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EFFECT OF USING MORINGA (*Moringa oleifera lam*.) LEAVES AS FEED ADDITIVES ON GROWTH PERFORMANCE, FEED UTILIZATION AND IMMUNE RESPONSE OF RED TILAPIA (*Oreochromis* sp.) FINGERLINGS

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ABSTRACT

The present study conducted at Mari Culture Research Center, Arish University, North Sinai. This study was done to investigate the effects of adding different concentrations of Moringa on feed utilization, productive performance and immune response of red tilapia. Moringa leaves additives were fed at three levels (0.5 %, 1% and 1.5% respectively). Eighty fish were divided in 8 aquaria for all experiments at ten fingerlings each aquarium with an average initial weight 6.1 ± 0.2 g and an average initial length 6.4± 0.5 cm. This study was carried out as four treatments with two replicates. The first group was used as control. Fish were fed diets containing 30 % crude protein twice a day at a rate of 3% / day of the fish total biomass. This experiment lasted for 14 weeks. Body weight, length and chemical analysis of whole body of red Tilapia were measured to determine growth performance, feed utilization and blood parameters at the end of experiment. The results of growth parameters indicated that T4 (1.5% Moringa) recorded high values of most growth parameters and feed utilization compared to control group. T1 (control) recorded the highest condition factor. Values of composition of blood protein and lysozyme activity were different significantly when compared with control group. In conclusion, Moringa could be added to red Tilapia fingerlings diets to improve growth rates, feed utilization and immune response.

INTRODUCTION

Moringa (*Moringa oleifera*) has been widely researched for its useful properties in a variety of animal species, special with fish. The growth promoting and health promoting properties are credited to a variety of bioactive components, with phenolic acids, vitamins, flavonoids, tannins, and saponins, which are abundant in several parts of the plant, including the leaves **(Vergara-Jimenez *et al.*, 2017)**.

Dada and Olugbemi (2013) demonstrated that medicinal plants are widely accepted as feed additives to improve feed utilisation efficiency and aquaculture productive performance. The same authors found that medicinal plants have recently been used to improve feed conversion capability and thus animal growth rates without laying down excessive amounts of fat. Moringa leaves are rich in energy, minerals, and phenolics, especially flavonoid and phenolic acids, which act as a natural antioxidant source.

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According to **Kamble *et al.* (2015)**, *Moringa oleifera*, a valued plant that could be used for the increase of viable aquaculture, it has many properties that can be practical in aquaculture. These properties contain larvicidal activity, piscicide, antimicrobial activity, and antifertility properties. Furthermore, **Richter *et al.* (2003)** discovered that using Moringa leaves in diets significantly improved the productive performance of Nile Tilapia (*Oreochromis niloticus* L.). **Abd El-Gawad *et al.* (2020)** discovered that *M. oleifera* leaf powder-supplemented diets could boost *O. niloticus* fry immune responses. Some studies have demonstrated the value of adding *Moringa oleifera* in diets to increase animal growth in general and fish growth in specific. Presence of 1.5 % Moringa leaf in the diet of Nile Tilapia (*Oreochromis niloticus*) efficiently improved growth and eased starvation stress by antioxidant indices and upregulating growth **(Elabd *et al.*, 2019; Hiam *et al.*, 2019)**.

Accordingly, this study investigated to evaluate the effect of addition moringa leaves as feed additives with different levels (0.5%, 1% and 1.5%) to red Tilapia (*Oreochromis* sp.) diets on growth rates, feed utilization and immune response .

MATERIALS AND METHODS

The study was carried out in Mari Culture Research Center (MRC), Faculty of Environmental Agricultural Sciences, Arish University, North Sinai, Egypt. This experiment lasted for 14 weeks during July, August, September and October 2019 to evaluate adding three different levels of Moringa (*Moringa oleifera* Lam.) leaves (0.5%, 1% and 1.5%, respectively) on red Tilapia fingerlings diets.

Experimental Fish and Facilities

Two hundred red Tilapia fingerlings were obtained from El-kilo 21 Marine Fish Hatchery belonging to General Authority for Fish Resources Development (GAFRD), Egypt. The fish were transferred to Mari Culture Research Center (MRC).

A total of eighty fish were equally distributed in eight glass aquaria (60 X 40 X 50 cm) with total capacity of 120 liter. Ten fingerlings per aquarium were stocked with an average initial weight 6.1 ± 0.2 g and an average initial length 6.40 ± 0.5 cm. The fish were acclimatized for two weeks and fed diets containing (30% Crude Protein) before the start of experiment. In the present work, all two replicate groups of fish hybrid red Tilapia (*Oreochromis* sp) for each treatment were fed the tested diets containing (~30% crude protein) isonitrogenous and (~ 456 Kcal/100g gross energy, GE) isocaloric and fed twice at a rate of 3%/day of the fish total biomass and adjust the feeding rate every two weeks. Every two weeks, the live weight of the fish was measured for each aquaria to know the growth rates and adjust the feeding rate of the fish.

