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EVALUATION OF FERMENTED MANGO *(Mangifera indica)* SEED MEAL IN THE PRACTICAL DIET OF NILE TILAPIA, *(Oreochromis niloticus)* FINGERLINGS

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ABSTRACT

This study evaluated the use of fermented mango *(Mangifera indica)* seed meal (FMS) to substitute yellow maize in the practical diet for Nile tilapia, *Oreochromis niloticus* fingerlings (4.76±0.32 g). Five iso-nitrogeneous (35% crude protein) and approximately iso-energetic (3400 ME Kcal/kg) dietsin which yellow maize was replaced by FMSat 0% (FMS0/Control diet), 25% (FMS25), 50% (FMS50), 75% (FMS75) and 100% (FMS100) levels were formulated. The fish were fed on the diets at 5% body weight for 84 days. Alkaloids were highest (2.32%) among the anti-nutritional factors analyzed in FMS, while oxalate (0.84%) was lowest. Potassium was highest (8.91 mg/g) among the minerals, while copper was lowest (0.01 mg/g). Weight gain, specific growth rate and feed conversion ratio were similar ($p>0.05$) in fish fed diets FMS0 and FMS50. The fish fed diet FMS0 had the highest protein efficiency ratio (1.88). Protein digestibility decreased ($p<0.05$) as dietary FMS increased, while carbohydrate digestibility gave an inverse relationship. Results obtained show that FMS could replace yellow maize at 50% level without affecting growth, nutrient utilization and apparent protein digestibility in diets for Nile tilapia fingerlings.

INTRODUCTION

Fish culture production is on the increase in developing countries and the problems of the sector include lack of nutritionally balanced and low-cost feeds (Falaye, 1992; Avnimelech et al., 2008). Fish feed accounts for about 60-70% of the variable cost in fish culture. This is due to the high cost of feed ingredients, especially maize which is the conventional source of dietary energy in fish and livestock feeds. Maize is also a staple for humans in many developing countries. In view of the scarcity and escalating costs of most conventional animal feed ingredients, it has become necessary to evaluate alternative nutrient sources to improve aquaculture production.

There have been some researches on various inexpensive agro-industrial by-products as substitutes for maize in fish diets with varying degrees of success. These include water fern *(Lemna paucicostata)* (Fasakin et al., 2001), duckweed *(Azola africana)* (Mbagwu et al., 1990; Youssouf et al., 2007), coffee pulp (Ulloa Rojas and Verreth, 2003) and housefly maggot (Ugwumba et al., 2001).

Mango (*Mangifera indica),* family Anacardiaceae, is high in probiotics, fibre, vitamin C, polyphenols, carotenoids and minerals (FAO 2004**).** The fresh kernel of the mango seed constitutes 13% of the weight of the fruit. After consumption or industrial processing of mangoes, considerable amount of mango kernels (seeds) form the discards as waste. Waste generated approximates 40 to 60% during processing of mangoes; 12 to 15% consists of peels and 15 to 20% of kernels (Budhwar, 2002).

One of the inexpensive ways to improve the nutritive value of agricultural residues biologically is fermentation. There exists a great potential in the use of microorganisms for the production of high quality feedstuffs from the abundantly available agro-industrial wastes. Mango seed by virtue of its relative low cost and its abundance in many developing nations stands as a suitable substrate for microbial fermentation and protein enrichment (Ubalua, 2007). Hence, this study evaluates the substitution of yellow maize with fermented mango seed meal on the growth performance and feed utilization of Nile tilapia, *Oreochromis niloticus* fingerlings.

