EFFECT OF REPLACING SOYBEAN MEAL BY SUNFLOWE R MEAL IN THE DIETS OF NILE TILAPIA, *OREOCHROMIS NILOTICUS* (L.)

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Abatract

Five experimental diets were formulated and soybean meal protein in the basal diets was replaced by sunflower meal protein at an increased levels 25, 50, 75 or 100%. Therefore, five experimental diets were prepared and tested in the experiment in ten glass aquaria (two replicates for each treatment). The experimental period lasted after 90 days.

The highest average body weight (16.76 g) was recorded in group 1 which was fed on basal diet followed in a descending order by those fed the diet D3 (15.25 g), D2 (14.89 g), D4 (14.73 g) and D5 (12.62 g), respectively and the differences between these means were significant indicating the possibility of partial replacement of soybean meal by sunflower meal up to 75% without adverse effect on final body weight of Nile tilapia and similar trend was also observed for body length (BL), weight gain (WG), specific growth rate (SGR).

The feed conversion ratio (FCR) at the end of the experimental period were ranged from 2.44 for fish fed the basal diet (D1) to 4.05 for fish fed the diet D5(complete replacement of soybean meal) and the same trend was also observed for protein efficiency ratio (PER) and the differences in FCR and PER for the different treatment were significant.

The complete substitution of soybean by sunflower meal showed the highest protein content of whole fish followed in a descending order by those fed the diets D1, D4, D3 and D2, and the differences were significant ($P<0.01$). Ether extract and ash content did not significantly affected by the increased level of sunflower meal in tilapia diets.

Increasing substitution level of soybean meal by sunflower meal at 25, 50, 75 and 100% decreased feed costs by 5.04, 10.08, 15.13 and 20.17, respectively. Compared to the control diet, feed costs decreased for all substitution levels of soybean meal by sunflower meal and the experimental diet D5 released the lowest feed costs while the control diet released the highest one. In conclusion, replacing 75% of soybean meal by sunflower meal reduced feeding costs by 15.13%.

INTRODUCTION

Aquaculture has become the fastest-growing food production sector of the world, with an average annual increase of about 10% since 1984 compared with a 3% increase for livestock meat and a 1.6% increase for capture fisheries (FAO, 1997). To sustain such high rate of increase in aquaculture production; similar increase in the levels of fish feed production is required. The intensive use of soybean meal in poultry and fish feeds led to increasing price of soybean meal with its unavailability. In 2003, Egypt imported one million ton of soybean in forms of seeds or meals (Osman and Sadek, 2004). In this context, research efforts have been directed to identify novel, alternative and economically viable plant protein sources for totally or partially replacing soybean meal in the fish feed. One of the possible alternative plant protein source is sunflower meal.

Since tilapia fish have become a top priority fish for culture in the tropics because of their fast growth, efficient use of natural aquatic foods, propensity to consume a variety of supplemented feeds, resistant to diseases and handling, ease of reproduction in captivity, tolerance to wide range of environmental conditions, Nile tilapia *Oreochromis niloticus* was therefore chosen to carry out this study.

MATERIALS AND METHODS

Experimental design:

The experiment was started on the 1 Jule 2005 and lasted until the 30 September of the same year (90 days). Ten rectangular aquaria 50 × 40 × 50cm (100 liter) were filled by 80 liter freshwater were used to represent five experimental treatments (2 replicates) and each aquarium was stocked with 12 fish with an initial weight ranged from 6.04 to 6.20 g for the second experiment.

Fish source and management:

The experimental fish were obtained from Abbassa hatchery, Abbassa village, Abu-Hammad district, Sherkia Governorate, Egypt. The experimental fish were transported in a 50 liter plastic bags filled with freshwater and oxygen to the laboratory, and after arrival to the laboratory fish were stocked in fiberglass tanks for two weeks before start the experiment for acclimization where all fish were fed daily on the control diet at a rate of approximately 3% of their average body weight to be adapted to pelleted feeds. After the acclimatization the experimental fish were distributed randomly into the experimental aquaria representing the five treatments studied. At stocking body weight and body length of fingerlings per aquarium were recorded.