The aquarium were daily cleaned and excreta were siphoned. The siphoned water was replaced with clean water of similar temperature before the first feeding in the morning. Each aquarium was supplied with compressed air. pH, salinity and water temperature Were measured once every week. Water salinity and temperature were recorded using conductivity-temperature meter (SET). pH was measured using a pH-meter. The water quality were, temperature averaged 25.6 ± 1.52°C, salinity averaged 28 ± 0.20 ppt, and the pH averaged 7.45 ± 0.02. Fish divided randomly into four groups (two replicates per group). Control group was fed diet (T1) free from Moringa while, from (T2) to (T4) groups were fed the control diet supplied by Moringa dry leaves powder (0.5%, 1% and 1.5%, respectively).

Experimental Diets

Ingredients the experimental diets were bought with suitable price. After making the diets, they were stored in labeled plastic bags and stored in the fridge at 4^{o}C until used. The diets formulation and chemical composition are shown in Table 1. proximate analysis of the experimental diets according to **(AOAC, 2000).**

Table 1. Proximate analysis of the experimental diets on dry matter basis

Diet	T1	T2	T3	T4
Fish meal	20	20	20	20
Soybean meal	12	12	12	12
Corn gluten	10	10	10	10
Yellow corn	35	34.5	34	33.5
Wheat bran	15	15	15	15
Medicinal plants	0	0.5	1	1.5
Linseed oil	2	2	2	2
Fish oil	2	2	2	2
Vitamamins and Minerals premix[1]	4	4	4	4
Proximate analysis				
Crud protein	30.05	30.21	30.31	30.43
Ether extract	8.87	8.94	8.96	8.98
Ash	6.41	6.51	6.49	6.52
Crude fiber	3.86	3.98	3.95	4.00
NFE	50.81	50.36	50.29	50.08
GE[2]	456.4	456.2	456.6	456.6
DE[3]	407.9	407.8	408.2	408.2
ME[4]	269.5	269.9	270.4	270.6
P/E[5]	111.5	111.9	112.1	112.4

[1]One kilogram of minerals and vitamins premix contain: 65mg manganese sulfate (MnSO4, 36 % Mn), 26mg pyridoxine HCl, 7.2mg thiamin HCl ,3077mg ferrous sulfate ($FeSO_4.7H_2O$, 20% Fe), 1.2mg sodium chloride (NaCl, 39% Na and 61% Cl), 6mg riboflavin, 150mg copper sulfate ($CuSO_4.5H_2O$, 25 % Cu) and89 mg zinc sulfate ($ZnSO_4.7H_2O$, 40 % Zn), 28mg potassium iodide (KI, 24 % K and 76 % I) , 4800 IU Vitam A, 2400 IU cholecalciferol (Vitam D), 4g Vitam B2, 6g Vitam ,B6 Vitam E, 4g Vitam B12, 8g Vitam K,6g Vitam B6, 4g pantothenic acid, 8g nicotinic acid, 400mg folic acid, 4g copper, 0.4g Iodine, 22g manganese, 22g zinc20mg biotin, 200mg choline, 12g Iron, , 0.04g selenium folic acid, 1.2mg niacin, 12mg d-calcium pantothenate,
[2]Gross energy (Kcal/100g) = 5.65 (CP %) + 9.44 (EE %) + 4.0 (NFE %) according to **(NRC, 1993)** .
[3]Digestable energy (Kcal/100g) = 5 (CP %) + 9 (EE %) + 3.5 (NFE %) according to **(NRC, 1993)** .
[4]Metabolizable Energy (Kcal/100g) = 3.9 (CP %) + 8 (EE %) + 1.6 NFE %) according to **(NRC, 1993).**
[5]P/E (mg/ Kcal) = (mg Protein/Metabolizable energy Kcal) according to Wee **(NRC, 1993).**

Growth Performance and Feed Utilization

Growth performance and feed utilization were measured using the following equations: Weight gain (WG) = final weight (g) – initial weight (g); Gain % = (WG/W1) x 100; Condition factor (K) = (W/L^3) x 100, where, W is weight of fish in grams and L is total length of fish in cm; specific growth rate (SGR) = (LnW2 – LnW1)/ t X 100, Where, Ln is the natural log; W1 is initial body weight and W2 is the final body weight in grams and "t" is the experimental period in days; feed conversion ratio (FCR) = Feed intake

(g)/Weight gain (g); Feed efficiency (FE %) = gain in weight (g) / feed intake (g) ; protein efficiency ratio (PER) = weight gain (g)/protein ingested (g); protein productive value (PPV%) = (retained protein/protein intake) X 100 and EPV% = energy retained / energy intake Retention of nutrients = (Final body weight x final nutrient concentration) - (Initial body weight x initial nutrient concentration).

