Effects of Dietary Natural Zeolite (Clinoptilolite) Levels on Water Quality, Growth Performance and Feed Utilization of Nile Tilapia (*Oreochromis niloticus*) Fingerlings

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Abstract: The objective of the study was to evaluate the effects of natural zeolite levels in fish diets on the water quality, growth performance, feed utilization, chemical body composition, hematological parameters, biochemical blood parameters, and economical evaluation of Nile tilapia (*Oreochromis niloticus*), fingerlings through-out an 84-days period. Each experimental diet was applied to triplicate groups of 13 fish (mean initial weight 10±0.01 g). Fish were fed two times a day with diets containing 30% (crude protein) and 8% (lipid). Four experimental diets were formulated supplemented with (0, 1, 2 and 3%) zeolite (clinoptilolite). The results showed that fish fed diets with zeolite had higher growth parameters and feed utilization than those fed diet without zeolite ($p<0.05$), the highest treatment in all of growth parameters and feed utilization was recorded for T3% zeolite. Fish fed diets with zeolite had a lower value of total ammonia nitrogen (TAN) than control group ($p<0.05$).The feeding costs decrease by 3% T3 with 3% zeolite from the control. In conclusion, zeolite as feed additive improved water quality enhanced growth performance and feed utilization, economical evaluation, of Nile tilapia (*Oreochromis niloticus*).

Keywords: Nile tilapia, zeolite, water quality, growth performance, feed utilization, economical evaluation

INTRODUCTION

Aquaculture is a worldwide important industry that delivers essential food to a rising world population, with a main role in the delivery of economy animal protein. The global aquaculture sector supplied 48% of the globe food fish production in 2020 and reported for half of the world's fish for direct utilization (FAO, 2022). Very fast progresses have been happened in aquaculture sector of Egypt in current years and displayed the strongest development of any fisheries-linked activity in the country; As a result aquaculture is taken into account as the only sustainable opportunity for decreasing the present gap between production and consumption of fish in Egypt. The fast growth in support activities such as hatcheries and regional feed mills created the sector more advanced and varied, universally. Egypt ranks the 6^{th} in fish cultivation production and 1^{st} among African nations. The aquaculture is applied in different production systems including semi-intensive, intensive culture in ponds and tanks (Soliman and Yacout, 2016). Cost of fish feed represents about 75-85% from the production operation costs (Fathi *et al*., 2017).

The past few years have seen a sharp rise in fish feed costs, due to imports of raw materials and fluctuations in foreign exchange rates (El-Sayed *et al*., 2015). With farmers buying feed on credit, feed prices continue to rise, while the price of fish products does not rise proportionately, which affects the economic viability of production facilities (Eltholth *et al*., 2015; El-Sayed, 2017). The development and sustainability of aquaculture dependent on the availability of quality and economy stuffs feed. Any decrease in the feed costs would cause a direct positive effect on the aquaculture profitability.

In the last years, researchers have been interested in the possibility of using materials which are environmentally friendly that can increase the aquaculture sector production either by rising the biomass productivity or by optimizing the aquatic environments for fish growth (Pogurschi *et al*., 2019).

The feed additives enhance the immunity, yield and cost-effective of fish via its improvement feed utilization and growth performance of the fish (Nssar, 2019).

The natural zeolites are microporous crystalline hydrated alumino silicates, which have originated several applications because of their unique physicochemical properties such as ion replacement and desorption–adsorption properties. In recent years significant improvement has been made on appliances of these inorganic materials in several industries including aquaculture, agriculture, water treatment, air sanitization and petrochemical (Ghasemi *et al*., 2018).

At present, more than 60 kinds of natural zeolites are global known and more than other 150 synthesized kinds. Between natural zeolites, clinoptilolite is effectively applied for ion exchange in water and applied as a feed additive in fish feed (Pogurschi *et al*., 2019).

