Effect of partial and total replacement of fishmeal with sand smelt (*Atherina boyeri*) meal in practical diets for mono sex Nile tilapia (*Oreochromis niloticus*) fingerlings.

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ABSTRACT

The objective of the present study was carried out to evaluate partial and total replacing of the fishmeal protein supplied by sand smelt fishmeal (SSFM) (*Atherina boyeri*) in practical diets on fish health, growth performance and feed utilization of mono sex Nile tilapia (*Oreochromis niloticus*) fingerlings. The experiment lasted 16 weeks and includes five treatments 0, 25, 50, 75 and 100% sand smelt fish meal (SSFM), respectively. An experimental diet containing is onitrogenous diets (30% crude protein), Ten ponds includes five treatments (Two replicates-almost 4 m^3/pond) and Nile tilapia fingerlings stocked in 25 fish/m^3 (7.65±0.3 g at initial body weight).

The highest weight gain WG (75.94 g) was recorded for fish fed the 25% replacing diet (SSM25) followed by those fed the diet SSM50 (75.24 g), SSM75 (74.26 g), SSM0 (73.16 g) and SSM100 (72.14g), respectively and the differences in weight gain among the different fry groups were significant ($P<0.05$) and the same trend was observed for specific growth rate SGR. The average feed intake and feed conversion ratio and protein efficiency ratio of Nile tilapia were significantly ($P<0.05$) affected by the incorporation of sand smelt fish meal as a substitute of fish meal.

Dry mater in whole fish body ranged between 28.83 and 29.59 with insignificant differences. Crude protein ranged between 55.69 and 58.06, ether extract ranged between 25.16 and 28.67, ash ranged between 14.83 and 15.58 with significant differences for ether extract and protein content of whole fish bodies.

The present study indicated that replacing up to 75% of FM by SSM higher affected growth and feed utilization and reduced feeding costs by 13.99% for Nile tilapia (*Oreochromis niloticus*) fingerlings compared with control. Also, The results showed he can use sand smelt meal as an alternative to fish meal (Herring meal) at a rate of 100% in diets fed Nile tilapia without effect on the growth of total production compared to the control, which leads to higher economic returns.

Keywords: Sand smelt meal, Fish meal replacement, *O. niloticus,* Growth performance, Feed utilization.

INTRODUCTION

Egypt is the leading country of aquaculture, especially aquaculture in fresh waterin Africa. The national governmentaims to increaseper capitaanimal proteinbyincreasing fish production and ensure their availabilityat low pricesto the consumer.

Nutrition is the most expensive component in the intensive aquaculture industry, where it represents over 60-70% of operating costs. Moreover, a protein component represents 55-75% of the total diet cost (FAO, 2015). In this regard, nutrition research that reduces the cost of fish feeds without reducing their efficacy will be crucial to the successful development of aquaculture.

In general, fish meal has been the major animal protein ingredient source in aquaculture diets because of its nutritional quality and for many reasons such as high protein content, rich source of essential amino acids, higher nutrient and energy digestibility, essential fatty acids, minerals and lack of anti-nutrients. It is also highly palatable and digestible to most freshwater and marine fishes (Watanabe *et al*. 1997; Glencross *et al*., 2007). Thus the main challenges for the aqua feed industry are to reduce the inclusion rate of fishmeal in aqua feeds and to identify economically viable and environmentally friendly alternatives (Gatlin *et al*., 2007; Agbo, 2008).

Several materials have been tested as alternative protein sources, such as animal by-products, single cell proteins, including micro algae, bacterial single cell protein and yeast (El-Sayed, 1998; Perera *et al*., 1995; Mazurkiewicz, 2009), and plant proteins (Guillaume and Métailler, 1991; Hasan *et al*., 1997). However, the rising cost and its limited availability of fish meal has led to investigations of either lowering or replacing the fishmeal content with more economic protein sources of plant and/or animal origin (Hardy, 2006; Gimenez *et al*., 2009; Gumus and Ikiz, 2009; Sevgili *et al*., 2009). The efficiency of various alternative animal protein sources has been evaluated in fish diets, e.g., meat and bone meal (Zhang *et al*., 2006), poultry by-product meal (Yang *et al*., 2006; Pine *et al*., 2008; Saoud *et al*., 2008), turkey meal (Muzinic *et al*., 2006), Gambusia meal (Abdelghany, 2003; Ahmad, 2008) and tuna liver meal (Gumus *et al*., 2009). The need for cheap, protein rich foods is a universal requirement, relevant to large and small producers alike. Sand smelt (*Atherinaboyeri*) enters Mediterranean Sea, Red Sea, the Nile River, and most of the Lakes and canals in Egypt. It abundantly and unintentionally produces in natural environments and, as an invasive species, competes with native fish for food, dissolved oxygen, and space. Generally, sand smelt is used for human consumption in the range narrow and has low economic value. Almost all caught sand smelt is used in fish farms as fresh feed and often leads to health problems. Therefore, sand smelt should be turned into a meal. The purpose of this study was to assess the suitability of using partial and total replacing of sand smeltfish meal (SSFM) as a substitute and a source cheaper of fish meal protein instead of expensive and scarce Herring fish meal (HFM) in practical diets on fish health, growth, feed utilization, whole body composition and productive performance of sex-reversed all male Nile tilapia (*Oreochromis niloticus*) fingerlings.