Biochemical Blood Indices

At the end of each experiment, the blood samples from six fish of the different treatments were collected by caudal vessels and the blood samples were taken in dry clean centrifuge tubes. Blood was separated at 3000 rpm for 15 minutes using digital centrifuge, kept in plastic vials well and stoppered at -20 °C until biochemical analysis. The serum total protein (g/dl) was determined by the method of **Doumas (1975)**, while Serum albumin was determined according to the method of **Doumas *et al.* (1971).** The globulin and albumin-globulin ratio were determined according to the method of **Coles (1986)**. The serum enzymes Alanine aminotransferase (ALT) and Aspartate aminotransferase (AST) were assayed by the method to **Reitman and Frankel (1957)** .Serum lysozyme activity (µg/ml) was determined by the method of **Ellis (1990) .**

Proximate Analysis

Proximate composition analyses of diets and whole body according to **(AOAC, 2000)** methodology on dry matter basis.

Statistical Analyses

Mean values and standard error (mean ± SE) for each parameter of all treatments were first calculated. Data were tested using the analysis of variance one way **(ANOVA)** using SAS **(SAS, 2004)**. Where a significant difference was observed for a measured value, mean separated using Duncan's multiple range test **(Duncan, 1955)** at the 5% level.

RESULTS

Growth Performance and Feed Utilization

The average initial weight, final weight, total weight gain, average daily weight gain (ADG), relative growth rate (RGR, %), specific growth rate (SR %), Survival rate, the initial length, final length and condition factor (K) of red Tilapia (*Oreochromis* sp.) fingerlings are presented in Table 2 and Fig. 1.

Results displayed that final weight, weight gain and ADG of fed diets fish containing T2, T3, and T4 treatments were increased significantly ($P<0.05$) than those fed the control diet. At the same time, Survival rate was 100% for fish fed diets contained T3.

In regard to specific growth rate (SGR) and relative growth rate (RGR) the result reported that significant increase ($P < 0.05$) with T2, T3, and T4 than those fed the control diet.

The best final weight, weight gain and ADG were recorded when fish fed with T4 group. Condition factor (K) found better in T4 fish group (1.6) while, the lowest was found with T1 (2.2).

Feed intake, protein intake, ether extract intake, ash intake, energy intake, Feed Efficiency (FE) and feed conversion ratio (FCR) of the experimental diets are presented in Table 3 and Fig. 3. Recorded results showed high and significantly ($P<0.05$) values of feed intake, protein intake, for T4 (55, 16.8, 4.955, 251.4 and 55.03) respectively when compared with control group T1. Best feed conversion ratio (FCR) was obtained for fish fed T4 diet as (1.81),

Table 2. Growth performance of red tilapia as affected by addition of Moringa with different concentrations in fish diets

	Experimental Diet			
***Item**	**T1**	**T2**	**T3**	**T4**
Initial weight (g/fish)	6.2 ± 0.45	5.9 ± 0.40	6.2 ± 0.10	6 ± 0.30
Final weight (g/fish)	25 ± 0.68^{d}	30 ± 0.66^{c}	33 ± 0.30^{b}	36 ± 0.25^{a}
Gain in weight (g/fish)	19 ± 0.23^{d}	24 ± 0.26^{c}	27 ± 0.20^{b}	30 ± 0.55^{a}
Average daily gain (g/fish/day)	0.19 ± 0.0024^{d}	0.25 ± 0.0027^{c}	0.27 ± 0.002^{b}	0.31 ± 0.0056^{a}
Relative growth rate %	300 ± 18^{d}	410 ± 24^{bc}	430 ± 3.80^{ab}	510 ± 34^{a}
Specific growth rate %	1.42 ± 0.046^{c}	1.66 ± 0.047^{ab}	1.71 ± 0.0072^{a}	1.84 ± 0.058^{a}
Survival rate %	95 ± 5	95 ± 5	100 ± 0	95 ± 5
Initial length (cm)	6.4 ± 0.1	6.6 ± 0.15	6.6 ± 0.2	6.8 ± 0.35
Finial length (cm)	10 ± 0.15^{c}	12 ± 0.10^{b}	12 ± 0.10^{b}	13 ± 0.11^{a}
Gain length (cm)	4.1 ± 0.05^{c}	5.4 ± 0.05^{bc}	5.7 ± 0.10^{ab}	6.2 ± 0.24^{a}
Condition factor (K)	2.2 ± 0.034^{a}	1.7 ± 0.0053^{b}	1.8 ± 0.027^{b}	1.6 ± 0.053^{c}

*Means followed by different letters in each row are significantly different (P<0.05)

