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STUDY ON GROWTH PERFORMANCES AND APPARENT DIGESTIBILITY COEFFICIENTS OF SOME COMMON PLANT PROTEIN INGREDIENTS USED IN FORMULATED DIETS OF NILE TILAPIA (*OREOCHROMIS NILOTICUS*).

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SUMMARY

The present investigation include two trials. The first trial was conducted to evaluate the effect of incorporation of soybean meal (SBM), sunflower seed meal (SSM) or cotton seed meal (CSM) into the reference diet at ratio of 7:3 (70% reference diet +30% of one of the tested meals) on nutrient digestibility of the mixed diets. The digestibility trail lasted for two weeks and performed in triplicates in the tanks of ($1m^3$) stated with Nile tilapia fry 1.50 ± 0.07g at a stocking density of 60 fry per m^3. Chromic oxide was used as a non-absorbed marker. Fish were fed diets of this trial at a rate 3% of the biomass daily divided into two equal portions. The first trial showed significant differences in digestibility coefficients of tested meals, where it ranged from 80-84.8%, 81.2-89.6%, 86-91.6%, 88-93.8% and 58-65% for dry matter, energy, crude protein, fat and nitrogen free extract, respectively. The cotton seed meal represent the least digestibility coefficients among the tested meals for dry matter, energy, crude protein, fat and nitrogen free extract, respectively.The second trial was performed to study the effect of inclusion of (SBM, SSM and CSM), meals as plant protein sources on growth performance and feed efficiency of Nile tilapia diets. Four diets were formulated to contain about (30.22±0.02%, CP), where the first group was fed on the control diet and the second diet was formulated to contain 20% of SBM and the third and fourth diets were formulated to contain either 20% SSM or 20% CSM, respectively. In the second trial 60 juvenile tilapia with an initial weight of (4.7±0.15g)were distributed in the same tanks. The experimental lasted 120 days after start. Results in the second trial showed significant differences ($P<0.05$) in growth performance and feed efficiency between diets. While the highest performances in terms of (Finial weight gain, Weight gain, Average daily gain, Specific growth rate, Feed conversion ratio, Protein efficiency ratio and Protein productive values) were obtained with the control, followed by SBM and SSM, without significance difference between them. However, fish fed CSM diet recorded less performance. In the same trend, significant differences among dietary groups were found for digestibility coefficient in the second trial and ranged from 81-85.4, 84-90.7, 89-94.5, 90-94.2 and 61-68% for dry matter, Energy, CP, Fat and nitrogen free extract, respectively. No significance difference ($P<0.05$) were found between fish carcass fed all feed types. Results of the present study indicated that, soybean and sunflower meals can be utilized at 20% inclusion level in tilapia *Oreochromis niloticus* diets, without adversely effects on growth performance, feed efficiency and digestibility coefficient, moreover digestibility values of tested meals asses as indices in formulating tilapia diets.

Keywords: *Oreochromis niloticus, soybean meal, sunflower meal, cotton seed meal, digestibility coefficient, growth performance*

INTRODUCTION

Tilapias are widely cultured in many tropical and subtropical regions of the world. Tilapias are known as " aquatic chicken " because of their fast growth, good quality of flesh, disease resistance, adaptability to wide range of environmental conditions, ability to grow and reproduce in captivity and feed on low trophic levels. Therefore, they have became an excellent choice for aquaculture, especially in tropical and subtropical environments (more than 22 tilapia species are cultured worldwide) and they constitute the third largest group of farmed finfish ·after carps and salmonids· (El-Sayed, 1999 and 2006).

Generally, protein digestibility is the first measure of its availability by fish. Protein quality depends on its sources, amino acid composition and their digestibility. Deficiency of an essential amino acid leads to poor utilization of dietary protein and consequently reduces growth and decreases feed efficiency (Halver and Hardy, 2002).

In a practical feeding situation, diet digestibility can be affected by factors unrelated to diet such as environmental condition, fish health and feeding practices. The composition of the diet and the manner it was processed also affect digestibility. Methods that employ fecal collection from the water typically produce higher digestibility coefficient than methods in which feces are collected from the fish itself (Windell *et al.*, 1978 and Cheng and Hardy, 2003). Glencross (2007), reviewed strategies of evaluation for aquaculture feedstuffs and highlighted five key evaluation components: characterization, ingredient digestibility measurements, ingredient palatability, determination of nutrient utilization or interferences from an ingredient and other ingredient functionality. They described that, chemical analysis coupled with ingredient digestibility measurements are often employed as a first step in evaluation of potential aquaculture feedstuffs. These values then serve as the basis for the necessity of further evaluation.

