EFFECTS OF REPLACING SOYBEAN MEAL WITH OTHER PLANT PROTEIN SOURCES ON PROTEIN AND ENERGY UTILIZATION AND CARCASS COMPOSITION OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*)'

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Abstract

The present study was conducted at the fish experimental unit belonging to The Faculty of Agriculture, Al- Azhar University. Nasr City, Cairo, ARE during the period from 1st July to the 3rd of November 2005. The study aimed to investigate the effect of incorporation of dried rumen contents (RC) or sunflower meal (SFM) and sesame seed cake (SSC) to replace 30% of soybean meal protein on growth performance of growing Nile tilapia mono-sex with an initial body weight of 30 ± 0.46 g. The experiment lasted 18 weeks after start and the experiment was performed in circular fiber glass tanks with a total volume of 1 m^3 each. The investigations involved four dietary treatment groups. The first group was fed on a control diet containing 30% protein from fish meal and soybean meal, while the second (RC) contained rumen contents; the third contained SFM and the fourth contained (SSC) to replace 30% of soybean protein in the control diet. Results obtained are summarized in the following:

1- Replacing 30% of soybean protein by dried rumen contents, sunflower meal or sesame seed cake had no significant effects on protein intake and protein efficiency ratio of Nile tilapia.

2- Nile tilapia fed on diets containing sesame seed cake showed the highest ($P < 0.05$) body protein retention followed by the other groups.

3- Protein productive value did not differed among the dietary treatments tested.

4- There were insignificant differences in net protein utilization (NPU) using the fibers as indicator in determination of protein digestibility among the dietary treatments. While using ash as indicator, results revealed a slight significant improvement in NPU for the favor of group fed the sesame seed cake diet.

5- Fat retention and fat productive values improved significantly using sunflower meal and sesame seed cake compared to the control and rumen contents diets.

6- The highest energy retention and energy utilization efficiency values ($P < 0.05$) were reported by sesame seed cake diet followed by the other treatment groups.

7- Dietary treatments applied released significant effects on whole body DM, CP, EE, ash% and energy contents Kcal GE/Kg DM.

8-Dietary treatments released no significant effects on percentages of fins and flesh with bones and skin, while the treatments applied showed significant effects on percentages of scales, viscera, head and hepatosomatic index.

Based on the obtained results it is worthy to recommend the incorporation of dried rumen contents, sesame seed cake or sunflower meal to replace 30% of soybean protein to reduce feed costs without any adverse effects on feed utilization and carcass traits and whole body chemical composition of growing Nile tilapia mono sex.

Key words: Nile tilapia monosex; Feed utilization; Dried rumen contents ; Sunflower meal ;Sesame seed cake; Soybean meal protein; carcass traits.

INTRODUCTION

Plant oilseeds and their by products usually constitute a major source of dietary protein within aqua feeds for warm water omnivorous/ herbivorous fish species (Akiyama, 1991; Lim and Dominy, 1991). Some of the factors which limit incorporation of these ingredients at high levels in fish feed ore low protein content, amino acid imbalance and presence of anti-nutritional factors (Wee, 1991). Moreover, another problem of selecting these ingredients in the aqua feeds is the lack of information on their digestibility in feed formulation and manufacture. It is essential to have knowledge of the digestibility of the main ingredients, as well as of the whole diet (De silva and Anderson, 1995). Hossain and Jauncey (1989) evaluated three oilseed meals (mustard, linseed and sesame) of Bangladeshi origin were as fish meal substitutes in diets of common carp (*Cyorinus carpio* L.). These oilseed meals were included in the diet at various levels (25.50 and 75% of dietary protein) and the response of fish fed these diets was compared to fish fed a fish meal based control diet (40% protein). They reported that, on the basis of observed growth rate, food conversion ratio, protein efficiency ratio and apparent net protein utilization, the control diet produced significantly ($P < 0.05$) the best growth performance. Growth responses were significantly affected by both type and inclusion level of oilseed protein.

Rumen contents obtained after slaughtering of ruminants are almost from plant materials included in the diets of such animals. Reddy and Reddy (1980) found that average values of rumen content from cattle and sheep were DM, 18.1 and 84.0; CP, 11.6 and 16.6; EE, 2.6 and 3.6; CF, 30.0 and 29.2; NFE, 36.7 and 34.6 and ash, 18.9 and 16.0 on dry matter basis, respectively. Omar *et al.*, (1993) reported that dried rumen contents could be incorporated in diets for tilapia at level of 15 and 30% as a dietary replacement SBBP without having an adverse effect on growth performance, feed utilization or body composition .This study was carried out to investigate the effect of replacing 30% of soybean meal protein by dried rumen contents, sesame seed cake or sunflower meal on nutrient utilization of Nile tilapia.

Recently Hasan and Gomah (2006) reported that dress out, fillet yield and total edible parts as percentages of body weight of Tilapia at weights ranging between 401-500 g were 83.92, 51.23 and 52.93 Percent, respectively. The same anthers reported that non-edible parts, viscera and scales percentages of Tilapia of the same average weights were 47.07, 9.48 and 3.31 percent of body weight, respectively.

MATERIALS AND METHODS

This study was performed at a fish culture tank system with closed water recirculation belonging to the fish experimental system, Department of Animal production, faculty of Agriculture, AL-Azhar University, Cairo, Egypt. The experiment lasted 18 weeks after start. The experiment started at first of July, 2005 and lasted at 3rd of November, 2005.

