

The effect of using some natural growth promoters on growth performance and feed utilization of monosex Nile tilapia (*Oreochromis niloticus*), fingerlings

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ABSTRACT

An experimental study was conducted to evaluate the effect of three different natural growth promoters as feed additives on growth performance of monosex Nile tilapia fingerlings. Three nutritional treatments were applied at two additive levels (0.15 & 0.3 %) of Paprika (Hot Red Pepper "*Capsicum annum*" meal), Proplis (Bee Glue) and Humapol-FIS Substance (Humic & Fulvic acids with Mixture of Minerals) each one in addition to Control diet. The tested treatments were conducted in two cement ponds (8×4×1 m), divided with nets to 16 equal aquatic compartments (2×2×1 m); 14 of them were used and stocked randomly with 20 fish/each one with an average initial body weight of 23.62 ± 0.13 g. The experiment lasted for 20 weeks (Six feeding days/week with the feeding rate at 3% of live body weight/day). The results at the end of the experiment showed that, growth performance and feed conversion ratio were significantly ($P < 0.05$) improved for monosex tilapia fingerlings fed on diets with the aforementioned natural feed additives compared to fish fed on the control diet. Feed cost required to produce 1kg weight gain compared to fish fed on the control diet was reduced by using the feed additives. These results revealed that using Proplis (P) at a dietary additive level of 0.3 % was the best treatment in terms of growth performance and feed utilization, while the highest revenue and the best economic evaluation were obtained from the Paprika (K) diet at a level of 0.3 % compared to the control diet.

Keywords: Growth promoters, feed additives, *O. niloticus*, growth performance, Proplis, Paprika, Humic substances.

INTRODUCTION

Aquaculture has evolved as the fastest growing food producing sector and developed as important component in food security (Ibrahim *et al.*, 2010). Therefore, it is considered as the world worth coming expansion to compensate the shortage in animal protein. Feed in aquaculture plays an important role in the production cycle and exert threshold on both practical and economic aspects. Feed additive sectors are expanding day after day to achieve better growth and health for fish and shrimp and to meet the potential requirements of the culturists (Ibrahim, 2013).

In Egypt, the production of fish coming from aquaculture represents about 74% of total fish production sources (GAFRD, 2012). This activity requires high-quality feeds, which should contain not only necessary nutrients, but also complementary feed additives to keep organism's healthy, favor growth and environment-friendly aquaculture. Feed additives are substances which added in trace amounts provide a mechanism by which such dietary deficiencies can be addressed which benefits not only the nutrition and thus the growth rate of the animal concerned, but also its health and welfare in modern day fish farming (Eid and Khalid, 2008). There is a large number of feed additives available to improve fish growth performance but some of

these additives used in feed mills are chemical products especially hormones and antibiotics which may cause unfavourable side effects (Baruah *et al.* 2008). Antibiotics have been used for many years as growth promoting agents in addition to their anti-pathogenic bacterial function which reduce growth and impaired feed conversion. These growth promoters were linked to emergence of multiple drug resistant bacteria and antibiotic residues in animal products (Wary and Davies, 2000). Thus, the use of antibiotic growth promoters (AGPs) as feed additives in the aquaculture industry has been criticized by government policies and consumers because of possible development of microbial resistance to these products and their potential harmful effects on human health (Baruah *et al.* 2008). To keep a sustainable growth pattern and health management, strategies must go beyond antibiotics and chemotherapeutics, which create resistant bacteria and immunosuppression in the host (Panigrahi and Azad, 2007; Adekunle, 2012). Therefore, using natural feed additives to substitute antibiotics has become an area of great interest (Kumar *et al.*, 2003). World Health Organization encourages using of medicinal herbs and plants to substitute or minimize the use of chemicals through the global trend to go back to the nature. Attempts to use the natural materials such as medicinal plants could be widely accepted as feed additives to enhance efficiency of feed utilization and animal productive performance (Levic *et al.*, 2008).