Ideally the nutrient requirements and nutrient concentration of feedstuff should be expressed in units of availability so that least-cost formulation can optimize the nutrient requirements minimizing the cost of feeds or fish production. The nutritive value of diets will depend on the digestibility of the individual ingredients, and since potential interaction among ingredients are possible the additively of individual digestibilities should be demonstrated. Ideally nutritional value of diet should be expressed on the basis of its digestible nutrients (Sklan *et al.*, 2004).

Fish meal and fish oil have been used for decades as the main dietary components of fish feeds, but they have become one of the main dietary components of fish feeds, but they have became scarce and expensive, leading to the search for alternatives. These alternative should not only fulfil fish dietary needs, but also be cheap and available (Watanabe, 2002).

Attempts have been made to replace fish meal in tilapia diets with various plant proteins such as cottonseed meal, sunflower and soybean (El-Saidy and Gaber, 2002&2003, Jackson *et al.*, 1982, Ofojekwa and Ejike, 2003, Ibrahim, 2007 and Saudi, 2008). Soybea meal is an available ingredients with high protein content and one of the best amino acid profiles among protein rich plant feedstuffs for meeting most of the essential amino acid requirements of fish (Mohsen, 1989). It has long been used as a substitute for animal protein in aquaculture feeds. The ant-nutritional factors (ANFs), that are present in soybean seeds and the considerable rise in soybean price over the last years are restricting factors for their use in fish feeds (Josupeit, 2008). Cotton seed meal (CSM) has bean used as a protein supplement in aquatic feed (Rinchard *et al.*, 2003), because of its high protein content and sufficient availability (Li and Robinson, 2006). However, the presense of gossypol, a yellow polyphenolic pigment found in the whole cotton plant, and the low level of fiber in CSM limit the use of cotton seed meal products in feeds of aquaculture species. However, gossypol often destroyed by heat treatment during CSM production process (Cheng and Harddy, 2002, Yue and Zhou, 2008). Sunflower meal (SFM) is highly palatable and has low anti-nutritional factors (a polyphenolic compound, 1-3%), but has low level of lysine. In addition, it has high level of fiber and lignin. It has been used as alternative plant protein to fish meal with a good results, but up to 30% maximum levels (Martinez, 1984). In tilapia randelli, the best results were obtained with 20% SFM substion (Olvera-Novoa *et al.*, 2002) and for Nile tilapia fingerlings ,the best results were obtained by 14% SFM (Furuya *et al.*, 2000). However in Atlantic salmon, the SFM replacement was 33% without any adverse effect on their performance (Gill *et al.*, 2006).

The present study aims to evaluate the effect of some common plant protein sources on nutrient digestibility, growth performance and proximate composition of Nile tilapia (*Oreochromis nilotics*) reared in fiber glass tanks.

MATERIALS AND METHODS

Fish culture and experimental diets

The present study was conducted using the research facilities of the experimental station at Shakshouk, Fayoum Governorate, National Institute of Oceanography and Fisheries (NIOF). The system contained two water pumps and upstream sandy filter units at a point between the water source and tanks. Each pump was drowning the water from storage cement pond and forced it through storage units and then to the rearing tanks in open system. Physicochemical characteristics of water tanks were examined every week, (Table,1) according to APHA (1992).

A-Test ingredients used in first trial (digestibility trial)

The experimental Nile tilapia fry used in the present study were a progeny hatched from Nile tilapia Broodstock (*Oreochromis nilotics*) in the station. The fry after hatched were reared in incubation tanks for one month and fed prepared powder diet, formulated from the same ingredients utilized in control diet and contains 30% crude protein. Tilapia fry with an initial average weight of 1.50 ± 0.07g were randomly distributed and stocked at 60 fry/tank in 12 fiber glass tanks with a volume of ($1m^3$) each. The experimental treatments were triplicated. A complete reference diet meeting all know nutritional requirements for tilapia (NRC,1993) was blended with Soybean meal (SBM), Sunflower seed meal (SSM) and Cotton seed meal (CSM) to evaluate the above ingredients in digestibility trial, (Table,2&3). All ingredients were ground and mixed with the reference diet at 7:3 ratio (70% of reference diet to 30% of test ingredients) as recorded by Cho (1993). The fish were fed the tested diets in digestibility trial for two weeks at a rate of 3% of fish biomass.

Table (1). An-averages of water physicochemical characteristics parameters during experimental period.

