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Effect of different levels of Aqua-Max Plus® on growth performance, feed efficiency and physiological responses of the mono-sex Nile tilapia (*Oreochromis niloticus*, L. 1758)

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ABSTRACT

This study was conducted to assess the effect of different levels of Aqua-Max Plus® on growth performance, feed efficiency, body chemical composition, hematological, and biochemical of the mono-sex Nile tilapia (*Oreochromis niloticus*, L. 1758) for 147 days (21 weeks). Aqua-Max Plus® was added at five levels (0, 1, 2, 3, 4 g/kg diet). Results exhibited that the addition of Aqua-Max Plus® at levels 2, 3, and 4 g/kg diet (T_3, T_4, and T_5) led to significantly improve the growth performance and feed efficiency parameters compared to the control group. By increasing the levels of Aqua-Max Plus®, ash and protein contents were significantly increased, while fat and energy content contents were decreased. No significant differences among treatments in hematological and serum biochemical parameters were detected. Thus, based on the obtained results, it could be concluded that the beneficial addition of 2 g Aqua-Max Plus® / kg diet as a growth promoter agent for the Nile tilapia.

INTRODUCTION

It is a fact that the aquaculture is the key resource in current years to augmented fish production after reduced output from capture fisheries. According to FAO (2018), aquaculture led to a rise in per capita consumption of fish to 20.3 kg in 2016 compared to 18.5 kg in 2011. In the past few years in Egypt, aquaculture grows quickly to meet the demand for fish protein (as an animal protein source). Currently, the total fish production in Egypt increased from 724,300 tons in 2000 to 1,762,174 tons in 2016 (GAFRD, 2018). Egypt produces about 1,048,276 tons of tilapia fish, which represents 80% of the total fish production in 2016 (GAFRD, 2018). Tilapia fish has many attributes that make them an ideal candidate for aquaculture such as fast growth, tolerance to a wide range of environmental conditions, high food conversion ratio, readily accepting artificial feeds, ease of breeding in captivity, disease resistance, high fecundity, good table food quality, and good market price (El-Sayed, 2006; Noor *et al.*, 2010). In addition, it can cultured many systems as

semi-intensively or intensively, and mono or/and polyculture and management strategies (Guerrero, 2002), as well as in both fresh and saltwater and in tropical, subtropical and temperate climates (Fitzsimmons *et al.,* 2006).

Nile tilapia (*Oreochromis niloticus*, L. 1758) is an economically main cultured species in numerous parts of the world especially in Egypt (El-Husseiny *et al*., 2007).

In aquaculture systems such as the intensive or semi-intensive systems, aiming to increase fish production, which exposes fish to many environmental changes (Abdel-Tawwab *et al.,* 2007). In addition, feeding cost represents over 50% of the operating costs in intensive aquaculture. Therefore, some chemical additives have been used as diet supplementation such as probiotics, enzymes, and acidifiers (Zhou *et al.,* 2010; Rimoldi *et al*., 2016; Wassef *et al.,* 2017). The benefits of the supplements include enhance growth, improved feed efficiency, enzymatic contribution to digestion, inhibition of pathogen, antimutagenic and anticarcinogenic activity, and increase immune response (Wang, 2007; De Schryver *et al.,* 2010).

The use of a multienzymes diet supplement results in enhanced fish performance improved nutrient utilization and reduced in fecal phosphorus excretion. Several studies have exhibited promising results of the use of probiotics in fish productive performance (Wang, 2007; Mehrim *et al*., 2017), which enables that probiotics to substitute the antibiotics as growth promoters. Previous researches also used dietary acidifiers as growth promoters, multi-nutritional functions and immune enhancers agents for many fish species (De Schryver *et al.,* 2010; Rimoldi *et al.,* 2016; Wassef *et al.,* 2017). Zinc is known to be an essential micronutrient both in plants and in animals, including fish. Zinc is involved in various metabolic pathways. The previous presentation shows that previous studies have used some chemical additives (such as enzymes, probiotics, zinc, and sodium butyrate) each separately. Therefore, the objective of the present study aimed to investigate the effect of different levels of dietary Aqua-Max plus® on growth performance, feed efficiency, the body chemical composition, and hematological and biochemical parameters of Nile tilapia, *O. niloticus*.