Rearing system and experimental fish

The experimental rearing system consisted of series of Four circular fiber glass each of one quibic meter water volume were used in the present study. The four tanks represented four nutritional treatments including the control soybean meal diet (C) rumen contents diet (RC) where rumen contents replaced 30% of soybean meal protein, sunflower meal diet (SFM) to replace 30% soybean meal protein and sesame seed cake diet (SSC) to replace 30% of soybean meal protein. The water supply of these tanks was the drinking tap water which derived the mechanical filter reservoir via a pump to another two fiberglass tanks 5 M^3 capacity. The series of the fiberglass tanks are connected together with a tap water supply as well as a drainage system and connected with the mechanical filter. All experimental tanks were supplied with air through an aeration system which connected with an oil free air compress or (3 ohv). Nile tilapia (*Oreochromis nilticus*) all male (sex reversed with hormone treatment), purchased from a private tilapia hatchery in Abbassa, Sharkiya Governorate, were used in this study. The fish were transported at early morning using a special fish transport car with aeration facilities. Fish were acclimated to the experimental system for 7 days before starting the experiment. There after the fish were randomly distributed into four groups represented one of the dietary treatments cited above and stocked in the experimental tanks at a rate of 30 fish/ m3, the initial weight and length were 30 g. and 11.8 cm, respectively. The experiment lasted 18 weeks after start.

Experimental diets

Chemical proximate analysis of feed ingredients used in the presents study is presented in table (1). Amino acids composition of rumen contents (RC), Sunflower meal (SFM) and Sesame seed cake (SSC) in the present study was determined using the amino acid analyzer model LC3000, Eppendorf, Germany. Results of the amino acid composition are presented in table (2) and the results of the same amino acids in soybean meal were illustrated according to N.R.C. (1993).

Table 1. Chemical analysis of the ingredients used in the experimental diets (on DM basis)

Ingredient	DM%	CP%	EE%	CF%	Ash%	NFE%*	GE**(Kcal/KgDM)
Fish meal	92.21	72.00	8.8	0.6	10.2	8.4	5259.6
Soybean meal	90.57	44.00	2.1	7.4	6.5	40	4580.45
Yellow corn	87.30	7.7	4.1	2.5	1.3	84.4	4298.5
Corn gluten	91.26	60.00	2.9	1.6	2	33.5	5068.05
Rice bran	91.18	12.8	14.00	11	11.3	50.9	4522.2
Sunflower meal	92.45	34.00	5.6	14.2	6.9	39.3	4590.2
Sesame seed cake	91.76	33.00	9	7	9.5	41.5	4655
Dried rumen contents	89.00	11.20	1	18.1	17	52.7	3559.3

* Calculated by differences

** Estimated, Jobling (1983). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.

Table 2. Composition of essential amino acids for rumen contents, sunflower meal and sesame seed cake compared with Soybean meal.

Composition	RC	FM	SSC	SBM
% dry matter	89.00	92.45	91.76	90.57
% crude protein	11.20	34.00	33.00	44.00
Threonine	0.31	1.44	1.73	N.R.**
Valine	0.83	2.10	1.91	N.R.**
Isoleucine	0.60	1.71	1.50	2.03
Leucine	1.00	2.55	2.68	3.49
Phenylalanine	0.86	1.97	1.94	2.22
Histidine	0.52	0.98	0.96	1.19
Lysine	0.94	1.41	0.99	2.85
Methionine	0.71	1.03	1.52	0.57
Arginine	1.06	3.37	4.68	3.39
Tryptophan	0.09	N.D.*	N.D.*	N.R**.
Cystine	0.23	0.64	0.72	0.70

N.D. = Not detected* **N.R. = Not recorded in N.R.C.(1993)

Four experimental diets were formulated to contain 30% crude protein and almost 4600 Kcal gross energy /kg (table, 3). The first diet had served as a control diet containing protein from fish meal and soybean meal. The second diet contained dried rumen contents to replace 30% of soybean meal protein. The third diet contained sunflower meal to replace 30% of soybean protein and the fourth diet contained sesame seed cake to replace 30% of the soybean meal protein. The experimental diets were prepared by fine grinding of the dietary ingredients. Thereafter all ingredients included in each experimental diet were mixed thoroughly and produced in a pelleted form (0.2 cm. in diameter) using minceing machine after mixing with 25% of water. The experimental pellets were sun dried and stored in good storage conditions till the experimental start. The experimental diets were fed to the fish at a rate of 3% of the tank fish biomass twice daily at 8^{00} o'clock am. and 3^{00} pm. daily. The amounts of feed were adjusted every two weeks according to the last body weight after weighing.