MATERIALS AND METHODS

Experimental fish and system

150 Nile tilapia fingerlings (4.76±0.32 g) were kept in a 250 L fibre tank, fed with a commercial feed twice daily to acclimatize for one week and starved for 24 h before the feeding trial. This was followed by randomly distributing the fingerlings into five treatments of ten fish each in triplicate and stocked in net hapa (0.5 m x 0.5 m x 1.0 m). The net hapa (15) were suspended in an outdoor concrete tank (8 m x 5 m x 1.5 m) to 75% of their volume with kuralon twine (No. 15) tied to bamboo poles. The concrete tank was filled to 5/6 of its volume (40 m^3) and was continually supplied with fresh water to sustain an optimal environment and to preclude primary productivity.

Feed preparation

The mangoes used consist of mixed varieties of ripe mangoes obtained locally from a market in New Bussa, Niger state, Nigeria. Next was the removal of seeds from the kernels, washing, sun drying, milling to powder (595 μm) and fermentation for 48 h at room temperature. Fermented mango seed meal was prepared by mixing the mango seed meal (in an airtight polythene bag) with water at a ratio of 1:1 (wt. /vol.). Fermentation took place at room temperature (28-30 °C) for 48 h, after which the pH decreased to a stabilized level (3.7). The temperature of the fermented mango seed meal was taken at 12 h intervals using mercury in glass thermometer model 2751-K. (Lonner et al., 1986). The fermented meal was sundried, milled and sieved using a 595 μm sieve. The resultant meal was packed in air tight container and stored in a cool dry place at room temperature.

Table 1. Gross composition of experimental diets

Feed stuff	FMS0	FMS25	FMS0	FMS75	FMS100
Yellow maize (%)	35.58	25.74	16.20	9.96	0.00
[1] FMS (%)	0.00	8.25	16.20	23.89	34.28
Fish meal (%)	23.27	23.51	23.74	23.97	24.19
Soybean meal (%)	23.27	23.51	23.74	23.97	24.19
Groundnut cake (%)	11.63	11.75	11.87	11.98	12.09
Vegetable oil (%)	7.00	6.00	5.00	3.00	2.00
Vitamin premix (%)	1.00	1.00	1.00	1.00	1.00
L-Methionine	0.5	0.5	0.5	0.5	0.5
DL-Lysine (%)	0.5	0.5	0.5	0.5	0.5
[2] DCP (%)	0.5	0.5	0.5	0.5	0.5
Chromic oxide (%)	0.5	0.5	0.5	0.5	0.5
Sodium chloride (%)	0.5	0.5	0.5	0.5	0.5
[3]Met. Energy (kcal/100g)	310.11	310.72	303.98	310.59	304.68
Energy/protein ratio	9.68	9.82	9.87	9.87	9.49

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.

[1] Fermented mango seed meal

[2] Di-calcium phosphate

[3] Metabolizable energy, calculated using Atwater's calculation as described by Foster and Smith (1997).where 1g of CP/ Crude ProteinLipid/EE and NFE (Carbohydrate) yields 3.5, 8.5 and 3.5 kcal/g, respectively.

Five iso-nitrogenous (35% crude protein) and approximately iso-energetic (3400 ME Kcal/kg) diets in which fermented mango seed meal protein replaced yellow maize at varying levels of 0% (Control diet /FMS0), 25% (FMS25), 50% (FMS50), 75% (FMS75) and 100% (FMS100) were formulated and prepared. Added to the diets were DL-lysine, L–methionine (0.5% each as fortification) and chromium III oxide (Cr_2O_3) at 0.5% as the external digestibility marker (Table 1). The feed ingredients were milled, weighed, mixed, pelleted, sun dried, packed in labeled air tight polyethylene bags and stored in a dry place at room temperature.

Experimental procedure

The experimental fish were fed the test diets twice daily at 5% of total biomass at 07:00 – 08:00 and 16:00 – 17:00 for 84 days. Fish were batch-weighted weekly with a sensitive electronic balance (METTLER TOLEDO, PB602). Mortality was monitored daily. Water temperature (°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 was determined by the methods described by Thomas and Lynch (1960), while conductivity was measured using a model CMD 80 TYPEWPA conductivity metre (WPA, Cambridge, UK).

