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EVALUATION OF MALLOW (*Malva parviflora L.*) PLANTS AS AN ALTERNATIVE PROTEIN SOURCE FOR NILE TILAPIA (*Oreochromis niloticus*) FINGERLINGS

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ABSTRACT

This study was conducted to evaluate the suitability of dried mallow plant, *Malva parviflora L.*, as an alternative protein source for Nile tilapia. Three experimental diets were formulated to contain this plant meal at levels of 10, 20 and 30% of the total dietary protein (diets 2, 3 and 4, respectively) and one diet acting as a control (diet 1) which included only fish meal, and soybean meal as protein sources. The four diets were isonitrogenous (26%) and isocaloric (4400 kcal GE/kg dry matter of feed). The feeding experiment extended for 10 weeks.

The results of this experiment showed that the best growth rate and FCR (1.85) were observed by fish group fed the control diet, while the poorest FCR (2.05) was observed by fish group fed diet 4, where 30% of its soybean protein was replaced by mallow meal protein. Slight decrease in protein efficiency ratio (PER) and protein productive value (PPV) was reported when the soybean protein was replaced by the mallow protein. The control group showed slightly higher protein and fat contents than the tested groups. The differences in PER were not significant ($P>0.05$) among groups fed diets No. 1, 2 and 3. While differences were significant ($P<0.05$) among diets No. 1 and 3 on one side and diet No. 4 on the other side. Diets with higher inclusion levels of mallow (diets 3 and 4) significantly depressed growth performance of the fish (SGR 1.52%/day) in both groups compared to diets 1 and 2 (SGR: 1.74% and 1.68%/day, respectively). There were differences in muscular area among diet 1 and other treated groups showed larger muscular area for the control and those fed on 10% mallow than for those fed on 20 and 30% mallow. There were also differences in organs weight among fish groups, where higher indices were calculated for groups fed diets 1 and 2 than for diets 3 and 4. The 20% inclusion level of mallow realized the lowest feed cost/kg fish gain. These results suggest that mallow can be used to substitute up to 10% of dietary protein in Nile tilapia diets without significant reduction in growth.

Keywords: Nile tilapia, Mallow, performance, Muscular area.

INTRODUCTION

Aquaculture is the fastest growing sector of world human food production and has an annual increase of about 10% (FAO, 1997). To sustain a high rate of growth, a matching increase in fish feed production is imperative (Francis *et al.*, 2001). On the other hand, the high cost and fluctuating quality of fish meal as well as its uncertain availability (Alceste, 2000) have led to the need to evaluate alternative protein sources for fish feeds. Considerable emphasis has been focused on the use of conventional plant protein sources such as soybean (Jackson *et al.*, 1982 and Sadiku and Jauncey, 1995), cotton seed (El-Sayed, 1990) and rapeseed meal (Jackson *et al.*, 1982). However, their scarcity and competition from other sectors for

such conventional crops for livestock and human consumption as well as industrial use make their costs too high and put them far beyond the reach of fish farmers or producers of aquafeeds (Fasakin *et al.*, 1999). Therefore, in order to attain a more economically sustainable, environmental friendly and viable production, research interest has been directed towrds the evaluation and use of unconventional protein sources, particularly from plant products such as seeds, leaves and other agricultural by-products (Olvera-Novoa *et al.*, 1988 ; El-Sayed, 1999 and Siddhuraju and Becker, 2001). The use of leaf protein concentrate as a potential dietary feed ingredient has also been evaluated with regard to tropical and subtropical plant leaves. Olvera-Novoa *et al.* (1990) showed that 35% replacement of fish meal with purified alfalfa protein concentrate had no adverse effect on *Mossambique tilapia*. Successful replacement of 25% processed (Soaked) leucoena leaf meal has also been reported for Nile tilapia (Wang, 1987). However, only limited information is available on the utilization prospects of foliager directly as alternative or additional protein sources as fish feed.

