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Nutritive Potential of Sweet Potato Peel Meal and Root Replacement Value for Maize in Diets of African Catfish (*Clarias gariepinus*) Advanced Fry

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Abstract: This study was carried out to evaluate the potential of Sweet Potato Peel (SPP) meal as a cheaper replacement for maize in the diet of *Clarias gariepinus.* Triplicate groups of 20 fish per plastic tank with average weight of 0.64±0.1 g per fish were fed four (4) diets, which were formulated to contain graded levels of sweet potato peel meal replacing 0, 25, 50 and 75 % of maize. The feeding trial lasted 6 weeks. The results showed that the diets did not significantly ($p<0.05$) affect fish performance within the treatments. Percentage Weight Gain (PWG) was 101.54% in fish fed with the control diet (0% sweet potato peel meal). The highest (PWG) of 150.77% was recorded in fish fed diets containing 25% sweet potato peel meal followed by a consistent decrease in PWG with increasing inclusion of sweet potato peels meal. However, diets containing 25, 50 and 75% SPP meal performed better than the control experiment with PWG of 150.77, 132.31 and 127.6%, respectively. The highest Feed Conversion Efficiency (FCE) was observed in the diet containing 25% SPP meal. A steady decrease in FCE was observed with increasing inclusion of SPP meal at 50 and 75%. Meanwhile, all the diets with SPP meal inclusion performed better than the control diet containing 0% SPP. The data indicated that *Clarias gariepinus* effectively tolerated diets containing sweet potato peel meal at low levels of concentration while fish growth performance and utilization decreased with increase in the sweet potato peel meal inclusion. The SPP meal based diets were cheaper than the control diet. The consequent better FCE and PWG of fish fed SPP diets showed that cost can be reduced while maintaining a high yield.

Key words: Sweet potato, *Clarias gariepinus,* diet, growth, utilization, incidence of cost

INTRODUCTION

Clarias gariepinus is one of the most important catfish species farmed in aquaculture in Africa and especially Nigeria. The need to intensify the culture of fish to meet the ever increasing demand for fish has made it essential to develop suitable diets either in supplementary forms for ponds or as complete feed in tanks and raceways.

For the purpose of nutritional and economic benefits previous researches have made attempts in recent times to increase the use of non conventional plant and animal materials to replace conventional feed ingredients like maize and fishmeal in livestock and fish feed ration[1-4]. The possibilities of designing practical fish diets with the use of plant feedstuffs have been reported[5,6]. The development of the fish feed processing industry will encourage the profitable use of some plant and animal products, which are presently discarded as wastes.

Potential uses of sweet potato as human food in nigeria: In Africa, Sweet Potato (SP) is used for human food. It provides good ground cover on soils with limited facilities. In Nigeria, the tubers are boiled, baked, fried and eaten fresh. It is drought resistant and the roots and leaves are sources of carbohydrates, proteins and minerals. Infants, young children and adults are usually encouraged to eat more orange fresh sweet potato, to protect them against blindness. SP contains adequate amount of calories in form vitamin B and vitamin C as well as useful amount of other micronutrients such as iron.

In Nigeria, there is little commercial sweet potato processing. More than average of the SP produced is boiled, fried or roasted. Other SP products in Nigeria include sweet potato chips, sweet potato starch, sweet potato puff-puff, chin-chin and cake. Sweet potato has a high nutrient yield per hectare per day: It is drought tolerant and it has a high ability to withstand typhoon conditions[7]. It is however, acceptable to consumers due to its palatability and low cost.

Sweet potato is a minor crop in Nigeria; hence its consumption is mainly directed to table use. Its growth require low amount of fertilizers and it can withstand stressful environmental conditions. Sweet Potato Peel (SPP) is a by-product often discarded as waste. Several metric tones of SPP could be available worldwide for use as animal feed if given relevant attention. The chemical composition of SP varies with the variety, soil, cultivars, climatic conditions, time of harvest, degree of maturity, soil fertility especially nitrogen fertilization, rate of growth of root and vine and also yearly variation, condition of handling after harvest (i.e., method of processing) and storage.

The carbohydrate of SP is highly digestible and soluble. It is low in fiber and consists predominantly of starch with 4-7% of it occurring as sugar[81].