Chemical analysis

At the beginning of the feeding trial, composite samples of ten whole fish were analyzed and a random sample of five fish per net hapa were analyzed for proximate composition at the end of the 84-day feeding period. Nitrogen, fat, fibre, ash and moisture content of the diets and composite fish samples were analyzed using A.O.A.C. (1990) method.

Determination of anti-nutritional factors such as the total phenolics and condensed tannins followed the spectrophotometric methods of Makkar et al. (1993), while phytic acid estimation followed the modified photometric procedure of Vaintraub and Lapteva (1988). In addition, the alkaloids determination followed the gravimetric method of Harborne (1973), total flavonoid content, colorimetric assay (Bonvehi et al., 2001), while oxalate followed the method of Dye (1956). The total saponin content followed the methods of Hiai et al. (1976). The Hydrolysis of fermented mango seed proteins took place in a sealed tube Technicon TSM-1 Model DNA 0209 with 6NHCl for 22 h at 110 °C. Tryptophan was determined as described by Matheson (1974). The essential amino acids of the experimental diets were calculated from the analyzed values of the mango seed and NRC (1993) values for feedstuffs.

Growth performance and nutrient utilization parameters were expressed as the mean weight gain (MWG), percentage weight gain (%WG), specific growth rate (SGR), feed conversion ratio (FCR), protein efficiency ratio (PER) and apparent net protein utilization (ANPU) and were calculated as follows:

MWG (g) = Final mean weight – Initial mean weight.

%WG = Final body weight – Initial body weight x 100/ Initial body weight

SGR (%day^{-1}) = 100(In (Final mean weight – Ln (Initial mean weight.) x 100/time (days)

FCR = (Total dry feed fed)/(Wet weight gain)

PER = Mean Weight Gain/Mean Crude Protein Fed

ANPU (%) = Final carcass protein – Initial carcass protein x 100/ Protein fed (g)

where

Protein fed (g) = % protein in feed x Total weight of diet consumed/100

Digestibility study commenced after the fish had fed for four days. Feaces were collected within each net hapa by hand stripping the fish and were oven-dried at 105 °C to a constant weight. Protein and carbohydrate contents of feaces were analyzed using AOAC (1990) methods. Determination of the chromium III oxide content of the feed and feacal samples in triplicates followed the method of Furukawa and Tsukahara (1966). ADCs calculation followed the following formula:

$ADC_{nutrient}$ (%) = 100(1- ((% Cr_2O_3 indiet)(% nutrient or energy in feaces)/(% Cr_2O_3 in feaces) (% nutrient or energy in diet)

Statistical analyses

Statistical comparisons of growth performance, protein utilization and nutrient digestibility values were made using analysis of variance (ANOVA) test (SAS 1988). Differences among means were also tested for significance ($P<0.05$) using Duncan Multiple Range Test (DMRT).

RESULTS

Water quality parameters did not differ significantly among the experimental compartments. Temperature ranged between 29.0 - 30.5 °C, pH, 7.6 – 8.7, dissolved oxygen, 6.5 – 8.4 and ammonia as ammonia - N (NH3-N) (0.25 - 0.45mg L^{1}).

Results of proximate analysis, anti-nutritional factors and minerals of the FMS (Table 2) showed that the nitrogen free extract (NFE) was highest, while the ash content was lowest. Alkaloids were highest while flavonoids were lowest. The minerals assay showed that copper was lowest and potassium had the highest value.

