Menoufia J. Animal, Poultry & Fish Prod., Volume 7 Issue 9 (2023) : 87 – 99

MENOUFIA JOURNAL OF ANIMAL, POULTRY AND FISH PRODUCTION

https://mjapfp.journals.ekb.eg/

THE INFLUENCES OF DIETARY NATURAL ZEOLITE SUPPLEMENTATION AND STOCKING DENSITY ON THE PERFORMANCE OF MONO-SEX NILE TILAPIA FRIES IN HAPAS

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Received: Dec. 3, 2023 Accepted: Dec. 16, 2023

ABSTRACT: A 12- week feeding trial was conducted to examine the effects of dietary zeolite and stocking density on the performance of mono-sex Nile tilapia, (*Oreochromis niloticus*) fries reared in hapas. Diets supplemented with different levels of natural zeolite (0, 15 and 30 g/kg diet), defined as CTRL, Z15 and Z30. The initial weight of fish was (1.75±0.02 g) and were randomly distributed in 18 hapas (1.5 × 0.5 × 1.0 m^3) located in six concrete tanks (2 × 2 × 1 m^3) under two levels of stocking density (20 and/or 40 fries/hapa). The diets used in the trial were designed to be comparable in crude protein (30.8 ± 0.2%) and crude lipids (5.04 ± 0.06%). The obtained results showed significant interaction between zeolite level and stocking density for temperature, dissolved oxygen, pH and ammonia concentrations in the rearing water. A significant increase in final body weight (FBW), weight gain (WG), average daily gain (ADG) and specific growth rate (SGR) was found and fish fed a diet supplemented with 30 g /kg of zeolite (Z30) in the high stocking density (40 fish/hapa) had the best feed conversion ratio (FCR) in comparison with the other groups, while a significant decreasing trend was observed in the survival rate by increasing the dietary zeolite level. Furthermore, notable variations were noted in feed consumption between fish fed diets varied in amount of dietary zeolite. In terms of, protein efficiency ratio (PER) results showed that fish fed Z30 diet in the high stocking density significantly differed among all treatments and followed by fish fed CTRL diet in the low stocking density. The outcomes of body composition examination revealed that the lowest dry matter was in fish fed CRTL diet without zeolite supplementation and more significance differences were observed in the interaction effect between dietary zeolite and stocking density in terms of protein content. Ash content values were increased by increasing the dietary zeolite level with significant differences. The least amount of lipids was found in fish fed Z30 diet under the high stocking density (40 fish/hapa). These findings led us to the conclusion that natural zeolite can be added to the diets at 30 g/kg under high stocking density (40 fries/hapa) and may improve the efficacy of mono-sex Nile tilapia fries reared in hapas.

Key words: Feed additive; Zeolite; Stocking density; Nile tilapia; Performance.

INTRODUCTION

Oreochromis niloticus (L.), often known as the Nile tilapia, is a prominent species in freshwater aquaculture. Fish farmers have significant difficulties due to the resilience of enhancing fish health and performance of farmed fish (Nicolae *et al.*, 2016). Intensive Nile tilapia culture typically calls for balanced diets that are made with a variety of substances, particularly additions that effectively support fish physiological and dynamic processes. After carp, tilapia is currently the most extensively farmed aquatic species worldwide (Ayyat *et al.,* 2020). Of all species of cultured fish produced in Egypt, Nile tilapia (*Oreochromis niloticus*) accounted for 71.2% of the entire production, or 4.2 million tones (FAO, 2018). However, fish at high stocking density are particularly stressed because they are more vulnerable to parasites, viruses, and bacteria (Wang *et al.,* 2015). Aquaculture is significantly expanding faster globally when compared to other agro-related industries and fish production rose when aquaculture was intensified but it also brought forth a number of diseases, including stress and pathogenic conditions in aquatic species (Mehboob *et al.*, 2017). Zeolites, a type of clay, contain limitless

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three-dimensional structures and are crystalline, hydrated aluminosilicates of alkali and alkaline earth cations (Mumpton, 1999). Because of their growth-promoting, detoxifying, and nutrient-absorbing qualities, they are employed as filler or supplement in livestock and fish diets (Eya *et al.*, 2008). In order to reduce nitrogen pollution, a certified diet that matches the physiological needs of the fish as well as high-quality raw materials is required. This feed is digestible with nutrients balanced. Furthermore, feed additives, such as zeolite, may help with this. The fish will feed a lot of food, zeolite will help to minimize the amount of nitrogen in the tank (Yıldırım *et al.,* 2009), and serve as a growth enhancer feed additive in fish diets (Arshad *et al.,* 2021). Therefore, the purpose of this study was to assess how various zeolite supplementation amounts affected the effectiveness of mono-sex Nile tilapia (*Oreochromis niloticus*) fries raised in hapas at two stocking densities.