Table 3. Composition of the experimental Diets (on DM basis)

Ingredients in percentage	Experiment Diets			
	Control	T_1	T_2	T_3
Fish meal herring	11.00	11.00	11.00	11.00
Corn gluten	14.00	16.22	14.00	14.00
Soybean meal	25.00	17.50	17.50	17.50
Dried rumen contents	-	29.46	-	-
Sunflower meal	-	-	9.71	-
Sesame seed cake	-	-	-	10
Yellow corn	41.30	17.20	42.07	42.10
Rice bran	3.00	3.00	3.00	3.00
Corn oil	3.10	4.62	1.40	1.40
Celluose powder	1.60	-	0.32	-
Fish premix*	1.00	1.00	1.00	1.00
Total	100	100	100	100
Chemical analysis of the experimental diets (on DM basis)				
Dry matter%	90.78	92.10	91.35	91.26
Crude protein %	30.88	30.36	30.91	30.94
Ether extract %	8.15	9.58	7.87	8.61
Crude fiber %	6.02	8.24	5.90	5.13
Ash %	7.69	11.45	7.94	8.37
**NFE %	47.26	40.37	47.38	46.95
*** Gross Energy (Kcal/ kg)	4646.10	4565.05	4621.33	4644.96

*Fish premix (each 1 kg contains: vitamin A, 2.5 m.i.u.; vitamin D_3, 1.25 m.i.u.; vitamin E. 125000 mg; vitamin K, 5000 mg; vitamin B_1, 7500mg; vitamin B_2, 5000 mg; vitamin B_6; 25000 mg; vitamin B_{12}, 10 mg; pantothenic acid, 10000 mg; Nicotinic acid, 100000; folic acid, 5000 mg; biotin, 750 mg; choline chloride, 2000000mg; copper, 3000 mg; Iodine, 125 mg; Iron, 75000 mg; Manganese, 6000 mg; Zinc, 65000 mg; Selenium, 150 mg).

** Calculated by differences

*** Estimated according to Jobiling (1983). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.

Records maintained

Protein efficiency ratio:

Protein efficiency ratio (PER) = Weight gain (g)/CP intake (g)

Protein productive value (PPV): PPV= PR2 – PR1/Pi X 100

Where:

PR2 is the total fish body protein at the end of the experiment.

PR1 is the total fish body protein at the start of the experiment.

Pi is the protein intake during the whole experimental period.

Calculated on DM basis.

Net protein utilization

$$NPU = \frac{PR2 - PR1}{Pi \times ADC \times 100}$$

Where:

ADC = Apparent digestibility coefficient

Energy utilization: (EU), Kcal = $100 \times (E_2 - E_1)/ E$

Where:

E = Gross energy intake (Kcal GE) during the whole experimental period E_1 = Total fish body energy (or flesh), Kcal GE. at the start of the experiment.

E_2 = Total fish body energy (or flesh), Kcal GE. at the end of the experiment.

Gross energy (GE), Kcal was calculated by multiplying CP x 5.65 + fat x 9.45 + Carbohydrate x 4 (Jobling, 1983)

Fat utilization:

Fat utilization (FU), gm = $100 \times (E_2 - E_1)/ E$

Where:

E = Fat intake (g) during the whole experimental period

E_1 = Total fish body fat (or flesh), (g) at the start of the experiment

E_2 = Total fish body fat (or flesh), (g) at the end of the experiment.

At the end of the experimental period 16 fish from each treatment were allotted in two aquaria (8 each) representing replicates to carry out the digestibility trial. The fish were fed the experimental diets at a daily rate of 1% of aquarium fish biomass. The experimental diets were offered once daily at 11^{00} am. after feces collection. Feces were collected by siphoning one time daily before feeding. Feces were kept in a deep freezer at -4°C after collection to avoid the fermentation according to the method of A.O.A.C. (1990). The digestion trial lasted 21 days after start.

Chemical analysis:

At the start of the experiment, four fish were taken randomly and exposed to whole body proximate composition (Dry matter, protein, fat, ash and fiber) according to the methods described by A.O.A.C. (1990). Nitrogen free extract (NFE) was calculated by difference. Also, all experimental diets were chemically analyzed according to A.O.A.C. (1990) methods. At the end of the experiment, four fish were chosen at random from each treatment and exposed to whole fish body analysis as described before. All calculations were based on dry matter weight.

Carcass traits

At the end of the experimental period four fish were taken randomly from each treatment and exposed to carcass test. In carcass test fish body weight, scales weight; fin weights; viscera weight; head weight and flesh weight with bones and skin were recorded. All carcass traits were calculated as percentage of the whole fish weight.

Hepatosomatic index

Hepatosomatic index (HSI) = 100 × [liver weight (g)/ fish weight (g)]

Statistical Analysis:

The data were analyzed using the SAS computer program (1996). Comparison between treatments was conduct according to Duncan (1955).

The used model was: $Xi = \mu + Ti + Ei$

Where: Xi is the observation on i treatment

μ is the overall mean

Ti is the effect of i treatment

Ei is the experimental error

RESULTS AND DISCUSSION

Protein utilization parameters:

Results of protein intake (PI); protein efficiency ratio (PER); protein retention (PR); protein productive value (PPV); net protein utilization (NPU) and apparent protein digestibility using the ash or fibers as indicators are presented in table (4). Results revealed that PER values had ranged between 1.78 (RC group) and 1.83 (SFM group) and differences in this trial among the treatment groups were insignificant. As presented in table (4) averages of total body protein contents on the dry matter at the experimental start had ranged between 3.42 g and 3.59 g with insignificant differences among treatment groups. At the end of the experiment averages of total body protein contents on DM basis were found to be 22.50, 22.60, 23.05 and 24.07 g for C, RC, SFM and SSC groups; respectively. The statistical evaluation of results revealed that SSC deposited more protein ($P < 0.05$) in their bodies followed in a significant ($P < 0.05$) decreasing order by SFM group and the RC, C groups, respectively. The same trend was observed with total amounts of protein retained in bodies. Concerning protein productive value (PPV), it averaged between 27.56 (RC group) and 27.93% (SFM group) with insignificant differences among the treatment groups. Concerning apparent protein digestion coefficient (APDC) using ash as indicator, results revealed (table 4) that average of APDC% for the C, RC, SFM and SSC groups were 72.98, 72.24, 73.65 and 75.05%, respectively. The corresponding

net protein utilization (NPU) values of the same groups cited above were 38.00, 38.15, 37.92 and 37.03%, respectively, indicating that C and RC groups showed higher results (worthier) ($P < 0.05$). NPU values compared to the SFM and SSC groups using ash in digestibility determination. The NPU values determined using fibers as indicator had ranged between 35.06% and 35.36% with insignificant differences among treatment groups. These results are not accordance with the findings of Hegazy (1990), who reported that inclusion of dried rumen liquor at a level of 30% in Nile tilapia diets containing a mixture of meat meal and cotton seed cake decreased feed utilization parameters including protein and energy utilization. Further more, Hossain and Jouncey (1989), reported that inclusion of mustard, linseed and sesame oilseed meals at 25.50 and 75% levels in Common carp diets depressed net protein utilization compared to the control group. The same authors added that the apparent protein digestibility for all diets ranged between 77.72 to 89.80% and these values decreased with increasing the level of plant protein sources (oil seed cake) levels in the diets. Concerning results of sunflower meal, results of table (4) are in agreement with the findings of Jackson *et al.* (1982) who obtained reasonable growth and feed conversion when up to 50% of a 30% protein diet was replaced with sunflower seed meal and fed to *S. mossambicus*. On the other hand, Martinez (1986) reported that replacing soybean meal by sunflower meal at 50 and 100% levels in a 40% fish meal diet containing 15% soybean meal and fed to rainbow trout, depressed growth performance, feed conversion ratio, protein efficiency ratio, apparent nutrient digestibility and proximate carcass composition. The same authors also indicated that fish performance was significantly ($P < 0.05$) enhanced on the basis of the above mentioned parameters. Furthermore, a reduction in the dietary brown fish meal concentration and an increase in sunflower meal concentration resulted in no loss in growth performance and diet utilization efficiency.

Sunflower meal has bean demonstrated to be a good dietary replacement for solvent extracted soybean meal in rations for trout. Results of Olvera- Novoa *et al.* (2002) replaced fish meal in diets of tilapia fingerlings by sunflower seed meal at 10, 20, 30, 40 and 50% levels. They reported that, during 70 days feeding period diets containing 10% and 20% plant protein provided the best growth and feeding efficiency results, with values statistically similar to those of the control diet based on fish meal as the sole protein. They continued that, the unitary feeding cost index showed the highest profit with diets containing 20% sunflower seed meal. The same authors showed that, growth depletion observed with diets containing higher sunflower seed meal percentages is explained by increasing Phe and met deficiencies and high non- digestible fiber content.

Table 4. Effect of the dietary treatments on protein utilization parameters of mono sex Nile tilapia

Parameters	Control diet	Replaced treatments		
		RC	SFM	SSC
Protein intake (g/fish)(PI)	68.69 ± 1.25[a]	69.01 ± 1.23[a]	70.28 ± 1.31[a]	73.70 ± 1.37[a]
Protein efficiency ratio(PEA)	1.79 ± 0.01[a]	1.78 ± 0.02[a]	1.83 ± 0.02[a]	1.81 ± 0.03[a]
Total body protein at the start	3.45 ± 0.01[a]	3.58 ± 0.01[a]	3.42 ± 0.01[a]	3.59 ± 0.01[a]
Total body protein at the end	22.50 ± 0.07[c]	22.60 ± 0.06[c]	23.05 ± 0.16[b]	24.07 ± 0.11[a]
Protein retention(PR)	19.05 ± 0.07[c]	19.02 ± 0.06[c]	19.63 ± 0.16[b]	20.45 ± 0.10[a]
Protein productive value %(PPV)	27.73 ± 0.10[a]	27.56 ± 0.09[a]	27.93 ± 0.22[a]	27.79 ± 0.14[a]
Apparent digestion factor of protein by using Ash method (1) as a digestive indices (%)	72.98 ± 0.60[b]	72.24 ± 1.06[b]	73.65 ± 0.68[ab]	75.05 ± 1.00[a]
or by using crude fibers method (2) as a digestive indices (%)	78.52 ± 0.43[a]	77.94 ± 0.19[a]	79.13 ± 0.20[a]	79.27 ± 0.87[a]
Net protein utilization by (1)(NPU)	38.00 ± 0.14[a]	38.15 ± 0.13[a]	37.92 ± 0.26[a]	37.03 ± 0.18[a]
Or by (2) %	35.32 ± 0.13[a]	35.36 ± 0.12[a]	35.30 ± 0.24[a]	35.06 ± 0.17[a]

(Means ± S.E.).

a, b, c...etc: Meaning the same row with different superscripts are significantly different ($P < 0.05$)

Fat and Energy Utilization Parameters:

Averages of fat intake (g), total fish body fat at the start and end of the experimental period (g), fat retention (g) and fat productive values % are presented in table (5) . Averages of fat intake had ranged between 17.90 g (SFM group) and 21.78 g (RC) group with insignificant differences among treatment groups.