Parameters	Diets			
	Control	SBM	SSM	CSM
Temperature °C	25.0±0.21	25.1 ±0.22	25.4 ±0.21	25.23 ±0.22
p^H	7.6 ±0.11	7.5± 0.12	7.6±0.1	7.5±0.1
Dissolved oxygen (mg/l)	6.3±0.13	6.2±0.12	6.3±0.11	6.2±0.12
Salinity ‰	1.11 ±0.13	1.12 ±0.1	1.12 ±0.1	1.11 ±0.1
Unionized ammonia (mg/l)	0.021± 0.01	0.024±0.01	0.030±0.002	0.033±0.001

Table (2). Proximate composition of feed ingredients (% as DM basis).

Ingredients	DM %	CP%	EE%	NFE%	CF%	Ash%
Fish meal	91.5	70.0	12.4	-	-	17.6
Poultry by-product meal	92.0	55.0	14.4	12.8	2.4	15.4
Gluten meal	90.4	35.0	2.2	55.8	2.4	4.6
Soybean meal	91.7	45.5	4.6	38.3	4.2	7.4
Sunflower meal	91.2	40.2	7.6	33.7	12.0	6.5
Cotton seed meal	91.0	40.4	6.1	38.5	7.8	7.2
Wheat bran	90.1	14.2	3.6	66.4	9.2	6.6
Sorghum	89.8	8.5	2.5	76.8	7.4	4.8

DM,dry mater;CP,crude protein;EE, ether extract; NFE, nitrogen free extract;CF, crude fiber.

Apparent Digestibility Coefficient

The experimental, reference and test diets with addition of 0.5% chromic oxide (Cr_2O_3) were fed to fishes for a period of two week in order to study the apparent digestibility coefficient (ADC%) of nutrients in each digestibility and growth trials. Any uneaten and fecal residues were siphoned out from the tank bottom two hour after first feeding (10.00 a.m.) and discarded. Fish fecal samples were collected every afternoon before the second feeding, new fecal materials were carefully siphoned and collected using the filtration system developed by Choubert *et al.* (1982). After freeze-drying of fecal samples, the feces were analyzed. Dry matter was calculated by gravimetric analysis at 105°C for 24 hrs. Chromic oxide levels were determined by atomic absorption spectrometry based on the method described by Bolin *et al.*, (1952).

Table (3). Formulation and chemical composition of reference and the experimental diets.

Ingredientes	Reference	Control	SBM	SSM	CSM
Fish meal (999)	10.0	10	5	5	5
Poultry-by-product meal	20.0	18	10	13	13
Corn gluten meal	21.0	25	23	22	22
Soybean meal	-	-	20	-	-
Sunflower seed meal	-	-	-	20	-
Cotton seed meal	-	-	-		20
Wheat bran	22.0	20	20	18	18
Sorghum	20.0	20	15	15	15
Fish oil	2.0	2	2	2	2
Sunflower oil	3.0	3	3	3	3
Vitamin/ Mineral Mix[1]	1.5	1.5	1.5	1.5	1.5
Chromic oxide	0.5	0.5	0.5	0.5	0.5
Chemical composition (%DM basis)					
Dry matter	93.50	93.50	91.80	92.40	92.60
Crude protein	30.17	30.19	30.26	30.21	30.25
Ether extract	10.49	10.4	10.47	10.4	10.1
Nitrogen free extract	45.4	45.2	46.72	45.29	45.25
Fiber	4.39	4.47	4.64	6.05	5.21
Ash	9.55	9.47	7.91	8.05	9.19
Free gossypol (mg kg^{-1})					24
Gross energy MJ kg^{-1} diets[2]	19.37	19.29	19.61	19.14	18.92
ME (MJ kg^{-1}diet)[3]	16.11	16.05	16.3	16.06	15.96

1-Vitamin-mineral premix, mg Kg^{-1} dry diets: vitamin A (as acetate), 7500 Iu kg^{-1} dry diet, Vitamin D3 (as cholecalcipherol); 6000IU kg^{-1} dry diet, vitamine E (as DL- α-tocopheryl-acetate); 150 IU kg^{-1} dry diet, vitamin k (as menadione Na-bisulphate); 0.06 ascorbic acid (as ascorbyle polyphosphate), 150 D-biotin, 42 choline (as chloride) 3000; folic acid, 3 niacin (as nicotinic acid), 30 pantothenic acid.60 pyridoxine, 15; ribflavine, 0.06; manganese sulphate, 0.18 ;potassium iodide, 0.02 zinc sulphate.

2-Schulz et al. (2007).

3-Jobling, M. (1994).

The ADC for test diets were calculated according to the equation described by Cho (1993).

$$ADC(n) = 100 - \{100(\%Cr2O3d/\%Cr2O3f) \times (\%Nf/\%Nd)\}.$$

Where ADC(n) = apparent digestibility coefficients of a nutrient in the test diets; Cr2O3d = % chromic oxide of the feces ; *N*d = nutrient in the test diet; *N*f= nutrients in feces.

