J.Animal and Poultry Prod., Mansoura Univ., Vol.4 (7): 455 - 467, 2013

Utilization of distillers dried grains with solubles in fish nutrition
2-partial replacement of fish meal and yellow corn by graded levels of ddgs in nile tilapia fingerlings diets (*Oreochromis niloticus*).

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ABSTRACT

This study was conducted to evaluate the effect of feeding different levels of DDGS in the diets of tilapia fingerlings on growth performance, feed utilization, chemical composition of the whole fish body, blood hematological and economic efficiency. Therefore, six graded levels of DDGS (0, 4, 8, 12, 16 and 20%) were used insteated of fish meal and yellow corn protein in sex tested diets approximately isonitrogenous and isocaloric. Fish were stocked in a rearing plastic tank for two weeks adaptation period, then it were stocked at the rate of 5 fish/glass aquarium with initial weight of 6.0 ± 0.14 g/fish. During the experimental period (72 days) the fish were fed the tested diets at the rate of 6% of the total biomass for six days per week. The obtained results showed that:

There were significant (P ≥ 0.05) effect of DDGS levels on all traits of growth performance and feed utilization parameters of Nile tilapia fed different levels of DDGS. All growth performance parameters were increased significantly (P ≤ 0.05) with increasing the replacement levels of DDGS until 16% of DDGS, then, decreased significantly with increasing the replacement level of DDGS. The highest values of growth performance parameters were found in replacement levels 16 % of DDGS. The best values of economic efficiency recorded with the level 12% and 16% of DDGS, respectively. It may be concluded that replacing fish meal and yellow corn by DDGS until 16% in the diets of tilapia had no any adverse effect on most of growth parameters, feed utilization, chemical composition of fish body, hematological blood parameters and economic efficiency of tilapia fingerlings.

Keywords : DDGS, Nile tilapia, fish meal, growth performance, hematological blood, economic efficiency.

INTRODUCTION

The DDGS are primary residues from yeast fermentation of cereal grains and are a by-product of the bourbon and ethanol distilling process. These by-products contain approximately 26-28% protein, closely matching the protein requirements of tilapia (25-35%) (Lim, 1989). Compared with many species, tilapia can utilize relatively high levels of plant feedstuffs (Twibell and Brown 1998). Also, Wu, *et al*. (1996) evaluated inclusion of DDGS at 30% of the total diet fed to tilapia and reported good growth parameters. However, research has shown that by combining complimentary animal and plant protein sources, nutrient utilization can be improved (Webster, *et al*., 1992 a&b; Brown, *et al* 1997 and Webster, *et al* .,2000).

With the rapidly growing aquaculture industry, the demand for high quality fish feeds is increasing. At the current and expected aquaculture growth rates, the demand will eventually outgrow the availability of fish meal as highly digestible protein source (Hardy, 2010). As a consequence the inclusion levels of plant derived proteins are increasing for formulated fish and crustacean feeds. However these plant derived ingredients have, in comparison to fish meal, a serious drawback since they always contain one or more anti-nutrients such as like protease inhibitors, lectins, gossypol, phytic acid, tannins or saponins (Francis *et al*., 2001). Since diet costs account for over 50% of production costs for most aquatic species, one way to increase production profitability is to reduce diet costs. Protein is generally the most expensive dietary component; therefore, determination of less-expensive sources of protein which provide good growth is advantageous for diet manufacturers and aquaculture producers. Other factors including inconsistent supply and environmental concerns with using fish meal in aquaculture diets make evaluation of alternative protein sources a high priority for fish nutritionists. Tilapia diets without fish meal have generally reduced growth under intensive culture conditions (Jackson, *et al*., 1982 and El-Sayed, 1990).

Therefore, influence of feeding different levels of DDGS (by reduce the percent of fish meal and yellow corn in tested diets) on growth performance, feed utilization, chemical composition of the whole fish body, blood hematological parameters and economic efficiency of tilapia (*Oreochromis niloticus*) fingerlings was the aim of this study.

