Abbassa Int. J. Aqua. Spiceal Issue 2010
The third scientific Conference, Al Azhar University, Cairo 17 –18 October 2010

PARTIAL OR COMPLETE REPLACEMENT OF FISH MEAL BY FERMENTED FISH BY-PRODUCTS SILAGE IN THE DIETS OF NILE TILAPIA (*OREOCHROMIS NILOTICS)* FINGERLINGS

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SUMMARY

The present study aimed to study the effect of incorporation of increasing levels of fermented fish silage (FFS) as a substitute of fish meal (FM) in the diets of Nile tilapia (*Oreochromis niloticus*) fingerlings. The highest average body weight, BW (40.14 g) was recorded for control group which fed the control diet (FFS0) followed by those fed the diet FFS25 (39.35 g) and the difference between these two groups was not significant. Compared to fish fed the control diet the other replacing levels of FM by FFS (FFS50, FFS75 and FFS100) significantly ($P<0.05$) decreased BW to 31.65, 32.37 and 30.64 g, respectively and the same trend was also observed for body length (BL), weight gain (WG), Specific growth rate (SGR), feed conversion ratio (FCR) and protein efficiency ratio (PER).

At stocking, condition factor (K) for Nile tilapia fingerlings ranged between 1.93 and 1.99 with insignificant differences in condition factor. At experiment end K value ranged from 1.70 to 1.80 and K value of Nile tilapia fingerlings significantly ($P<0.05$) affected by the substituting levels of FM by FFS.

The highest (35.92 g) feed intake was recorded for fish group fed the basal diet FFS0 followed by those fed the diets FFS25 (34.34 g), FFS75 (32.50 g), FFS50 (29.83 g) and FFS100 (29.21 g) and the differences were significant ($P<0.05$).

Dry matter (DM) content of whole fish lie in three groups the first group included fish fed the diets FFS0 and FFS75% and the second group included fish groups fed the diets FFS25 and FFS50 while the third one included fish group fed the diet FFS100 and the differences between these groups were significant ($P<0.05$). The complete substitution of FF by FFS released the highest (76.25%) crude protein content (CP) of whole fish followed in a descending order by those fed the diets FFS25(66.13%), FFS0 (62.49%), FFS75 (58.63%) and FFS50 (56.05%), and the differences between fish groups for protein content were significant ($P<0.01$). Ether extract and ash content of whole fish body found to be 10.46, 12.20, 17.14, 13.22 and 17.76% and 19.75, 18.19, 19.75, 20.33 and 19.03%, respectively and the differences in ether extract only among fish groups fed the diets were significant.

In conclusion, replacing 25% of FM by FFS did not significantly affected growth and feed utilization parameters and reduced feed costs by 7.93% for tilapia fingerlings.

Keywords: Replacement, fish meal, fish by-products silage, Nile tilapia fingerlings.

INTRODUCTION

During recent years there has been increased interest in the use of enzymatic stabilization techniques for the preservation and utilization of feed materials for animal feeding in particular, a great deal of attention has been concentrated on the utilization of fishery by-products, including low grade industrial fish species, filleting waste and by-catch. Although it has also been possible to treat plant protein and terrestrial animal by-products using ensiling techniques (Norman *et al.* 1979), the concentration of research effort on fishery by-products has arisen because of the high level of wastage within the industry due to its often seasonal nature and cost of storing (freezing) and transporting these materials over long distances to the nearest fish meal plant.

The two techniques which have deals ensiling through chemical acidification (acid preserved silage) or bacterial fermentation (fermented silage).

Acid preserved silages:

Various acids, (both organic and inorganic), have been used. In organic acids, typically sulphuric acid and hydrochloric acid, have the advantage of being strong acids, relatively cheap and widely available but they require the pH of the final silage to be 2 or below to prevent bacterial spoilage, in addition before such a silage is fed (by mixing with an appropriate dry binder premix).

