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EFFECTS OF ZEOLITE (Clinoptilolite) ON SOME WATER AND GROWTH PARAMETERS OF RAINBOW TROUT (*Oncorhynchus mykiss* WALBAUM, 1792)

DURALI DANABAS[a*], TULAY ALTUN[b]
[a]*Tunceli University, Fisheries Faculty, TR62000, Tunceli, Turkey.*
[b]*Cukurova University, Fisheries Faculty, TR01330, Adana, Turkey.*

The effects of zeolite (Clinoptilolite (CL)) added into pond water, on some water and growth parameters of rainbow trout (*Oncorhynchus mykiss* Walbaum, 1792), were investigated, in the present study. CL was added into water by 0 (control), 1, 2, 3 mg l^{-1} rates and carried out in 100 days. The results of the study showed that average body weights of fish in group were respectively, 128.242±4.748 g, 126.623±5.545 g, 126.349±0.339 g and 126.556±7.663 g and average total lengths were 21.870±0.355 cm, 21.340±0.341 cm, 21.783±0.255 cm and 21.191±0.193 cm. However, there was no statistical difference among groups for all parameters (P>0.05). At the end of the study, there was no statistical difference among groups for water parameters (P>0.05), but an obvious decreasing was observed in nitrate rates during study and in ammonium and nitrite rates during only first period.

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1. Introduction

Zeolites, one of the groups of the most important raw material in present industry, on especially environmental pollution and purification, and herbal and animal production, have attracted attention.

Today, zeolite types are classified more than 150, as 40s of it are natural (analcime, chabazite, clinoptilolite (CL), erionite, ferrierite, heulandite, laumontite, mordenite, phillipsite, etc.) and others are synthetic (Zeolite A, X, Y, ZMS-5, etc.) [1, 2, 3, 4, 5].

Zeolite is the crystalline hydrated alumino-silicates of alkali and alkaline metals and in frame silicates groups. Skeleton system of zeolite mineral consists of one, two or three dimensional cavity systems or channels that its volume range from 20 % to 50 % of total volume [3, 6]. One of the most important properties is also, easily and selectively adsorption and excluding them depending on cavities/channels volume and sizes of liquid and gaseous molecules and alkaline ions being in medium. Thus, those molecules can move between zeolite and environment.

As a consequence of these properties, zeolite molecules called as “molecular sieves” use generally as commercial absorbent and adsorbent [3, 5, 6, 7, 8, 9]

Different kinds of zeolite are used in many fields like paper and detergent industry, sectors of building and health, mining and metallurgy, herbal and animal production, pollution control and aquaculture [6, 10].

Zeolites are fundamentally used four aims for aquaculture applications, at the present time. These are;

- To provide pollution control in ponds,
- To remove N-compounds from water of hatcheries, fish transport and aquariums,

*Corresponding author: ddanabas@tunceli.edu.tr

- To increase oxygen in aquarium and fish transport,
- To increase growth parameter values of fish via adding into feed [3, 4, 6, 7, 11, 12, 13, 14, 15, 16, 17, 18].

In this study, it is aimed to investigate the effects of zeolite (CL), known to has no negative side effects on feeding of animal and poultry, on especially some parameters of production pond water and growth performance of rainbow trout (*Oncorhynchus mykiss*), is first place (61.173 tone year^{-1}) among finfish culture in Turkey [19].

2. Experimental

The study was performed at Fresh Water Fisheries and Culture Research Station of The Fisheries Faculty of Cukurova University (Adana, Turkey) during 100 days from 02.03.2007 to 13.06.2007 dates and used fingerlings of rainbow trout (*Oncorhynchus mykiss*) (20.8984±0.564 g average live weight (W) and 12.8263±0.122 cm average total length (L)). At the beginning, hepatosomatic index (HSI), gonadosomatic index (GSI), and vicerosomatic index (VSI) of fish were calculated as 1.4694±0.03 %, 0.123±0.03 % and 9.4671±0.53 %, respectively.

Channel type of concentrate ponds (4.75x1.0x0.75 m in size) and water from irrigation canal of The State Hydraulic Works were used, in the study.

Zeolite added in to water (3-7 mm in size) was assured from Enli Mining Corporation (Izmir, Turkey). It was used that trout feed (3 mm in size) has min. 47 % crude protein (Abalıoglu Company, Denizli, Turkey). Feed was given fish at 2 % rate of average live weights of every group.

Groups of trial were planned as 4 groups (Control (0 g l^{-1}): Group A (1 g l^{-1}), Group B (2 g l^{-1}) and Group C (3 g l^{-1})) and triplicates.

CL put into bags (25x20 cm) which are 500 g capacity and made from cloth. It was waited for accumulation of matters demanded binding (ammonium, nitrate, and nitrite), first 7 days after beginning of the experiment and then, the bags put into pond water. CL bags were renewed at every measurement term and plunged 5 % salt-water solution during 20 minutes between two measurement terms. In this way, CL was purified from adsorbing matters and reused until next term [20].

At the end of the trial, 8 fishes of every repetition were caught, randomly and W, L, liver, gonad and viscera of every fish were measured. However, some growth parameters of fish were calculated. Daily Growth Rate (DGR) was calculated and investigated according to formula informed by Wotten [21]; Feed Conversion Rate (FCR), Cushing [22]; Falcon's Condition Factor (C), Ricker [23]; Specific Growth Rate (SGR), De Silva and Anderson [24]; Survival Rate (SR), Pechsiri and Yakupitiyage [25]; HSI, Wotten [21]; GSI, Avsar [26] and VSI, Zhou et al. [27]. Nevertheless, it was used fenat process for ammonium (NH_4^+) analysis and cadmium reduction process for nitrite (NO_2) – nitrate (NO_3) analysis in water samples (500 ml) [28].

