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Original Research Article

Utilization of autoclaved and fermented sesame (*Sesamum indicum L.*) seed meal in diets for Til-aqua natural male tilapia

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ABSTRACT

Current research emphasis has been on the reduction of feed cost by incorporating processed sesame seed meal in the diet of tilapia. Raw sesame (*Sesamum indicum*) seed was soaked and subjected to either autoclaving or fermentation, after which their oil contents were mechanically extracted. Graded levels of autoclaved (71.2, 165.5 and 296.3 g/kg designated as diets 1, 2 and 3, respectively) and fermented (71.0, 164.3 and 292.2 g/kg designated as diets 4, 5 and 6, respectively) sesame seed meal were included into fishmeal based diets for Til-aqua natural male tilapia (NMT) fry (initial weight, 1.69 ± 0.02 g). A diet without sesame seed meal served as the control. Diets were approximately iso-nitrogenous (35% crude protein). Fish were fed 5 times their maintenance requirement, which was $3.2 \times 5 \times$ [fish weight (g)/1,000]$^{0.8}$ daily for 56 days. Processing improved the nutritional profile of raw sesame seed meal in terms of its crude protein and antinutrient compositions. Growth performance of fish was similar ($P > 0.05$) in the control and dietary treatments. The group fed diet 3 exhibited significantly poorer feed conversion ratio (1.14), protein efficiency ratio (2.77) and economic conversion ratio (US$1.38/kg) relative to the group that received diet 5. Apparent digestibility coefficients for protein, lipid and energy in diet 3 were similar ($P > 0.05$) to those in diet 6 but significantly lower ($P < 0.05$) than those of the control and other dietary groups. The sesame seed meals processed with different methods did not significantly affect crude protein, crude lipid and gross energy compositions in the fish carcass. The study demonstrated that 71.2 g/kg of autoclaved and 164.3 g/kg of fermented sesame seed meal could be incorporated in the diet of Til-aqua NMT with cost benefit.

1. Introduction

The demand for fish feed has continued to increase as a result of growing global aquaculture production which reached an all-time high of 60 million tonnes (1 tonne = 1,000 kg) in 2010 (FAO, 2012). The challenge of fish feed industry is to formulate quality fish feeds that meets the nutritional requirements of fish and also minimise production cost, limit environmental impacts and enhance products quality (Guo et al., 2011; Evans et al., 2005) using non-conventional sources of protein from both plant and animal origins. Less expensive plant protein feedstuffs such as soybean meal (Evans et al., 2005), lupins (Glencross et al., 2008) and various oilseeds (El-Saidy and Saad, 2008; Guo et al., 2011) have been widely explored. Many authors have however reported that constraints such as low crude protein content, deficiency of key amino acids, low digestibility, the presence of high amounts of carbohydrate, fiber and other antinutritional factors, decreased palatability and limited their overall nutritive value and inclusion in practical feeds (Francis et al., 2001; Refstie et al., 2005; Dongmeza et al., 2006). To encourage the incorporation of non-conventional protein sources in fish feed at high inclusion level, efforts are geared towards the enhancement of their nutritive value through

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processing to increase the bioavailability of nutrients and reduce or remove their antinutritional factors (Francis et al., 2001; Refstie et al., 2005).

Sesame (*Sesamum indicum*) is cultivated primarily for its oil (Lee et al., 2010), with substantial oilcake generated as a by-product which could be utilized as source of dietary protein in animal feeds including fish (Guo et al., 2011; Nang Thu et al., 2011). In 2012, about 4.04 million tonnes of sesame seeds were produced globally having risen from 1.4 million metric tonnes in 1960 (FAO, 2013); the bulk of which came from Asian and African countries. Nigeria's production of the crop consistently increased from about 15,000 metric tonnes in 1980 to about 158,000 metric tonnes in 2012 (FAO, 2013). USAID (2009) had earlier suggested a vast potential for increased production in Nigeria owing to large expanse of suitable land available to grow the crop.

This study was conducted to assess the effects of soaking, followed by either autoclaving or fermentation on the nutritive value of sesame seed and also evaluate the potential of the processed meals in the diet of Til-aqua red natural male tilapia (NMT) fry.

2. Materials and methods

2.1. Experimental system and fish

The experiment was conducted at the fish hatchery of Durante Fish Industries Limited, Old Nigerwest Building, Orita Challenge, Ibadan, in 14 recirculating systems. The recirculating system consists: plastic rearing tanks (1.10 m × 0.9 m × 0.45 m) which carries 2 cylindrical filter blocks (diameter: 0.3 m, height: 0.3 m) in a pipe (diameter: 0.31 m, height: 0.71 m); an ultraviolet compartment consisting of an 11-W bulb with its transformer and glass casing; 2 sedimentation (0.66 m × 0.30 m × 0.54 m) and pump units (0.66 m × 0.30 m × 0.54 m) with their filter blocks (0.6 m × 0.25 m × 0.3 m) and submersible pumps (Aquamaxima; 7,500 L/h). The systems were supplied with water from an overhead 7,500 L-capacity reservoir.

