REPLACEMENT OF FISH MEAL BY FRESH WATER CRAYFISH MEAL *(PROCOMBRUS CLARKII)* IN PRACTICAL DIETS FOR NILE TILAPIA *(OREOCHROMIS NILOTICUS)*

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Abstract

The present study was carried out to investigate the effect of partial and complete replacement of fish meal by fresh water crayfish meal or silage at levels of 33.3, 66.6 and 100% on growth performance, feed and protein utilization as well as body composition of Nile Tilapia. Two feeding experiments were carried out for 84 days for each. Fish were stocked at 15 and 12 fish/glass aquarium (60× 35 ×40 cm) in the first and second experiment, respectively. The fish were obtained from El-Sharaky Hatchery, Tolombat 7, Kafr El-Sheikh, then acclimatized for one month on the experimental condition. The fish were fed at 3% of the total body mass in two equal meals. The diets contained approximately 32% crude protein. Each treatment was applied on three replicates. Water temperature was maintained at 26°C using electric heaters with thermostats. Photo period was adjusted to provide a 14 hrs light and 10 hrs dark daily. The results indicated that including crayfish meal in the diet caused a decrease in growth parameters at all substitution levels while substitution of fish meal by crayfish silage at level 33.3% did not decrease AWG, ADG or SGR but, increasing crayfish silage level to 66.6 or 100% from fish meal or silage resulted in a significant depression in the all mentioned growth parameters. The results also showed lower cost of one ton of all diets containing crayfish meal or silage than the control diet. The best economical efficiency was noticed in the diet containing 100% crayfish meal followed by the control diet this could be attributed to the lower cost of crayfish meal and to the higher weight gain in the control diet.

Keywords: crayfish meal, silage, fish meal, growth performance, economical efficiency.

INTRODUCTION

Recently, many areas of the world have dietary protein shortage and this situation is most severing in Africa. Since protein is required by fish in large amounts and is the most expensive component in fish diets, the quality and quantity of protein in the diet constitute the major economical considerations in fish feed formation. Fishmeal has been the major source of animal protein in fish diets, its high cost and dwindling availability has called for the search of alternative protein sources (Tacon, 1993 and Adeparusi and Ajayi, 2000). As long as protein component represents 55-75% of the total diet cost, protein alternatives have the first priority in formulating diet of tilapia as alternatives for the high cost of fish meal (Hanley, 2000). Little researches were conducted on animal protein sources as alternatives for fish meal such as blood meal, earth worms, fish silage, silk worm pupae and processed meat soluble (Reece, 1995, Tacon *et al.*, 1983, Jackson *et al.*, 1984, Fowler, 1991, Hossian *et al.*, 1997 and Millamena *et al.*, 2000). The utilization of the cheaper sources such as meat meal or whole soybean seeds are promising and need further investigations.

Crayfish (*Procambrus clarkii*) play an important role in aquatic ecosystems (pond, lakes, streams and marshes), by serving as a preferred food item for a large number of aquatic and terrestrial animals. It was accidentally introduced to Egypt in the Nile River during 1980. In fact, crayfish have been suggested as biological controls for nuisance water weeds. Most crayfish are not active predators and have difficulty capturing fast moving animals. This crayfish most certainly become important new food source for few invertebrates and many vertebrates. On the other hand, crayfish had a bad effect on the irrigation and draining as well as digging tunnels and big holes (72 cm length and 0.5-4.0 cm width) "U" shaped under the dams and canals sides through their reproduction and aestivation, which destroyed the dams and canals. Moreover, crayfish fed on fish eggs and fry it also causes cut of fish nets.

This work was carried out to study the effect of partial replacement of fishmeal (33.3, 66.6 and 100%) by whole crayfish meal or silage in Nile tilapia fish diets on growth performance, protein utilization, body composition, and economical efficiency.

MATERIALS AND METHODS

The present work was carried out at the Department of Animal Production, Faculty of Agriculture Kafr El-Sheikh, Tanta University during year 2005. Two experiments were conducted to study the effect of crayfish *(Procambrus clarkii)* meal or silage on growth performance, carcass composition, protein utilization and economical efficiency of Nile tilapia. The experimental system consisted of 24 glass aquarium (65 x 35 x 40 cm), 12 aquariums for each experiment. Aquariums were continuously supplied with compressed air. Dechlorinated tap water was used to change one third of the water in each aquarium every day. Temperature was controlled thermostatically and maintained at (25-26°C).