MATERIALS AND METHODS

The present study was carried out at the Baltim station belonging to the National Institute of Oceanography and Fisheries. The aim of the experiment is to investigate the effect of incorporation of increasing levels of sand smelt fish meal (SSFM) in the diets of Nile tilapia (*Oreochromis niloticus*). The practical work of the present experiment was started on the 8th August 2014 and lasted until the 8th December of the same year (16 weeks). Ten rectangular concrete ponds 4.6*2.4*0.37m were filled by underground water mixed with the drinking tap water for reduces the salinity optimum range (2 replicates for each treatment) and each pond was stocked with 25/m^3 fish with an initial weight ranged from 7.60 and 7.70g,

The experimental fish were obtained from private hatchery, Tollumbat No.7 in Riyad City, Kafr El-Sheikh Governorate. After acclimatization fish were randomly distributed into the experimental pond representing the five treatments at stocking body weight (BW) and body length (BL) for each pond were recorded. The ponds were cleaned and water was replaced every four days, dissolved oxygen was maintained by continuous aeration and water temperature at 27.2 to 29.8°C

Diet preparation:

Five diets were prepared by thoroughly mixing the ingredients which composed of fish meal, soybean meal, sand smelt fish meal, yellow corn, wheat bran and linseed oil. Proximate composition of the feed ingredients used in the experimental diets is given in (Table 1) with the different percentage (Table 2).

Table 1: Proximatecomposition of the feed ingredients used in the experimental dietformulation (% of dry matter).

Ingredients	Proximate composition						
	DM	CP	EE	CF	Ash	NFE*	GE**
Fish meal	91.33387	72.31	7.07	0.6	17.62	2.4	4844.33
Sand smelt meal	87.39	65.3	4.72	0.66	17.49	11.83	4614.70
Soybean meal	88.5	44	4.82	7.3	6.75	37.13	4462.65
Yellow corn	87.5	8	5.27	2.3	2.91	81.52	4299.16
Wheat bran	88.62821	15.31	8.86	9.9	5.27	60.66	4192.99

(DM=Dry matter, CP=Crude protein, EE=Ether extracts*, CF=Crude Fiber, NFE=Nitrogen Free Extract, GE = Gross energy)
* Calculated by differences [Nitrogen free extract (NFE) =100-(CP+ EE+ CF+ Ash)]
** Gross energy value was calculated from their chemical composition, Estimated according to NRC (1993). As 5.64, 9.44 and 4.11 Kcal/g for protein, lipid and NFE, respectively.

Table 2: Dietary formulation and proximate composition of the experimental diets using Sand smelt meal as a partial and completly replacement for fish meal (% of dry matter).

Ingredient (%)	Graded levels of SSM in Experimental Diets (%)				
	D1 - 0% (Control)	D2 - 25%	D3 - 50%	D4 - 75%	D5 - 100%
Fish meal	20	15	10	5	0
Sand smelt meal	0	5.54	11.08	16.62	22.16
Soybean meal	25	25	25	25	25
Corn	30	29.46	28.92	28.38	27.84
Wheat bran	15	15	15	15	15
***Vit & Min .Mix.**	2	2	2	2	2
Linseed Oil	6	6	6	6	6
****CMC**	2	2	2	2	2
Total	100	100	100	100	100
Chemical analysis of the experimental diets (% on DM basis)					
Dry matter (DM) %	91.27	90.92	90.82	90.68	89.98
Crude protein (% CP)	30.16	30.12	30.08	30.04	30.04
Crude lipid (% CL)	12.99	13.38	13	13.22	12.47
Crude fiber (CF) %	8.32	6.89	7	8.18	7.51
Ash%	4.44	4.42	4.43	4.41	4.44
*****NFE%**	44.09	45.19	45.49	44.15	45.54
******GE (Kcal/ kg)**	4685.07	4764.90	4739.16	4702.65	4689.01
*******DG (Kcal/ kg)**	3513.80	3573.67	3554.37	3526.99	3516.76
C/P %ratio	64.37	63.21	63.46	63.87	64.06

1. Control diet (D_1); without Sand smelt meal(0 % SSM),
2. Diet (D_2); substituted by (5.54 % SSM)with 25% replacement of fish meal protein,
3. Diet (D_3); substituted by (11.08 % SSM) with 50 % replacement of fish meal protein,
4. Diet (D_4); substituted by (16.62 % SSM)with 75% replacement of fish meal protein,
5. Diet (D_5); substituted by (22.16 % SSM) with 100 % replacement of fish meal protein.

