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The Effect of Stocking Density and Replacing Soybean Meal With Waste Mulberry Leaf on Productive Performance of Nile Tilapia (*Oreochromis niloticus*) Fingerlings

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ABSTRACT

A 13 week trial was conducted in cement ponds at Central Lab. For Aquaculture Research, Abbassa, Shrkia. Twelve cement ponds (3 m^3 each) were used to investigate the effect of different stocking densities and replacing soybean meal with waste mulberry leaf (WML) on productive performance and economic efficiency of Nile tilapia *O. niloticus* in monoculture system. Duplicated six treatments were applied in this experiment; three levels of soybean substitution (0%, 50 % and 100 %) by WML under two stocking densities (15 fish / m^3 and 10 fish / m^3). The average initial weight of Nile tilapia fingerlings was 19.73 ± 1.36 g /fish. Results showed that there were no significant ($P > 0.05$) differences in growth parameters due to the stocking densities. In case of replacement soybean meal with WML the highest value ($P< 0.05$) for ADG was recorded for the group fed 50% replacement (396 mg/fish) followed by 0% replacement group (380 mg/fish), while the lowest value was obtained for those fed 100% replacement (321 mg/fish). The same trend was recorded with body weight gain and SGR. With regard to feed utililzation the best FCR was recorded for the group fed 50% replacement (2.41) followed by 0% replacement group (2.55), while the worest FCR was recorded for the group fed 100% replacement (2.9). In conclusion we can stocke tilapia fish up to 15 fish / m^3 with one third of pond water changed three times a week and WML can replace up to 50 % of soybean meal in tilapia fish diet, where better growth rate, feed utilization and economic efficiency were achieved.

Keywords: Waste mulberry leaf, silkworm, stocking density, Nile tilapia, cement ponds.

INTRODUCTION

Tilapia culture has been growing at an outstanding rate during the past two decades. As a result, the production of farmed tilapia has witness a 6-folds increase during the past 15 years, jumping form 383,654 mt in 1990 to 2,096,187 mt in 2005 (FAO, 2007). Egypt is the first country in mullet production (132,651 mt) but it is the second country in tilapia production (199,038 mt) in 2004 around the world (FAO, 2006).

Stocking density is a major factor affects fish growth under farmed conditions (Jobling, 1995; Yi *et al*. 1996; Hengsawat *et al*.; 1997 and Maragoudaki *et al*., 1999). Stocking density, and therefore the volume of water for fish, is a significant factor in determining production. Increasing stocking density results in stress, which leads to enhance energy requirements causing reduced growth and food utilization (Leatherland and Cho, 1985).

El-Sayed (2002), stocked *Oreochromis. niloticus* fry (0.16g) in 20 L., fiberglass tanks, in closed re-circulating indoor system, at five stocking densities (3, 5, 10, 15 and 20 fry/L) and fed a larval test diet (40% crude protein) for 40 days. He found that the best performance was achieved at 3 fry / L.

Essa (1996), reported that mean individual growth rate was highest for the lower density and lowest for the higher density. The growth rate of both species (*O. niloticus* and *M. cephalus*) was negatively affected at higher stocking density.

Looking for new feed resources for fish nutrition is the main target in the developing countries (Ghazalah, *et al*., 1998). The intensive use of soybean meal in poultry and fish feeds led to increasing price of soybean meal with its unavailability. In 2003, Egypt imported one million ton of soybean meal in form of seeds or meals from the international market (Osman and Sadek, 2004a). Therefore, the price of fish feeds has been increased in the last few years (Osman and Sadek, 2004b). This situation encouraged the Egyptian researchers to look for local available plant protein sources, which could partially or totally replace soybean meal in the fish feed. One of the possible alternative plant protein sources is waste mulberry leaf (WML) which were collected from sericultrue. However, no much research has been conducted to study the effect of including WML in fish feeds in Egypt.

Yet, Cruz and Luadencia (1978) obtained promising results with Nile tilapia fingerlings fed on rations containing mulberry leaf meal. Vasudevappa *et al*. (1996) indicated that incorporation of suitable plant material (waste mulberry leaf or groundnut leaf) in the diet enhances the growth of giant freshwater prawn.

Hence, the present study was conducted to examine the effect of different stocking densities and replacing soybean meal with WML on growth performance, feed and economical efficiency of Nile tilapia (*O. niloticus*) in monoculture system.