Some of the natural feed additives for animal feed are humic substances, which classified as a decomposed natural organic matter; they are composed of humus, humic acid, fulvic acids, ulmic acids, humin and minerals (Osman Tolga, 2012). Humic acid is the most common form of organic carbon in the natural environment. Most humic substances are chemically attached to inorganic components (clay minerals and oxides), and a smaller part gets dissolved in the soil (Islam *et al.*, 2005). Humic acid is generally shown many positive effects on the fattening performance, resistance against diseases, immune system and stress in poultry production (Osman Tolga, 2012).

Red pepper (*Capsicum annuum*) Linn (family: Solanaceae) produces capsaicin and capsaicin, used as spice and medicine (Columbus, 1987). Capsaicin, the pungent active principle of red chilli has been shown to cause gastric mucosal oedema and hyperemia and decrease in the gastric acid output (Desai *et al.*, 1977; Nopanitaya, 1973). Capsaicin helps the metabolism of epoxide aromatic hydrocarbons, which interferes with their ability of bind to DNA “causing mutations” (Suzuki and Iwai, 1984). Paprika and chilli contain a large amount of carotenoids, including capsanthin, capsorubin, b-carotene, cryptoxanthin, and zeaxanthin. The carotenoid concentrations encountered in paprika and chilli samples are 2.6 and 3.3 mg/g dry matter, respectively, according to Schweiggert *et al.* (2007). Another important carotenoid is capsaicin, responsible for the pungent characteristic of these products, which is only present in chilli peppers and has been shown to be effective against some bacteria and fungi (Cichewicz and Thorpe, 1996; Singh and Chittenden, 2008; Kraikruan *et al.*, 2008; Tewksbury *et al.*, 2008). However, chilli peppers, as well as paprika peppers, contain other components whose antimicrobial activities have not been well studied, as capsanthin or capsorubin. These two compounds, which are responsible for the red colour, can only be found in *Capsicum* products (Schweiggert *et al.*, 2007).

Propolis (bee glue) is a natural dark-coloured and is used as a sealant and sterilant in their nests. Propolis has been used since ancient times as a medicine because of its biological properties as an antimicrobial, antifungal, antiprotozoan and antiviral agent (Krell, 1996). Propolis is a resinous sticky substance produced by honeybees. The bees collect it from trees, buds, flowers and other botanical sources and mixed with

hypo pharyngeal secretions for protection of hives as sealer, draught excluder and embalming substance to cover arises from hive-invaders and against bacterial and fungal infection (Kosalec *et al.*, 2003; Cuesta *et al.*, 2005). Propolis has many different biological and pharmacological properties such as antibacterial, antifungal, antiviral, antiprotozoae, local-anesthetic, anti-inflammatory and immunostimulant (Miyake and Shibamoto, 1997; Sforcin, 2007). The most potent microbicidal component in propolis is flavanone pinocembrin “5,7-dihydroxyflavanone” (Houghton *et al.*, 1995). Propolis exhibits bacteriostatic activity against different bacterial genera and can be bactericidal at high concentrations (Drago *et al.*, 2000).

The objective of this study, to investigate the effect of three different dietary natural feed additives (Humic substance, Paprika and Propolis) as growth promoters in Nile tilapia, fingerlings diets on growth performance, feed utilization, survival rate, whole body chemical composition and economic evaluation.

MATERIALS AND METHODS

Experimental unit

The present study was conducted on the Fish Research Station at El-Kanater El-khairia, National Institute of Oceanography and Fisheries (NIOF), Qalyubia Governorate, Egypt. Two cement ponds (8×4×1 m) were used; each pond was divided to equal eight aquatic compartments by nets with the total water volume of 4m³ (2×2×1 m) each one; 14 of them were used and stocked with the experimental fish and supplied with fresh water from well with depth 60m underground. The turnover rate of water was 20 % daily/pond; fish were held under a natural light photoperiod at 12h light/ 12h dark schedule.

