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Potentials of Sweet Potato (*Ipomoea batatas*) Leaf Meal as Dietary Ingredient for *Tilapia zilli* Fingerlings

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Abstract: An 8-week feeding trial was conducted to evaluate the potential of sweet potato (*Ipomoea batatas*) leaf meal as dietary protein source in the diet of *Tilapia zilli* fingerlings. Five isonitrogenous diets of 30% crude protein were formulated to contain 0, 5, 10, 15 and 20% sweet potato leaf meal (Diets 1-5) to partially replace other protein ingredients in the tilapia diet. The diet containing 0% leaf meal served as the control. *Tilapia zilli* fingerlings were reared in 50L circular plastic tanks maintained in a flow-through system. Each dietary treatment was tested in triplicate groups of 10 fingerlings per tank. The results of the growth and nutrient utilization responses show that there were no significant (p>0.05) differences among the fish fed diets 1-4 (0-15% sweet potato leaf meal) but were significantly (p<0.05) different from fish fed on diet 5 (20% sweet potato leaf meal) which had lower growth and feed utilization values. There were no significant (p>0.05) differences in the carcass composition of *Tilapia zilli* fingerlings fed on experimental diets. The present findings show that sweet potato leaf meal has good potential for use as one of the protein sources in *Tilapia zilli* diet up to 15% level without compromising growth.

Key words: Sweet potato leaf meal, plant protein, feed utilization, growth, tilapia

Introduction

One of the problems facing the aquaculture industry today is the high cost of fish feed. Nutritionist all over the world are constantly searching for the dietary protein sources in which fish will maximize growth and increase production within the shortest possible time and at lowest cost. Leaf meals are one of the cheapest sources of proteins that may reduce the high cost of fish feed. Many studies have been conducted using various sources of leaf meal proteins (Ng and Wee 1989, on cassava leaf meal, Yousif *et al*., 1994 on Alfalfa, Reyes and Fermin, 2003 on *Carica papaya* and other leaf meal, Bairagi *et al*., 2004 on *Leucaena leucocephala*).

The sweet potato, *Ipomoea batatas* L. (Lam) belongs to the morning-glory family Convolvulaceae. It is cultivated in over 100 nations and ranks fifth among the most important food crops in the tropical areas (An, 2004). The leaves of this plant have been used in the tropics as a cheap protein sources in ruminant feeds.

Studies have been conducted to determine the nutritive value of sweet potato leaf meal. According to Woolfe (1992), Ali *et al*. (1999), Ishida *et al*. (2000), An (2004), Ekenyem and Madubuike (2006), the leaf meal has a high protein content of between 26 to 33%, with high amino acid score. It has good mineral profile and vitamins such as A, B_2, C and E. Aside from its nutritive values, sweet potato leaves can be harvested many times throughout the year (Hong *et al*., 2003) thereby making the leaf meal to be abundant. One major factor limiting the use of this leaf meal in fish feed is the presence of anti-nutritional factors (Tacon, 1993). The antinutritional substances present in the sweet potato leaves, according to Oyenuga (1968), are the invertase and protease inhibitors. These substances can be inactivated by various processing methods such as oven or sun-drying, boiling or steaming and grinding prior to inclusion in fish feeds.

Although, various leaf meals have been tested as potential fish feed ingredient to decrease diet cost, the use of sweet potato leaf meal has not been tested. It is against this background that the present study was designed, to evaluate the potentials of incorporating sweet potato leaf meal into the pelleted feed of *Tilapia zilli*, a widely culturable fish species in Africa. The objective of this work, therefore, was to determine the growth performance, feed utilization and carcass composition of *Tilapia zilli* fingerlings fed on graded levels of sweet potato leaf meal.

Materials and Methods

Collection and preparation of sweet potato leaf meal: Fresh leaves of sweet potatoes were collected from evergreen farms Idiroko road, Ogun State, Nigeria. The collected samples were washed thoroughly with tap water to remove dirt and debris, drained properly and later sun dried to a constant weight. The dried leaves were milled using a laboratory miller, packed in the freezer at-20°C until use.

Diet formulation and preparation: Five isonitrogenous and isocaloric diets were formulated to contain 30% crude protein. The sweet potato leaf meal was incorporated into each of these diets at 0, 5, 10, 15 and 20% to replace other protein ingredients in the diets. The diet containing 0% leaf meal serves as the control. Feed ingredients were weighed according to the gross composition table in Table 1. The ingredients were mixed together using a kitchen mixer before the addition of vitamin premix. Oil was later added to the dry ingredient and mixed thoroughly. Warm water was added to the premixed ingredients and homogenized until a dough-like paste was formed. The dough was passed through an improvised pelleting machine. The moist pellets were oven dried at 60°C to a constant weight and kept in air tight containers.

