Response of Nile Tilapia (*Oreochromis Niloticus*) Fingerlinges to Diets Containing Azolla Meal as a Source of Protein

Ebrahim ,M. S.M; Zeinhom ,M.M and Abou-Seif, R. A,

Central Laboratory for Aquaculture Research, Agriculture Research Center, Cairo, Egypt.

ABSTRACT

Sun- dried *Azolla nilotica* was ground and incorporated into experimental diets at various levels (10.6 ,21.2 ,31.8 and 42.2% of the diets) to replace about 50%of soybean meal protein in the control diet (about 30% of total protein in diet). All experimental feeds contained 30% crude protein, 300 Kcal digestible energy/100g and protein/energy ratio about 70 mg protein/Kcal. Diets were fed to Nile tilapia *Oreochromis niloticus* fingerlings with initial mean body weight of 8.1g ± 0.3g at 3% of fish biomass daily for 90 days. The obtained results revealed that, Azolla meal (dried pellet form) is a suitable component for Nile tilapia fingerlings diets since, growth performance in all tested and control diets were nearly similar without significant differences. Also, hepatosomatic index and survival rate were not affected with increasing Azolla meal percentage in the diets. While, feed conversion ratio gradually increased with increasing Azolla meal percentage in the diets without significant differences until 31.8% inclusion level after that, significantly decreased. Body protein and fat content were significantly decreased with increasing Azolla meal percentage in the diets. But moisture and ash content were significantly increased with increasing Azolla meal percentage in the diets. Economical feed efficiency improved as the level of the dietary Azolla meal increased from 10.6 to 31.8% of the diet. These data suggested that, Azolla meal at a maximum percentage of 31.8% can replace about 50% of soybean meal protein (about 30% of total protein in diet) in fingerlings tilapia diet without any adverse effect on growth performance, feed efficiency and survival rate. In addition, Azolla meal was economically superior than soybean meal protein.

Keyword: Nile tilapia, Azolla meal, Growth performance, Feed conversion, Carcass composition, Economical efficiency.

INTRODUCTION

In semi-intensive and intensive culture systems of tilapia species, artificial feed are an important nutrient source. The feeds must be nutritionally

adequate and economical for the culture system. Feed is the major cost variable in tilapia culture representing up to 60% of total variable cost, since protein is the most critical ingredient in tilapia diets from stand point of cost and growth response (Jose et al., 2007).

The high quality of soybean meal protein has resulted in its wide inclusion as the main plant protein source in diets of cultured fish. But, in the near future, the production of such protein may not be enough to cover the increasing demand. Therefore, it is necessary to find out other protein source.

In this regard, many attempts have been made to partially or totally replace soybean protein with less-expensive and available protein source or local untraditional protein sources in fish feeds.

Azolla is an ideal feed substitute, it is an aquatic fern (pteridophyte), floating on water surface of flooded rice fields, small ponds ,and canal. Its size is 1-5cm except for a giant *Azolla nilotica* (it size is 15cm approximately).Seven extant azolla species are recognized (some taxonomists recognized 6 species), are distributions widely from temperature to tropical regions. Azolla has been used as a feed for pig, duck, and fish. Amit Biotech (2004) reported that, azolla has high protein content (20-30% on dry weight basis) rich in almost all essential amino acids, vitamin A, vitamin B-complex, beta-carotene and minerals (Calcium, phosphorus, potassium, iron, copper and magnesium). The same author added that, nutritional value of Azolla to fish vary greatly on Azolla species. *Azolla microphylla* or *Azolla nilotica* are the best and palatability by fish are better than other species.