1- Experimental fish:

A group of 180 of Nile tilapia *(Oreochromis niloticus)* with an average initial body weight of 6.5 gm were used in the first experiment while a group of 144 of Nile tilapia with an average initial body weight of 21 gm were used in the second experiment. Fish were obtained from the stock of El-Sharaky Hatchery in Kafr El-Sheikh governorate. The fish were transported to the aquaria located in the Fish Laboratory, Faculty of Agriculture, Kafr El-Sheikh. They were maintained in these aquaria for one month before the beginning of the experiment for acclimatization purpose. The fish were fed during the acclimatization period on an artificial diet at a rate of 3% of the body weight daily. The fish in the first experiment were distributed into the aquaria at 15 fish per aquarium, while in the second experiment each aquarium contained 12 fish. The experimental treatments were tested in three aquaria for each.

2- Experimental diets:

A control diet containing 32% crude protein was formulated from the commercial ingredients. An amount of red swamp crayfish were collected from Tolombat 11 drain in Kafr El-Sheikh governorate. One part of the collected crayfish was dried in drying oven at 65°C, ground in electric mill and stored in deep freezer until use. The other part of crayfish was prepared as silage by adding sulfuric acid and formic acid at 1.5 % for each (w/w) to obtain a homogenous mixture of minced crayfish. The silage was stored in polyethylene containers with close fitting lids to reduce evaporation. Silage was stirred periodically to ensure a complete dispersal of acid amongst fish liquid and to prevent setting out with in the silage. The silage stored at room temperature for 40 days. Before using, crayfish silage was neutralized by adding 1.6% calcium hydroxide to raise the silage pH to 6.3. Three test diets in both the first and the second experiment were formulated to substitute 33.3, 66.6 and 100% of fish meal in the control diet by crayfish meal in the first experiment and by crayfish silage in the second experiment. All ingredients of the tested and the control diets in both of the first and the second experiment were mixed well together to produce a pelleted from at 2mm in diameter. All the experimental diets were adjusted to be isonitrogenious and contain approximately 32% protein. Composition and chemical analysis of the control and the tested diets in the first and the second experiments are present in Tables (1 and 2), respectively.

Table 1. Composition of the different experimental diets.

Item	D1	D2	D3	D4	D5	D6	D7
Fish meal	15.0	10.0	5.0	—	10.0	5.0	—
Crayfish meal	—	5.0	10.0	15.0	—	—	—
Crayfish silage	—	—	—	—	5.0	10.0	15.0
Soybean meal	40.0	45.0	50.0	52.0	45.0	50.0	52.0
Yellow corn	29.7	24.7	19.7	17.7	24.7	19.7	17.7
Wheat bran	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Rice bran	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Sunflower oil	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Vit. and Min.	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Total	100	100	100	100	100	100	100

D1: 100% fish meal (FM) + 0% crayfish (CF). D2: 66.7% FM + 33.3% CF meal.
D3: 33.3% FM + 66.7% CF meal. D4: 0% FM + 100% CF meal.
D5: 66.7% FM + 33.3% CF silage. D6: 33.3% FM + 66.7% CF silage. D7: 0% FM + 100% CF silage.

Table 2. Chemical analysis and energy content of the experimental diets in the first and the second experimental on DM basis.

Ingredients, %	Control DI	First experiment			Second experiment		
		D2	D3	D4	D5	D6	D7
DM%	90.6	91.1	89.4	89.4	90.5	90.3	90.3
CP%	32.6	32.4	32.8	32.8	32.6	31.7	31.2
EE%	5.0	5.8	5.9	6.4	6.2	5.1	6.3
CF%	4.5	5.3	5.3	6.3	4.6	4.3	5.1
Ash%	9.5	9.4	10.3	10.6	7.8	9.5	10.4
NFE%	47.5	47.1	45.7	44.2	48.8	49.4	47.0
GEMJ/Kg (1)	18.53	18.87	18.76	18.87	19.45	18.65	18.74
MEMJ/Kg (2)	15.48	14.93	14.83	14.73	15.35	14.90	14.86
P/E (3)	13.99	14.46	14.96	14.79	14.16	13.80	13.36