MATERIALS AND METHODS

Experimental design

Mono-sex Nile tilapia, *Oreochromis niloticus* fries were acquired from a nearby hatchery in Kafr El-Shaikh, Egypt, and were acclimated to laboratory conditions for a period of two weeks. A number of 540 fries with mean initial weight of 1.7± 0.02 g were divided at random into 18 hapas (net enclosures of 1.5 m × 0.5 m × 1 m) that were set up in six concrete basins measured 4 m^3 filled with fresh water. Fish were divided into two stocking density as 20 and/or 40 fries with three replicates/ treatment. The Institutional Laboratory Animal Care and Use Committee of Menoufia University in Egypt provided recommendations that were followed for all operations including animal handling. Fish from each hapa were counted and weighed each two weeks to evaluate the growth and readjust the feeding rate. Fish in each of the three groups were fed one of the experimental diets at a rate of roughly 7% of their body weight, which was progressively reduced to 3% by the end of the feeding study. Fish were fed three meals a day (9.00 a.m., 11 a.m., and 1 p.m.) for six days a week, with a 12-week feeding trial.

Experimental diets

The basal diet was formulated to contain 30.8 ± 0.2% as crude protein and 5.04 ± 0.06% ether extract (Table 1). The zeolite levels were added to the basal diet and were performed (g/kg diet) as, CTRL, Z15 and Z30 zeolite (statement of the supplier A&O Trading, Giza, Egypt, Table 2). The items listed in Table (1) were carefully mixed to make the experimental diets. According to AOAC (2012), the proximate composition of the experimental diets was established.

Body composition

Following the feeding trial, samples of the experimental fish were obtained in order to assess the moisture, protein, lipid, and ash contents using the regular methods (AOAC, 2012). For analysis, six fish were taken from each treatment. Blended samples were utilized only for biochemical analysis and stored at -18°C. Following drying in a drying oven at 105°C for six hours, the dry matter was measured. Crude protein and crude lipids were evaluated separately using the micro Kjeldahl (N × 6.25) and Soxhlet method for ether extraction analysis, respectively. The amount of ash was measured using a furnace muffler set to 600°C for two hours.

Growth performance parameters

1. Weight gain was measured as following

Weight gain (g/fish) = Final weight (g) - Initial weight (g).

2. Average daily gain was determined as following

Average daily gain (g/fish/day) =

[Final weight (g) - Initial weight (g)]/n

Where, n is the experimental period.

3. Specific growth rate

Specific growth rate (SGR %/ day) was calculated using the equation:

SGR (%/day) = 100 × (Ln FBW−Ln IBW) /T

Where, FBW is the final fish weight at the end of the experiment; IBW is the initial weight at the start of the experiment; Ln is the natural log and T is the experiment period (Days).

Table (1). Ingredients and chemical composition of the experimental diets.

	Dietary groups (g/kg)		
Ingredients (g/kg)	**CTRL**	**Z15**	**Z30**
Fish meal (65%)	100	100	100
Soybean meal (44%)	400	400	400
Yellow corn (7.5%)	150	150	150
Wheat bran (10%)	180	165	150
Wheat flour (14%)	140	140	140
Vegetable oil	20	20	20
Premix[1]	10	10	10
Zeolite®[2]	-	15	30
Total	1000	1000	1000
Chemical analysis (%)			
Dry matter	89.96	90.80	91.60
Crude protein	30.75	30.78	30.77
Ether extract	5.05	5.00	5.04
Ash	5.60	5.20	5.50
Crude fiber	5.71	5.69	5.68
NFE[3]	52.89	53.33	53.01
GE (kcal/100g)[4]	444.66	446.21	445.18
ME (kcal/100g)[5]	363.87	365.13	364.29