In applied, organic fertilization for 3 months followed by feeding on artificial feed

(25%CP) beside azolla at a rate of 10 kg/ton for Nile tilapia, *Oreochromis niloticus* reared in earthen ponds was higher in body weight, weight gain, specific growth rate, total fish yield/feddan, fish body composition content (dry matter, protein & fat), average dressing percentage and the net returns/feddan than ponds were received standard diet (25% protein)only or with blue green algae at a rate 10kg/ton (Soltan *et al*., 2007). Also, Abdel-Fattah and Abdel-Aziz (1990) found that, azola meal replaced 25% of fish meal in practical diet for nile tilapia fingerlings (*Oreochromis niloticus)* without compromising tilapia growth and nutrient utilization. The authors added that, with increasing azolla level in the experimental diets, fish performance was significantly reduced and the worst performance was associated with the highest level of Azolla in the diet (100%) as a sole dietary protien source. Santiago *et al*., (1988) suggested that, azolla meal is a suitable component of diets for Nile tilapia fry since, growth performance and feed conversion ratios were improved as the level of the dietary azolla meal increased from 8.5 to 42.45% of the diets In the same manner, less than 25% of *Azolla pinnata* substitution was possible for fishmeal replacement in Nile tilapia *(O. niloticus*) feeds (El-Sayed, 1992).when dried azolla meal was incorporated in practical diet for nile tilapia fingerlings up to 50%, Thrwat (1999) found that, growth and feed utilization of (*O. niloticus)* were not significantly reduced, while fish fed on fresh azolla alone exhibited extremely poor growth performance.

The present study was conducted to evaluate the biological and economical effect of incorporated sun-dried azolla meal (dried pellet form) at various levels (10.6, 21.2 ,31.8 and 42.2%of the diets) to replace about 50% of soybean meal protein in the diet of

Nile tilapia fingerlings (*Oreochromis niloticus*).

MATERIALS AND METHODS

Preparation of Azolla meal

Azolla nilotica was collected from some ponds. rinsed with tap water and distributed on plastic sheet and sun dried for 6 days, then transfer to oven to be dried again at 105 C° for 6 hours, then crushed and grind through the feed grinder and finally kept in plastic jars at 5 C° until using in experimental diets. Chemical composition of azolla meal present in Table (1).

Table 1: ***The chemical composition (on DM basis) of azolla meal.***

Items	**%**
Moisture content (Fresh Azolla)	94
Crude protein C.P	24 — 30
Crude lipid E.E	3 — 3.3
Crude fiber C.F	9.1
Ash	10.5
Starch	6.5
Soluble sugar	3.5
Nitrogen	4.0 — 5.0
Water holding capacity	360
Color	Brownish
Smell	Fishy
Phosphorus (%)	0.5-0.9
Potassium (%)	2 - 4.5
Calcium (%)	0.4 - 1
Magnesium (%)	0.5 - 0.6
Manganese (%)	0.11 - 0.16
Iron (%)	0.06 - 0.26
Chlorophyll (%)	0.34 - 0.55

Source: *Pullin and Almazan (1983).*

Experimental diets

Experimental diets were designed to contain 30% crude protein, 300 Kcal digestible energy /100g and protein/energy ratio about 70mg protein/Kcal. Table (2), presents the constituents and composition of tested diets. About 50% of soybean meal protein (equal about 30% of total protein in the control diet) was substituted by azolla meal.

Azolla meal is incorporated into the tested diets at levels, 10.6, 21.2, 31.8 and 42.2% of the diet.

Table 2: ***The formulation and chemical composition of the tested diets .***

	Control diet	Tested diets			
Ingredients					
	T_1	**T_2**	**T_3**	**T_4**	**T_5**
Fish meal (59.1%CP)	17.0	17.0	17.0	17.0	17.0
Soybean meal (49.77%CP)	40.1	35.2	30.1	25.1	20.0
Azolla meal (23.60%CP)	–	10.6	21.2	31.8	42.4
Dextrin	35.4	29.2	23.2	17.6	12.1
Fish oil	2.0	2.0	2.0	2.0	2.0
Vegetable oil	2	2.5	3	3	3
Vitamin premix [1]	1.0	1.0	1.0	1.0	1.0
Mineral premix [2]	1.0	1.0	1.0	1.0	1.0
Binder (CMC)[3]	1.5	1.5	1.5	1.5	1.5
Total	100	100	100	100	100
Chemical composition (on DM basis)					
Dry matter (DM)	91.60	91.80	92.00	92.20	92.40
Crude protein (CP)	30.00	30.30	30.00	30.40	30.00
Crude lipid	7.90	8.00	8.25	7.90	7.60
Crude fiber (CF)	3.1	3.5	3.7	4.0	4.7
Ash	6.73	7.45	8.60	9.76	10.70
N.F.E[4]	43.87	42.55	41.45	40.14	39.40
Gross energy/100g[5]	433.9	432.9	430.0	424.5	419.6
Protein energy [6]	39.41	39.90	39.77	40.82	40.75
Digestible energy/100g[7]	315.00	315.60	314.55	311.38	306.60
P:E ratio [8]	69.1	70.0	69.8	71.6	71.5