The protein of SP has been found to be low and consists to a large extent of non-protein nitrogen[9]. Protein content of sweet potato root collected from North Carolina was determined and protein content ranged from 0.14-1.73% dry basis. Japanese cultivar has 9% protein but worldwide report vary from 2.46-11.85. The amino acid composition of SP has been observed to be short in trytophane and total sulphur amino acids when compared to the reference amino acid profile[10].

Sweet potato is moderately high in ascorbic acid, carotene and also contains other vitamins such as thiamin, riboflavin and niacin. The nutritive quality of SP is tremendously reduced by anti-nutritional factors in the roots. The effects of this anti-nutritional factors range from binding of nutrients in SP, introduction of bad taste and paralysis to domestic animals and at times death. This anti-nutritional factors include tannins, phytins, oxalates and solanines. However they can be reduced to the barest minimum in feed by the methods of processing applied which include oven drying and sun drying.

In view of the increasing demand for fish, the high cost of conventional feed ingredients, the competition for maize by both human beings and animals and the international concern for conservation of resources, it was necessary to investigate the possibility of using sweet potato peel in fish as a partial replacement for maize.

This study therefore focused on evaluating the effect of the substitution of maize with increasing levels of SPP meal on the growth performance of *Clarias gariepinus* advanced fry.

MATERIALS AND METHODS

The feeding trial was carried out between February and April 2005 for a period of 6 weeks. *Clarias gariepinus* with an average weight of 0.64±0.1 g was obtained from a reliable commercial farm in Ibadan and transferred to the University of Ibadan fisheries laboratory and acclimatized for a week. The advanced fry were fed on a 48% crude protein formulated diet during the acclimatization period. The experiment was carried out using plastic tanks that contained 10 liters of water each, with 100% water change daily and water quality parameters was monitored[11].

Sun drying processed sweet potato peels. The dried peels were subsequently milled and sieved to obtain a fine particle sized product. Starch made from local pap was added as a binder. All other ingredients were mixed thoroughly with groundnut oil, processed into a paste by adding hot water at 90°C and pelleted using a pelleting machine. The resulting pellets were then sun dried to prevent fungal growth and the feed was sieved to obtain finer feed size.

The four diets were prepared in a way that SPP replaced maize progressively at 0, 25, 50 and 75%, respectively. *Clarias gariepinus* advance fry were distributed randomly at a stocking density of 20 fish per tank. Treatments were in triplicate and were randomly arranged. They were fed 5% of their body weight daily. Fish from each tank were weighed weekly and corresponding adjustments made in the amount of feed fed. Proximate analyses of the diets and fish carcass before and after the experiment were also carried out. The feed utilization efficiencies were calculated as follows:-

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Total Feed Fed}}{\text{Total wet weight gain}}$$

$$\text{Food Conversion Efficiency (FCE)} = \frac{\text{Weight gain x 100}}{\text{Feed intake}}$$

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Wet weight gain}}{\text{Amount of protein fed}}$$

COST ANALYSIS

The cost analysis was calculated for profit index and incidence of cost. Parameters used were; value of fish and

Table 1: Composition of experimental diets (%)

Ingredients	0% SPP 1	25%SPP 2	50% SPP 3	75% SPP 4
Maize	14.47	10.85	7.24	3.62
Sweet potato peels	-	5.72	11.74	17.14
Wheat offal	6.29	4.19	2.08	-
Fish meal	38.12	38.12	38.12	38.12
Soya bean meal	38.12	38.12	38.12	38.12
Vegetable oil	1.0	1.0	1.0	1.0
Min/Vit premix	0.5	0.5	0.5	0.5
Salt	0.5	0.5	0.5	0.5
Binder	1.0	1.0	1.0	1.0
Total	100	100	100	100

Vit/Min. premix supplies 100g per diet: Palmitate (A). 1000IU: Cholecalciferol (D3), 100 IU; a – tocopherol acetate (E), 1.0 mg; menadione (K), 0.2mg; thiamine (B), 0.63mg: riboflavin (B2), 0.5mg pantothenic acid, 0.9 mg: pyridoxine (B6), 0.15 mg; cyanobalamine (B12), 0.01 mg; nicotinic acid, 30 mg; folic acid, 0.1 mg: choline, 3.13 mg; ascorbic acid, 2.5 mg; Fe. 0.05 mg; Mn. 6.0 mg; Co, 0.05 mg; Zn, 5.0 mg; 1.0.25 mg; S,0.02 mg

Table 2: Proximate composition of the experimental diets (% dry weight)