The present study aimed to evaluate the inclusion of different levels of natural zeolite (clinoptilolite) in the Nile tilapia (*Oreochromis niloticus)* feed on the growth performance, feed utilization and water quality.

MATERIALS AND METHODS

The present study was conducted at the fish nutrition unit at the world fish center (ICLARM) at Sharqia government, Egypt. An experiment was designed to investigate the effect of zeolite levels on water quality, growth performance, feed utilization and body composition of Nile tilapia (*Oreochromis niloticus*) fingerlings

Experimental Fish and Culture Technique

Nile tilapia, *Oreochromis niloticus* fingerlings was obtained from ICLARM hatchery (Abbassa strain). Fish was acclimated to the experimental conditions as well as to adapt the artificial diet and conditions of the trail for 15 days at the research unit of fish Nutrition in the ICLARM, Egypt. During this period, tilapia was fed a control diet (30% crude protein) at a rate of 3% of biomass, which offered of equal rations at 09:00 and 15:00 h (6 days/ week) for 2 weeks. After the acclimatization period fish were distributed randomly into the experimental conic fiber glass tanks with water volume 110 L provided by two air stones to maintain the optimum oxygen level. There were four treatments in triplicate. A 146 fish of tilapia mono-sex male fingerlings with average initial weight of (10±0.06 g) were used in this study with stocking density 13 fish per tank. The fish were fed for 84 days. To adjust the amount of feed fish were weighted in patch through the experimental period. Every two weeks. One-third of water volume in each tank was replaced by new aerated freshwater after cleaning and removing of the accumulated excreta every two days.

Experimental diets

Four isonitrogenous (30%crude protein) and isocaloric 19.45 MJ kg^{-1} gross energy) diets were formulated (Table 1) in this study. The control diet didn't contain zeolite 0% (T0). Other three diets were supplemented with (1% (T1), 2% (T2), and 3% (T3) zeolite) respectively. Natural clay minerals zeolite (Clinoptilolite) (Table 2) was obtained from feed additives supplier, Kafr El-Sheikh, Egypt.

Table (1): Formulation and chemical composition of the experiments

Ingredients %	Control	T1	T2	T3
Soybean Meal CP 46%	40	40	40	40
Maize	15	15	15	15
wheat bran	15	14	13	12
Rice Bran 14%CP	14	14	14	14
Maize Gluten meal 60%CP	7	7	7	7
Meat and bone meal	2.5	2.5	2.5	2.5
Soybean oil	2	2	2	2
Poultry meal	2	2	2	2
Mono-Ca phosphate	1	1	1	1
Fish Premix	1.5	1.5	1.5	1.5
Zeolite	0	1	2	3
Proximate analysis %				
Moisture	8.4	8.8	9	8.6
Protein	30.1	29.8	29.6	29.4
Fat	6.8	6.9	7.1	7.2
Fiber	4.4	4.8	4.6	4.8
Ash	7.4	7.8	8	8.4
Nitrogen free extract (NFE)[3]	56.8	57.9	60.6	61.7
Gross energy (MJ per 100 g)[4]	19.18	18.67	18.46	18.58

All the ingredients were carefully mixed with soybean oil, and then the mixture was passed through a laboratory pellet mill (2-mm die; California Pellet Mill, San Francisco, CA, USA) at the ICLARM, Al Sharqia Governorate, Egypt. The temperature of pellets in this stage did not go over 40 ºC. Diets were dried in opened air (35°C), then packed in plastic bags and stored at −20°C till used.

Water quality

Water quality parameters were monitored to maintain the optimum water criteria of Nile tilapia (*Oreochromis niloticus).*pH, temperature were measured daily at 13.00 h using Hanna HI 9828 model device. Dissolved oxygen (DO) was measured with an YSI 556 MPS model device. Total ammonia was analysed three times a week using visocolor Eco kits and photometer device, No_2, No_3 analysed three times a week using visocolor Eco Kits.

