

Evaluation of some unconventional plant proteins in diets for Red Tilapia (*Oreochromis spp*) fingerlings.

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Abstract

The potential of canola meal and atriplex leaves meal in formulated diets for red tilapia (*Oreochromis spp*) was evaluated. Seven diets (30 % ± 0.016 crude protein), 4640 kcal GE/kg were formulated. Fish meal protein was substituted at the rate of 10, 20 and 30% with canola meal protein or atriplex leaves. A diet containing no plant sources served as the control. A diet containing 10 % canola meal had significantly ($p \leq 0.05$) better weight gain and conversion values. All fish fed diets supplemented with 20 and 30 % canola meal 10 , 20 and 30 % atriplex demonstrated reduced growth and feed utilization efficiency ($p \geq 0.05$). Except fish diet 10 % canola, the growth rate and other nutritional parameter decreased with increasing inclusion levels of the two plant protein sources. Fish group fed diets control, 10% and 20% canola and 10 % atriplex had a highest survival rate having their values 100% respectively. All water parameters tested were within permissible levels for Tilapia maximum growth so the use of canola meal up to 10 % and up to 20 % of atriplex is recommended, without adverse effect on Red Tilapia, fingerlings.

Keywords: unconventional plant proteins, canola meal, atriplex leaves, Red Tilapia

Introduction

Many studies have been conducted to evaluate the replacement of fish meal (FM) in practical diets for tilapia with cheap, locally available plant and animal protein sources (Nova et al., 1997; Fasakin et al., 1999, 2005; Richter et al., 2003; Boregson et al., 2006 ; Hassanen et al., 2012, Hassanen et al., 1995). The evaluation of feed ingredients is crucial to nutritional research and feed development for aquaculture species. In evaluating ingredients for use in aquaculture feeds, there are several important knowledge components that should be understood to enable the judicious use of particular ingredients in feed formulation (Enami, 2002 and 2003 a&b). This include information on 1- ingredients digestibility, 2- ingredients palatability and nutrient utilization and interference (Glencross et al., 2007). Progressive trend of aquaculture and fish farming, similar to other countries, makes us to choose an alternative protein sources (Hassanen, 1991).

The unconventional plant protein sources were chosen: canola meal and atriplex leaves. As fish meal is both expensive and difficult to obtain in Egypt and many developed countries, the alternative sources were tested at various inclusion rates, increasing to maximum possible levels compatible with providing a 30 % protein diet, which has been shown to be the lowest level still providing reasonable growth in various tilapia species (Cruz and laudencia, 1977; Davs and Stickney, 1978; Mazid et al., 1979. Although Cowey, (1979) have demonstrated that *tilapia zilli* require the same 10 essential amino acids

as other fish no data are available as to the quantitative requirement in hybrid tilapia species.

The main objective was to determine maximum inclusion rates for the canola meal and atriplex leaves and the necessity for limitation arising from palatability or toxic factors. Given known amino acid profiles of the ingredient it was expected that, as a consequence of varying the quantity of the protein supplied by the various sources. To discover the most limiting amino acids and gain an indication as to their optimum levels under the condition provided.

Materials and methods

This experiment was carried out at the Mari - culture Research Center (MRC) of the Suez Canal University, El-Arish, North Sinai- Egypt. Red Tilapia fingerlings (*Oreochromis spp*) with an average initial weight of 17.8±0.10 g. were randomly selected and placed into 125 L. Fiberglass tanks (10 fish / tank) at the beginning of adaptation of period). A flow rate of the water was 1.5 L/min/ tank. Each tank was equipped with an air stone and external stand pipe.

The experimental fish were regularly supplied with artificial feeds formulated from conventional and unconventional ingredients. The conventional ingredients were used for formulating the standard diet. A total of 7 experimental diets were formulated in the dry pelleted form as shown in table (3). The unconventional ingredients used in preparing the experimental diets were atriplex leaves meal and / or canola meal to evaluate the effect of incorporation of them at levels of 10, 20 and 30 % to substitute fish

meal . Diet number (1) was considered as the control diet while the other six diets.(No 2 to 7) were as treatments. All diets were isonitrogenous 30 ± 0.16 crude protein and nearly isocaloric .