Averages total body fat contents at the end for the groups C, RC, SFM and SSC were found to be 10.68, 10.37, 11.44 and 12.86, respectively. The statistical evaluation of results indicated that group SSC deposited significantly ($P < 0.05$) more fat in their bodies followed in a significant ($P < 0.05$) decreasing order by SFM, C and RC groups. The same trend was observed in fat retention where the SFM group retained significantly ($P < 0.05$) more fats in their bodies compared to other treatment groups. Averages of fat productive values were the highest ($P < 0.05$) for groups SFM and SSC followed in a significant decreasing order by C then the RC groups, respectively. These results indicated that incorporation of sunflower meal or sesame seed cake in growing tilapia diets improved. Fat utilization as the fat productive value improved.

Table 5. Effect of the dietary treatments on fat utilization parameters of mono sex Nile tilapia

Parameters	Control diet	Replaced treatments		
		RC	SFM	SSC
Fat intake (g/fish)	18.13 ± 0.33[a]	21.78 ± 0.39[a]	17.90 ± 0.34[a]	20.51 ± 0.38[a]
Total body fat at the start	1.30 ± 0.02[a]	1.35 ± 0.02[a]	1.29 ± 0.02[a]	1.35 ± 0.02[a]
Total body fat at the end	10.68 ± 0.15[c]	10.37 ± 0.18[c]	11.44 ± 0.16[b]	12.86 ± 0.11[a]
fat retention	9.38 ± 0.13[c]	9.02 ± 0.16[c]	10.15 ± 0.14[b]	11.51 ± 0.09[a]
Fat productive value % (fat utilization)	51.74 ± 0.73[b]	41.41 ± 0.73[c]	56.70 ± 0.77[a]	56.12 ± 0.43[a]

(Means ± S.E.).

a, b, c...etc: Meaning the same row with different superscripts are significantly different (P< 0.05)

In this connection, Ali (2004) reported that the highest value of ether extract intake was recorded by tilapia fed on diet containing 25% dried rumen contents compared to groups fed on diets containing higher levels i.e. 50 or 75%. The same author reported that incorporation of sunflower seed meal to replace 25, 50 or 75% of soybean meal protein had no significant effects on ether extract intake of Nile tilapia.

Results of table (5) revealed that total energy intake and total body energy contents at the start did not significantly differed among the treatment groups, but total body energy contents kcal GE/ body at the end were found to be 231.31, 228.73, 242.12 and 261.75 kcalGE/ body dry matter for C, RC, SFM and SSC groups, respectively. The statistical evaluation of results indicated that SSC group had significantly (P<0.05) higher total body energy contents followed by SFM and C and RC groups, respectively. The same trend was observed with total body energy retention. Energy utilization efficiency percent for the C, RC, SFM and SSC groups were 19.27, 18.84, 20.01 and 20.64%, respectively, where the SSC group showed significantly(P<0.05).The highest value followed in a significant decreasing order by the SFM; C and RC groups, respectively. Results of tables (5) and (6) indicated that incorporation of sesame seed cake improved fat utilization and consequently energy utilization of Nile tilapia. These results confirm the findings of Abd El-Hakim *et al.* (2003), who reported that incorporation of sesame seeds in tilapia diets improved energy utilization compared to the full-fat extruded soybean and canola seeds or linseeds.

Also, results concerning rumen contents and its effect on fat and energy utilization (Tables, 5&6). The findings of the present work are in accordance with those of

Ibrahim (1985) who reported that Nile tilapia diets supplemented with 20% rumen contents (represented 6.7% of dietary protein) depressed energy digestibility and utilization. On the other hand, *Hegazy* (1990) showed that incorporation of dried rumen liquor at 30% level in Nile tilapia diets did not significantly affected energy retention or feed conversion ratio. In this connection, Omar Eglal et *al.* (1993) reported that incorporation of dried rumen liquor in diets of carp and mullet fishes decrease the energy utilization and the decrease was more pronounced at higher incorporation levels. The same trend was also observed by Ibrahim (1997) who incorporated dried concentrated rumen liquor (DCRL) in diets of Nile tilapia at levels 10, 25, 50, 75 and 100% in replacement of fish meal and found that incorporation of DCRL at the levels tested released significant effects on energy intake while energy retention and energy retention efficiency decreased significantly with each increased in DCRL level. The higher energy utilization efficiency results (Table 6) obtained using sesame seed meal in the present study were not in agreement with the findings of El-Hammady (2001), who showed that significant negative correlation in energy retention as sesame seed meal incorporation levels in diets of tilapia increased from 40 to 60 or 80% to replace the dietary protein of the control diet.

Table 6. Effect of the dietary treatments on energy utilization parameters of mono sex Nile tilapia (Means ± S.E.).

