameters tested showed that the experimental diets (T0, T10, T20, T30 & T40) had significant lower ($P < 0.05$) (which increased

proportionally as *Telfairia occidentalis* leaf increases in the diets) effect in *H. bidorsalis* fingerlings as compared with control except experimental diet T10 which showed a non-significant difference ($p > 0.05$).

A							
Replicate	**Treatment**						
	T0	T10	T20	T30	T40		
R1 (s)	3.25	4.35	6.6	7.3	8.2		
R2 (s)	2.72	3.79	5.25	6.99	8.03		
R3 (s)	3.25	3.18	4.43	7.56	7.99		
Average (s)	3.07±0.31	3.77±0.59	5.43±1.10	7.28±0.29	8.07±0.11		
P = 0.0382							
B							
Treatment (g)	**Week**						**Average**
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	
T0	1.15	1.35	1.45	1.46	1.61	1.68	1.83	1.40±0.17
T10	1.17	0.93	1.28	1.38	1.38	1.47	1.57	1.23±0.19
T20	1.31	1.37	1.34	1.67	1.67	1.73	1.81	1.44±0.15
T30	1.17	1.14	1.32	1.51	1.51	1.52	1.54	1.33±0.18
T40	1.15	1.09	1.14	1.36	1.36	1.37	1.4	1.21±0.12
P = 0.015							
C							
Treatment (g)	**Week**						**Average**
	Week 0	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	
T0	4.47	4.49	4.85	4.96	5.17	5.34	5.46	4.96±0.39
T10	4.47	4.48	4.73	4.95	4.89	4.97	5.08	4.80±0.24
T20	4.47	4.85	4.95	5.09	5.13	5.19	5.25	5.03±0.18
T30	4.6	4.59	4.92	5.14	5.02	5.17	5.23	4.95±0.26
T40	4.53	4.67	4.71	4.73	4.82	4.89	4.99	4.76±0.15
P = 0.269							
D							
Treatment (%)	**Week**						
	Week 1	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Total (%)**	
T0	17.39	7.41	0.69	10.27	4.35	8.93	49.04	
T10	-21.05	37.63	7.81	0	6.52	6.8	37.71	
T20	4.58	-2.19	13.43	9.87	6.59	4.62	36.9	
T30	-2.56	13.64	15.15	-0.66	0.66	1.32	27.55	
T40	-5.22	4.59	15.79	3.03	0.74	2.19	21.12	
P = 0.00373							
E							
Treatment	**Week 1**	**Week 2**	**Week 3**	**Week 4**	**Week 5**	**Week 6**	**Total (%)**	
T0	2.29	1.02	0.1	1.4	0.61	1.22	6.64	
T10	3.28	4.56	1.07	0	0.9	0.94	4.19	
T20	0.64	0.32	1.8	1.34	0.5	0.65	4.61	
T30	0.37	2.09	2.02	0.09	0.09	0.19	3.93	
T40	0.77	0.64	2.09	0.43	0.1	0.31	2.8	
P = 0.0405							

Table 2: Effects of the experimental diets on acceptability (A), body weight (B), body standard length (C), weight gain (D) and specific growth rate (E) of *H. bidorsalis* fingerlings.

Effects of the Experimental Diets on Feed Intake, Feed Conversion Ratio & Survival Rate of *H. bidorsalis* Fingerlings

The results on the effects of the experimental diets on feed intake, feed conversion and survival ratio of *H. bidorsalis* fingerlings are shown in Table 3. The results as observed in all parameters tested showed that the experimental diets (T0, T10, T20, T30 & T40) had significant lower ($P < 0.05$) (which increased proportionally as *T. occidentalis* leaf increases in the diets) effect in *H. bidorsalis* fingerlings as compared with control except experimental diet T10 which showed a non-significant difference ($p > 0.05$).

Feed intake		Feed conversion ratio		Survival rate	
T0	55.2	T0	0.81	T0	100
T10	53.1	T10	1.33	T10	88.89
T20	53.9	T20	1.08	T20	100
T30	52.7	T30	1.42	T30	100
T40	51.1	T40	2.04	T40	94.44
P = 0.0382		P = 0.051		P = 1.00	

Table 3: Effects of the experimental diets on Feed intake, feed conversion ratio & survival rate of *H. bidorsalis* fingerlings.

Effects of the Experimental Diets on Water Quality Parameters

There was no significant difference ($p > 0.05$) observed in all parameters tested (temperature, pH and dissolved oxygen) compared with control (Table 4).