Adequate amount of *Atriplex halimus* were collected from the farm of Faculty of Environmental Agricultural Sciences, El-Arish. Leaves were dried aerobically for 5 days, then fully dried by used drying oven at 40°C for the 72 h. The dry matter was ground by electric mill. The samples were preservation in the form of powder in plastic jars.

Canola meal was obtained from a local dealer. Feed ingredients were ground to fine particles; linseed oil was incorporated in order to reach the desirable total lipids and essential fatty acid levels. The feed mixture was processed into a pellet meal machine. The pellet was soft enough for the fish to take and retain. Particle size was 2 mm diameter, 4mm length.

The first ten days of the experimental period was considered as an acclimatization period where the experimental feeds were given to the fish as 3% of the body weight per day .The actual period followed directly. The daily ration was offered three times a day at 9 am, 12 am and 3 pm in three equal portions. The experimental diets were feed to duplicate groups. Each group of fish was weight at the beginning and once every 2 weeks and amount of diet was adjusted accordingly for the subsequent 2 weeks. Conversion index was calculated. At the end of the experimental period of 12 weeks after start, fish were weighing individually.

Feedstuffs were analyzed for macro nutrients and amino acid composition before used in diets formulation (table 1 and 2). Proximate composition (crude protein, fat, crude fiber, ash and moisture) of the dietary composition, experimental diets, and Red tilapia fingerlings body were determined according to **A.O.A.C (1990)**, tables 4 and 7.

Amino acid of protein sources and experimental diets were determined by using amino acid analyzer according to methods described by **Ibrahim (1974)**,tryptophan was determined calorimetrically in alkaline hydrolysis according to methods described by **Blauth et al., 1963**. Tables (2 and 5) show the essential amino acid of the protein sources and the experimental diets.

Dietary protein utilization of the experimental diets for growth was evaluate by determining protein efficiency ratio (PER = gain/protein intake), protein productive value % (PPV=100 body protein gain/protein intake) indices. Also the following indices were calculated:

FCR (Feed conversion ratio) = dry feed intake (g)/ wet weight gain (g).

FE (feed efficiency) = wet weight gain (g)/ dry feed intake (g).

SGR (% /day) specific growth rate = (Ln final weight – Ln initial weight / number of days) x 100.

Retained nutrient, protein, fat, ash and energy, = final body nutrient – Initial nutrient.

All data were subjected to analysis of variance (**Steel and Torrie , 1980**) and differences between means were tested by Duncan's multiple rang test (**Duncan, 1955**).

Results:

Essential amino acid composition, chemical score and essential amino acid index (EAAI) of the tested diets as compared with the requirement of *Tilapia (O. niloticus)* are presented in table (5). It can be noticed that tryptophan was the first limiting amino acid in all tested diets except in control diet. In diet No 4 (30 % canola meal), leucine was the second limiting amino acid, so the EAAI for this diet was 42.87. While for all diets EAAI was 100.00, 98.83, 98.65, 99.47, 95.38 , and 94.60 for groups control , 10 % canola, 20 % canola ,10 % atriplex , 20 % atriplex and 30 % atriplex leaves respectively .

At the end of the experimental period (12 weeks), data concerning average initial and final body weight, weight gain , average daily gain (ADG), specific growth rate (SGR%/ day) , gain % and survival rate are presented in table (6). The analysis of variance of these data indicated that the highest weight gain, ADG, SGR, Gain percentages and survival rate was obtained by the group fed diet 10 % canola meal protein replacement of fish meal, followed in decreasing order by the control group (diet No 1) and diets No 5,6,7,3 and 4 where the gain percentages were 83.60, 79.16, 73.62,64.94, 60.17 and 57.22 % respectively .