Experimental fish

Two hundred and eighty of mono sex Nile tilapia, *Oreochromis niloticus* (sex reversed with hormone treatment), were used in the present study. The fish were purchased and transported at early morning using a special fish transport car with aeration facilities from a private tilapia hatchery in El-Fayoum and were used in the experiment after acclimatization to the experimental system under normal conditions for seven days before starting the experiment. Thereafter, the fish were randomly divided into equal experimental groups (40 fish each Level/treatment; 2 replicate/level) representing four nutritional groups. One group served as control diet and three groups were represented the feed additives tested. The experimental fish were weighted every 4 weeks in order to adjust the daily feed rate, which was 3 % of the average fish body weight. The daily ration of feed was divided into two equal amounts and offered at two times/ day (9.00 am and 3.30 pm) for six feeding days per week. The initial weight of experimental fish was stocked with an average body weight of 23.62 ±0.13g, at a stocking density of 5 fish/m³. The experiment lasted for 20 weeks after the start.

Experimental diets

Seven isonitrogenous diets were formulated to contain (25%, Crude Protein) and isocaloric (4400 Kcal gross energy /kg diet) from practical ingredients (Table1) including the control basal diet (without feed additives). The other diets were supplemented by three different sources of natural growth promoters at two dietary additive levels (0.15 and 0.3 %) of each Paprika, K (Hot Red Pepper meal), Propolis, P (Bee Glue) and Humapol-FIS Substance, H (Humic & Fulvic acids with Mixture of Minerals). The experimental diets were prepared by individually weighing of each component and by thoroughly mixing the mineral, vitamins and additives. This

mixture was added to the components together with oil. Water was added until the mixture became suitable for making granules. The wet mixture was passed through a granule machine with the 2mm diameter. The produced pellets were sun-dried for (48 h) and kept frozen at (- 4°c) until the experimental start and used.

Table 1: Composition and proximate analysis of the experimental diets

Feed Ingredients	Experimental Diets						
	Control	H		K		P	
		0.15	0.3	0.15	0.3	0.15	0.3
Fish meal (59.9%)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Soybean meal (44%)	26.00	26.00	26.00	26.00	26.00	26.00	26.00
Yellow corn	37.35	37.20	37.05	37.20	37.05	37.20	37.05
Wheat bran	20.00	20.00	20.00	20.00	20.00	20.00	20.00
Sun flower oil	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Fish premix ¹	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Di-Calcium Phosphate	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Lysine	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Methionine	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Humapol-FIS ²		0.15	0.30				
Paprika ³				0.15	0.30		
Proplis ⁴						0.15	0.30
Total	100	100	100	100	100	100	100
Chemical analysis of the experimental diets (on DM basis)							
Dry matter %	88.74	88.97	89.00	88.85	88.92	88.70	88.58
Crude protein %	25.18	25.19	25.23	25.20	25.26	25.25	25.34
Ether extract %	5.03	5.00	5.08	5.11	5.17	5.20	5.29
Crude fiber %	4.82	4.84	4.90	4.88	4.94	4.81	4.85
Ash %	6.64	6.75	6.91	6.69	6.85	6.83	6.90
N.F.E ⁵	58.33	58.22	57.88	58.12	57.78	57.91	57.62
Gross energy (Kcal/ kg) ⁶	4424.01	4418.14	4416.76	4426.70	4424.56	4426.83	4430.42

* H, K and P are symbolized to diets containing Humapol-FIS, Paprika and Proplis, respectively.

1- Each kg of vitamins & mineral mixture premix contained: MnSO₄, 40 mg; MgO, 10 mg; K₂SO₄, 40mg; ZnCO₃, 60 mg; KI, 0.4 mg; CuSO₄, 12 mg;

ferric citrate, 250 mg; Na₂SeO₃, 0.24 mg; Co, 0.2 mg; retinol, 40,000 IU; cholecalciferol, 4,000 IU; α - tocopherolacetate, 400 mg; menadione, 12 mg; thiamine, 30 mg; riboflavin, 40 mg; pyridoxine, 30 mg; cyanocobalamin, 80 mcg; nicotinic acid, 300 mg; folic acid, 10 mg; biotin, 3 mg; pantothenic acid, 100 mg; inositol, 500 mg; ascorbic acid, 500 mg.

