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Research Article

Growth Performance, Feed Utilization and Body Composition of Nile Tilapia (*Oreochromis niloticus*) Fingerlings Fed *Moringa* (*Moringa oleifera* Lam.) Seed Meal

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Abstract

Objective: The main aim of the present study to determine the effect of dietary *Moringa* Seed Meal (MSM) (*Moringa oleifera* Lam.) on growth performance, feed efficiency and body composition of Nile tilapia (*Oreochromis niloticus*) fingerlings. **Methodology:** Feeding trail was conducted for 83 days. Fish were fed diets formulated with graded levels of *Moringa* seed meal (0, 4, 8 and 12%). All the diets were isonitrogenous (28% crude protein kg^{-1}) approximately isocaloric (3581.5). Fish (240) were fed diets in 12 glass aquaria (each $60\times30\times40$ cm^3). Treatments were divided into 4 groups each one was represented with 3 aquaria. In each aquaria, 20 fish was distributed with initial weight (12.58 g). Twice daily diets were fed to fish at feeding level (3%) of total biomass. **Results:** All feed levels of MSM improved fish performance and body composition significantly. **Conclusion:** The main target of the present study is to use MSM as an alternative plant protein to decrease the production cost and be added value in fish diet.

Key words: Nile tilapia, *Moringa* seed meal, growth performance, feed

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Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

One of the ideal species for culture is Nile tilapia because, tilapia is highly tolerant for different environmental conditions and having fast rate of growth.

International production of farmed tilapia was 383.654 t in 1990 (4.5%) of total production and increased to 4.507.002 t in 2012 (6%) of total aquiculture production and (10.2%) of farmed fish production with (13.5%) average annual growth[1]. The rapid increase of tilapia production shifted tilapia culture from extensive and semi-intensive to intensive production systems, leading to elevated dependence on feed formulations[2]. However, searching to adequate and cost effective feed formulation for tilapia represent a challenge facing tilapia culture[3].

Efforts to reduce feed costs should therefore be focused on replacement extensive animal ingredients in diet formulations with natural plant protein[4]. However, the limited FMs supply, competition for their use with other animal production sectors and continuous increase in their prices are currently the main constraints limiting the use of FMs as a protein source in fish feeds. Therefore, plant-based protein sources, particularly soybean meal (SBM) have been widely used as partial or total fish meal replacers in aqua feed industry[5]. However, the over-dependence on SBM will cause a hike in the price of soybean meal, therefore, utilization of other an inexpensive plant protein reducing the feed cost[4].

Fast growing plant *Moringa* (*Moringa oleifera*) is widely available in tropics and subtropics zones. *Moringa* play a great economical role in medicinal and industrial sectors[6,7]. Its seeds have been extensively investigated as a source of oil. Content of *Moringa* seed protein are higher than proteins of grain legumes and soybean[8]. Analyses of *M. oleifera* seeds revealed high levels of protein[9,10]. The EAA composition in *Moringa* seed cake showed high essential amino acids, especially the sulfur amino acids (methionine, cystine and tryptophan)[11] except for lysine, threonine and valine)[9]. However, these amino acidsare very low in soybean meal.

Moringa acquiring double goal, the first one contain high levels of methionine which play important role in protein synthesis and the second one contain low concentrations of anti-nutritional factors in the seeds[8].

So, *M. oleifera* seed cheaper, less competitive, not relatively in high demand and resistant to drought, compared to soybean meal. The main objectives of this study are to assess using *Moringa* Seed Meal (MSM) on Nile tilapia fingerlings growth performance, feed utilization and body composition.

MATERIALS AND METHODS

Fish and culture facilities: Monosex (all male) Nile tilapia juveniles (12.5 g) used in the present study were obtained from a commercial tilapia farm at Abbassa, Sharkia governorate, Egypt. Four treatments with triplicate groups of fish were stoked in12 aquaria ($60\times30\times40$ cm^3) at an closed water system present in fish nutrition Laboratory in the National Research Centre, Dokki, Giza, Egypt at a density of 20 fish/aquarium. The fish were acclimated to the culture system for 2 weeks, during which they were fed the tested diets. At the end of the acclimation period, a random sample of 100 fish was netted from fish stock, weight collectively and the average initial weights were recorded.