* Vitamin & mineral mixture/kg premix: Vitamin D, 0.8 million IU; A, 1.33g; D3, 1.68g; E, 6.66g; C, 16.8g; k, 0.8g; B1, 0.4g; Riboflavin 3.75g; B6 2.45g; B12, .33mg; NI, 9.42g; Pantothenic acid, 12.42g; Folic acid, 0.68g; Biotin, 16.6mg; BHT, 0.5g; Mn, 14.7g; Zn, 31.6g; Fe, 18.3g; 1, 0.62g; Selenium, 0.22g and Co, 6.8mg.
** Carboxy methyl cellulose.
*** Calculated by differences [Nitrogen free extract (NFE) = [100-(CP+ EE+ CF+ Ash)]
**** Estimated according to NRC (1993). As 5.64, 9.44 and 4.11 Kcal/g for protein, lipid and NFE, respectively.
***** Digestible energy, estimated according to Jobling, (1983), using digestible energy = gross energy X 0.75.

In preparing the diets, dry ingredients were first ground to a small particle size. Ingredients were mixed and then water was added to obtain a 30% moisture level. Diets were passed through a mincer machine with diameter of 3 mm and were sun dried for 3 days. The experimental diets were formulated to replace 0, 25, 50, 75 or 100% of FM by SSM based on protein content. All diets were formulated to be isonitrogenous (30% protein) and isocaloric (3500 kcal ME/kg diet).

Tilapia fish fed the pelleted diets (3 mm in diameter) at a daily rate of 3% of total biomass 6 day/week (twice daily at 9.00 am and 3.00 pm), and the amount of feed was weekly adjusted according to the changes in body weight throughout the experimental period (16 weeks). Water temperature, pH and dissolved oxygen were measured daily at 2.00 pm while total ammonia and nitrites were weekly measured. Water quality parameters measured were found to be within acceptable limits for fish growth and health (Boyd, 1979).

Essential amino acid composition of the experimental diets, Sand smelt meal and Herring fishmeal:

Experimental diets, Sand smelt meal and Herring fishmeal were analyzed for essential amino acid composition (Table 3). Amino acid was analyzed using HPLC after a 20 hour hydrolysation process with 6 molar HCI and a previous stabilization with BA (OH) 2 of tryptophan. Separation of amino acids was made using an inner hyperbole ODS 250 x 4 mm-column after pre-column derivatisation with OPA (orthophtalaldehyde). The diets contained all essential amino acids needed to meet the requirements for Nile tilapia fry (NRC, 2011).

Table 3: Amino acid composition of sand smelt meal, herring meal, diets and amino acid requirements for *O. Niloticus* (% of dry matter).

Amino acid	Requirements for *O. Niloticus*	Herring Fish meal	Sand smelt meal	Graded levels of SSM in experimental diets (%)				
				D1 0%	D2 25%	D3 50%	D4 75%	D5 100%
Arginine	1.2	3.73	4.96	1.77	1.86	1.94	2.03	2.11
Histidine	1	1.53	1.3	0.72	0.71	0.71	0.70	0.70
Isoleucine	1	3.64	2.6	1.39	1.35	1.31	1.27	1.23
Leucine	1.9	4.69	5.17	2.23	2.27	2.32	2.37	2.41
Lysine	1.6	7.3	3.08	2.29	2.10	1.90	1.71	1.51
Methionine	0.7	2.2	1.95	0.68	0.68	0.67	0.67	0.67
Cysteine	0.3	1.6	0.61	0.59	0.54	0.50	0.45	0.40
Phenylalanine	1.1	2.68	1.6	1.30	1.25	1.21	1.16	1.11
Tyrosine	0.5	2.1	2.15	0.91	0.92	0.94	0.95	0.96
Threonine	1.1	2.49	1.79	1.07	1.05	1.02	0.99	0.97
Tryptophan	0.3	0.67	0.76	0.33	0.34	0.35	0.36	0.37
Valine	1.5	3.26	3.67	1.47	1.50	1.54	1.58	1.62

Biological evaluation of fish growth performance:

Fish from each pond was measured individually for weight and length every 7 days and at the end of the 16 week trial. Final harvesting was made through draining of water by water pump. Growth performance for each treatment group was determined and feed utilization was calculated as described by Sveier *et al.* (2000) as follows:

