EVALUATION OF TAMARIND (*Tamarindus indica*) SEED MEAL AS A DIETARY CARBOHYDRATE FOR THE PRODUCTION OF NILE TILAPIA *Oreochromis niloticus* (L)

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ABSTRACT

A feeding study was conducted to assess the value of Tamarind, Tamarindus indica seed meal as dietary carbohydrate in the diets of Nile Tilapia, Oreochromis niloticus. Tamarind seeds were used to replace maize at 0, 20, 40, 60, 80, 100 % substitution levels for treatments 1 to 6. Growth trial was conducted in outdoor concrete tanks for 56 days. The fishes were fed at 4 % body weight twice daily. There were no significant variations in the mean weight gain, specific growth rate (SGR), food conversion ratio (FCR) and protein efficiency ratio (PER) (p >0.05). The apparent digestibility coefficient (ADC) of protein and energy of the fishes fed diets 1 – 6 were similar (p > 0.05). There were no significant differences in the blood total erythrocyte counts, (TEC), pack cell volume (PCV) and red blood cells count (RBC) (p >0.05). Based on the findings, complete replacement of maize with tamarind seed meal in the diets of O. niloticus is recommended.

Keywords: Tamarind, Replacement, Maize, *Oreochromis niloticus.*

INTRODUCTION

Plant protein and carbohydrate feedstuffs, particularly soybean (*Glycine max*) and maize (Zea mays), have been extensively used in fish feeds with nutritional, environmental and economic benefits (Tacon,1993). As the use of soybeans and maize in human food and livestock feed increases, their costs have increased, and the economics of using them in fish feeds may become less favourable. Hence the evaluation of underutilized indigenous plant protein/energy-rich sources becomes imperative and remains a high research priority in Nigeria.

Vast quantities of forest seeds are discarded as wastes in Nigeria. There is a strong economic justification for their use either as protein or carbohydrate/energy supplements in low cost diets for fish. A national feedstuff survey revealed that the seed of tamarind, (*Tamarindus indica*) represents a good source of digestible dietary energy and is desirable in fish feeds because of its low cost and availability (Balogun 1990). Tamarind contains about 18 % crude protein, with amino acid profile comparable to maize, but with a higher methionine + cystine (met + cys) value than maize. There is a dearth of information on the nutritive value of tamarind seed meal as a feedstuff for Nile tilapia, *Oreochromis niloticus.*

Oreochromis niloticus is a fast growing and preferred aquaculture species in Africa and is capable of utilizing plant materials in its diets. The present study was conducted to evaluate the nutritional and economic feasibility of replacing maize with tamarind seeds in practical diets for *O. niloticus.*

MATERIALS AND METHODS

Diet: The ingredients used in this study were purchased from Pfizer (Livestock) feeds depot, Ibadan Nigeria, while tamarind seeds were obtained from Kainji lake area, New Bussa, Nigeria. Tamarind seeds were mechanically de-hulled. The dehulled seeds were soaked in warm water for 24 h to remove the inner coat before sun drying to a constant moisture of < 10 %, and milled into fine powder. Phytin and tannin contents of the tamarind seed meal (TM) were determined according to the methods of Sathe and Salunkhe (1981). The mineral content of TM was determined as described by Harris (1970), while the proximate composition was determined according to the methods of AOAC (1990) (Table 1).

Based on the proximate composition of the feedstuffs, six diets were formulated (Table 2). The control diet (diet 1) contained 30% of maize which was replaced with TM in diets 2, 3, 4, 5 and 6 at 20, 40, 60, 80 and 100% respectively. The feedstuffs were milled, blended, moistened, pelleted, sun-dried at 30^{0}C between 1200 – 1600h for three days and stored in air-tight polythylene bags at ambient temperature (28°C). Proximate analysis of the diets and the fishes, (moisture, crude protein (N 58. x 6.25), crude lipid, crude fibre and total ash) were conducted in triplicate samples according to AOAC (1990) methods. Gross energy of the diets was determined in triplicate samples by combustion in bomb calorimeter.