Experimental design and feeding trials: Fingerlings of *Tilapia zilli* were purchased from Animashaun fish farms, Badagry, Lagos, Nigeria. The fish were allowed to acclimatize for 10days, during this period, they were fed on commercial diet. Prior to the commencement of the experiment, all fish were starved for 24 hours. This practice was to eliminate variation in weight due to residue food in the gut and also to prepare the gastro intestinal tract for the experimental diets, while at the same time to increase the appetite of the fish.

The feeding trial was conducted in flow-through plastic aquaria each with 50L capacity of water. 150 fingerlings of initial mean weight of 2.13±0.85g were randomly allotted at the rate of 10 fingerlings per aquarium into five dietary groups designated Diet 1, Diet 2, Diet 3, Diet 4 and Diet 5 and each group was fed on 0, 5, 10, 15 and 20% sweet potato leaf meal respectively. Fish were fed on allotted experimental diets at 3% of their total body weight per day. Feedings were generally done in the mornings at 09:00 and 16:00 h. Except on weighting days when they were fed after weighing. All fish were reweighed every fortnight and feed weight was adjusted accordingly to accommodate for weight changes. For statistical reasons, each of the dietary group was triplicate. The experiment lasted for 56 days.

Digestibility study: The digestibility trial was conducted separately in static aquaria. Removal of the uneaten feed was done by siphoning. Faecal samples were then collected from the three replicates of each dietary treatment. The faeces were easily detected and immediately removed from the water with a glass canula and dried to a constant weight in an oven at 60°C (Ramachandran and Ray, 2007). Apparent digestibility coefficient for protein (ADC_P) was calculated according to Zhao *et al*. (2006).

$$\% ADCp = \frac{100 - (100 \times \% Cr2\,O3 \text{ in diet} \times \% \text{ protein in diet}}{\% Cr2\,O3 \text{ in faeces} \times \% \text{ protein in faeces.}}$$

Chemical analyses: Samples of sweet potato leaf meal, the experimental diets, faecal samples and experimental fish at the beginning and at the end of the feeding trial were subjected to proximate analyses. Moisture was obtained by drying the sample at 105°C in an oven until constant weight was achieved. Crude protein was determined by using the microkjeldah digestion method (N×6.25). Crude lipid content was done by soxhlet-extraction. Ash content was done by combustion in muffle furnace to constant weight at 550°C. Crude fiber was determined using the acid/base digestion process. Nitrogen Free Extract (NFE) was computed by taking the sum of values for crude protein, crude lipid, crude fiber and moisture and subtracting this from 100 (Maynard *et al*., 1979). All analyses followed the procedures of A.O.A.C (1990).

Water analyses: Water quality was monitored every week throughout the feeding trials. Temperature ranged between 26-28°C, dissolved oxygen 5.0-6.5mg/l and pH 6.5-7.3. These water parameters were within the recommended range for tilapia culture (Balarin and Halton, 1979).

Evaluation of growth and nutrient utilization parameters: Growth and nutrient utilization parameters were assessed in terms of body weight gain (WTG), Percentage Weight Gain (PWG), Specific Growth Rate (SGR), Food Conversion Ratio (FCR) Gross Food Conversion Efficiency (GFCE) and Protein Efficiency Ratio (PER). The following formulas were used.

WTG = Mean final body weight-mean initial body weight

$$PWG = \frac{\text{Mean weight gain}}{\text{Mean initial weight}} \times 100$$

$$SGR = \frac{\text{Log}_e\, W_2 - \text{Log}_e\, W_1}{T_2 - T_1} \times 100$$

Where W_2 = Weight of fish at time T_2 in days

W_1 = Weight of fish at time T_1 in days

Log_e = Natural log to base e

$$FCR = \frac{\text{Weight of dry feed fed (g)}}{\text{Live weight gain of fish (g)}}$$

$$PER = \frac{\text{Gain in weight of fish (g)}}{\text{Protein consumed (g)}}$$

Statistical analysis of data: All experimental data were subjected to the analysis of variance test (ANOVA) using Microsoft software STATISTICA followed by Duncan's multiple range test (Duncan, 1955).

Results

The result of the proximate analysis of the sweet potato leaf meal is presented in Table 2. Sweet potato leaf meal had a crude protein level of 23.57% crude fat 3.07, crude fiber 8.28%, total ash, 11.01% and 49.05% for nitrogen free extract.