2- Each kg of HUMAPOI-FIS® contained: Humic acid 700g, Fulvic acid 180g, Mineral mixture 120g; Manufactured by VITAMIN

POLLEN FEED ADDITIVES. SAN. TIC. LTD. STI. Established since 1993, Agir San. Bölge Kepsut Cd., Balıkesir – Turkey

3- Each of 100g/kg Paprika meal contained: Dry matter, 87.43; Crude protein, 17.54%; Ether extract, 4.04%; Crude fiber, 7.99%; Ash, 9.95%; N.F.E⁵, 60.48 %.

4 Each 100g of Egyptian Propolis contains: phenolic acid esters (72.7%); phenolic acids (1.1%); aliphatic acids (2.4%); dihydrochalcones (6.5%); Chalcones (1.7%); flavanones (1.9%); flavones (4.6%) and tetrahydrofuran derivatives (0.7%), Abd El Hady and Higazi (2002).

5- Nitrogen free extract (NFE) = 100 – (CP + EE + Ash).

6- Gross energy Calculated Based on 5.65 Kcal/g protein, 9.45 Kcal/g fat and 4 carbohydrate Kcal/g according to Jobling (1983)

Sampling and Experimental Methodology

At the beginning of the experimental trial, four pooled groups of Nile tilapia fish were collected to serve as an initial carcass composition. At the end of the experiment, 4 fish from each aquatic compartment were sampled at random from each level/treatment. The tested diets and fish samples were analyzed for crude protein (CP %), ether extract (EE %), crude fiber (CF %), ash (%) and moisture, while the whole

body composition of fish samples were taken randomly and analyzed at the trial start and end, except crude fiber (CF %) according to the procedures described by Standard Methods (1995). The nitrogen free-extract (NFE %) was calculated by differences. Also, all calculations were based on dry matter weight.

Measurements of water quality parameters:

Analytical methods of water quality were determined according to the American Public Health Association (APHA, 1998). Water temperature, dissolved oxygen, ammonia and pH were monitored during the experimental period to maintain water quality at the optimum range for Nile tilapia. Water temperature was recorded daily in each pond using a mercury thermometer (°C) suspended at 30 cm water depth, dissolved oxygen was measured by a digital oxygen meter (Yellow Spring Instrument Co., model 58, OH, USA); total ammonia was measured using DREL/2 HACH kits (HACH Co., Loveland, CO, USA) and pH values were determined by a digital pH-meter (Digital Mini-pH Meter, model 55, Fisher Scientific, Waltham, MA, USA).

Growth performance records maintained

Live body weight and body length

Live body weight (LBW), g and body length (BL), cm of individual fish of each experimental aquatic compartment were recorded every 4 weeks during the experimental period.

The average weight-gain (AWG), specific growth rate (SGR), feed conversion ratio (FCR), feed efficiency ratio (FER) and Survival rate (SR) were calculated according to the following equations:

TWG (g/fish) = final weight – initial weight.

ADG (g/fish/d) = total weight gain (g) /period (day)

RGR (%) = Total weight gain (g) / Initial weight (g) X 100

$K = W / (L)^3 \times 100$

Where: W = fish weight “grams”

L = fish length “cm”

$SGR = \ln W_2 - \ln W_1 / T \times 100$

Where: Ln = the natural log

W₂ = final weight at certain period (g)

W₁ = Initial weight in the same period (g)

T = period of experiment (day).

SR (%) = No. of surviving fish/total No. of fish at the beginning X100

Economic efficiency

EE = Total income (L.E.) / Total costs (L.E.) X 100

Statistical analysis

Statistical analysis was performed using analysis of variance (ANOVA). It was performed with SPSS statistical software (version 17.0, SPSS). The data were subjected for test of homogeneity of variances and Duncan post-hoc test. Duncan's multiple range test (Duncan, 1955) was used to resolve differences among treatment means at 5% significance level (Data were considered significantly different when $P < 0.05$).