[1]Premix: HI-MIX®AQUA (Fish) each one kilogram (1 kg) contains; vitamin A, 4,000,000 International Unit (IU); vitamin D_3, 8,00,000 IU; vitamin E, 40, 000 IU; vitamin K_3, 1,600 mg; vitamin B_1, 4,000 mg; vitamin B_2, 3,000 mg; vitamin B_6, 3,800 mg; vitamin B_{12}, 3 mg; Nicotinic acid 18000 mg; Pantothenic acid, 8000 mg; Folic acid, 800 mg; Biotin, 100 mg; Choline chloride 120,000 mg; Iron, 8000 mg; Copper, 800 mg; Manganese, 6000 mg; Zinc, 20,000 mg; Iodine, 400 mg; Selenium, 40 mg; Vitamin C (coated), 60,000 mg; Inositol, 10,000 mg; Cobalt, 150 mg; Lysine, 10,000 mg; Methionine, 10,000 mg; Antioxidant, 25,000 mg.

[2]Zeolite® Natural zeolite (Clinoptilolite).

[3]Nitrogen Free Extract (NFE) = 100 – (% Protein + % Fat + % Fiber + % Ash).

[4]GE (kcal/100g DM) = Gross energy based on protein (5.65 kcal/g), Fat (9.45 kcal/g), and carbohydrate (4.22 kcal/g) according to (NRC, 2011).

[5] ME (kcal/100g DM) = Metabolically energy was calculated by using factors 4.5, 8.1 and 3.49 kcal/g for protein, fat and carbohydrates, respectively according to Pantha (1982).

Table (2). Chemical composition of zeolite (Clinoptilolite).

*Component	%
SiO_2	65.00 – 71.30
Al_2O_3	11.50 – 13.10
CaO	2.70 – 5.20
K_2O	2.20 – 3.40
Fe_2O_3	0.70 – 1.90
MgO	0.60 – 1.20
Na_2O	0.20 – 1.30
TiO_2	0.10 – 0.30
Si/Al	4.80 – 5.40

*Statement of the supplier (A&O Trading, Giza, Egypt).

4. Survival rate

Survival rate (%) was estimated using the equation:

Survival rate (%) = 100 × (no. of survived fish at the end of the experiment ÷ no. of survived fish at the beginning of the experiment).

Feed utilization parameters

1. Feed conversion ratio (FCR)

Feed conversion ratio (FCR) was calculated according to the following equation:

FCR = Feed consumed (g) during the experimental period ÷ weight gain during the experimental period (g)

2. Protein efficiency ratio (PER)

Protein efficiency ratio (PER) was calculated according to the following equation:

PER = Weight gain (g) ÷ Protein intake (g)

Water quality parameters

The modern YSI Model 58 was used to regulate weekly water testing for the measurement of ammonia, pH, temperature, and dissolved oxygen (APHA, 1995). The water-quality data averaged during the feeding trial to (±SD): water temperature, 27.47 ± 1.35 °C; dissolved oxygen, 7.90 ± 1.9 mg^{-1}; pH, 7.68 ± 0.27; ammonia, 0.036 ± 0.00 mg^{-1} and it was under normal conditions for rearing Nile tilapia.

Statistical analysis

By using a two-way ANOVA, the differences between the tested groups were analyzed. Arcsine conversion was used to determine the percentage of particular growth rates prior to the ANOVA analysis. $P < 0.05$ was used to determine the significance of differences. Duncan's multiple range test was used to assess the differences between means (Duncan, 1955).

The statistical model used

$Y_{ij} = \mu + H_i + C_j + (H \times C)_{ij} + e_{ij}$

where:

Y_{ij} : Observation of zeolite levels, j stocking density;

μ : General mean;

H_i : Fixed effect of zeolite level

C_j : Fixed effect of stocking density;
$(H \times C)_{ij}$: Effect of interaction $(H \times C)_{ij}$;
e_{ij} : Residual effect.

RESULTS

Water quality

Concentrations of water quality parameters were in the normal range suitable for rearing Nile tilapia. Final results were presented in (Table 3). There were no appreciable variations in temperature across all treatments excepting control. There were notable variations in the levels of dissolved oxygen, pH, and ammonia. Enhanced dissolved oxygen (DO) by adding zeolite and decreasing stocking density were observed. Significant interaction between zeolite level and stocking density for temperature, DO and pH concentrations was found. In terms of ammonia concentration, the obtained results displayed significant differences with decreasing trend by increasing the dietary zeolite levels (Table 3; Fig. 1).