Growth Trials: Groups of 20 fingerlings of *O. niloticus* (6.15 ± .03g) having been acclimated for seven days were randomly stocked into 18 outdoor rectangular concrete tanks (1.8 x 1.8 x 1m) containing 800 L of water for growth trials. The mean pH, dissolved and temperature of the tank waters were 6.9 ± 0.2, 5.6 ± 0.4 and 26.8 ± 0.6 respectively. Each of the diets was fed to the fishes in triplicate tanks at 4 % body weight twice daily (0900–1000 and 1500–1600h) for 56 days. Fresh water was used to change the water in the experimental tanks once every two weeks. Total weight of fishes in each tank was taken bi-weekly to monitor growth responses and for feed adjusments. Mean weight grain (MWG) specific growth rate (SGR), protein efficiency ratio (PER) and food conversion ratio (FCR) were estimated from bi-weekly weight data according to the methods of Olivera Novoa *et al.* (1990) as follow: Mean weight gain = final mean weight – initial mean weight; Specific growth rate = 10^2 (Log_e final weight -Log_e initial weight)/culture period (days); Food conversion ratio = Dry weight of feed fed (g)/ fish weight gain; Protein efficiency ratio = fish weight gain/protein fed.

Carcass and Haematological Analyses: At the beginning and end of feeding trials, six tilapia, randomly selected from each treatment group were oven dried at 48 °C for 48 h, blended into fine powder, packed in air-tight polythene bags and stored in a deep freezer (-20°C), prior to carcass analyses. Similarly, before and after the feeding trials three fish from each tank (9 fish/treatment) were removed, anesthetized using 10 mg/l tricaine methane sulfonate (MSS222, Sandoz). Blood samples were withdrawn from the caudal vein with heparinized syringes, and immediately centrifuged at 5,000 rpm for 15 mins to remove red blood cells. The blood parameters, total erythrocyte count (TEC), pack cell volume (PCV) and red blood cells (RBC) were determined according to the methods of Svobodova *et al.* (1991).

Digestibility Studies: Groups of 20 *O. niloticus* fingerlings (7.2 ± 0.8g) having been acclimated for seven days were randomly stocked into 18 indoor 60 L rectangular glass tanks (75 x 40 x 40 cm) supplied with fresh water (flow rate 1L m^{-1}). Each of the diets was fed to the fishes in triplicate tanks at 4 % body weight twice daily for 14 days. Faeces were collected from each of the tanks eight hours after each feeding. The faeces and unfed diets were pooled separately and their proximate composition determined according to the methods of AOAC (1990). The digestibility of unfed feed and the dried faeces per sample/treatment were determined by AIA method (Halver *et al.* 1993). These samples were ashed and digested by Acid in soluble Ash (AIA). AIA% = 10^2 (weight of Ash-weight of AIA) / weight of Ash. Apparent digestibility coefficient (ADC) was determined from the formula, ADC = 10^2 – (10^2 x (Af/At x Nt/Nf) where, Af = AIA in feeds, At = AIA in faeces, Nf = Nutrient in feed and Nt = Nutrient in faeces.

Statistical Analyses: The one way analysis of variance (ANOVA) and Duncan's multiple-range tests (Zar,1984) were used to compare differences between diet treatment means (p = 0.05).

RESULTS AND DISCUSSION

Table 1 presents the mineral, proximate composition, and anti-nutrients in tamarind seeds; which showed potassium (K), calcium (Ca), and magnesium (Mg), as the most abundant minerals. The protein content is high (16.6%), with low fat and fibre contents.

Table 1: Mineral, anti-nutrient and proximate composition of tamarind seed meal

Items Analyzed	Proximate Composition (g/100g/DM)
Mineral and Anti-nutrient (g/kg)	
Iron (Fe)	0.10
Zinc (Zn)	0.13
Magnesium (Mg)	0.31
Sodium (Na)	0.23
Potassium (K)	0.43
Calcium (Ca)	0.40
Phytin	1.17
Tannin	0.02
Nutrients	
Crude Protein	16.6
Fat	0.35
NFE	69.8
Moisture	4.74
Fibre	5.82
Ash	2.70