Til-aqua red NMT (average weight of 280 fish = 1.69 ± 0.02 g) used in the present study were produced using *Oreochromis niloticus* individuals that have 2Y chromosomes (YY) and no X chromosome. The YY male was produced using the technique described by Subasinghe et al. (2003), except that temperature rather than hormone was used to sex reverse normal (XY) male. The YY line was then crossed with normal female (XX) from a separate normal mixed sex line to produce NMT. The fry were randomly distributed into 14 systems at the density of 40 fish per system. The design of the experiment was completely randomized and each treatment was duplicated. Experimental fish were batch-weighed with a top-loading balance (RCL-15) at the start and weekly till the end of the experiment.

2.2. Feed ingredients and preparations

All feed ingredients were from Durante Feed Mill (New Garage, Ibadan, Nigeria) except for the sesame seeds, which were collected from the Institute of Food Security, Environmental Resources and Agricultural Research (IFSERAR) of the Federal University of Agriculture, P.M.B. 2240 Abeokuta, Nigeria. The seeds were cleaned and a portion (unprocessed) was kept for biochemical analysis. The remaining seeds were soaked in water (1:4, wt:vol) for 24 h at room temperature (30°C) according to Mukhopadhyay and Ray (1999a,b). Water temperature and pH were monitored 8-hourly during soaking. Subsequently, the seeds were divided into 2 portions and a portion was autoclaved using Prestige Clinical Autoclave (Series 2100) at 121°C and 15 psi (1.05 kPa/cm^2) for 30 min (Siddhuraju and Becker, 2001). The autoclaved seeds were dried in a Binder (FO 115, Germany) drying cabinet at 100°C for 2 h, finely ground using a locally fabricated hammer mill and screw-pressed with an improvised mechanical screw-press for 6 h. The other portion of the soaked sesame seeds were dried in a Binder (FO 115, Germany) oven at 100°C for 2 h and finely ground using a locally fabricated hammer mill after which it was subjected to solid state fermentation for 48 h at room temperature (30°C) using *Lactobacillus plantarium* at the Department of Microbiology, Federal University of Agriculture, P.M.B. 2240 Abeokuta, Nigeria according to the method described by Mukhopadhyay and Ray (1999b). The pH and temperature of the medium were monitored periodically. The oil from the fermented sample was also extracted as previously described. The resultant cake from the autoclaved and fermented samples were pulverized and passed through a fine mesh sieve (595 μm) to ensure homogeneity.

Seven approximately isonitrogenous (35% crude protein) diets were formulated (Table 1). There was a control diet without any of the processed sesame seed meal, but diets designated as diets 1 to 6 contained graded levels of autoclaved (71.2, 165.5 and 296.3 g/kg) and fermented (71.0, 164.3 and 292.2 g/kg) sesame seed meal (Table 2). Chromic oxide was used at 0.5% in all the experimental diets as an inert marker to determine the digestibility coefficient of nutrients in the diets. The ingredients were properly sieved using a 595 μm sieve to remove chaff and ensure homogenous size profile, thoroughly mixed and pelleted through a 2 mm die using hand pelletizer (unbranded). The pellets were sundried at an average temperature of 42°C for a day, packed in properly labeled cellophane bags and stored in a refrigerator at 4°C before the commencement of the feeding trial.

2.3. Fish maintenance and sample collection

The fish were fed 5 times their maintenance requirement {5 × 3.2 × [fish weight (g)/1,000]$^{0.8}$} per day according to Kumar et al. (2010). The daily rations were offered in 2 equal portions at 09:00 and 16:00. The fish were fed daily except the day when they were weighed. The quantity of feed was adjusted according to the weekly weight gain and the experiment lasted for 56 days. Water temperature (27.83 ± 0.05°C), pH (8.09 to 8.36) and conductivity (0.056 ± 0.01 S/m) were measured using calibrated combined meter (Combo, Hanna). A pond lab oxygen test kit was used to measure dissolved oxygen (9.33 ± 0.44 mg/L). Nitrite (0.08 ± 0.08 mg/L) was monitored using a Colombo nitrite test kit, and ammonia was not detected using Merck (Germany) ammonium test kit. Fish faeces were collected daily for 2 weeks to the end of the experiment. One hour after the feed was administered; any feed and faeces present in the tank was removed. Fresh faeces produced by the fish after this period and before the second feed was given were siphoned immediately according to replicates to minimize leaching of nutrients into water. The collected faeces were filtered onto filter paper and dried at 105°C for 2 h. The faecal samples from each replicate tank were pooled according to treatment and stored in tagged cellophane bags in a freezer at −10°C. Based on chromic oxide content of the diet and nutrient content of the diet and faeces, digestibility coefficients for feed protein, energy and lipid were determined using the acid digestion method of Furukawa and Tsukahara (1966) and calculated using the relationship: Apparent digestibility coefficient (ADC, %) = 100 − [100 × (%Cr_2O_3 in diet × %nutrient/energy in faeces)/(%Cr_2O_3 in faeces × %nutrient/energy in diet)]. Five fish were collected at the start of the experiment and also at the end from each replicate of the dietary treatments, killed by decapitation and stored in tagged polythene bag in a freezer at −10°C for subsequent biochemical analysis.

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