Table 2. Proximate composition, anti-nutritional factors and mineral content of fermented mango seed meal

Nutrient	Mean±sd
Moisture content (%)	5.17±0.08
Crude protein (%)	9.57±0.10
Ash (%)	1.97±0.08
Crude fat (%)	11.10±0.13
Crude fibre (%)	1.99±0.12
NFE (%)	70.14±0.42
Tannin (%)	1.89±0.02
Phenols (%)	0.56±0.02
Alkaloids (%)	2.32±0.01
Flavonoids (%)	0.50±0.02
Saponin (%)	2.30±0.02
Phytic acid (%)	1.14±0.00
Oxalate (%)	0.84±0.02
P (mg/g)	1.91
Ca (mg/g)	0.75
Na (mg/g)	1.67
K (mg/g)	8.91
Mg (mg/g)	0.18
Zn (mg/g)	0.05
Fe (mg/g)	0.07
Mn (mg/g)	0.02
Cu (mg/g)	0.01

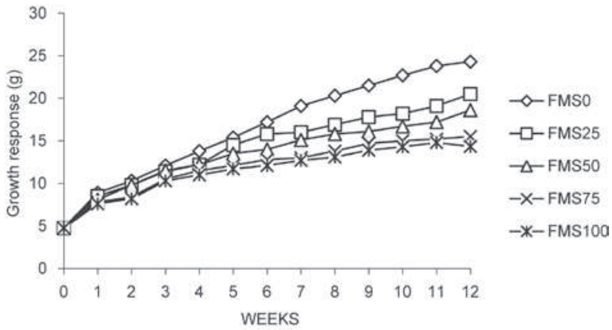

Fig 1. Growth performance of *Oreochromis niloticus* fed experimental diets

Table 3 presents the essential amino acid (EAA) profiles of maize, soybean meal, fishmeal (calculated values of NRC 1993) and FMS (analyzed). Leucine was highest while tyrosine was lowest. Table 4 shows the proximate composition of the experimental diets. There was no significant difference (p>0.05) in the crude protein, moisture and ether extract. The calculated Metabolizable energy was highest in diet FMS25 and lowest in diet FMS50. The calculated EAA composition of the experimental diets (Table 5) increased as fermented mango seed meal increased in the diets. Fig 1 shows the growth of Nile tilapia fed the experimental diets. The highest increase took place between week 0 and 1. The highest increase in growth took place in fish fed the control diet (FMS0).

Table 6 shows growth, feed utilization, nutrient digestibility and survival of fish fed the experimental diets. The fish readily accepted the feeds and all fish fed actively throughout the duration of the trial.

Table 3. Essential amino acid profile of the experimental feed ingredients

Ingredient	Arg	His	Iso	Leu	Lys	Met	Phe	Thr	Try	Val
*Maize (%)	0.43	0.26	0.35	1.21	0.25	0.17	0.48	0.35	0.08	0.44
*Soybean meal (%)	3.39	1.19	2.03	3.49	2.85	0.57	2.22	1.78	0.64	2.02
*Fish meal (%)	4.54	1.65	3.13	5.19	5.57	2.08	2.71	2.90	0.77	4.30
Fermented mango seed meal (%)	3.79	1.60	2.23	5.67	2.69	0.64	3.05	1.80	0.52	2.64

*NRC (1993) values

Table 4. Proximate composition of experimental diets

Parameter	MSM0	MSM25	MSM50	MSM75	MSM100
Moisture (%)	10.21±0.12	10.23±0.12	10.53±0.14	11.12±0.16	10.60±0.23
Crude protein (%)	35.85±0.88	35.35±0.21	34.63±0.18	35.21±0.38	35.42±0.47
Ash (%)	11.65±0.60a	10.59±0.31b	11.19±0.09a	10.09±0.06b	11.74±0.36a
Ether extract (%)	10.31±0.14	10.83±0.27	10.50±0.25	10.77±0.40	10.06±0.37
Crude fibre (%)	4.27±0.10b	5.89±0.02a	5.93±0.04a	5.44±0.07a	5.98±0.09a
1NFE (%)	27.71±0.96	27.11±0.20	26.72±0.60	27.37±0.62	27.20±0.21

a or b superscript shows significant differences (p<0.05) across rows
Values are means of three replicates with standard deviation
[1] Nitrogen free extract