MATERIALS AND METHODS

Experimental management

The experiment was carried out in concrete ponds at the private farm by Yousef Assal, Al-Gamaliah, Dakahlia Governorate, Egypt. Five concrete ponds used in this study with dimensions 3 m length × 2 m width × 1 m depth (Total volume 6 m^3). Each concrete pond divided into two equal replicates (3 m^3) by a separator network. Six hundred mono-sex (all male) Nile tilapia, *O. niloticus* fingerlings with an average initial body weight (74.64 g ± 2.5g) were adapted for a week as they kept in cages inside Lake Manzala in the same farm. Fish weighed and then randomly distributed into five experimental groups. Fish stocked at a rate of 20 fish / m^3 (120 fish per treatment). The light period was a 14 h light: 10 h dark as a daily photoperiod.

Feeding system:

Aqua-Max Plus® is a commercial product contents of mixture of some growth promoters such as enzymes, organic acids, probiotics, and zinc, as described in Table 1. All components of the control diet were purchased local market and mixed with a hand grinder. The control diet contains 25.7% crude protein and gross energy 486.80 Kcal/100g DM. The components of the diet and chemical analysis were shown in Table 2. After that, Aqua-Max plus® was added by graded levels 0, 1, 2, 3 and 4 g per kg diet, referred to treatments number T_1 (as a control group), T_2, T_3, T_4, and T_5,

respectively, for 147 days (21 weeks). All ingredients of the experimental diets were carefully milled and mixed, then pressed by manufacturing machine (pellets size 1 mm). Pellets were air-dried to less than 10% moisture and stored at 4 °C until use.

Fish were fed at a rate of 3% to 2% of the total biomass of Nile tilapia. The diet was handly offered twice daily at 8.30 a.m. and 14.00 p.m. Body weight of *O. niloticus* in each treatment was measured biweekly to modify daily feed intake.

Table 1: Formulation of the experimental Aqua-Max Plus® fed to fish according to the manufacturer's configuration

Ingredients	g per 2 kg	Effective Material	Amount
Hostazym® X	250.00	Xylenes enzyme (IU)	1500000
Hostazym p10000	50.00	Phytase enzyme (IU)	500000
Gustor Aqua BP70	500.00	Sodium butyrate $NaC_4H_5O_6$ (g)	350
Biomet zinc Aqua	75.00	Zinc (g)	1650
ECOBIOL Aqua	1000	*Bacillus amyloliguefaciens*	1×10^{12}
$CaCO_3$ was supplemented up to 2 kg			

Water quality parameters:

Water quality parameters such as water temperature, dissolved oxygen (DO), total ammonia (TA), total solids (TS), and pH values were measured. DO (mg/L) was determined by HANNA HI 9146-04–Romania. TA concentration of water was tested by direct Nesslerization methods using CHEMETS® test kits (CHEMETRICS, INC, USA) according to APHA (1992) every two weeks. TS (g/L, ‰), and pH-values were measured by Consort C860 – Belgium. Water temperature, pH, DO, TA, TS were 25.17±2.77 °C, 8.24±0.20, 7.56±0.31 mg/L, 0.01±0.001 mg/L, and 0.94±0.35 g/L, respectively. All tested water quality was appropriate for rearing the Nile tilapia .

Table 2: Formulation and the chemical analysis of the experimental diets

Ingredients	Ingredients per ton diet
Fishmeal	110
Corn gluten	50
Soybean meal	90
DDGS	120
Broken lentils	100
Wheat Bran	110
Rice Bran	80
Yellow corn	270
Oil	50
$CaHPO_4.2H_2O$	5
Salt	7.5
Vit & min[1]	7.5
Nutrient composition (% on dry matter basis)	
Dry matter (DM)	86.29
Crude protein (CP)	25.70
Ether extract (EE)	9.09
Ash	7.41
Crude fiber (CF)	4.50
Nitrogen free extract (NFE)	53.30
[2]Gross energy (GE) (Kcal/100g DM)	486.80
[3]Protein/energy (P/E) ratio	52.80