First Experimental = Crayfish meal Second Experimental = Crayfish silage

1. GE (gross energy) calculated by the values 4.1, 5.6, and 9.44 kcal GE/g DM of carbohydrate, protein, and fat, respectively (Jobling, 1983).
2. ME (metabolizable energy) calculated using the value of 3.49, 8.1, and 4.5 kcal/g for carbohydrate, fat and protein, respectively, according to Pantha (1982).
3. P/E ratio = protein to energy ratio (mg crude protein /KJGE)

3-Experimental procedure:

Both of the 1st and 2nd experiments were continued for 12 weeks. During the experimental period fish were fed on the experimental diets at a rate of 3% of the live body weight. The diets were introduced twice daily at 8 a.m. and 2 p.m. The fish groups were weighed weekly and the amount of feed was adjusted based on the actual body weight changes. Samples of water were taken weekly from each aquarium to determine water quality parameters, photo period was controlled by an electric timer to provide a 14 hrs light and l0 hrs dark daily. Details concerning the diets composition and experimental design in the first and second experiments are summarized in Table (3).

Table 3. The experimental designs in the first and second experiments.

Item	First experiment	Second experiment
Crayfish level, %	33.3, 66.6 and 100	33.3, 66.6 and 100
Av. Initial weight (g)	6.5	21
No. of fish per aquarium	15	12
No. of replicates per treatment	3	3
Experimental period (d)	84	84
Feeding level (% of body weight)	3	3
Feed frequency	2 times daily	2 times daily

Representative Samples from crayfish meal, crayfish silage, experimental diets as well as experimental fish at the end of the first and the second experiments were obtained, and then forced dried, milled and deep frozen until determination the chemical analysis according to the methods described by A.O.A .C (1998). Water samples were taken weekly from each aquarium to determine water quality parameters. Dissolved oxygen concentrations were determined by an oxygen meter. Water temperature in degree centigrade was recorded every day by using a thermometer. PH value of water was measured weekly using electric digital pH meter (Oriant Research Model 201). The measurements of No_2, No_3, Hardness, Po_4 and alkalinity analysis were carried out using commercial kits.

Average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR %/d), feed conversion ratio (FCR), protein efficiency ratio (PER), protein productive value (PPV %), and survival rate were calculated.

The data were statistically analyzed using general linear models procedure adapted by SPSS (1997) for user's Guide, with a one-way ANOVA, means were compared using Duncan's multiple range tests.

RESULTS AND DISCUSSION

1- Concentration of heavy metals in crayfish body and canal water.

The frequency distribution of element in the examined water and crayfish body samples was shown in Table (4). Most of the heavy elements in both canal water and crayfish body were within the normal permissible limits as described by many organizations such as Food Stuff: Cosmetics and Disinfectants (1972), FAO / WHO (1992) and E.O.S.Q.C. (1993). The same trend was also reported by Haleem (2003) who investigate a total of 24 surface water samples and 24 muscle samples fresh water crayfish collected from two villages in Zagazig district, Sharkia Governorate for detection and determination cadmium, lead, copper, zinc and mercury. The results obtained revealed that the mean values of Cd, Pb, Cu, Zn and Hg in water samples were 0.13, 1.37, 0.02, 0.11 and 0.26 ppm, respectively, while, the average residues of the same metals in crayfish muscle were 2.85, 11.60, 9.91, 6.43 and 2.51 ppm, respectively. On the other aspect nickel could not be detected in all examined water and crayfish muscle samples.

Table 4. Frequency distribution of heavy elements in examined water and crayfish body used in the present study.

Elements	Concentration of heavy metal residues in water	Permissible limits	Concentration of heavy metal residues in crayfish body	Permissible limits
Fe, ppm	0.37-0.39	-------	0.08-0.09	25
Cu, ppm	0.17-0.18	1.00	3.51-3.55	20
Mn, ppm	06-0.8	------	2.7-2.8	30
Zn, ppm	0.08-0.09	5.00	0.17-0.18	50

2- Water quality parameter:

The most important physic-chemical parameters of water used in the experiment are shown in Table (5). Data indicated that the values obtained lie in the acceptable ranges required for normal growth of tilapia (Abd El- Hakim *et al.*, 2002 and Abd El-hamid, 2003).