Table 1: Gross composition of the experimental diets (%)

Ingredient	Diet 1 0%SPL	Diet 2 5%SPL	Diet 3 10%SPL	Diet 4 15%SPL	Diet 5 20%SPL
Yellow Maize	31.85	25.18	19.15	13.73	8.82
Groundnut cake	30.20	28.56	27.07	25.75	24.15
Fish meal	12.08	11.44	10.84	10.30	9.82
Sweet potato leaf meal	-	9.99	18.97	27.30	34.37
Soybean meal	18.12	17.13	16.26	15.43	14.73
Corn oil	5.00	5.00	5.00	5.00	5.00
Bone meal	1.00	1.00	1.00	1.00	1.00
Chromic Oxide	1.00	1.00	1.00	1.00	1.00
Vitamin premix	0.50	0.50	0.50	0.50	0.50
Sodium chloride	0.25	0.25	0.25	0.25	0.25

SPL = Sweet potato leaf meal

Table 2: Proximate composition of sweet potato (*Ipomoea batatas*) leaf meal

Nutrient	Percentage composition
Moisture	4.02
Crude protein	23.57
Crude fat	3.07
Crude fiber	8.28
Total Ash	11.01
Nitrogen Free Extract (NFE)	49.05

The growth performance and feed utilization efficiencies of *Tilapia zilli* fingerlings in terms of weight gain, specific growth rate feed conversion ratio and protein efficiency ratio are presented in Table 3. The mean final weight of the fish increased from the initial value in all the dietary treatments. *Tilapia zilli* fingerlings fed on Diet 1 had the highest weight gain while Diet 5 had the poorest weight gain. The general trend was that decreasing growth rate was observed with increasing inclusion level of sweet potato leaf meal in the experimental diets. However, there were no significant differences (p>0.05) in the weight gain of fingerlings fed Diet 1 with those fed on Diets 2, 3 and 4. Fingerlings fed on Diet 5 had significantly (p<0.05) lower weight gain than the other diets.

The FCR was lowest 1.53±0.20 in fish fed on Diet 1 and highest 3.8±1.76 in fish fed on Diet 5, however, FCR values were not significantly (p>0.05) different in all the diets except Diet 5 which was significantly (p<0.05) different from other diets.

The protein efficiency ratio were not significantly (p>0.05) different in Diets 1, 2, 3 and 4 but were all significantly (p<0.05) different from Diet 5. The apparent protein digestibility of the experimental diets by the tilapia fingerlings range from 75.39% in Diet 5 to 79.79% in Diet 1.

The results of carcass composition of *Tilapia zilli* fingerlings before the commencement of the feeding trials and at the end of the experiment are presented in Table 4. There were no significant (p>0.05) differences in the carcass composition of *Tilapia zilli* fingerlings fed on diets containing different levels of sweet potato leaf meal. However, the initial carcass composition of fish before the feeding trials had lower moisture, crude protein and crude lipid content than the final body composition of the fish.

Discussion

When alternative sources of feedstuff such as plant protein are used in fish diets, one of the common problems is the acceptability by fish and this has to do with the palatability of the diet (Rodriguez *et al*., 1996). In the present investigation, all the experimental diets were accepted by *Tilapia zilli* fingerlings, indicating that the levels of incorporation of sweet potato leaf meal did not affect the palatability of the diets. This might be due to the processing technique employed in this study. These drying and the grinding techniques might have reduced the antinutrient in the sweet potato leaf meal thereby increasing its palatability in *Tilapia Zilli.* This observation is in support of the work of Siddhuraju and Becker (2003), Francis *et al*. (2001) and Fagbenro (1999). These workers reported that reduction in antinutrient by different processing techniques resulted in better palatability and growth in fish.

The potentials of a feedstuff such as leaf meal in fish diets can be evaluated on the basis of its proximate chemical composition, which comprises the moisture content, crude protein, crude fibre, crude lipid, total ash and nitrogen- free extract. The proximate composition of sweet potato leaf meal in the present investigation revealed that the crude protein content was 23.57%, crude fibre 8.2% and ash 11.01%. These values were lower than the values reported by Woolfe (1992) and An (2004) for sweet potato leafmeal. These differences might be due to different environmental conditions such as soil type, harvesting time, local varieties and processing methods.

On the protein digestibility, the overall efficiency of *Tilapia zilli* fingerlings to digest protein in the experimental diets decreased as the level of sweet potato leafmeal increased in the diet. These values were in a close range (75.39-79.79%) and were not likely to be significant. This decreasing trend have been reported in diets containing black gram seedmeal (Ramachandran

Table 3: Mean growth and nutrient utilization parameters of *Tilapia zilli* fingerlings fed on experimental diets