Table 5. Essential amino acid composition of the experimental diets

Amino acids	FMS0	FMS25	FMS50	FMS75	FMS100	Tilapia requirement*
Arginine (%)	1.91	2.22	2.51	2.79	3.06	1.18
Histidine (%)	1.21	1.33	1.45	1.56	1.67	0.48
Isoleucine (%)	1.66	1.83	1.99	2.15	2.30	0.87
Leucine (%)	2.03	2.42	2.79	3.15	3.50	0.95
Lysine (%)	2.61	2.75	2.97	3.18	3.38	1.43
Methionine (%)	0.77	0.82	0.86	0.91	1.95	0.91
Phenylalanine (%)	1.91	2.14	2.36	2.57	2.78	1.56
Threonine (%)	1.59	1.72	1.88	1.98	2.09	1.05
Tryptophan (%)	0.40	0.44	0.48	0.52	0.55	0.33
Valine (%)	1.94	2.14	2.33	2.51	2.69	0.78

Calculated from the analyzed values for fermented mango seed meal and (NRC, 1993) values for feedstuffs;
*Tilapia requirement (Santiago and Lovell, 1988)

Table 6. Growth performance, nutrient utilization, nutrient digestibility and survival of *O. niloticus* fingerlings fed varying dietary levels of fermented mango meal-based diets (Number of fish per net hapa = 10; Replicates = 3; Total fish sample/treatment = 30; MWG = Mean weight gain; % WG = Percentage weight gain SGR = Specific growth rate; FCR = Feed conversion ratio; PER = Protein efficiency ratio; ANPU = Apparent net protein utilization; $ADC_{Carbohydrate}$ = Apparent digestibility coefficient; $ADC_{Protein}$ = Apparent digestibility coefficient)

Parameters	**DIETS**				
	Diet 1	**Diet 2**	**Diet 3**	**Diet 4**	**Diet 5**
Initial mean wt. (g)	4.75±0.11	4.76±0.25	4.76±0.26	4.76±0.18	4.76±0.10
Final Mean wt. (g)	24.30±3.18^{a}	20.50±3.90^{ab}	18.61±3.09^{b}	15.51±2.18^{c}	14.34±2.00
MWG (g)	19.55±1.24^{a}	15.74±31.65^{ab}	13.85±38.30^{ab}	10.75±22.16^{c}	9.58±27.00^{d}
%WG	412.21±17.9^{a}	330.67±65.9^{ab}	290.97±81.31^{ab}	225.84±46.70^{b}	201.26±2.00^{b}
Mean feed intake (g)	29.72±2.52^{a}	25.65.26±2.00^{a}	23.82±3.98^{a}	21.02±1.04^{b}	20.10±2.73^{b}
SGR (%/day)	1.94±0.07^{a}	1.74±0.30^{a}	1.62±0.35^{ab}	1.41±0.21^{bc}	1.31±0.29^{c}
FCR	1.52±0.21^{c}	1.63±0.57^{bc}	1.72±0.53^{bc}	1.95±0.44^{a}	2.10±0.41^{a}
PER	1.88±0.13^{a}	1.65±0.87^{a}	1.49±0.21^{ab}	1.46±0.60^{b}	1.36±0.77^{c}
ANPU (%)	79.61±3.45^{a}	60.62±8.74^{a}	52.82±5.90^{b}	30.49±5.20^{bc}	11.46±3.01^{c}
$ADC_{Carbohydrate}$	64.95±5.62^{c}	72.91±3.33^{ab}	68.00±4.27^{b}	70.06±3.23^{b}	78.58±3.22^{a}
$ADC_{Protein}$	72.55±7.14^{a}	59.14±9.21^{ab}	60.62±8.07^{a}	54.37±8.23^{b}	49.40±5.23^{c}
Survival (%)	95.3±7.86	93.5±6.43	95.7±8.22	90.6±5.75	93.2±6.33

a, b, ab, bc or c superscript shows significant differences (p<0.05) across rows
Values are means of three replicates with standard error.