Growth performance

Table (4) displays the results of initial body weight (IBW), final body weight (FBW), weight gain (WG), average daily gain (ADG), and specific growth rate (SGR). Fish fed diet supplemented with 30 g zeolite/kg recorded the highest final body weight and significantly differed ($P< 0.05$) among all treatments (Fig. 2). Fish fed Z30 under high density gained the highest final weight compared to control and other treatments with significant differences and the same trend was observed in WG, ADG and SGR (Table 4). Declining pattern was observed in survival rate by increasing dietary zeolite level with significant differences (Table 4; Fig. 3).

Feed utilization

There were notable variations in the amount of feed consumed between fish fed diets with varying amounts of dietary zeolite (Table 4). The interaction effect between dietary zeolite and stocking density showed that feed consumption did not significantly differ among all dietary treatments except fish fed the control diet and that supplemented with 15 g/kg zeolite in the high density which consumed the lowest feed, respectively. The dietary zeolite amount increased, improving the feed conversion ratio (FCR) (Table 4). The interaction effect showed significant differences among all treatments and the best FCR was observed in fish fed diet supplemented with 30 g/kg zeolite in the high stocking density (40 fish/hapa). Protein efficiency ratio (PER) results showed that fish fed diet supplemented with 30 g/kg dietary zeolite in the high stocking density differed significantly among all treatments and followed by fish fed diet without zeolite in the low stocking density (Table 4). The interaction between dietary zeolite level and stocking density showed more significant differences across all groups.

Body composition

The examination of the entire body composition revealed notable variations between all groups (Table 5). Dry matter was the lowest in fish fed control diet. There were notable variations in the protein content and fish fed diet supplemented with 30 g/kg zeolite gained the lowest value under low stocking density (20 fish/hapa) and differed significantly across all groups. More significance differences were observed in the interaction effect between dietary zeolite and stocking density. Ash content values were increased by increasing the dietary zeolite level with significant differences. Fish fed diet supplemented with 30 g/kg zeolite under high stocking density (40 fish/hapa) had the lowest lipid content.

Table (3). Total ammonia of mono-sex Nile tilapia (*Oreochromis niloticus*) fries in the rearing water after 12 weeks.

Variables	Dietary zeolite (g/kg diet) under low density (20 fish/hapa)			Dietary zeolite (g/kg diet) under high density (40 fish/hapa)			P- value		
	CTRL	Z15	Z30	CTRL	Z15	Z30	Z^1	D^2	$Z \times D^3$
Temp. (C°)	26.20 ± 0.03^b	28.70 ± 0.03^a	28.80 ± 0.03^a	26.20 ± 0.03^b	28.80 ± 0.03^a	26.10 ± 0.03^b	0.000 **	0.000 **	0.000 **
Dissolved oxygen (O_2, mg/l)	6.34 ± 0.03^c	9.78 ± 0.03^a	9.75 ± 0.03^a	6.01 ± 0.03^d	6.83 ± 0.03^b	5.87 ± 0.03^e	0.000 **	0.000 **	0.000 **
pH	7.43 ± 0.004^f	7.97 ± 0.004^a	7.87 ± 0.004^b	7.61 ± 0.004^d	7.64 ± 0.004^c	7.57 ± 0.004^e	0.000 **	0.000 **	0.000 **
TAN (mg/l)	0.070 ± 0.0024^d	0.090 ± 0.0024^b	0.060 ± 0.0024^e	0.100 ± 0.0024^a	0.090 ± 0.0024^b	0.080 ± 0.0024^c	0.000**	0.000**	0.000**

CTRL, control without zeolite; Z15, diet supplemented with 15 g zeolite/kg diet; Z30, diet supplemented with 30 g zeolite /kg diet.

Values are means ± SEM, n= 3 per treatment. Means in the same row with different superscript differ significantly (P<0.05) as analyzed by two way ANOVA; [1]Z, zeolite level; [2]D, stocking density; [3]Z× D = zeolite level × density interaction effect.