Table 5. Averages of some physic- chemical parameters of water

Item	Temperature (°C)	pH Value	DO Mg/l	Alkalinity mg/L	Hardness mg/L	PO_4 mg/L	NO_2 mg/L	NO_3 mg/L
Exp. 1	25-26	6-7.4	5-5.5	140-145	200-250	0.1-0.3	0.13-0.14	1-4
Exp. 2	25-28	6.5-8	5.5-6	145-155	230-255	0.1-0.2	0.15-0.16	1.25-2.25

3- Growth performance:-

Data concerning average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR) and survival rate (SR) in the first and second experiments are shown in Table (6). The results indicated that including crayfish meal in the diet (Exp I) caused a decrease in growth parameters at all substitution levels. The decrease was slightly at 33.3% crayfish meal and values about 12.57% as compared with the growth of the control groups, while the decrease was more pronounced and valued more than 50% when all fish meal was substituted by crayfish meal. There were significant differences in all growth parameters between the control group and the experimental groups. Substitution of fish meal by crayfish silage at 33.3% level diet did not significantly decrease AWG, ADG and SGR, but increasing crayfish silage level at 66.6 and 100%

from fish meal resulted significant depression in the mentioned growth parameters. The results indicated that 33.3% fish meal in the diet can be spared by adding crayfish silage without any significant reduction in growth. The present results suggested that replacing fish meal with crayfish meal or crayfish silage give the possibility of reducing the feeding cost without significant decrease in growth performance. Fish groups fed diets containing 66.6 and 100 % crayfish meal or silage in the two feeding experiments showed significant reduction in growth parameters. This may be due to the poorer appetite observed with these diets than the other diets (33.3% crayfish and control). Hafez et al., (2003) substituted 50 and 100 % of fish meal by crayfish meal in the diet of Nile tilapia and found that the fish grew significantly (P<0.05) better when fed on fish meal diet than the crayfish diets, which was in accordance with the results of this study. Moreover, Megahed *et al.,* (1997) obtained significant differences in specific growth rate of Nile tilapia between groups fed sulphoric/formic silage and those fed fish meal diets when fish meal was replaced totally by fish silage. These results were in disagreement with the results of the present study. The study carried out by Agouz and Tonsy (2003) indicated that the use of crayfish meal in the diet as a replacement fish meal up to 50% was more economical than the higher replacement percentage. They added that body weight gain of Nile tilapia was affected by supplementation of the whole crayfish meal. It is also suggested that the highest weight gain and SGR was found in the control diet followed by 25, 50 and 100 % crayfish. These results are in a close accordance with those obtained in the present study. Al-Azab, (2005) reported that final weight of Nile tilapia decreased significantly (P<0.05) with increasing shrimp meal in the diet. The decrease was more pronounced at incorporation levels of 50 and 100 % in replacement with fish meal, but he found no significant differences (P>0.05) in SGR among the fish meal diet and shrimp meal diets at 25 and 50 % levels.

Table 6. Growth performance parameters of Nile tilapia fed on the experimental diets containing different levels of crayfish meal and silage.

Treatment	AWG (g/fish)	ADG (g/fish/day)	SGR (%/day)	SR %
Crayfish meal				
0 %	16.7 ± 0.64^{a}	0.19 ± 0.00^{a}	1.56 ± 0.03^{a}	100 ± 0.00^{a}
33.3%	14.3 ± 0.64^{b}	0.17 ± 0.00^{b}	1.43 ± 0.04^{b}	97.7 ± 2.2^{a}
66.6%	10.4 ± 0.38^{c}	0.12 ± 0.00^{c}	1.17 ± 0.02^{c}	97.77 ± 2.2^{a}
100%	8.1 ± 0.10^{d}	0.09 ± 0.00^{d}	0.99 ± 0.00^{d}	95.7 ± 2.2^{a}
Crayfish silage				
0%	21.1 ± 0.38^{a}	0.25 ± 0.00^{a}	0.74 ± 0.08^{ab}	100 ± 0.00^{a}
33.3%	20.3 ± 0.27^{a}	0.24 ± 0.00^{a}	0.72 ± 0.00^{a}	100 ± 0.00^{a}
66.6%	17.2 ± 0.73^{b}	0.21 ± 0.00^{b}	0.71 ± 0.02^{ab}	100 ± 0.00^{a}
100%	15.5 ± 0.61^{c}	0.18 ± 0.00^{c}	0.66 ± 0.01^{b}	94.4 ± 2.78^{b}

[a, b c] Means within a column with different superscripts are significantly different at (P<0.05).