In contrast, organic acids although more expensive have much better anti-bacterial properties. It is possible to use a mixture of inorganic and organic acids to obtain the strength and economy of the former with the preservative properties of the latter. Propionic acid is often used not only for its antibacterial properties but also because it prevents mould growth. Mould growth, in particular *Aspergihus flavus*. have been reported in formic acid silage stored in tropical conditions even at pH less than 4 (Kompiang *et al,* 1980 a). Rungruangsak and Utne (1981) fed fish silages prepared by using different acids to rainbow trout and examined changes in protease activity in the digestive tracts. They reported that, the acids tested (formic; hydrochloric and sulphuric) only hydrochloric acid had no effect on protease activity in any region of the intestine, while formic and sulphuric acids caused reduction in protease activity at high dietary silage levels. Co-dried sulphuric/propionic fish silage has been used successfully as a replacement for fish meal in rainbow trout diets (Hardy *et al.,* 1984).

Fermented silages:

Silage production is also possible by lactic acid bacterial fermentation. To undergo proper fermentation the raw material must contain lactic acid bacteria, a suitable nutritional substrate for the bacteria and a temperature compatible with rapid growth. Although lactic acid bacteria are invariably present in the raw material and a starter culture is not required (Kompiang *et al*., 1980b and 1980c) the inoculation of material with fermented starter culture is recommended.

To favor the growth of lactic acid bacteria as opposed to spoilage bacteria a specific fermentable substrate is mixed with the minced raw material to be ensiled. Molasses added at a ratio of at least 1:10 (w/w) molasses to fish are particularly effective (Kompiang *et al*., 1980b and Raa and Gildberg, 1982). Under favourable conditions the lactic acid produced reduces the pH of the silage, preserving it form spoilage and encouraging autolysis by naturally occurring protease enzymes. In view of the enhanced storage properties of these acid preservation techniques animal/Carbohydrates silages hold particular promise for use within the subtropical/tropical regions where conventional freezing techniques are expensive or not available (Jackson, 1984). Soltan and Tharwat (2006) indicated that fermented fish silage can successfully replace up to 25 and 50% of fish meal in Nile tilapia, *O. niloticus* and African catfish, *Claris gariepinus* diets without adverse effect on growth performance or feed utilization of each of tilapia and catfish fish.

The aim of the experiment is to investigate the effect of incorporation of increasing levels of fermented fish by-products silage in the diets of Nile tilapia (*Oreochromis niloticus*) fingerlings.

MATERIALS AND METHODS

The present study was carried out at the Laboratory of Fish Nutrition Faculty of Agriculture at Moshtohor, Benha University. The practical work of the present experiment was started on 1 September and lasted until 30 November of the same year (90 days). Fifteen rectangular aquaria 50×40×50cm (100 liter for each) were filled by 90 liter freshwater (3 replicates for each treatment) and each aquarium was stocked with 12 fish with an initial weight ranged from 18.13 to 19.11 g,

The experimental fish were obtained from Abbassa hatchery, Abu-Hammad, Sharkya. After acclimatization fish were randomly distributed into the experimental aquaria representing the five treatments At stocking body weight (BW) and body length (BL) for each aquarium were recorded. The aquaria were cleaned and water was replaced every four days, dissolved oxygen was maintained at 3.5 – 7.0 mg/l by continuous aeration and water temperature at 25 to 28°C. During the last month of the experiment (November) thermo-regulated electrical heaters (200 Watt for each aquarium) were used to adjust water temperature at 25-28°C.

Preparation of fermented fish silage (FFS):

Fish by-products (non edible parts) were obtained from El-Obour market and minced. FFS was prepared by mixing the minced fish by-products (60%) rice bran (30%) as filler, dried molasses (5%) as a source of carbohydrate (energy) and 5% yogurt (as a source of *Lactobacillus spp* for lactic acid anaerobic fermentation process). Potassium sorbate solution (1%) as antimicrobial agent was sprayed and the mixture was packed in black polyethylene bags. All bags were incubated in tightly hard plastic container and stored at ambient temperature that ranged from 30 to 38ºC. The ensilage process completed after 30 days and at the end, a liquid FFS of pH 4.5 was obtained and sun-dried for 3 days. The resultant dried FFS had brownish color and strong fish odor and contained 38.12% crude protein (CP).

Diet preparation

Five diets were prepared by thoroughly mixing the ingredients which composed of fish meal, soybean meal, fermented fish silage, yellow corn, vegetable oil and wheat bran with different percentage (Table 1). In preparing the diets, dry ingredients were first ground to a small particle size. Ingredients were mixed and then water was added to obtain a 30% moisture level. Diets were passed through a mincer machine with diameter of 2 mm and were sun dried for 3 days.