RESULTS AND DISCUSSION

Quality parameters of rearing water

All tested water quality criteria were suitable for rearing Nile tilapia fingerlings as cited by El-Hammady (2001), Abdel-Hakim *et al.* (2002) and Abdelhamid (2009). The water temperature ranged between (27 and 28°C), pH values (7.5 and 9), and

dissolved oxygen ranged between (7 and 8.5 mg/l). Also, Abdelhamid *et al.* (2002) suggested that these values are suitable for rearing Nile tilapia. In the same trend, Abdelhamid *et al.* (2004) found that all the tested water quality (temperature, pH value, conductivity mg/l and dissolved oxygen mg/l) criteria were suitable for rearing Nile tilapia fish.

Growth performance and Feed Utilization

In general, the fish growth experiment performed very well with growth and feed efficiency similar or higher than the control diet. The growth performance parameters of Nile tilapia (*Oreochromis niloticus*) fingerlings which fed diets supplemented with other feed additives of Paprika, Proplis and Humapol-FIS are shown in Table (2). Average of initial body weight of Nile tilapia fingerlings fed on the experimental diets at the start was not different, indicating that the groups were homogenous.

Table 2: Growth Performance and feed utilization of Nile tilapia fingerlings fed on the experimental diets

Parameters	Experimental Diets							±SE*
	Control	H 0.15	H 0.3	K 0.15	K 0.3	P 0.15	P 0.3	
Initial avg. wt. (g)	23.67	23.52	23.58	23.60	23.55	23.69	23.74	0.13
Final avg. wt. (g)	172.85 ^c	175.24 ^c	178.92 ^c	187.73 ^b	191.51 ^b	194.30 ^{ab}	200.16 ^a	1.36
Weight gain (g)	176.42	170.61	167.96	164.13	155.34	151.72	149.18	1.27
SGR (%/day)	1.42 ^c	1.43 ^c	1.45 ^{bc}	1.48 ^{ab}	1.50 ^{ab}	1.50 ^{ab}	1.52 ^a	0.01
RGR (%)	630.25 ^c	645.07 ^c	658.78 ^c	695.47 ^b	713.21 ^{ab}	720.18 ^{ab}	743.13 ^a	3.61
FCR	1.48 ^c	1.48 ^c	1.46 ^b	1.42 ^{ab}	1.40 ^a	1.39 ^a	1.38 ^a	0.01
PER	2.68 ^c	2.69 ^{bc}	2.71 ^c	2.79 ^b	2.82 ^{ab}	2.84 ^{ab}	2.87 ^a	0.02
Feed intake (g)	242.83	237.87	235.57	233.13	227.33	224.29	221.36	1.66
Survival rate (%)	100	95	97.5	100	100	100	100	0.94

* Values are presented as means ± standard error (SE). Means in the same row with different superscripts are significantly different ($P \leq 0.05$).

* H, K and P are symbolized to diets containing Humapol-FIS, Paprika and Proplis, respectively, followed by experimental additive levels of each one.

* Pooled standard error of a mean.

At the end of the experimental period (140 days), the group of fish fed on the supplemented diets grew as well or better than the group of fish fed on the control diet. Whereas, the final body weight of the fish groups fed on diets P0.3, P0.15 and K0.3 had significantly ($P < 0.05$) higher body weight than the rest of the experimental groups. However, the lowest final body weight (172.85 g) was achieved by the group of fish fed on the control diet. Analysis of variance for weight gain followed the same trend as in the final body weights. On the other hand, the fish groups fed on diets P0.3, P0.15 and K0.3 had significantly ($P < 0.05$) higher SGR than the rest of experimental groups. However, at the end of the trial, SGR values were 1.42 (control diet), 1.43, 1.45, 1.48, 1.50, 1.50 and 1.52 %/d for fish groups fed on diets containing 0.15, 0.3 Humapol, Paprika and Proplis, respectively. The average values of the feed conversion ratio (FCR) in fish groups fed on diets P0.3 and P0.15 followed by groups of fish fed on diets K0.3, K0.15, H0.3 and H0.15 were significantly ($P < 0.05$) improved in comparison with the other groups and better than the basal diet. The FCR was found to be 1.48 (control diet), 1.38, 1.39, 1.40, 1.42, 1.46 and 1.48, respectively. These results indicated that the best ($P < 0.05$) FCR values were obtained for a group of fish fed on diet P0.3, P0.15 and K0.3 respectively. The best FCR values observed with Proplis 0.3 supplemented diets suggested that addition of Proplis improved feed utilization. In practical terms, this means that the use of Proplis can decrease the amount of feed necessary for animal growth, which could result in reductions of

