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Evaluation of fermented pineapple (*Ananas comosus*) peel meal as a substitute for maize meal in the diet of Nile tilapia, *Oreochromis niloticus*

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Abstract

A feeding trial was conducted to investigate the effect of fermented pineapple peel meal (FPM) on Nile tilapia, Oreochromis niloticus fingerlings. One hundred and eighty (180) fingerlings of Nile tilapia (1.35±0.13g) were stocked and fed at 5% body weight per day for 56 days. Four iso-nitrogenous diets containing 35% crude protein in which corn meal was replaced by fermented pineapple peel meal at 0% (FPM0), 25% (FPM25), 50% (FPM50) and 75% (FPM75) were formulated and prepared. There was no significant difference (p>0.05) in growth, nutrient utilization, survival, protein digestibility and blood parameters between the fish fed the reference diet (FPM0) and fish fed diet FPM75. Weight gain (3.57g) was highest in fish fed diet FPM75 and lowest (2.18g) in fish fed diet FPM50. Feed conversion ratio was lowest (1.70) in fish fed diet FPM25 and highest (1.77) in fish fed diet FPM50 while protein efficiency ratio was highest in fish fed diets FPM0 (1.22) and lowest (I.03) in fish fed diet FPM50.Highest value of packed cell volume (36.33%) was in fish fed diet FPM25 while the lowest value (33.00%) was recorded in fish fed diet FPM75. From the above results therefore, yellow maize could be replaced with fermented pineapple peel meal at 75% level in the diet of Nile tilapia, Oreochromis niloticus without affecting fish growth, nutrient utilisation, protein digestibility and the blood profile.

Keywords: Pineapple peel, Nile tilapia, Digestibility, blood profile

Introduction

In the last decade, aquaculture production has increased and is expected to continue expanding as the need for cost-effective and sustainable feed increases. Alternative high quality ingredient sources are needed to fully or partially replace conventional feed ingredients. According to Okoye and Sule (2001), nutrient values estimated from locally available conventional and non-conventional plant sources are high and would appear to justify continuous investigation of their nutritional potentials to enhance economic fish production.

A major source of metabolizable energy in many formulated diets for fish and livestock is maize (Balogun and Fagbenro, 1995). However, the increasing prohibitive cost of this commodity as a result of its many competing uses (especially in developing African countries) and the decline in recent years in the local production of maize have led to attempts to replace or supplement the maize component of fish feed with cheaper non conventional energy sources. Previous attempts include cassava (Olurin *et al,* 2006), plantain peels (Falaye and Oloruntuyi, 1998) and tigernut (*Cyperus esculentus*) meal (Alatise *et al* 2006).

Pineapple is a common name for a tropical plant and its edible fruit. It can be grown as an ornamental, especially from the leafy tops. Pineapple contains 15% sugar, malic and citric fruit acid. It is rich in vitamins B1, B2, B6 and C and a protein digesting enzyme called bromelain (Hebber *et al* 2008). The peel is a by–product resulting from pineapple processing whose disposal can result in environmental pollution. However, it has the potential of being turned to wealth. Pineapple peel was ensiled to produce methane which can be used as a biogas. Anaerobic digestion takes place and the digested slurry may find further application as animal, poultry and fish feeds (Rani and Nand, 2004). It is rich in cellulose, hemi cellulose and other carbohydrates. These make the pineapple peel a good source of metabolizable energy for both livestock and fish. Thus, the need to evaluate its utilisation as a substitute for maize in the diets and implication on the health of *O. niloticus* fingerlings.

Materials and methods

The feeding trial was conducted in 12 plastic tanks (40 litres) in hatchery complex of the Federal University of Agriculture, Abeokuta. The tanks were filled to 2/3 of its volume with water supplied from the university's water reservoir. To sustain optimal environment and to preclude primary productivity, the water was introduced in a splash for better aeration. The system was continuously flushed with freshwater through outflow pipes from the bowls.

One hundred and eighty all- male Nile Tilapia, ***Oreochromis niloticus*** *(mean weight* 1.39±1.96g) fingerlings were obtained from a reputable hatchery in Ibadan, Nigeria. The fish were transferred to the hatchery complex of the University of Agriculture, Abeokuta and acclimatized for two weeks.