[1]Vitamin premix :- each 2.5Kg contain Vit A 10MIU, D_3 1MIU, E 10gm, K gm, B_1 gm, B_2 4gm, B_6 1.5gm, B_{12} 10gm, Pantothenic acid 10gm, Nicotinic acid 20gm, Folic acid 1000gm, Biotin 50gm And Coline chloride 500gm.

[2]Mineral premix. No # 5 (tilapia) source: Jauncey and Ross,1982.

[3]CMC = Carboxymethyl cellulose.

[4]N.F.E = Nitrogen free extract = 100 — (moisture + protein + lipid + fiber +ash)

[5]Gross energy in kcal/100g ,based on 5.7 kcal/g protein,9.5 kcal/g lipid,4.0 kcal/g carbohydrate.

[6]Protein energy = (energy in protein/gross energy) X 100.

[7]Digestible energy in kcal/100g based on 5.0 kcal/g protein,9.0 kcal/g lipid,2.0 kcal/g carbohydrate (Wee and Shu.1989).

[8]P/E ratio = Protein to energy ratio in mg protein/kcal of gross energy.

All experimental diets balanced in essential amino acids, essential fatty acids, digestible energy, P/E ratio and fiber content. Fish and vegetable oil served mainly as a sources of omega 3 and omega 6 supplements. Dextrin was added as a low–density energy source to preclude the use of any non- nutritive filler. The control diet contained fish meal /soybean meal ratio (1:2) as a source of protein and dextrin as an energy supplement Binder, vitamin and mineral premix were kept constant in all diets. All diets were pelleted and then crumbled before feeding to the fish.

Experimental fish and management

A total of 150 Nile tilapia fingerlings (Oreochromis niloticus) were obtained from the hatchery in Central Lab. for Aquaculture Research, Agriculture Research Center.

The fish obtained were apparently healthy, and free from any infection. Fish with an average body weight of (8.1g/fish ± 0.3g),were placed in a fiberglass tank inside the wet lab, fed on control diet about two week for acclimation. The fingerlings were divided into 15 equal groups and transferred into glass aquaria, measured (40 X 50 X 60) and it was supplied with dechlorinated aerated tap water. The aquaria were cleaned and water was changed weekly.

Dissolved oxygen was maintained at an acceptable level (5.5 - 6.6 mg / L), water temperature was thermostatically controlled at the range of 27 ˚C ± 2 ˚C , with thermostatic heater and water pH adjusted at 7.4. Each group with three replicates and each aquarium contain 10 fish. *Oreochromis niloticus* fingerlings fed by 3% of body weight three times daily on experimental diets for 90 days. All fish per aquarium were weighed and counted at biweekly intervals to determine growth rates and to adjust rations.

At the end of the experiment, fish in each aquarium were counted and weighted, growth and feed utilization parameters were calculated. Also, analysis of both diet and fish fore moisture, crude protein, fat and ash were determined by Standard Methods According to (AOAC, 1984).

Economical analysis

Economical analysis was done at the end of the experiment. The net return and economical feed efficiency were calculated as follow: The net return (L.E) = [Total return – (total variable costs + total fixed costs)]. Economical feed efficiency (%) = [Return (L.E) ÷ Feed cost (L.E) / kg fish body gain] × 100.

Statistical methods

The data obtained in the present study were analyzed statistically. Differences in means were compared by Duncan, s New Multiple Range test ($p< 0.05$) (Duncan, 1955).