Growth performance parameters:

Fish growth performance, weight gain, average body weight gain, condition factor, specific growth rate and Survival rate were determined by the following equations:

Body weight gain:

(BWG) = (W1) – (W0)

Where: W1: means final weight W0: means initial weight

Condition factor:

(K) = FW / FL3 x 100

Where: FW: Final body weight (g) FL3: Final body length (cm3)

Specific growth rate:

(SGR, % / day) = [Ln W1 – Ln W0 / T] 100

Where: Ln = the natural log W1 = final weight at the certain period (g)

W0 = initial weight at the same period (g) T = experimental period (day)

Survival rate:

(SR %) =Number of fish at final / Number of fish at start X100

Feed efficiency parameters:

Feed conversion ratio:

The feed conversion ratio (FCR) is expressed as the proportion of dry foodfed consumed per unit live weight gain of fish.

FCR = Feed intake (g) / weight gain (g).

Protein efficiency ratio:

(PER) = Weight gain (g) / Protein intake (g)

Feed efficiency:

(FE %) = [Weight gain (g) / Feed intake (g)]

Protein productive value:

(PPV %) = [PR_1– PR_0 / PI] 100

Where:

PR_1 = is the total fish body protein at the end of the experiment. (On dry matter basis)

PR_0 = is the total fish body protein at the start of the experiment. (On dry matter basis)

PI = Protein intake.

Energy retention (%):

(ER %)= E-E_0 / E_F X 100

Where:

E= the energy in fish carcass (kcal) at the end of the experiment.

E_0= the energy in fish carcass (kcal) at the start of the experiment.

E_F = the energy (kcal) in feed intake.

Statistical analysis:

All the data collected during the experiment were recorded and preserved in computer spread sheet. Mean values and Standard Error (S.E) were calculated from the results. One way analysis of variance(ANOVA) was applied for comparison of the mean values using SPSS (2006); and the level of significance was based on $p<0.05$ was established. Duncan, 1955 was applied to compare means for detection of the level of variation among treatments.

RESULTS

Water quality:

Results of water quality parameters of the experimental ponds during the experimental period (16 weeks) as averages of the weekly samples are summarized in Table (4). In general, averages of water temperature ranged from 27.2 to 29.8°C during the experiment course (8th August – 8th December). Gui *et al*. (1989) found that an average temperature of 28°C was optimal for growth of Nile tilapia.

Dissolved oxygen ranged between 5.7 and 6.00 mg / l. Stickney (1979) reported that 2.3 mg DO /l is above the normal tolerance level of tilapia. pH ranged between 7.4 and 7.7. Boyd (1998) reported that waters with a pH range of 6.5 – 9 are the most suitable for fish production. The ranged of ammonia (NH4) between 0.20 to 0.24 mg/l for T1, T2, T3, T4 and T5, respectively, the concentration of nitrite ranged between (0.04 to 0.06 mg/l) during the whole experimental period (El-sayd, 2006).

Table 4: Average values of water quality criteria parameters of all experimental ponds during the experimental period (16 weeks).

Parameter	Rang
Water Temperature °C	27.2 - 29.8
Dissolved Oxygen (mg/L)	5.7 – 6
PH	7.4 – 7.7
Ammonia (NH4-mg/L)	0.2 – 0.24
Nitrites (NO2- mg / L)	0.04 – 0.06

Growth performance of Nile tilapia fingerlings:

The effects of partial and completely replacement of Herring fishmeal by sand smelt meal (SSM) in experimental diets on growth performance of mono sex Nile tilapia (*O. Niloticus*) fingerlings were illustrated in Table (5). Results revealed that averages of initial weights and lengths of the experiment start had ranged between (7.60 ± 0.30 and 7.70 ± 0.20) for weight and (6.20 ± 0.10 and 6.50 ± 0.30) in length, with insignificant differences among the experimental indicating that the complete randomization of individual fish among the experimental trials at the start of the experiment and were homogenous.

