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Feed Utilization and Growth Response of Tilapia Fingerlings Fed Cassava Leaf Protein Concentrate Based Diet

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Abstract **– An experiment was carried out to evaluate the effect of varying dietary inclusion levels of cassava leaf protein concentrate (CLPC) on the growth performance and nutrient utilization of the Nile Tilapia (Oreochromis niloticus) fingerlings. Five isonitrogenous diets were formulated to contain 0, 10, 20, 30 and 40% CLPC to partially replace fishmeal. The diet containing 0% CLPC served as the control. All dietary treatments were tested in triplicate groups for 10 weeks. Results for growth and feed utilization responses show that there were no significant differences ($p > 0.05$) among all treatment groups when compared to those fed control diet. The study reveals that CLPC based diet has a good potential for use as one of the major protein sources in Nile Tilapia diet of up to 40% inclusion levels without compromising growth.**

Keywords **– Tilapia Fingerlings, Cassava Leaf Protein Concentrate, Feed Utilization, Growth Response.**

I. INTRODUCTION

An increasing awareness in health, food and responsible human nutrition had led to a significant high demand in animal protein especially from fish. However, about 80% of the cost of aquaculture production is borne by fish feed of which about 70% is contributed by the protein component, which is expensive. There is therefore the need to explore the use of alternative protein sources in combating the problem of escalating cost of fish feed in Nigeria. Cassava leaves are a significant source of potential alternative protein resource for both humans and animals (Fasuyi, 2005).

Apart from lower methionine, lysine and perhaps isoleucine content, the amino acid profile of cassava leaf protein compares favourably with those of milk, cheese, soyabean, fish and egg. The leaves contained a high level of crude protein compared to a conventional vegetable (Awoyinka et al., 1995).

Recent development in the improved cultivars has made cassava production to be possible in all ecological zones of Nigeria. Cassava production of 34 million metric tonnes in Nigeria is the largest in the world.

While the tuber and stem are utilized, the leaves are un-utilized and discarded as waste in Nigeria. The leaves constitute about 6% of the whole plant. This would translate to the generation of over 2 million MT of cassava leaves which are discarded as wastes annually. Fresh leaves of cassava are rich source of protein which could be useful both for man, livestock feed and aqua feed production. Cassava leaves have been studied as protein sources for cattle (Ffoulkes & Preston 1978; Wanapat, 2001), goats (Seng Sokerya 2009), and chickens (Khieu Borin, 2005). However, their use in fish feed has not been studied at least in Nigeria. Thus, the aim of this study is to determine the effect of utilizing cassava leaf protein concentrate on the feed utilization and growth responses of the Nile Tilapia fingerlings. The utilization of cassava leaves in this study will complete the missing link in the value-chain of cassava and also stimulate more cassava production in Nigeria.

II. MATERIALS AND METHOD

The cassava leaves used in this experiment were from an improved (sample 419) "sweet" variety considered to have a low level of HCN precursor. Processing of cassava leaves into cassava leaf protein concentrate (CLPC) was done by the method described by Oresegun et al., (2016). The CLPC from this cultivar was characterized with respect to its proximate composition and anti-nutritional factors. A least cost CLPC based fish diet from this cultivar was formulated, compounded and evaluated in Tilapia fingerlings. Table 2 shows the chemical composition of the CLPC used and processed according to Oresegun et al., (2016).

2.1. *Formulation of Experimental Diets*

Five iso-nitrogenous (30% CP) diets were formulated with different inclusion levels of of CLPC (0 control, 10, 20, 30 and 40%) as shown in Table 1. Cassava leaf protein concentrate was manually mixed thoroughly with other ingredients. The diet mixture was then pelleted through a 2- mm pelleting machine to form strands which were mechanically broken into pellets of suitable sizes for Tilapia fingerlings. The pelleted diets were dried and stored in a dark polythene bags for use.

2.2. *Collection and Acclimatization of Experimental Fish*

The experiment was conducted in a flow through plastic tank system. A total of 750 Tilapia (*Oreochromis niloticus*) fingerlings with initial mean weight of 6.28g $\pm$ 0.35g were utilized for this experiment. The fingerlings were acclimatized to laboratory conditions for 7 days before the commencement of feeding trial. The fish were fed to satiation twice daily for a period of 12 weeks at 5% body weight between (9:0h and 17:0h) and the feeding rate was adjusted during each sampling period throughout the experiment. The length and corresponding weight of the fish were recorded on a biweekly basis.