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

Elements	%
SiO_2	71.92
Al_2O_3	8.04
Mn O	0.02
MgO	0.68
Na_2O	1.82
Fe_2O_3	0.88
P_2O_5	0.24
So_3	0.22
K_2o	3.65
Ca O	3.1
TiO_3	0.09
Lo I	10.09

Growth parameters

Mean final body weight (FBW), weight gain (WG), specific growth rate (SGR %/days), feed conversion ratio (FCR), protein efficiency ratio (PER), were calculated using the following equations:

WG = Final body weight (g) - Initial body weight (g)

SGR% /days = (ln FBW - ln IBW) /t ×100; where: FBW is final body weight (g); IBW is initial body weight (g); ln= natural logarithmic; t = time in days =84 days

FCR = Diet intake (g) /Weight gain (g)

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

Condition factor (K) was determined according to (Busacker *et al*., 1990) as the following equation:

K= mean [body weight (g) /body length^3 (cm)]×1000

RGR= weight gain/ initial weight

Fillet yield % = (fillet weight / fish weight)×100

Blood sampling and hematological and biochemical indices

At the end of the trial, blood was collected from the caudal vein of five fish for each treatment, then divided into two portions. The first one was collected with the anticoagulant 10% ethylene diaminetetra acetate (EDTA) to estimate hematology parameters: (hematocrit (HTC), hemoglobin (Hb), red blood cells (RBCs) and white blood cells (WBCs). HTC was determined according to methods of (Reitman and Frankel, 1957). Hb was determined using hemoglobin kits which is a standardized procedure of the cyanomethemoglobin method. Total count of WBCs was estimated by the indirect method of Martins *et al.* (2004). The second portion of the blood was allowed to clot at 4°C and centrifuged at 3,000 rpm for 10 min. The non-hemolyzed serum was collected to estimate the liver function activities. Serum aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were measured according to the method described by Reitman and Frankel. (1957).

Chemical analysis

At the beginning and the end of the trial, carcass samples were submitted to proximate composition. Fish samples were oven-dried, ground, and stored at –20ºC for subsequent analysis. The chemical composition of fish samples was determined according to the procedures of (AOAC, 1995). Dry matter was determined after drying the samples in an oven (105ºC) for 24 h. Ash was determined by incineration at 550ºC for 12 h. Crude protein was determined by micro-Kjeldahl method, %N × 6.25 (using Kjeltechauto analyzer, Model 1030, Tecator, Höganäs, Sweden) and crude fat was determined by Soxhlet extraction with diethyl ether (40 - 60ºC). Crud fiber was estimated according to Georing and Van Soest (1970). Gross energy was calculated according to NRC. (1993). Nitrogen free extract (NFE) was calculated as:

NFE (%) =100 - (% crude protein + % crude lipid + % crude fiber + % ash).

Total carbohydrate Calculated as:

100 - (% crude protein + % crude lipid + % ash)

Economic analysis

The cost of feed required to produce a unit required to produce a unit of fish biomass was estimated using economic analysis. The estimation was based on the local retail sale market price of all the dietary ingredients at the time of the study. These prices (in EGP/kg) were as follows:-

Table (3): Raw materials price

Raw material	Price (EGP)
Soybean meal 46 % CP	8.5
wheat bran	5
Rice bran	4
Maize	7
Maize Gluten meal 60 % CP	13
Meat and bone meal	8
Soybean oil	20
Poultry meal	6
Mono-Ca phosphate 22.7% P	18
Fish Premix	20
Zeolite	4.8

Feed cost of kg: Calculated from the price of feed ingredient and the cost per kg gain (FCR price of kg feed).

Statistical analysis

Database was created using Excel 2016 software to make first analysis using descriptive statistics. All statistical analysis was performance as described by

Dytham (1999) using SYSTAT 13 software (SPSS, Chicago, IL, USA). Water quality parameters and nutritional content values were analyzed by one-way ANOVA analysis. It was considered significant differences at (P<0.05) level. When significant differences were observed by Duncan, 1955 test was made to identify differences between experimental groups.