ADCs of nutrients from each ingredients were calculated according to the equation proposed by Forster (1999).

$$ADCing = \{(a + b) \times ADCN\ test - a \times ADCN\ ref\}/b.$$

Where *a*=nutrient contribution of reference diet to nutrient content of test diet; *b*=nutrient contribution of test ingredients to nutrient content of combined diet; *a*+*b*= level of nutrient in combined diet (%); ADCNtest=apparent digestibility coefficient of a nutrient in combined diet; ADCNref=apparent digestibility coefficient of a nutrient in reference diet.

B-Experimental diets in second trial (growth trial).

Four isonitrogenous diets were formulated to contain an average of 30.22±0.02% crude protein(Table 3). The first diet was formulated without plant protein meal and considered as a control diet (C), Soybean meal diet (SBM), Sunflower seed meal diet (SSM) and Cotton seed meal diet (CSM) were formulated with the same ingredients in control diet, except that 20% inclusion level from Soybean meal, Sunflower seed meal and cotton seed meal, respectively. All diets were processed into dry sinking pellet form, using California pelleting machine with 3mm diameter. Juvenile tilapia with an initial average weight of 4.70±0.15g were randomly distributed and stocked at 60 juvenile/tank in 12 fiber glass tanks with a volume of ($1m^3$) each and the treatments were performed in triplicates. The diets were given at 3% of live body weight (BW) twice daily at 10.00 a.m and 16.00 p.m. The experiment lasted 120 days after start.

Measured Parameters

Chemical analysis

The all ingredients used in feed formulation, the experimental diets and fish carcass were dried for subsequent protein (Kieldahl), ether extract (Soxhlet) and moisture analysis, according to AOAC (1995). Protein levels were calculated by multiplying the total nitrogen (N) with 6.25. Amino acid composition was determined by High Performance Liquid Chromatography (HPLC), following acid-hydrolysis of samples. Nitrogen free extract was calculated based on the difference between the dry matter content minus protein, fat and ash content according to Association of Official Analytical Chemists (AOAC, 1995). Free gossypol concentration in cotton seed meal was determined according to Luo *et al.*, (2006).

Gross energy (MJ Kg^{-1} diet) was calculated according to Schulz *et al.* (2007) using the following calorific values: 23.9, 39.8 and 17.6 KJ Kg^{-1} diet for protein, ether extract and nitrogen free extract, respectively. The metabolizable energy contents of the experimental diets were calculated as 18.9, 35.7 and 14.7 KJ Kg^{-1} diet for protein, lipid and nitrogen free extract, respectively according to Jobling (1994).

For amino acids analysis, diets were hydrolyzed with 6 N HCl at 110°C for 24h for the chromatographic separation using the HPLC as described by Gardner and Miller (1980). Tryptophan was determined calorimetrically in alkaline hydrolysate according to the method described by Blauth *et al.* (1963).

Growth performance and feed utilization

Growth performance and feed utilization in terms of final individual fish weight (g), weight gain (g), average daily gain (g/fish/day), Specific growth rate (SGR%), Feed conversion ratio (FCR), Protein efficiency ratio (PER) and Protein productive value (PPV%) were determined according to El-Sayed *et al.*, (1994).

Statistical analysis

One way Analysis of Variance (ANOVA) was applied to test the effect of different dietary plant protein sources on various growth parameters, chemical composition and apparent digestibility coefficients according to Snedecore and Cochran (1987). Duncan Multiple Range test was used to detect the significant differences between the means of treatments (Duncan, 1955). All analysis were performed using SAS (version 6, 1986 SAS Institute, Cary, NC, USA).

RESULTS AND DISCUSSION

Physicochemical characteristics

Water physicochemical characteristics (Table 1) revealed that temperature, pH, dissolved oxygen, salinity and unionized ammonia are within the optimum ranges for rearing *Oreochromis noliticus* according to (Wangead *et al.*, 1988 and El-Shafai *et al.*, 2004). Similar physicochemical condition were found in all tanks.

Chemical composition of tested ingredients and diets

Protein and Amino acids

Results of the chemical composition analysis of all tested ingredients are shown in (Table 2). The plant proteins tested showed good protein contents which varied from(40.2-45.5%) and lipids (4.6-7.6%); while nitrogen free extract recorded moderate value (33.7-38.5%), high crude fiber (12.0 & 7.8%) in sunflower and cotton seed meals, respectively and allowable ash content (6.5-7.4%.). As can be seen in (Table 3), the experimental diets were almost similar in protein content (30.19-30.26%) and gross energy (18.92-19.61 MJ kg^{-1} diets).