4- Efficiency of Feed and protein utilization:

Efficiency of feed and protein utilization represented in FCR, PER and PPV% are shown in Table (7). FCR values indicated that increasing crayfish meal or silage in the diet of tilapia over 33.3 % affected negatively on the efficiency of feed utilization, the differences between the fish groups fed the control and 33.3% crayfish meal or silage were not significant (P>0.05.). The worst FCR observed with fish groups 66.6 and 100 % crayfish meal or silage may be due to the lower weight gain obtained in these groups. Protein utilization parameters (PER and PPV %) showed the same trend as in FCR, except in diet containing 66.6 % crayfish meal or silage. The lower PER in the high crayfish meal and silage diets may be attributed also to the poor weight gain observed in fish groups fed these diets. The results of Al- Azab, (2005) indicated that FCR was the best in fish meal diet as compared with shrimp meal diet and the values were worst as the level of shrimp meal increased in the diet. He suggested that shrimp meal could replace up to 50% of fish meal in growing tilapia diets without any adverse effect on feed utilization parameters (FCR and PER). These preview results are in close accordance with those obtained in the present study. Efficiency of protein utilization represented in PPV % recorded also the best values in fish meal diet as compared with shrimp meal diets as that observed in the study of AL-Azab (2005) and Solimam (2000) the later suggested that shrimp meal reduced steadily the apparent protein digestibility of Nile tilapia which may be also the reason for the reduction of PPV % in crayfish diets in our study. The same trend wan observed in FCR in the work of Hafez *et al.* (2003) but there were no significant differences among the fish meal diet and crayfish meal or its by–products in PER, although the value was the best in the fish meal diet. The worst values of FCR PER and PPV were observed by 100 % whole crayfish meal diet fed to Nile tilapia which may be due to the higher difficult digestible crude fiber content in the crayfish body (Agouz and Tonsy, 2003).

Table 7.Feed and nutrient utilization of Nile tilapia fed on the experimental diets containing different levels of crayfish meal and silage.

Treatment	FCR	PER	PPV %
Crayfish meal			
0 %	1.24 ± 0.03^{c}	2.65 ± 0.09^{c}	31.68 ± 0.57^{a}
33.3%	1.48 ± 0.01^{c}	2.19 ± 0.03^{c}	26.66 ± 0.39^{b}
66.6%	1.80 ± 0.07^{b}	1.79 ± 0.09^{b}	29.48 ± 0.44^{c}
100%	2.04 ± 0.04^{a}	2.06 ± 0.12^{a}	$24.02 \pm 0.35^{d)}$
Crayfish silage			
0 %	1.40 ± 0.03^{b}	1.25 ± 0.01^{ab}	29.22 ± 0.13^{a}
33.3%	1.44 ± 0.02^{b}	1.27 ± 0.008^{a}	26.06 ± 0.26^{b}
66.6%	1.45 ± 0.13^{b}	1.20 ± 0.02^{bc}	23.03 ± 0.07^{c}
100%	1.89 ± 0.12^{a}	1.17 ± 0.02^{c}	19.29 ± 0.43^{d}

$^{a, b, c, d}$ Means within a column with different superscripts are significantly different at (P<0.05).

5- Body composition:

Dry matter, crude protein, ether extract and ash of the whole fish bodies are summarized in Table (8). The results of carcass composition showed that no significant differences (P<0.05) in CP between fish groups fed the control diet and the groups fed 33.3% crayfish meal (diet 2). There were significant differences (P<0.05) in DM content between the control and each of the tested diets. A significant increase (P<0.05) in EE was observed in carcass of fish groups fed the control diet as compared with the groups fed on other diet. Ash content did not show a clear trend and there were slight fluctuations. The data also, indicated that there were no significant differences (P>0.05) in CP between fish groups received the control and crayfish silage diets. The percentage of fish carcass composition obtained in this study indicated that substituting fish meal with crayfish meal or silage up to 33.3% was good and comparable with the control diet. The worst values were obtained when crayfish meal or silage was increased to 66.6 or 100 %. AL-Azab (2005) reported that replacement of shrimp meal at 75% and 100% levels from fish meal in the diet of tilapia caused significant (P<0.05) higher dry matter content as compared with the lower substitution levels. He attributed that by increasing ash contents in shrimp meal. These results are disagreement with those obtained in present study, where DM decreased with increasing crayfish meal or silage in the diet. In contrast, Solimam (2000) found that incorporation of shrimp meal in the diet of tilapia increased ash content of the whole fish bodies and dry matter, However the data obtained by the two previous authors concerning CP contents in the whole fish bodies were in agreement with the present results, where increasing of crayfish meal or silage and shrimp meal and shrimp waste caused a decrease in CP contents. Ether extract of the whole fish bodies showed the same trend observed in the work of AL- Azab (2005) and Solimam (2000). Ash contents of fish bodies was found to be higher as the shrimp meal or waste increased in the investigations of AL-Azab (2005) and Solimam (2000), while it could not observed any clear trend in this study. Also, there were some investigators which were in discordance with our results. For example, Hafez et al, (2003) obtained the highest significant DM and CP in fish bodies fed the higher crayfish meal containing diets, while Agouz and Tonsy, (2003) found no significant differences P<0.05) in DM and ash in the bodies of tilapia fed fish meal or whole crayfish meal containing diets, but the highest CP contents were found in the bodies of fish fed 100% crayfish meal.