RESULTS

Water Quality Parameters

Average water quality parameters temperature: DO, pH, total ammonia nitrogen, nitrite (NO_2), nitrate (NO_3) are listed in Table (4). During the trial, the lowest temperature among the groups was measured as 23.4°C and 27.8°Cfor the highest.

Average water temperatures were 25.58, 25.62, 25.56 and 25.64°C for control, T1, T2 and T3 respectively. DO were measured at their lowest levels as 6.1 and their highest ones as 7.8 and pH were 8.5. Average DO in control, T1, T2 and T3 were measured to be7.26, 7.26; 7.25; 7.27ppmrespectively, pH in control, T1, T2 and T3 were measured to be 8.1; 7.9; 7.9; 7.8, respectively.

Average total ammonia nitrogen, in the treatments fed with diets supplemented with 1, 2 and 3% zeolite, were 0.23,015 and 0.10 mg/L, respectively, and the highest value (0.62 mg/L) was found in control group. Total ammonia–N discharge in the treatments that were fed diets supplemented with zeolite was observed to be relatively lower (p<0.05) than control.

The average of nitrate in control, T1, T2 and T3 were measured to be 57.2, 56.4, 55.6and 55.06mg/L, respectively.

Table (4): Water quality parameters of tanks water during the trial period

Items	Control	T1	T2	T3
Temperature (°C)	25.58±0.27^a	25.62±0.28^a	25.56±0.28^a	25.64± 0.27^a
Dissolved oxygen (mg/L)	7.26±0.08^a	7.26±0.07^a	7.25±0.08^a	7.27± 0.08^a
pH	8.1±0.04^a	7.9±0.02^b	7.9±0.03^c	7.8±0.02^{bc}
Total ammonia (mg/L)	0.62±0.01^a	0.23±0.01^b	0.15±0.01^c	0.10±0.06^d
Non-Ionized ammonia NH_3 (mg/L)	0.043±0.003^a	0.01±.001^b	0.006±0.003^c	0.003±0.006^d
Nitrite (No_2)	0.32±0.02^a	0.24±0.01^a	0.22± 0.02^{ab}	0.21± 0.01^b
Nitrate (No_3)	57.22±1.93^a	56.41±1.60^a	55.6± 1.28^b	55.06±1.52^b

Growth performance parameters

The growth performance of *Oreochromis niloticus* fed the experimental diets of the present study is presented in Table (5) for the experimental period of 84 days. At the beginning of the trial, there were no significant differences in initial weights among the treatment groups (p>0.05).After 84 days the group fed the diet containing 2% zeolite had the highest final body weights, weight gain and specific growth rates (SGR) (P ≤ 0.05).

Table (5): Growth parameters of *O. niloticus* after 84 days of feeding natural clay zeolite supplemented diets

Items	Control	T1	T2	T3
Initial weight (g/ fish)	10.00 ^{a} ± 0.01	10.00 ^{a} ± 0.01	10.00 ^{a} ± 0.01	10.00 ^{a} ± 0.01
Final weight (g/fish)	61.80 ^{a} ±1.68	64.73 ^{a} ± 1.43	65.41^a ±1.72	65.80 ^{a} ± 1.46
Weight gain (g/fish)	51.80 ^{a} ±1.68	54.73 ^{a} ± 1.72	55.41^a ± 1.43	55.80 ^{a} ± 1.46
Daily growth rate (g)	0.61 ^{a} ± 0.005	0.65 ^{a} ± 0.01	0.66 ^{a} ± 0.01	0.67 ^{a} ± 0.01
Relative growth rate (%)	5.18 ^{b} ± 0.01	5.47 ^{ab} ± 0.01	5.54 ^{a} ± 0.01	5.58 ^{a} ± 0.01
Specific growth rate (%/days)	2.08 ^{c} ± 0.03	2.13 ^{b} ± 0.03	2.18 ^{ab} ± 0.02	2.24 ^{a} ±0.02
Survival Rate (%)	94.66 ^{a} ± 2.66	94.66 ^{a} ± 2.66	97.33 ^{a} ± 2.66	97.33 ^{a} ± 2.66
Condition Factor (K)	1.73 ^{b} ± 0.08	2.06 ^{ab} ± 0.08	2.03 ^{ab} ± 0.08	2.26 ^{a} ± 0.08
Fillet Yield (%)	33.26 ^{b} ± 1.64	37.40 ^{ab} ± 1.10	37.70 ^{ab} ± 0.89	41.40 ^{a} ± 0.55