1- Vitamins & minerals premix each 3 kg contains: Vitamin A, 10000000 IU; Vitamin D_3, 2500000 IU; Vitamin E, 20000 IU; Vitamin K_3, 3000 IU; Vitamin B_1, 200 mg; Vitamin B_2, 5000 mg; Vitamin B_6, 2000 mg; Vitamin B_{12}, 15 mg; Biotin, 60 mg; Folic acid, 1000 mg; Nicotinic acid, 30 g; Pantothenic acid, 10 g; Mn 80 g; Cu 88g; Zn 70g; Fe 100 g; Co 0.4 g; I 1 g and Se 0.3g. Calcium carbonate was supplemented up to 3 kg

2- GE (Kcal/100 g DM) = CP x 5.64 + EE x 9.44 + 4.11 calculated according to (Macdonald *et al.*, 1973).

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

Growth performance and feed efficiency measurements:

At the end of the experiment, the weight and length of the fish body were individually measured in each treatment to calculate the growth performance traits, such as total weight gain (TWG, g), average weight gain (ADG, g/fish/day), relative growth rate (RGR, %), specific growth rate (SGR, %/day), and feed utilization parameters as feed intake (FI, g), feed conversion ratio (FCR), feed efficiency (FE, %), protein efficiency ratio (PER), protein productive value (PPV, %) according to Halver and Hardy (2002). While, the condition factor (K, %) ~~to~~ was calculated according to the following equation; K= (fish weight (g) ×100) / total length^3 (cm).

Chemical analysis of the experimental diet and fish carcass:

At the end of the experiment, fish samples (n = 3 from each replicate) were taken and ~~were~~ kept frozen (– 20° C) until chemical analysis. The chemical analysis of diet and fish samples was carried out according to **AOAC (2004)**.

Blood sampling and analytical methods:

At the end of the experiment, blood samples (n = 5 for each treatment) were randomly taken and received in plastic tubes. Blood samples were collected and transferred by centrifugation for 15 minutes at 3500 rpm to obtain blood serum. Serum samples were kept in the deep freezer until the biochemical examination. Serum samples were used for the definition of creatinine (Tietz, 1986), triglycerides (McGowan *et al.*, 1983), total protein (Tietz, 1990) and albumin (Wotton and Freeman, 1982), as well as aspartate aminotransferase (AST) and alanine aminotransferase (ALT) activities by marketable test kits (Humalyzer 3000 manufactured by Human, Germany). Serum globulin level was calculated by subtracting albumin from total protein.

The other samples of whole blood were used to test the hematological parameters as hemoglobin (Hb), total erythrocytes (RBCs), total leukocytes (WBCs) (Natt and Herrick, 1952) and hematocrit (Hct) (Decie and Lewis, 2006). Blood indices such as mean cell volume (MCV), mean cell haemoglobin (MCH), and mean cell haemoglobin concentration (MCHC) were calculated according to Dacie and Lewis (1995).

Statistical analysis

All data were statistically analyzed using general linear models (GLM) procedure according to SAS (2009), with one-way analysis. All ratios and percentages were arcsine-transformed prior to statistical analyses. The differences between mean were statistically compared for the significance ($P \leq 0.05$) using Duncan's (1955) multiple range tests, evaluated by using the following model:

$$\mathbf{Yij = \mu + Ti + eij}$$

Where; Yij = the data of growth performance, feed efficiency, the body chemical composition hematological and biochemical parameters of *O. niloticus*; μ = the overall mean; Ti = the fixed effect of treatments and eij= is the random error.

RESULTS

Growth performance parameters:

Growth performance traits of Nile tilapia were presented in Table 3. Results exhibited that dietary addition of Aqua-Max Plus® at levels 2, 3 and 4 g / kg diet (T_3, T_4, and T_5) had the highest significant ($P \leq 0.05$) values of growth performance parameters (such as FW, TWG, ADG, RGR, SGR, and K factor) compared to the other treatments (T_1 and T_2).