Treatment	CP (%)	Fat (%)	Crude (%)	Ash (%)	Moisture content (%)
Diets 1	42.29^{a}	0.68^{ab}	16.25^{b}	18.28^{c}	13.13^{c}
Diets 2	41.44^{a}	0.77^{a}	18.31^{ab}	21.34^{b}	14.64^{bc}
Diets 3	40.38^{ab}	0.51^{b}	19.07^{a}	22.71^{ab}	14.95^{ab}
Diets 4	39.81^{b}	0.43^{c}	19.66^{a}	23.19^{a}	15.13^{a}

Means in the same column with different superscripts are significantly different ($p<0.05$)

kilograms of fish produced. The cost 1kg of fish is taken to be N 250.00 (Approximately £1.00).

Data obtained were analyzed statistically in one way ANOVA followed by the Least Significant Difference (LSD) test for a comparison among treatment means where need be.

RESULTS AND DISCUSSION

The mean of the water quality parameters are presented in Table 3. All diets were accepted by the fish and they ingested the feeds actively throughout the trial period.

The feeding trial lasted 6 weeks. The diets did not significantly ($p<0.05$) affect fish performance when the level of significance within the treatments were considered using the LSD test. Percentage Weight Gain (PWG) was 101.54% in fish fed the control diet (0% sweet potato peel meal). The highest percentage weight gain of 150.77% was recorded in fish fed with diets containing 25% sweet potato peel meal followed by a consistent decrease in PWG with increasing inclusion of sweet potato peel meal. However diets containing 50 and 75% sweet potato peel meal performed better than the control experiment with PWG of 132.31 and 127.69%.

The highest Feed Conversion Efficiency (FCE), SGR and PER were observed in diets containing 25% SPP meal and a constant decrease in these growth parameters was noticed with further inclusion of SPP meal (Table 5). The data indicated that *Clarias gariepinus* effectively tolerated diets containing sweet potato peel meal at low level of concentration while fish performances and utilization decreased with increase in sweet potato peel meal inclusion.

This study revealed that SPP could replace up to 75% maize in the diets of *C. gariepinus* without adversely affecting the growth and health status of the fish. The decrease in the PWG, SGR and the PER of the experimental fish with the increasing content of SPP meal, however, indicates that SPP meal utilization efficiency decreases at higher levels of inclusion. The effect of plantain peel meal on the growth of goats and also (Falaye and Oloruntuyi[12]) on the nutritive potential of plantain peel meal and replacement value for maize in diets of African Catfish (*Clarias gariepinus)* It was observed that increased supplementation of maize with plantain peel meal caused reduction in the growth rate of goats. The PWG of fishes fed the experimental diets is shown in Fig. 1. The graph in Fig. 1 confirms diet 2 to have optimum growth performance and utilization out of all the experimental diets.

Previous studies have shown that other non-conventional feedstuffs could be used as carbohydrate sources in fish feeds with potential for supplying energy and saving protein[2,3,5,6,12]. All these authors emphasized the usefulness of non conventional feed stuffs in fish diets. However, they observed that certain factors such as palatability, energy level, composition and digestibility, availability of nutrients and cost of feed procurement determine how far they affect the growth performance of the test organisms.

Table 3: Result of water quality analysis for the duration of the experiment

Parameters	
Calcium	76-96 mg L^{-1}
Alkalinity	16-18 mg L^{-1}
Dissolved oxygen	2.5-4 mg L^{-1}
Temperature	26-28°C
PH	6.7-7.0
Carbon (iv) Oxide (mg L^{-1})	12.5-14.6

Table 4: Proximate Composition of Experimental Fish (% dry weight)

Treatment	CP (%)	Fat (%)	Crude Fibre (%)	Ash (%)	Moisture Content (%)
Fish before Experiment	43.98	4.33	1.23	30.36	10.01
Fish after Experiment					
Treatment 1	63.20	3.18	1.06	15.28	8.31
Treatment 2	61.15	3.96	1.02	14.89	9.13
Treatment 3	60.55	4.14	1.11	15.13	8.44
Treatment 4	59.93	4.07	1.08	15.09	8.16

Table 5: Growth evaluation of experimental fish fed diets containing increasing inclusion levels of SPP meal