Four iso-nitrogeneous diets (35.00% crude protein) in which maize (10.81% crude protein) was replaced by pineapple peel meal (6.84% crude protein) (Table 1) at 0% (FPM0), 25% (FPM25), 50% (FPM50), and 75% (FPM75) were formulated and prepared. Chromium III oxide (Cr_2O_3) was used at 0.50% in all the experimental diets as the external marker to determine the digestibility coefficient of nutrients in the diets. The entire feed ingredients (Table 2) except the pineapple peel were obtained from a local feed mill. Pineapple peels were obtained from a local market as a discard, oven-dried at 80° C for 12hours, milled and then fermented.

Fermented meal was prepared by mixing

Table 1. Proximate composition (%) of experimental ingredients

Samples	Crude Protein	Moisture	Fat	Crude Fibre	Ash	NFE[1]	ME[2] (Kcal/100g)
Pineapple Peel	6.84	11.32	3.12	9.24	1.21	68.27	328.52
Maize	10.81	10.73	5.50	1.40	3.40	68.16	365.50

[1]Nitrogen free extract

[2] Metabolizable energy was calculated by using the physiological equivalent factors where 1g of CP, Lipid/EE and NFE (Carbohydrate) yields 4.0, 9.0 and 4.0 kcal/g respectively (Lee and Putnam, 1973)

Table 2: Composition (% dry matter) of the experimental diets

Ingredients	FPM0	FPM25	FPM50	FPM75
Fermented Pineapple Peels	-	8.14	16.43	24.13
Fishmeal	19.98	19.88	19.74	19.68
Soybean Meal	19.98	19.88	19.74	19.68
Groundnut Cake	19.98	19.88	19.74	19.68
Maize	32.25	24.41	16.43	8.29
Vitamin C	0.50	0.50	0.50	0.50
Vitamins / Minerals Premix	1.00	1.00	1.00	1.00
Di Calcium Phosphate	0.50	0.50	0.50	0.50
Fats & Oil	5.00	5.00	5.00	5.00
Mineral Salt	0.30	0.30	0.30	0.30
Chromic Oxide	0.50	0.50	0.50	0.50
Analyzed Composition				
Moisture (%)	8.76	8.63	9.12	8.67
Lipid	5.66	5.47	4.96	4.78
Ash	11.49	11.37	11.74	11.44
Crude Fibre	3.23	3.46	3.69	3.81
Crude Protein	34.87	35.26	34.69	35.37
Nitrogen free extract	36.59	36.32	35.59	35.45
*ME (Kcal/100g)	336.78	335.55	325.76	327.10
Energy/protein ratio	9.62	9.59	9.31	9.25

*RADAR VIT. PREMIX supplies per 100 g diet. Palmitate (A) 1000 IU; cholecaciferol (D) 1000 IU; a- tocopherol acetate (E) 1.1 mg; Menadione (K) 0.2 mg; Thiamine (BI) 0.63 mg; Riboflavin (B2) 0.5 mg; panthothenic acid, 0.9 mg; Pyridoxine (B6) 0.15 mg; Cyanocobalamine (B12), 0.001 mg: Nicotinic acid 3.0 mg; Folic acid 0.1 mg; Choline 31.3 mg; Ascobic acid (C), 2.5 mg; Fe, 0.05 mg; Cu 0.25 mg Mn 6.0 mg; Co, 0.5 mg; Zn 5.0 mg; I, 0.2 mg; S, 0.02 mg.

* Metabolizable energy was calculated by using the physiological equivalent factors where 1g of CP, Lipid/EE and NFE (Carbohydrate) yields 4.0, 9.0 and 4.0 kcal/g respectively (Lee and Putnam, 1973)

the pineapple peel meal with water in a ratio 1:1 (weight per volume) and allowed to ferment at room temperature (28-30ºC) for 48h, after which the pH reduced to a stabilized level (3.71). The temperature of the fermented pineapple peel meal was taken at 12h intervals using thermometer model 2751-K.

The fermented pineapple peels meal was sundried for 48h after which all the ingredients were milled with hammer mill and sieved using a 595µm size sieve to remove chaff and ensure homogenous size profile. The ingredients for each diet were mixed thoroughly in a bowl and pelletized with a locally fabricated manually operated pelletizer. The moist pellets were oven-dried at 80℃ for 12h, packaged in tagged air-tight polythene bags and stored in a dry place at room temperature.