Table 2: Ingredient and proximate composition of experimental diets

Items Analyzed	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Ingredients(g/100g/DM)						
Fish meal	15	15	15	15	15	15
Soybean meal	45	45	45	45	45	45
Maize	30	24	18	12	6	0
Tamarind	0	6	12	18	24	30
Fish oil	6	6	6	6	6	6
Vitamin-Mineral Premix[1]	2	2	2	2	2	2
Carboxymethyl cellulose	2	2	2	2	2	2
Proximate Composition (g/100g/DM)						
Crude protein	30.0	31.0	31.8	32.0	32.9	33.1
Ether extract	8.0	8.06	8.57	8.70	8.99	8.78
Nitrogen free extract	43.4	42.8	42.0	41.7	41.0	40.1
Crude fibre	1.24	1.22	1.20	1.19	1.17	1.15
Ash	6.64	6.41	6.20	6.08	5.89	5.88
G. Energy (kcal/g/DM)	398.8	398.9	404.0	405.2	409.3	404.7
Protein – Energy Ratio	76.8	77.8	78.6	79.0	80.2	81.7

[1] *supplied as (mg/kg diet): Ca-pantothenic acid, 40; pyridoxine, 10; riboflavin, 12; niacin, 20; folic acid, 2; choline chloride, 2000; thiamin HCl 2; D-biotin, 0.28; cyanocobalamin (B_{12}), 0.04; menadione sodium bisulphate (vitamin K), 2; ascorbic acid (vitamin C), 100; DL-a-tocopherol acetate (vitamin E), 100; cholecalciferol (vitamin D), 4000IU; retinyl acatate (vitamin A), 5000IU; salt (NaCl), 6200; copper sulphate ($CuSO_4.5H_2O$), 56; ferrous sulphate ($FeSO_4.7H_2O$), 130; manganese sulphate ($MnSO_4.H_2O$), 178; zinc sulphate ($ZnSO_4.H_2O$), 120; potassium iodide (KI), 16; corn starch*

Table 3: Growth, nutrient utilization and apparent digestibility coefficient ADC) of *O. niloticus* fed tamarind diets for 56 days

Parameters	Diet 1	Diet 2	Diet 3	Diet 4	Diet 5	Diet 6
Initial mean weight (g)	6.10 ±0.17	6.30 ±0.17	6.36 ±0.18	6.04 ±0.19	6.04 ±0.18	6.00 ±0.17
Final mean weight (g)	13.13±0.52	13.66±0.51	14.23±0.53	14.25±0.51	13.61±0.51	13.04±0.52
Weight gain (g)	7.03 ±0.47	7.30 ±0.46	7.87 ±0.48	8.21 ±0.46	7.57 ±0.46	7.04 ±0.48
SGR (g/day)	1.37 ±0.06	1.37 ±0.05	1.44 ±0.03	1.53 ±0.05	1.45 ±0.06	1.39 ±0.05
FCR	2.29 ±0.09	2.31 ±0.08	2.21 ±0.10	2.08 ±0.07	2.17 ±0.10	2.27 ±0.08
PER	3.67 ±0.24	3.76 ±0.25	3.96 ±0.25	4.10 ±0.24	3.69 ±0.25	3.41 ±0.24
ADC protein (%)	84.9 ±3.05	87.0 ±3.04	89.6 ±3.10	91.2 ±3.11	88.2 ±3.08	82.9 ±3.12
ADC energy (%)	82.4 ±3.41	84.9 ±3.40	87.9 ±3.43	89.7 ±3.42	86.4 ±3.43	80.6 ±4.13

Values along the same row are not significantly different (P > 0.05)

Table 4: Carcass composition and blood parameters of *O. niloticus* fed for 56 days

Fish Fed	Crude protein	Ether extract	Ash	TEC (million/il)[a]	PCV (%)[b]	RBC (10^4 mm^3)[c]
Before feeding	36.3	6.25	27.6	3.0	30	180
Diet 1	53.5	11.2	21.5	3.0	29	181
Diet 2	53.6	11.1	21.5	3.1	31	179
Diet 3	53.7	11.2	23.1	3.2	30	182
Diet 4	53.8	11.2	23.9	3.0	31	180
Diet 5	54.0	11.2	23.8	3.1	29	181
Diet 6	54.1	11.6	24.4	3.2	31	180