	Diet			
Parameters	1	2	3	4
Initial mean weight (g)	0.65	0.64	0.66	0.66
Final mean weight (g)	1.31	1.63	1.51	1.48
Final mean weight (g)	0.66	0.99	0.85	0.82
Percentage weight gain (%)	50.38	60.74	56.29	55.41
Total feed fed (g)	109.55	123.02	118.42	115.96
Specific growth rate	1.63	1.19	1.37	1.41
Feed Gain Ratio (FGR)	3.82	3.07	3.31	3.38
Protein Efficiency Ratio (PER)	0.032	0.050	0.042	0.041

Source: Field survey

Table 6: Cost analysis

	Diet			
	Diet 1	Diet2	Diet 3	Diet 4
Cost of feed fed (N)	37.43^{b}	41.33^{a}	39.15^{a}	37.71^{ab}
Value of fish (N)	6.55^{bc}	8.15^{a}	7.55^{ab}	7.4^{b}
Kg of fish produced	0.0655^{bc}	0.0815^{a}	0.0755^{ab}	0.0744^{b}
Profit Index	0.1750^{bc}	0.1972^{a}	0.1928^{ab}	0.1962^{a}
Incidence of cost	571.45^{bc}	507.12^{a}	518.54^{ab}	506.85^{a}

Means in the same row with different superscripts are significantly different ($p<0.05$)

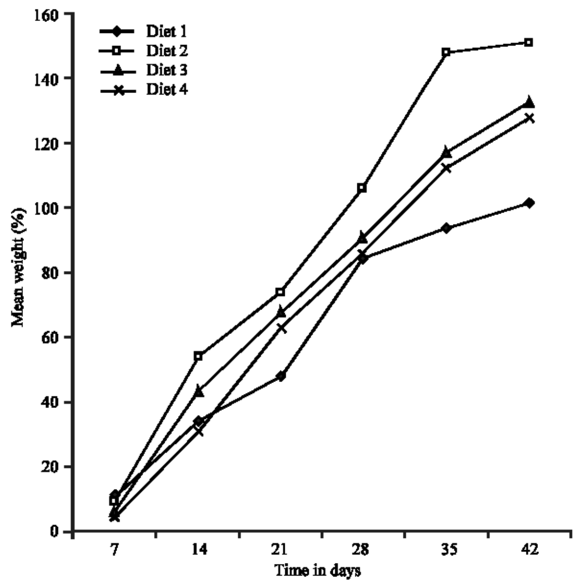

Fig. 1: Mean weight (%) gained by experimental fish fed the treatment diets over 6 weeks

Maize and SPP have different protein levels[8,13]. Maize contains 10% Crude Protein (CP) while Sweet potato has 6.3% CP; however, a conversion factor of 1.8 was used in the diets to make them iso-proteinous and iso caloric.

Table 4 above shows that the higher the incidence of cost the lower the profit index. Diet 4 had the lowest incidence of cost followed insignificantly different (p = 0.05) from diet 2 and diet 3 while diet 1 has the highest incidence of cost. This observation agrees with observations of previous researches where the addition of non-convectional feedstuff reduces the incident cost of feed (Olukunle[2]), (Falaye and Oloruntuyi[12]).

The statistical analysis employed (Completely Randomized Design) showed that there is no significant effect (p<0.0.5) on the carcass composition of *Clarias gariepinus* at the end of the feeding trial. The higher level of carcass protein observed in the treatments may have been due to the better digestibility, utilization and retention of nutrients by the experimental fish, when fed with reduced amounts of SPP.

CONCLUSION

The study reveals the possibility of the utilization of SPP meal in the practical diets of advanced fry of Clarias *gariepinus*. The good performances of fish fed diets containing SPP meal inclusion showed that fish production can be increased by substituting SPP for maize in the diets of *Clarias gariepinus* advanced fry at 25, 50 and 75%, respectively. However, when the cost of the diet, the mean weight gain (Fig. 1), the FGR and the PER (Table 5) is to be considered a substitution level of 25% of SPP for maize is cost effective (Table 6) and nutritionally a better choice.

The reduced costs of diets containing SPP meal also showed that the cost of feed which accounts for a gross percentage of the running cost of any farm (60%) could be reduced to increase profit by approximately 11.3% while still maintaining increase in fish yield.

There are numerous feedstuffs available out of which many have potentials as ingredients in fish feed manufacture but their nutrient composition, relatively cheaper cost and availability should be considered in selecting feedstuffs for each species at different phases of their development. The processing methods, cost, the problems of handling and storage would also affect the selection of feedstuffs for fish diet preparation.

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