REPLACEMENT OF FISH MEAL PROTEIN BY OKARA MEAL IN PRACTICAL DIETS FOR ALL-MALE MONOSEX NILE TILAPIA (*OREOCHROMIS NILOTICUS*)

MOHAMMAD H. AHMAD[1] AND AHMED S. DIAB[2]

1. Fish Nutrition Dept. and 2- Fish Disease Dept., Central Laboratory for Aquaculture Research, Abbassa, Abo-Hammad, Sharkia, Egypt.

Corresponding author e-mail: md_ahmad55@yahoo.com

Abstract

A 15-week experiment was conducted to evaluate the use of okara meal (soybean by–product) in practical diets for all-male monosex Nile tilapia, *Oreochromis niloticus* (30.1±0.1 g). Five isonitrogenous diets (25% protein) were formulated in which okara replaced 0.0%, 25%, 50%, 75%, or 100% of the protein supplied by herring fish meal (HFM). Fish were fed one of the tested diets at the rate of 3% of body. Diets were offered 6 days a week; 2 times a day at 9.00 and 14.00 h. Results demonstrated that okara meal has good potential as a complete substitute of the protein supplied by HFM in the tested diets with no significant ($P > 0.05$) adverse effects on growth performance, feed efficiency, and protein utilization compared to fish fed the HFM–based diet (control diet). Survival rate of fish fed all the tested diets was high and ranged from 96.70% to 100% without significant difference among them ($P > 0.05$). At the end of the study, partial or complete replacement of okara meal for HFM–protein in diets did not affect fish body composition of dry mater, protein, or fat levels compared to the control treatment. The study clearly indicated that okara meal could serve as a complete replacement for fish meal in practical diets for all-male monosex Nile tilapia.

Keywords: Okara meal, soybean by-product, Nile tilapia, growth, feed utilization, proximate chemical composition.

INTRODUCTION

Feeding costs represents over 50% of the operation costs of fish farming. The shortage in world production of fish meal (FM), which is the main conventional protein source coupled with its increased demand in feeds for livestock and poultry is likely to reduce the dependence on it as a single protein source in aqua feeds (El-Sayed, 1999). FM is considered the most desirable animal protein ingredient in aquaculture feeds because of its high protein content, balanced amino acid profile, high digestibility and palatability, and as a source of essential n-3 polyenoic fatty acids (Hardy and Tacon, 2002). Therefore, fish nutritionists have made several attempts to partially or totally replace fish meal with less expensive and locally available protein sources.

Okara meal (OM) is the residue left from ground soybean after extraction of the water extractable fraction used to produce soy milk and tofu (O,Toole, 1999). About 1.1 kg of fresh OM is produced from every kilogram of soybean processed for soymilk (Khare *et al.*, 1995). Huge quantities of OM are produced. In Japan, about 700000 tons of OM were produced from the tofu production industries in 1986, most of which was burnt as waste (Ohno *et al.*, 1993). Recently, in Egypt, there are some small industries produce soymilk, tofu, and other soy products producing OM as a waste. The chemical analysis of OM on dry matter basis was 34% crude protein, 22.5% crude fiber, 12.7% ether extract, 27.5% nitrogen free extract, and 3.8 % ash (Farhat *et al.*, 1998).

Ma *et al.* (1996) conducted some studies to evaluate the use of OM in poultry feeding and reported that it has a high quality protein for livestock feeding. Abd-Elsamee *et al.* (2005) reported that the use of OM as a replacer for soybean meal in broiler diets up to 60% did not adversely affect feed conversion and improved the economical efficiency.

This study was carried out to evaluate the use of OM as a herring fish meal (HFM) substitute in practical diets for fingerlings all-male monosex Nile tilapia and its relation to growth performance, feed utilization, and whole-fish body composition.

MATERIALS AND METHODS

Analysis of Water Quality

Water samples were collected every 2 weeks from the entrance, the middle and the end of cages location. Water temperature and dissolved oxygen were measured by oxygen-meter YSI model 58, USA. The pH degree was measured by a pH-meter, and water conductivity and salinity were measured by conductivity-meter (YSI model 33, USA). Water transparency was measured by Secchi disk.

Table 1. The range of water quality parameters during the experimental period 2007.

Site	Temp. °C	D.O. mg/l	S.D. cm	pH	NH3 mg/l	TDS g/l	Salinity g/l
Water entrance to cages	22.5-29.5	0.5-4	67	8	1.1-2.2	2.232	1.1
Cage in middle	23.5-29.5	0.3-3.5	65	8	1.3-2.4	2.238	1.1
Cage in the end	23 -30	0.1-3.2	64	8	1.4-2.4	2.241	1.1
Outlet of water	23.5-29.5	0.1-3.0	67	8	1.4-2.4	2.244	1.1

The values of these parameters are within the acceptable range of fish farming except dissolved oxygen (Boyd, 1990).