Table 7. Carcass composition of *O. niloticus* fingerlings fed experimental diets containing different levels of fermented mango seed meal (Number analyzed at initial = 10, while number analyzed at the end of the trial = 5/net hapa net)

Nutrients	**Initial**	**FMS0**	**FMS25**	**FMS50**	**FMS75**	**FMS100**
Moisture (%)	12.22	11.65±1.11	12.82±2.07	12.97±3.12	11.00±1.08	11.15±2.06
Crude protein (%)	57.95	62.05±0.93^{a}	61.29±0.12^{a}	60.67±0.12^{ab}	59.52±0.31^{b}	58.04±0.16^{c}
Ash (%)	12.70	13.23±2.58^{ab}	13.50±3.15^{ab}	15.93±3.03^{a}	12.51±2.26^{b}	12.83±4.16^{b}
Ether extract (%)	7.85	8.25±0.12^{a}	7.01±0.06^{b}	7.76±0.05^{b}	8.20±0.08^{a}	9.52±0.24^{a}

a, b, ab or c superscript shows significant differences (p<0.05) across rows
Values are means of three replicates with standard error.

There was a significant reduction (p<0.05) in mean weight gain, mean feed intake, specific growth rate, feed conversion ratio, apparent net protein utilization, apparent protein and carbohydrate digestibility in fish fed diets above 50% inclusion of FMS. Survival was high in all treatments (90 – 95%) with no significant difference (p>0.05).

Table 7 shows the carcass composition of Nile tilapia at the beginning and the end of the experiment. Carcass composition differed significantly

($p<0.05$) within the treatments, except the moisture content ($p>0.05$). Crude protein decreased significantly ($p<0.05$) as FMS increased in diets.

DISCUSSION

Throughout the feeding trial, water quality in all treatments stayed within the favorable range required by tilapia (Balarin and Hatton, 1979; Mataka and Kang'ombe, 2007). The results of this trial demonstrated significant differences ($p<0.05$) among fish fed varying levels of fermented mango seed meal based diets. Growth and feed utilization decreased significantly ($p<0.05$) in fish fed diets above 50% FMS inclusion level. Although the essential amino acid profile of diets increased as fermented mango seed increased in the diet, protein digestibility significantly decreased while carbohydrate digestibility assumed an inverse relationship. This decrease might be due to a number of factors. These include the presence of anti-nutritional factors such as tannins, phytates and oxalate, which may not have pronounced interference with carbohydrate bioavailability as in protein. Mole and Waterman (1987) and Enujiugha and Ayodele-Oni (2003) observed that these anti-nutrients form complexes with protein thereby reducing the digestibility and consequently biological availability of this nutrient. Also, Olaofe and Sanni (1988) and Dendougui and Schwedt (2004) stated that the anti-nutritional activity of oxalates and phytin lies in their ability to form complexes with metals like Ca, Zn, Mg and Fe, while phytic acid acts as a strong chelator, forming protein and mineral-phytic acid complexes thereby reducing protein and mineral bioavailability. Van Egmund et al. (1990) and Fasasi et al. (2003) observed that tannins interfere with digestion by displaying anti-trypsin and anti-amylase activity, forming complexes with vitamin B_{12} and interfering with the bioavailability of proteins.

The lower feed intake recorded in this study as FMS inclusion increased above 50% in the diet might be due to lowering palatability. This could result from the presence of tannin in the FMS. Azaza et al. (2009) reported that the presence of 2.4% tannin in faba beans (*Vicia faba* L. var. minuta) might be responsible for low palatability and consequently low feed intake in Nile tilapia.