The proximate composition of the plant protein meals showed that are good nutrient sources for tilapia, (Table 2). The experimental diets in this study were formulated to have identical levels of energy and protein. In the same trend the amino acid contents in all tested diets (Table 4) met the requirements of tilapia as recommended by (NRC, 1993).

Amino acid composition of diets

The amino acid contents of the experimental and reference diets were presented in (Table 4). The results showed that the all amino acid concentration (g $100g^{-1}$) diet among experimental and reference diets were high than the recommended values of NRC, (1993).

Table (4). Essential amino acid composition of reference and experimental diets ($g100g^{-1}$) diet.

Amino acid	Requirement*	Diets				
		Reference	Control(C)	SBM	SSM	CSM
Arginine	1.18	1.82	1.71	1.75	1.86	1.91
Histidine	0.48	0.78	0.77	0.73	0.70	0.72
Isoleucine	0.87	1.37	1.35	1.59	1.35	1.30
Leucine	0.95	3.23	3.19	3.32	2.98	2.97
Lysine	1.43	1.91	1.88	1.76	1.67	1.62
Methionine+ cyst	0.9	1.23	1.22	1.12	1.06	1.03
Phenylanine + Tyrosine	1.55	1.98	1.96	1.85	1.82	1.78
Threonine	1.05	1.25	1.22	1.15	1.15	1.11
Tryptophane	0.28	0.43	0.41	0.45	0.43	0.44
Valine	0.78	1.59	1.58	1.45	1.53	1.44

**Requirement for tilapia from NRC (1993).*

Apparent digestibility coefficient (first trial)

As presented in (Table 5), results reveal that the apparent digestibility coefficients of the reference, SBM and SSM diets were significantly (P<0.05) higher than that of the CSM, however differences among the reference, SBM and SSM groups in this trait were insignificant. The same trend was observed with energy, protein and lipid apparent digestibility coefficients, thus the values of the reference, SBM and SSM were significantly (P<0.05) than those of CSM (Table 5). Concerning the apparent digestibility of NFE results of (Table 5) revealed that the reference group showed the highest NFE digestibility coefficient (P<0.05) followed in a significant decreasing order by both SBM and SSM diets and CSM diet, respectively.

Information on the apparent digestibility coefficient of protein and energy in different feedstuffs fed to tilapia is contra-diversely and this often leads to extrapolation on the nutritive value of an ingredient based on the chemical composition and/or data on the digestibility of nutrients in other species. In general, there are many factors complicate protein digestibility comparisons across widely varying ingredients including nutrient inclusion level and fecal collection method. Therefore, its important to statistically compare ingredient based on their similarities in proximate composition and source of origination.

The ADC of protein (86.0-91.6%) in test ingredients for Nile tilapia *Oreochromis niloticus* in the current study is in agreements with the reports ADC of protein in various feed ingredients for Nile tilapia (75-95%) as recorded by (Koprucu and Ozdemir, 2005). For example soybean meal values were recorded by different authors, (91.0-94.4%, Pompa, 1982, 90-94.4, Hanley, 1987, and 91%, Borgeson *et al.*, 2006) by using Gulf system collection. On the other hand, Gaylord and Barrows (2008) recoded less protein digestibility in trout 89 and 75% for soybean and cotton seed meals, respectively. Part of the variability in ADC of protein may explain by difference in species, chemical composition, origin and processing of these various feed ingredients and methods of feces collection. Previous studies (Anderson *et al.*,1991) have indicated that in tilapia as in other species (Dabrowski and Dabrowska, 1981 and Lupastsch *et al.*, 1997), crude protein digestion is relatively high and this is found even in feeds containing high fiber.

Table (5). Apparent digestibility coefficients of reference and test ingredients.

Nutrients	Diets			
	Reference diet	Soybean meal	Sunflower seed meal	Cotton seed meal
Dry matter	85.3^a	84.8^a	84.4^a	80.0^b
Energy	90.2^a	89.6^a	89.3^a	81.2^b
Protein	93.8^a	91.6^a	91.3^a	86.0^b
Fat	94.5^a	93.8^a	93.4^a	88.0^b
Nitrogen free extract	70.0^a	65.0^b	64.60^b	58.0^c

Means in the same row with different superscript letters are significantly different (P<0.05).