MATERIALS AND METHODS

Experimental fish and conditions:

This research was carried out at Fish Laboratory Research, Animal Production Department, Faculty of Agriculture, Mansoura University, Egypt, during the period from December, 2008 to March, 2009. The fish were stocked in a rearing tank for adaptation two weeks preconditioning period, then fed with the tested diets. A total numbers of 90 fingerlings weighted 6 ± 0.14 g/fish that appeared healthy before its stocking at 5 fish/glass aquarium (90 x 40 x 50 cm) as three replicates per treatment were randomly assigned to the sex tested diets (D1 to D6). Each aquarium was supplied with 108 L dechlorinated tap water, electric heater and an air stone connected with electric small compressor to permit suitable level of dissolved oxygen**.** The dissolved oxygen was in normal range (6 – 8 mg/L). The replacement of the aquaria water was done partially every day to re-new the tap water after removing the wastes. Light was controlled by a timer to provide a 14h light: 10h dark as a daily photoperiod.

Experimental diet and feeding:

Six experimental diets were formulated (D1 – D6) to replace DDGS at the rate of 0, 4, 8, 12, 16 and 20% instead of fish meal (FM) and yellow corn protein. The DDGS used contained 26.84% crude protein, 11.08% crude fat, 6.30% crude fiber, 10.20% moisture and 4.24% ash. The ingredients and chemical composition of diets are shown in Table (1).

All diets except the control diet were supplemented with methionine to cover the needed level of this amino acid in all diets. The control diet (without DDGS) was formulated to contain 27.82 % CP. All ingredients and additives were milled and mixed, then pressed through a pelleting machine (pellets size 1mm) . During the experimental period (72 days), the fish were fed daily on the previous diets at a rate of 6 % of the live biomass for six days a week and twice daily at 8 am and 2 pm. The amount of feed was adjusted bi-weekly based on the actual body weight changes.

Table (1): Formulation (%) and chemical analysis of the tested diets on dry matter basis

Ingredients (%)	D1 (control)	D2 (4%)	D3 (8%)	D4 (12%)	D5 (16%)	D6 (20%)
Fish meal	20	18	16	15	13	11
Soybean meal	32	32	33	33	34	34
DDGS	0	4	8	12	16	20
Yellow corn	26	24	21	18	16	13
Wheat bran	10	10	10	10	9	10
Corn oil	6	6	6	6	6	6
Molasses	5	5	5	5	5	5
*Vit. and Min. premix	1	0.7	0.7	0.7	0.7	0.7
Methionine (g/kg diet)	-	0.3	0.3	0.3	0.3	0.3
Chemical analysis (%)						
Dry Matter	90.64	89.79	90.35	87.34	86.74	88.77
Ash	11.40	9.41	8.30	8.54	10.10	8.73
Crude Protein	27.82	27.45	27.82	27.95	28.18	28.17
Crude fat	6.13	5.74	5.01	5.01	5.75	6.32
Total carbohydrates	54.65	57.40	58.87	58.50	55.97	56.78
*Gross energy (GE)(Kcal/100 g DM)	439.91	445.47	446.73	450.07	443.80	452.46
** Protein/ energy (P/E) ratio (mg CP/Kcal GE)	63.24	61.62	62.27	62.10	63.49	62.25

***Vitamin and minerals premix containing A vit. (15 million I.U.), E vit. (15 mg), B1 vit. (1.0 mg), B12 vit. (5.0 mg), K3 vit. (2.5 mg), B6 vit. (2.0 mg), Pantothenic acid (10.0 mg), Folic acid (1.2 mg), Biotin (0.05 mg) and D3 vit. (3.0 million I.U.). Copper (7.0 mg), manganese (100.0 mg), iodine (0.4 mg), Iron (40.0mg), Zinc (50.0 mg), Selenium (0.15 mg) and anti-oxidant (125.0 mg). * GE (Kcal/100 g DM) = CP x 5.64 + EE x 9.44 + Carbohydrates x 4.12 calculated according to (NRC, 1993).**