MATERIALS AND METHODS

The present study was carried out at outdoor circular cement ponds

($3m^3$ each) in Central Laboratory for Aquaculture Research, Abassa, Sharkia Governorate, Egypt. Waste mulberry leaf (WML) from growing silkworm was obtained from Department of Sericulture, Plant Protection Institute, Agricultural Research Center. The young silkworm was reared under polythene cover (Ghazy, 2008). The larvae were fed four times daily with fresh mulberry *Morus alba* var Canava. The remaining leaves (WML), were collected, separated from cuticle and faces and dried in sun light.

Before starting the experiment, all ponds were drained completely and then were refilled with fresh water coming from Ismailia canal through a canal to the experimental station or occasionally from deep well. Nile tilapia (*O. niloticus* L.) 19.73 ± 1.36 g were obtained at 16 Augst 2009 from Fish Hatchery, Central lab. Abbassa, Sharkia Governorate. Fish were transported in tanks and were adapted to the new conditions for one hour, then distributed randomly into twelve circular cement ponds. One third of the water volume was changed three times a week throughout the whole experimental period (91 days). Total volume of water of each pond was changed once a week.

Six treatments were applied in this experiment; three levels of soybean substitution (0, 50 % and 100 %) by WML under two stocking densities (15 fish / m^3 and 10 fish / m^3). Each treatment was performed in duplicate.

Diet preparation

The proximate chemical analysis of soybean meal and WML are shown in Table 1.

Soybean meal was replaced by WML where the basal diet was formulated to contain either 0, (control diet), 50% or 100% of WML (diets 2 and diet 3), respectively (Table 2). Diets were formulated to be isonitrogenous (25% crude protein) and isocaloric (4500 Kcal GE/ kg). Feed ingredients were grounded to fine particles and then blended with approximately 10% water. A steam-pelleting machine (California mill Co.) was used to prepare the pelleted diets, which were air dried after being pelletized. Each diet was fed to fish in two selected ponds for 13 weeks. Fish were fed daily at a rate of 3% of their body weight. The daily feed allowances were divided into two equal portions and were fed at 9.00 and 13.00 O'clock. Fish in each pond were collectively weighed at biweekly basis and the given feed were adjusted accordingly.

Proximate analysis of the diets, soybean meal and WML was carried out according to established procedures of AOAC (1990) and given in Tables 1 and 2.

Table (1): ***Chemical composition of soybean meal and WML used in the experiment (DM basis).***

Chemical composition	Ingredients	
	Soybean meal	Waste mulberry leaf
Dry matter (%)	90.33	91.47
Crude protein (%)	44	25
Ether extract (%)	1.1	9.3
Crude fiber (%)	7.3	12.40
Ash (%)	6.3	16.12
Nitrogen free extract (%)	41.3	37.18

Table (2): ***Composition and chemical analysis of the experimental diets***

Composition of the diets	Diet 1 Control	Diet 2 50% waste mulberry leaf	Diet 3 100% waste mulberry leaf
Fish meal (72% CP)	5	5	5
Soybean meal (44% CP)	25	12.5	-
Waste mulberry leaf	-	22	44
Yellow corn meal	42	31	25
Corn glutine	10	11.5	13
Rice bran	13	13	8
Corn oil	4	4	4
Vitamin & Mineral Premix[1]	1	1	1
Total	100	100	100
Chemical analysis of the diets (DM basis).			
Dry Matter (DM%)	90.92	90.10	90.42
Crude Protein (CP%)	25.52	25.57	25.35
Ether Extract (EE%)	4.42	5.78	6.75
Crude Fiber (CF%)	5.84	4.19	7.35
Ash %	4.80	5.51	6.66
NFE[2] %	59.42	58.95	53.89
Gross Energy[3] (Kcal/ kg)	4459	4502	4503

1)Each kg contains: Vit A 4.8 mIU; D_3 0.8 mIU; E 4 g; K 0.8 g; B_1 0.4 g; B_2 1.6 g; B_6 0.6 g; B_{12} 4g ; Pantothenic acid 4g; Nicotinic acid 8 g; Folic acid 400 mg; Biotin 20 mg; Cholin chloride 299 g; Copper 4 g; Iodine 0.4 g; Iron 12 g; Manganese 22 g; Zinc 22g and Selenium 0.04g