Table 3: Effect of graded levels of Aqua-Max Plus® on growth performance parameters of Nile tilapia

Treatment	FW (g)	TWG (g)	ADG (g/fish/day)	RGR (%)	SGR (%/day)	K (%)
T_1	176.5^{c} ±0.167	101.8^{c} ±0.16	0.690^{c} ±0.00	236.4^{c} ±0.22	0.586^{c} ±0.003	1.82^{c} ±0.02
T_2	184.3^{b} ±0.08	109.6^{b} ±0.08	0.747^{b} ±0.003	246.9^{b} ±0.11	0.613^{b} ±0.003	1.85^{bc} ±0.03
T_3	190.2^{a} ±0.01	115.5^{a} ±0.01	0.790^{a} ±0.00	254.7^{a} ±0.02	0.640^{a} ±0.001	1.95^{a} ±0.03
T_4	190.3^{a} ±0.17	115.7^{a} ±0.17	0.787^{a} ±0.003	254.9^{a} ±0.23	0.640^{a} ±0.001	1.92^{ab} ±0.03
T_5	190.6^{a} ±0.28	115.9^{a} ±0.28	0.790^{a} ±0.001	255.3^{a} ±0.37	0.640^{a} ±0.002	1.93^{ab} ±0.02

Mean in the same column having different small letters are significantly different ($P \leq 0.05$). FW: Final weight; TWG: Total weight gain; ADG: Average weight gain; RGR: Relative growth rate; SGR: Specific growth rate; K: condition factor.

Feed efficiency parameters:

Results in Table 4 showed that the effect of different levels of Aqua-Max pellet Plus® on feed efficiency parameters of adult females and males Nile tilapia. Dietary addition of Aqua-Max Plus® at levels 2, 3 and 4 g / kg diet (T_3, T_4, and T_5) led to significantly improve of the feed efficiency parameters (such as FI, FCR, FE, PER, and PPV) compared to the other treatments (T_1 and T_2).

Table 4: Effect of graded levels of Aqua-Max Plus® on feed efficiency parameters of Nile tilapia

Treatment	FI (g)	FCR	FE (%)	PER	PPV (%)
T_1	260.40^{d} ±0.11	2.50^{a} ±0.003	39.12^{d} ±0.046	1.52^{d} ±0.001	18.35^{d} ±0.026
T_2	264.80^{c} ±0.34	2.40^{b} ±0.003	41.40^{c} ±0.02	1.61^{c} ±0.002	19.28^{c} ±0.008
T_3	268.10^{a} ±0.54	2.30^{c} ±0.005	43.09^{a} ±0.08	1.67^{b} ±0.003	20.03^{b} ±0.037
T_4	266.10^{b} ±0.06	2.30^{c} ±0.003	43.44^{a} ±0.07	1.69^{a} ±0.005	20.08^{b} ±0.037
T_5	266.40^{b} ±0.21	2.30^{c} ±0.005	43.52^{a} ±0.13	1.69^{a} ±0.005	22.65^{a} ±0.075

Mean in the same column having different small letters are significantly different ($P \leq 0.05$). FI: feed intake; FCR: feed conversion ratio; FE: feed efficiency; PER: protein efficiency ratio; PPV: protein productive value.

Chemical composition of the fish body:

Ash, crude protein (CP), fat, and energy contents in the fish body were significantly influenced by addition of Aqua-Max Plus® in the Nile tilapia diet (Table 5). By increasing the levels of Aqua-Max Plus® ash and CP were significantly increased, while fat and energy content decreased ($P \leq 0.05$). Results exhibited that no significant ($P \geq 0.05$) difference in dry matter content among all treatments.