Table 5: Least square means and standard error for the effect of replacing levels of fish meal by Sand smelt meal (SSM) on in the diets on growth parameters of Nile tilapia.

parameter	**Graded levels of SSM in Experimental Diets (%)**				
	D1 - 0% (Control)	**D2 - 25%**	**D3 - 50%**	**D4 - 75%**	**D5 - 100%**
Initial. Fish weight (g)	7.70±0.20	7.70±0.20	7.60±0.30	7.63±0.30	7.60±0.30
Final fish weight (g)	73.16±0.24ab	75.94±0.83a	75.24±0.91a	74.26±0.86ab	72.14±0.9 b
Initial. Fish length(cm)	6.40 ±0.30	6.50±0.30	6.30±0.20	6.40±0.20	6.20±0.10
Final fish length (cm)	14.0± 0.44	14.2±0.54	14.1±1.47	14.1±0.33	13.8±0.36
Total weight gain (g)	65.46± 0.24ab	68.24±0.83a	67.64±0.91a	66.63±0.86ab	64.54±0.9 b
AV. Daily gain (g)	0.55±0.005ab	0.57±0.010a	0.56±0.005ab	0.56±0.005ab	0.54±0.010b
SGR (%/ day)	2.59±0.006bc	2.63±0.010a	2.63±0.01a	2.61±0.015abc	2.59±0.010 c
Condition factor (K)	2.67±0.24	2.65±0.29	2.68±0.81	2.65±0.18	2.74±0.28
No. of fish at Start.	100	100	100	100	100
No. of fish at end.	100	100	100	100	100
Survival ratio (SR %)	100	100	100	100	100

A. b. c Values in the same row with different superscripts are significantly different from each other ($P<0.05$)

As described in table (5), results showed that at the end of the experimental period (16 weeks), the higher final weight was achieved in the experimental fish fed diets which containing up to 25% SSM (75.94 g) and had a significantly ($P<0.05$) higher total weight gain compared to the control diet than the rest of the experimental diets. However, the lowest growth performance was noted in experimental fish fed the experimental diet (D5) 100 % SSM with an average of 72.14 ± 0.9 (g) compared to the control diet than the rest of the experimental diets. Substantial weight was also noted in an experimental fish fed diets (D3 (50%, SSM) and D4 (75%, SSM) with the average of 75.24 ± .83 and 74.26 ± 0.91 (g), respectively. These results of averages of final fish weights and growth performance indicated that replacing up to 75% of SSM showed positive effects on growth performances of male Nile tilapia (*O. Niloticus*) fingerlings and improvement in body weight.

The present study showed that the mean final weight, weight gain (WG), daily Weight Gain(DWG) and specific growth rate (SGR) of fish fed diets containing SSM up to 75% were significantly higher ($p<0.05$) than that of fish fed with the 100% SSM. This trend was significantly noticeable ($p<0.05$) for WG and SGR, in which there was obvious decreases as the SSM replacement approached 100% compared to fish fed the control diet, while fish fed the 100% SSM diet had the lowest FBW, BWG and SGR. Condition factor (K) of fish fed diets containing SSM 100% were higher ($p<0.05$) than that of fish fed with the other diets. No significant differences ($P<0.05$) in survival were confirmed on the experimental groups and no significant differences ($p<0.05$) with relevance to dietary SSM replacement ($P<0.05$, Table 5) could be observed.

Feed utilization of Nile tilapia fingerlings:

Averages of feed utilization in terms of feed intake (FI), daily feed intake (DFI), feed conversion ratio (FCR), feed efficiency (FE), protein efficiency ratio (PER), productive protein value (PPV) and energy retention (ER) are presented in table (6). These results indicated that differences in D1 (control) among the experimental diets were insignificant ($P<0.05$). On the other hand, the experimental fish fed on D2 (25% SSM), D3 (50% SSM) and D4 (75% SSM) had an insignificantly ($P<0.05$) higher feed intake, daily feed intake, (FE) and (PER) than the rest of experimental diets. Whereas the lowest (FI), (DFI), (FE), (PER) and (PPV) were achieved by experimental fish fed on a diet containing D1 (Control, 0% SSM) and D5 (100% SSM). The experimental fish fed diets containing SSM up to 75% were demonstrated the best in significantly ($p<0.05$) (FCR) than that of fish fed with the 100% SSM and control. The lowest FCR was observed by diet D5 (100% SSM). An average of FCR during the period had an insignificant difference ($P<0.05$) among the experimental diets. This trend was significantly noticeable ($p<0.05$) for (ER), in which there was obvious decreases as the SSM replacement approached 100% compared to fish fed the control diet (D1). PER value increased significantly, while FCR decreased significantly with increasing the SSM level up to 75% in diets. In contrast, ppv values were similar in that.