2.3. *Proximate Composition of Cassava Leaf Protein Concentrate*

The proximate composition was determined for moisture, crude protein, fat, ash, and total carbohydrate as described by (Association of Official Analytical Chemist Official [AOAC], 2000). Thereafter, the nitrogen was determined by the Micro-Kjeldahl method.

Table 1. Ingredient Composition (%) of the Experimental Diets.

CLPC Inclusion Levels	**0%**	**10%**	**20%**	**30%**	**40%**
Ingredients (CP)	Control	TRT 2	TRT 3	TRT 4	TRT 5
Fishmeal (Danish 70%)	15	13.5	12	10.5	9
CLPC (40.19%)	-	2.5	5	7.5	10
Defatted SBM (45%)	40	42	44	46	48
Cassava Flour (2.6%)	40	37	34	31	28
Vegetable Oil	3.8	3.8	3.8	3.8	3.8
Vitamin Mineral Premix	0.5	0.5	0.5	0.5	0.5
Vitamin C	0.5	0.5	0.5	0.5	0.5

CLPC Inclusion Levels	0%	10%	20%	30%	40%
Anti-Mould	0.2	0.2	0.2	0.2	0.2

CLPC: cassava leaf protein concentrate. CP: crude protein. SBM: soya bean meal.

2.4. *Determination of Growth Indices*

The mean initial weight (MIW), mean final weight (MFW), weight gain (WG), percentage weight gain (PWG), average daily growth (ADG), specific growth rate (SGR) and feed conversion ratio (FCR) were calculated.

2.5. *Statistical Analysis*

All data resulting from the experiment were presented as means ± SD and analyzed by one way analysis of variance (ANOVA) using the SPSS (Statistical Package Computer, Software 2004 version Chicago Illinois, USA). Duncan's multiple range test for least significant difference were used to compare differences among individual means. Differences were regarded as significant at $P < 0.05$ (Zar, 1999).

III. Results and Discussion

The fresh cassava leaves used in this study contained cyanogenic glucoside levels (Table 2) that are lower than the permissible maximum level of 100 mg kg^{-1} hydrocyanic acid set by the Council of the European Community for cassava products to be used as animal feed (Ingram, 1975 as cited by Gomez & Valdivieso, 1985).

In this study, no mortality was observed among the treatment groups throughout the experimental period. These general performance characteristics indicated that the husbandry practices (feeding rates, basal diet formulations and fish handling, etc.) were adequate as all experimental diet treatments (Control, Trt 2, Trt 3, Trt 4 and Trt 5) were accepted by the Tilapia fingerlings indicating that the inclusion of CLPC in the different diets at these concentrations did not affect the palatability of the diets. This is in agreement with the results of Ty Chhay et al., (2010), Du Thanh Hang and Preston (2005), Chhay Ty & Preston (2005a,b, 2006) and Chhay Ty et al., (2009) in other non ruminant species (pigs) showing that health and production responses are not related with levels of ingestion of HCN precursors.

The chemical compositions of fresh cassava leaves and CLPC used in this study are represented in Table 2 and 3.

Table 2. Chemical Composition of Fresh Cassava Leaf and its Anti-Nutrient Factors.

Composition Parameters	Value (%)
Moisture	6.71± 0.13
Crude Protein	48.85± 0.45
FAT	13.27± 0.06
ASH	3.87± 0.04
Total Carbohydrate	27.31± 0.56
Total Beta Carotene (µG G-1)	816.92± 8.80

Composition Parameters	Value (%)
Cyanide (MG 100G-1)	0.98 ± 0.05
Phytate	1.63
Tannin	1.07

Values are means + SD.

Table 3. Proximate Composition of Cassava Leaf Protein Concentrate.

Composition Parameters	Value (%)
Moisture	6.33 + 0.01
Crude Protein	43.95 + 0.08
FAT	12.13 + 0.06
ASH	3.76 + 0.01
Total Carbohydrate	33.84 + 0.11

Values are means + SD.

Table 4. Feed Utilization of Tilapia Fed Cassava Leaf Protein Concentrate Diets.