** Significant differences at $P \leq 0.01$

Table (4). Growth performance and feed utilization of mono-sex Nile tilapia (*Oreochromis niloticus*) fries reared in hapas for 12 week

Variables	Dietary zeolite (g/kg diet) under low density (20 fish/hapa)			Dietary zeolite (g/kg diet) under high density (40 fish/hapa)			P- value		
	CTRL	Z15	Z30	CTRL	Z15	Z30	Z^1	D^2	$Z \times D^3$
IBW (g)	1.75±0.02	1.75±0.01	1.75±0.00	1.71±0.01	1.71±0.00	1.71±0.02	0.000	0.000	0.000
FBW (g)	16.61±0.82^{ab}	15.37±0.82^{bc}	13.30±0.82^{cd}	9.72±0.82^{e}	11.19±0.82^{de}	18.97±0.82^{a}	0.005**	0.020*	0.000**
WG (g/fish)	14.86±0.82^{ab}	13.62±0.82^{bc}	11.55±0.82^{cd}	8.01±0.82^{e}	9.48±0.82^{de}	17.26±0.82^{a}	0.005**	0.022*	0.000**
ADG (g/fish/day)	0.18±0.01^{ab}	0.16±0.01^{bc}	0.14±0.01^{cd}	0.10±0.01^{e}	0.11±0.01^{de}	0.21±0.01^{a}	0.006**	0.023*	0.000**
SGR (%/day)	2.68±0.08^{ab}	2.59±0.08^{bc}	2.41±0.08^{cd}	2.07±0.08^{e}	2.24±0.08^{de}	2.86±0.08^{a}	0.005**	0.011*	0.000**
Feed consumption (g/fish)	26.82±0.77^{a}	27.10±0.77^{a}	25.21±0.77^{a}	17.54±0.77^{c}	20.62±0.77^{b}	26.90±0.77^{a}	0.001**	0.000**	0.000**
FCR	1.80±0.09^{c}	1.99±0.09^{b}	2.18±0.09^{a}	2.19±0.09^{a}	2.18±0.09^{a}	1.56±0.09^{d}	0.106	0.742	0.001**
PER	1.80±0.07^{b}	1.63±0.07^{bc}	1.49±0.07^{c}	1.48±0.07^{c}	1.49±0.07^{c}	2.09±0.07^{a}	0.022*	0.401	0.000**
Survival (%)	98.33±2.49^{a}	91.67±2.49^{bc}	86.67±2.49^{cd}	79.05±2.49^{de}	81.90±2.49^{de}	77.14±2.49^{e}	0.048*	0.000**	0.000**

CTRL, control without zeolite; Z15, diet supplemented with 15 g zeolite/kg diet; Z30, diet supplemented with 30 g zeolite /kg diet.

Values are means ± SEM, n= 3 per treatment. Means in the same row with different superscript differ significantly (P<0.05) as analyzed by two way ANOVA; ^{1}Z, zeolite level; ^{2}D, stocking density; ^{3} $Z \times D$ = zeolite level × density interaction effect.

** Significant differences at $P \leq 0.01$

* Significant differences at $P \leq 0.05$

Table (5). Whole body proximate composition of mono-sex Nile tilapia (*Oreochromis niloticus*) fries after 12 weeks.

Variables (%)	Dietary zeolite (g/kg diet) under low density (20 fish/hapa)			Dietary zeolite (g/kg diet) under high density (40 fish/hapa)			P- value		
	CTRL	Z15	Z30	CTRL	Z15	Z30	Z^1	D^2	$Z \times D^3$
Dry matter	22.01 ± 0.60^{c}	23.65 ± 0.60^{bc}	26.65 ± 0.60^{a}	24.79 ± 0.60^{b}	26.06 ± 0.60^{a}	26.60 ± 0.60^{a}	0.001*	0.004**	0.001**
Protein	66.58 ± 0.84^{a}	65.63 ± 0.84^{ab}	64.32 ± 0.84^{b}	66.69 ± 0.84^{a}	65.41 ± 0.84^{ab}	66.40 ± 0.84^{a}	0.000**	0.027*	0.000**
Lipid	18.18 ± 0.80^{a}	17.97 ± 0.80^{ab}	18.82 ± 0.80^{a}	18.06 ± 0.80^{a}	17.67 ± 0.80^{ab}	16.65 ± 0.80^{b}	0.000**	0.001**	0.000**
Ash	15.2[illegible]$\pm 0.60^{b}$	16.40 ± 0.60^{a}	16.86 ± 0.60^{a}	15.25 ± 0.60^{b}	16.92 ± 0.60^{a}	16.95 ± 0.60^{a}	0.000**	0.241	0.000**

CTRL, control without zeolite; Z15, diet supplemented with 15 g zeolite/kg diet; Z30, diet supplemented with 30 g zeolite /kg diet.

Values are means ± SEM, n= 3 per treatment. Means in the same row with different superscript differ significantly ($P<0.05$) as analyzed by two way ANOVA; [1]Z, zeolite level; [2]D, stocking density; [3]Z× D = zeolite level × density interaction effect.