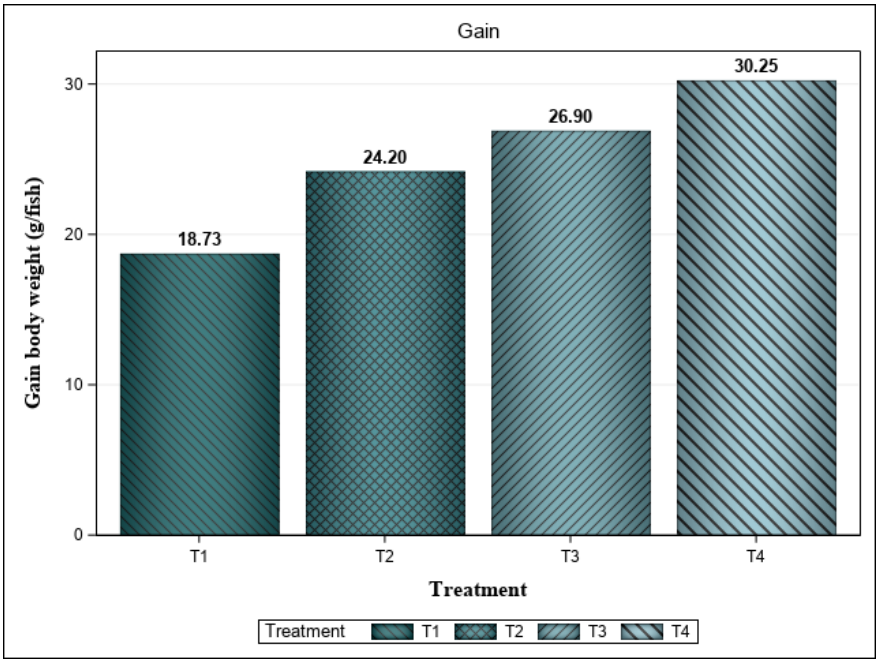

Fig. 1. The effect of adding Moringa leaves to the diets on body weight of red Tilapia (*Oreochromis* sp.) fingerlings

Table 3. Feed utilization as affected by different levels of Moringa additives for red Tilapia (*Oreochromis* sp.) fingerlings

	Experimental Diet			
***Item**	**T1**	**T2**	**T3**	**T4**
Feed intake (g fish-1)	40.93 ± 2.033^{d}	47.73 ± 1.286^{c}	51.49 ± 0.0042^{b}	55 ± 0.9173^{a}
Protein intake (g fish-1)	12.3 ± 0.60^{d}	14.47 ± 0.39^{c}	15.67 ± 0.00^{b}	16.81 ± 0.28^{a}
Ether extract intake	3.633 ± 0.22^{d}	4.277 ± 0.12^{c}	4.624 ± 0.00^{b}	4.955 ± 0.08^{a}
Energy intake	187 ± 9.53^{d}	218.1 ± 5.87^{c}	235.3 ± 0.00^{b}	251.4 ± 4.22^{a}
FCR[1]	2.185 ± 0.08^{a}	1.972 ± 0.03^{b}	1.914 ± 0.014^{c}	1.819 ± 0.06^{d}
FE[2]	45.83 ± 1.7020^{c}	50.72 ± 0.8219^{b}	52.24 ± 0.3927^{b}	55.03 ± 1.9200^{a}
PER[3]	1.525 ± 0.05^{c}	1.673 ± 0.02^{b}	1.717 ± 0.017^{ab}	1.801 ± 0.06^{a}
PPV[4] (%)	27.51 ± 1.20^{c}	33 ± 0.82^{b}	34.37 ± 0.34^{b}	36.43 ± 1.16^{a}
EPV[5] (%)	15.17 ± 0.63^{c}	17.35 ± 0.44^{b}	18.06 ± 0.12^{b}	19.27 ± 0.76^{a}

*Means followed by different letters in each row are significantly different $P < 0.05$. 1- FCR= feed conversion ratio, 2- FE= feed efficiency, 3- PER= protein efficiency ratio, 4- PPV= protein productive value, EPV= energy productive value.