**** P/E ratio (mg protein/Kcal gross energy) = CP x 1000/GE**

Water temperature (°C) was recorded every two days by using a thermometer, and water pH-value was measured weekly using an electric digital pH meter model (Jenway Ltd, model 350-pH meter). Aeration provided continuously using an air stone connected with electric small compressor and water temperature was thermostatically controlled on 27± 1°C throughout the experimental period. Dissolved oxygen was measured every day in each aquarium using an YSI model 58 oxygen meter. During the 72 days of experiment, means of water quality parameters were temperature 26-27; pH 7.4±0.6; and dissolved oxygen (6-8 mg/L). At the end of the experimental period, fish sample were taken and dried at 70 °C for 24 hours and passed through mincer into one composite homogenate per group. Contents of the homogenized fish for each experimental diet were analyzed chemically using the methods described by Association of Official Analytical Chemists (A.O.A.C. 2000). Also, at the end of the all rearing periods, three fish per replicate within treatment were randomly chosen then individually weighed. Livers and intestine were removed, then it weighed to determine hepatosomatic index (HSI) and intestine somatic index (ISI) as follow:

HSI = (Liver weight/ fish weight) ×100 (Jangaard, *et al*., 1967)

ISI = (intestine weight/fish weight) ×100

At the end of the experiment, blood samples were collected from all residual fish from caudal peduncle of the different groups. Adequate amounts of whole blood in small plastic vials containing heparin were used for the determination of hemoglobin (Hb) by using commercial kits (Diamond Diagnostic, Egypt) and the hematocrit (PCV%) was measured according to Stoskopf (1993). Total erythrocytes (RBCs) and total leukocytes (WBCs) were counted according to Dacie and Lewis (1995) on an Ao Bright – Line Haemocytometer model (Neubauer improved, Precicolor HBG, Germany).

The obtained data were statistically analyzed using general linear models procedure according to SAS (2006) for users guide, with a one - way ANOVA. Means of treatments were statistically compared for the significance ($p \leq 0.05$) using Duncan (1955) multiple range test.

RESULTS

Growth performance parameters:

Data in Table (2) showed that all growth performance parameters were increased significantly ($P \leq 0.05$) with increasing the levels of DDGS until 16%, then, it was decreased significantly with increasing the level of DDGS up to 20%. However, no significant differences were recorded between the control diet and the replacement level 20%. The highest values of growth performance parameters were found in diet 5 at the replacement levels 16% of DDGS. There were no significant differences were recorded in survival rate of tilapia fed the six experimental diets (D1-D6). Generally, survival rate was high and ranged from 90 to 100% in the most treatments in the present study.

Feed utilization parameters:

As shown in Table (3) there were no significant differences in feed intake (FI) among different DDGS levels were observed. On the other hand, the FCR improved significantly with increasing level of DDGS up to 16%. While the other feed utilization parameters (FE, PER, PPV and EU) were decreased significantly ($P \leq 0.05$) with increasing replacement of DDGS until 8% level then increased with increasing levels of DDGS until 16%. The level 16% DDGS gave the best values of feed conversion ratio (FCR) and the highest values of feed utilization parameters (FE, PER, PPV and EU). The highest PPV and EU% were recorded with 12% DDGS level.

Chemical composition of the whole fish body:

The results in Table (4) indicated that the percentage of dry matter and crude protein of fish body were decreased significantly ($P \leq 0.05$) with increasing DDGS levels. Crude fat (%) was increased significantly ($P \leq 0.05$) by increasing of DDGS levels up to 16% compared with the control diet. Crude protein was significantly ($P \leq 0.05$) differed among treatments. The highest value of DM % and EC was observed in fish fed the level of 12% DDGS, while the highest value of crude fat and ash were observed at level 4% of DDGS. The highest value of crude protein % was observed in the control diet and the level 8 % DDGS.