Growth performance (Second trial)

As presented in (Table 6) averages of initial weights ranged between 4.5 to 4.9 g/fish with insignificant differences among the dietary groups indicating the random distribution of the experimental fish among treatment groups. Concerning finial weights the control group recorded the highest value (47.5 g) followed in an insignificance order by the SBM and SSM groups and in a significant (P<0.05) order by the CSM group, respectively. The same trend was observed with total gain in weight and the daily gain, where the CSM group recorded the lowest (P<0.05) values compared to the other treatments groups (control, SBM and SSM) among them differences in growth traits cited above were insignificant. Furthermore, the control group recorded the highest value of SGR followed in an insignificant decreasing order by both SBM and SSM and significant (P<0.05) decreasing order by the CSM group, respectively.

As presented in (Table 6) average amounts of feed consumed were found to be 69.0, 70.0, 72.0 and 75.0 g for the control, SBM, SSM and CSM groups, respectively which indicate slight increases in feed consumption in the dietary groups compared to the control group. On the other hand, the best FCR (lowest) values were obtained by the control group followed in an insignificant increasing order by SBM and SSM groups and a significance(P<0.05) increasing (worth) order by the CSM group, respectively. As presented in the same table the highest PER and PPV values (2.06 and 29.90) were recorded by the control group followed in an insignificance decreasing order by SBM and SSM groups and significant decreasing order by the CSM group, respectively.

The weight gain, average weight gain and specific growth rate, of tilapia *Oreochromis niloticus* fed the plant protein meals not significantly difference between SBM and SSM compared with the CSM diet. In contrast, the less performance of CSM than those in the other dietary groups, including the control, compared with the other diets. The same finding was found in previous work in tilapia (Robinson *et al.*, 1984, Mbahinzireki *et al.*, 2001 and Yue and Zhou, 2008) and in trout (Luo *et al.*, 2006). On the contrast, no reduction in growth performance of tilapia *Oreochromis niloticus* fed cotton seed meal as recorded by (El Saidy and Gaber, 2002). As recorded by (Barros *et al.*, 2002), free gossypol when present in large quantities in the diet, has been shown to be toxic to monogastric animals including fish. However, Jackson *et al.*, (1982) found no negative effect on growth when free gossypol content was as high as 30 mg/kg diet in tilapia (*Sarotherodon mossambicus*). Moreover, Robinson *et al.*, (1984) also reported that growth was not affected when free gossypol was 180 mg /kg in tilapia (*Tilapia aurea*). In the current study, free gossypol concentration of CSM diet was 24 mg/kg diet even less than the tolerance values for tilapia recorded by (Jackson *et al.*, 1982 and Robinson *et al.*, 1984).

As can be seen from (Table 6), the FCR, and PER were not significantly differed ($P<0.05$) between control, SBM and SSM diets and the best value was recorded by control diet. On the other hand, fish fed CSM showed the worst value for the previous parameters. Similar and comparable results of FCR and PER were recorded with tilapia (Bahurmiz and Ng, 2007; Garduno-Lugo and Olvera-Novoa, 2008; Nguyen *et al.*, 2009 and Yones, 2010).

Furthermore, the results in (Table 6) declared that PPV% was well utilized by fish fed different plant meal sources where PPV% achieved the highest values for the first three diets, 29.90, 27.95 and 26.96%, respectively, and then reduced to 21.73% in CSM diet. These results were comparable with the results of Yones, (2010) in Tilapia *Oreochromis* sp., Hassanen *et al.*(1998) on grey mullet *Liza ramada* and El-Sayed (1994) on sea bream *Rhabdosargus sarba*. They tested some plant protein in each tilapia, grey mullet and sea bream, respectively.

Table (6). Growth performance mean values of *Oreochroms niloticus* fed the experimental diets.

Parameters	Diets			
	Control	SBM	SSM	CSM
Initial aveg. Weight (g/fish)	4.5^{a}	4.8^{a}	4.6^{a}	4.9^{a}
Final aveg. Weight (g/fish)	47.5^{a}	46.6^{a}	45.4^{a}	40.3^{b}
Gain (g/fish)	43.0^{a}	41.8^{a}	40.8^{a}	35.4^{b}
Average daily gain (g/fish/day)	0.36^{a}	0.35^{a}	0.34^{a}	0.29^{b}
Specific growth rate[1]	1.96^{a}	1.9^{a}	1.9^{a}	1.75^{b}
Feed consumed (g/ fish)*	69.0	70.0	72.0	75.0
Feed conversion ratio[2]	1.6^{a}	1.67^{a}	1.76^{a}	2.11^{b}
Protein efficiency ratio[3]	2.06^{a}	1.97^{a}	1.87^{a}	1.56^{b}
Protein Productive Value (PPV%)[4]	29.90^{a}	27.95^{a}	26.96^{a}	21.73^{b}

Means in the same row with different superscript letters are significantly different ($P<0.05$).

* *Non-consumed portion of the food was collected, dried and deducted daily from the total given ration.*

1- Specific growth rate = 100 X (Ln final weight- Ln initial weight)/ 120.