RESULTS AND DISCUTION

1- Growth performance

The results of the effect of feeding Nile tilapia fingerlings diets containing different levels of azolla meal on growth performance are shown in Table (3) .It could be noticed that, the initial body weight of tilapia in all treatments were approximately similar and the differences were insignificant .

Growth performance (final body weight, total weight gain, daily weight gain, specific growth rate and relative growth rate) were nearly similar in all treatments after 2 weeks, and there were not significant differences observed in all growth parameters between all treatments. Growth performance after feeding period (90 days) were slightly different as the level of azolla meal increased to 31.8% of the diet (diets T2, T3 and T4)

Table (3).But at 42.2% azolla diet (T5),growth performance was slightly decreased. However, there were no significant differences observed in growth parameters ($P< 0.05$) among the tilapia fed diets containing 10.6, 21.2, 31.8 and 42.4% azolla meal and control diet.

In respect of Hepatosomatic index, It could be noticed that, Hepatosomatic index values ranged from 1.65 to 1.76, and did not differ significantly among treatments .Concerning with survival rates, the obtained resulted revealed that, survival rates ranging from 83.3 to 90%, did not differ significantly among treatments.

These results may be due to azolla meal available protein (25%). It is rich in almost all essential amino acids, vitamin $_{A}$, vitamin $_{B}$ complex, beta-carotene and minerals (calcium, phosphorus, potassium iron, copper and magnesium) Amit Biotech (2004). Also, the nutritional values of azolla to fish vary greatly on azolla species. Azolla nilotica is better than others species. Also, these results may be due to the diets which were nearly similar in protein, energy, P/E ratio , and fiber content.

The growth data are in agreement with those obtained by Santiago *et al*., (1988**)** Who suggested that, azolla meal is a suitable component of diets for Nile tilapia fry since, growth performance and feed conversion ratios were improved as the level of the dietary azolla meal increased from 8.5 to 42.45% of the diets. But, survival rates, were not affected by increased azolla meal from 8.5 to 42.45% of the diets.Pullin *et al*., (1983) reported that, azolla can be mixed up to 10% of the purchased animal feed**.** Balogun *et al*., (1995) Showed that, macadamia presscake was suitable as dietary protein supplement for tilapia when incorporated up to 50% replacement for soybean protein.

Table 3: ***The effect of feeding Nile tilapia fingerlings diets containing different levels of azolla meal on them growth performance.***

Items	Control diet	Tested diets			
	T_1	T_2	T_3	T_4	T_5
Initial body weight (g/fish)	8.1±0.31[a]	8.0±0.49[a]	8.1±0.68[a]	8.3±0.27[a]	8.0±0.62[a]
Final body weight (g/fish)	32.0± 1.2[a]	31.0±1.1[a]	31.6±1.2[a]	30.8±1.4[a]	27.7±1.5[a]
Total body weight gain (g/fish)	23.9±1.2[a]	23.0±1.1[a]	23.5±0.97[a]	22.5±1.4[a]	19.7±1.4[a]
Daily body weight gain (g/fish)[1]	0.26±0.12[a]	0.25±0.11[a]	0.26±0.10[a]	0.25±0.15[a]	0.22±0.14[a]
Specific growth rate (%)[2]	1.95±0.26[a]	1.93±0.21[a]	2.10±0.22[a]	1.85±0.29[a]	1.75±0.27[a]
Relative growth rate (%)[3]	294.9±4.4[a]	287.8±3.5[a]	292.6±2.4[a]	269.8±4.7[a]	243.8±4.0[a]
Feed conversion ratio [4]	2.00±0.23[b]	2.25±0.33[ab]	2.15±0.33[b]	2.40±0.37[ab]	2.95±0.33[a]
Hepatosomatic Index (H5SI)[5]	1.65±0.19[a]	1.70±0.20[a]	1.76±0.16[a]	1.67±0.22[a]	1.66±0.17[a]
Survival rate (%)[6]	86.7±1.3[a]	90±0.0[a]	86.7±2.0[a]	86.7±1.8[a]	83.3±1.3[a]

Means with different superscript letters within a row are significantly different (P<0.05).