Water quality parameters, including water temperature (T), Dissolved Oxygen (DO) and pH were monitored weekly.

Test diets and feeding regime: Four isonitrogenous (28% crude protein kg^{-1}) and isocaloric (3581.5 kcal kg^{-1}) tested diets were prepared. *Moringa* seed meal (30.24% crude protein, 8.39% crude lipid, 29.92% crude fiber, 5.51% ash and 25.94% NFE) was incorporated at levels of 0, 4, 8 and 12% (Table 1). The test diets were fed to the fish twice a day (at 8 am and 13 pm) for 83 days. The diets were offered at 3% of the fish body weights during the experiment. The average weight of fish was recorded every 15 days intervals, their average weights were recorded and the daily rations were readjusted accordingly.

Table 1: Composition and proximate analysis (%) of the test diets

Ingredient (%)	0.0%	4%	8%	12%
Concentrate	17.0	18.85	19.5	20.73
Soybean meal	40.0	36.0	32.0	28.0
Corn	28.0	28.0	28.0	28.0
Wheat bran	10.0	8.75	7.5	6.27
Oil	3.0	3.0	3.0	3.0
Premix*	2.0	2.0	2.0	2.0
Moringa seed meal	0	4.0	8.0	12.0
Total	100	100	100	100
Crude protein	28.65	27.57	28.63	28.54
Crude lipid	9.2	9.3	9.06	11.59
Ash	9.33	9.17	9.36	9.68
Crude fiber	9.5	9.7	12.8	12.6
NFE[#]	43.32	44.26	40.15	37.59
GE (kcal)[$]	3479	3563	3609	3675

*Contains (kg^{-1}): Vitamin A: 3,333,333 IU, Vitamin D_3: 833.333 IU, Vitamin E: 3,333 mg, Vitamin K: 333 mg, Vitamin B_1: 333.3 mg, Vitamin B_2: 1,667 mg, Vitamin B_6: 500 mg, Vitamin B_{12}: 3.33 mg, Niacin: 10,000 mg, Pantothenic acid: 3,333.3 mg, Folic acid: 333.3 mg, Biotin: 16.7 mg, Iodine, 100 mg, Iron: 10,000 mg, Manganese: 20,000 mg, Copper: 1,333 mg, Cobalt: 33.3 mg, Selenium: 33.3 mg, Zinc: 16,667 mg and Calcium carbonate: 1,000 mg, [#]Nitrogen Free Extract (NFE), determined by differences, [$]Gross energy value was calculated from their chemical composition, using the factors 5.65, 9.45, 4.00 and 4.00 (kcal g^{-1}) for protein, fat, fiber and NFE, respectively[12]

Body composition analysis: At the end of the experiment, fish in each aquarium were netted, counted, weighed and frozen at -20°C for final body composition analysis. Initial body analysis was performed on a pooled sample of 100 fish, which was weighed and frozen before the experiment. A sample of each test diet was also stored -20°C for chemical analysis. Proximate analyses of the test diets and whole-body moisture, protein, lipid and ash were performed according to the standard AOAC[13] methods.

Calculations of fish performance: Growth rates and feed efficiency were calculated as follows:

$$\text{Weight Gain (WG)} = (Wf-Wi)$$

$$\text{Specific Growth Rate (SGR)} = 100\ (\text{LnWf-LnWi})/t$$

where, Wi and Wf are initial and final weights (g) and t is time of experiment (days).

$$\text{Feed Conversion Ratio (FCR)} = \frac{\text{Dry feed intake (g)}}{\text{Fish live weight gain (g)}}$$

$$\text{Protein Efficiency Ratio (PER)} = \frac{\text{Weight gain (g)}}{\text{Protein intake (g)}} \times 100$$

$$\text{Protein Productive Value (PPV)} = \frac{\text{Protein gain (g)}}{\text{Protein fed (g)}} \times 100$$

$$\text{Energy Retention (ER)} = \frac{\text{Retained energy in carcass (kcal)}}{\text{Energy intake (kcal)}} \times 100$$

Statistical analysis: All data were subjected to one-way analysis of variance (ANOVA) at a 95% confidence limit, using SPSS[14] software, version 12. Duncan[15] multiple range test was used to compare means when F-values from the ANOVA were significant ($p<0.05$).