2) Nitrogen free extract is calculated by difference =100 - (CP+ EE + CF + Ash)

3) Calculated by the conversion factors: protein 5.65 Kcal/g, lipid 9.2 Kcal/g and carbohydrate 4 Kcal/g (Jobiling, 1983)

Water temperature, dissolved oxygen and pH were measured daily at 6 a.m. and 12 p.m. using thermometer, dissolved oxygen meter YSI model 57 (Yellow Spring Instrument Co., Yellow Springs, Ohio$_1$) and pH meter (Thermo-Orion, Model 420, UK).), respectively. Transparency was measured by a Secchi disc. Determinations of alkalinity and ammonia were carried out every two weeks according to the methods of Boyd (1984). Filterable orthophosphate was measured by ascorbic acid method and measured by spectrophotometer (WPA Linton Cambridge UK) according to APHA (1985). Five samples were collected from different sites of the experimental ponds randomly to represent the water of the whole pond. Chlorophyll a content was determined by filtering 100 ml of water sample through Millipore filter paper (0.45 m) and extracting it in 90% acetone. Chlorophyll a was then measured spectrophotometrically according to Boyd (1984).

Specific growth rate (SGR) was calculated by using the following equation:-

$SGR\% = 100 (Ln W_2 - LnW_1) / T$

Where W_2 is the fish weight at the end (g), W_1 is the weight at the start (g), Ln is the natural log. and T is the period (d) as described by Bagenal and Tesch (1978).

Condition factor (K):

K= weight (g) x 100 /length (cm³) (Hopkins, 1992).

Economic efficiency

Costs were calculated according to the commercial feed prices in local markets during 2009, where I kg of fish meal, soybean meal, rice bran, yellow corn, corn oil, vitamins and minerals premix, corn glutine and WML were 11.00, 2.50, 0.80, 1.40, 7.00, 10.00, 4.00 and 0.20 LE, respectively.

Statistical analysis

Statistical analysis for the experimental results was carried out by using SAS program (SAS Institute, 2006). Differences between averages were determined by using Duncan's multiple range test (Duncan, 1955). The first model was applied for water quality parameters and the second model was applied for growth parameters wheres used Analysis of Covariance (ANCOVA) to correct for the effect of initial weights.

1- $Y_{ijk} = U + D_i + R_j + (DR)_{ij} + e_{ijk}$

2- $Y_{ijk} = U + D_i + R_j + (DR)_{ij} + b (x_{ijk} - x^{-}) + e_{ijk}$

where:

Yijk = is the observation on the Kth fish in the ith Stocking density with the jth level of replacment.

U = an effect common to all fish.

Di = a common effect to all fish stoked of i<u>th</u> Stocking density

i = 1 to 2 (15 fish/m_3 and 10 fish/ m_3).

Rj = an effect common to all fish given diets replacing soybean with waste mulberry leaf with j<u>th</u> level of replacment.

j = 1 to 3 (0, 50 and 100%).

(DR)ij = an effect particular to i<u>th</u> Stocking density and j<u>th</u> level of replacment.

eijk = is a randomized error of all unidentified factors that may affect the

dependent variables and are not included in the model.

b = is the regression coeffient of y_{ijk} on x_{ijk} (initial weight)

x^- = Average of initial weight

RESULTS AND DISCUSSION

Water quality parameters

Data concerning the effects of diet replacement on water quality parameters of Nile tilapia (*O. niloticus*) at different stocking densities during the experimental period (91 days) as averages are demonestrated in Table (3). Pooled data of the effect of stocking density and replacement of soybean meal with waste mulberry leaf on water quality parameters are displayed in Table (4). Data obtained alongside the study period concerning water temperature as represented in Table (3) and Table (4) showed that there were no significant differences (P>0.05) among different treatments. Data of Table 3 showed that there were interaction between replacement and stocking denisity in DO, the highest (P<0.05) DO was for the zero replacement at 10 fish/m^3 (6.6 mg/l) and the lowest was that for 100 replacement at 15 fish/m^3 (2.6 mg/l). Pooled data of Table 4 showed that averages of dissolved oxygen (DO) were 4.47 and 4.32 mg/ l for the stocking density of 15 fish / m^3 and 10 fish / m^3, respectevily. With respect to the effects of replacement of soybean meal with wast mulberry leaf, data of Table (4) clearly showed that DO was significantly higher (P<0.05) for zero replacement (6.3 mg/ l) than 50% (3.6 mg/l) and 100% replacement (3.25 mg/l). AIT (1986), and Hasssan *et al.* (1997) reported that 2.3 mg DO /l is above the normal tolerance level of tilapia. Data of Table 3 showed that there were interaction between replacement and stocking denisity in pH values. Pooled data of Table 4 showed that the pH values were higher (P<0.05) 9.6 for 15 fish / m^3 than 10 fish / m^3 9.45, respectively. With regard to the effects of replacement of soybean meal with wast mulberry leaf no significant differences among treatments were occurred. Boyd (1998) reported that waters with a pH range of