Table 5: Effect of graded levels of Aqua-Max Plus® on body chemical composition of Nile tilapia

Treatment	DM (%)	On dry matter basis			
		Ash (%)	Fat (%)	Protein (%)	EC (Kcal/100g)
T_1	21.66 ±0.13	25.13^{b} ±0.37	12.12^{ab} ±0.17	62.74^{b} ±0.34	468.2^{b} ±2.40
T_2	21.19 ±0.98	25.37^{ab} ±0.30	11.07^{b} ±0.03	63.55^{ab} ±0.27	463.0^{b} ±1.87
T_3	21.08 ±0.15	23.45^{c} ±0.30	12.61^{a} ±0.181	63.64^{ab} ±0.25	477.9^{a} ±2.19
T_4	21.04 ±1.05	25.42^{ab} ±0.50	11.04^{b} ±0.87	63.55^{ab} ±0.69	462.6^{b} ±5.53
T_5	22.16 ±0.16	26.51^{a} ±0.19	8.873^{c} ±0.02	64.61^{a} ±0.18	448.2^{c} ±1.14

Mean in the same column having different small letters are significantly different ($P \leq 0.05$); DM= Dry matter; EC= Energy content.

Hematological parameters:

The hematological parameters of Nile tilapia fed different levels of Aqua-Max Plus® were presented in Table 6. Results showed that no significant differences among treatments in all tested hematological parameters were recorded ($P \geq 0.05$).

Table 6: Effect of graded levels of Aqua-Max Plus® on hematological parameters of Nile tilapia

Treatment	RBCs ($\times 10^6$/mm^3)	Hb (g/dL)	PCV (%)	Platelets ($\times 10^3$/mm^3)	Blood indices			WBCs ($\times 10^3$/mm^3)
					MCV (µ3)	MCH (pg)	MCHC (%)	
T_1	1.76 ±0.10	8.19 ±0.44	39.41 ±5.23	39.51 ±1.91	226.1 ±33.01	46.60 ±0.88	22.05 ±3.38	43.34 ±1.47
T_2	1.60 ±0.09	8.58 ±0.47	41.25 ±2.39	40.18 ±2.88	262.1 ±28.81	54.59 ±5.93	20.98 ±1.43	41.16 ±2.37
T_3	1.87 ±0.07	8.48 ±0.50	42.85 ±2.84	38.25 ±3.64	238.1 ±13.07	47.17 ±2.41	19.89 ±1.07	43.55 ±1.41
T_4	1.66 ±0.13	8.34 ±0.70	43.65 ±3.89	40.44 ±3.45	272.7 ±41.83	51.88 ±7.33	19.51 ±2.40	44.05 ±6.27
T_5	1.62 ±0.08	8.37 ±0.44	45.55 ±6.14	39.77 ±1.53	280.4 ±31.02	51.68 ±1.27	19.22 ±2.39	45.5 ±2.09

Mean in the same column having different small letters are significantly different ($P \leq 0.05$). RBCs: Red blood cells; Hb: Hemoglobin; PCV: Packed cell volume; Platelets: Blood platelets; MCV: Mean corpuscular volume; MCH: Mean corpuscular hemoglobin; MCHC: Mean corpuscular hemoglobin concentration; WBCs: White blood cells

Serum biochemical parameters:

Results in Table 7 showed that the effect of different levels of Aqua-Max Plus® serum biochemical parameters of Nile tilapia. There were no significant ($P > .05$) differences in serum biochemical parameters among all treatments.

Table 7: Effect of graded levels of Aqua-Max Plus® on serum biochemical parameters of Nile tilapia

Traits	Treatment				
	T_1	T_2	T_3	T_4	T_5
ALT (IU/L)	38.05 ±2.11	39.38 ±3.60	42.75± 6.013	40.73± 3.816	39.85 ±2.66
AST (IU/L)	149.7 ±18.8	147.0 ±10.2	155.3± 9.435	159.2± 4.002	157.6 ±19.09
Total Cholesterol (mg/ dL)	150.0 ±12.2	149.5 ±7.26	156.5 ±4.77	154.2 ±6.60	149.2 ±7.85
Triglyceride (mg/ dL)	163.0 ±1.62	162.2 ±5.93	168.0 ±6.67	166.7 ±9.86	166.5 ±8.56
HDL (mmol/L)	60.75 ±4.17	63.00 ±5.14	61.75 ±3.44	64.25 ±6.79	63.50 ±6.30
LDL (mmol/L)	56.65 ±14.79	54.05 ±5.87	61.15 ±9.19	56.65 ±5.08	52.45 ±9.80
Total protein (g / dL)	5.38 ±0.14	5.63 ±0.14	5.80 ±0.21	5.55 ±0.18	5.51 ±0.07
Albumin (g / dL)	3.68 ±0.03	3.78 ±0.12	3.99 ±0.49	3.73 ±0.16	3.74 ±0.09
Globulin (g / dL)	1.70 ±0.14	1.85 ±0.07	1.90 ±0.06	1.82 ±0.06	1.80 ±0.05
Al / Gl ratio	2.218 ±0.20	2.05 ±0.110	2.052 ±0.024	2.053 ±0.039	2.06 ±0.08