Results were presented as means ± SE of triplicate observations. Means in the same row with different superscript letters were significantly different p ≤ 0.05.

Feed Utilization Parameters

The results of feed utilization parameters as presented in Table (6) demonstrated that the feed intake amount significantly different ($p < 0.05$) between control treatment and different zeolite Supplementation treatments. The higher values were obtained withT3 and T2, and the smallest value obtained by control group. Also, the values of feed conversion ratio (FCR) values were significantly different ($p < 0.05$) between control treatment and different Zeolite Supplementation treatments and the lowest FCR values were obtained by T3.

Table (6): Feed utilization parameters of *O. niloticus* after 84 days of feeding natural clay zeolite supplemented diets

Items	Control	T1	T2	T3
Total Feed Intake	743.50 ^{c} ± 1.90	751.10 ^{b} ± 1.21	759.00 ^{a} ±0.01	759.00 ^{a} ±0.01
Feed conversion ratio	1.18^{a} ± 0.01	1.11^{b} ± 0.01	1.10^{cb} ± 0.01	1.08^{cb} ± 0.01
Feed conversion efficiency	84.89 ^{c} ± 0.48	89.95 ^{b} ± 0.40	91.10 ^{a} ± 0.53	91.10 ^{a} ± 0.53
Protein efficiency ratio	2.10 ^{c} ± 0.01	2.25 ^{b}± 0.005	2.30 ^{a} ± 0.01	2.30 ^{a} ± 0.01

Results were presented as means ± SE of triplicate observations. Means in the same row with different superscript letters were significantly different at $p < 0.05$.

Chemical Body Composition

The results in Table (7) showed that control treatment had the lowest dry matter (DM) content with total mean (28.71) and the highest ash content with total mean (13.16) compared to other treatments. Crude protein content in a whole fish body showed significantly increased ($P<0.05$) with increasing zeolite levels and the highest protein content was noted at T3 (64.85%). The corresponding values of protein for fish in the control treatment which have fed diet without zeolite observed the lowest value of other treatments and was significantly different ($P<0.05$).

Regarding the effect of zeolite treatments on lipid content of Nile tilapia fish *O. niloticus*, showed that lipid content at the end of this trial were 23.53, 22.70, 21.45and 21.20 % for control and the three zeolite treatments T1, T2 and T3, respectively. The results showed that lipid content of fish at control treatment was higher than those obtained at other treatments

The average of ash values for Nile tilapia at the end of the experiment were 13.16, 12.13, 11.38 and 10.16%, for control and the three zeolite treatments T1, T2 and T3, respectively. However, ash percentage for control was the highest one**.**

Table (7): Effect of natural zeolite (clinoptilolite) treatments on chemical composition % of Nile tilapia, *O. niloticus* (DM basis)

Items	Control	T1	T2	T3
Dry Matter%	28.71 ^{a} ±0.57	29.79 ^{c} ±0.58	30.07 ^{b} ±0.54	32.01 ^{c} ±0.52
Crude Protein%	56.54 ^{c} ±1.10	62.78 ^{b} ±1.12	64.81 ^{a} ±1.15	64.85 ^{a} ±1.17
Lipid Extract%	23.53 ^{a} ±0.78	22.70 ^{a} ±0.72	21.45 ^{b} ±0.70	21.20 ^{b} ±0.74
Ash%	13.16 ^{a} ±0.46	12.13 ^{b} ±0.38	11.38 ^{c} ±0.52	10.16 ^{d} ±0.48

Means with the same letter in each row are not significantly different at P=0.05 level.