** Significant differences at $P \leq 0.01$

* Significant differences at $P \leq 0.05$

Figure (1). Ammonia concentration of mono-sex Nile tilapia (*Oreochromis niloticus*) fries in the rearing water after 12 weeks.

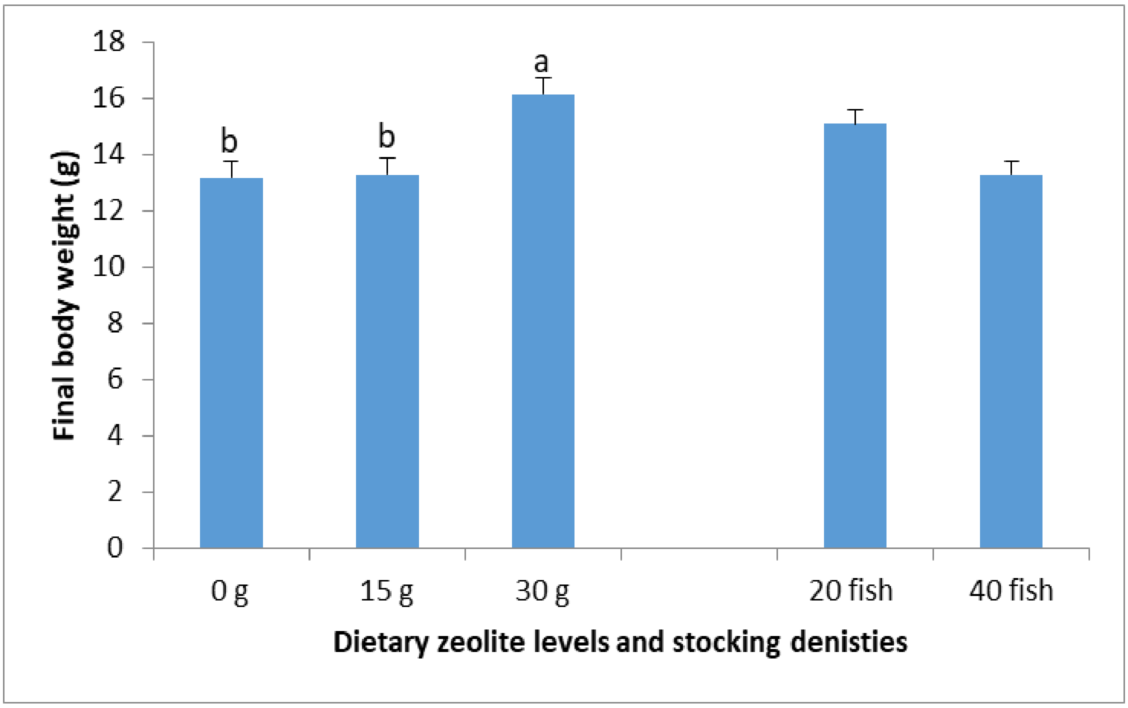

Figure (2). Final body weight of mono-sex Nile tilapia (*Oreochromis niloticus*) fries reared in hapas for 12 weeks.