Table 3: ***Effect of diet replacement on water quality parameters of Nile tilapia (*****O. niloticus*****) at different stocking densities.***

Treatments		0% replacement	50% replacement	100% replacement
Temperature °C	Stoc. Den. 10 fish/m^3	$24.75^{a}\pm0.38$	$23.75^{a}\pm 0.38$	$23.85^{a}\pm 0.38$
	Stoc. Den. 15 fish/m^3	$23.85^{a}\pm 0.38$	$24.00^{a}\pm 0.38$	$23.50^{a}\pm 0.38$
DO (mg/L)	Stoc. Den. 10 fish/m^3	$6.6^{a}\pm 0.64$	$3.05^{c}\pm0.64$	$3.9^{bc}\pm0.64$
	Stoc. Den. 15 fish/m^3	$6.0^{ab}\pm0.64$	$4.2^{bc}\pm0.64$	$2.6^{c}\pm0.64$
NH3 (mg/L)	Stoc. Den. 10 fish/m^3	$0.60^{b}\pm0.03$	$0.77^{a}\pm0.03$	$0.77^{a}\pm0.03$
	Stoc. Den. 15 fish/m^3	$0.70^{ab}\pm0.03$	$0.60^{b}\pm0.03$	$0.68^{ab}\pm0.03$
Ph	Stoc. Den. 10 fish/m^3	$9.8^{a}\pm0.07$	$9.65^{ab}\pm0.07$	$9.5^{b}\pm0.07$
	Stoc. Den. 15 fish/m^3	$9.2^{c}\pm0.07$	$9.4^{bc}\pm0.07$	$9.6^{ab}\pm0.07$
OP (mg/L)	Stoc. Den. 10 fish/m^3	$0.62^{a}\pm0.62$	$0.56^{a}\pm0.06$	$0.51^{a}\pm0.06$
	Stoc. Den. 15 fish/m^3	$0.44^{a}\pm0.06$	$0.50^{a}\pm0.06$	$0.53^{a}\pm0.06$
SD	Stoc. Den. 10 fish/m^3	$23^{c}\pm11.6$	$90^{a}\pm11.6$	$62^{abc}\pm11.6$
	Stoc. Den. 15 fish/m^3	$36^{ab}\pm11.6$	$47^{bc}\pm11.6$	$68.5^{ab}\pm11.6$
Total alkalinity (mg/L)	Stoc. Den. 10 fish/m^3	$260^{a}\pm6.45$	$255^{a}\pm6.45$	$245^{a}\pm6.45$
	Stoc. Den. 15 fish/m^3	$260^{a}\pm6.45$	$250^{a}\pm6.45$	$250^{a}\pm6.45$
Chlorophyll "a" (µg/l)	Stoc. Den. 10 fish/m^3	$236^{b}\pm4.7$	$266^{a}\pm4.7$	$224^{b}\pm4.7$
	Stoc. Den. 15 fish/m^3	$236^{b}\pm4.7$	$156^{c}\pm4.7$	$166^{c}\pm4.7$

Values followed by A, B, etc. at the same row are significantly (P<0.05) different.