Table 6: Least square means and standard error for the effect of replacing levels of fish meal by Sand smelt meal (SSM) in the diets on the Feed utilization of mono sex Nile tilapia (*O. Niloticus*) fingerlings.

parameter	Graded levels of SSM in Experimental Diets (%)				
	D1 - 0% (Control)	**D2 - 25%**	**D3 - 50%**	**D4 - 75%**	**D5 - 100%**
Feed intake (g/fish) (FI)	126.53±0.89	127.52±0.34	129.08±0.771	127.77±1.152	126.45±0.854
Daily Feed intake	1.05±0.007	1.06±0.002	1.07±0.006	1.06±0.009	1.05±0.007
Feed conversion ratio (FCR)	1.93±0.02	1.87±0.03	1.90±0.01	1.92±0.04	1.96±0.04
Feed efficiency (FE)	0.51±0.005	0.53±0.007	0.52±0.003	0.52±0.011	0.51±0.010
protein efficiency ratio (PER)	1.70±0.005	1.78±0.02	1.74±0.01	1.74±0.04	1.70±0.03
Productive protein value (PPV%)	27.59±0.005 c	30.80±0.46 a	29.58±0.22 ab	29.35±0.64 ab	28.94±0.59 bc
Energy retention (ER %)	48.76±2.48 a	30.46±0.76 c	33.96±1.26 bc	38.41±1.26 b	44.47±1.89 a

A. b. c Values in the same row with different superscripts are significantly different from each other ($P<0.05$).

According to the experimental results Nile tilapia growth was not negatively affected by the high inclusion level of SSM substitution .The results of the current trial revealed the possibility of replacing 75% of the high cost Herring fish meal by the low cost Sand smelt meal (SSM) in Nile tilapia fingerlings diets , but increasing the level of (SSM) in the experimental diets above this level (75%) significantly (P<0.05) decreased body weight, growth performance and feed utilization of Nile tilapia fingerlings, *O. Niloticus* compared with control diet (D1. 0% SSM).

Chemical composition of the Whole body experimental fish:

At the start and end of the feeding trial, proximate composition of whole fish body values for fish fed with experimental diets is given in Table 7. At the end of the experiment, no significant differences were found in the whole body dry matter (28.83 -29.59 %), protein (55.69 -58.06 %; dry matter), lipid (25.16 -28.67 %; dry matter), ash (14.83 -15.58 %; dry matter) and Growth energy (5699-5882 Kcal GE/g) contents of fish fed with the different experimental diets (P<0.05).

Table 7: Least square means and standard error for the effect of replacing levels of fish meal by Sand smelt meal (SSM) in the diets on whole body chemical composition and energy content.

Proximate composition	Initial	Graded levels of SSM in Experimental Diets (%)				
		D1 - 0% (Control)	D2 - 25%	D3 - 50%	D4 - 75%	D5 - 100%
Dry matter (DM)	23.60±0.035	28.95±0.05	29.50±0.20	29.59±0.10	29.55±0.05	28.83±0.50
Crude protein (CP)	56.88±0.010	55.78±0.20c	58.06±0.06a	56.88±0.10b	56.78±0.15b	55.69±0.20c
Ether extract (EE)	22.85±0.003	28.67±0.20a	25.16±0.05e	26.14±0.10d	26.92±0.04c	28.16±0.16b
Ash	19.55±0.021	14.83±0.27b	15.58±0.10a	15.56±0.14a	15.45±0.20ab	15.18±0.18ab
Gross energy (Kcal GE/g)	5394.38±0.24	5882±24.81a	5699± 7.69c	5734±12.61bc	5778±12.64b	5839±18.98a

A. b. c Values in the same row with different superscripts are significantly different from each other (P<0.05)

DISCUSSION

These results show that the growth performance or feed utilization of Nile tilapia fingerlings was affected by different experimental diets (P<0.05). The growth performance of Nile tilapia fingerlings fed with up to 75% SSM diets was higher than fed with 0.0% SSM diet in which fish meal was the sole protein source. These results are in agreement with those of Gumus *et al*., (2010), who also found no significant differences (P>0.05%) between growth performances of Nile tilapia fry (*Oreochromis niloticus*) fed with up to 75% SSM and fish meal based diets. However, Abdelghany, (2003) and Ahmad, (2008) found that the highest growth was obtained at 50% and 75% replacement of fishmeal protein with Gambusia fish (*Gambusia affinis*) meal protein in diets for red tilapia (*O. niloticus* x *O. mossambicus*) and Nile tilapia fry (*O. niloticus*), respectively. These differences may have resulted from the differences in nutrient requirements, especially for essential amino acids, the culture conditions of the fish and/or proximate composition of replacement ingredients. It can be said that the growth performance was reduced with the SSM content higher than 75% as the lowest growth was obtained in fish fed with 100% SSM diet. Along with sand smelt meal, several other ingredients of animal origin, such as Tuna liver meal (Gumus *et al*., 2009), poultry by-product meal (Hernandez *et al*., 2010; Gumus and Ayden., 2013; Yang *et al*., 2004; Soltan., 2009), blood and meat meal (Tan *et al*., 2005; Zhang *et al*., 2006; Yang *et al*., 2004), wastes fishers (Chitmanat *et al*., 2009) or gambusia meal (Abdelghany., 2003; Ahmad., 2008). But, as seen in the present study, growth performance tends to be reduced when high proportion or all of fish meal is replaced with various ingredients. Gumus *et al*., (2010) stated that the growth reduction in fish fed with the diet containing 100% SSM may be attributed to reduced palatability or attractiveness of the diet causing a reduced feed intake. Also, it might be ascribed to deficiencies caused by low availability of certain EAAs in SSM or AA imbalances (Abdelghany, 2003; Gumus *et al*., 2010 and Ahmad, 2008). On the other hand, this study showed that no significant in growth performance between the use of Sand smelt meal at a rate of 100% and the control this is due to Sand smelt in Egyptian water containing in essential amino acid proportions with convergent Herring fish meal Where he excels in the proportions of certain acids such as (Arginine, Leucine, Tyrosine, Valine and Tryptophan) and drop it in others such as (Phenylalanine, Cystine, Lysine, Isoleucine, Histidine) As for relative decline, not significant in the growth may be due to the Method of preparation of fish meal and the only supported on sun-drying and the grind Which may not make it available completely fish, causing relatively low growth, not significant differences.