Table 1. The approximate analysis of the ingredients used in feed formulation for Red Tilapia (*Oreochromis spp*) on DM basis

	kcal/ME2 kg	kcal/GE1 kg	NFE	Ash	CF	EE	CP	Ingredients %
Conventional								
Fish meal	70.00	8.50	0.60	16.40	4.50	4986.25	3491.60	
Yellow corn	8.50	3.60	2.30	1.30	84.30	4284.45	1968.30	
Wheat bran	16.40	4.00	9.90	5.30	64.40	4276.60	1990.00	
Soybean meal	44.00	1.10	7.30	6.30	41.30	4533.95	2464.80	
Rice bran	14.40	2.10	10.80	5.40	67.30	4136.05	1806.40	
Unconventional								
Canola meal	37.19	3.50	10.70	6.80	41.81	4532.39	2399.37	
Atriplex leaves	20.70	7.40	4.40	25.50	42.00	3724.85	2071.30	

Table 2. Amino acid contents of some ingredients used in feed formulation for Red Tilapia (*Oreochromis spp*) as dietary protein%.

Ingredients	Essential Amino Acid									
	Leu	Isl	Phe	Met	Val	Thr	Arg	His	Lys	try
Conventional										
fish meal	6.29	4.41	3.97	2.57	4.78	3.78	5.88	2.47	5.82	0.84
Soybean meal	3.67	2.50	2.67	0.70	2.43	1.98	3.91	1.32	3.10	0.62
Yellow corn	1.20	0.36	0.46	0.18	0.49	0.36	0.48	0.26	0.26	0.07
Wheat bran	0.89	0.65	0.27	0.34	0.53	0.55	0.68	0.88	0.20	0.30
Unconventional										
Caonla meal	2.62	1.70	1.43	0.76	2.04	1.63	2.15	1.16	2.07	0.50
Atriplex leaves	1.25	0.85	0.68	1.27	1.11	0.73	0.53	0.39	0.89	0.62

Table 3. Composition of diets containing various percentage of Atriplex and canola meal as replacement for fish meal protein

Ingredients	control	Canola meal				Atriplex leaves		
	1	2	3	4	5	6	7	
Fishmeal (70%CP)	26.00	23.40	20.80	18.20	23.40	20.80	18.20	
Soybean meal(44%CP)	15.00	15.00	15.00	15.00	15.00	15.00	15.00	
Canola meal (37.19%CP)	-	4.89	9.78	14.67	-	-	-	
Atriplex leaves	-	-	-	-	8.80	17.60	26.40	
Wheat bran	16.00	10.00	10.00	10.00	16.00	16.00	16.00	
Rice bran	6.00	10.00	10.00	10.00	14.500	16.300	17.400	
Yellow corn	30.00	29.71	27.42	25.13	15.30	7.30	-	
Vit . Mix	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
Min . Mix	2.00	2.00	2.00	2.00	2.00	2.00	2.00	
Linseed oil	3.00	3.00	3.00	3.00	3.00	3.00	3.00	
Total	100	100	100	100	100	100	100	

Table 4. Nutrient composition of diets containing various percentages of Atriplex leaves or Canola meal as replacement for fish meal protein (on dry matter basis)

Nutrient	Control	Canola meal			Atriplex leaves		
		10%	20%	30%	10%	20%	30%
CP	30.26	30.36	30.13	29.96	30.74	30.32	29.85
E.E	7.21	6.98	6.67	6.67	7.28	7.46	7.65
CF	4.11	4.49	5.01	4.32	5.06	5.44	5.68
Ash	7.35	5.39	5.4	5.4	7.57	6.07	6.23
NFE ¹	51.07	52.78	52.79	53.65	49.85	50.71	50.59
GE ²	4606	4666	4645	4642	4601	4664	4660
ME ³	2585.56	2586.92	2553.31	2560.44	2570.86	2590.64	2585.59
P/E ⁴	118.97	117.36	118.00	117.01	119.57	117.04	115.45

1- NFE: Nitrogen Free extract= 100- (CP%+EE%+CF%+Ash%).

2- GE=Gross energy (Kcal/kg diet).

3- ME= metabolizable energy (Kcal/kg diet)

4- P/E ratio = mg protein/kcal ME.