The aquaria were cleaned and water was replaced every four days, dissolved oxygen was maintained at 3-6 mg/L by continuous aeration (estimated by using dissolved oxygen meter) and water temperature at 23 to 27°C.

Diet preparation and feeding practices

Five experimental diets were formulated as shown in Table (1). Diets of the experiment were prepared by thoroughly mixing the ingredients which composed of fish meal, soybean meal, sunflower meal, yellow corn, wheat flour, corn oil and bran with different percentage. Water was added to the ingredients of each diet for mixing these ingredients and then dried. After drying, the diets were broken up and sieved into the convenient pellet size.

Fish were given the diets at a daily rate of 4% of total biomass till the end of experimental period. Fish were fed on the experimental diets at the rates mentioned above 6 day/week (twice daily at 9.00 am and 3.00 pm). Every two weeks, total fish was taken from each aquarium then weighed and the amount of feed was adjusted according to the changes in body weight throughout the experimental period (90 days).

Table (1): Composition and chemical analysis of the experimental diets

Feed ingredients	Experimental diets				
	Diet1	Diet2	Diet3	Diet4	Diet5
Fish meal (65%)	16	16	16	16	16
Yellow corn	28	28	28	28	28
Soybean meal (40%)	40	30	20	10	0
Sunflower meal	0	10	20	30	40
Wheat bran	10.5	10.5	10.5	10.5	10.5
Vegetable oil	2.5	2.5	2.5	2.5	2.5
Vit. & Min. mixture[1]	3.0	3.0	3.0	3.0	3.0
Sum	100	100	100	100	100
Chemical analysis *(determined on dry matter basis)*					
Dry matter (DM)	7.44	6.55	6.12	7.15	5.89
Crude protein (CP)	30.18	30.66	30.71	30.80	30.91
Ether extract (EE)	4.44	4.23	4.87	4.20	4.36
Crude fiber (CF)	9.33	10.22	10.10	10.24	10.66
Ash	10.12	10.14	10.33	10.45	10.15
NFE[2]	45.93	44.75	43.99	44.31	43.92
ME (Kcal/kg diet)[3]	2610	2609	2607	2600	2595
P/E ratio[4]	115.63	117.52	117.80	118.46	119.11

[1] Vitamin & mineral mixture/kg premix : Vitamin D_3, 0.8 million IU; A, 4.8 million IU; E, 4 g; K, 0.8 g; B1, 0.4 g; Riboflavin, 1.6 g; B6, 0.6 g, B12, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg , Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.

[2] Nitrogen free extract (NFE) =100-(CP+EE+CF+Ash)

[3] Metabolizable energy was calculated from ingredients based on NRC (1993) values for tilapia.

[4] Protein to energy ratio in mg protein/Kcal ME.

Growth performance and feed utilization parameters:

Records of live body weight (g) and body length (cm) of individual fish were measured in all fish for each aquarium and registered every 14 day (two weeks) during the experimental period. Growth performance parameters were measured by using the following equations:

Condition factor (K): it expressed the relationship between weight and length in fish at a given period. Condition factor was obtained using the following formula:-

$K = (W/L^3) \times 100$

Where: W = weight of fish in "grams" L = total length of fish in "cm"

specific growth rate (SGR): it is one of the most important methods of growth expression, which are related to time and estimated using the following equation.

$$SGR = \frac{LnW2 - LnW1}{t} \times 100$$

Where: Ln = the natural log, W_1 = first fish weight, W_2 = the following fish weight in "grams" and t = period in days.