2- Feed conversion= (feed given per fish)/ (weight gain per fish).

3- Protein efficiency ratio = (weight gain per fish)/ (protein intake per fish).

4- Protein productive value(%) = 100(protein gain / protein fed).

The slight tendency toward a higher feed intake as dietary plant meals involved diets can be explained as a compensatory intake to meet demands for protein to maintain maximum growth. The same finding was recorded in tilapia and sea bream by (Yones, 2005 and 2010), rainbo trout, De la Higuera *et al.*, (1988) and Atlantic salmon, Espe *et al.*, (2007).

The experimental diets in growth trial showed a good digestibility coefficient for the tested diets except that fish fed cotton seed meal diet. These results are in agreement with the results of Mamun *et al.*, (2004). Similar and comparable ADC values of feed dry matter, protein, lipid and energy were also observed by several authors in digestibility studies with tilapia (Shiau *et al.*,1987, Koprucu and Ozdemir, 2005, Gay-Sliessegger *et al.*, 2005 and Yones, 2010).

Apparent digestibility coefficient in growth trial

Average of nutrients apparent digestibility coefficients in growth experiment for dry matter (DM), energy (E), crude protein (CP), fat and nitrogen free extract (NFE) are presented in (Table 7). Results revealed that apparent digestibility coefficients for DM, E, CP and fat for the control group,,SBM and SSM groups were significantly ($P<0.05$) superior than that of CSM group. On the other hand, NFE digestibility coefficient of the control group recorded the highest ($P<0.05$) value followed in a significant ($P<0.05$) decreasing order by SBM, SSM and CSM groups, respectively.

Fat digestibility values range from 85 to 95% for fish as recorded by (Cho and Slinger, 1979 & Aksnes and Opstvedt, 1998). However, Sklan *et al.*, (2004) reported that for tilapia the ADC of lipid varied from 72-90% and energy 39-89%. In the current study 88.0-93.8% reported values for lipid and 81.2-89.6% for energy in test ingredients and are in agree with that of (Sklan *et al.*, 2004, Mamun *et al.*, 2007).

Table (7). Apparent digestibility coefficients of the experimental diets.

Nutrients	Diets			
	Control	SBM	SSM	CSM
Dry matter	86.8^{a}	85.4^{a}	86.2^{a}	81.0^{b}
Energy	91.4^{a}	90.7^{a}	90.3^{a}	84.0^{b}
Protein	94.6^{a}	94.5^{a}	93.3^{a}	89.0^{b}
Fat	95.0^{a}	94.2^{a}	94.1^{a}	90.0^{b}
Nitrogen free extract	72.0^{a}	68.0^{b}	65.0^{c}	61.0^{d}

Means in the same row with different superscript letters are significantly different ($P<0.05$)

The reduced protein digestibility observed for the plant products in the current study may be attributed to increased rate of passage or interference with the proteolytic enzymes in the gut lumen by the fiber or other carbohydrate fractions.

These contradictory results could be because of anatomical results and physiological differences in the digestive tract among, the feed processing method, and different equations used to calculate ingredients digestibility (Higera, 1987). Therefore, care must be taken when comparing digestibility values as a result of differences in feces collection method, which could influence nutrient digestibility values (Allan *et al.*, 2000 and Pezzato,*et al.*, 2002 b).

As recorded by other study in tilapia (Skalan *et al.*, 2004), the decreased in carbohydrate digestibility in SSM and CSM due to its high fiber content, where CF reflects reduced enzymatic access to potential substrates, or alternatively due to direct interaction between CF components and the digestive processes.

Carcass analysis

Results of whole fish body chemical analysis recorded that the applied dietary treatments had no significant effects on whole body dry mater, crude protein fat and ash contents.

The carcass proximate composition of tilapia indicated that the dry matter, protein, lipid and ash were not affected by the dietary of the plant meals ingredients. Similar results have been reported for tilapia by (Yue and Zhou, 2008, Garduno-Lugo and Olver-Novoa, 2008 and Yones, 2010) and rainbow trout (Luo *et al.*,2006).

Table (8). Carcass analysis of *Oreochromis niloticus* fed the experimental diets (%w/w basis).

Items	Diets				
	Initial	Control	SBM	SSM	CSM
Dry matter	26.4	26.1[a]	26.0[a]	25.7[a]	25.9[a]
Protein	15.4	14.5[a]	14.2[a]	14.4[a]	14.1[a]
Lipid	5.2	5.3[a]	5.5[a]	5.4[a]	5.4[a]
Ash	5.8	6.3[a]	6.3[a]	5.9[a]	6.4[a]

Means in the same raw with different super script letters are significantly different (P<0.05).