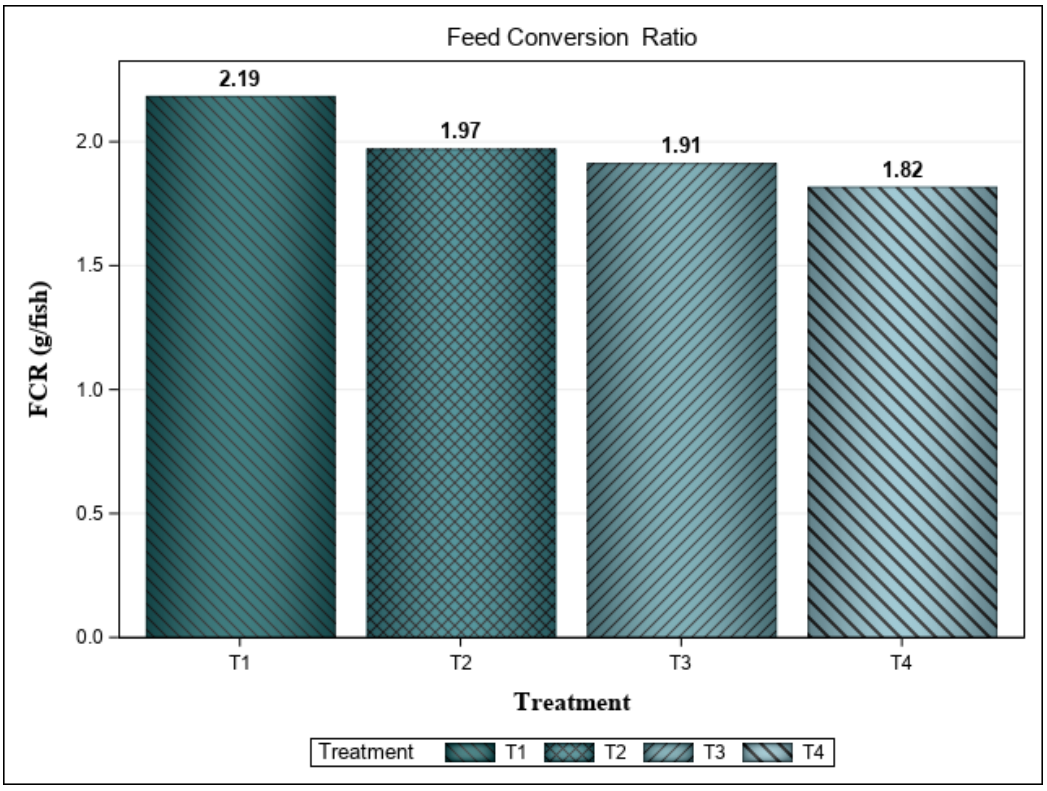

Fig. 2. Feed conversion ratio (FCR) as affected by different levels of Moringa additives for red Tilapia (*Oreochromis* sp.) fingerlings

at the same time, relatively the worst FCR as (2.18) was that recorded for fish fed control diet. Also Table 2 show the averages of the protein efficiency ratio (PER) , protein productive value (PPV) and energy productive value (EPV) after 98 days of the experimental start at the end of feeding trials. It appears that fingerlings hybrid red Tilapia (*Oreochromis* sp.) fed on diets supplemented with T2, T3 and T4 were recorded the highest significant in PPV values (33, 34.37 and 36.43, respectively). Similarly, feeding red Tilapia (*Oreochromis sp.*) fingerlings fed diets supplemented with T2, T3 and T4 achieved the high EPV values (17.35, 18.06 and 19.27, respectively) compared with T1 group. On the other hand, the best protein efficiency ratio (PER) was obtained for fish fed T4 diet (1.8), followed by fish fed T3 diet (1.71).

Body Composition and Energy Content of Whole-Body Fish

Chemical composition of whole body fish on dry matter (DM), crude protein (CP), either extract (EE), ash content and gross energy content of red tilapia (*Oreochromis* sp.) at the beginning and the end of the experimental period shown in Table 4. Dry matter and ash contents expressed as percentages of whole body, were high (31.36, 22.98), respectively at the start of the experiment and lower in crude protein and ether extract than those at the end of experiment. At the end trails the result showed that crude protein was high significantly ($P<0.05$) in T4 group with value 66.32 compared with control group. The energy content kcal/100g.DM fish at the end of the experiment were significantly higher in control T1 than that all other groups. At the end of feeding trial protein, fat, ash and energy retained are presented in Table 5. The D3 diet, showed higher retention significantly for all parameters than other groups.

Blood Parameters

Serum biochemical parameters could be used as indicators of the nutritional and physiological status of red Tilapia fish (*Oreochromis* sp.); results are presented in Table 6 and Fig. 3. It is noticed that dietary treatment was significantly affected ($P<0.05$) total protein, albumin, Globulin, A/G ratio, lysozyme, alanine aminotransferase (ALT) and aspartate aminotransferase (AST). Red Tilapia fed T4 had high ($P\leq0.05$) total protein, Globulin, lysozyme (5.31, 2.64 g/dl and 4.22 µg/ml, respectively) as compared to the control group. Albumin (2.83 g/dl) was increased ($P\leq0.05$) by feeding red Tilapia on diets supplemented with T3 compared with the other treatments.

DISCUSSION

The medicinal plants use in aquaculture has improved significantly over the last decade for a variety of purposes contain sex reversal compound **(Mirzargar *et al.*, 2011)**, growth enhancer **(Asadi *et al.*, 2012)**, immune stimulant, and antipathogenic **(Yılmaz *et al.*, 2013)**.

Growth Performance and Feed Utilization

Moringa is a source of plant-based protein which can be used for fish feed formula, because it contains protein up to 30.3% and has 19 amino acids like methionine, cysteine, and tryptophan **(Moyo *et al.*, 2011)**, as well as vitamins B, C, K, and beta carotene **(Ganzon-Naret, 2014)**. Moringa leaves contain high energy, minerals and phenolics, particularly flavonoid and phenolic acids as natural antioxidant source **(Valdez-Solana *et al.*, 2015)**.