Table 5. Essential amino acids composition, chemical score and essential amino acids index of the tested diets (% Dietary protein)

E.A.A	Tilapia requirements of E AA	Control		Canola meal%						Atriplex leaves%					
		E.A.S	CS	10		20		30		10		20		30	
				E.A.A	CS	E.A.A	CS	E.A.A	CS	E.A.A	CS	E.A.A	CS	E.A.A	CS
Leu	6.45	9.15	141.86	9.00	139.53	8.86	137.36	2.61	40.46	8.78	136.12	8.20	127.13	7.90	122.48
Isol	3.45	5.97	173.04	5.87	170.14	5.79	167.82	1.70	49.27	6.01	174.20	5.68	164.64	5.59	162.03
Phe	3.39	5.51	162.54	5.44	160.47	5.34	157.52	1.56	46.01	5.40	159.29	5.02	148.10	4.88	144.38
Meth	0.3	3.11	1036.66	3.06	1020.00	2.97	990.00	0.86	268.90	3.44	1146.70	3.56	1187	3.75	1250
Val	4.02	6.26	155.72	6.17	153.48	6.10	151.74	1.80	44.78	6.19	153.93	5.89	146.51	5.79	144.03
The	3.33	5.04	151.35	4.96	148.94	4.91	147.45	1.45	43.54	4.99	149.84	4.70	141.40	4.60	138.14
Arg	5.04	8.02	159.13	7.82	159.12	7.69	152.58	2.26	44.84	7.71	152.98	7.00	138.89	6.67	132.34
His	2.1	3.64	173.33	3.52	167.62	3.50	166.66	1.04	49.52	3.61	171.90	3.37	160.48	3.29	156.70
Lys	5.94	7.24	121.88	7.23	121.72	7.10	119.53	2.08	35.02	7.35	123.74	6.98	117.50	6.84	109.90
Try	2.52	2.78	110.3	2.24	88.89	2.20	87.30	0.38	15.10	2.39	94.84	1.95	62.30	1.45	57.40
E.A.A.I		100		98.83		98.65		42.87		99.47		95.38		94.60	

Table 6. Chemical score (CS) and limiting amino acids for Red Tilapia in unconventional ingredients used in the present study (As dietary protein %).

E.A.A	Tilapia requirement	Caonla	Atriplex
Leu	6.45	40.62	19.38
Isl	3.45	49.27	24.64
Phe	3.39	42.18	20.05
Met	0.30	253.33	423.33
Val	4.02	50.75	27.61
The	3.33	48.95	48.95
Arg	5.04	42.66	10.52
His	2.10	55.38	18.57
Lys	5.94	34.85	14.98
Try	2.52	19.84	24.60
Limiting amino acid			
first		Try	Lys
second		Lys	His
third		Leu	phe

** Ogunji et al., 2002

Body composition, dry matter, crude protein (CP), ether extract (EE), ash and energy content of Red Tilapia at the beginning and the end of the experimental period (12 week) are given in table (7). As compared with the control group (diet 1) there were significant increases ($P \leq 0.05$) in protein contents for groups fed 10 % canola meal, 10% atriplex, 20 and 30% atriplex and canola meal. The highest fat contents were obtained by the 30 % atriplex leaves which associated with the low protein content. The energy content as GE(Kcal/g) dry matter fish at the end of the experiment were significantly higher ($P \leq 0.05$) in fish group fed 10% canola meal and 10 % atriplex leaves than that of the control group .

Feed intake, CP, fat and energy intake of the experimental diets are present in table (8), In all experiment it was clear that replacement of fish meal protein by other unconventional protein (canola meal or atriplex) sources increased the nutrient intake. However, the analysis of variance indicated that the replacement of fish meal protein by 20 or 30 % canola meal protein showed the highest feed intake and followed by 10, 20% atriplex leaves and control diet.

Protein, fat, ash and energy retained as presented in table (8). The 10 % canola meal and 10 % atriplex leaves groups (diet No 2 and 5), showed higher protein and energy retained than the other groups. Differences were insignificant ($p \leq 0.05$) among groups fed diets 20 and 30 % canola meal respectively ($P \leq 0.05$).

Protein and energy retained for diets 2 and 5 as percentage of the control were 112.1 and 106.25 % for protein and 102.10 and 107.08 % for energy respectively. Diets 4(30% canola meal) 7 (30 % atriplex leaves exhibited a lower protein and energy retained.