Table 4: ***Effect of stocking density and replacement of soybean meal with waste mulberry leaf on water quality parameters***

Treatments	Items							
	Temp. °c	DO (mg/L)	NH3 (mg/L)	pH	OP (mg/L)	SD (cm)	T.alkal. (mg/L)	Chlorophyll a (µg/l)
Effect of stocking density								
15 fish / m3	$24.0^{a}\pm0.22$	$4.47^{a}\pm0.37$	$0.63^{b}\pm0.02$	$9.6^{a}\pm0.04$	$0.55^{a}\pm0.03$	$46^{a}\pm6.7$	$253^{a}\pm3.7$	$186^{b}\pm2.7$
10 fish / m3	$23.8^{a}\pm0.22$	$4.32^{a}\pm0.37$	$0.74^{a}\pm0.02$	$9.45^{b}\pm0.04$	$0.50^{a}\pm0.03$	$62^{a}\pm6.7$	$253^{a}\pm3.7$	$242^{a}\pm2.7$
Effect of replacement level								
0 replacement	$24.3^{a}\pm0.27$	$6.3^{a}\pm0.45$	$0.65^{a}\pm0.02$	$9.5^{a}\pm0.05$	$0.53^{a}\pm0.04$	$30^{b}\pm8.2$	$260^{a}\pm4.6$	$236^{a}\pm3.3$
50% replacement	$23.9^{a}\pm0.27$	$3.6^{b}\pm0.45$	$0.68^{a}\pm0.02$	$9.53^{a}\pm0.05$	$0.53^{a}\pm0.04$	$68^{a}\pm8.2$	$253^{a}\pm4.6$	$211^{b}\pm3.3$
100% replacement	$23.7^{a}\pm0.27$	$3.25^{b}\pm0.45$	$0.72^{a}\pm0.02$	$9.55^{a}\pm0.05$	$0.52^{a}\pm0.04$	$65^{a}\pm8.2$	$248^{a}\pm4.6$	$195^{c}\pm3.3$

Values followed by A, B, etc. at the same colummne are significantly (P<0.05) different.

6.5 – 9 are the most suitable for fish production. Data of Table 3 showed that there were interaction between replacement and stocking denisity in NH_3, the highest ($P<0.05$) NH_3 was for the 50 % replacement at 10 fish/m^3 and 100 % replacement at 10 fish/m^3 (0.77 mg/l) and the lowest was that for 50 replacement at 15 fish/m^3 and zero replacement at 10 fish/m^3 (0.60 mg/l). Pooled data of Table 4 showed that averages concentration of unionized ammonia (NH_3) was higher ($P<0.05$) for treatment 10 fish / m^3 0.74 mg/l than for treatment 15 fish / m^3 0.63 mg/l . In the case of the effect of replacment of soybea meal with waste mulberry leaf there were no significant differences among treatments. This low concentration of total ammonia may be attributed to oxidation of ammonia to nitrate, especially in high dissolved oxygen conditions (Boyd, 2000). Data obtained alongside the study period concerning Seechi disk (SD) readings as represented in Table (3) and Table (4) showed that there were no significant differences ($P>0.05$) among different treatments. However, in the case of replacement soybean meal with waste mulberry leaf the SD readings were significantly lower ($P<0.05$) for zero replacement than 50% and 100% replacement. These may be due to its high concentration of chlorophyll "a" (236 µg /l) than in 50% and 100% replacement which were 211 and 195 µg / l, respectively. The highly available nutrients in ponds fed at high feeding rate led to subsequent increases in phytoplanktonic production (Hargreaves 1998). In this regard, Hietala *et al*. (2004) found that nutrient enrichment clearly increased the biomass of phytoplankton, and the chlorophyll "a" concentration. The values of the total alkalinity and orthophosphate (OP) showed that no significant differences between treatments (Tables 3 and 4). The above results showed that all parameters of water quality were in the suitable range (Boyd, 1979).