Mean water quality parameters			
	Parameters		
Diet composition	Temperature (°C)	pH	Dissolved oxygen
Diet 1 (T_0) – 0% *Telfairia occidentalis* leaf meal	23.71±0.49	6.41±0.14	5.84±0.16
Diet 2 (T_{10}) - 10% *Telfairia occidentalis* leaf meal	23.71±0.49	6.45±0.10	5.89±0.20
Diet 3 (T_{20}) - 20% *Telfairia occidentalis* leaf meal	23.71±0.49	6.46±0.14	5.89±0.23
Diet 4 (T_{30}) - 30% *Telfairia occidentalis* leaf meal	23.71±0.49	6.46±0.10	5.84±0.14
Diet 5 (T_{40}) - 40% *Telfairia occidentalis* leaf meal	23.71±0.49	6.51±0.13	5.70±0.36

Table 4: Effects of the experimental diets on mean water quality parameters.

Discussion

The four inclusion levels of *T. occidentalis* leaf meal in the experimental feeds supported the growth of *H. bidorsalis* fingerlings. However, growth performance and feed utilization were favoured most by no inclusion (the control) level and low inclusion levels of *T. occidentalis* leaf meal in the diets. The growth performance of *H. bidorsalis* decreased as the level of *T. occidentalis* leaf meal in the diet increased. These results are consistent with past studies on the replacement of fishmeal with plant-based protein [11,12]. At all inclusion levels, the growth parameters measured were poorer in the *Telfairia*-based diets (except feed conversion ratio) compared with the control.

The acceptability and feed intake decreased with increased *T. occidentalis* leaf meal inclusion in the diets and were poorer on fish fed *Telfairia*-based diets compared with control. The lower feed intake observed in the *Telfairia*-based diets could be an important factor that may be responsible for the poor growth performance in fish fed *Telfairia*-based diets. This is consistent with the findings of Afuang W, et al. [13] who showed reduced feed intake with increasing leaf meal (particularly moringa leaf meal). The decreased acceptability and feed intake could also be attributed to lack of attractant and the smell of *Telfairia*-based diets (denatured pumpkin leaf smell) unlike the control diet which smells fishy. Also, the decreased acceptability could be as a result of the light weight of *Telfairia*-based diets, which were observed to be lighter and sinks slower than the control diet, hence the higher acceptability index of the control diet. This can also be attributed to the heavy nature of fishmeal, unlike the lighter *T.occidentalis* leaf meal. The decreased feed intake in this study was not in conformity with Dada AA [14], who reported increased feed intake as the *T.*

occidentalis leaf meal increased in the diets of *C. gariepinus*.

Diet 5 (T40) with the highest *T. occidentalis* leaf inclusion gave the poorest performance in specific growth rate values and was significantly lower than the other diets. Other diets containing *T. occidentalis* leaf meal also gave poor specific growth rate values that is significantly different from the control diet. This result corresponds to Osuigwe DI [15] report on decreased specific growth rate of *H. longifilis* fed plant meal (raw and boled *Mucuna cochnchnenss* seed meal). But contradicts the findings of several researchers who showed increased growth of animals using plant protein. Such include; *Telfairia* as feed additive for *Clarias gariepinus* fingerlings [14], *T. occidentalis* leaf powder in diets promoted growth and feed conversion efficiency in birds [16,17] used the medical herb red clover *Trifolium pratense* as a growth-promoting agent for *Tilapia Oreochromis aureus*, Diab AS, [18] also reported that Nile *Tilapia Oreochromis niloticus* fingerlings fed on diets supplemented with medicinal plants exhibited faster growth than those fed with the control diet, and African catfish *C. Gariepinus* [19]. Increase in feed conversion ratio was reported in this study for *Telfairia*-based diets, with the control diet having the poorest value. This is in conformity with the report of Dada AA [14] who recorded increased feed conversion ratio and increased growth performance with increased treatment.

Water quality parameters (temperature, pH, and dissolved oxygen) were not affected by the various *Telfairia* substituted diets and were within the recommended range for the normal physiological functioning of catfishes. This corresponds to the report of Dada [14,20].

Conclusion

We conclusively state that it is evident from this study that fishmeal cannot be replaced totally by *Telfairia occidentalis* leaf meal in the diet of *Hetobranchus bidorsalis* fingerlings. However, based on the non-significant difference observed in the growth performance of *Hetobranchus bidorsalis* fingerlings fed the control diet and 10% *Telfairia*-based diet, we recommend that *Hetobranchus bidorsalis* fingerling producers can substitute fishmeal with *Telfairia occidentalis* leaf meal just at optimal level of 10%.

Competing Interest

Authors have declared that no competing interest exists.

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