Our study was designed to look into the effects of three different concentrations of Moringa dry leaves on growth performance, feed utilization, and feed utilization in red Tilapia diets.

Table 4. Chemical composition and energy content of whole body of red tilapia as affected by different levels of Moringa additives for red Tilapia (*Oreochromis* sp.) fingerlings on dry matter basis

		Experimental diet			
***Item**	**Initial sample**	**T1**	**T2**	**T3**	**T4**
DM	31.36	28.09 ± 0.09^{c}	29.35 ± 0.15^{b}	29.58 ± 0.03^{a}	29.64 ± 0.02^{a}
CP	63.52	63.1 ± 0.23^{d}	65.22 ± 0.21^{c}	65.65 ± 0.03^{b}	66.32 ± 0.11^{a}
EE	13.5	22.15 ± 0.31^{a}	19.22 ± 0.08^{b}	18.96 ± 0.11^{b}	18.82 ± 0.19^{b}
ASH	22.98	14.75 ± 0.08^{b}	15.56 ± 0.12^{a}	15.4 ± 0.07^{a}	14.86 ± 0.07^{b}
GE	549.31	565 ± 1.68^{a}	541 ± 1.72^{c}	549 ± 0.39^{b}	549 ± 0.85^{b}

*Means followed by different letters in each row are significantly different $P < 0.05$

Table 5. Protein, fat, ash and energy retained of whole-body composition with different levels of Moringa additives for red Tilapia (*Oreochromis* sp.) fingerlings at the end of the experiment

	Experimental diet			
***Item**	**T1**	**T2**	**T3**	**T4**
Protein retained (g)	3.18 ± 0.00^{d}	4.59 ± 0.00^{c}	5.19 ± 0.05^{b}	5.93 ± 0.10^{a}
Fat retained (g)	1.29 ± 0.04^{d}	1.45 ± 0.02^{c}	1.59 ± 0.00^{b}	1.77 ± 0.05^{a}
Ash retained (g)	0.586 ± 0.013^{d}	0.949 ± 0.01^{c}	1.06 ± 0.016^{b}	1.16 ± 0.03^{a}
Energy retained (g)	30.1 ± 0.39^{d}	39.5 ± 0.17^{c}	44.3 ± 0.32^{b}	50.1 ± 1.02^{a}

*Means followed by different letters in each row are significantly different $P < 0.05$

Table 6. Effect of dietary levels of Moringa leaves in diets on blood biochemical parameters of red Tilapia (*Oreochromis* sp.) fingerlings

	Experimental diet			
Item	**T1**	**T2**	**T3**	**T4**
Total Protein (g/dl)	2.86 ± 0.095^{d}	3.88 ± 0.310^{c}	4.43 ± 0.090^{b}	5.31 ± 0.130^{a}
Albumin (g/dl)	1.32 ± 0.10^{c}	2.44 ± 0.12^{b}	2.83 ± 0.04^{a}	2.67 ± 0.08^{a}
Globulin (g/dl)	1.54 ± 0.195^{b}	1.44 ± 0.430^{b}	1.6 ± 0.050^{b}	2.64 ± 0.050^{a}
Albumin/globulin ratio (A/G)	0.882 ± 0.177^{b}	1.89 ± 0.647^{a}	1.77 ± 0.0303^{a}	1.01 ± 0.0112^{b}
lysozyme (µg/ml)	1.52 ± 0.12^{d}	2.94 ± 0.01^{c}	3.29 ± 0.03^{b}	4.22 ± 0.12^{a}
AST (u/l)	47.8 ± 0.66^{a}	41.2 ± 0.71^{b}	40.5 ± 0.61^{b}	38.8 ± 0.79^{c}
ALT (u/l)	23.5 ± 0.86^{a}	18.8 ± 0.68^{b}	17.5 ± 0.23^{c}	17.1 ± 0.45^{c}

*Means followed by different letters in each row are significantly different $P < 0.05$