Hematological Parameters

Table (8) presented the effect of natural zeolite inclusion on Nile tilapia hematological indicators: HTC, Hb, RBC and WBC counts. HTC, Hb, RBC and WBC counts were significantly ($P < 0.05$) higher in the fish groups fed diet with zeolite inclusion (2% and 3%) compared with control groups.

Table (8): Hematological parameters after 84 days of *O. niloticus* fed on natural zeolite supplemented feeds

Items	Control	T1	T2	T3
Hematocrit (%)	27.95 ± 2.62^{b}	31.7 ± 0.23^{ab}	33.4 ± 0.40^{ab}	35.50 ± 0.34^{a}
Hemoglobin (g/ dl)	8.3 ± 0.57^{b}	9.05 ± 0.14^{ab}	9.35 ± 0.08^{ab}	9.90 ± 0.05^{a}
WBCs (×10-3mm-3)1	82.97 ± 33.30^{b}	146.3 ± 1.70^{ab}	152.41± 0.22^{ab}	159.77 ± 1.08^{a}
RBCs (×10-3mm-3)2	1.69 ± 0.11^{b}	1.87 ± 0.01^{ab}	1.96 ± 0.02^{ab}	2.02 ± 0.01^{a}

Results were presented as means ± SE of triplicate observations. Means in the same row with different superscript letters were significantly different at $p < 0.05$. [1](WBCs) = white blood cell count, [2](RBCs) = red blood cell count.

Biochemical blood parameters

According to the results of the blood analysis, the group that fed on diet supplemented with 3% zeolite exhibited significantly (P<0.05) lower AST, ALT and ALP activity compared with the control as showed in Table (9).

Economic Evaluation

Calculations of economic efficiency of the tested diets based on the cost of feed, costs of one Kg gain in weight are shown in Table (10).

Table (9): Blood biochemical parameters of *O. niloticus* after 84 days of feeding natural clay zeolite supplemented diets

Items	Control	T1	T2	T3
AST	$30.50^{a} \pm 0.40$	$26.00^{a} \pm 0.57$	$18.50^{ab} \pm 0.30$	$10.50^{b} \pm 0.28$
ALT	$125.00^{a} \pm 2.48$	$97.50^{ab} \pm 2.32$	$90.00^{ab} \pm 1.98$	$87.50^{ab} \pm 1.32$
ALP	$95.00^{a} \pm 1.58$	$88.50^{a} \pm 1.42$	$75.00^{ab} \pm 1.06$	$60.00^{b} \pm 0.98$

Results were presented as means ± SE of triplicate observations. Means in the same row with different superscript letters were significantly different at $p < 0.05$.
ALT[1] = Alanine aminotransferase; AST[2] = Aspartate aminotransferase; ALP[3] = Alkaline phosphatase

Table (10): Economical evaluation of Nile tilapia (*O. niloticus*) fingerlings fed on the natural zeolite supplemented feed throughout the experimental period (84 days)

Items	Control	T1	T2	T 3
Feed intake (kg)	0.743	0.751	0.759	0.760
Feed cost/kg EGP	9.4	9.45	9.55	9.5
(1) Feed intake cost EGP	6.98^{c}	7.07^{b}	7.24^{a}	7.22^{a}
(2) Relative to feed cost %	0.96	0.97	100	0.99
(3) FCR	1.18	1.11	1.10	1.08
4) Feed cost/kg fresh fish EGP	11.06^{a}	10.47^{b}	10.47^{b}	10.28^{c}
(5) Relative feed cost/kg	100	0.94	0.94	0.92

1. Feed cost ×Feed intake2. Value of each treatment feed intake cost / highest value × 100
3. Feed Conversion ratio 4. Feed cost / kg gain = FCR × Feed cost /Kg EGP
5 Feed cost /kg fresh fish EGP value for each treatment / highest value ×100

DISCUSSIONS

Ortatatli *et al*. (2005) and Nssar *et al*. (2020) reported that addition of zeolite in fish diet improve growth rate, improve condition factor, reduce mortality, and increase production.