Fish survival and Growth performance

Data concerning the effects of diet replacement on growth parameters of Nile tilapia (*O. niloticus*) at different stocking densities during the experimental period (91 days) as averages are demonestrated in Table (5). Data of Table 5 showed that there were interaction between replacement and stocking denisity on final weight, the highest ($P<0.05$) final weight was for the zero replacement at 10 fish/m^3 (60.2 g/fish) and the lowest was that for 100 replacement at 15 fish/m^3 (45.7 g/fish). The same trend was obtained with ADG, SGR and % incease of weight. While the lowest value for survival rate was recorded for zero replacement at 15 fish/ m^3. Pooled data of the effect of stocking density and replacement of soybean meal with waste mulberry leaf on growth parameters are displayed in Table (6). It is clearly shown (Table 6) that all the tested growth parameters (ADG, SGR, increase of weight) showed no significant defferences between the two stocking densities. This may be due to the two stocking densities were still low and no competition between individuals was occoured. However, in the case of replacement soybean meal with waste mulberry leaf the highest values ($P< 0.05$) for ADG were recorded for the group fed 50% replacement (396 mg/fish) while lowest values were obtained for those fed 100% replacement (321 mg/fish). Vijayakumar swamy and Devaraj (1994) reported that the ADG of *Catla catla* (Ham.) fry was significantly higher when fed on diets the fish meal was completely replaced with waste mulbery leaf (MF) and least when replaced with lucerne leaf (LF). On the other paper Vijayakumar swamy and Devaraj (1995b) resulted that the average daily growth of common carp, *Cyprinus carpio* fry was higher when fed on dried silkworm pupae SF (25 mg) and almost the same with LF (21 mg) and MF (23 mg). Kamal *et al*. (2010) when compere waste mulberry leaf with rigirs, silkworm litter, mixed of waste mulberry leaf and silkworm litter and commerial diet 25% protein found that (T_2) applied with waste mulberry leaf at rate of 50 g/ m^3 every week surpassed all treatments and recorded higher ($P< 0.05$) final body weight than the treatments (T_4) applied weekly with rigirs at rate of 50 g / m^3 and non significant higher ($P> 0.05$) than,T_1, T_3 and T_5 respectively. Followed by (T_5) fed daily with diet 25% protein at a rate of 7% of fish body weight 5 days a week (control, (T_1) applied weekly with Silkworm litter at rate of 50 g / m^3 and (T_3) applied weekly with mixed of Silkworm litter and waste mulberry leaf at rate of 50 g / m^3. Pooled data of Table (6) showed that average values of SGR found to be 1.1, 1.2 and 0.96 for the group of fish 0%, 50% and 100% replacement, respectivily. The highest value of SGR (1.2) was recorded for fish group fed diet 50% replacement of soybean with waste mulberry leaf, while lowest values were obtained for those fed 100% replacement (0.96). There were no significant differences between zero and 50 % replacement. Kamal *et al*. (2010) recorded that there were no significant differences between treatments in SGR. Survival was lower ($P<0.05$) for 10 fish / m^3 (96 %) than 15 fish / m^3 (99 %), respectively. With respect to the effects of replacement of soybean meal with waste mulberry leaf , data of Table (4) clearly showed that fish survival was significantly lower ($P<0.05$) for zero replacement (94%) than 50% (99%) and 100%

replacement (99%). With regard to condition factor (K), no significant differences (P> 0.05) was found between treatments.

Feed utilization value

Data concerning the effects of diet replacement on feed utilization of Nile tilapia (*O. niloticus*) at different stocking densities during the experimental period (91 days) as averages are demonestrated in Table (5). Data of Table 5 showed that there were interaction between replacement and stocking denisity on feed intake and feed conversion ratio (FCR), the best FCR was recorded for zero replacement at 10 fish / m^3 and the worst was recorded for 100% replacement at 15 fish / m^3. Pooled data of the effect of stocking density and replacement of soybean meal with waste mulberry leaf on feed utilization are displayed in Table (6). It is clearly shown (Table 6) that there is no effect of stocking denisity on feed utilization. However, in the case of replacement soybean meal with waste mulberry leaf the 50 % rplacement and 0 % replacement have the best values where, 2.41 g and 2.55g feed, respectivily, was required to produce 1 g fresh fish weight gain (Table 6). The 100 % replacement of soybean meal with waste mulberry leaf showed the worst (P<0.05) feed utilization value where, 2.9 g feed was required to produce 1 g weight gain. Increasing the waste mulberry leaf content in the diet up to 100 % showed decrease in feed utilization by tilapia fish. The relative or apparent obvious positive effects of waste mulberry leaf incorporated in tilapia feeds on the feed utilization of fish may be attributed to their higher fines particles than other component lead to high durability. MacBain (1966) indicated that a variation in particle size produces a better pellet than a homogeneous particle size. This results were agreement with Vijayakumar Swamy and Devaraj (1995a) reported that waste mulberry leaf (ML) was more digestible and better assimilated by Catla fry than dried silkworm pupae (SF) and lucerne leaf (LF). Vijayakumar Swamy and Devaraj (1995b), posteluted that the feed conversion ratio of common carp, *Cyprinus carpio* fry fed on dried silkworm pupae (SF) was 3.06, lucerne leaf (LF) was 3.14 and waste mulberry leaf (MF) was 2.93. Abou Zead *et al.* (2008) obtained best FCR 2.44 by Nile tilapia for the control group while, the worest FCR 4.05 recorded for 100% replacement of soybean meal with sunflower.