	Control Diet	Test Diets			
	1 (0%CLPC)	TRT 2 (10% CLPC)	TRT 3 (20% CLPC)	TRT 4 (30% CLPC)	TRT 5 (40% CLPC)
Mean Initial Weight (G)	6.28A ± 0.35	6.41A ± 0.22	6.62 A ± 0.35	6.57B ± 0.01	6.88A ± 0.88
Mean Final Weight (G)	19.16 B ± 0.07	19.8 B ± 0.56	17.09 A ± 0.95	16.40A ± 0.00	16.81A ± 1.31
Weight (G) Gain	12.91B ± 0.07	11.9AB ± 2.84	10.4A ± 0.60	9.84A ± 0.01	9.93A ± 0.42
Weight (G) Gain (%)	205.93A ± 0.24	163.90A ± 83.64	157.95A ± 0.64	149.97A ± 0.04	145.24B ± 12.50
ADG	0.24 A ± 0.01	0.22 B ± 0.04	0.19A ± 0.01	0.18A ± 0.00	0.18A ± 0.01
SGR	0.86 A ± 0.07	0.73 ± 0.25A	0.74A ± 0.01	0.72A ± 0.02	0.69A ± 0.35
FCR	1.38 A ± 0.01	1.39 A ± 0.47	1.61A ± 0.11	1.67 A ± 0.01	1.7 A ± 0.05

Note: $^{a, b}$ Mean values in the same row with different superscripts show significant difference ($P<0.05$).

Weight Gain: Difference between the initial weight and final weight.

Weight gain (%) = (final – initial weight) x 100.

SGR: Specific growth rate (%/day) = 100 × (ln final weight – ln initial weight)/days.

FCR: Food conversion ratio = total dry feed intake (g)/wet weight gain (g).

ADG: Average daily growth.

Trt: Treatment.

Traditionally, fishmeal is the main and preferred source of protein used in the animal feed industry because of its excellent nutritional composition. However, the rising demand and limited supply makes fishmeal an expensive protein source (FAO, 2006).

In this study, we evaluated different inclusion levels of CLPC as alternative to fishmeal in the Nile tilapia diet. The use of CLPC as an alternative to fishmeal in this study agrees with previous reports (Bohnenberger, 2008) indicating that alternative protein sources can be used in tilapia feed without affecting the growth performance. In this investigation, adequate nutrients were provided in the experimental diets. However, the slight differences in the value of some growth parameters in the experimental diets were not due to processing conditions of CLPC, digestibility of ingested feed by experimental fishes or palatability of feed but rather the increasing inclusion levels of the plant protein (CLPC) deficient in some essential amino acids like methionine in the diets. This finding agrees with the work of Nengas et al. (1999) and Webster et al. (2000).

Highest weight gain of 11.9 $\pm$ 2.84 g was achieved by the treatment diet containing 10% inclusion levels of CLPC and the least weight gain of (9.84 $\pm$ 0.01 g) was recorded by the treatment diet containing 30% CLPC inclusion levels (Table 4). However, these results are not significantly different ($P > 0.05$) from the rest diet treatments. This finding is similar to the values obtained by Faturoti & Akibote (1986) and Amalia Sutriana (2007) for *Oreochromis niloticus* and *Clarias gariepinus* respectively, fed varying levels of cassava leaf meal.

Specific growth rate measures the rate of body weight change within a specific time frame and a high positive SGR indicates that consumed dietary feed nutrients are partitioned towards optimum growth. In this study, SGR values for 10, 20, 30 and 40% inclusion levels of CLPC were however not significantly different ($P > 0.05$; Table 4). These observations are in line with that reported by Oresegun & Alegbeleye (2001), for *Oreochromis niloticus* fed varying levels of cassava peels.

Feed conversion ratio is an important economy indicator in feed production industry. FCR is a marker of how efficiently an animal utilizes feed, therefore minimizing feed wastage. Low FCR is usually desired in feed production. Generally, the FCR values (1.38 – 1.70) observed in this study (Table 4) were similar in range to those reported by Wu et al. (2000), Siddiqui et al. (1988) and Stickney & McGeachin (1984) for tilapia fishes fed plant protein based diets containing full fat – soya, corn gluten meal and synthetic amino acids with a range of FCR 1.67-1.79. However, these values are lower than those reported by Amalia Sutriana, (2007) and Bichi et al. (2010) who worked on varying dietary inclusion levels of processed cassava leaves for *Oreochromis niloticus* and *Clarias gariepinus* fingerlings with FCR range of 0.12 - 0.16. This might be as a result of differences in experimental fish species. The lowest growth response observed in fishes fed 30 and 40% CLPC based diets was probably caused by reduced palatability of the diet which causes reduced feed intake. This finding agrees with the work of Hassan et al., (2017) who worked on the effect of cassava leaf meal on the growth performance and nutrient utilization of the African catfish (*Clarias gariepinus*) in the semi arid-zone of Nigeria.

IV. Conclusion

Oreochromis niloticus in this study showed a tolerable response to the intake of CLPC based diets at 10, 20, 30 and 40% dietary inclusion levels. CLPC did not significantly affect growth performance and feed utilization of *Oreochromis niloticus* fingerlings.

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