Weight gain = final weight (g) – initial weight (g)

Feed conversion ratio (FCR): FCR = Feed ingested (g)/Weight gain (g)

Protein efficiency ratio (PER) = Weight gain (g)/Protein ingested (g)

Chemical analysis of fish and experimental diets

At the end of each experiment, three fish were randomly sampled from each aquarium and subjected to the chemical analysis of whole fish body. Moisture, dry matter (DM), ether extract (EE), crude protein (CP), crude fiber (CF) and ash content of diets and fish were determined according to the methods described in AOAC (1990): dry matter after drying in an oven at 105°C until constant weight; ash content by incineration in a muffle furnace at 600°C for 12 hrs; crude protein (N × 6.25) by the kjeldhal method after acid digestion; and ether extract by petroleum ether (60-80°C) extraction.

Statistical analysis of the obtained data was analyzed according to SAS (1996). Differences between means were tested for significance according to Duncan's multiple rang test as described by Duncan (1955). The following model was used to analyze the obtained data:

$Y_{ij} = \mu + \alpha i + e_{ij}$ Where: Y_{ij} = the observation on the ij^{th} fish eaten the i^{th} diet; μ = overall mean, α_i= the effect of i^{th} diet and E_{ij} = random error assumed to be independently and randomly distributed (0, $\delta^2 e$).

RESULTS AND DISCUSSION

Growth performance:

No significant differences (P>0.05) were observed between fish groups (6.04-6.2 g/fish) at the beginning of the experimental period (90 days). The highest average BW (16.76 g), at the end of the experiment was recorded in group 1 which fed the basal diet.

In previous study, Sanz *et al.,* (1994) evaluated the nutritive potential of sunflower meal protein as compared to soybean meal and fish meal protein in trout diets and they found that, sunflower meal protein could replace up to 40% of fish meal protein or soybean meal protein in the diet at the same replacing percentage in trout diets without

any negative effect on BW. In another study, Abdul-Aziz *et al.,* (1999) evaluated the possibility of replacing soybean meal by different cheap plant protein sources, sunflower, cottonseed, linseed and rapeseed as a partial replacement of soybean meal in practical diets for Nile tilapia fingerlings and they showed the possibility of partial substitution of soybean protein by sunflower protein up to 50% without adverse effect on BW of Nile tilapia fingerlings.

In recent studies, some attempts were carried out to replace the high cost animal protein source by sunflower meal (low costs plant protein). Fagbenro and Davies (2000) replaced 67% of fish meal in tilapia diets by each of soybean, sunflower meal, peanut, roselle seed, cottonseed, sesame seed and winged bean. They found that, replacement of 67% of fish meal by each of soybean meal or sunflower meal in tilapia diets did not significantly altere the final weight of tilapia fish while the other plant protein sources significantly affected the final body weight of tilapia fish.

In this respect, Olvera-Novoa *et al.,* (2002) showed the possibility to replace animal protein source in tilapia fry diets with sunflower seed meal up to 20% without significant effect in BW of Nile tilapia fry while the highest replacing levels significantly decreased the BW. In another study, El-Saidy and Gaber (2002) replaced fish meal protein by dehulled sunflower meal protein at replacing levels of 0, 25, 50, 75 and 100% in Nile tilapia diets and they found that up to 50% dehulled sunflower meal protein could be used to replace fish meal as a protein source in the diet of Nile tilapia, *Oreochromis niloticus* without significant effect on the BW of Nile tilapia.

Abbas *et al.,* (2005) the gradual rise in replacement level negatively affected growth performance of major carps and the minimum decrease in fish production was recorded at 25% replacement level while the maximum decrease was recorded at 75% replacing level of fish meal by sunflower meal.

Table (2): Effect of increasing levels of sunflower in the diets on body weight (BW), body length (BL) and condition factor (K) of Nile tilapia.