Economic efficiency

It is well known that feeding cost of fish production is about 50-60% of the total production costs (Collins and Delmendo, 1979). Under the present experimental conditions all other costs are constant. Accordingly,

Table 5: *Effect of diet replacement on Growth performance of Nile tilapia (O. niloticus) at different stocking densities.*

Treatments	Stocking Density	0% replacement	50% replacement	100% replacement
Final weight (g/fish)	10 fish/m^3	60.2^a±2.32	58.3^a± 2.65	54.2^{ab}± 2.5
	15 fish/m^3	49.5^b± 2.44	53.0^{ab}± 7.11	45.7^b± 4.13
ADG (mg/fish)	10 fish/m^3	440^a± 27.8	406.4^{ab}±31.7	371.3^{abc}±30.1
	15 fish/m^3	320^{bc}±29.4	385.3^{ab}±85.2	270.1^c±49.5
SGR (%)	10 fish/m^3	1.21^a±0.05	1.16^a±0.05	1.08^{ab}±0.05
	15 fish/m^3	0.99^{bc}±0.05	1.21^a±0.14	0.85^c±0.08
Increase of weight (%)	10 fish/m^3	204.5^a±12.2	189^{ab}±13.8	170^{ab}±13.1
	15 fish/m^3	147.5^{bc}±12.9	202.5^a±37.2	119^c±21.6
Survival rate (%)	10 fish/m^3	100^a±1.2	100^a±1.4	100^a±1.3
	15 fish/m^3	88.9^b±1.3	97.8^a±3.7	98.9^a±2.2
Feed intake (g/fish)	10 fish/m^3	91.9^a±1.6	92.3^a±1.8	88.6^{ab}±1.7
	15 fish/m^3	83^{bc}±11.7	84.4^{bc}±4.9	81.3^c±2.8
FCR	10 fish/m^3	2.28^b±0.15	2.44^b±0.17	2.62^b±0.16
	15 fish/m^3	2.83^{ab}±6.45	2.38^b±0.45	3.3^a±0.26
K	10 fish/m^3	1.79^a±0.05	1.72^a±0.05	1.75^a±0.05
	15 fish/m^3	1.78^a±4.7	1.84^a±0.15	1.74^a±0.08

Values followed by A, B, etc. at the same row are significantly (P<0.05) different.

Table 6: *Effect of stocking density and replacement of soybean meal with waste mulberry leaf on growth parameters of Nile tilapia*

	Items							
Treatments	final weight (g/fish)	ADG (mg/fish)	SGR (%)	Increase of weight (%)	Survival rate (%)	Feed intake (g/fish)	FCR	K
Effect of stocking density								
15 fish / m3	53^a±1.69	365^a±20.19	1.1^a±0.03	175^a±8.83	99^a±0.88	85.8^a±1.16	2.64^a± 0.11	1.8^a±0.03
10 fish / m3	54^a±1.69	366^a±20.19	1.1^a±0.03	168.^{a}±8.83	96^b±0.88	87.9^a±1.16	2.63^a±0.11	1.7^a±0.03
Effect of replacement level								
0 replacement	55^a±1.72	380^{ab}±20.56	1.1^a±0.03	176^a±8.78	94^b±0.89	87^a±1.18	2.55^b±0.11	1.8^a±0.04
50% replacement	56a ± 3.17	396^a±38.02	1.2^a±0.06	196^a±16.62	99^a±1.65	88^a±2.18	2.41^b±0.2	1.8^a±0.06
100% replacement	50^a±2.74	321^b±32.84	0.96^b±0.05	145^b±14.35	99^a±1.43	85^a±1.88	2.9^a±0.17	1.7^a±0.06

Values followed by A, B, etc. at the same colummn are significantly (P<0.05) different.

Table (7): Economic efficiency for production of one kg gain of Nile tilapia *O. niloticus* fed different treatments for 13 weeks.