The fish fed with zeolite-supplemented feed, ammonia and ammonium were attained relatively lower than in control group. Total ammonia nitrogen (TAN) consisted of non-ionized (NH_3) and ionized ammonia (NH_4).

The results of this trial zeolite can reduce ammonia exceed in culture water and this result is agreed with (Ghasemi *et al*., 2018), (Ghiasi and Jasour, 2012) and (Farhangi and Hajimoradloo, 2011). Furthermore, zeolite consumption cause change of pH (Yildirim *et al*., 2009). Zeolite can hold ammonia gas (NH_3) and ammonium ions (NH_4) in the digestive system (Yildirim *et al*., 2009).

Total weight gain, SGR and condition factor and fillet yield (%) for *Oreochromis niloticus* observed the highest for T3 was (702.50) g compared with 631.20, 675.60 and 691.46 g for Cont., T1 and T2, respectively. The same trend was observed for SGR T3 was (2.24) Compared with 2.08, 2.13 and 2.18 %for Cont., T1 and T2, respectively. This mean that clinoptilolite used in Nile tilapia, (*Oreochromis niloticus*) feed provided an increase of weight gain with increase dietary zeolite levels.There were significant differences(P<0.05) between the control and different zeolite treatments in condition factor(K), indicate that the feed supplementation with zeolite increase fish condition factor and its level of 3%zeolite /kg diet resulted in the highest K (2.26) compared to the control group (1.73).Similar results obtained by Emadi *et al.* (2001) for Nile tilapia, (*Oreochromis niloticus*) fed with 2 % of zeolite. Ibrahim *et al.* (2016) reported that feeding Nile tilapia, *Oreochromis niloticus*on artificial feed containing crude protein (25%) supplemented with 2% zeolite cause enhance in growth performance of Nile tilapia and survival %.

Khodanazary *et al*. (2013) reported that, dietary supplement of zeolite can be used as a new fish feed ingredient forcommon carp and has effect in enhance the growth performance parameters. Ismael *et al*. (2021) concluded that supplementation of Nile tilapia *Oreochromis niloticus* diet with dietary 20 g kg^{-1} of dietary zeolite significantly improved all growth parameters ($P \leq 0.05$).

In the present study supplementation of Nile tilapia *O. niloticus* diet by different ratio of natural zeolite *clinoptilolite* improve the feed utilization the fish fed diet with 2 and 3% zeolite showed the highest feed intake (759.0), the best FCR (1.10) and (1.08) respectively, this results in agreement with. Nssar (2020) who reported that addition of natural zeolite as feed additive from 5 to10 g/kg to Nile tilapia *O. niloticus* diet enhance the feed utilization and decrease the FCR. Abdel Rahim (2017) reported that feeding Nile tilapia*, O. niloticus* on diet supplemented with 2% zeolite enhanced the feed utilization and feed conversion ratio. Yildirim *et al*. (2009) reported that (*Tilapia zillii)* fed diets supplemented with 1-2% zeolite improve protein efficiency rate ($p<0.05$), and better feed utilization than those fed diet without zeolite. Ortatatli *et al*. (2005) and Hassaan *et al*. (2020a) concluded that addition of zeolite in fish diet was controlled mycotoxins, improved feed intake, decrease the conversion coefficient of dietary protein, decrease feed conversion rate.