[1]*Daily weight gain = $(W_1 - W_o) \div T$*

[2]*Specific growth rate (%) = $[(Ln_{w1} - Ln_{w0}) \div T] \times 100$.*

[3]*Relative growth rate (%) = $[(W_1 - W_0) \div W_0] \times 100$.*

Where, Ln = natural log, W_0 = Initial body weight (g) , W_1= Final body weight (g) and T= Time(day)

[4]*Feed conversion ratio = Feed consumed (g) / Total weight gain (g).*

[5]*Hepatosomatic Index (HSI) = [liver weight ÷ fish weight] × 100*

[6]*Survival rate (%) = Fish No. at the end ÷ Fish No. stocked at the beginning.*

Olevera-Novoa *et al.*, (1990) found that, alfalfa leaf protein could be included at levels of up to 35% of the dietary protein in feeds for tilapia. Nahid *et al.*, (2003) suggested that, moringa leaf meal can be used to substitute up to 10% of dietary protein in Nile tilapia without significant reduction in growth .Bairagi *et al.*, (2002) found that, fermented lemma leaf meal can be incorporated into carp diets up to 30% level compared to 10% level of raw meal. Carter *et al.*, (2000) Showed, no significant differences observed in weight gain when replaced 25 and 33% of fish meal protein by soybean meal or

concentrates made from narrow-leafed lupine or field peas in extruded feeds for *Atlantic salmon*. De La Higuera *et al*. (1988) showed that, the possibility of including crude lupine seed meal in trout diets at levels as high as 30% of dietary protein and Perla *et al*., (1998) found, no significant differences observed in weight gain and specific growth rate between shrimp juvenile (*penaeus indicus*) fed on diets containing leguminous seeds meals (white cowpea) and leaf meals (papaya and cassava) comparing with control diet.

Concerning with feed conversion ratio, It could be noticed that, feed conversion ratio was not significantly affected by increasing azolla meal in the diets (2.0 to 2.4) except for tilapia fed on diet T_5 which contained 42.4% azolla meal (2.95).Values of FCR were nearly similar to those obtained by Santiago *et al*., (1988) who found that, feed conversion ratio ranged from 2.3 to 3.4 when fed fry of Nile tilapia on diet containing azolla meal.

2- Body composition

The carcass composition of the Nile tilapia at the beginning and end of the feeding trial are shown in Table (4). The obtained results revealed that, an increase in the dietary level of azolla meal resulted in a significant decrease in carcass fat content and generally an increase in carcass moisture and ash. The carcass protein content was not significantly affected by increasing azolla meal in the diets except for carcass protein of tilapia fed on T_4 and T_5 had a substantial reduction in body protein. These results showed the same trend of those obtained by Ng-Wing and Wee, (1989) who reported that, carcass composition of the Nile tilapia was significantly affected with increasing levels of cassava leaf meal in the diet, Nahid *et al*., (2003) and Bairagi *et al*., (2002) showed that, carcass composition

of the Nile tilapia was affected by dietary protein source.

3-Economical analysis

The effect of feeding Nile tilapia fingerlings diets containing various levels of azolla meal on cost-benefit analysis are given in Table (5), The price of Kg experimental diets were gradually decreased by increasing azolla meal level by 5.90, 10.07 15.62 and 21.18% respectively compared with the control diet.

With the exception of diets T_3, and T_4 the decrease of feed cost by increasing azolla meal was not reflect on the gain cost, return and economical feed efficiency because feed conversion in these diets (T_2 and T_5) was gradually increased (not improved) than diets T_3 and T_4. So, the diet T_3 and T_4 were gave the best gain cost, return and economical feed efficiency than other tested diets.

Similar results were reported with herring by- product (Ebrahim, 2007),corn gluten feed and meal (Wu *et al*., 1995) and cotton seed meal (EL-Sayed, 1990) Since these sources were economically superior than fish meal or soybean meal in tilapia diets.