Mallows are most abundant in the tropical region, where they form a lrage proportion of the vegetation. A thousand of mallow had been discovered, all of which not only contain much mucilage, but are totally devoid of unwhalesome properties. Besides the medicinal virtues of some species, some are employed as food, hemp, cotton and ornament. Mallow (*Malva parviflora L.*) is an annual winter weed, can be biennial. Flowers are white pinkish tinge at the edges, borne either singly or in clusters. Fruits are green and resemble rounds of cheese. Seeds are reddish-brown. Mature plant is bushy, well branched, 20-30 cm high, with smooth stems. Leaves are bright green and circular in shape, with shallow Lobes. Reproduction is by seed. This plant is found in field orchrds, roadisdes and waste areas. Leaves are edible. The plant is rich in carotenoids, ascorbic acid and iron. The leaves and pods are widely recognized as a food source for humans and a dry season feed for animals(Grieve, 2004). Therefore, the present study was carried out to evaluate the suitability of mallow plant as a protein sources for partial replacement for soybean meal in practical diets for Nile tilapia.

MATERIALS AND METHODS

The present work was carried out at the Wet. Lab. of the Department of Animal and Fish Production, Faculty of Agriculture Kafr El-Sheikh, Tanta University during year 2004.

1. Fish and rearing:

A total number of 80 fingerlings of *Oreochromis niloticus* with an average initial body weight of 10 g were used in this study. The fish were taken from the stock of Almoasasa farms. The fish were divided into 8 similar group in glass aquaria (60 x 35 x 40 cm) containing 70 L of water with 10 fish in each. The groups were distributed into the experimental treatments in duplication. Four air pumps and 8 air stones were used for aerating the aquaria waters. Dissolved oxygen was measured means an oxygen-meter

model 9070. Analyses of NO_2, NO_3 and Hardness were carried out using kits (Hach International Co., Cairo, Egypt). Analyses of PO_4 and alkalinity were estimated by kits (LaMotte International Co., Cairo, Egypt).

Table (1): Proximate composition (% dry matter basis) and essential amino acids composition of mallow and soybean meals.

Items	Mallow meal	Soybean meal
DM	90	89
CP	25	44
EE	4.81	1.1
Ash	18.50	6.3
CF	12.88	7.3
NFE	38.81	41.3
Ca^{++}	0.485	0.260
P^{+++}	2.385	0.64
Mg^{++}	0.75	0.30
Calculated values:		
GE (kcal/kg)[b]	3445.2	4261.14
DE (kcal/kg)[c]	2583.9	3195.85
Amino acid con.(%)	determined (%)	(NRC, 1993)
Arginine	0.48	3.39
Histidine	0.82	1.19
Isoleucine	0.41	2.03
Leucine	1.28	3.49
Lysine	0.68	2.85
Methionine	0.24	0.57
Cystine	0.16	0.70
Phenylalnin	0.48	2.22
Threonine	0.34	1.78
Tryptophane	0.10	2.02
Valine	0.52	2.02

a) NFE = 100 - (CP + EE + CF + Ash).
b) GE = Gross energy was calculated by multiplication the factors 4.1, 5.6 and 9.44 kcal GE DM for carbohydrate, protein and fat respectively (Jobling, 1983).
c) DE was calculated as 75% of the gross energy (Jobling, 1983).

Light was controlled by a timer to provide 14-h light: 10 h dark as a daily photoperiod. The fingerlings were acclimatized for one week to the aquarium conditions and feeding regime. Four isonitrogenous (26% crude protein) and isocalorlic (4300 kcal GE/kg DM). Feed mixtures, from ingredients ingredients and imported herring meal were formulated and offered for 10 weeks. The ingredients used and chemical analysis the mixed diets are presented in Table 2.

Fish were offered the diets at a rate of 3% of their body weight. Fish were weighed weekly and the amount of feed quantity for each equarium was adjusted accordingly. The daily ration was introduced at 2 equal meals at 8 am and 2 pm. Dechlorinated tap water was used to change one third of the water in each aquarium every day.

2. Diet formulation:

The mallow (*Malva parviflora*) plant was freshly harvested from Kafr El-Sheikh Governorate, then dried, finely ground in a laboratory mill and stored at 18°C. Prior to feed formulation, the proximate composition and amino acids analysis of *Mallow parviflora* plant (Table 1) were carried out. Dried mallow plants were added in the diets to replace 0, 10, 20 and 30% of soybean meal protein and were designated as diets No. 1, 2, 3 and 4, respectively (Table 2).