Feed conversion ratio (FCR), feed efficiency (FE %) and nutrient utilization are presented in table (9). Results showed that there are significant differences ($P \leq 0.05$) between all the experimental groups which fed the tested diets in FCR ,FE%,PER and PPV% . The averages of FCR of fish fed on diets 1 and 2 had a significantly ($P \leq 0.05$) higher than the other dietary groups . The groups of fish fed diets 2 and 5 showed the highest FE%, 74.14 and 60.40 % respectively. The average of PER was 2.57, 2.00, 1.8,1.72,1.4 and 1.22 for group of fish on diets 2,1,5,6,7,3 and 4 respectively. Statistical analysis revealed that diets 2 and 1 (control) had a significantly ($P \leq 0.05$) higher PER than the rest of groups. Similarly, PPV % was found also to be the highest in group fed 2,5and having their values 43.18, 32.57and 32.30 respectively.

Results illustrated in table (10) indicated that the feed costs per kg gain in weight were the lowest in group 2 (10 % canola meal followed in an increasing order by groups 4, 3, 7, 1, 6 and 5 respectively.

Discussion

The experiment was conducted to investigate new sources of unconventional plant protein in Red Tilapia (*Oreochromis spp*) diets. Study examined the effects of partial substitution of canola meal and/or atriplex leaves at levels 10, 20 and 30% for each ingredient to replacement of fish meal protein. So the basic of this study was to develop practical diets for Red Tilapia from the available, inexpensive local ingredients in North Sinai Governorate.

In this study, based primary on the proximate analysis of the canola meal, it is contain 10.70% fiber (table, 1) indicated that increased dietary fiber can reduce growth in Red Tilapia.

These results are in agreement with **Shiau and Kowk (1989)** in Tilapia . **Liang (2000)** and **Yigit et al. (2012)** reported that fiber can induce a faster passage rate, reducing the opportunity for digestion and increasing endogenous nitrogen loss through abrasive action or binding endogenous protein. **Lie and Robinson (1994)** found that feeds for channel catfish can contain at least 25 % canola meal by replacement of soybean meal without detrimental effects. **Davies et al., (1990)** suggested an inclusion limit of 15 % canola meal in the diet of Tilapia (*Oreochromis mossambicus*) fry. The differences of these studies from the present study could be due to different fish species and glucosinolate content of canola meal.

Groups of fish fed 20 % and 30 % canola meal significantly ($p \geq 0.05$) showed lower body weight than that in fish group fed 10 % canola meal. These increases of canola meal protein with fish deleterious effects of glucosinolate on growth inhibition .Results are in agreement with **Burel et al., (2000)** who reported that 300 g/kg rapeseed and containing a low level of glucosinolate (5 m mole/g) could be used in practical rainbow trout diets without deleterious effect.

In the present study, feed intake, protein, fat and energy intake were lower in fish fed low level (10 %) of canola meal than the other groups of fish fed on 20 and 30 %, where these parameter increased with increasing levels of canola meal in diets. These results were contrast to studies of **Shafaeipour et al., (2008)** who showed that feed intake decreased with increasing dietary canola meal level in the trout. Similar trend with the study of **Cheng et al., (2010)** who observed an increasing in feed intake with increasing dietary canola meal level in Japanese sea bass. Differences between our study and another studies may be due to the use of different species and size .

Also, in our study results obtained of FCR, FE%, PER, PPV% and EPV% clear the addition of 20 and 30 % canola meal to diets resulted in lower for these parameters following lower protein, fat and energy retained.

In Atriplex leaves diets (5, 6 and 7). Accordingly, any differences in the performance of fish received such diets could be attributed to the quality and feeding value of the levels Atriplex leaves material (10,20 and 30%) used.

The obtained results clearly showed that, the replacement up to 20 % FM by Atriplex leaves meal allowed FI, FCR and PER similar to those exhibited by control groups (FM based diet) and the same trend was obtained for growth parameters (BW,WG and SGR %/ day). The highest replacing levels (more than 20 %) significantly reduced FI, PER, FCR)and also negatively affected growth parameters (BW, WG and SGR %/day) .These results suggests that the protein , ash and energy retained for diet No 7 (30 % atriplex) is lower than that of FM (basal diet) for Red Tilapia . Possible reasons for the reduced feed intake, protein intake, fat, ash and energy intake and growth parameters recorded at the highest replacing

levels of FM by Atriplex more than (20 %). Also, it may be related to the high–crude fiber, presence of identified or unidentified anti-nutritional factors and poor palatability of 30 % atriplex which reduced FI and adversed FCR and PER .Results are in agreement with (Soltan et al., 2008).