Table 4: ***Body composition (on as fed basis) of Nile tilapia fingerlings fed diets containing different levels of azolla meal .***

Chemica	Initial	Control diet	Tested diets			
Composi		T_1	T_2	T_3	T_4	T_5
Moisture	75.14±o.33^{c}	76.19±0.36^{c}	76.97± 0.66^{b}	76.73±0.46^{b}	79.20±0.25^{a}	79.20±0.16^{a}
Crude protein	14.60±o.40^{a}	14.90±o.30^{a}	14.30±0.33^{a}	14.70±0.28^{a}	13.30±0.53^{b}	12.80±0.27^{b}
Crude lip	3.57±0.25^{a}	3.88±0.27^{a}	2.25±0.27^{b}	1.76±0.18^{c}	0.87±o.11^{d}	0.74±0.15^{d}
Ash	4.51±0.32^{bc}	4.20±0.27^{c}	4.63±0.27^{bc}	5.05±0.28^{b}	5.50±0.34^{ab}	5.98±0.05^{a}

Means with different superscript letters within a row are significantly different (p<0.05).

Table 5: ***The effect of feeding Nile tilapia fingerlings diets containing different levels of azolla meal on them economical parameters.***

Items	Control diet	Tested diets			
	T_1	T_2	T_3	T_4	T_5
Price/kg feed L.E*	2.88	2.71	2.59	2.43	2.27
Relative price to control diet (%)	100.00	94.10	89.93	84.38	78.82
Kg feed/kg gain	2.00	2.25	2.15	2.40	2.95
Feed cost/kg gain L.E	5.76	6.10	5.57	5.83	6.70
Relative economical to control diet (%)	100.00	105.90	96.70	101.22	116.32
Return L.E	2.24	1.90	2.43	2.17	1.30
Economical feed efficiency (%)	38.89	31.15	43.63	37.22	19.40

The price of each diet was estimated according to the price of ingredient, which were 5.0, 2.8, 0.60, 1.5,5.0,4.0,15 and 5.0 Egyptian pound (L.E) per one Kg of fish meal, soybean meal, Azolla meal , Dextrin ,fish oil, vegetable oil vitamin premix and mineral premix. The price of fish harvest was 8.0 L.E / one kg body weight.

In conclusion, the present study revealed that, azolla meal at a maximum level of 31.8% (dried pellet form) was suitable as a dietary protein supplement for tilapia when incorporated 50% replacement for soybean protein, without any adverse effect on growth performance, survival rate, feed utilization and economical parameters.

REFERENCES

Abdel-Fattah, M. E. S. and Abdel-Aziz, S. H. 1990. The use of *Azolla pinnata* protein source for tilapia (*Oreochromis niloticus* L.) fingerlings. Proc. of Intern. Symp. on Biology and Culture of Tilapia. Oceanography Dep. Fac. Sci., Alex. Univ., Egypt. 27-31 October:319-320.

Amit Biotech. 2004. Animal Nutrition – Products. Cited from Web site. Amit Biotech, pp:1-2.

Association of Official Analytical Chemists (A.O.A.C). 1984. Official Methods of Analysis.13th Ed., Association of Official Analytical Chemists. Washington DC,USA.

Bairagi, A; Sarkar-Ghosh, K; Sen, S. K and Ray, A. K. 2002. Duck weed (lemnapolyrhiza) leaf meal as

a source of feed stuff in formulated diets for rohu (Labeo rohita Ham.) fingerlings after fermentation with a fish intestinal bacterium. Bioresour Technol. 85 (1) : 17-24.2002

Balogun, A. M and Fagbenro, O. A. 1995. Use of macadamia presscake as a protein feedstaff in practical diets for tilapia (*Oreochromis niloticus*). Aquaculture Research, 26: 771-7 77.

Carter, C. G and Hauler, R. C. 2000. Fish meal replacement by plant meal in extruded feeds for Atlantic salmon, *Salmo salar* L. Aquaculture 185: 299-311.