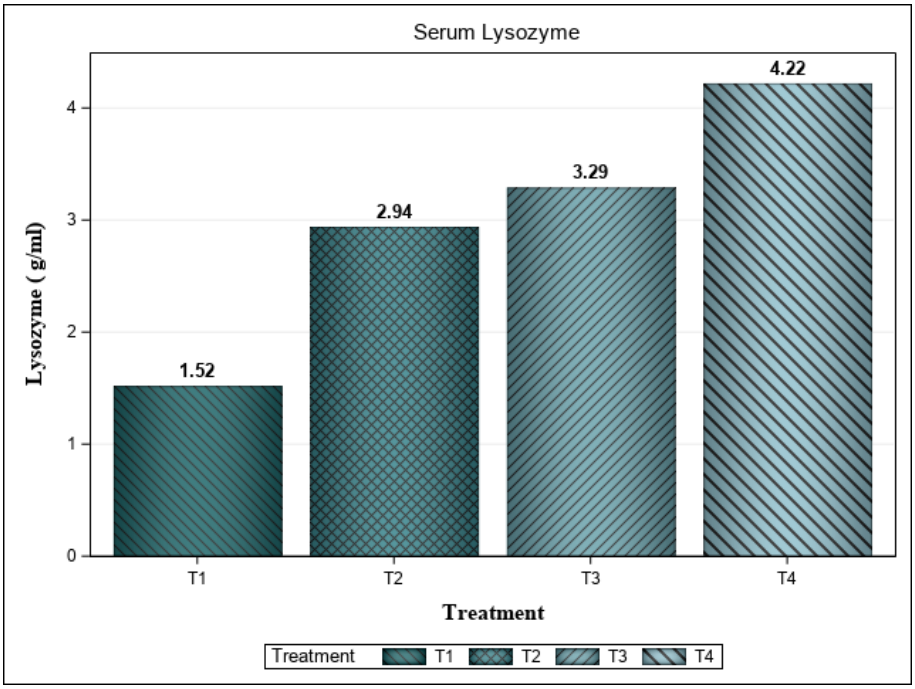

Fig. 3. Serum lysozyme (µg/ml) in growing red Tilapia (*Oreochromis* sp.) as affected by different levels of Moringa leaves in diets of red Tilapia (*Oreochromis* sp.) fingerlings

In the current study, the best final weight, weight gain, average daily gain (ADG) and survival rate obtained in fish which fed on diets containing Moringa (0.5%, 1% and 1.5%) were increased significantly ($P<0.05$) than those fed the control diet. These results are in agreement with **Ayoub *et al.* (2019)** who found that fish fed 1% of Moringa (*Moringa oleifera*). It led to a significant increase ($P<0.05$)in Relative percent survival. Furthermore, **Puycha *et al.* (2017)** demonstrated that *M. oleifera* leaf supplementation aids in growth improvement and efficient utilization. The current findings are consistent with those of **Karpagam and Krishnaveni (2014),** who discovered significant increase in weight and specific rate of growth in *Oreochromis mossambicus* fed *Moringa oleifera* leaves as a growth promoter at a 5% concentration supplemented feed.

The best growth rates of fish fed Moringa leaf meal could be refer to improved protein utilization, this is supported by reduced ammonia in water and blood urea in fish fed Moringa. Elevated ammonia levels occur, resulting in oxidative stress and tissue damage, which, in turn, suppresses growth performance as a result of poor protein utilization, **(Hoseini *et al.*, 2019; Mirghaed *et al.*, 2019; Rajabiesterabadi *et al.*, 2020)**. Furthermore, the increased growth may be due to the high concentrations of antioxidants found in Moringa (*Moringa oleifera* lam) leaves, such as - vitamin C and carotene which improve fish health **(Vergara-Jimenez *et al.*, 2017)**.Also, the results agree with those of **El-Kassas *et al.* (2020)**, who discovered that including Moringa in the diet at a concentration of 5% significantly improved growth performance, as indicated by final body weight gain, body gain, specific growth rate and improved feed conversion Ratio (FCR). **Ayoub *et al.* (2019)** found that Tilapia fed a diet adding with 1% *M. oleifera* had a lower percent of mortality than Tilapia fed a control diet. Moringa's

protective effect may be due to the presence of powerful antioxidant agents that can be associated with increased production of antibodies that aid in fish survival and recovery **(Hammed *et al.*, 2015)**. **Stohs and Hartman (2015)** reported that *M. oleifera* contains niaziridin as an active component with the ability to improve the absorption of several minerals, micro-nutrients, and vitamins in the gastrointestinal tract. Moringa's protective effect may be due to the presence of powerful antioxidant agents, which can be linked to an increase in antibody production, which aids in fish survival and recovery **(Hammed *et al.*, 2015)**. **Stohs and Hartman (2015)** found that *Moringa oleifera* contains niaziridin as an active component that can improve the absorption of various minerals, micronutrients, and vitamins in the gastrointestinal tract.

In this study the feed conversion ratio ranged from 1.82 ± 0.06 to 2.18 ± 0.20**;** and the feed efficiency values ranged from 45.83± 3.44 to 55.03 ± 1.92%. The high level of feed efficiency value depicts that feed has good quality, so that red Tilapia (*Oreochromis* sp) utilized feed optimally.

According to **Billah *et al.* (2020)**, dietary Moringa powder could be involved in the diet to improve survival, growth, and immune response. We conclude that feeding Moringa leaves in the diet was effective in improving the growth performance of Nile Tilapia (*Oreochromis niloticus*) and feed conversion ratio. Nile Tilapia's health may benefit from additives.