The experimental diets were formulated to replace 0, 25, 50, 75 or 100% of FM by FFS based on protein content. All diets were formulated to be isonitrogenous (30% protein) and isocaloric (2700 kcal ME/kg diet).

Tilapia fingerlings fed the pelleted diets (2 mm in diameter) at a daily rate of 3%, 6 day/week (twice daily at 9.00 am and 3.00 pm) and the amount of feed was bi-weekly adjusted according to the changes in body weight throughout the experimental period (90 days). About 25% of water volume in each aquarium was daily replaced by aerated fresh water after cleaning and removing the accumulated excreta. Water temperature, pH and dissolved oxygen were measured daily at 2.00 pm while total ammonia was weekly measured. Water quality parameters measured were found to be within acceptable limits for fish growth and health (Boyd, 1979).

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

	Experimental diets				
Feed ingredients	Diet1	Diet2	Diet3	Diet4	Diet5
Fish meal (65%)	20	15	10	5	0
Fermented fish silage (FFS)	0	10	20	30	40
Soybean meal	47	47	47	48	48
Yellow corn	18	18	16	10	5
Wheat bran	9	4	1	1	1
Vegetable oil	3	3	3	3	3
Vit. & Min. mixture[1]	3	3	3	3	3
Sum	100	100	100	100	100
Chemical analysis	*(determined on dry matter basis)*				
Dry matter (DM)	94.52	95.11	94.78	95.05	93.98
Crude protein (CP)	33.33	33.18	32.92	32.80	32.49
Ether extract (EE)	6.15	6.16	7.54	6.97	6.46
Crude fiber (CF)	8.56	9.25	8.67	9.88	10.36
Ash	7.55	8.45	9.36	7.66	8.16
NFE[2]	44.41	42.96	41.51	42.69	42.53
ME (Kcal/kg diet)[3]	2520	2513	2532	2500	2457
P/E ratio[4]	132.25	132.03	130.00	131.00	132.23

[1] Vitamin & mineral mixture/kg premix : Vitamin D_3, 0.8 million IU; A, 4.8 million IU; E, 4 g; K, 0.8 g; B1, 0.4 g; Riboflavin, 1.6 g; B6, 0.6 g, B12, 4 mg; Pantothenic acid, 4 g; Nicotinic acid, 8 g; Folic acid, 0.4 g Biotin,20 mg , Mn, 22 g; Zn, 22 g; Fe, 12 g; Cu, 4 g; I, 0.4 g, Selenium, 0.4 g and Co, 4.8 mg.
[2] Nitrogen free extract (NFE) =100-(CP+EE+CF+Ash)
[3] Metabolizable energy was calculated from ingredients based on NRC (1993) values for tilapia.
[4] Protein to energy ratio in mg protein/Kcal ME.

Growth performance and feed utilization parameters were measured as follows:

Condition factor (K) = $(W/L^3) \times 100$ Where:- W = weight of fish in "grams", L = total length of fish in "cm"

Specific growth rate (SGR) $= \frac{LnW2 - LnW1}{t} \times 100$ Where Ln = the natural log, W_1 = first fish weight, W_2 = the following fish weight in "grams" and t = period in days.

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

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

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

At the end of each experiment, three fish were randomly sampled from each aquarium and subjected to the chemical analysis of whole fish body. Moisture, dry matter (DM), ether extract (EE), crude protein (CP), crude fiber (CF) and ash content of diets and fish were determined according to the methods described in AOAC (1990).

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

$$Y_{ij} = \mu + \alpha i + e_{ij}$$

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

RESULTS AND DISCUSSION

Body weight (BW and, Body length (BL)

The initial body weight among the different fish groups received the different diets ranged between 18.13 and 19.11 g with insignificant differences in BW.

At experiment termination (after 90 days form the experimental start) the highest average BW (40.14 g) was recorded for control group which fed the diet FFS0 followed in descending order by those fed the diet FFS25 (39.35 g) which fed on diet supplemented with 25% FFS as a replacer of FM, FFS75 (32.37 g), FFS50 (31.65 g), and those fed the diet FFS100 (30.64 g).