Diets	No.	Body weight (BW)/gm		Body length (BL)/cm		Condition factor	
		Initial	Final	Initial	Final	Initial	Final
D1 (0% SFM)	24	6.12±0.5	16.76±0.9 a	7.06±0.2	10.12±0.2 a	1.75±0.04	1.72±0.01 b
D2 (25% SFM)	24	6.16±0.5	14.89±0.9 a	7.06±0.2	10.36±0.2 a	1.75±0.04	1.82±0.01 b
D3 (50% SFM)	24	6.05±0.5	15.25±0.9 a	7.04±0.2	10.54±0.2 a	1.74±0.04	1.76±0.01 b
D4 (75% SFM)	24	6.04±0.5	14.73±0.9 a	7.05±0.2	10.47±0.2 a	1.73±0.04	1.74±0.01 b
D5 (100 SFM)	24	6.20±0.5	12.62±0.9 b	7.08±0.2	8.35±0.2 b	1.75±0.04	2.17±0.01 a

Averages within each column followed by different letters are significantly different (P<0.05)

As described in this table average BL at the beginning of the experiment in different treatments ranged between 7.04 and 7.08 cm with insignificant differences between the different experimental treatments (table, 11). At the experiment termination, complete replacement of soybean meal by sunflower meal released the

lower BL (8.35 cm) while fish fed the diet (D3) gained the longest BL (10.54 cm) and the differences in BL among the different treatments were significant (P<0.05).

Results of tilapia BL as affected by replacing soybean meal by sunflower meal indicated that replacing soybean meal by sunflower meal in tilapia diets up to 75% did not affect the final BL while the complete replacement significantly reduced the BL of tilapia and these results relatively similar to those obtained for BW (tables, 11 and 12).

At the start of the experiment average values of condition factor (K) ranged between 1.73 and 1.75 and the differences among the experimental groups were not significant while at experimental termination, fish group fed the diet D5 showed the highest (2.17) K value and this value is significantly different (P<0.05) from those recorded for the other experimental diets, D1(1.72), D2(1.82), D3, (1.76), and D4 (1.74).

In the study of Abdul-Aziz *et al.,* (1999) soybean meal was replaced by different cheap plant protein sources, sunflower, cottonseed, linseed and rape seed as a partial replacement in practical diets for Nile tilapia fingerlings and the authors reported that condition factor did not significantly affect when 25 or 50% of soybean meal was replaced by sunflower meal in tilapia diet.

Results of Table (3) showed that, after 90 days of the experimental start, the averages of weight gain (WG) were found to be 10.64, 8.74, 9.20, 8.70 and 6.42 g for the experimental diets D1, D2, D3, D4 and D5, respectively.

Sanz *et al.,* (1994) found that, sunflower meal protein could replace up to 40% of fish meal protein or soybean meal protein in the diet at the same replacing level in trout diets without significant effect on weight gain of trout. Also, **El-Saidy and Gaber (2002)** showed that up to 50% dehulled sunflower meal protein could be used to replace fish meal as a protein source in the diet of Nile tilapia, *Oreochromis niloticus* without significant effect on the weight gain of Nile tilapia.

Table (3): Effect of increasing levels of sunflower in the diets on body weight gain (WG) and specific growth rate (SGR) of Nile tilapia fed experimental diets.

Diets	No.+	Weight gain (g/fish)	Specific growth rate
D1 (0% SFM)	2	10.64±0.62 a	1.12±0.05 a
D2 (25% SFM)	2	8.74±0.62 ab	0.98±0.05 a
D3 (50% SFM)	2	9.20±0.62 a	1.03±0.05 a
D4 (75% SFM)	2	8.70±0.62 ab	0.99±0.05 a
D5 (100 SFM)	2	6.42±0.62 b	0.79±0.05 b

Averages within each column followed by different letters are significantly different (P<0.05)
+ Average of two replicates (aquaria)

On the other hand, Fagbenro and Davies (2000) substitute fish meal in tilapia diets by each of soybean meal or sunflower meal and they found that replacing 67% of fish meal by soybean meal did not significantly affected weight gain of Nile tilapia while

the same level of replacing fish meal by sunflower meal significantly (P<0.05) adversed WG of Nile tilapia. In the same respect, Furuya *et al.,* (2000) incorporated sunflower meal in Nile tilapia diets at inclusion levels of 0, 7, 14, 21 and 28% and they concluded that, increasing sunflower meal in tilapia diets resulted in quadratic effect (P<0.05) on WG of Nile tilapia. Also, Olvera-Novoa *et al.,* (2002) showed that it possible to replace animal protein source in tilapia fry diets with sunflower seed meal up to 20% without significant effect on WG of Nile tilapia fry while the highest replacing levels significantly decreased the final body weight of Nile tilapia fry.