Blood Parameters

Today, biochemical and haematological parameters are important parameters used in aquaculture to reflect fish growth performance and health **(Fazio *et al.*, 2013 ; Fazio, 2019).**

In this study, fish that fed T4 had high (P≤0.05) total protein (5.31, g/dl), serum globulin, (2.64, g/dl) and lysozyme (4.22, µg/ml) as compared to the control and others treatment. When, Albumin (2.83 g/dl) was increased (P≤0.05) by feeding red Tilapia (*Oreochromis* sp) on diets supplemented with T3 compared with the other treatments. However, feeding fish on the control diets lead to increase (P≤0.05) AST (47.8) while, noticed higher significant was the control group which was the best treatment when compared with other groups in ALT (23.5u/l). These results are in agreement with **Ayoub *et al.* (2019)** who found an improvement in fish health status when fish fed a diet containing moringa plant by 1%. The current study supports the findings of **Monir *et al.* (2020)**, who observed that incorporating plant Moringa (*Moringa oleifera*) into fish diets resulted in high significant levels of globulin and total protein due to the improvement of the immune response and antibody production or to an increase in palatability, digestibility, and absorbability **(Nayak *et al.*, 2004)**. On the other hands, moringa had some negative influences on blood indicators **(Billah *et al.*, 2020)** and, **(El-Gawad *et al.*, 2011)** observed no high difference in growth rates when Tilapia fed on dietary supplementation of *M. oleifera* leaf powder. Moreover, **Richter *et al.* (2003)** observed that the insignificance in growth rates of Tilapia (*Oreochromis niloticus*) may due to the Moringa leaf content from saponins, tannins and phenol which led to lower growth rates in Tilapia **.** One of the most important components of fish defense mechanisms, lysozyme works by activating the complement system and phagocytosis **(Magnadottir, 2006).** Furthermore, lysozyme has antibacterial **(Saurabh and Sahoo, 2008)**. These results were consistent with those of **Ardo *et al.* (2008)**, who discovered high increase in lysozyme activity in Nile Tilapia after one week of feeding. others have reported that feeding *M. oleifera* leaf resulted in significantly increased lysozyme activity **(Khalil and Korni, 2017)**.

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الملخص العربي

تأثير استخدام أوراق نبات المورينجا (*Moringa oleifera*) كإضافات علفية على أداء النمو، والاستفادة الغذائية والاستجابة المناعية لأصبعيات البلطي الأحمر (*Oreochromis*)

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تمت الدراسة بمركز بحوث الاستزراع البحري، جامعة العريش، شمال سيناء، مصر، تهدف الدراسة إلى تقييم تأثير إضافة نسب مختلفة من اوراق المورنجا الجافة على أداء النمو والاستفادة من الغذاء والاستجابة المناعية لإصبعيات البلطي الأحمر حيث تم توزيع 80 سمكة في 8 احواض زجاجية (120 لتر) بمعدل 10 سمكات للحوض الزجاجى بمتوسط وزن إبتدائي 6.1 ±0.2 جرام ومتوسط طول إبتدائي 6.4± 0.5 سم. أقلمت الأسماك لمدة أسبوعين على ظروف التجربة، صممت هذه التجربة من 3 معاملات بجانب المجموعة الضابطة ولكل معاملة مكررتين. المجموعة الأولى كانت المجموعة الضابطة التي تغذت على نظام غذائي بدون مكملات غذائية، المجموعة الثانية والثالثة والرابعة تم تغذيتها على النظام الغذائي الضابط المزود بمسحوق أوراق المورينجا الجافة (0.5٪، 1٪، 1.5٪ على التوالي). غذيت الاسماك على علائق تحتوي على 30٪ بروتين خام وتم تغذيت الاسماك مرتين في اليوم بمعدل 3٪ من إجمالي وزن الجسم لمدة 14 أسبوعًا. في نهاية التجربة تم حساب وزن الجسم والطول النهائى والتحليل الكيميائي لجسم الاسماك لحساب معاملات النمو واستخدام العلف وتم اخذ بعض قياسات الدم. أشارت نتائج معاملات النمو إلى أن المجموعة رقم 4 سجلت أعلى قيم لمعظم معاملات النمو واستخدام العلف مقارنة بالمجموعة الضابطة. لكن المجموعة الضابطة سجلت أعلى معامل حالة (K). أظهرت قيم تكوين بروتين الدم ونشاط الليزوزيم اختلافات معنوية ($P < 0.05$) بين جميع مجموعات الأسماك. في الختام نستنتج من ذلك انه من الممكن إضافة نبات المورينجا (*Moringa oleifera*) إلى علف إصبعيات البلطي الأحمر لتحسين معدلات النمو واستخدام الأعلاف والاستجابة المناعية وان اضافتها بالحدود المذكورة يكون سهل التطبيق وامن الاستخدام ومفيدا.

الكلمات الاسترشادية: البلطي الاحمر، أوراق المورنجا، أداء النمو، الاستفادة الغذائية، الاستجابة المناعية.

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