Results of the present study indicated that substituting 25% of FM by FFM (on protein content basis) did not significantly affected the final BW and body length (BL) of

Nile tilapia however the other higher levels (50, 75 or 100%) significantly reduced the final BW and BL of Nile tilapia. The obtained results of the two experiments indicating the possibility of replacing 25% of FM by FFS in Nile tilapia fingerlings diets without adverse effect on the final BW (Table 2).

The obtained results are in agreement with those obtained by Salah Al-Din (1995). He found that the best final body weight of catfish was obtained from fish fed 30% fish silage sun or oven dried. Soltan *et al.,* (2008) found that after 90 days there were gradually decreased ($P<0.001$) in final BW as the replacing levels of FM by FFS increased while increasing replacing levels of FM by FFS up to 50% in the diets did not significantly affected the final BW of catfish while the higher replacing levels (75 or 100%) significantly ($P<0.001$) decreased the final BW of catfish. Also, Soltan and Tharwat (2006) found that replacement of FM by FFS by in the diets of Nile tilapia up to 25% did not significantly affected the final BL after 90 days of the experimental period while the higher replacing levels (50, 75 or 100%) significantly decreased the final BL of Nile tilapia.

On the other hand, Cavalheiro *et al.,* (2007) substituted FM by fermented shrimp industry wastes at a substituting levels of 0, 33.3, 66.6 and 100% in the diets of Nile tilapia, *O. niloticus* and the authors found that, the partial or complete replacement of fish meal by fermented shrimp industry wastes did not show any statistical differences in the average daily gain in length.

Condition factor (K):

The initial condition factor (K) for Nile tilapia fry ranged between 1.88 and 1.99 with insignificant differences in condition factor. At experiment termination, K values ranged between 1.70 to 1.90 and the differences between K values were significant ($P<0.05$). Compared to control group all replacing levels of FM by FFS significantly affected K values of Nile tilapia fingerlings.

In the study of Cavalheiro *et al.,* (2007) FM substituted by fermented shrimp industry wastes at a substituting levels of 0, 33.3, 66.6 and 100% in the diets of Nile tilapia, *O. niloticus* and the authors found that, the partial or complete replacement of fish meal by fermented shrimp industry wastes did not show any statistical differences in K values at the 5% probability levels and K values ranged from 1.36 to 1.83.

K values obtained in the present study are near the range of 1.36 – 1.83 for Nile tilapia, *O. niloticus* (Cavalheiro *et al.,* 2007) and 1.45 to 1.7 for female and 1.3 to 1.78 for males of Nile tilapia (Mainardes-Pinto *et al.,* 1986).

Table (2): Least square means and standard error for the effect of replacing levels of fish meal by fermented fish silage in the diets on body weight, body length and condition factor of Nile tilapia fingerlings.

Diets	No.	Body weight (BW)/g		Body length (BL)/cm		Condition factor	
		Initial	Final	Initial	Final	Initial	Final
FFS0(control)	36	19.11	40.14 a	9.88	12.84 a	1.98	1.90 a
FFS25	36	18.34	39.35 a	9.92	13.20 a	1.88	1.73 b
FFS50	36	18.62	31.65 b	9.90	12.07 b	1.95	1.80 ab
FFS75	36	18.45	32.37 b	9.78	12.18 b	1.99	1.79 ab
FFS100	36	18.13	30.64 b	9.79	12.19 b	1.93	1.70 b
Standard error		±0.70	±1.53	±0.15	± 0.21	±0.17	±0.03

Averages within each column having different letters are significantly different ($P<0.05$)

Weight gain (WG) and specific growth (SGR):

Results of table (3) showed that, after 90 days of the experimental start, the averages of WG were found to be 21.04, 21.01, 13.03, 13.92 and 12.51 g and the values of SGR found to be 0.83, 0.85, 0.59, 0.63 and 0.59 for the different experimental diets FFS0, FFS25, FFS50, FFS75 and FFS100, respectively.