Reduced growth response in Nile tilapia fed diets in which soybean meal was completely replaced by sunflower meal have been explained by sub-optimal amino acid balance, inadequate levels of phosphorus, inadequate levels of energy, low feed intake caused by palatability, presence of high content of endogenous anti-nutrients (Lim and Dominy, 1991). Lower growth at the complete replacement of soybean meal by sunflower meal in the present study may have been caused by one or some of these factors.

Average values of SGR found to be 1.12, 0.98, 1.03, 0.99 and 0.79 for the different experimental diets D1, D2, D3, D4 and D5, respectively. The higheest value of SGR (1.12) was recorded for fish group fed the basal diet and this may be attributed to the positive effect of balanced amino acid composition content of soybean meal compared to sunflower meal.

In the study of El-Saidy and Gaber (2002) fish meal protein was replaced by dehulled sunflower meal protein at levels of 0, 25, 50, 75 and 100% in Nile tilapia diets. They found that up to 50% dehulled sunflower meal protein could be used to replace fish meal in the diet of Nile tilapia without significant effect on SGR while the highest replacing levels (75 or 100%) significantly decreased SGR.

On the other hand, Fagbenro and Davies (2000) substitute fish meal in tilapia diets by each of soybean meal or sunflower meal and they found that replacing 67% of fish meal by soybean meal did not significantly affected SGR of Nile tilapia while the same level of replacing fish meal by sunflower meal significantly (P<0.05) reduced SGR of Nile tilapia. In this respect, Sanz, *et al.,* (1994) concluded that, up to 40% of fish meal in trout diets could be replaced by each of soybean meal or sunflower meal without significant effect of SGR. Also, Shipton and Britz (2001) replaced dietary fish meal by each of soybean meal or sunflower meal in abalone diets at replacing levels of 30, 50, 75 or 100% and they found no significant differences in growth rates between control diet (100% fish meal) and diets in which 30% fish meal component had been replaced by either soybean or sunflower meal.

In another study, Olvera-Novoa *et al.,* (2002) showed that replacement of fish meal in tilapia fry diets with sunflower seed meal up to 20% did not significantly affected SGR of Nile tilapia fry while the highest replacing levels significantly decreased SGR of Nile tilapia fry.

Sunflower meal has been reported to contain a lot of endogenous anti-nutritional factors, such as a protease inhibitor, an arginase inhibitor and the polyphenolic tannin

chlorogenic acid (Tacon *et al.,* 1984). It has relatively high crude fiber content, which can reduce the pelleting quality and protein digestibility of the feed included at high levels (Kamarudin *et al.*, 1989). Sunflower meal also contains low levels of lysine. Despite these drawbacks, sunflower meal has been reported to be a good protein source for Nile tilapia, *Oreochromis niloticus* even at 696 g/kg of the diet (Jackson *et al.,* 1982).

Feed utilization

Feed conversion ratios (g of feed per g of live weight gain) of fish in the different groups throughout the experimental period are shown in table (4).

The final FCR at the end of the experimental period were ranged from 2.44 for fish fed the basal diet (D1) to 4.05 for fish fed the diet D5(complete replacement of soybean meal) and the differences in FCR between the different treatment were significant .

The present results are in good agreement with those obtained by Furuya *et al.,* (2000) who incorporated sunflower meal in Nile tilapia diets at inclusion levels of 0, 7, 14, 21 and 28% . They concluded that, increasing sunflower meal in tilapia diets resulted in quadratic effect ($P<0.05$) on feed conversion ratio of Nile tilapia.