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

Ingredients (%)	Diets No.(% mallow replacement of soybean meal protein)			
	T1 (control) (0%)	T2 (10%)	T3 (20%)	T4 (30%)
Fish meal (72%)	10	10	10	10
Soybean meal (44%)	34	30.6	27.2	23.8
Yellow	39	36.44	33.84	31.30
Wheat bran	10.7	10.7	10.7	10.7
Sun flower oil	6	6	6	6
Vit. & min. (1)	0.3	0.3	0.3	0.3
Mallow meal	-	5.96	11.96	17.9
Determined values (%) dry matter basis				
Dry matter	89.57	89.50	89.76	89.11
CP	26.36	26.22	26.10	25.20
EE	7.09	7.20	7.53	7.69
CF	5.34	6.50	6.83	6.96
Ash	5.52	7.15	7.76	8.08
NFE	55.69	52.93	51.78	52.07
Calculated values:				
GE kcal /kg (2)	4446.18	4335.56	4312.98	4289.22
DE kcal/kg (3)	3334.64	3251.67	3234.73	3216
ME kcal/100 g (4)	373.3	363.98	362.24	360.56
P/E ratio (5)	59.28	60.47	60.51	58.75

(1) vitamin and mineral mixture (product of HEPOMIX). Each 2.5 kg contains: 12.000.000 IU Vit. A ; 2.000.000 IU Vit. D_3 ; 10 gm Vit. E ; 2 gm Vit. K_3 ; 1 g Vit. B_1 ; 5 g Vit. B_2 ; 1.5 g Vit. B_6 ; 10 mg Vit. B_{12} ; 30 g Nicotinic acid ; 10 g Pntothenic acid ; 1 g Flic acid ; 50 mg Biotion ; 250 g Coline coride 50% ; 30 g Iron ; 10 g Cpper ; 50 gzinc ; 60 g Mnganese ; 1 g Idine ; 0.1 g Slenium and 0.1 g Cbalt.

(2) 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).

(3) DE was calculated as 75% of the gross energy (Jobling, 1983).

(4) 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).

(5) P/E ratio (protein to energy ratio) = mg crude protein /kcal GE.

3. Biochemical analysis:

Fish samples (4-5 fish from each group) were obtained at the end of the experiment for chemical analysis and measuring muscular areas and

abdominal cavity. Infiltration/muscular areas were estimated using Echo Scan (Hs/s) ultrasonic, diagnostic insterment, Budapest, Romany Co., according to Salem (2003). Chemical analysis for dry matter (DM), crude protein (CP), ether extract (EE) and ash in the diets used and in fish body (besides crude fiber, CF in the diet) was carried out according to A.O.A.C. (1980).

4. Growth and efficiency parameters of feed and protein :

Average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR), survival rate (SR), feed conversion ratio (FCR) and protein efficiency ratio (PER) protein productive value (PPV) were calculated according to the following equation:

1- AWG (g/fish) = [average final weight (g) - average initial weight (g)]
2- ADG (g/fish/day) = [AWG (g) / experimental period (d)]
3- SGR (%/day) = Ln final weight (g) - Ln initial weight (g) x 100 / experimental period (d)
4- Survival rate (SR) = Total number of fish at the end of the experimental x 100 / total number of fish at the start of the experiment
5- FCR = Feed intake, dry weight (g) / live weight gain (g)
6- PER = Live weight gain (g) / protein intake (g)
7- PPV = 100 [fonal fish body protein (g) - initial fish body protein (g) / crude protein intake (g).

5. Organs indices:

All fish were killed and soon the abdominal cavity was opened to remove liver, kidney gonads and spleen and then were individually weighed at once. Liver (HSI), kidney (KSI), gonads (GSI), and spleen (SSI) indices were calculated as follow:

HSI (Hepato Somatic Index) = Liver weight x 100 / Gutted fish weight (Jangaard *et al.*, 1967).
GSI (Gondo Somatic Index) = Gonads weight x 100 /Fish weight (Tseng and Chan, 1982).
KSI (Kidney Somatic Index) = kidneys weight x 100 / Fish weight (Abdelhamid *et al.*, 2004-a).
SSI (Spleeno Somatic Index) = Spleen weight x 100 / Fish weight (Abdelhamid *et al.*, 2004-a).

6. Statistical analysis:

The obtained numerical data were statistically analyzed using SPSS (1997) for one-way analysis of variance. When F-test was significant, Least significant difference was calculated (Duncan, 1955).