The highest values of WG and SGR were recorded for fish group fed the FFS25 diet in which 25% of FM was replaced by FFS and did not significantly different from those recorded by fish group fed the basal diet (FFS0) whoever the higher replacing levels (50, 75 or 100%) significantly reduced the WG and SGR of Nile tilapia fingerlings and this may be attributed to the positive effect of balanced amino acid composition content of FM compared to FFS. Similar results were obtained by Hardy *et al.,* (1984) who revealed that reducing fish silage to 12.5% or increasing it to 50% reduced WG and SGR and the best growth was found by using 25% fish silage. Soltan *et al.,* (2008) found that after 90 days there were gradually decrease ($P<0.001$) in final WG and SGR as the replacing levels of FM by FFS increased.

On the other hand, Cavalheiro *et al.,* (2007) substituted FM by fermented shrimp industry wastes at a substituting levels of 0, 33.3, 66.6 and 100% in the diets of Nile tilapia, *O. niloticus* and the authors found that, the partial or complete replacement of fish meal by fermented shrimp industry wastes did not show any significant effect in the average daily WG. Also, Wassef *et al.,* (2003) found that replacement of 25, 50, 75 or 100% of FF by FFS alone or mixed with soybean meal (1:1) significantly ($P<0.05$) decreased the final BW of Nile tilapia fed 28% CP experimental diets while WG and SGR did not significantly affected by the partial or the complete replacement of FFS alone or when mixed with soybean meal.

Reduced growth response in Nile tilapia fingerlings fed diets in which FM was completely replaced FFS meal have been explained by sub-optimal amino acid balance, inadequate levels of energy and low feed intake caused by palatability. Lower growth at the complete replacement of FM by FFS in the present study may have been caused by one or some of these factors.

Results of growth performance parameters illustrated in Tables (2 and 3) of Nile tilapia fingerlings indicated that replacement of FM by FFS up to 25% in fingerlings diets did not affected BW, BL, WG, and SGR while the higher or the complete replacement of FM by FFS significantly ($P<0.05$) reduced these growth parameters.

Espe *et al.,* (1999) reported a similar effect for low inclusion levels (15%) using fish silage in Atlantic salmon diets. Also, Jatomea *et al.,* (2002) found that, replacing FM by shrimp head silage in Nile tilapia diets up to 15% showed the best response in growth performance while the higher replacing levels (20, 25 or 30%) resulted in the worst growth response. Berge and Storebakken (1996) reported that small amounts of silage improved the growth efficiency of Atlantic salmon fry. Nwanna and Daramola (2001) found that, replacing FM by shrimp head waste meal at 0, 15, 30, 45 and 60% in 30% protein diets decreased final BW, WG and SGR and the decrease was more pronounced at the higher replacement levels.

The higher levels (50% FM replacement by FFS) were reported in earlier reports of Lapie and Bigueras-Benitez (1992) who found no differences in growth performance of Nile tilapia fed a formic acid preserved fish silage blended with FM (1:1), and growth performance was significantly reduced when the replacing levels increased up to 75%. Also, Fagbenro (1994) and Fagbenro *et al.,* (1994) stated that, up to 75% of FM protein could be successfully replaced with tilapia silage and soybean meal (1:1) in 30% CP diets for all male *O. niloticus*.

Table (3): Least square means and standard error for the effect of replacing levels of fish meal (FM) by fermented fish silage (FFS) in the diets on body weight gain (WG) and specific growth rate (SGR) of Nile tilapia fingerlings.

Diets	No.$^{+}$	Weight gain (g/fish)	Specific growth rate
FFS0 (control)	3	21.04±1.38 a	0.83± 0.04 a
FFS25	3	21.01±1.38 a	0.85± 0.04 a
FFS50	3	13.03±1.38 b	0.59± 0.04 b
FFS75	3	13.92±1.38 b	0.63± 0.04 b
FFS100	3	12.51±1.38 b	0.59± 0.04 b

Averages within each column having different letters are significantly different (P<0.05).
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Fagbenro and Jauncey (1995) prepared fermented fish silage and blended it with either soybean meal, poultry by-product meal, hydrolyzed feather meal or meat and bone meal to obtained isonitrogenous (40% CP) and isocaloric (4.3 kcal/g gross energy) diets and containing one of the dried fish silage as a supplement providing 50% of the total dietary protein in dry matter. They found that, the differences among the different diets in WG and SGR of catfish, *Clarias gariepinus* were significant (P<0.05) and they added that, hydrolyzed feather meal is often considered as an inferior source of protein for fish because of its poor digestibility and amino acid profile (Tacon, 1993). In contrast, soybean has a good amino acid profile and its protein is digestible by catfish (Balogun and Ologhobo, 1989), but it has a lower digestible energy content than fish meal (Tacon, 1993). Also, Kling *et al.,* (1994) reported that Atlantic salmon, *Salar salar*, fed diets containing dried blends of acid ensiled dogfish processing wastes and soybean meal were significantly smaller than those receiving diets containing dried blends of silage and poultry meal or fish meal.