Diet Preparation and Feeding Regimen

Five diets were formulated to be is nitrogenous (25.2% crude protein) and isolipidic (6.92% crude fat). All the diets contained a constant level of plant protein from soybean meal (SBM), corn meal and wheat bran to complete the protein requirement. The proximate chemical compositions of the main ingredients in the diets were analyzed and are shown in Table 2. A consideration was also given to the equivalence of other components such as fiber. The composition of the diets is shown in Table 3. Diet 1 (control) contained herring fish meal (HFM) as a sole source of animal protein, diet 5 contained OM as a replacement source of animal protein. Diets 2 to 4 contained mixtures of HFM and OM with the proportions of each adjusted so that each of the two ingredients provided similar graded levels of protein. Graded levels of protein replacements were 100%, 75%, 50%, 25% and 0% respectively. In the present study, the OM had been obtained from the soybean Research section, Agriculture Research Center, Ministry of Agriculture, Giza, Egypt. The diets were prepared, palletized, stored as previously described by Abdelghany (2003).

Table 2. Proximate chemical analysis Herring fish meal (HFM), okara meal (OM), soybean meal (SBM) and corn meal (CNM) (%; on dry matter basis).

	HFM	OM	SBM	CNM
Chemical analysis				
Dry matter	92.50	93.77	93.81	88.37
Crude protein	71.26	36.57	45.60	9.30
Total lipids	14.18	12.10	6.27	5.47
Ash	11.05	4.11	7.87	1.2
NFE*	2.17	31.23	34.79	68.89
Crude fiber	0.70	15.99	5.42	15.14
Gross energy (GE)**	536.65	448.83	459.64	388.38

*Nitrogen-Free Extract (calculated by difference) = 100 – (protein + lipid + ash + fiber).
**Gross energy was calculated from (NRC, 1993) as 5.65, 9.45, and 4.1 kcal/g for protein, lipid, and carbohydrates respectively

1.40; wheat bran, 1.40; starch, 2.0; fish oil, 7.0; corn oil, 5.0; vitamin premix, 7.0; mineral mixture, 3.0; cellulose 3.0. An additional 50.0 LE/ton manufacturing cost.

RESULTS

The chemical analysis of the ingredients (HFM, OM, SBM, and CNM) is present in diets and all diets were well accepted by Nile tilapia. Fish accustomed to the experimental diets and were observed to feed actively throughout the duration of this study. Initial body weigh at all experimental treatments did not differ significantly (Table 4). The partial or complete replacement of OM for HFM in all experimental diets did not significantly influenced Nile tilapia survivability (Table 4). Survival rate of fish fed all the treatments was high and ranged from 96.7 to 100 % without significant difference among them ($P > 0.05$; Table 4). The present study showed that growth performance (final body weight, weight gain, weight gain%, and specific growth rate) was not significantly ($P > 0.05$) differed. Diet utilization (feed intake, FCR, FER, and PER) was not significantly ($P > 0.05$) affected by OM inclusion levels.

Table 4. Growth performance and feed utilization of Nile tilapia fed diets containing different levels of OM. The same letter in the same row is not significantly different at $P < 0.05$.

	OM levels (%)				
	0.0	25	50	75	100
Initial weight (g)	30.00±0.05	30.00±0.01	30.07±0.03	30.00±0.01	29.97±0.08
Final weight (g)	97.10±0.49	97.83±0.67	98.20±0.46	97.80±0.66	97.23 ±0.54
Weight gain (g)	67.10±0.47	67.83±0.69	68.13±0.46	67.80±0.72	67.26±0.59
SGR (%g/d)	1.12±0.01	1.13±0.01	1.13±0.01	1.13 ±0.02	1.12±0.02
Weight gain %	223.67±1.5	226.10±2.42	226.57±1.57	226.00±2.97	224.42± 2.45
FI (g feed/ fish)	134.67±1.58 b	139.74±2.77ab	139.06±1.19ab	141.15±1.45 a	139.81±1.52ab
FCR	2.01±0.02	2.06±0.02	2.04±0.01	2.08±0.03	2.08±0.02
FER	49.83±0.75	48.54±0.49	48.99±0.22	48.03±0.87	48.13±0.77
PER	2.18±0.1a	2.11±0.02b	2.13±.01ab	2.10±0.02b	2.12±.06b
Survival rate (%)	100±0.0	96.7±1.7	100±0.0	98.9±1.1	100+0.0
Cost (LE/ton diet)	2665.00	2516.06	2297.04	2066.46	1837.67

The whole-body composition of all-male monosex Nile tilapia at the end of the study is shown in Table 5. The partial or complete replacement of OM for HFM–protein in diets did not reduce fish composition of dry matter, protein, or fat levels compared to the control treatment. Ash levels were irregularly fluctuated in fish bodied among treatment at the end of the experiment.