The acclimatized Nile tilapia fingerlings were randomly stocked into 12 plastic tanks at the rate of 15 fingerlings per tank. There were four treatments and each treatment was replicated thrice. The experimental fish were fed the experimental diets twice daily at 5% of total biomass, between the hours of 07:00 and 08:00 then 16:00 and 17:00 for ten weeks. Fish were batch weighted weekly with a sensitive electronic balance (METTLER TOLEDO, PB602). Water temperature (^{0}C) was monitored daily using mercury-in glass thermometer; dissolved oxygen (DO) was measured using Jenway DO meter model 9071 while the pH was measured using glass electrode pH meter (E520) metrolin model. Ammonia and alkalinity were monitored by the titrimetric determination of total

Table 3: Proximate composition (%dry matter) of the experimental fish carcass

Parameter	Initial	FPM0	FPM25	FPM50	FPM75
Crude protein	48.5±3.15	55.48±4.33	53.75±5.87	57.88±6.22	59.39±6.82
Moisture	9.55±1.02	8.62±1.05	8.73±1.06	8.22±1.91	8.71±1.02
Fat	6.57±0.62	7.88±0.76	8.15±1.43	7.72±0.22	7.67±0.75
Ash(%)	11.51±1.24	11.56±1.52	11.78±1.05	11.61±1.55	12.59±1.56

alkalinity (Thomas and Lynch, 1960).

At the beginning of the feeding trial, composite samples of ten whole fish and a random sample of five fish per aquarium at the end of the 56 days experimental period were analyzed for proximate composition. Nitrogen content was determined by A.O.A.C. (1990) methods and the factor of 6.25 was used to convert the nitrogen to protein. Also, A.O.A.C. (1990) method was used for the analyses of fat, fibre, ash and moisture contents of the diets and composite fish samples. Blood samples for analyses were collected from the caudal peduncle with a fine (needle) syringe and drawn into heamatocrit bottle for analysis. Analysis for the following blood parameters: erythrocyte counts (RBC), white blood cell count (WBC) and pack cell volume were carried out according to Blaxhall and Dalsey (1973). Heamoglobin was according to Roberts (1978) while, mean corpuscular volume (MCV) mean corpuscular heamoglobin concentration (MCHC) and mean corpuscular heamoglobin (MCH) were analyzed according to Meyer et al 1992. Diet performance was evaluated on experimental fish according to Olivera *et al* (1990). Statistical comparisons of growth performance and protein utilization and haematological values were made by using analysis of variance (ANOVA) system (SAS 1988). Differences among means were also tested for significance ($P<0.05$) using Duncan Multiple Range Test (DMRT).

Results

Result of the water quality parameters of the culture system monitored during the course of the feeding trial showed that the pH ranged between 7.19 and 7.25, dissolved oxygen 6.70 and 7.66 mgl^{-1} litre and temperature 22.8.3 and 29.20 ℃. NH_3 0.16 and $0.45mgl^{-1}$ and Alkalinity 153 and 175 mgl^{-1}

Table 3 shows the proximate composition of the experimental fish carcass.

The growth, nutrient utilization and digestibility of ***O. niloticus*** fingerlings fed the experimental diets are presented in Table 4. Mean weight gain was highest (8.57g) in fish fed diet FPM75 but not significantly different ($p>0.05$) from 8.12g of fish fed diet FPM0. Likewise, there was no significant difference ($p>0.05$) between the lowest (1.70) feed conversion ratio recorded in fish fed diet FPM25 and the highest (1.77) in fish fed diet FPM50.

The result of the blood parameters of ***Oreochromis niloticus*** fed various levels of FPM based diets is presented in Table 5. All the blood parameters measured were consistently numerically higher but not significantly different ($p>0.05$) in fish fed diet FPM25 and lowest in fish fed diet FPM75.

Discussion

The observed water quality parameters in this study were probably due to constant water exchange of the culture system. The values of the calculated ME and energy/protein ratio in all the diets are

Table 4: Growth, nutrient utilization and digestibility of all-male O. niloticus fingerlings fed varying levels of fermented pineapple peel meal based diets