Parameters	Control diet	Replaced treatments		
		RC	SFM	SSC
Energy intake (Kcal/fish)	1033.53 ± 18.84^{a}	1037.64 ± 18.55^{a}	1050.84 ± 19.65^{a}	1106.48 ± 20.61^{a}
Total body energy at the start	32.13 ± 0. 35^{a}	33.25 ± 0.32^{a}	31.83 ± 0.31^{a}	33.40 ± 0.33^{a}
Total body energy at the end	231.31± 2.14^{c}	228.73 ± 2.20^{c}	242.12 ± 1.63^{b}	261.75± 1.40^{a}
Energy retention	199.18 ± 1.90^{c}	195.48 ± 1.91^{c}	210.29± 1.37^{b}	228.35± 1.18^{a}
Energy utilization (%)	19.27 ± 0.18^{c}	18.84 ± 0.18^{c}	20.01 ± 0.13^{b}	20.64 ± 0.10^{a}

a, b, c...etc: Meaning the same row with different superscripts are significantly different (P< 0.05)

Effect of dietary treatments on whole body chemical composition of Nile tilapia

Averages of chemical composition of whole fish bodies including dry matter (DM), total body protein (CP), body ether extract (EE), ash and energy contents Kcal GE/Kg DM calculated as percentages of DM at the experimental start and end are presented in Table (7) . Average DM contents of Nile tilapia whole bodies at the experimental start was 21.38% and increased sigfnicantly (P<0.05) in all treatments groups at the end of the experiment with insigfnicant differences among the treatment groups in this trial at termination of the experiment.

Results of the same table revealed that total CP% in whole fish body at the start of the experiment was significantly ($P<0.05$) higher than that of all treatment groups at the end of experiment indicating a decrease in whole body CP with advanced age and this decrease in whole fish body CP parallel are increase in whole fish body EE. At the end of the experiment and within the treatment groups, control group and RC group had higher CP% in their whole bodies ($P<0.05$) compared with SFM and SSC groups among the both last groups no significant differences in body CP% was observed. The reverse trend was observed with total body EE where it was significantly ($P<0.05$) low at the experimental start and increased ($P<0.05$) in all treatment groups at the end of the experiment compared with its initial (start) values. At the end of the experiment and within the treatment groups, SSC group showed significantly ($P<0.05$) higher EE contents in their bodies (27.03%) followed in a significant decreasing order by SFM, C and RC groups. These results indicated in general that CP% in whole fish body is related to EE contents where the increase in one is on the costs of the other. These results also revealed that SSC released more potential in fat deposition than RC or SFM when incorporated in growing tilapia diets. Concerning whole body ash%, results revealed that ash% in whole tilapia bodies was the highest ($P<0.05$) at the experimental start compared to those of all dietary treatment groups at the end of the experiment. At the end of the experiment, the RC group showed the highest ($P<0.05$) ash% followed by the C; SFM and SSC groups, respectively. The higher ash% in the RC may due to higher ash percentages in rumen contents used in this study.

As presented in the same table energy contents at the start of the experiment was found to be 5083.84 Kcal GE/Kg dry matter and was increased to 5335.92; 5289.74; 5374.49 and 5500.01 Kcal GE/Kg DM in C; RC; SFM and SSC groups at the experimental end, respectively. Within the treatment groups and at the end of the experimental period the SSC group showed significantly ($P<0.05$) higher energy contents in the body compared to C; RC and SFM groups.

Concerning the effect of incorporation of dried rumen contents results of table (7) are in accordance with that recorded by Ibrahim (1997) who found that inclusion of dried rumen liquor (DCRL) in growing Nile tilapia diets at levels 10, 25, 50 and 75%, released no significant effects on body protein contents except the group fed the diets containing 100% DCRL in replacement with fish meal which showed significantly higher CP contents compared to the control group. Results concerning the effect of rumen contents on CP contents of whole body of Nile tilapia are also in partial accordance with that obtained by several authors, Wee and Shu (1989) in *Tilapia*

nilotica, Fowler (1991) in salmon, Reigh and Ellis (1992) in red drum and Gomes *et al.* (1993) in trout.

Results of table (7) showed that incorporation of rumen contents in diets of Nile tilapia reduced significantly ether extract contents of the whole body which are not in agreement with that reported by Ibrahim (1997) who reported that incorporation of dried rumen liquor in tilapia diets at 10% level in replacement to fish meal increased significantly EE contents of the whole body.

As presented in table (7) results showed that incorporation of rumen contents increased significantly whole bodies ash contents which agree completely with the findings of Fowler (1991); Khattab (1996) and Ibrahim (1997). In this respect, Omar *et al.* (1993) reported that replacing soybean byproducts meal by dried rumen liquor at levels of 0, 50 and 100% in diets of Nile tilapia; common carp and mullet decreased carcass crude protein decreased and ether extract and ash increased within all species when DRL was fed with the exception of ash within tilapia. Results of the present study showed that incorporation of sunflower meal and sesame seed cake in diets of growing Nile tilapia had insignificant effect on whole body dry matter. However, it reduced whole body protein and ash contents significantly and caused a significant increase in EE contents. These results are not in agreement with the findings of Hossain and Jauncey (1989) who reported that incorporation of mustard, linseed and sesame oil seed meals in diets of common carp at 25, 50 and 75% of dietary protein increased significantly carcass moisture and lower carcass lipid contents. In this connection, Dabrowski and Kozlowska (1981) and Yurkowski *et al.* (1978) observed that similar reductions in carcass lipid in common carp and rainbow trout, respectively, fed diets containing rapeseed meals. Appler and Jauncey (1983) also observed marked decrease in carcass lipid contents of *O. nilotics* fed diets containing filamentous algae as the partial or sole source of dietary protein. Results of Table (7) indicated that incorporation of sesame seed meal in Nile tilapia diets increased the EE contents in fish whole body which is in agreement with the findings of Abd El-Hakim *et al.* (2003) who reported that incorporation of sesame seeds (full fat) in diets of Nile tilapia increased significantly whole body lipid contents compared full fat rapeseed (Canola), linseed and peanut seeds when incorporated at 12.5% levels in growing Nile tilapia diets. Concerning sunflower meal, results of Martinez (1986), revealed that substitution of soybean meal with sunflower meal in diets of trout at 50 and 100% levels seemed to have no effect on whole body chemical composition except carcass moisture contents which was elevated in fish fed diets containing sunflower meal. In this connection Tahoun (2007) reported that using different protein sources (plant alone; plant and animal or animal protein) resulted in significant differences in dry