Table 8. Carcass chemical composition (%) of Nile tilapia feed on the experimental diets containing different levels of crayfish meal and silage.

Treatments	DM	CP	EE	Ash
Crayfish meal				
0 %	23.60 ± 0.47[a]	58.60 ± 0.23[a]	16.83 ± 0.49[a]	14.23 ± 0.15[ab]
33.3%	22.47 ± 0.38[b]	57.60 ± 0.40[a]	15.03 ± 0.14[b]	15.03 ± 0.31[a]
66.6%	22.07 ± 0.08[b]	56.20 ± 0.35[b]	14.76 ± 0.03[b]	13.73 ± 0.47[b]
100%	21.87 ± 0.12[b]	55.80 ± 0.23[b]	14.56 ± 0.20[b]	15.00 ± 0.46[a]
Crayfish silage				
0%	24.50 ± 0.20[a]	64.23 ± 0.20[a]	8.50 ± 0.29[b]	21.73 ± 0.08[a]
33.3%	24.20 ± 0.32[ab]	63.33 ± 0.20[b]	9.80 ± 0.23[a]	20.30 ± 0.10[b]
66.6%	23.43 ± 0.35[b]	62.50 ± 0.29[b]	8.33 ± 0.43[b]	21.76 ± 0.20[a]
100%	23.33 ± 0.23[b]	61.20 ± 0.35[c]	9.63 ± 0.26[a]	22.33 ± 0.26[a]

[a, b, c] Means within a column with different superscripts are significantly different at ($P<0.05$).

5- Economic efficiency:

The economic efficiency of the control and the tested diets are presented in Table (9). The values showed lower cost of one ton for all diets containing crayfish; however, the control diet recoded the highest price being 1976.7 LE. The data indicated that the best economical efficiency was noticed in the diet containing 100% crayfish meal or silage followed by the control diet (100% fish meal diet). This could be attributed to the lower cost of crayfish meal or silage and to the higher weight gain in the control diet.

Table 9. Data of the economical efficiency due to feeding fish on graded level of crayfish meal and silage.

Treatments	Feed intake g/fish	Cost of one ton diet (LE)	Cost of feed intake (LE)	Total gain g/fish	Feed cost/kg gain (LE)*
Crayfish meal					
0 %	20.78	1976.7	0.04	16.76	2.45
33 %	21.14	1706.7	0.04	14.33	2.51
66 %	18.76	1436.7	0.03	10.40	2.59
100 %	16.54	1159.2	0.02	8.10	2.36
Crayfish silage					
0 %	29.63	2096.7	0.06	21.13	2.91
33 %	29.33	1826.7	0.05	20.33	2.64
66 %	25.06	1556.7	0.04	17.23	2.26
100 %	29.28	1279.2	0.04	15.50	2.42

*feed cost / kg gain (LE) = FCR × cost of one kg diet.

The calculations were based on the average price of dietary ingredients at year 2005, where local market prices / ton were as follows: fish meal 6000 LE, wheat bran 750 LE, soybean meal 1250 LE, rice bran 1000, yellow corn 1000 LE, sunflower oil 350 LE, Vit and Min mixture 12400 LE, Acids 4 LE/ L and crayfish 3500 LE.

The data in the literature indicated that including shrimp meal in the diet of Nile tilapia reduced the cost of the diet and this reduction shrimp meal level (Al-Azab, 2005). This was in accordance with the results of the present study. In addition Hafez *et al.*, (2003) stated that the diet containing 50% crayfish meal was more efficient from the economic point of view than fish meal containing diet. The results of Agouz and Tonsy (2003) were in agreement with our results, where they found that the cost of one ton feeding mixture was reduced in all levels of crayfish substitution which ranged from 25 to 100%.