Atriplex leaves meal has been used to replace fish meal partially in diets of (*Oreochromis aureus*) (Youssif et al., 1994) but the results were negative where the performance parameter decreased significantly by increasing the level of Atriplex leaves meal. Artichoke leaves waste meal (*Cynaro scolymus*) has been successfully used in diets of Red Tilapia.

In conclusion, all unconventional plant sources used in the present study can be used as a source of protein which can be include safely with fish meal in red tilapia diets aiming to reduce the costs

Table 7. Average of body weight, daily gain (ADG), specific growth rate (SGR) and gain % of Red tilapia.

diet No	1	2	3	4	5	6	7
Replacement	Control	Canola meal		Atriplex leaves			
Unconventional protein %	0	10	20	30	10	20	30
Initial weight (g/fish)	17.80 ^a ±0.08	17.80 ^a ±0.11	17.60 ^a ±0.14	17.60 ^a ±0.06	17.80 ^a ±0.03	17.70 ^a ±0.01	17.80 ^a ±0.23
final weight(g/fish)	32.68 ^b ±0.07	33.85 ^a ±0.13±	28.19 ^f ±0.09±	27.67 ^g ±0.03±	31.89 ^c ±0.18±	30.73 ^d ±0.12±	29.36 ^e ±0.14±
weight gain (g/fish)	14.88 ^b ±0.01	16.05 ^a ±0.01	10.59 ^f ±0.05	10.07 ^g ±0.02	14.09 ^c ±0.22	13.03 ^d ±0.13	11.56 ^e ±0.09
Average daily gain (g/fish)	0.18 ^b ±0.001	0.19 ^a ±0.001	0.13 ^f ±0.001	0.12 ^g ±0.001	0.17 ^c ±0.003	0.15 ^d ±0.002	0.14 ^e ±0.001
Specific growth rate(% day)	0.72 ^b ±0.003	0.76 ^a ±0.004	0.56 ^f ±0.005	0.54 ^g ±0.01	0.69 ^c ±0.01	0.655 ^d ±0.005	0.599 ^e ±0.01
Gain%	83.60	90.17	60.17	57.22	79.16	73.62	64.94

Table 8. Chemical composition and energy content of whole body of Red Tilapia as affected by different treatments (DM basis)

diet No	1	2	3	4	5	6	7
Replacement	Control	Canola meal		Atriplex leaves			
Unconventional protein %	0	10	20	30	10	20	30
DM	24.62	23.88 ±0.04	23.45 ±0.14	23.65 ±0.01	23.58 ±0.02	22.77 ±0.31	22.95 ±0.04
CP	65.50	68.83 ^c ±0.67	74.08 ^{ab} ±0.78	71.75 ^{abc} ±0.03	71.05 ^{bc} ±0.82	74.67 ^a ±0.04	70.50 ^d ±0.43
EE	13.66	14.42 ^f ±0.13	12.76 ^d ±0.23	11.33 ^{abc} ±0.29	14.43 ^d ±0.46	14.19 ^b ±0.32	14.27 ^{cd} ±0.59
Ash	18.76	16.10 ^{bc} ±0.19	12.76 ^{abc} ±0.23	16.10 ^{abc} ±0.23	14.84 ^d ±0.46	14.04 ^b ±0.39	14.66 ^{abc} ±0.59
GE(kcal/g)	5.17	5.13 ^{bc} ±0.06	5.39 ^b ±0.13	5.13 ^c ±0.20	5.42 ^b ±0.04	5.75 ^a ±0.06	5.05 ^c ±0.06