All variables related to feed utilization efficiencies such as FCR and PER in all experimental diets were influenced by dietary treatments. Feed utilization of Nile tilapia fingerlings was improved slightly when fed with diets containing up to 75% SSM without significant difference among them ($P<0.05$), while significant decreases were obtained with the increase in the SSM replacement rate from 75% to 100% ($P<0.05$). However, Ahmad, (2008) reported that fish fed with diets having up to 75% gambusia fish meal replacements of fish meal protein had the best FI, SGR, FCR and PER to fish fed with the fish meal-based diet. Abdelghany, (2003) also found that fish fed diets in which gambusia fish meal protein replaced up to 100% of fishmeal protein had similar FCR and PER compared with fishmeal control diet. Gumus *et al*., (2010) offered that up to 75% replacement of sand smelt meal protein can be used successfully as a total replacement for FM protein in practical diets of Nile tilapia fry without adverse effects on feed utilization.

The dietary graded levels of SSM in the present study did not significantly affect also the proximate body composition (dry matter, protein, ash content and Gross Energy) of fish fed the control and replacement a rate 100% SSM. Similar results have been presented by Muzinic *et al*., (2006) in sunshine bass, Abdelghany, (2003) in red tilapia, Yang *et al*., (2004) in gibel carp, Ahmad, (2008) and Gumus *et al*., (2010) in Nile tilapia. However, the best values of (Protein and Ash) in 25% replacement with SSM. Similar that Abdelghany, (2002) incommon carp. Also, the values higher of (Fat and Gross energy) in the control treatment. Similar that Masagounder *et al*., (2014) in juvenile bluegill *Lepomis macrochirus*, Gumus, (2011) in Mirror Carp (*Cyprinus Carpio*).

Economical evaluation:

The results of economic evaluation, including feed costs, the costs of one kg gain weight and its ratio to that of control group fed the diet SSM0 are presented in Table 8.

This result indicated that incorporation of SSM in Nile tilapia diets as a substitute of FM decreased feed costs by 4.51, 9.03, 13.54 and 18.05 for the diets SSM25, SSM50, SSM75 and SSM100 compared to the control diet SSM0. The costs of one kg gain in weight were 13.09, 12.11, 11.78, 11.26 and 10.89 for fish feed the diet SSM0, SSM25, SSM50, SSM75 and SSM100 respectively.

This result showed that the best of economical treatment were 100% SSM because decreased feed costs relative to control a rate 18.05%. Also decreased feed costs/kg weight gain relative to control a rate 83.22%. However no significant deference between the treatments controls and replacement 100% SSM in these growth performance and feed utilization. The other searches in the study replacement fish meal of the most results were indicated the replacement in the rate up to 75%. Such as Abdelghany (2003), Ahmed (2008), Gumus (2010), soltan *et al*., (2008) and

Chitmanat *et al*., (2009) all this reported that pliability replacement fish meal by traditional fish meal (gambusia meal in diets for red tilapia, Gambusia meal in diets for Nile tilapia, Sand smelt meal in diet for Nile tilapia, fermented silage fish in diets for African catfish and Wastes fisheries in diets for Nile tilapia, respectively) a rate (50%, 75%, 75%, 35% and 25%, respectively).

Table 8: Feed costs (*LE*) for producing one kg weight gain by fish fed the Experimental diets.