RESULTS

Water quality parameters (Temperature, pH) were monitored every week through the whole experimental period and they were the tolerable ranges for Nile tilapia (*Oreochromis niloticus*) culture in all the treatments[3], water temperature was around (27.5°C) and pH was (7.95).

All fish having no sign of disease throughout the whole period of experiment.

Growth parameters of Nile tilapia: Average values of initial weight, final body weight, weight gain and specific growth rate of Nile tilapia fed graded levels of MSM are presented in Table 2. The results indicated that, there was no significant differences ($p<0.05$) among all treatments in initial weight which reflect homogeneity in fish weight at the beginning of the experiment.

No significance was observed in final weight as revealed by the results between the control diet and each of the tested diets except the second treatment (4% *Moringa* seed meal). The lowest final weight was recorded in diet 2 (24.23) while the other values were almost similar (27.3, 28.03, 27.6) and did not differ significantly. The heighest weight gain was recorded in treatment 3 and 4 (8 and 12% MSM) have the same trend as in final weight. The differences in specific growth rate between the 2nd treatment 4% (3.70) and each of the control and other tested diets (8 and 12%) were significant.

Feed utilization: Table 3 indicated that in feed utilization there were significant difference among all treatments ($p<0.05$) in Feed Intake (FI), Feed Conversion Ratio (FCR), Protein Efficiency Ratio (PER) and Energy Retention (ER) parameters except Protein Productive Value (PPV) where the differences among the control diet and the other tested diets were not significant. Generally the best values were recorded in the higher *Moringa* levels (8 and 12%) in feed intake, best FCR, PER and ER (49.43, 3.20, 1.29 and 17.47) for 8% treatment and (49.63, 3.31, 1.25 and 16.48) for 12%, respectively.

Table 2: Growth performance parameters of Nile tilapia fed the tested diets

Treatments (%)	Initial weight (g)	Final weight (g)	Weight gain (g)	Specific growth rate
0	12.60	27.30 ± 1.79^{a}	14.69 ± 1.80^{ab}	3.86 ± 0.09^{a}
4	12.57	24.23 ± 0.52^{b}	11.66 ± 0.52^{b}	3.70 ± 0.03^{b}
8	12.58	28.03 ± 0.23^{a}	15.44 ± 0.25^{a}	3.90 ± 0.01^{a}
12	12.58	27.60 ± 0.60^{a}	14.99 ± 0.03^{a}	3.88 ± 0.01^{a}

Values in the same column with different superscripts are significantly different at $p<0.05$

Table 3: Feed utilization parameters of Nile tilapia fed tested diets

Treatments (%)	Feed intake	FCR	PER	PPV	ER
0	52.27 ± 3.68^{a}	3.60 ± 0.20^{ab}	1.22 ± 1.50^{ab}	20.47 ± 0.73^{a}	13.90 ± 0.60^{d}
4	45.27 ± 0.69^{b}	3.89 ± 0.13^{a}	0.97 ± 0.04^{b}	22.53 ± 1.37^{a}	14.07 ± 0.71^{c}
8	49.43 ± 0.29^{ab}	3.20 ± 0.05^{b}	1.29 ± 0.02^{a}	23.90 ± 1.67^{a}	17.47 ± 1.04^{a}
12	49.63 ± 0.70^{ab}	3.31 ± 0.05^{b}	1.25 ± 0.0^{a}	24.36 ± 0.84^{a}	16.48 ± 0.34^{b}

Values in the same column with different superscripts are significantly different at $p<0.05$

Table 4: Body composition on dry matter basis of Nile tilapia fed the tested diets

Treatments	DM	Crude protein	Ether extract	Ash
Initial	17.00	54.63	16.18	11.4
0%	24.20±1.06	61.50±0.26^{b}	16.22±0.48^{c}	6.86±0.14^{b}
4%	25.09±0.94	62.43±0.47^{ab}	15.58±0.44^{c}	5.85±0.41^{b}
8%	25.35±0.99	61.38±0.38^{b}	21.20±0.23^{a}	10.70±0.44^{a}
12%	25.54±0.78	63.00±0.11^{a}	19.11±0.63^{b}	10.12±0.08^{a}

Values in the same column with different superscripts are significantly different at p<0.05

Body composition: Statistical analysis of Nile tilapia body composition (Table 4) fed graded levels of MSM showed no significant differences (p<0.05) among all treatments at the end of the experiment in DM. Meanwhile the other parameters (CP, EE and Ash) indicated that there were significant differences (p>0.05) between different treatments. The highest CP found in carcass for 12% MSM (63.00) and 8% (61.38), however, the other levels showed little difference between them (0, 4 and 8%) (61.50, 62.43 and 61.38), respectively and all the levels at the end of the experiment showed superiority than the CP at the beginning of the experiment.