Table (2): Effect of feeding different levels of DDGS on growth performance parameters for Nile tilapia fingerlings

Traits	Level of (DDGS%)						SE	Pr > F
	0	4	8	12	16	20		
IW (g)	5.88	6.04	5.87	6.08	5.93	6.05	0.02	0.098
FW (g)	28.25^{c}	28.30^{bcd}	28.44^{bc}	29.53^{ab}	31.80^{a}	28.48^{bc}	0.938	0.019
TWG (g)	22.37^{bc}	19.85^{c}	22.47^{bc}	23.45^{ab}	25.87^{a}	22.43^{bc}	0.935	0.018
ADG (g/ fish/ day)	0.319^{bc}	0.283^{c}	0.321^{bc}	0.335^{ab}	0.369^{a}	0.320^{bc}	0.013	0.018
RGR (%)	380.3^{b}	328.7^{c}	382.8^{b}	385.6^{b}	436.2^{a}	370.7^{bc}	15.78	0.013
SGR	2.23^{b}	2.07^{c}	2.24^{b}	2.25^{ab}	2.38^{a}	2.21^{bc}	0.046	0.012
Survival (%)	90	95	100	90	100	100	0.564	0.865

Means In the same rows having different small letters differ significantly (P ≤ 0.05). AWG (g/fish) = [Average final weight (g)–Average initial weight (g)]. ADG (g/fish/day) = [AWG (g)/experimental period by days (d)]. RGR = 100 [AWG (g)/Average initial weight (g)]. SGR (%/day) = 100 [In final body weight - In initial body weight]/ experimental period by days (d). SR = 100 [Total No. of fish at the end of the experimental/Total no. of fish at the start of the exsperiment]. (Initial weight (IW), final weight (FW), total weight gain (TWG), average daily gain (ADG), relative growth rate (RGR) and specific growth rate (SGR)) . SE = Standard Error Pr > F = Probability value

Table (3): Feed utilization parameters of Nile tilapia fingerlings fed different levels of DDGS

Traits	Levels of (DDGS)%						SE	Pr > F
	0	4	8	12	16	20		
FI (g)/d	48.83	46.25	52.18	46.14	48.11	47.75	1.733	0.227
FCR	2.65^{a}	2.32^{ab}	2.33^{ab}	1.96^{bc}	1.86^{c}	2.12^{ab}	0.07	0.002
FE (%)	45.79^{c}	43.03^{c}	42.95^{c}	51.04^{ab}	53.75^{a}	46.97^{bc}	1.561	0.002
PER	1.64^{b}	1.56^{b}	1.54^{b}	1.89^{a}	1.90^{a}	1.66^{b}	0.066	0.007
PPV (%)	21.82^{ab}	18.85^{c}	19.76^{bc}	24.40^{a}	22.66^{a}	19.62^{bc}	0.813	0.003
EU (%)	12.63^{b}	12.03^{b}	11.57^{b}	15.77^{a}	14.79^{a}	11.83^{b}	0.459	<.0001

Means in the same rows having different small letters differ significantly (P ≤ 0.05).
FCR = Feed Intake, (g)/ weight gain (g). FE = 100 [Live weight gain (g)/Feed Intake, (g)].
PER = Live weight gain (g)/protein intake (g). PPV (%) = 100 [Final fish body protein content (g) – Initial fish body protein content (g)]/crude protein intake (g).
EU (%) = Retained energy x 100/consumed feed energy.