production cost. The same trend was observed in PER where the fish groups fed on diets P0.3 and P0.15 showed better ($P < 0.05$) PER values compared with the other groups. The PER was found to be 2.68 (control diet), 2.69, 2.71, 2.79, 2.82, 2.84 and 2.87 for groups of fish fed diets H0.15, H0.3, K0.15, K0.3, P0.15 and P0.3, respectively. The protein efficiency ratio results indicated that supplementing diets with Propolis was significantly ($P < 0.05$) improved protein utilization in the diets of tilapia. Also, in the present study, the natural growth promoters were used had significantly ($P < 0.05$) enhanced feed efficiency. These results are in agreement with the results of Abd-El-Rhman (2009) who fed Nile tilapia fingerlings by Propolis as supplementation in fish diet and reported that, the greater growth performance than those fed on the control diet. Also, reported that the diet contained 30% protein as basal diet supplemented with Propolis-ethanolic-extract (1%) and crude propolis (1%) produced the highest growth rate, average daily gain (ADG), specific growth rate (SGR) and feed efficiency ratio (FER) among *O. niloticus*. On the other hand, the best feed conversion ratio (FCR) was obtained with propolis-ethanolic-extract, but Alberto Cuesta *et al.* (2005) found little effect of propolis on gilthead seabream growth, fed for up to six weeks. Also, they found that the specific growth rate was not significantly affected by the dietary intake of propolis at 0.1 and 10 g propolis kg diet, moreover Propolis is an appropriate growth-stimulating additive in tilapia cultivation. It is also necessary, to consider the possibility of interspecies differences with the use of the Propolis. In addition, the supplementation of Propolis led to 100% Survival rate, which is shown in Table (2). These results about Survival rate are in agreement with Guobin Zhang *et al.* (2009) who were feeding Chinese sucker fish with different dosage (0.1%, 0.5% or 1.0%) of traditional Chinese medicine (TCM) formulated from propolis and Herba Epimedii extracts at the ratio of 3:1 (w/w) extracts for five weeks and recorded that, feed containing 0.5% TCM extracts was the most effective with the mortality of the fish significantly reduced by 35% compared to the control. Also, Abd-El-Rhman (2009) found the fish mortalities kept decreasing compared with the control diet. The same trend results were observed by Turan (2006) who used the medical herb red clover (*Trifolium Pretense*) as a growth-promoting agent for tilapia, *O. aureus*. Zakes *et al.* (2008) also reported that juvenile pike perch (*Sander lucioperca*) fed on diets supplemented by medicinal plants exhibited faster growth than those fed on the control diet. Similar results were reported for using medicinal plants as growth-promoting agents for the common carp, *Cyprinus Carpio* (Yilmaz *et al.* 2006). Also, Sevdan Yilmaz *et al.* (2013) supplemented diets for tilapia, *Oreochromis mossambicus* with astaxanthin, paprika and capsicum to determine their effects on growth performance and pigmentation and these found the growth performance was significantly improved in the paprika groups and recorded the best final weight, weight gain, SGR, and FCR were obtained with the 60 mg paprika diet. In contrary with these findings, Wassef *et al.* (2010) fed Gilthead Seabream fish on the experimental diets contained red bell-pepper (*Capsicum annum*) meal and carrot (*Daucus carota*) meal as a natural dietary carotenoid source as compared to initial fish and detected no significant differences ($P > 0.05$) in final weight or feed conversion ratio among fish fed on different carotenoid-added diets.