RESULTS

1. Water quality parameters:

The most important physico-chemical parameters of tap water used in the experiment are shown in Table (3). Data in this table indicate that the values obtained lie in the acceptable ranges required for normal growth of tilapia.

Table (3): Physico-chemical parameters of fish rearing water.

Temperature °C	pH value	DO_2 ppm	Alkalinity mg/L	Hardness mg/L	PO_4 mg/L	NO_2 mg/L	NO_3 mg/L
26-28	7.5-8.5	5-6	150-160	300-360	0.1-0.3	0.14-0.15	1.5-2.5

2. Growth performance:

Data concerning average weight gain (AWG), average daily gain (ADG), specific growth rate (SGR) and survival rate (SR) are presented in Table (4). Result present in Table 4 revealed that the values of AWG, ADG, SGR and SR did not differ significantly (P>0.05) among groups No. 1, 2 and 3 but were significantly better than those obtained in the 4th group fed on 30% mallow.

Table (4): Effect of different dietary levels of mallow meal protein on growth and survival rate of the fish (X±SE).

Treatment (mallow %)	AWG (g/fish)	ADG (g/fish/day)	SGR (%/day)	SR (%)
1-control (0%)	24.40^{a} ±0.001	0.35^{a} ±0.001	1.74^{a} ±0.01	100^{a} ±0.001
2 (10%)	23.25^{a} ±0.05	0.33^{a} ±0.001	1.69^{a} ±0.02	100^{a} ±0.001
3 (20%)	23.15^{a} ±0.04	0.33^{a} ±0.001	1.70^{ab} ±0.02	100^{a} ±0.001
4 (30%)	19.65^{b}±0.04	0.29^{b} ±0.001	1.52^{c} ±0.02	95^{b} ±0.005

a and b means in the same column bearing the same letter do not differ significantly at 0.05 level.

3. Feed and protein utilization:

Feed and protein utilization expressed as feed conversion ratio (FCR) and protein efficiency ratio (PER) and protein productive value (PPV) are given in Table (5).

The data indicated that FCR, PER and PPV were poorer in fish groups fed on the highest level of mallow (30%) compared with the control and the lower levels of mallow (10 and 20%).

Table (5): Effect of different dietary levels of mallow meal protein on FCR, PER and PPV.

Treatment (% mallow)	FCR	PER	PPV
1-control (0%)	1.85^{b} ±0.02	2.04^{a} ±0.03^{a}	21.34^{a} ±0.05
2 (10%)	1.93^{b} ±0.005	1.98^{ab} ±0.005^{ab}	19.06^{b} ±0.09
3 (20%)	1.89^{b} ±0.002	2.02^{a} ±0.02^{a}	19.69^{b} ±0.04
4 (30%)	2.06^{a} ±0.03	1.94^{a} ±0.01^{a}	17.71^{c} ±0.03

a, b and c means in the same column bearing the same letter do not differ significantly at 0.05 level.

4. Body composition:

Values of dry matter (DM), crude protein (CP), ether extract (EE) and ash of the fish body are summarized in Table (6).

Crude protein percentage was significantly higher on the 0 and 10% mallow diets comparing with those fed on 20 or 30% mallow. Yet, all diets included mallow significantly increased ash content of the whole fish body but did not significantly alter its ether extract percentage.

Table (6): Means ± standard errors of proximate chemical analysis (% on the dry matter basis) of the experimental fish fed on graded levels of mallow meal.

Treatments (% mallow protein)	DM	CP	EE	Ash
1control (0%)	26.00 [a] ±0.01	60.93 [a] ±0.13	16.90 [a] ±0.05	22.17 [b] ±0.08
2 (10%)	25.66 [b] ±0.07	60.04 [a] ±0.14	15.90 [a] ±0.04	24.11 [a] ±0.09
3 (20%)	26.30 [a] ±0.04	59.94 [b] ±0.12	15.85 [a] ±0.04	24.21 [a] ±0.07
4 (30%)	25.60 [b] ±0.02	58.44 [c] ±0.15	15.92 [a] ±0.04	25.63 [a] ±0.06

a, b and c means in the same column bearing the same letter do not differ significantly at 0.05 level.