Abdul-Aziz *et al.,* (1999) studied the possibility of replacing soybean meal by different plant protein sources, sunflower, cottonseed, linseed and rape seed as a partial replacement in practical diets for Nile tilapia fingerlings. They found that, replacement of soybean meal by sunflower meal at a replacing levels of 25% or 50% significantly adversed FCR of Nile tilapia. Also, Olvera-Novoa *et al.,* (2002) showed that replacement of fish meal source by sunflower seed meal up to 50% in tilapia fry diets improved FCR of Nile tilapia fry. In the study of El-Saidy and Gaber (2002) fish meal protein was replaced by dehulled sunflower meal protein at replacing levels of 0, 25, 50, 75 and 100% in Nile tilapia diets and the authors found that up to 50% dehulled sunflower meal protein could be used to replace fish meal as a protein source in the diet of Nile tilapia without significant effect on the FCR of Nile tilapia, *O. niloticus* while the highest replacing levels significantly adversed FCR of Nile tilapia. Fagbenro and Davies (2000) replaced 67% of fish meal in tilapia diets by each of soybean, sunflower meal, peanut, roselle seed, cottonseed, sesame seed and winged bean and they found that, replacement of 67% of fish meal by each of soybean meal or sunflower meal in tilapia diets did not significantly altered the FCR of Nile tilapia fish while the other plant protein sources significantly affected the final body weight of tilapia fish.

In the study of Martinez (1986) sunflower meal was used as a replacer of soybean meal up to 100% and growth assessed by means of body weight, specific growth rate, feed conversion ratio, protein efficiency ratio, nutrient digestibility and proximate carcass composition and he decided that sunflower meal is a good dietary replacement for soybean meal in rations of trout.

El-Saidy and Gaber (2002) reported that the fish fed with 100% fish meal and diets including 25 or 50% dehulled sunflower meal had significantly better final protein efficiency ratio than fed with 75% and 100% dehulled sunflower meal. Also, Furuya *et*

al., (2000) incorporated sunflower meal in Nile tilapia diets at inclusion levels of 0, 7, 14, 21 and 28% and they concluded that, increasing sunflower meal in tilapia diets resulted in quadratic effect (P<0.05) on PER of Nile tilapia.

In the study of Abdul-Aziz *et al.,* (1999) 25% only of soybean meal could be replaced by sunflower meal without significant effect on PER of Nile tilapia. Also, Olvera-Novoa *et al.,* (2002) showed that replacement of fish meal source by sunflower seed meal up to 50% in tilapia fry diets improved PER of Nile tilapia fry.

On the other hand, Fagbenro and Davies (2000) substitute fish meal in tilapia diets by each of soybean meal or sunflower meal and they found that replacing 67% of fish meal by soybean meal did not significantly affected PER of Nile tilapia while the same level of replacing fish meal by sunflower meal significantly (P<0.05) reduced PER of Nile tilapia. Also, Sanz *et al.,* (1994) found that replacement of fish meal by each of soybean meal or sunflower meal up to 40% did not significantly alter PER of trout while the same replacing level of fish meal by sunflower meal significantly adversed SGR of trout.

Table (4): Effect of increasing levels of sunflower in the diets on feed conversion ratio (FCR) and protein efficiency ratio (PER) of Nile tilapia fed the experimental diets.

Diets	No.+	Feed conversion ratio (FCR)	Protein efficiency ratio (PER)
D1 (0% SFM)	2	2.44±0.30 c	1.36±0.06 a
D2 (25% SFM)	2	2.97±0.30 b	1.10±0.06 b
D3 (50% SFM)	2	2.83±0.30 ab	1.15±0.06 b
D4 (75% SFM)	2	2.99±0.30 ab	1.09±0.06 b
D5 (100 SFM)	2	4.05±0.30 a	0.80±0.06 c

Averages within each column followed by different letters are significantly different (P<0.05)

+ Average of two replicates (aquaria)

Chemical composition of fish:

Results of body composition of whole fish body (Table 15) showed that, dry matter (DM) of whole fish lie in three groups the first group included fish fed the diet D2 and the second group included fish fed the diet D3 while the third one included fish groups fed the diets D1, D4 and D5. Analysis of variance (table 16) indicated that the differences between fish in the first and the second groups (D2 and D3) were significant (P<0.05) while the differences between each of the first (D2) or the second group (D3) and the third group were not significant (P>0.05).