matter, crude protein and EE contents in tilapia whole bodies in favor of animal protein source based diets followed by diet containing protein from both sources and the least figures were obtained with the diet contained plant protein sources alone.

Table 7. Effect of the dietary treatments on chemical composition of whole body of Mono sex Nile tilapia (mean ± S.E.).

Treatment	Chemical composition (as a percentage of DM)				
	DM%	CP	EE	Ash	Energy* (Kcal GE/Kg DM)
At start of the experiment:-	b	a	d	a	c c c c
(Zero group)	21.38 ± 0.22	54.65 ± 0.08	20.59 ± 0.23	23.5 ± 0.18	5083.84 ± 18.31
At end of the experiment:-					
Control Diet	a	b	c	c	b b
	28.44 ± 0.30	51.90 ± 0.16	24.63 ± 0.19	21.56 ±0.13	5335.92 ± 12.67
RC	a	b	c	b	b bbb
	28.21 ± 0.21	52.26 ± 0.14	23.99 ± 0.29	22.00± 0.24	5289.74± 23.19
SFM	a	c	b	c	b b
	28.58 ± 0.22	51.17 ± 0.34	25.40 ± 0.25	21.35 ±0.09	5374.42± 11.39
SSC	a	c	a	d	a bbba
	29.00 ± 0.20	50.58 ± 0.21	27.03 ± 0.14	20.19 ±0.09	5500.01± 9.76

a, b, c... : meaning the same column with different superscripts are significantly different ($P<0.05$).

* Estimated according to Jobling, (1983). Using the factor 5.65, 9.45 and 4 for crude protein, ether extract and carbohydrate, respectively.

Effect of the dietary treatments on carcass traits of Nile tilapia

Results of carcass traits including viscera, fins, scales, head and flesh with bones and skin as percentages of final fish weight are presented in table (8). Concerning scales percentage, results revealed that values of this trait ranged between 3.63 and 3.74% where group RC showed significantly ($P<0.05$) higher value compared to SSC group with insignificant differences among the other groups. Results of the same table showed that fins percentages had ranged between 2.82 and 2.87 with insignificant differences among treatment groups. Results of table (8) revealed that group RC showed significantly ($P<0.05$) the lowest value of viscera compared to the other dietary treatment groups, thus differences among C, SFM and SSC groups in this trait were insignificant. Averages of head percentage for the C, RC, SFM and SSC groups were found to be 21.06, 21.38, 21.00 and 20.94%, respectively and the RC showed significantly ($P<0.05$) higher head percentage compared to the other groups. Hepatosomatic index (Table 8) showed highest value in SSC group followed in a decreasing order by SFM, C and RC groups, respectively. As presented in table (8), results revealed that percentages of flesh with bones had ranged between 58.14 and 58.07% with insignificant differences among treatment groups.

In this connection, Ibrahim (1997) reported that incorporation of dried concentrated rumen liquor at 0, 10, 25, 50, 75 and 100% levels in replacement to fish

meal in diets of Nile tilapia had no significant effects on hepatosomatic index except the replacing level of 100% which decreased the HSI signficantly. Also, Khattab (1996) noticed that hepatosomatic index ranged from 2.09 and 2.40 in Nile tilapia which is similar to the results of the presents study. El-Hammady (2001) reported that replacing the dietary protein in diets of hybrid tilapia by sesame seed or corn gluten meals at 40, 60 or 80% levels increased the hepatosomatic index and the increase was more pronounced as the level of the replacement increased. In (2006) Hasan and Gomah reported that, dress out percentage of tilapia ranged between 79.85 and 83.92%. The same authors reported that the percenatge of edible parts in tilapia were found to be 52.93; 52.48; 53.79 and 52.98 for weight groups 401-500, 301-400, 201-300 and 101-200 gm., respectively. These figures reported for tilapia edible parts are almost in partial agreement with the values reported in the present study.

Table 8. Effects of the dietary treatment on carcass traits and hepatosomatic index of mono sex Nile tilapia (mean ± S.E.).