Body composition

Data of chemical composition (% DM basis) of the fish body at the start and at the end of the experimental period are presented in Table (3) for those fed on the experimental diets. This Table explored that the average of the whole body composition, including crude protein (CP), ether extracts (EE) and ash, besides the energy content (GE) estimated as a dry matter basis.

The carcass composition concerning their DM and EE contents are increased by age advance, but the ash percentages were decreased.

At the end of the experiment, percentages of the whole body DM, CP and ash were significantly ($P < 0.05$) influenced by all dietary treatments. Otherwise, no Statistical differences were observed in the whole body ether extracts and gross energy. These results are in close agreement with the findings of Salem (2010), Ringo and Gatesoupe (1998) and Scholz *et al.* (1999). Nevertheless, Wassef *et al.* (2010) detected no considerable ($P > 0.05$) differences in major nutrients composition between Gilthead Seabream fish fed on the experimental diets contained red bell-pepper (*Capsicum annum*) meal as a natural dietary carotenoid source as compared to initial fish. Also, Diab *et al.* (2002), Lara-Flores *et al.* (2003) and EL-Haroun *et al.* (2006), Eid and Khalid (2008) found that no differences were observed for moisture, ash and protein content among different dietary diets.

Table 3: Chemical composition of whole body Nile tilapia fingerlings fed on the experimental diets (As Dry Matter basis)

Chemical composition	Initial	Experimental diets							±SE*
		(Control)	H 0.15	H 0.3	K 0.15	K 0.3	P 0.15	P 0.3	
DM (%)	21.38	28.65 ^d	28.94 ^d	29.72 ^{bc}	29.57 ^c	30.23 ^{ab}	29.98 ^b	30.46 ^a	0.20
Crude protein (%)	56.31	51.25 ^c	51.46 ^c	51.53 ^c	51.42 ^c	51.97 ^c	52.76 ^b	53.89 ^a	0.23
Ether extract (%)	18.60	24.64	24.32	24.08	24.19	24.46	24.53	24.65	0.29
Ash (%)	23.87	22.18 ^{ab}	22.76 ^a	22.79 ^b	22.63 ^a	21.59 ^{bc}	21.30 ^c	20.16 ^d	0.26
Gross Energy (Kcal/Kg)	4988.02	5301.31	5264.13	5251.01	5261.59	5326.98	5355.43	5426.21	9.37

* Values are presented as means ± standard error (SE). Means in the same row with different superscripts are significantly different ($P \leq 0.05$).

* H, K and P are symbolized to diets containing Humapol-FIS, Paprika and Proplis, respectively, followed by experimental additive levels of each one.

* Pooled standard error of a mean.

Economic evaluation

Results of inputs and outputs of the experimental treatments are present in Table (4). Calculations of economical efficiency of the tested diets based on the cost of the feed, the cost of one kg gain in weight and its ratio of the control group are shown in this table. Also, prices of experimental diets based on feed ingredients in the local market during the experiment are present in below of the Table.

As described in this Table Revenues (L.E) were the highest for the Paprika 0.30 diet (41.98 L.E) and gradually decreased with the decreasing addition level of it. This trend was found in tested feed additives were used. The lowest relative percentage of feed cost/ kg fish for improving growth and feed utilization parameters of mono sex Nile tilapia fingerlings as noted in Table (2). On the other hand, the incorporation of Paprika in tilapia fingerlings diets seemed to be economical at incorporation level 0.3%. The reduction of feed costs was easily observed for the feed cost/Kg weight gain, which decreased with increasing incorporation levels of Paprika as feed additives for tilapia fingerlings diets in agreement with EL-Haroun *et al.* (2006) who recorded the lowest values of total pond income (LE) and net production per pond for fish fed on the control diet (4.72 kg pond⁻¹) in comparison with fish fed on diet contents Biogens as feed additives at levels of 0.5%, 1.0%, 1.5% and 2.0% respectively.