Parameters	FPM0	FPM25	FPM50	FPM75
Initial mean weight (g)	1.31± 0.26	1.38 ±0. 23	1.52 ± 0.09	1.45 ± 0.07
Final mean weight (g)	9.43 ± 0.71	9.64± 0.27	9.70 ±0.31	10.02 ± 0.41
Mean weight gain (g)	8.12 ±0. 60	8.26 ±0. 40	8.18 ±0.30	8.57 ±0.48
% weight gain	619.85±38.22	598.55±46.35	538.16±69.32	591.03±36.47
Specific growth rate	2.36 ± 0.41	2.21 ± 0.38	2.05 ± 0.15	2.25 ± 0.22
Feed intake (g)	10.38 ±1.02	10.53 ±0.77	10.81 ±1.22	11.02 ±0.88
Feed Conversion ratio	1.73 ± 0.53	1.70 ± 0.43	1.77 ± 0.29	1.73 ± 0.30
Daily Growth Rate	0.58 ± 0.12	0.58 ± 0.08	0.57 ± 0.05	0.64 ± 0.08
Protein Efficiency ratio	1.22 ± 0.31	1.10 ± 0.19	1.03 ± 0.19	1.12 ± 0.18
Survival (%)	100±0.00	100±0.00	100±0.00	100±0.00
Net Protein Utilization (%)	19.81±1.23	16.93±1.05	25.86±2.35	29.67±4.31
$ADC_{Protein}$	70.35	82.82	73.60	83.21

NOTE: values without common superscripts in horizontal rows are significantly different (P<0.005)

within the generally acceptable ranges for fish culture. Hastings (1979) stated that generally, foods containing less than 3000kcal/kg or 300kcal/100g are low in gross food efficiency, for they contain low fat and high fibre ingredients. He further suggested that a rule of thumbs on gross physiological energy content in fish feed is to provide not less than 8kcal/kg protein in the diet.

The result of growth and nutrient utilization of *O. niloticus* obtained in this study is similar to that obtained by Alatise (2011). He observed that corn meal could be replaced with mango seed meal at 50% level in the diet of *O. niloticus*. The increase in growth and nutrient utilization indices as pineapple peel meal increased in the diet as observed in this study could be due partly to the presence of bromelain, the protein digesting enzyme in pineapple coupled with the presence of sugar which is the form of carbohydrate in pineapple (Hebber *et al* 2008). Furthermore, Edwin and Meng (1996) stated that although tilapia uses carbohydrate efficiently, but sugar such as glucose and sucrose are more efficiently utilized by tilapia. Tilapia is also said to be significantly more efficient than channel catfish in the digestion of more complex carbohydrate in highly fibrous feedstuff (Thomas and Leonard 1995).

The increase in protein digestibility as

Table 5: Haematological profile of Oreochromis niloticus fingerling fed pineapple peel meal based diets

Parameters	Initial	FPM0	FPM25	FPM50	FPM75
PCV (%)	31	34.00 ± 2.80	36.00 ± 2.51	34.00 ± 2.08	33.00 ± 4.35
HB (g/dl)	10.3	11.36 ± 0.40	12.16 ±0.86	11.33 ±0.68	11.10±1.47
RBC(million/mm^3)	3.5	3.80 ±0.10	4.03 ±0.35	3.76±0.28	3.73±0.49
WBC(10^6/l)	5.600	5.33±0.31	5.40±1.36	5.27±1.15	5.33±1.41
Glucose(mg/dl)	60	63.33±2.88	66.00±5.00	63.33±5.77	61.66±7.63
Total protein(mg/dl)	50	54.33±1.52	58.33±3.51	54.09±4.35	52.66±6.4

NOTE: values without common superscripts in horizontal rows are significantly different (P<0.005)

. PCV - Pack Cell Volume, Hb - Haemoglobin, RBC - Red Blood Count, WBC - White Blood Count pineapple peel meal increased in diet recorded in this study is in contrast to that obtained by Alatise (2011). He recorded lowering protein digestibility as mango seed meal increased in diet. This buttresses the assertion of Hebber *et al* (2008) of the presence of bromelain, a protein digesting enzyme present in pineapple which probably caused the increase in protein digestibility as FPM increased in the diet.

Blood cells responses are important indicators of changes in internal and/or external environment of the animals (Golovina 1996). Thus, the absence of significant difference (p>0.05) in the blood parameters of *C. gariepinus* fingerlings fed FPM based diets is an indication that the inclusion of FPM at level up to 75% did not negatively affect the health status of *C. gariepinus* fingerlings. Result obtained in this study is however similar to the result obtained by Brucka-Jastrzebska and Protasowicki (2005). They subjected common carp *(Cyprinus carpio)* to cadmium and nickel exposure for a prolonged period. Although, there was initial erythrocyte system dysfunction as evidenced by haemolytic anaemia observed at the onset of the experiment. This was later followed by a return of homeostasis and levelling off of the haematological parameters at 14 or 30 days after injection. It could therefore be concluded that maize could be replaced at 75% level by fermented pineapple peel meal without affecting growth, nutrient utilisation, digestibility and the blood profile of Nile tilapia, *O. niloticus* fingerlings.

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