Treatments	Cost / ton feed (L.E).*	Reduction in feed cost %	FCR	Feed cost / kg fish gain (L.E.)	% change in feed cost to produce Kg fish gain
0 % replacements	2557	0.00	2.55	6.52	100.00
50 % replacement	2195	14.2	2.41	5.29	81.13
100 % replacement	1862	27.2	2.90	5.40	86.40

****Based on the local market price of the following feed stuffs (year 2009) Price (L.E./ ton):***

Fish meal	*11000*	*Corn gluten*	*4000*
Yellow corn	*1400*	*Waste mulberry leaf*	*200*
Corn oil	*7000*	*Soybean meal*	*2500*
Vit. Min. Mix	*10000*	*Rice bran*	*800*

the feeding costs to produce one kilogram of fish body weight gain could be used as a comparison parameter btween treatments.

The cost of producing one ton of mixed feed and the cost of producing one kg fish gain in LE from each diet are presented in Table (7). The calculated figures in this experiment showed that the inclusion of waste mulberry leaf in fish diets reduced the cost of producing one ton mixed feed. This reduction is dependent on the replacement level of waste mulberry leaf. The results obtained from the present study showed that the cheapest diets for producing one kg fish gain was 50 % level of replacement), which was 5.29 LE, followed by 100 % level of replacement which was 5.40 LE while, The highest feed cost to produce one kg fish gain was the control diet (0 % replacement) was 6.52 LE.

CONCLUSION

It could be concluded from the present study that Nile tilapia (19.75 g) could be stocked fish up to 15 fish / m^3 with change one third of the pond water three times a week. Waste mulberry leaf can replace up to 50 % of soybean meal in tilapia fish diet where better growth rate, feed utilization and economic efficiency were achieved.

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تأثير كثافة التخزين و أستبدال كسب فول الصويا بمخلفات ورق التوت على الأداء الانتاجى لإصباعيات البلطى النيلى

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أجريت هذه الدراسة لمدة 13 أسبوع فى أحواض أسمنتية بالمعمل المركزي لبحوث الأسماك بالعباسة مدينة أبو حماد- محافظة الشرقية – مصر. أثنى عشرة حوض أسمنتى حجم كل منها 3م3 وكان الهدف منها دراسة تأثير كثافات تخزينية مختلفة و أستبدال كسب فول الصويا بورق التوت المتخلف من تربية دودة القز عليه على الأداء الإنتاجى و الكفاءة الاقتصادية لإصباعيات البلطى النيلى فى نظام الاستزراع للسمكى النوع الواحد.

6 معملات بمكررين أجريت فى الأحواض الأسمنتية، 3 مستويات من الأستبدال صفر% و 50% و 100% أستبدال من كسب فول الصويا بمخلفات ورق التوت تحت كثافتين للتخزين 15 سمكة/م3 و 10سمكت /م3.

وكان متوسط وزن الأصباعيات من أسماك البلطى النيلى فى البداية 19.73 جم.

و كانت النتائج المتحصل عليها على النحو التالى:-

لا يوجد أختلافات معنوية فى كل القياسات بين كثافتى التخزين. فى حالة أستبدال كسب فول الصويا بمخلفات ورق التوت أعلى قيم لمتوسط النمو اليومى سجلت لمجموعة الاسماك التى غذيت على 50% أستبدل (396مجم/سمكة) تلاها مجموعة صفر أستبدال (380 مجم /سمكة)، بينما أقل قيمة كانت لتلك التى غذيت على 100% أستبدل (321 مجم/سمكة). نفس الأتجاه سجل للزيادة فى الوزن و معدل النمو النوعى.

أحسن معدل تحويل سجل لمجموعة الاسماك التى غذيت على 50% أستبدل (2.41) تلاها مجموعة صفر أستبدل (2.55)، بينما أقل قيمة كانت لتلك التى غذيت على 100% أستبدل (2.9).

الخلاصة: يمكن استزراع أصباعيات البلطى النيلى بكثافة تخزينية حتى 15 سمكة/م3 مع تغيير ثلث مياه الحوض ثلاث مرات أسبوعيا. كما يمكن أستبدال 50% من كسب فول الصويا بمخلفات ورق التوت فى علائق البلطى النيلى حيث حققت أفضل معدل نمو و أفضل أستفادة من الغذاء و أفضل كفاءة أقتصادية.