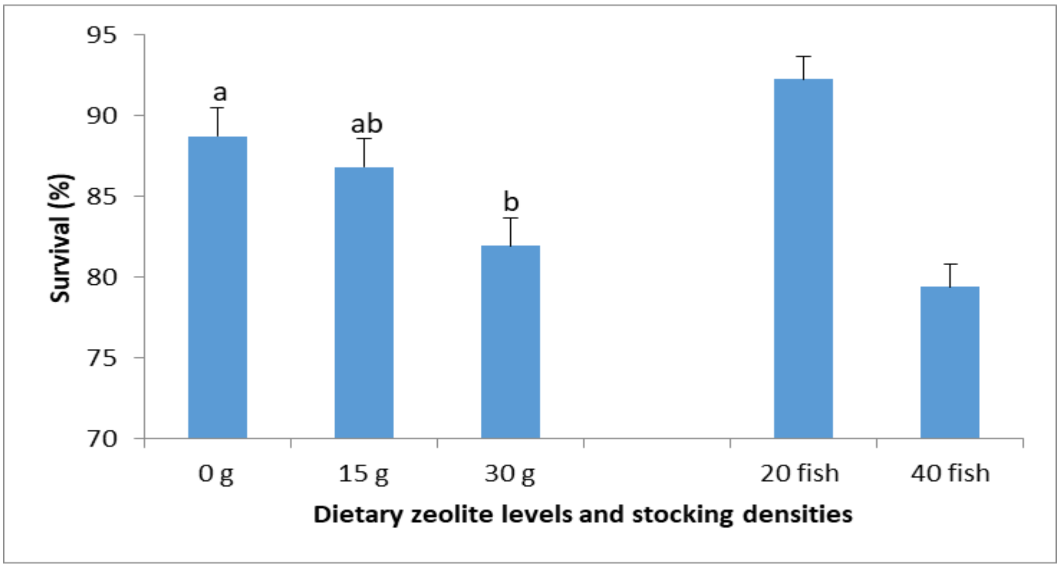

Figure (3). Survival rate (%) of mono-sex Nile tilapia (*Oreochromis niloticus*) fries reared in hapas for 12 weeks.

Discussion

Stocking density beside water quality parameters are the most effective factors affected the growth performance fluctuation in the production cycle. In general, the water quality parameters were under the standard conditions and suitable for raising Nile tilapia. Increased stocking density induces food habitat and competition that commonly negatively affected the production (Shoko *et al.*, 2016). High density clearly affected water quality in the reared ponds of sea bass, *Dicentrarchus labrax* juveniles for 120 days under three stocking densities of 1, 2 and 3 kg/m^3. Ammonia concentration and water quality parameters are shown in Table (3). Notable variations were noted in dissolved oxygen, pH and ammonia concentrations. Enhanced dissolved oxygen by adding zeolite and decreasing stocking density was observed. Significant interaction between zeolite level and stocking density for temperature, dissolved oxygen and pH concentrations was found. In terms of ammonia concentration, the obtained results displayed significant differences with decreasing trend by increasing the dietary zeolite levels (Table 3; Fig. 1). There was significant interaction between dietary zeolite level and stocking density for ammonia concentration. Saeed *et al.* (2015) showed that application of zeolite significantly decreased all the inorganic dissolved nitrogen in the water. These results in accordance with our results with increasing zeolite levels in the diets. Zeolite could be effectively applied to minimize ammonia concentrations in freshwater (Besser *et al.*, 1998). The obtained results showed decreasing trend in water quality parameters by increasing zeolite levels in the diets. Stocking density and zeolite levels had significant influence on water quality parameters (Table 3) and a high density may result in high concentrations of ammonia. These results match with those of Fayed *et al.* (2019). Fayed *et al.* (2019). Final weight (FBW), weight gain (WG, g), specific growth rate (SGR %), feed consumption, feed conversion ratio (FCR), protein efficiency ratio (PER) and survival rate are presented in Table (4). The obtained results showed significant effect on growth and feed utilization of Nile tilapia fed dietary zeolite at 15 and 30 g/kg diet. The outcomes are in line with Obradović *et al.* (2006) who indicated the positive effect of 1% zeolite (minazle) enriched diet fed to rainbow trout. Also, Eya *et al.* (2008) fed rainbow trout the dietary zeolite (Bentonite and Mordenite) at 0, 2.5, 5 and 10% and Khodanazary *et al.* (2013) in common carp noted an improvement in dry matter and protein ADC values with the addition of zeolite.

These results may be due to the supplementation level, fish species and type of zeolite. Significant increasing in growth performance was found when fish fed diet supplemented with high level zeolite (30 g/kg diet) under high density (40 fish/hapa) compared to other groups (Table 4). These findings are opposed to Nssar *et al.,* (2019) when fed juvenile Nile tilapia dietary zeolite at 5 and 10 g/kg. The fish enhancement is related to the improvement of feed nutrients (Olver, 1989) and/or purifying the effects of zeolite (Rizzi *et al.,* 2003). Our results are in contrast with (Arshad *et al.,* 2021). This may be linked to micro and macro mineral adsorption and ion exchange in the feed and fish gut, which is critical for fish growth (Oluwaseyi, 2016). There was a decline seen in survival rate when the dietary zeolite amount increased with significant differences (Table 4; Fig. 3). These results are opposed to Arshad *et al.* (2021) and Nssar *et al.* (2019), this may be due to the stocking density. The dietary zeolite amounts increased, improving the feed conversion ratio (FCR) (Table 4). The interaction effect showed notable variations across all groups and the best FCR was observed in fish fed diet supplemented with 30 g/kg zeolite in the high stocking density (40 fish/hapa). The same findings were stated by Fayed *et al.* (2019) when reared European sea bass, *Dicentrarchus labrax* juveniles under three stocking densities (1, 2 and 3 kg/m^3) in water with three levels of zeolite (5, 7.5 and 10 ppt). The influence of dietary zeolite on whole-body composition of Nile tilapia is presented in Table (5). Stocking density and dietary zeolite levels had significant differences on whole-body composition. These results are like Fayed *et al.* (2019). High density clearly significantly affected lipid content. By raising the amounts of dietary zeolite, the crude lipid was reduced as ash content increased, and these findings are consistent with those of Eya *et al.* (2008).