Mean in the same row having different small letters are significantly different ($P \leq 0.05$). ALT: Alanine aminotransferase; AST: serum aspartate aminotransferase; HDL: High-density lipoprotein; LDL: Low-density lipoprotein; Al / Gl ratio = albumin / globulin ratio.

DISCUSSION

Improvement in fish growth is evidence of adequate environmental conditions and abundant food (Kiessling *et al*., 2006). This study exhibited that the increasing of graded levels of Aqua-Max Plus® levels in Nile tilapia diets had a positive effect on growth performance and feed efficiency parameters. Improving growth performance may be attributed to containing Aqua-Max Plus® on some growth promoters such as sodium butyrate, zinc, and probiotics. Many studies displayed the benefits of these supplements as growth-promoting factors and feed value, enzymatic contribution to digestion, and increase immune response (Wang, 2007; Mehrim, 2009; De Schryver *et al*., 2010; Mehrim *et al*., 2017). In addition, these additives stimulate the appetite of fish, which is reflected in increased food intake. This is consistent with the results obtained from this study. Similarly, Mehrim (2009) concluded that the inclusion of the commercial probiotic Biogen® is useful to get the best fish performance with friendly effects on the environment. In addition, Shelby *et al.* (2006) and Mehrim *et al.* (2017) displayed that the probiotic used with juvenile Nile tilapia diet had an effect on specific growth-promoting or immune stimulating aspects. In contrast, Silva *et al*. (2015) found that growth and feed conversion of juvenile tilapia were not significantly influenced by probiotics.

In aquaculture, enzymes are used in fish feed to overcome many problems such as anti-nutritional factors, thereby improving the nutritive value, nutrient utilization, and animal growth (Saputra *et al*., 2016). Therefore, the improvement in growth performance and nutritional efficiency in this study is possible due to containment on some enzymes such as xylanase and phytase enzymes. These enzymes led to enhance feed utilization specifically diet protein, which reflected to improve values PER and PPV in this study. Bar *et al*. (2012) stated that xylanase supplementation improves conjugated bile acid function in intestinal contents and increases the villus size of the small intestine wall. In the same trend, Jiang *et al.* (2014) found that added xylanase in a plant protein-enriched the diet of Jian carp (*Cyprinus carpio*) resulted in improvements in growth, percent WG, FE, PER, and the microflora in intestinal enzyme activities. Similar results were also recorded by Ai *et al.* (2007) in Japanese seabass (*Lateolabrax japonicas*).

Results in the current study showed that Nile tilapia fed Aqua-Max Plus® led to improve the chemical composition of the whole fish body, where it caused by increased of protein content and decreased the fat content. These results suggest that supplemented of Aqua-Max Plus® plays an important role in enhancing FI, which sequentially led to enhance of fish body composition. The improvement in the composition of the fish body is due to the combined effect of the different substances found in Aqua-Max Plus® such as probiotics, enzymes, sodium butyrate, which was reflected in the improvement of growth performance parameters observed in the current study (Table 3). The positive effects of probiotic on the chemical composition of body fish observed in many studies on Nile tilapia (Khattab *et al*. 2004; EL-Haroun *et al*., 2006; Mehrim, 2009). Also, dietary sodium butyrate supplementation had led to an appreciable increase in protein concomitant with a decrease in lipid contents of fish, as well as enhancement of fish hematological profile in European sea bass (*Dicentrarchus labrax*) fry (Abdel-Mohsen *et al*., 2018). Generally, El-Ebiary and Zaki (2003) stated that the relationship between crude protein and crude fat of *O. niloticus* carcass is negative, and a positive correlation between crude protein and crude ash contents of *O. niloticus*, where inversely results were obtained by Abdelhamid *et al*. (2007). On the other hand, Silva *et al*. (2015) found that addition