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Initial weight (g)	2.34±0.28[a]	2.23±0.31[a]	2.09±0.18[a]	2.17±0.33[a]	2.14±0.29[a]
Final weight (g)	4.93±0.43[a]	4.67±0.48[a]	4.31±0.31[a]	4.36±0.64[a]	3.19±0.38[b]
Weight gain (g)	2.58±0.29[a]	2.45±0.46[a]	2.22±0.19[a]	2.19±0.34[a]	1.05±0.29[b]
Feed intake (g)	3.93±0.47[a]	3.74±0.52[a]	3.51±0.31[a]	3.64±0.56[a]	3.59±0.49[a]
(SGR)% day	1.69±0.19[a]	1.56±0.37[a]	1.42±0.15[a]	1.38±0.27[a]	0.01±0.57[b]
FCR	1.53±0.20[a]	1.60±0.47[a]	1.58±0.15[a]	1.67±0.15[a]	3.80±1.76[b]
PER	2.22±0.33[a]	2.23±0.58[a]	2.12±0.23[a]	2.00±0.19[a]	0.99±0.31[b]
[1]APD	79.79	77.62	77.02	75.63	75.34

Figures in the same row having similar superscript are not significantly different at p>0.05; [1]Statistical analysis not determined, as samples were pooled

Table 4: Proximate carcass composition of *Tilapia zilli* fingerlings at the start and end of the feeding trials

Carcass composition%	Initial fish	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5
Moisture	3.27±0.02[a]	5.26±0.20[a]	5.15±0.02[a]	5.10±0.20[a]	5.00±0.02[a]	5.20±0.01[a]
Crude protein	59.0±0.20[a]	62.13±0.20[a]	63.50±0.15[a]	63.0±0.13[a]	62.80±0.10[a]	63.00±0.10[a]
Crude lipid	5.13±0.15[a]	8.50±0.50[a]	8.45±0.50[a]	8.10±0.05[a]	8.00±0.40[a]	7.85±0.20[a]
Total ash	11.14±0.60[a]	11.28±0.40[a]	11.50±0.50[a]	10.85±0.40[a]	11.00±1.30[a]	11.20±0.25[a]

Figures in the same row having similar superscript are not significantly (p>0.05) different

and Ray, 2007) diets with leaf meal (Ray and Das, 1994; Bairagi *et al*., 2004) and diets with grass pea seed meal Ramachandran and Ray, 2004; Ramachandran *et al*., 2005). The reasons for this present observation might be due to high fibre content of leafmeal and the presence of protease inhibitor in sweet potato leaf meal (Oyenuga, 1968); decreased in proteolytic enzyme activity (Falge *et al*., 1978; Eusebio *et al*., 2004) and nutrient absorption (Shiau, 1997; Olivera-Novoa *et al*., 2002). Although the nutritional quality of sweet potato leaf meal as determined by Tilapia body weight gain, specific growth rate, food conversion ratio and protein efficiency ratio was higher in fish fed the control diet (0% leaf meal) no significant (p>0.05) differences were observed in other experimental diets containing leaf meal up to 15% level. To date, there is no published information on the incorporation of sweet potato leaf meal in fish diets, available information on other leaf meals revealed that 1pil-1pil, *Leucaema leucocephala* leaf meal in the diets of *Oreochromis niloticus* at 12.5% inclusion did not affect growth, however, at high levels of inclusion, 25% or more, the growth of *O. niloticus* was adversely affected (Santiago *et al*., 1988). In the present investigation, inclusion of sweet potato leaf meal at 20% level reduced the growth rate and feed utilization of *Tilapia zilli* fingerlings.

Fasakin *et al*. (1999) reported that 30% inclusion of duckweed, *Spirodela polyrrhiza* in the diet of *O. niloticus* supported growth. Ritcher *el al*. (2003) reported that *Moringa oleifera* leaf meal could replace 10% fish meal based dietary protein for Tilapia without causing any adverse effect on fish growth.

However, Afuang *et al*. (2003) reported that solvent-extracted moringa leafmeal could replace 30% of fish meal from *O. niloticus* diets. These various workers have shown that leaf meal protein at low levels of inclusion (less than 50%) in fish diets were able to support growth, therefore, supporting the results of this study.

The proximate carcass composition data of *Tilapia zilli* fingerlings showed insignificant (p>0.05) differences in fish fed diets containing different levels of sweet potato leaf meal, these amount however increased more than the initial values. This observation is in accordance with the report of Ramachandran and Ray (2004). The body moisture and crude protein content were similar in all the experimental groups, but there were reductions in the body lipid of fish fed on sweet potato leaf meal. The reason here might be due to the reduction of the level of fishmeal lipid as the level of sweet potato leafmeal increased in the diets. This is in agreement with the results of Siddhuraju and Becker (2001) and Afuang *et al*. (2003) who observed similar reductions in body lipid of fish fed on diets containing plant-based proteins.

In conclusion, the results of this study show that sweet potato leaf meal could be included up to 15% level in Tilapia zilli diets without any negative effects on the growth and feed efficiency. Furthermore, sweet potato leaves are locally available in the tropics and can be obtained throughout the year.

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