Table (4): Chemical composition on dry matter basis of the whole fish body components of Nile tilapia fingerlings fed different levels of DDGS

Treat.	DM %	% On Dry matter basis			
		CP (%)	**EE** (%)	**Ash** (%)	**EC (Kcal/100 g)**
At the start of the experiment					
	18.48	56.99	19.81	23.20	508.4
At the end of the experiment					
Levels of DDGS%					
0	20.70^{b}	61.30^{a}	20.96^{d}	17.73^{bcd}	543.63^{c}
4	20.67^{c}	56.54^{d}	24.45^{a}	19.01^{a}	549.73^{bc}
8	20.19^{d}	60.93^{a}	22.14^{c}	16.93^{d}	552.67^{ab}
12	20.99^{a}	59.00^{bc}	23.71^{b}	17.29^{cd}	556.60^{a}
16	20.05^{e}	58.03^{c}	23.51^{b}	18.45^{ab}	549.27^{bc}
20	19.32^{f}	59.53^{b}	22.19^{c}	18.28^{abc}	545.20^{c}
SE	**0.000**	**0.381**	**0.148**	**0.329**	**1.861**
Pr > F	**<.0001**	**<.0001**	**<.0001**	**0.0071**	**0.003**

Means in the same column having different small letters differ significantly (P ≤ 0.05).

Indices of body:

Data in Table (5) showed that heptosomatic index (HSI) and intestine somatic index (ISI) of Nile tilapia fingerlings were significantly different (P ≤ 0.05) among different levels of DDGS. The highest values of HIS and ISI were observed with the level of 12 % DDGS(diet 4).

Table (5): Hepatosomatic index (HSI) and intestine somatic index (ISI) of Nile tilapia fingerlings fed different levels of DDGS

Traits	Levels of (DDGS) %						SE	Pr > F
	0	4	8	12	16	20		
HIS	1.97^{bc}	1.69^{c}	1.18^{d}	2.32^{a}	2.22^{ab}	1.71^{c}	**0.087**	**0.0054**
ISI	3.13^{b}	3.78^{b}	3.92^{b}	5.38^{a}	3.94^{b}	4.09^{b}	**0.301**	**<.0001**

Means in the same column having different small letters differ significantly (P ≤ 0.05).

Blood profile:

Data of blood hematological and biochemical parameters are given in Table (6) . The results cleared that there were no significant (P ≥ 0.05) differences among means of blood hematological parameters compared with the control, except those of mean corpuscular volume (MCV) red blood cells (RBCs) which were significant among different treatments. The RBCs value was significantly (P ≥ 0.05) the highest in the diet containing 4% of DDGS compared with other ones. On the other hand, the MCV values were the lowest (P ≥ 0.05) in the diets containing 12% and 16% of DDGS. The highest value of MCV was observed at the level 16% of DDGS.

Table (6): Blood parameters of Nile tilapia fingerlings fed different levels of DDGS

Traits	Levels of (DDGS)%						SE	Pr > F
	0	4	8	12	16	20		
Hb (g/dl)	4.65	6.25	5.3	5.5	6.45	5.95	**0.506**	**0.167**
RBCs ($\times 10^6 mm^{-3}$)	1.19^{b}	2.27^{a}	2.05^{a}	1.33^{b}	1.39^{b}	1.70^{ab}	**0.179**	**0.006**
WBCs ($\times 10^3 mm^{-3}$)	128.5	153	161.8	100.2	105.8	106	**52.29**	**0.135**
Hematocrit %	15.25	19.35	17.5	14	17	15.85	**1.559**	**0.276**
MCV (□^{3})	129.0^{a}	83.6^{cd}	80.6^{d}	108.3^{abc}	122.5^{ab}	98.0^{bcd}	**7.927**	**0.004**
MCH (pg)	38.3	27.1	25.3	44.07	44.6	38.2	**4.93**	**0.065**
MCHC (%)	36.4	32.5	32.5	39.5	37	38.4	**2.563**	**0.316**

Means in the same column having different small letters differ significantly ($P \leq 0.05$).

Economic efficiency:

The results in Table (6) indicated that total outputs, net return, economic efficiency and relative economic efficiency were gradually increased with the increasing the level of DDGS up to 16% and then decreased at 20% DDGS. The total outputs, net return, economic efficiency and relative economic efficiency were the highest for the level of 16% of DDGS. Also, the levels 12% and 16% of DDGS gave the lowest total feed costs.