5. Internal organ's indices:

The main effects of dietary mallow inclusion on fish indices were on female gonads (ovaries) and spleen, where 20 and 30% mallow reduced significantly females GSI but all levels of mallow inclusion reduced SSI proportional to its dietary levels. Yet, there was not clear trend of mallow diets on HSI and KSI. Moreover, it did not alter significantly male GSI (Table 7).

Table (7): Effect of dietary levels of mallow meal protein on organ's indices of the experimental fish (X±SE).

Treatment (% mallow meal protein)	HSI	GSI (female)	GSI (male)	KSI	SSI
1-control (0%)	2.91±0.05[a]	4.12±0.10[a]	0.83±0.07[a]	0.09±0.01[a]	0.28±0.01[a]
2 (10%)	2.57±0.38[ab]	4.16±0.05[a]	0.77±0.02[a]	0.08±0.01[a]	0.15±0.01[b]
3 (20%)	1.53±0.52[b]	3.60±0.61[b]	0.74±0.03[a]	0.07±0.01[ab]	0.10±0.01[c]
4 (30%)	1.72±0.09[ab]	3.52±0.85[b]	0.75±0.01[a]	0.06±0.005[b]	0.06±0.03[d]

a, b, c and d means in the same column had different letters significantly (P<0.05) differ.

6. Muscular areas:

The fish were examined for infiltration/ muscular areas. This test presented the variation among the tested groups as illustrated in figures (1-4), where zm; the number of the actually zoom (zoom 2 to 8 am), st: the number of the actually displayed memory is shown PR: automatically identifies the type of connected probe (e.g., is Mhz liner probe), Ng; indicates the measure of actual near gain in a range of 1-16, FG : indicates the measure of the actual acoustic power, DP: active only with sector probe and indicates the measure of damping of piezo crystals of the pro, PA ; picture averaging, pp; post-processing, DIR ; direction of scanning, FR; fast or slow scanning, HI ; high scanning rate, F; the various measurements can be selected, N; not active and ID ; identifying characters.

This test presented the variation among the tested fish groups, where those fed on the control (Fig. 1) and 10% mallow (Fig. 2) diets showing larger macular (white) areas than in those fed on 20 and 30% mallow (Figs. 3 and 4).