Treatments	Carcass traits					
	Fins %	Scales	Viscera%	Head %	HSI (liver)	% flesh with bones and skin
Control diet	a 2.84 ± 0.03	ab 3.68 ± 0.02	a 11.98 ± 0.04	b 21.06 ± 0.07	b 2.34 ± 0.01	a 58.10 ± 0.16
RC	a 2.87 ± 0.02	a 3.74 ± 0.03	b 11.71 ± 0.02	a 21.38 ± 0.03	c 2.23 ± 0.01	a 58.07 ± 0.07
SFM	a 2.85 ± 0.02	ab 3.71 ± 0.03	a 11.96 ± 0.05	b 21.00 ± 0.06	b 2.35 ± 0.01	a 58.13 ± 0.15
SSC	a 2.82 ± 0.03	b 3.63 ± 0.04	a 12.05 ± 0.03	b 20.94 ± 0.06	a 2.42 ± 0.01	a 58.14 ± 0.14

a, b, c : meaning the same column with different superscripts are significantly different (P<0.05).

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كفاءة البروتين,الطاقة، تركيب الجسم فى اسماك البلطى النيلى كمتأثّر بإستِبْدال بروتينِ مسحوق فول الصويا بمصادرِ بروتينِ نباتيةِ أخرى

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أجريت هذه الدراسة فى المزرعة السمكية البحثية التجريبية الخاصة بكلية الزراعة جامعة الأزهر– مدينة نصر – القاهرة – جمهورية مصر العربية ، خلال الفترة من الأول من يولية وحتى الثالث من نوفمبر سنة ٢٠٠٥.

هدفت هذه الدراسة إلى تقييم أثر إحلال كل من محتويات الكرش الجافة أو كسب زهـرة الشمس أو كسب السمسم لتحل محل ٣٠% من بروتين كسب فول الصويا على أداء النمو لإسماك البلطى النيلى وحيد الجنس النامية بمتوسط وزن إبتدائى ٣٠ جم.

استمرت التجربة لمدة ١٨ إسبوع بعد بدايتها وأجريت التجربة فى أحواض مستديرة من الفيبرجلاس حجم الحوض الكلى١ م^{٣}.

- المعاملة الأولى: تم تغذيتها على عليقة ضابطة (مقارنة) احتوت على ٣٠% بروتين مصدره مسحوق السمك المجفف وكسب فول الصويا.
- المعاملة الثانية: احتوت العليقة على محتويات الكرش الجافة.
- المعاملة الثالثة: احتوت العليقة على كسب زهرة الشمس.
- المعاملة الرابعة: احتوت العليقة على كسب السمسم.

لتحل محل ٣٠% من بروتين فول الصويا الموجود فى العليقة الضابطة على التوالى ويمكن تلخيص النتائج التى تم التحصل عليها فى الآتى:

١- لم يؤدى إحلال ٣٠% من بروتين فول الصويا فى العليقة الضابطة لكل من محتويات الكرش الجافة أو كسب زهرة الشمس أوكسب السمسم إلى اختلافات معنوية فى كل من كمية البروتين المأكول وكذلك كفاءة تحويل البروتين فى أسماك البلطى النيلى.

٢- احتوت أجسام أسماك البلطى النيلى المغذاه على كسب السمسم أعلى (معنوياً) قيم للبروتين المحتجز فى الجسم تلاها المعاملات الأخرى.

٣- القيمة الإنتاجية للبروتين لم تتأثر معنوياً بالمعاملات الغذائية للتجربة.

٤- لم تكن هناك فروق معنوية فى معامل تحويل البروتين الصافى (NPU) باستخدام الألياف الخام كدليل فى تقدير معدلات هضم البروتين الظاهرية بين المعاملات فى حين أنه باستخدام الرماد كدليل فى تقدير معدلات هضم البروتين الظاهرية كان هناك تحسناً معنوياً بسيطاً فى قيم معامل تحويل البروتين الصافى فى صالح المجموعة المغذاه على العليقة المحتوية على كسب السمسم

٥- تحسنت قيم كل من الدهن المحتجز والقيمة الإنتاجية للدهن معنوياً باستخدام العلائق المحتوية على كل من كسب زهرة الشمس وكسب السمسم مقارنتاً بالعليقة الضابطة والعليقة المحتوية على محتويات الكرش الجافة.

٦- تم التحصل على أعلى قيم للطاقة المحتجزة وكفاءة تحويل الطاقة معنويا بواسطة معاملات الأسماك المغذاه على العليقة المحتوية على كسب السمسم تلاها بقية المعاملات.

٧- أدت المعاملات الغذائية المختبرة إلى اختلافات معنوية فى كل من محتوى الأجسام من المادة الجافة والبروتين الخام والدهن الخام والرماد وكذلك محتوى الأجسام من الطاقة (كيلو كلورى طاقة كلية لكل كيلو جرام من المادة الجافة).

٨- لم يكن للمعاملات الغذائية المختبرة أثراً معنوياُ على كل من النسبة المئوية للزعانف واللحم الصافى بالعظام والجلد فى حين أن هذه المعاملات أدت لفروق معنوية فى كل من النسبة المئوية للقشور والأمعاء والرأس وكذلك الدليل الكبدى الجسمى.

بناء على النتائج المتحصل عليها فإن احلال ٣٠% من بروتين محتويات الكرش الجافة أو كسب عباد الشمس أو كسب بذرة السمسم محل نفس النسبة من بروتين فول الصويا ليس له تأثير سلبى على كفاءة الغذاء وتركيب الجسم فى أسماك البلطى النيلى وحيد الجنس .