Ether extract content in fish carcass was higher in fish received 8% MSM (21.20), followed by 12% (19.11), then 0 and 4% (16.22 and 15.58) with no significant difference between them.

Concerning ash of the final carcass, there were significant differences between treatments. The highest one was recorded in 8 and 12% (10.70, 10.12) with no significant difference between them, followed by (0 and 4%) with no significant differences between them two (6.86, 5.85).

DISCUSSION

The previous results cleared that the maintenance of the growth performance parameters may be due to the high content of crude protein and fat in the proximate composition of *M. oleifera* seed. This previous results of the present study was in agreement with the results of Ndabigengeser and Narasiah[16]. *Moringa* seeds are a good source of fats, proteins and crude fibers[17,18]. These go parallel with results of Bamidele *et al.*[19] who found that the results of the growth response observed in their study might probably be an indication that the parameters were influenced by the replacement levels of soybean meal by MSM. Results showed that dried MSM could replace soybean meal upto 75% replacement level without any negative influence on the growth, beyond which growth was significantly depressed.

The lower feed intake recorded when MSM increased above 75% in the diet may be due to the lower palatability, which might be due to the presence of tannin in the dried MSM[19].

Tannins interfere with digestion by displaying anti-trypsin and anti-amylase activity, forming complexes with vitamin B12 and inferring with the bioavailability of proteins[20,21]. Consequently presence of 2.4% tannin in faba beans (*Vicia faba* L.var. minuta) might be responsible for low palatability and low feed intake by Nile tilapia[22].

Yuangsoi *et al.*[23] found that the decreasing of growth performance and growth parameters may be be attributed to several factors, one of them the presence of anti-nutrients. Anti-nutritional compounds may narrow the use of high levels of vegetable feedstuffs in fish feeds[24]. In fact, a decrease in nutrient utilization, mediated by soybean carbohydrates has been reported in salmonids[25]. High levels of phytic acid (25.8 g kg^{-1}) greatly decreased the growth rate in salmon fish[26]. These could be the mild factors causing growth retardation. *Moringa* kernel samples contain higher phytate contents than vegetative parts[27]. Phytic acid can decrease the protein digestibility by the formation of phytic acid-protein complexes via depressing the absorption of nutrients[28]. Phytates present to an extent of 1-6 g kg^{-1} reduced mineral bioavailability in monogastric animals particularly[29], Zn^{2+} and Ca^{2+}. It has been reported that 50-60 g kg^{-1} diet can reducing the growth of rainbow trout[29] and common carp[30]. Taking in consideration, phenolic compounds reducing growth performance and feed utilization in tilapia[31] and in common carp[32]. The tannin content appears to be directly related to protein digestibility[33]. Giner-Chavez[34] reported that levels from 5.0-20.0 g kg^{-1} can cause depression in growth and the levels of tannins above 50 g kg^{-1} in the diet, which are often lethal. However, plant protein ingredients are of low nutritional value, they have possible palatability problems and to lower feed intake[35]. Yuangsoi *et al.*[23] found that the replacement of protein in soybean meal with *Moringa* seed cake in fish feed did not lead to mortality and slightly lower growth performance of fish fed more than 750 g kg^{-1} of soybean meal protein replacement. Thus, dietary *Moringa* seed cake was readily consumed and safe for bocourti's cat fish, these results go parallel with the results of the present study due to using low levels from MSM than the aforementioned studies to be sure that the diets safe with minimal limit of anti nutritional factors present in *Moringa* seeds.

CONCLUSION

Dietary MSM was readily consumed and safe for Nile tilapia and can efficiency be used as aplant protein source and

as alternative protein source in fish diet reducing the production cost of the fish diets and add value to a plant origin.

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