The complete substitution of soybean by sunflower meal released the highest (60.05) crude protein content (CP) of whole fish followed in a descending order by those fed the diets D1(52.16%), D4(50.94%), D3(48.94%) and D2(42.78%), and the differences between fish groups for protein content were significant (P<0.01).

Ether extract and ash content of whole fish body found to be 16.92, 14.63, 13.92, 14.03 and 15.42% and 14.63, 15.39, 14.68, 13.61 and 15.02%, respectively for D1, D2, D3, D4 and D5 and the differences in ether extract or ash contents among fish groups fed the diets contained the graded levels of sunflower meal were not significant.

Table (5): Means and standard error for the effect of increasing levels of sunflower in the diets on chemical composition of Nile tilapia.

Diets	No.+	Dry matter (DM)	Crude protein (CP)	Ether extract (EE)	Ash
D1 (0% SFM)	6	25.66±0.46 ab	52.16±1.62 b	16.92±1.50	14.63±0.61
D2 (25% SFM)	6	26.24±0.46 a	42.78±1.62 c	14.63±1.50	15.39±0.61
D3 (50% SFM)	6	24.41±0.46 b	48.94±1.62 b	13.92±1.50	14.68±0.61
D4 (75% SFM)	6	25.85±0.46 ab	50.94±1.62 b	14.03±1.50	13.61±0.61
D5 (100 SFM)	6	25.57±0.46 ab	60.05±1.62 a	15.42±1.50	15.02±0.61

Averages within each column followed by different letters are significantly different (P<0.05)

Economical efficiency:

The current investigation highlights the potential of using sunflower meal for partial or complete replacement for soybean meal in Nile tilapia diets. Generally, results of the present study showed the possibility of replacing of soybean meal by sunflower meal up to 75% with no adverse effect on growth performance and feed utilization.

Feed cost is considered to be the highest recurrent cost in aquaculture, often ranging from 30 to 60%, depending on the intensity of the operation. Any reduction in feed costs either through diet development, improved husbandry or other direct or indirect means is therefore decreased the total production investment and increased the net return (Collins and Delmendo, 1979; Green; 1992 and De Silva and Anderson, 1995).

All other costs are almost constant, therefore, the feeding costs required to produce one kg gain in weight could be used to compare the economical efficiency of different experimental treatments.

As shown in Tables (6 and 7), feed costs (LE/ton) decreased gradually with increasing substitution level of soybean meal by sunflower meal. Data presented in the same table showed that, increasing substitution level of soybean meal by sunflower meal at 25, 50, 75 and 100% decreased feed costs by 5.04, 10.08, 15.13 and 20.17, respectively. Compared to the control diet, feed costs (LE/kg WG) were decreased for all substitution levels of soybean meal by sunflower meal and the experimental diet D5 released the lowest feed costs while the control diet released the highest one. In conclusion, replacing 75% of soybean meal by sunflower meal reduced feeding costs by 15.13%.

Table (6): Feed costs (L.E) for producing one kg weight gain by fish fed the experimental diets.

Diets	Costs (L.E)/ ton	Relative to control %	Decrease in feed cost (%)
D1 (0% SFM)	2975	100	0
D2 (25% SFM)	2825	94.96	5.04
D3 (50% SFM)	2675	89.92	10.08
D4 (75% SFM)	2525	84.87	15.13
D5 (100 SFM)	2375	79.83	20.17

* Feed costs/kg weight gain = FCR × costs of kg feed.