Table 9. Intake of feed and retained of protein, fat, ash and energy of Red Tilapia at the end of the experiment:

diet No	1	2	3	4	5	6	7
Replacement	Control			Canola meal		Atriplex leaves	
Unconventional protein %	0	10	20	30	10	20	30
Feed Intake (g/fish)	24.55 ^e	20.54 ^g	26.47 ^b	29.20 ^a	25.90 ^c	25.02 ^{cd}	22.54 ^f
Protein intake (g/fish)	7.43 ^{de}	6.23 ^g	7.97 ^{ab}	8.75 ^a	7.83 ^c	7.59 ^d	6.73 ^f
Fat intake (g/fish)	1.77 ^d	1.43 ^f	1.76 ^d	1.94 ^a	1.88 ^b	1.87 ^{bc}	1.72 ^e
Energy intake (kcal,GE)	113.10 ^d	95.84 ^{fg}	121.76 ^b	134.32 ^a	119.17 ^c	116.69 ^e	105.4 ^f
Protein retained(g)	2.40 ^c	2.69 ^a	1.94 ^{efg}	1.80 ^{ef}	2.55 ^{ab}	2.12 ^d	1.84 ^e
Fat retained (g)	0.53 ^{ab}	0.41 ^d	0.26 ^f	0.48 ^c	0.43 ^{cd}	0.41 ^d	0.56 ^a
Ash retained (g)	0.43 ^a	0.19 ^{ef}	0.26 ^b	0.16 ^e	0.20 ^{bcd}	0.22 ^{bc}	0.14 ^{efg}

Table 10. Feed conversion ratio (FCR), Feed efficiency (FE %), protein efficiency ratio (PER), Protein productive value (PPV %) and Energy productive value (EPV%) for Red Tilapia

diet No	1	2	3	4	5	6	7
Replacement	Control			Canola meal		Atriplex leaves	
Unconventional protein %	0	10	20	30	10	20	30
FCR	1.65 ^e	1.28 ^f	2.5 ^b	2.90 ^a	1.84 ^{cd}	1.92 ^c	1.95 ^c
FE%	60.60 ^b	74.14 ^a	40.01 ^f	36.44 ^g	54.40 ^c	53.08 ^{cd}	51.29 ^e
PER	2.00 ^d	2.57 ^a	1.49 ^g	1.22 ^h	1.80 ^e	1.72 ^f	1.72 ^f
PPV%	32.30 ^b	43.18 ^a	24.34 ^f	20.57 ^g	32.57 ^c	27.93 ^d	27.34 ^e
EPV%	15.64 ^b	18.84 ^a	9.69 ^f	9.65 ^{fg}	16.03 ^c	11.21 ^e	13.03 ^d

Table 11. Feed cost per kg of Red Tilapia fed experimental diets.

diet No	1	2	3	4	5	6	7
Replacement	Control			Canola meal		Atriplex leaves	
Unconventional protein %	0	10	20	30	10	20	30
Cost per kg diet L.E	5.17	4.93	4.69	4.45	4.83	4.49	4.15
Consumed feed to produce kg fish,kg	.75	.61	.56	.56	.81	.81	.77
Feed cost/kg fresh fissile	3.88	3.00	2.63	2.49	3.91	3.64	3.19
Relative % of feed cost /kg fish	155.8	120.5	105.6	100	157.0	146.2	128.1
Feed cost / kg gain, L.E	8.5	6.3	7.0	6.9	8.9	8.6	8.1
Relative % of feed cost of kg gain	135.0	100	111.0	109.5	141.0	136.0	128.6

2- Feed intake per fish period / final weight, kg / kg.

1- Step 1X step 2.

4- Respective figure for steps 3/ lower figure in this step.

5- feed intake per kg gain X step 1

6- Respective figure for step 5/lower figure in this step.

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الملخص العربي

الهدف من هذه الدراسة هو تكوين علائق تجريبية لأسماك البلطي الأحمر تحتوي على عناصر علفية غير التقليدية للاحلال الجزئي لبروتينات مسحوق السمك. المصادر البروتينية غير التقليدية هي (أوراق الأتريلكس ومسحوق الكانولا).

اشتملت الدراسة على تقدير القياسات الآتية :-

النمو ، الزيادة في الوزن ، النسبة المئوية للزيادة في النمو ، ومعدل النمو اليومي ، معدل النمو النوعي ، ومتوسط الكميات المأكولة من كل من الغذاء والعناصر الغذائية. تم تقدير معامل التحويل الغذائي والانتاجية وكفاءة الاستفادة من البروتين ومعدل الانتاجية لكل من البروتين والطاقة وذلك بالاعتماد على النمو والتحليل الكيميائي لأنسجة جسم الأسماك . تم قياس وتسجيل درجة حرارة وقياس الاس الهيدروجيني للمياه فترة التجربة . تم تحليل النتائج احصائيا لتحديد معنوية الفروق بين متوسطات العينات عند مستوى احتمال (0.05).