Table (7): Economic efficiency parameters of Nile tilapia fingerlings fed different levels of DDGS

Traits	Levels of DDGS (%)						SE	Pr > F
	0	4	8	12	16	20		
Total outputs[1]	0.447^{bc}	0.397^{c}	0.449^{bc}	0.469^{ab}	0.517^{a}	0.448^{bc}	**0.018**	**0.018**
Total feed costs[2]	0.127^{a}	0.127^{ab}	0.128^{a}	0.111^{b}	0.112^{b}	0.107^{b}	**0.004**	**0.023**
Net return[3]	0.319^{bc}	0.279^{c}	0.321^{bc}	0.357^{ab}	0.405^{a}	0.340^{b}	**0.016**	**0.003**
Economic efficiency[4] (%)	250.8^{c}	237.5^{c}	249.2^{cf}	323.6^{ab}	361.4^{a}	315.6^{b}	**12.87**	**0.0001**
Relative economic efficiency	100^{c}	94^{c}	99^{c}	128^{ab}	144^{a}	125^{b}	**5.022**	**0.0001**

Means in the same column having different small letters differ significantly ($P \leq 0.05$).
Total cost of feed intake (LE) = feed costs per one kg diet X feed intake
1- Total outputs per treatment (LE) = fish price X total fish production*
2- Total fish production per treatment = final number of fish X fish weight
3- Net return per treatment (LE) = total outputs – total feed costs
4- Economic efficiency per treatment (%) = (net return/ total feed costs) X 100

DISCUSSION

The obtained results indicated that most of growth performance (FW, WG, DAG, RGR and SGR) and feed utilization (FCR, FE, PER, PPV and EU) parameters were improved significantly ($P \leq 0.05$) with increasing the replacement level of DDGS up to 16% of DDGS. However, no significant differences among the control diet and 20% of DDGS were observed. The highest values of growth performance parameters were found at the replacement levels 16% of DDGS. These results are in agreement with those of Wu, *et al.* (1994 and 1995) who reported that diets containing corn gluten meal 18% or corn distillers grains with solubles 29% and 32% or 36% protein resulted in higher weights of tilapia than fish fed a commercial fish feed containing 36% protein and fish meal for tilapia. In this respect, Wu, *et al*. (1996) reported that the growth response of Nile tilapia *(Oreochromis niloticus)* fed diets containing 16 – 49% DDGS resulted in good WG (weight gain), FCR (Feed conversion ratio), and PER(Protein efficiency ratio). Tidwell, *et al.* (2000) compared the growth of Nile tilapia (*Oreochromis niloticus*) raised in cages fed either a sinking DDGS pellet or a sinking commercial catfish (*Ictalurus punctatus*) diet. The results showed that fish received the catfish diet grew 25% faster, cost of gain was 43% lower for fish fed the DDGS pellets. The authors concluded that an efficient and economical tilapia growth can be obtained using direct feeding of DDGS in situations where optimal growth is not essential.

Also, Lim and Webster (2006) found that 20% fuel-based DDGS can be included in Nile tilapia diets without a significant effect on overall growth performance. However, fish fed diets containing 30% DDGS had similar WG, PER and feed efficiency ratio (FER) as those fed the control diet, while fish fed 40% DDGS had significantly lower WG, PER and PER than those on the control diet. Vy (2006) found after 4 months culture period, the best growth rates of red tilapia were obtained in the fish fed 10% and 15% DDGS. The lowest growth rate was presented in the 0% DDGS diet. The lowest FCR of the whole culture period were obtained at 15% DDGS. On the other hand, Hung (2007) indicated that DDGS can be fed to growing common carp up to 15%; however there is an indication that the feeding at 10-15% gave a faster growth rate than that fed 0 and 5%.