Table 5. Proximate chemical analyses (%; on dry matter basis) of Nile tilapia fed diets containing different levels of OM. The same letter in the same row is not significantly different at $P < 0.05$.

	OM levels (%)				
	0.0	25	50	75	100
Dry matter	24.52±0.17	25.58±0.55	25.50±0.62	25.89±0.30	25.69±0.74
Crude protein	62.54±0.49	62.86± 0.37	62.93±0.39	63.00±0.22	64.77±0.45
Total lipid	16.59±0.47	16.32±0.24	16.24±0.42	16.12±0.53	16.48±0.79
Ash	20.55±0.33	19.99±0.34	20.20±0.16	20.38±0.17	18.03±0.43

The economical evaluation of the experimental diet contained different OM levels to replace 25, 50, 75, and 100% of HM are shown in Table (6). The cost to produce one kg of the experimental diet compared with the cost of control diet showed that the lowest cost was obtained when diet contained 100% OM. The reduction in feed cost compared with control diet showed 26.09 % to produce one kg fish gain of treatment containing 100 % OM.

Table 6. Economic efficiency for production of one Kg gain of Nile tilapia fed different treatments.

Items	OM levels (%)				
	0.0	25 %	50 %	75 %	100%
Price/ kg feed P.T	2.84	2.62	2.40	2.20	2.03
Reduction in feed cost	100	7.75	15.49	22.54	28.52
FCR (kg feed/kg gain)	2.01	2.06	2.04	2.08	2.08
Feed cost / kg gain P.T	5.71	5.40	4.90	4.58	4.22
Reduction cost in kg gain	100	5.43	14.19	19.79	26.09

DISCUSSION

The using of plant conventional sources to partially or entirely replace expensive fish meal protein diets has been a good Table 2. OM is a good plant protein source and may replace HFM protein in Nile tilapia of fish nutritionists for many years. Among the all plant protein sources tasted, soybean meal has been widely used. In the present study, the chemical analysis of OM (Table 2) is similar to that reported by El-Manylawi (2007), and it was 37% crude protein, 12% ether extract, 16.5% crude fiber, and 3.78% ash.

In the present study, fish fed diets actively and grow efficiently without external sign of nutritional deficiency. Growth performance (final body weight, weight gain, and specific growth rate) of fish fed diets containing various levels of OM were similar to those of fish fed a control diet in this study. This observation suggested that the OM contained all the necessary growth factors required by all-male monosex Nile tilapia. In addition, the isoniterogenous, isolipidic, and isocaloric nature of the experimental diets, explained why there was no disparity in growth response of fish and efficiency of feed utilization. Tilapia species are mainly omnivores and can satisfy up to 50% of their amino acid requirement from natural food if available in semi-intensive farming system (Chowdhury *et al.*, 2006). Samocha *et al.* (2004) reported that the use of plant protein ingredient in tilapia diets helps the nutritionists to reduce the cost of fish production. On the other hand, Ma *et al.* (1996) conducted some studies to evaluate the use of OM in poultry feeding and found that although OM protein was nutritionally lower than soybean meal protein, it has a high quality protein for livestock feeding.

In the present study, fish fed diets in which OM replaced up to 100% of the protein supplied by HFM had similar feed utilization efficiency (FI, FCR, FER, and PER) to fish fed the control diet (Table 3). The results of growth performance and feed utilization clearly indicated that protein from OM is digested and utilized in a manner similar source of protein for HFM and its use in practical diets for all-male monsex Nile tilapia is feasible.

Dry matter of whole-fish body received OM diets was higher than that fed the control diet. These results indicated that partial or complete replacement of OM for HFM – protein did not alter the nutritional value of the fish produced. The results also suggested that all-male monosex Nile tilapia efficiently ingested, digested, assimilated and utilized protein from OM similar to HFM. These results are in agreement with Tibaldi *et al.* (2006) who reported that feeding diets that include various types and levels of soybean derivatives did not affect the whole body composition.

As a conclusion of this study, it is suggested that without amino acid supplementation, OM could safely replace up to 100% of HFM in practical diets for all-male monosex Nile tilapia. These results may allow for formulation of less expensive diet and may reduce the diet costs for producers.

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