Duncan, D. B. 1955. Multiple range and multiple F tests. Biometrics,11: 1-42.

De La Higuera, M; Garcia-allego, M; Sanz, A; Cardenete, G; Suarez, M. D and Moyano, F. G. 1988. Evaluation of lupine seed meal as an alternative protein source in feeding of rainbow trout (*Salmo gairdneri*). Aquaculture,71: 37-50.

Ebrahim, M. S. M. 2007. Herring by-product utilization in Nile tilapia (*Oreochromis niloticus)* feed. Egypt. J. of Appl. Sci., 22(9) 2007.

El-Sayed, A. F. M. 1992. Effects of substituting fish meal with Azolla pinnata in practical diets for fingerlings and adult Nile tilapia, *Oreochromis niloticus* (L). Aqua. & Fish. Manag., 23:167-173.

EL-Sayed, M. 1990. Long-term evaluation of cotton seed meal as a protein source for Nile tilapia *Oreochromis niloticus.* Aquaculture 84, 315-320.

EL-Sayed, M. 1998. Total replacement of fish meal with animal protein sources in Nile tilapia feeds *Oreochromis niloticus*. Aquaculture Research. Vol 29 p.275-280.

Jauncey, K and Ross, B. 1982. A guide to tilapia feed and feeding. Institute of Aquaculture. University of Sterling. Scotland.

Jose, M. O; Erivelto, O. S and Pushkar, S. B. 2007. Utilization of shrimp industry waste in the formulation of tilapia

(*Oreochromis niloticus* Linnaeus) feed. Bioresource Technology. Vol. 98.I (3) PP: 602-606.

Nahid, R; Perumal, S and Klaus, B. 2003. Evaluation of nutritional quality of moringa (Moringa oleifera Lam.) leaves as an alternative protein source for Nile tilapia (*Oreochromis niloticus*). Aquaculture, Volume 217,issues 1-4,17 March 2003,Pages 599-611.

Ng-Wing, K and Wee, K. L. 1989. The nutritive value of cassava leaf meal in pelleted feed for Nile tilapia (*Oreochromis niloticus*). Aquaculture. 83: 45-58.

Olvera-Novoa, M. A; Compos G. S; Sabido, G. M and Mortinez Palacios, C. A. 1990.The use of alfalfa leaf protein concentrates as a protein source in diets for tilapia (*Oreochromis mossambicus*) Aquaculture, 90, 291-302.

Perla, S. E and Relicardo, M. C. 1998. Evaluation of leguminous seed meals and leaf meals as plant protein sources in diets for juvenile *Penaeus indicus*.The Israeli Journal of Aquaculture – Bamidgeh 50 (2) :1998,47-54.

Pullin, R. S. V. and Almazan, G. 1983. Azolla as a fish food. ICLARM Newsletter 6(1):6-7.

Santiago, C. B; Alidaba, M. B; Reyes, O. S and Laron, M. A. 1988. Response of Nile tilapia (*Oreochromis niloticus*) fry to diets containing Azolla meal. The second International Symoosiu. ICLARM conference proceedings 15,623p.Department of Fisheries, Bangkok, Thailand, and International Centre for Living Aquatic Resources Management, Manila, Philippines.

Soltan, M. A; Bakeer, M. N and Samraa, I. M. 2007. Effect of some feeding regimes on water quality, growth and productivity of nile tilapia, *Oreochromis niloticus* reared in earthen ponds. Egyptian journal of agriculture research. 84. (1A) :1-14.

Tharwat, A. A. 1999. Production evaluation of Nile tilapia *Oreochromis niloticus* utilized fresh and dried *Azolla pinnata* in semi-intensive fish culture.

Wu, V; Rasati, R. R; Sessa, D and Brown, P. 1995. Utilization of corn gluten feed by Nile tilapia. Progressive Fish Culturist 57,305-309.

Egyptian J. Anim. Prod., 36 (1):71-82

Wee, K. L and Shu, S. W. 1989. The nutritive value of boiled full fat soybean in pelleted feed for Nile tilapia. Aquaculture.81:303-314.