Feed intake, Feed conversion ratio (FCR) and Protein efficiency ratio (PER):

Results of average feed intake (g/fish) of Nile tilapia fingerlings as affected by replacing levels of FM by FFS in the experimental diets are presented in table (4). As described in this table, the highest (35.92 g/fish) feed intake was recorded for fish group fed the basal diet FFS0 followed in descending order by those in groups fed the diets FFS25 (34.34 g), FFS75 (32.50 g), FFS50 (29.83 g) and FFS100 (29.21 g) and the differences between these values were significant (P<0.05). Jatomea *et al.,* (2002) found that, replacing FM by shrimp head silage in Nile tilapia diets up to 15% did not significantly affected FCR while the higher replacing levels (20, 25 or 30%) significantly adversed PER of Nile tilapia.

Values of FCR and PER of Nile tilapia fingerlings as affected by replacing levels of FM by FFS in the experimental diets are illustrated in table (4). Compared to control group, replacing FM by FFS up to 25% in the diets of Nile tilapia fingerlings did not significantly affected FCR or PER while the higher replacing levels, 50, 75 or 100% significantly adversed FCR and PER

The obtained results are relatively agreed those obtained by Jatomea *et al.,* (2002) who found that, replacing FM by shrimp head silage in Nile tilapia diets up to 20% did not significantly affected FCR or PER while the higher replacing levels (25 or 30%) significantly adversed FCR and PER of Nile tilapia.

Table (4): Least square means and standard error for the effect of replacing levels of fish meal (FM) by fermented fish silage (FFS) in the diets on Feed intake, Feed conversion ratio and Protein efficiency ratio of Nile tilapia fingerlings.

Diets	No.$^{+}$	Feed intake (gm/fish	Feed conversion ratio	Protein efficiency ratio
FFS0 (control)	3	35.92±1.12 a	1.72±0.18 b	1.76±0.12 a
FFS25	3	34.34±1.12 a	1.64±0.18 b	1.84±0.12 a
FFS50	3	29.83±1.12 b	2.30±0.18 a	1.33±0.12 b
FFS75	3	32.50±1.12 ab	2.34±0.18 a	1.31±0.12 b
FFS100	3	29.21±1.12 b	2.35±0.18 a	1.33±0.12 b

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On the other hand, Fagbenro (1994) blended fermented fish silage (1:1 w/w) with either soybean meal, poultry by-product meal, hydrolyzed feather meal or meat and bone meal to obtained isonitrogenous (30% CP) and isocaloric (3.82 kcal/g gross energy) diets and containing one of the dried fish silage as a supplement providing 50% of the total dietary protein in dry matter. They found that, fish fed fish silage diets showed a similar (P>0.05) FCR and PER as those of the control diet. In this respect, Fagbenro and Jauncey (1995) prepared fermented fish silage and blended fermented fish silage with either soybean meal, poultry by-product meal, hydrolyzed feather meal or meat and bone meal to obtained isonitrogenous (40% CP) and isocaloric (4.3 kcal/g gross energy) diets and containing one of the dried fish silage as a supplement providing 50% of the total dietary protein in dry matter. They found that, the differences among the different diets in PER of catfish, *Clarias gariepinus* were insignificant.

Proximate analysis :

Results of body composition of whole fish body (Table 5) showed that, dry matter (DM) of whole fish lie in three groups, the first group included fish fed the diets FFS0 and FFS75% and the second group included fish groups fed the diets FFS25 and FFS50 while the third one included fish group fed the diet FFS100 and the differences between these groups were significant (P<0.05).