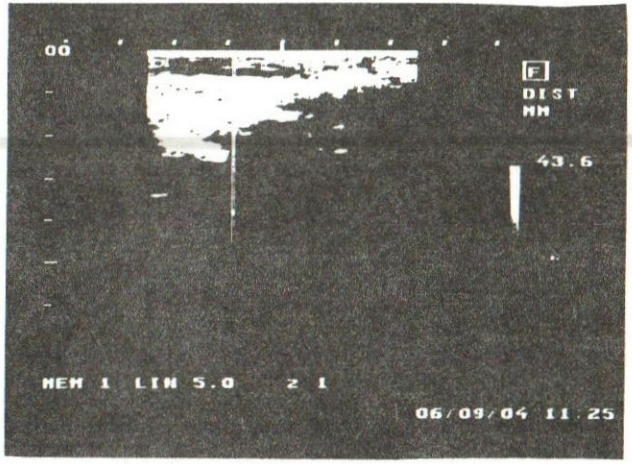

Fig. 1: The control fish

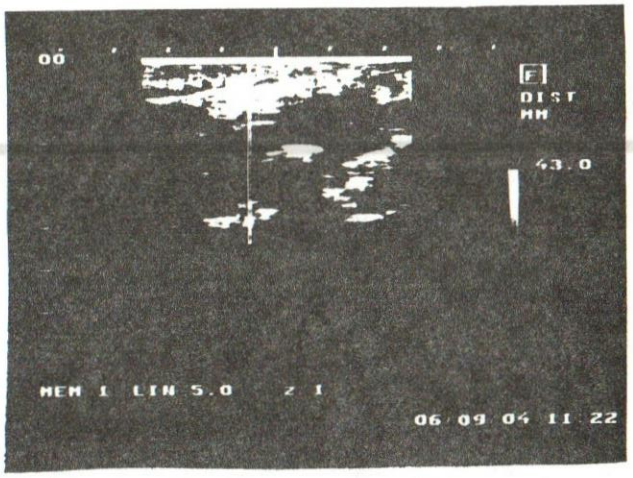

Fig. 3: Fish fed on 20% mallow

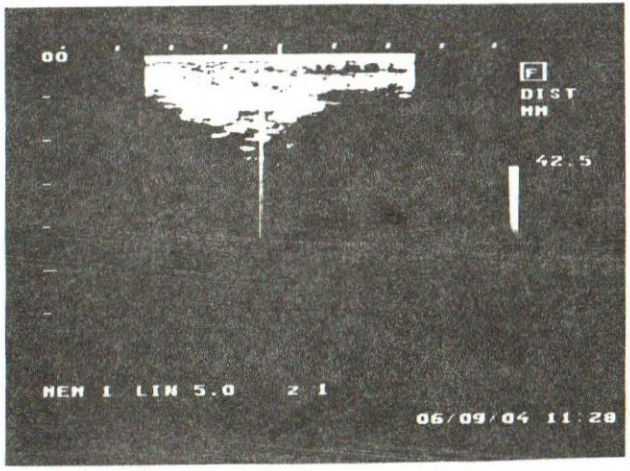

Fig. 2: Fish fed on 10% mallow

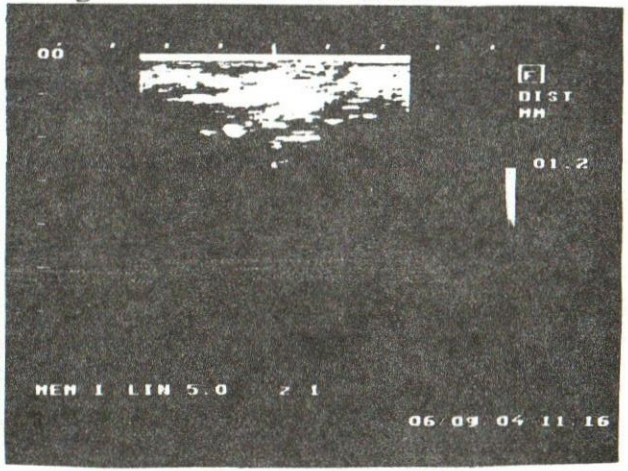

Fig. 4: Fish fed on 30% mallow

7. Economic study:

The economic parameters of the tested diets are presented in Table (8). The calculation depends on the average price of dietary ingredients at year 2003, where local marked price /ton of fish meal 4000 LE, soybean meal 1500 LE, yellow corn 900 LE, oil 3000 LE and Vit. & min. 12000 LE. The calculated figures showed lower cost of one ton of all diets included mallow. However, the control diet recorded the highest price being 1541.2 LE/ton. The highest mallow level containing diet (30%) showed the lowest fish gain comparing with the others mallow levels (10 and 20%) and the control diet. Therefore, diet 4 showed high feed cost/kg gain but the level of 20% mallow gave the best feed cost /kg gain being 2.03 LE .

Table (8): Data of the economical study of feeding fish on graded levels of mallow meal protein.

Treatment	Fed intake (g/fish)	Cost (LE) of one ton	Decrease in feed cost (LE)	Total gain (g/fish)	Feed cost/kg gain (LE)*
control (0%)	369.65	1541.2	-	244.0	2.33
2 (10%)	359.65	1467.1	74.1	232.5	2.26
3 (20%)	338.85	1393	148.2	231.5	2.03
4 (30%)	334.20	1318.9	222.3	196.5	2.24

*** feed cost /kg gain (LE) = feed intake x cost (LE) of ton feed x 1000/total gain**

DISCUSSION

The physical and chemical parameters of water quality revealed its suitability for rearing Nile tilapia fish, since all tested criteria had values within the standard scales of water quality criteria for fish culture according to Abo-Salem *et al.* (1992), Abdelhamid (1996 and 2003a), and Abd El-Hakim *et al.* (2002). Mallow plants have 45.8% edible parts, 86.3% moisture, 34.64% protein, 1.16% ether extract, 16.44% ash, 36.99% soluble carbohydrate and 10.77% crude fiber on dry matter basis (Anon, 1968). Replacing 10% soybean meal protein by mallow meal (5.96% of the diet) did not significantly affect fish growth, survival rate, feed conversion ratio, protein efficiency ratio, most of body composition and indices of internal organs and muscular area. Moreover, the presence of mallow meal in the fish diets lowered the feed cost per kilogram gain. This mean that mallow meal could be economically beneficial if it is added to fish diet at a level of 6% without causing any adverse effect on fish. Aquaculturists are in need to use such nutrition weeds, field wastes, agro-industrial by-products, as well as wild and medicinal herbs as unconventional feed resources and additives. Mainly to solve the environmental pollution problem and to overcome the feeding gap and competition among different animal species on the conventional feed resources.