CONCLUSION

Soybean and sunflower meals can be utilized in tilapia *Oreochromis niloticcus* diets, without adversely effects on growth performance, feed efficiency and digestibility coefficient. This study also details the digestibility of some plant protein ingredients for Nile tilapia and recommended that theses values can be used to assist in formulating tilapia diets on an equivalent digestible protein and energy basis.

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دراسة معاملات الهضم واداء النمو لبعض مصادر البروتينات النباتية المستخدمة فى علائق البلطي االنيلى.

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تضمنت الدراسة الحالية تجربتين: الأولى صممت لتقدير معاملات الهضم لبعض مصادر البروتين النباتية مثل فول الصويا، عباد الشمس أو كسب القطن مع استخدام عليقة مرجعية بنسبة ٣: ٧ (٧٠% عليقة مرجعية + ٣٠% من المصدر المختبر) في عليقة مختلطة. استمرت تجربة الهضم لمدة أسبوعين مع استخدام ثلاث مكررات لكل معاملة حيث وزعت زريعة البلطي النيلى بوزن أولى (٥. ١± ٧ ٠,٠ جم) وبمعدل تخزيني ٦٠ سمكة/حوض في أحواض سعة ١ متر مكعب. تم استخدام اوكسيد الكروميك كدليل غير ممتص في العليقة لقياس معاملات الهضم وغذيت لأسماك بنسبة % ٣ من الوزن الكلى.

أظهرت معاملات الهضم للتجربة الأولى اختلافات معنوية عند مستوى (٠,٠٥ %) للمساحيق النباتية المختبرة حيث كانت مدى معاملات هضمها بالنسب الآتية: ٨٠ - ٨ . ٨٤%، ٨١,٢ – ٦ . ٨٩%، ٨٦ –٦ . ٩١ %، ٨٨ - ٨. ٩٣ % و٥٨ - ٦٥% لكل من المادة الجافة، الطاقة، البروتين الخام، الدهن الخام و الكربوهيدرات على التوالي، في حين سجل كسب القطن اقل معاملات هضمية بين المساحيق النباتية المختبرة لكل من المادة الجافة، الطاقة، البروتين الخام، الدهن و الكربوهيدرات على التوالي.

التجربة الثانية أجريت لدراسة اثر إدخال المساحيق النباتية السابقة بعد تقدير معاملات هضمها وتقيمها في تجربة نمو على البلطي النيلى ، مع قياس معدلات النمو، الاستفادة من مركبات الغذاء و تركيب جسم الأسماك. تم استخدام كل من فول الصويا، عباد الشمس و كسب القطن بنسبة ٢٠% من العليقة وكونت ٤ علائق لتحتوى على (30.22±0.02% بروتين خام). وزعت الأسماك ذات الوزن الأولى (٧. ٤± ٠,١٥جم) بمعدل ٦٠ سمكة/ حوض فى نفس الأحواض المستخدمة في تجربة الهضم و استمرت التجربة ١٢٠ يوم.

سجلت نتائج التجربة الثانية اختلافات معنوية عند مستوى(٠,٠٥ %) متمثلة في وزن نهائي، معدلات نمو ،معامل تحويل غذائي وكفاءة استخدام الغذاء ، حيث أعطت عليقة الكنترول أعلى معدلات أداء تلتها عليقة فول الصويا ثم عليقة عباد الشمس وبدون فروق معنوية بين العلائق السابقة وقد سجلت العليقة المحتوية على كسب القطن اقل معدلات اداء وكفاءة غذائية. أظهرت معاملات الهضم للعلائق المستخدمة فى تجربة النمو نسب هضمية كالتالي: ٨١- ٨٥,٤%، ٨٤ – ٧ . ٩٠%، ٨٩ –٥. ٩٤ %، ٩٠ - ٢. ٩٤ % و٦١ - ٦٨% لكل من المادة الجافة، الطاقة، البروتين الخام، الدهن الخام و الكربوهيدرات على التوالى. لم تظهر تركيب جسم الأسماك اختلافات معنوية عند مستوى (٠,٠٥ %) بين العلائق المختلفة.

وقد خلصت نتائج الدراسة إلى أن استخدام كل من مسحوقي فول الصويا وعباد الشمس بنسبة ٢٠ % لكلا منهما في علائق اسماك البلطي النيلى لم يكن لهما تأثيرات معاكسة على معدلات الأداء ، الكفاءة الغذائية و معاملات الهضم بالإضافة إلى أن تقدير معاملات الهضم للمساحيق النباتية السابقة يعد كدليل يساعد عند تكوين علائق البلطي.