The results in the presnt study indicated that HSI and ISI values were significantly differed ($P \leq 0.05$) among different levels of DDGS. The highest values of HSI and ISI were observed at the level 12% of DDGS. Meanwhile, Schaeffer *et al* (2009) showed that the hepatosomatie indices did not significantly differ between fish fed 20% DDGS and the reference diets. The variation in the inclusion levels reported could be attributed to a number of factors such as species, fish age or size, source and quality of the tested ingredients, composition and nutrient content of the experimental diets, supplementation of limiting nutrients such as essential amino acid, culture system, feeding management and experimental conditions (Lim and Yildrim-Akosy, 2008 and Tangendjaja, 2008).

Finally, It appears that the current processing techniques of fuel-based DDGS did not yet provide any significant benefits over older beverage-based DDGS. Even though studies have shown increasing trends in protein and lipid levels of DDGS (Spiehs *et al.,* 2002 and Belyea, *et al.,* 2004) which should be beneficial to aquaculture diets. The current study indicated that fish fed lower levels of DDGS (20%) had similar growth responses as those fed a fishmeal-based commercial diet, while studies using older DDGS had similar results using higher amounts of DDGS (>35%) (Wu *et al.,* 1996 and 1997).

In this study, there were no significant differences in survival of tilapia fed the six diets. Overall, survival was high and ranged from 90 to 100%. These results are in agreement with those of Vy (2006) and Hung

(2007) with *O. niloticus* and Webster, *et al.* (1992 a&b) with channel catfish. Coyle *et al.* (2004) found no significant differences in survival of tilapia, overall, means of survival was high and ranged from 96.4 to 100%. Abo-State *et al.* (2009) showed no significant differences survival rate among tilapia fed diets containing different levels of DDGS(0, 25, 50, 75 and I00 %). Survival rate was approximately 100% for fish fed all diets. In contrast, previous study of feeding DDGS to tilapia indicated an improvement on survival rate when DDGS was included in the diet (Tangendjaja and Chien., 2007).

Concerning the chemical composition of fish body, the results indicated that energy content (%) of fish body did not significantly ($P \leq 0.05$) differ with increasing DDGS levels up to 12% then decreased thereafter. The crude ash and fat increased significantly ($P \leq 0.05$) with increasing DDGS levels. In the same trend, the crude protein was significant ($P \leq 0.05$) among treatments. The highest value of DM and EC percentage observed in fish fed the levels of 12 % DDGS. The present results agreed with those reported for many authers. In this respect, VY (2006) found after 4 months culture period, that there is no different in the composition of the fish after feeding diets containing different levels of DDGS. Also, Hung (2007) indicated that there is no different in composition of the fish after feeding diets containing different levels of DDGS.

Salama *et al.* (2011) found that fish fed diet containing 100 % of DDGS recorded the highest values of EE and conversely with protein content. The fish fed 100 % DDGS recorded the highest value of ether extract while fish fed 50 % DDGS recorded the lowest values. The research results indicated that total outputs, net return, economic efficiency and relative economic efficiency were gradually increased with the increasing the levels of DDGS in tested diets.

Aquaculture diet costs can account for over 50% of production with considering that protein is the most expensive dietary constituent (**Coyle *et at.*, 2004**). The results in the present research indicated that the total outputs, net return, economic efficiency and relative economic efficiency were gradually increased with the increasing levels of DDGS until levels 16%, and then decreased with increasing of DDGS level. The total outputs, net return, economic efficiency and relative economic efficiency were the highest for the level 16% of DDGS which showed also the lowest total feed costs.