تم اجراء البحث في مركز بحوث الاستزراع البحري بالعريش - فرع جامعة قناة السويس .

تم تكوين سبعة علائق ستة منها اشتملت على مصادر بروتين غير التقليدية ، العليقة الأولى رقم (1) اعتبرت عليقة مقارنة اما الثلاث معاملات التالية (العلائق 2، 3، 4) فقد احتوت على مسحوق الكانولا بنسب 10 ، 20 ، 30 % لتحل جزئياً محل بروتين مسحوق السمك في عليقة المقارنة على التوالي. أما المعاملات التي تحمل ارقام (5، 6، 7) فقد احتوت في مكوناتها على نفس نسبة الاحلال وهي 10 ، 20 ، 30 % من مسحوق أوراق الأتريلكس لتحل جزئياً أيضا محل بروتينات مسحوق السمك في عليقة المقارنة .

تم استخدام 14 تنك فيبرجلاس على شكل مخروطي سعة 120 لتر بمعدل تخزين 10 سمكات لكل تنك بمتوسط وزن أولى 0.10 ± 17.8 جرام وزعت الأسماك عشوائيا وكل معاملة اشتملت على مكررتين . استمرت التجربة لمدة 12 اسبوع .

جميع العلائق المقدمة للأسماك متساوية تقريبا في كل من البروتين الخام ($0.16 \pm 30\%$) والطاقة الكلية (4640 كيلو كالوري / كجم) والطاقة الممتلئة (2575 كيلو كالوري / كجم) وترواحت النسبة بين البروتين والطاقة (P/E ratio) بين 115.45 إلى 119.57 ملجم بروتين / كيلو كالوري طاقة ممتلئة .

أهم النتائج المتحصل عليها في هذه التجربة :

- 1- من غير المتوقع فقد كانت نتائج معدل النمو ومعامل التحويل الغذائي والكفاءة الغذائية والكفاءة النسبية للبروتين والقيمة الاجمالية للاستفادة من البروتين والطاقة **عالية معنويا** ($P < 0.05$) في مجموعة الأسماك التي تغذت على عليقة رقم(2) التي احتوت على 10 % مسحوق الكانولا عن مجموعة المقارنة (الكونترول - عليقة رقم 1) والتي احتوت فقط على مسحوق السمك كمصدر وحيد للبروتين الحيواني .
- 2- يليها العليقة المقارنة (الكونترول) من ناحية النمو والكفاءة الغذائية .
- 3- بمقارنة النتائج المتحصل عليها عند مستوى الاستبدال الجزئي لبروتين السمك لكل من مسحوق الكانولا ومسحوق أوراق الأتريلكس عند المستويات 10 ، 20 ، 30 % اتضح أن معاملات التحويل الغذائي ، الكفاءة الغذائية ، والكفاءة النسبية للبروتين والقيمة الاجمالية للبروتين والطاقة أفضل لمجموعة الأسماك التي تناولت الكانولا بنسبة 10 % حتى انها تفوقت على مجموعة أسماك المقارنة (الكونترول) رغم اختلاف الوزن النهائي بين المعاملات .
- 4- كانت تكلفة الكيلو جرام من الأسماك مرتفعة في عليقة (المقارنة) الكونترول والعلائق رقم 5 ، 6 ، 7 وهي مجموعة الأتريلكس وكانت العلائق رقم 2،3، 4 (10 ، 20 %) مسحوق الكانولا أرخص العلائق (3.00 ، 2.63 جنيه على الترتيب) .
- 5- كانت تكلفة الكيلو جرام نمو من الاسماك مرتفعة في مجموع اسماك الكونترول ومجموع أسماك الأتريلكس ورخيصة عن مجموعة الكونترول في مجموعة الاسماك التي تغذت على مسحوق الكانولا عند المستويات 10 ، 20 ، 30 % احلال جزئي لبروتينات السمك.