The level of anti-nutritional factors in the FMS was rather high, compared to that obtained in fermented African breadfruit seed *(Treculia africana)* (Fasasi et al., 2003). However, fermentation improved the nutritional quality considerably. It completely removed hydrocyanic acid, significantly reduced the phytates, tannin and oxalate and increased the phosphorus content of African breadfruit seed *(T. africana)* significantly (Fasasi et al., 2003). Olaofe and Sanni (1988) also reported that it improves the nutritional value of weaning foods, converts insoluble proteins to soluble components and increases the levels of lysine as well as of vitamins B and C.

The high ash contents recorded in all the experimental diets, in spite of the low observed in mango seed meal, were expected. This is due to the high ash contents of some key ingredients like fishmeal and groundnut cake as observed by Sogbesan and Ugwumba (2008) and Akintayo et al. (2008), respectively.

The higher value of essential amino acid composition of FMS protein in this study than that of maize, and comparable to that of soybean meal, was expected. Augustine and Ling (1987) and Ahmed et al. (2007) reported that mango seed protein contains high values of essential amino acids. The presence of deficiency in methionine requirement for Nile tilapia in the first three diets might be due to a higher level of methionine in the protein of FMS than in the proteins of other plant-based ingredients in the diets. This is in agreement with Jackson et al. (1982) and Iqbala et al. (2006) who reported that methionine and lysine are the most limiting amino acids in plant protein sources, frequently causing reduced growth.

Therefore, we concluded that fermented mango seed meal could replace maize at 50% inclusion level in the diet of Nile tilapia as a carbohydrate source. This could also reduce the price of feed and consequently the cost of production of Nile tilapia.

At above 50% inclusion level, growth, feed utilization and apparent nutrient digestibility significantly reduced due to the presence of anti-nutritional factors present in the fermented mango seed meal. These factors were also responsible for the reduction in palatability and low feed intake in Nile tilapia.

Sažetak

UPOTREBA SJEMENA FERMENTIRANOG MANGA (*Mangifera indica*) U HRANIDBI MLAĐI TILAPIJE (*Oreochromis niloticus*)

Ovim istraživanjem prikazana je upotreba sjemena fermentiranog manga kao zamjene za žuti kukuruz u hrandibi mlađi tilapije, *Oreochronis niloticus* (4,76±0,32g). Žuti kukuruz zamijenjen je s pet izoazotnih (35% sirovih bjelančevina) i približno toliko izoenergetskih (3400 ME Kcal/kg) oblika hranidbe sjemenom manga u sljedećim postocima:

FMS 0% (FMS0/kontrolna skupina), 25% (FMS25), 50% (FMS50), 75% (FMS75) and 100% (FMS100). Hranidba riba eksperimentalnom hranom vršena je 84 dana na razini od 5% njihove tjelesne težine. Alkaloidi su bili najbrojniji (2,32%) od štetnih prehrambenih faktora analiziranih u FMS-u, dok je postotak oksalata bio najmanji (0,84%). Analiza je pokazala kako je kalij najzastupljeniji od minerala (8,91%), dok je bakar najmanje zastupljen (0,01 mg/g). Omjer povećane težine, specifične stope rasta i utjecaja promjene prehrane bio je sličan u FMS0 i FMS50 oblicima novih načina hranidbe (p>0,05). Oblik hranidbe riba FMS0 imao je najveći omjer djelotvornih bjelančevina (1,88). Probavljivost bjelančevina smanjila se povećanjem dijetetskog FMS-a, dok se probavljivost ugljikohidrata povećala. Dobiveni rezultati pokazuju mogućnost zamjene žutog kukuruza sjemenom fermentiranog manga u hrandibi tilapija do 50% bez da taj oblik hranidbe utječe na rast, iskoristivost nutritivnih sastojaka i probavljivost bjelančevina prilikom hranidbe mlađi tilapije.

Ključne riječi: fermentacija, sjeme manga, probavljivost nutrijenata, tilapija, neprehrambeni faktori

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