The complete substitution of FM by FFS released the highest (76.25%) crude protein content (CP) of whole fish followed in a descending order by those fed the diets FFS25(66.13%), FFS0 (62.49%), FFS75 (58.63%) and FFS50 (56.05%), and the differences between fish groups for protein content were significant (P<0.01).

Ether extract and ash content of whole fish body found to be 10.46, 12.20, 17.14, 13.22 and 17.76% and 19.75, 18.19, 19.75, 20.33 and 19.03%, respectively and the differences in ether extract only among fish groups fed the diets were significant.

In the experiment conducted by Fagbenro and Jauncey (1995) fermented fish silage was prepared and blended fermented fish silage with either soybean meal, poultry by-product meal, hydrolyzed feather meal or meat and bone meal to obtained isonitrogenous (40% CP) and isocaloric (4.3 kcal/g gross energy) diets and containing one of the dried fish silage as a supplement providing 50% of the total dietary protein in dry matter. They found that, there were no significant differences in dry matter, protein, lipids and ash content of catfish, *Clarias gariepinus* bodies.

Jatomea *et al.,* (2002) found that, all replacing levels (10, 15, 20, 25 and 30%) of FM by shrimp head silage in Nile tilapia diets significantly affected dry matter, crude protein, ether extract and ash contents of Nile tilapia.

Soltan and Tharwat (2006) found that DM of whole fish bodies did not significantly affected by all replacing levels (25, 50, 75 or 100%) of FM by FFS and the same trend was also observed for ash content of whole fish bodies. They added that, all replacing levels of FM by FFS significantly (P<0.001) decreased protein content and the opposite trend was observed for fat whereas fish group fed the control diet (FFS0) gained the lower fat content. Fish group fed the diet FFS25 showed the lower (P<0.001) ash content of whole fish bodies but the differences between the other groups (FFS0, FFS50, FFS75 and FFS100) were not significant.

Table (5): Least square means and standard error for the effect of replacing levels of fish meal (FM) by fermented fish silage (FFS) in the diets on proximate analysis of Nile tilapia fingerlings.

Diets	No.+	Dry matter	Crude protein	Ether extract	Ash
FFS0	9	26.42±0.31 b	62.49±0.60 c	10.46±0.86 c	19.75±0.67
FFS25	9	24.74±0.31 c	66.13±0.60 b	12.20±0.86 bc	18.19±0.67
FFS50	9	24.72±0.31 c	56.05±0.60 e	17.14±0.86 a	19.75±0.67
FFS75	9	26.30±0.31 b	58.63±0.60 d	13.22±0.86 b	20.33±0.67
FFS100	9	28.32±0.31 a	76.25±0.60 a	17.76±0.86 a	19.03±0.67

Economical Efficiency:

The current investigation highlights the potential of using fermented fish silage as a replacement for fish meal in the diets of Nile tilapia fry and fingerlings in two separate experiments. Generally, results of the present study showed the possibility of replacing of FM by FFS up to 50% or 25% in tilapia fry and fingerlings, respectively without adverse effect on growth performance and feed utilization.

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

All other costs are almost constant, therefore, the feeding costs required to produce one kg gain in weight could be used to compare the economical efficiency of different experimental treatments. As shown in Tables (6 and 7), feed costs (LE/ton) decreased gradually with increasing substitution level of FM by FFS. Data presented in the same tables showed that, increasing substitution level of FM by FFS at 25, 50, 75 and 100% decreased feed costs by 7.93, 15.59, 23.12 and 30.86%, respectively.

In conclusion, replacing 25% of fish meal by fermented fish silage reduced feed costs by 7.93% for tilapia fingerlings.

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

Nile tilapia fingerlings							
Diets	Costs (L.E)/ ton	Relative to control %	Decrease in feed costs (%)	FCR	Feed costs* (L.E.)/kg weight gain	Relative to control %	Decrease in Feed costs * (L.E)/kg Weight gain
FFS0	2735.50	100	0.00	1.72	4.71	100	0
FFS25	2518.50	92.07	7.93	1.64	4.13	87.69	12.31
FFS50	2309.00	84.41	15.59	2.30	5.31	112.74	-12.74
FFS75	2103.00	76.88	23.12	2.34	4.92	104.46	-104.46
FFS100	1891.25	69.14	30.86	2.35	4.44	94.27	5.73