دراسة مدى إستجابة إصبعيات البلطى النيلى للتغذية على علائق تحتوى على نبات الأزولا كمصدر من مصادر البروتين

محمد صلاح محمد إبراهيم، محمد محمد زينهم ، رمضان عبد الهادي ابوسيف

المعمل المركزي لبحوث الثروة السمكية – مركز البحوث الزراعية - مصر

خلال هذه الدراسة تم إضافة نبات الأزولا من جنس *Azolla nilotica* المجفف شمسيا إلى أربع علائق تجريبية (مجهزة فى صورة مصبعات مفتتة) بمعدل ٦و١٠ , ٢و٢٢ , ٨و٣١ , ٤و٤٢% من وزن العليقة لتحل محل ٥و١٢, ٢٥, ٥و٣٧ ,٥٠% من بروتين فول الصويا والذى يغطى حوالى ٦٠% من إجمالي بروتين العليقة الكنترول.

اشتملت الأربع علائق التجريبية والعليقة الكنترول على ٣٠% بروتين خام – ٣٠٠ كيلو كالورى طاقة مهضومة /١٠٠ جرام عليقة وكانت نسبة البروتين للطاقة فى العلائق هى ٧٠ ملجرام بروتين / كيلو كالورى. غذيت أصبعيات البلطى النيلى ذو متوسط وزن ١ و٨ جرام/سمكة (± ٣و. جرام) بمعدل ٣% من الوزن الحى يوميا حيث يتم ضبط كمية العلف كل ١٥ يوم طبقا للتغير فى الوزن ولمدة ٩٠يوم وهى فترة التجربة داخل١٥ حوض زجاجي سعة الحوض (٤٠ X ٥٠X ٦٠) ومزود كل منها بمصدر مياة خالى من الكلور ومصدر للأكسجين وثرموستات لضبط درجة الحرارة عند ٢٧م° ±٢م°. أوضحت النتائج المتحصل عليها أن : -

مسحوق الأزولا مكون مناسب فى علائق أصبعيات البلطى النيلى كمصدر من مصادر بروتين العليقة حيث : -

١- لم يظهر التحليل الأحصائى أى إختلافات معنوية فى معدل النمو لأصبعيات البلطى النيلى والتى غذيت على العلائق التجريبية والعليقة الكنترول حيث كانت جميع قياسات النمو متقاربة فيما بينها.

٢- معامل التحويل الغذائى إنخفض تدريجيا بصورة غير معنوية بزيادة مستوى مسحوق نبات الأزولا فى العلائق تحت الدراسة.

٣- معدل الأعاشة لم يتأثر بزيادة مسحوق نبات الأزولا بالعلائق حيث أوضح التحليل الأحصائى عدم وجود أى إختلافات معنوية فيما بين العلائق تحت الدراسة.

٤- أوضح التحليل الإحصائى وجود إختلافات معنوية فى تركيب جسم الأسماك حيث زاد معنويا محتوى جسم الأسماك من الرطوبة والرماد وإنخفض محتوى الدهن بزيادة مسحوق نبات الأزولا بالعلائق. بينما لم يتأثر معنويا محتوى الجسم من البروتين بزيادة نبات الأزولا بالعلائق فيما عدا الأسماك التى غذيت على العليقة الرابعة والخامسة حيث حدث لهما إنخفاض معنوى فى المحتوى البروتينى .

٥- أوضحت العليقة المحتوية على نسبة ٨و٣١% من وزن العليقة مسحوق أزولا أفضل كفاءة إقتصادية مقارنة بالعليقة الكنترول.

يستنتج من هذه الدراسة أن بروتين مسحوق نبات الأزولا يمكن أن يحل محل حوالى ٥٠% من بروتين فول الصويا (حوالى ٣٠% من بروتين العليقة) فى علائق إصبعيات البلطى النيلى دون أى تأثير ضار أو معنوى على معدل النمو والإستفادة الغذائية ومعدل الإعاشة بالأضافة إلى إنة أرخص كثيرا وأكثر إقتصاديا.