Chemical composition of fish could clarify its health status. Chemical composition analysis at the end of a feeding trial is often used to determine the impact of feed on fish chemical body composition. According to Hanley *et al*. (1964).

In the present study, hematological parameters of Nile tilapia (*O. niloticus*) were measured, and there was a significant difference between treatments. Higher red blood cell (RBC), HTC and Hb values were obtained in fish fed diet with 3% zeolite. Inclusion of natural zeolite enhanced hematological parameters of Nile tilapia (*O. niloticus*); on the other hand, excess supplementation could unfavorably affect the health of fish (Shahkar *et al.,* 2015).

In this study, serum activities of ALT and AST were significantly improved by zeolite addition, which indicating that the dietary zeolite with different levels had no harmful effect on tilapia health. These results agree with Filep *et al.* (2016) in common carp, Sheikhzadeh *et al.* (2017) in rainbow trout Nssar (2019) and Refaey (2021) in Nile tilapia (*O. niloticus*) fed diets with different levels of zeolite. Serum proteins are helpful for production more energy during stress conditions (detoxify the toxicant) to overwhelm this stress (Singh *et al.,* 2010).

The economic analysis demonstrated that the inclusion of zeolite levels decreases the rations costs, because of its effect in decreasing feed conversion ratio. In addition, the highest savings were with the use of 3% zeolite, because of the ration of lower cost, and with which the lower feed conversion was obtained. These results are in agreed with El-din (2015).

The present results indicated that the supplementation of fish diet with natural zeolite has positive effect in the fish chemical composition

CONCLUSION

It could be concluded that T (2, 3% Zeolite) was the best in terms of growth performance, feed utilization, body composition and economical evaluation under these experimental conditions.

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تأثير مستويات من الزيوليت الطبيعي (كلينوبتيلوليت) في علائق الأسماك علي جودة المياه والأداء الإنتاجي، والاستفادة الغذائية في سمك البلطي النيلي

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الهدف من الدراسة هو تقييم تأثير مستويات الزيوليت الطبيعي في علائق الأسماك على جودة المياه، وأداء النمو، الاستفادة الغذائية، التركيب الكيماوي لجسم الأسماك، معاير الدم والتقييم الاقتصادي لأسماك البلطي النيلي، تم تغذية إصبعيات البلطي النيلي خلال فترة ٨٤ يومًا. تم تطبيق كل معاملة على ثلاث مكررات من ١٣ سمكة (متوسط الوزن الابتدائي ١٠ ± ٠.٠١ جم). تم تغذية الأسماك مرتين في اليوم بعلائق تحتوي على ٣٠٪ (بروتين خام) و ٨٪ (دهون) مع (كنترول)، ١ ، ٢ و ٣٪ زيوليت (كلينوبتيلوليت). المجموعات التي تم تغذيتها بالزيوليت ذات معامل نمو أعلى وأفضل من حيث الاستفادة الغذائية من تلك التي تم تغذيتها علي العليقة بدون الزيوليت، وكانت أفضل معاملة في جميع مؤشرات النمو والاستفادة الغذائية هي معاملة ٣٪ زيوليت. المجموعات التي تم تغذيتها بالزيوليت كانت ذات قيمة أقل في الأمونيا الكلية (TAN)من المجموعة الكنترول ($P \leq 0.05$)، انخفضت تكاليف التغذية لإنتاج كيلو جرام واجد من أسماك البلطي عند إضافة الزيوليت بنسبة ٣% إلي علائق الأسماك مقارنة بالمعاملة التي لا تحتوي علي الزيوليت تدل النتائج أن الزيوليت كمادة مضافة للأعلاف يحسن جودة المياه، ويعزز أداء النمو والاستفادة الغذائية وأفضل من حيث الكفاءة الاقتصادية لأسماك البلطي النيلي.

الكلمات الدالة: سمك البلطي النيلى، جودة المياه، الزيوليت، أداء النمو، الاستفادة الغذائية، التقييم الاقتصادي