* ×

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

Ingredients	Price (L.E.) / ton
Fish meal	6000
Yellow corn	1250
Soybean meal	2000
Fermented fish silage (FFS)	1000
Wheat bran	900
Vegetable oil	4000
Vit. & Min. Mixture	10000

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الإحلال الجزئى والكلى لمسحوق السمك بالسيلاج الناتج من تخمر مخلفات الأسماك فى علائق أصبعيات أسماك البلطى النيلى

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الملخص العربي

كان الهدف من إجراء هذه التجربة دراسة تأثير إدخال مستويات مختلفة من السيلاج المصنع من مخلفات الأسماك في علائق أصبعيات أسماك البلطي النيلى. وبشكل عام يتم تلخيص أهم النتائج في التالي .

- فى نهاية فترة التجربة (بعد ٩٠يوم) كان أعلى متوسط لوزن الجسم هو ٤٠,١٤ جرام سجل في مجموعة الكنترول والتي غذيت على العليقه الاساسيه دون إضافة السيلاج وعند إستبدال ٢٥% من مسحوق السمك بسيلاج مخلفات السمك المخمر أدى هذا الإستبدال إلى خفض الوزن النهائي إلى ٣٩,٣٥ ولم تكن الفروق بين المجموعتين معنوية أما مستويات الإحلال العالية (٥٠، ٧٥ ، ١٠٠%) فقد أدى إلى خفض متوسط وزن الجسم إلى ٣١,٦٥ ، ٣٢,٣٧ ، ٣٠,٦٤ جم على التوالى وكانت الاختلافات فى متوسطات وزن جسم الأسماك للعلائق التجريبية المختلفة معنوية. وقد أظهرت نتائج طول الجسم والزيادة فى وزن الجسم ومعدل النمو ومعامل تحويل الغذاء وكفاءة تحويل البيروتين أعطت نتائج مشابهه لوزن الجسم.
- تراوحت متوسطات معامل الحالة في بداية التجربة بين ١,٨٨ ، ١,٩٩ ولم تكن هناك فروقاً معنوية بين هذه المتوسطات، وفي نهاية التجربة كان أعلى متوسط لقيم معامل التصحيح (١,٩٠) قد سجلت فى المجموعة التى تغذت على عليقة المقارنة والتى لم تحتوى على سيلاج الأسماك أما مجموعة الأسماك التى تغذت على العليقة التى تم فيها إحلال مسحوق بسيلاج السمك إحلالاً تاماً (١٠٠%) أقل قيمة (١ر٧٠) وكانت الفروق بين متوسطات قيم معامل الحالة في نهاية التجربة فروقاً معنوية.
- أتضح من النتائج المتحصل عليها فى التجربة الثانية أن أعلى قيمة للغذاء المأكول (٣٥,٩٢ جرام/سمكة) قد سجلت لأسماك مجموعة الكنترول ثم أسماك المجموعة الثانية (٣٤,٣٤ جم) فالمجموعة الرابعة (٣٢,٥٠ جم) فالمجموعة الثالثة (٢٩,٨٣ جم) وأخيراً المجموعة الخامسة (٤٦,٨٨ جم) وقد جد ان هناك تأثير معنوي على كمية الغذاء المأكول نتج عن استخدام السيلاج كبديل لمسحوق الأسماك فى علائق أصبعيات البلطى النيلى.

- أظهرت نتائج التحليل الكيماوي للأسماك ان متوسطات نسب المادة الجافة قد تراوحت مابين ٢٤,٧٢ ، ٢٨,٩٩%. أما بالنسبة للبروتين الخام فقد تراوحت قيمه مابين ٥٦,٠٥ ، ٧٦,٢٥% كما تراوحت قيم الدهن الخام مابين ١٠,٤٦ ، ١٧,٧٦% ، والرماد ١٨,١٩ ، ٢٠,٣٣ % وكانت الفروق بـــين متوسطات قيم المادة الجافة والبروتين والدهن فروقاً معنوية.

من نتائج هذه التجربة وجد أنه عند استبدال ٢٥% من مسحوق السمك بسيلاج مخلفات الأســماك أدى ذلك إلى تقليل تكاليف تكوين العلف بنسبة ٧,٩٣%.