Table (7): Local market price (L.E./ton) for feed ingredients used for formulating the experimental diets when the experiment was started.

Ingredients	Price (L.E.) / ton
Fish meal	7000
Yellow corn	1250
Soybean meal	2500
Sunflower meal	1000
Wheat bran	1000
Corn oil	4000
Vit. & Min. Mixture	10000

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تأثير إستبدال كسب فول الصويا بكسب عباد الشمس بعلائق البلطى النيلى

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أجريت هذه الدراسة بمعمل تغذية الاسماك – قسم الإنتاج الحيوانى– كلية الزراعة بمشتهر، جامعة بنها بهدف دراسة تأثير استبدال كسب فول الصويا بكسب عباد الشمس المقشور بنسب متزايدة (صفر، ٢٥ ، ٥٠ ، ٧٥ ، ١٠٠%) فى علائق أسماك البلطى النيلى لخفض تكاليف التغذية. وقد أستخدمت عشرة أحواض زجاجية (مكررين لكل معاملة) وكان من أهم النتائج المتحصل عليها مايلى:

فى نهاية فترة التجربة فقد وجد أن اعلى متوسط لوزن الجسم قد وصل إلى ١٦,٧٦ جم قد حققته مجموعة الكنترول التى غذيت على العليقة الأساسية ثم أسماك المجموعة الثالثة (١٥,٢٥ جم) تلاها المجموعة الثانيه (١٤,٨٩ جم) والأسماك فى المجموعة الرابعه (١٤,٧٣ جم) واخيراً المجموعة الخامسه (١٢,٦٢ جم)، على الترتيب كما نتائج مقاييس طول الجسم والزيادة فى وزن الجسم ومعدل النمو النسبى نتائج مشابهة لوزن الجسم الاختلافات بين متوسطات هذه الصفات والراجعة لعملية الإحلال معنوية ويوضح ذلك امكانية احلال جزء من بروتين كسب الفول الصويا ببروتين كسب عباد الشمس المقشور حتى ٧٥% بدون تأثير معنوى على صفات النمو.

تراوحت قيم معدل التحويل الغذائى خلال فترة التجربة بين ٢,٤٤ للاسماك المغذاة على العليقة الاساسية الى ٤,٠٥ للاسماك المغذاة على العليقة الخامسة (التى تم فيها الاحلال الكامل لكسب فول الصويا بكسب عباد الشمس) وكانت الاختلافات فى قيم معدل التحويل الغذائى للمعاملات المختلفة معنوية. بالنسبة لكفاءة تحويل البروتين فقد وجد أن قيمه قد تراوحت بين ٠,٨ (للعليقة الخامسة التى تم فيها الإحلال التام لكسب فول الصويا بكسب عباد الشمس) الى ١,٣٦% (للعليقة الاساسية). وكانت الفروق بين المعاملات المختلفة معنوية عند مستوى معنوية ٠,٠١ هذا وقد أظهرت النتائج أن كفاءة تحويل البروتين لمجموعة الاسماك التى كانت تتغذى على العليقة الاساسية اعطت اعلى القيم.

أظهرت نتائج التحليل الكيميائى للأسماك بعد إنتهاء فترة التجربة أن الاحلال الكامل لكسب فول الصويا بكسب عباد الشمس المقشور اظهر اعلى محتوى من البروتين فى كل الاسماك ثم باقى المجموعات الأولى والرابعه والثالثة ثم الثانية على التوالى وكانت الاختلافات معنوية. أما بالنسبة لمحتوى الجسم من الدهن والرماد فقد أظهرت النتائج عدم وجود فروق معنوية بين المعاملات المختلفة.

ومن النتائج المتحصل عليها فى هذه التجربة يمكن التوصية باحلال ٧٥% من كسب فول الصويا بكسب عباد الشمس المقشور والذى سيؤدى إلى خفض تكاليف الغذاء بنسبة ١٥,١٣%.