Table 4: The economical efficiency of the experimental diets to produce one Kg gain of Nile tilapia.

ITEMS	(control)	Experimental Diets					
		H 0.15	H 0.3	K 0.15	K 0.3	P 0.15	P 0.3
Initial weight (Kg)	0.947	0.941	0.943	0.944	0.942	0.948	0.950
Final weight (Kg)	6.914	7.010	7.157	7.509	7.660	7.772	8.006
Total amount of feed intake per treatment (Kg)	8.855	8.971	9.093	9.325	9.423	9.515	9.713
Price of one kg of ration (L.E.)	3.47	3.50	3.52	3.51	3.54	3.70	3.92
Total feed costs (L.E.)	30.73	31.40	32.01	32.73	33.36	35.20	38.08
Cost of the fingerlings per treatment (L.E)	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Total costs (L.E)	42.73	43.40	44.01	44.73	45.36	47.20	50.08
Total fish weight gain per treatment (Kg)	5.967	6.069	6.214	6.565	6.718	6.824	7.057
Sale price Kg fish (L.E)	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Total income per treatment for fish weight gain (L.E)	77.57	78.89	80.78	85.35	87.34	88.72	91.74
Revenues (L.E)	34.85	35.49	36.77	40.62	41.98	41.51	41.66
Economic efficiency (%)	181.56	181.78	183.55	190.80	192.56	187.94	183.20

1. Total amount of feed intake per treatment (Kg) = feed intake \times total fish number per treatment.

2. Total feed costs (L.E) = price of one kg ration \times total amount of feed intake.

3. Total fish weight gain / tank (kg) = final weight – initial weight.

4. Total fish weight gain per treatment (Kg) = Total fish weight gain / tank (kg) \times sale price kg fish (L.E).

5. Revenues (L.E) = Total income per treatment for fish weight gain (L.E) – Total costs (L.E).

6. Economical efficiency (%) = Total income per treatment for fish weight gain (L.E) / Total costs (L.E) \times 100.

* The local market prices in 2010 of kg ingredients used were 11.00 L.E for fish meal (60%), 3.00 L.E for soybean meal (44%), 1.35 L.E for wheat bran, 1.80 L.E for yellow corn, 9.00 L.E for sunflower oil, 12.00 L.E for Vit. & Min., 1.9 L.E for Di-Calcium Phosphate, 38.5 L.E for L-methionine, 29 L.E for L-lysine, 150.00 L.E for Proplis, 17.00 L.E for Humapol-FIS and 22.50 L.E for Paprika meal.

These results also indicated that, the highest economical efficiency was reported by the K0.3 group followed in a decreasing order by K0.15, P0.15, H0.3, P0.3, H0.15 and control group, respectively. These results indicated that, these feed additives can be incorporated in tilapia diets as the best natural growth promoter for better economical efficiency results as well as best growth performance and nutrient utilization. In this connection, Salem (2010) showed a lower cost of one ton of all diets containing probiotic. However, the control diet recorded the highest price, being 2916.2 LE/ton. The diets containing (0.1%, 0.2%, and 0.3% Bio-Nutra200) showed the low cost of fish diet comparing with the control diet. Yet, diets no. 1 and 4 showed high cost/kg gain, being 6.86 and 5.32 LE, but diet no. 2 and 3 gave the lowest feed cost/kg gain, being 4.70 and 4.57 LE. These results supported the results of Eid and Khalid (2008).

CONCLUSION

From the previous results, it could be concluded that the positive influence of additions (Proplis, Paprika meal and humapol-FIS) on growth performance of the monosex fingerlings, Nile tilapia diets showed positive effects and they are promising natural growth promoters as feed additives to fish diets. From feed utilization data and the economical point of view, the diets supplemented with Paprika 0.3% and Proplis 0.15 % were the best treatments in comparison with Control diet.

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