Aquaculture in Egypt is a must, since the yearly fish import value exceeded the export value by more than 40 folds for the increased demand and shortage of production from the natural fisheries. Moreover, there is incapable feed resources or scarcity that is one of the causative agents for the aquaculture inadequacy (Abdelhamid, 2002 and 2003b). Therefore, many

feed additives and replaces were evaluated as unconventional aquafeeds by tilapia including black seed meal roquette seed meal (Abd Elmonem *et al.*, 2002), dried dropping date (Srour *et al.*, 2002), fig jam by-product (El-Dakar *et al.*, 2003), active yeast (El-Ebiary and Zaki, 2003), licoric roots (Shalaby *et al.*, 2003), sesame meal (Abdelhamid *et al.*, 2004-b), olive pulp (Abdelmonem, 2004), sesame hulls (Abd Elmonem *et al.*, 2004), fennel seed meal (El-Dakar *et al.*, 2004), faba bean middlings (Shalaby *et al.*, 2004) and others with variable success.

CONCLUSION

The results suggest to useness of whole mallow plant meal to replace up to 10% soybean meal protein in fish diets.

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تقييم نبات الخبيزة كمصدر للبروتين فى علائق اصبعيات أسماك البلطى النيلي

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تم إجراء هذا البحث بمعمل الأسماك بكلية زراعة كفرالشيخ لدراسة تأثير الاستبدال الجزئى لكسب فول الصويا بنبات الخبيزة على أساس نسبة البروتين وذلك بمعدلات (صفر ، ١٠ ، ٢٠ ، ٣٠%)، وتم استخدام اصبعيات أسماك بلطى نيلى بمتوسط وزن أولى ١٠ جم ، حيث تم التغذية بمعدلات ٣% يوميا على أساس الوزن الحى للأسماك بالأحواض الزجاجية وذلك مرتين يوميا، وتم عمل مكررتين لكل معاملة . كانت البروتين والطاقة فى العلائق المتكونة فى حدود ٢٦% و ٤٤٠٠ كيلو كالورى طاقة كلية / كجم علف على الترتيب، واستغرقت هذه التجربة ١٠ أسابيع . وأهم النتائج المتحصل عليها أن معدلات النمو والصفات الإنتاجية كانت متقاربة بين العليقة الكنترول والعليقة التى بها نسبة الاستبدال (١٠%) وذلك بالمقارنة ببقية المعدلات (٢٠ ، ٣٠%) ، وتم التحليل الكيماوي لجسم الأسماك ووجد انه لا توجد فروق بين الكنترول والمجموعة ذات الـ ١٠% استبدال لبروتين فول الصويا ببروتين الخبيزة وذلك بالمقارنة ببقية المعاملات. وكان وزن المناسل أكبر فى الكنترول ثم المجموعة ذات التركيز ١٠% ، وتم قياس مساحة العضلات ومساحة التجويف البطنى حيث وجد أن مساحة العضلات بالكنترول كانت مساوية لمساحة العضلات بأسماك المجموعة ذات التركيز (١٠% استبدال) ثم قلت هذه المساحة بزيادة نسبة الاستبدال الى ٢٠ ، ٣٠% بروتين مسحوق خبيزة . وتم عمل تقييم اقتصادى للعلائق للوقوف على أفضل عليقة ومدى العائد الاقتصادى من عملية الاستبدال ، ووجد أن تكلفة الغذاء اللازم للحصول على كيلوجرام من الزيادة فى الوزن الحى فى السمك كانت قليلة فى المعاملات التى بها استبدال بنسب ١٠ ، ٢٠ ، ٣٠% بروتين خبيزة، على الترتيب حيث حققت العليقة ٢٠% بروتين خبيزة أقل تكلفة. ومن ثم يمكن التوصية باستخدام مسحوق نبات الخبيزة فى علائق اصبعيات أسماك البلطى النيلى ليحل محل ١٠% من بروتين العليقة دون تأثير سلبى على مظاهر نمو الأسماك.