Conclusion

It could be concluded that, the inclusion of natural zeolite at 30 g/kg diet under high stocking density (40 fries/hapa) may enhance the performance and feed utilization of mono-sex Nile tilapia (*Oreochromis niloticus*) fries reared in hapas.

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تأثيرات إضافة الزيوليت الطبيعي في العلائق والكثافات العددية علي أداء زريعة أسماك البلطي النيلي وحيد الجنس في الهابات

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الملخص العربي

أجريت تجربة غذائية لمدة ١٢ أسبوع لدراسة تأثيرات إضافة الزيوليت الطبيعي في العلائق والكثافة العددية علي أداء زريعة البلطي النيلي وحيد الجنس المرباه بالهابات. تم إضافة الزيوليت الطبيعي في العلائق المتماثلة فى نسب البروتين والدهن بمعدلات صفر (كنترول)، ١٥ (زيوليت ١٥) و ٣٠ جم (زيوليت ٣٠) لكل كجم عليقة لزريعة أسماك البلطي النيلي وحيد الجنس بمتوسط وزن ابتدائي ١.٧ ± ٠.٠٢ جم والتي تم توزيعها عشوائياً في ١٨ هابة سعة ١.٥ ×٠.٥ × ١ متر[٣] والمثبتة في أحواض أسمنتية سعة ٤ متر[٣] تحت مستويين من الكثافة العددية ٢٠ و ٤٠ زريعة لكل هابة. أوضحت النتائج المتحصل عليها وجود تداخل معنوي بين مستوي الزيوليت والكثافة العددية في درجة الحرارة وتركيزات الأكسجين المذاب و ال pH والأمونيا في مياه التربية. ظهرت زيادة معنوية في متوسط وزن الجسم ومعدل الزيادة في الوزن ومتوسط الوزن اليومي و معدل النمو النوعي للأسماك التي تغذت علي عليقة مضاف إليها الزيوليت بمعدل ٣٠ جم لكل كجم عليقة تحت مستوي الكثافة العددية العالية (٤٠ زريعة لكل هابة) مقارنة بالمجموعات الأخري. انخفض معدل الحيوية معنوياً بزيادة مستوي الزيوليت في العلائق كما اختلف معنوياً معدل استهلاك الغذاء بين الأسماك التي تغذت علي مستويات مختلفة من الزيوليت، وكان أفضل معدل تحول غذائي في الأسماك التي تغذت علي عليقة زيوليت ٣٠ تحت مستوي الكثافة العالية (٤٠ زريعة لكل هابة) كما اختلف معنوياً معدل كفاءة البروتين لنفس المعاملة وتبعها الأسماك التي تغذت علي العليقة الكنترول تحت مستوي الكثافة المنخفضة (٢٠ زريعة لكل هابة). أظهرت نتائج تحليل جسم الأسماك أن المادة الجافة كانت أقل قيمة في الأسماك التي تغذت علي عليقة الكنترول ، وكان التداخل بين الكثافة العددية والزيوليت أكثر معنوية في محتوي الجسم من البروتين بين المعاملات. ظهرت زيادة معنوية في محتوي الجسم من الرماد بزيادة معدل الزيوليت المضاف في العلائق. وبالنسبة لمحتوي الجسم من اللبيدات كانت أقل نسبة في الأسماك التي تغذت علي زيوليت ٣٠ تحت مستوي الكثافة العالية (٤٠ زريعة لكل هابة). من النتائج السابقة يمكن التوصية بإضافة الزيوليت الطبيعي للعلائق بمعدل ٣٠ جم لكل كجم عليقة تحت مستوي الكثافة العالية (٤٠ زريعة لكل هابة) لتحسين الأداء والاستفادة الغذائية لزريعة أسماك البلطي النيلي وحيد الجنس المرباه في الهابات.