Items	D1 - 0% (Control)	D2 - 25%	D3 - 50%	D4 - 75%	D5 - 100%
Costs (L.E) / ton	6780	6474.01	6168.02	5862.03	5556.04
Cost (L.E) /kg	6.78	6.47	6.17	5.86	5.56
Relative to control (%)	100	95.49	90.97	86.46	81.95
Decrease in feed costs (%)	0	4.51	9.03	13.54	18.05
FCR	1.93	1.87	1.91	1.92	1.96
Feed costs* (L.E) /kg weight gain	13.09	12.11	11.78	11.26	10.89
Relative to control (%)	100	92.52	90.03	86.01	83.22
Decrease in feed costs* (L.E) /kg weight gain	0	7.48	9.97	13.99	16.78

CONCLUSION

The results of the present study indicate that, SSM could be used as a substitute for a Herring fish meal by up to 75% has positive effects on growth performance and feed utilization under the experimental diets in this study, and higher substitution levels resulted in growth reduction or poor feed utilization. On the other hand, replacement of 100% of FM by SSM did not significantly affect all growth and feed utilization parameters and reduced feed costs/kg diet and feed costs/kg weight gain. Hence, can be used sand smelt meal a rate 100% in diets of Nile tilapia (*Oreochromis niloticus*) because the locally obtained, easily available and cheaper than imported marine HFM.

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ARABIC SUMMARY

تأثير الاحلال الجزئي والكلي لمسحوق السمك بمسحوق سمك البساريا فى علائق تغذية إصبعيات البلطي النيلي وحيد الجنس.

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تهدف هذه الدراسة الى تقييم الإحلال الجزئى والكلى لبروتين مسحوق سمك البساريا محلبروتين مسحوق السمك الهيرنج في علائق إصبعيات البلطى النيلى وأثرها على اداء النمو والاستفادة الغذائية لإصبعيات اسماك البلطى النيلى وحيد الجنس. استمرت التجربة ١٦ أسبوعاوتشملخمسمعاملات٠، ٢٥، ٥٠،٧٥،و ١٠٠٪ لمسحوق سمك البساريا، تم إستخدام ١٠ أحواض مستطيلة لتمثل الخمس معاملات (مكرررتين لكل معاملة -تقريبا ٤ م^3/ الحوض) ، وتم تسكين إصبعيات البلطي النيلى وحيد الجنس بمعدل ٢٥ سمكة / م^{3}بمتوسط وزن ٧.٦٥±٠.٣٠جرامعند بداية التجربة. وإحتوت جميع العلائق التجريبية على نسبة بروتين خام (٣٠%). وكانتأهم النتائج المتحصل عليها كالتالى:

سجلت المعاملة الثانية (٢٥٪) أعلى معدل لوزن الجسم (٧٥.٩٤جم)، تليها المعملة الثالثه (٥٠٪ - ٧٥.٢٤جم)، المعاملة الرابعه (٧٥٪ - ٧٤.٢٦جم)، المعاملة الإولى (التحكم ٠٪ - ٧٣.١٦جم) ثم المعاملة الخامسة (١٠٠٪ - ٧٢.١٤جم) على التوالى وكانت الإختلافات معنوية بين المعاملات.ولوحظ نفسا لاتجاه فى معدلا لنمو النوعى تأثر متوسط استهلاك العلف ومعدلا لتحويل الغذائى ومعدل كفاءة البروتين معنويا بإحلال مسحوق سمك البساريا محل مسحوق السمك.

ومن خلال التحليل الكيماوى لجسم السمكة تراوحت نسبة المادة الجافة فيجسم السمكة بين ٢٨.٨٣ و٢٩.٥٩٪ مع وجود اختلافا تضئيلة. تراوحت البروتين الخامبين ٥٥.٦٩ و ٥٨.٠٦٪،وتراوحت نسبة مستخلص الايثربين ٢٥.١٦ و ٢٨.٦٧٪،وتراوحت نسبة الرماد بين ١٤.٨٣ و ١٥.٥٨٪مع وجود اختلافات معنوية لكل من مستخلص الايثرو محتوى البروتين للسمكة الكاملة.

نخلص من هذا:

أنه يمكن إحلال مسحوق سمك البساريا محل مسحوق السمك الهيرنج بنسبة ٧٥٪حيث أظهرت اعلي مقاييس للنمو وكذلك الإستفادة من الأعلاف مما أدى الى خفض تكاليف التغذية ١٣.٩٩٪ لإصبعيات البلطى النيلي مقارنة بالكنترول. أيضاً، أظهرت النتائج انه يمكن إستخدام مسحوق البساريا كبديل لمسحوق السمك (الهيرنج) بمعدل ١٠٠% فى علائق تغذية البلطي النيلي دون تأثير على النمو والإنتاج الكلي مقارنة بالكنترول مما يؤدي الي إرتفاع العائد الإقتصادي.