From the results obtained in the present study, it seems that the preservation of crayfish silage is more efficiency than crayfish meal. Moreover, the results also suggested that crayfish meal or silage can be used successfully up to 33% of the Nile tilapia diets, also replacing fish meal by crayfish meal or silage give the possibility of reducing the feeding cost without a significant decrease in growth performance. While using higher levels of (66 or 100%) of crayfish meal or silage showed a significant reduction in all growth parameters this may be due to the lower energy content and high crude fiber contents in the diets contain crayfish meal or silage. Therefore, further studies on using crayfish as a replacer to fish meal in fish diets still needed.

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إحلال مسحوق السمك بمسحوق إستاكوزا المياة العذبة في علائق أسماك البلطي النيلي

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أجريت هذة الدراسة بقسم الإنتاج الحيواني- كلية الزراعة- جامعة كفر الشيخ لمعرفة تأثير الاستبدال الجزئي والكلى لمسحوق الأسماك بمسحوق إستاكوزا المياة العذبة بعد تجفيفة وطحنة أو علي صورة سيلاج بمعدل صفر، ٣٣,٣، ٦٦,٦، ١٠٠ % لكل من مسحوق أو سيلاج إستاكوزا المياة العذبة في علائق البلطي النيلي علي معدلات النمو ومعدلات الاستفادة من البروتين والغذاء والتركيب الكيماوي لجسم الأسماك وكذلك الكفاءة الاقتصادية. إجريت تجربتين لمدة ٨٤ يوم واستخدم في كل تجربة ١٢ حوض زجاجي (٦٠x ٥٣ x ٤٠سم). وكان كل حوض في التجربة الأولى (مسحوق الإستاكوزا) يحتوي على عدد ١٥ سمكة للحوض و التجربة الثانية (سيلاج الإستاكوزا) عدد ١٢سمكة وقد تم عمل أقلمة لهذه الأسماك لمدة شهر قبل بدء التجربة. وكان يتم تغذية الأسماك أثناء فترة التجربة بمعدل ٣% من الوزن الحي وكانت تقدم العلائق مرتين يوميا وكانت العلائق على صورة حبيبات قطرها ١ مم وتحتوى على ٣٢% بروتين خام وقد طبقت كل معاملة في ثلاثة مكررات. كان يتم قياس كل من درجات الحرارة ، ودرجة الحموضة pH، والأكسجين الذائب بالإضافة إلي قياس النيتريت، والنترات، والفوسفات، والملوحة أسبوعيا خلال مدة التجربة كما تم تسجيل أوزان الأسماك أسبوعيا لحساب معدل النمو والأداء الانتاجى كما سجلت نسبة التفوق لحساب معدلات الحيوية للأسماك. وكانت أهم النتائج كالأتي:

١- إحلال مسحوق أو سيلاج الإستاكوزا محل مسحوق السمك أدي إلي انخفاض معنوي لكل مقاييس النمو باستثناء مستوي الاستبدال ٣٣,٣% لكل من مسحوق وسيلاج الإستاكوزا لم يكن الانخفاض معنويا.

٢- إحلال مسحوق أو سيلاج الإستاكوزا محل مسحوق السمك أدي الي انخفاض تكاليف العلائق وتحسين الكفاءة الاقتصادية وكانت أفضل كفاءة اقتصادية بالنسبة للعليقة التي تحتوي على ١٠٠% مسحوق او سيلاج الإستاكوزا تليها تلك التي على ١٠٠ % مسحوق السمك وذلك يرجع الي انخفاض تكاليف مسحوق أو سيلاج الإستاكوزا من ناحية وارتفاع الزيادة في الوزن بالنسبة للعليقة المقارنة (١٠٠% مسوق السمك).

من هذه الدراسة يتضح أن استخدام إستاكوزا المياة العذبة في علائق الأسماك في صورة سيلاج أفضل من استخدامها في صورة مسحوق. كما يتضح أنه يمكن استبدال كلا من مسحوق أو سيلاج الإستاكوزا بمسحوق السمك فى علائق الأسماك بدون تاثير واضح علي مقاييس النمو المختلفة بينما مستويات الاستبدال المرتفعة (٦٦,٦ او ١٠٠%) لها تاثير سلبي معنوي علي مقاييس النمو المختلفة.