a. Total erythrocyte count b. Pack cell volume c. Red blood cells

This protein content is higher than that of maize (10%). The major anti-nutrients found in tamarind seed meal were low values of phytin and tannin. Gross composition of the experimental diets, the proximate composition, gross energy (GE) and protein-energy ratio (P: E) were presented in Table 2. The mean value of the dietary fat recorded from the present study is within the acceptable range recommended for fish culture (Teshima and Kanazawa, 1986). The low fibre contents of the experimental diets depict the high quality which can support high feed digestibility and good fish yield. The mean value of the GE obtained is close to the value of 467 $kcal.g^{-1}$ used by Abdelghany (2000) for good tilapia production. Li *et al.* (1991) showed that P:E of diets influenced nutrient utilization and growth; and optimum P:E boosted the profitability of diets and protein sparing ability of the diets (Xiquin *et al.* 1994).

The mean P:E obtained from this study was high but lower than 100mg $kcal^{-1}$ recorded by Santiago and Laron (1991) as optimum for red tilapia fed 30 % crude protein diets. However, the value compared favourably with the mean value of 86 $\pm$ 1.6 which supported good yield of *O. niloticus,* (Nwanna and Daramola, 2000). Results of the feeding trials (Table 3) showed no significant variations in the mean weight gain (MWG), specific growth rate (SGR), food conversion ratio (FCR) and protein efficiency ratio (PER) among the fishes fed the control diet and those fed diets supplemented with tamarind sed meal at 20, 40, 60, 80 and 100 % levels of substitution. The mean values of SGR and FCR obtained from this study was close to the mean values of 1.28 $\pm$ 0.17 and 1.77 $\pm$ 0.33 for SGR and FCR reported for *O. niloticus* fed cottonseed meal based diets Mbahinzireki *et al.* (2001). The SGR obtained was also similar to the mean value of 1.53 ± 0.06 documented for *O. niloticus* fed compounded diets (Maina *et al.* 2002). Furthermore, the mean value of PER obtained from the present study compared well with the mean values of PER of 2.64 ± 0.46, and 2.48 ± 0.55 reported by Hossain *et al.* (2002) and Ulloa and Verreth (2002) for *O. niloticus* fed dhaincha seed meal based diets and bacteria-treated coffee pulp meal based diets, respectively.

The digestibility of individual ingredients in compounded diet is one of the important factors affecting the growth of fish (De Silva *et al.*, 1996). Uys (1988) noted that rather than look at growth responses, the digestibility of nutrients and energy contents of feedstuffs could be used to assess the suitability and nutritive value of feedstuffs/diets in fishes. The apparent digestibility coefficient (ADC) for protein and energy (Table 3) obtained from the present study were high. There were no significant variations in the ADC for protein and energy of the fishes fed diets 1 – 6 ($p > 0.05$). However, the ADC for protein and energy were marginally higher in fish fed 60 % of tamarind seed meal based diet than in fishes fed other diets ($p > 0.05$). The high values of the ADC for protein and energy recorded from this study indicated that the diets were well digested. The mean values of ADC for protein and energy obtained are close to the ADC for protein (93.0%) and energy (83.0%) recorded by Degani *et al.* (1997) for hybrid tilapia (*O. niloticus*♂ x *O. aureus*♀) fed corn meal. Furthermore, the ADC for protein recorded from the present experiment was similar to mean ADC value for protein of (81.7$\pm$ 7.3) reported by Mbahinzireki *et al.* (2001).

The carcass composition and blood parameters of the fishes fed diets 1-6 for 56 days are presented in Table 4. Protein and fat deposition were similar in all the fishes fed diets 1–6, and there was no significant difference in ash content ($p > 0.05$). The total erythrocyte count (TEC), pack cell volume (PCV) and the red blood cells (RBC) were high. There were no significant variations in TEC, PCV and RBC of the fishes fed all the diets ($p > 0.05$). The RBC value in this study was close to the range of 700,000-2,000,000 cells mm^3 recommended by Saunders (1966) for healthy teleosts. The mean PCV value obtained from the present study was similar to the value of 32.1 % reported by Abdelghany (2000), and the mean value of 36 $\pm$ 0.5 reported for *O. niloticus* by Mbahinzireki *et al.* (2001).

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