These results are in agreement with Schaeffer *et al*, (2010) who reported that fishmeal may be replaced with low levels of fuel-based DDGS to reduce feeding cost; however, additional supplements should be considered to enhance fish performance. Because of the rising cost and uncertain availability of fishmeal from over-fished marine stocks, researchers have begun to investigate alternative protein sources (Jauncey and Ross, 1982; Fontaınhas-Fernandes *et al*., 1999 and Coyle *et al*., 2004). One plant nutrient source available for aquaculture feeds is distillers dried grains with solubles (DDGS) (Webster *et al*., 1992a,b, 1993; Wu *et al*., 1996, 1997; Coyle *et al*., 2004 and Lim and Webster., 2006). Tidwell *et al.* (2000) concluded that an efficient and economical tilapia growth can be obtained using direct feeding of DDGS in situations where optimal growth is not essential. These results agreed with the use of plant derived protein sources cheaper than SBM could be explored to further reduce the cost of fish feeds (Amayaet *et al*. 2007). The increasing price of feed is considered one of the most important factors limiting profitability in fish culture. The high cost of fish feed mainly due to the high costs of fish meal and SBM and therefore finding a relatively lower cost alternative ingredient was the ongoing research goal (Fomter *et al.* 2003 and Hernndez *et al.* 2008).

It may be concluded that replacing fish meal and yellow corn by DDGS until 16% in the diets of tilapia had no any adverse effect on most of growth parameters, feed utilization, chemical composition of fish body, hematological blood parameters and economic efficiency of tilapia fingerlings.

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الإستفادة من مستخلصات تقطير الحبوب الجافة والذائبات فـى تغذيـة الأسـماك: ٢-الإستبدال الجزئي لمسحوق السمك والذرة الصفراء بمسـتويات متدرجـة مـن النواتج العرضية لتقطيرالأذرة (DDGS) فى علائـق إصـبعيات أسـماك البلطـى النيلى.

أحمد عبد الرزاق جبر، فتحى فتوح خليل و سماح السيد الشرقاوى
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وقد أجريت هذه الدراسة لتقييم تأثير التغذية على مستويات متدرجة مـن بـروتين DDGS فـى علائق إصبعيات أسماك البلطي على أداء النمو، والإستفادة الغذائية، والتركيـب الكيميـائي لجسـم السـمكة بأكملها، ومكونات الدم والكفاءة الاقتصادية. ولذلك، تم استخدام مسـتويات متدرجة(صـفر،١٦,١٢,٨,٤و٢٠%) من بروتين ال DDGS ليحل محل مسحوق السمك والذرة الصفراء فى تكوين العلائق المختبرة والبـروتين الخام بها (٢٧.٨٢٪) وكانت العلائق متزنة تقريبا فى محتواها من البـروتين والطاقـة. وكانـت الأسـماك مخزنة في تانكات بلاستيك للتربية خلال فترة الأقلمة التى إستغرقت أسبوعين، ثم تم توزيع الأسـماك عشـوائيا بمعدل ٥سمكة / حوض زجاجى، وكان متوسط وزن السمكة (٦.٠ ± ٠.١٤ جم / سـمكة). وخـلال الفتـرة التجريبية التى إستغرقت (٧٢ يوم) كانت تغذية الأسماك يوميا بمعدل ٦٪من وزن الجسم، ولمدة ستة أيـام فـي الأسبوع.

وأظهرت النتائج أن هناك فروق معنوية عند مستوي ٥% لتأثير مستويات DDGS علـى جميـع الصفات تحت الدراسة من أداء النمو ومعدلات استهلاك الأعلاف. وأشارت النتائج إلـى حـدوث زيـادة فـى جميع معدلات أداء النمو بزيادة مستوى DDGS حتى المستوى ١٦٪. وأفضل نتائج للإسـتفادة مـن الغـذاء ومعدلات النمو والكفاءة الإقتصادية سجلت عند المستويين ١٢٪ و ١٦٪ من ال DDGS على التوالي.

لذا توصى الدراسة بإمكانية إحلال بروتينDDGS محل جزء من مكونات العليقة غالية الثمن مثـل مسـحوق السمك والذرة الصفراء حتى ١٦٪ في علائق أسماك البلطي النيلى بدون أى تأثير سلبي على معظم قياسـات النمو، والإستفادة من الغذاء، التركيب الكيميائي لجسم السمك ومكونات الدم والكفاءة إقتصادية.

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