of probiotic on Nile tilapia diet showed no significant difference in proximal composition of fish. The differences between previous and current findings may be due to fish size and age, experimental period, experimental conditions, and type of dietary supplement.

Hematological and biochemical changes in blood are used to study the health status of fish and as an indicator of the various environmental and food changes that fish are exposed to in their environment (Satheeshkumar *et al*., 2012), as well as it provides reliable information on metabolic disorders and deficiencies (Bahmani *et al*., 2001). The obtained results of the present study showed that the addition of Aqua-Max Plus® to the Nile tilapia diet did not have any significant effects on the hematological and biochemical parameters. This indicates that there have been no adverse effects of Aqua-Max Plus® on the fish health status in the current study. These results are consistent with the results obtained from Eid and Mohamed (2008). Similarly, Ali *et al*. (2017) showed that hematological parameters were not significantly affected by dietary Biogen® and sodium butyrate. Inversely, Nie *et al*. (2007) found that improvement of hematological and biochemical parameters of Nile tilapia fed different levels of xylanase.

In addition, these differences in results may be due largely to the combined effect of the commercial dietary agent (Aqua-Max Plus®) used in the present study, which includes many compounds such as probiotics, enzymes, sodium butyrate, and zinc. However, previous studies used only one of these stimuli components. Generally, the currently findings obtained herein indicated that the addition of Aqua-Max Plus® starting from 2 to 4 g per kg diet (T_3, T_4 and T_5) led to improve both of the growth performance, and feed efficiency parameters of Nile tilapia, with no significant differences between these levels. Where, the obtained results in the present study confirmed the useful addition of 2 g Aqua-Max Plus® per kg diet, which led to seriously improve of growth performance, feed efficiency, and body chemical composition of Nile tilapia. Thus, it could be concluded that Aqua-Max Plus® can be used as a promising growth promoter agent for Nile tilapia (*O. niloticus*), especially at level 2 g/kg diet.

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ARABIC SUMMARY

تأثير مستويات مختلفة من Aqua-Max Plus على أداء النمو وكفاءة التغذية والصفات الهيماتولوجية والبيوكيماوية لدم أسماك البلطي النيلي وحيد الجنس

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أجريت هذه الدراسة لتقييم تأثير مستويات مختلفة من الأكواماكس بلاس على أداء النمو، كفاءة العناصر الغذائية، التركيب الكيميائي لجسم الأسماك، الصفات الهيماتولوجية والبيوكيماوية لأسماك البلطي النيلي وحيد الجنس، لمدة ١٤٧ يومًا (٢١ أسبوعا). تمت إضافة أكواماكس بلاس بخمسة مستويات (٠، ١، ٢، ٣، ٤ جم / كجم عليقة). أظهرت النتائج أن إضافة أكواماكس بلاس بالمستويات ٢ ، ٣ ، ٤ جم / كجم عليقة (المعاملات الثالثة، الرابعة ، الخامسة) أدت إلى تحسين أداء النمو وكفاءة التغذية بشكل ملحوظ مقارنة بالمجموعة الضابطة. بزيادة مستويات أكواماكس بلاس زادت محتويات الرماد والبروتين بشكل ملحوظ ، في حين انخفضت محتويات الدهون والطاقة في جسم الأسماك. لا توجد فروق ذات دلالة إحصائية بين المعاملات في الصفات الهيماتولوجية والبيوكيماوية لسيرم الأسماك. لذلك وفقا للنتائج المتحصل عليها يمكن التوصية بالأستخدام المفيد للأكواماكس بلاس كمحفز للنمو لأسماك البلطي النيلي عند مستوى ٢ جرام / كجم عليقة.