All statistical analyses were performed using Duncan Multiple Range Test in "SPSS 13.0" package program and significance level was 0.05.

3. Results and discussion

3.1 Water Parameters

Some water parameters (water temperature, dissolved O_2, pH, NH_4^+, NO_2 and NO_3) were measured regularly, in the study.

3.1.1 Water Temperature, Dissolved O_2 and pH

Temperature averages of groups in the trial were determined as 19.09±0.13 °C, 19.28±0.12 °C, 19.00±0.06 °C and 19.27±0.10 °C, respectively (P>0.05) and they are in temperature limits of optimal survival and growth of rainbow trout [29, 30, 31].

Dissolved O_2 and pH averages of groups in the trial were, respectively, 9.96±0.24 mg l^{-1}, 10.46±0.20 mg l^{-1}, 10.06±0.37 mg l^{-1} and 9.86±0.27 mg l^{-1}; 7.30±0.04, 7.33±0.03, 7.36±0.04 and

7.38±0.01. It was verified that there is no effect of CL rates applied in trial on dissolved O_2 and pH values of pond water (P>0.05).

3.1.2 Ammonium

It was observed that CL rates in each group adsorbed highly NH_4^+ in only first sampling term (Table 1).

Table 1. Ammonium averages (mg l^{-1}) of groups in trial terms

Groups	Initial Term	1st Term	2nd Term	3rd Term	4th Term
Control	0.0245±0.0[a]*	0.0088±0.03[a]	0.0251±0.03[a]	0.0284±0.02[a]	0.0310±0.02[a]
A	0.0245±0.0[a]	0.0067±0.03[a]	0.0280±0.05[a]	0.0322±0.06[a]	0.0326±0.01[a]
B	0.0245±0.0[a]	0.0062±0.02[a]	0.0270±0.03[a]	0.0289±0.03[a]	0.0317±0.05[a]
C	0.0245±0.0[a]	0.0059±0.01[a]	0.0226±0.01[a]	0.0304±0.01[a]	0.0321±0.05[a]

* The letters in the same column, show the differences in the results of statistical analyses.

It was observed that NH_4^+ rates of each groups in proceeded terms, increase slightly according to initial term. It was found any differences among NH_4^+ averages of groups at the end of trial (P>0.05).

Initial NH_4^+ value of trial was measured from sample of pond water without fish. It decreased sharply and parallely to CL rates, in 1st term, although fish add into ponds. This was in accordance with results of previous researches [8, 14, 15, 16, 32, 33].

However, NH_4^+ rates didn't increase parallely to CL rates, in last 2 terms. But, although NH_4^+ averages increase in pond water, all of them were below the maximum value (1.5 mg l^{-1}) of rainbow trout, informed by Sarioglu [20].

NH_4^+ adsorption rate of CL changes under physical and chemical characteristics, rates of treated CL [20] and time. It could be expressed that adsorption capacity of CL decrease by passing time, due to be long changing reveals of CL in ponds. However, it could be said that CL rates in the present study, weren't suffice to decrease to targeted NH_4^+ rate.

Thus, to decrease NH_4^+ rate of pond water as far as possible, it could be said that higher CL rates than those in this study, must be apply; using CL must be change more frequently; and it must be provide to reusing of CL, after it was passed in salt solution.

3.1.3. Nitrite – Nitrate

There were no statistical differences between NO_2^- (Table 2) and NO_3^- (Table 3) averages of groups in all terms of trial (P>0.05).

Table 2. Nitrite averages (mg l^{-1}) of groups in trial terms

Groups	Initial Term	1st Term	2nd Term	3rd Term	4th Term
Control	0.0056±0.0[a]*	0.0064±0.02[a]	0.0142±0.01[a]	0.0116±0.01[a]	0.0214±0.01[a]
A	0.0056±0.0[a]	0.0044±0.01[a]	0.0143±0.01[a]	0.0115±0.01[a]	0.0208±0.02[a]
B	0.0056±0.0[a]	0.0053±0.01[a]	0.0141±0.01[a]	0.0113±0.01[a]	0.0201±0.05[a]
C	0.0056±0.0[a]	0.0037±0.01[a]	0.0148±0.01[a]	0.0113±0.01[a]	0.0206±0.02[a]

* The letters in the same column, show the differences in the results of statistical analyses.

Table 3. Nitrate averages (mg l^{-1}) of groups in trial terms

Groups	Initial Term	1st Term	2nd Term	3rd Term	4th Term
Control	4.500±0.0 a*	4.760±0.33a	0.615±0.04a	0.516±0.01a	0.385±0.03a
A	4.500±0.0a	4.169±0.50a	0.571±0.03a	0.505±0.01a	0.370±0.07a
B	4.500±0.0 a	3.745±0.35a	0.534±0.01a	0.538±0.03a	0.370±0.09a
C	4.500±0.0 a	4.368±0.27a	0.569±0.02a	0.507±0.01a	0.272±0.03a

* The letters in the same column, show the differences in the results of statistical analyses.

It is informed that toxic NO_2^- rates for rainbow trout were 0.1 – 0.2 mg l^{-1} [29, 30]. The results of trial were under of those values. But, the adsorption rate of NO_2^- in 4th term was decreased, because of decreasing adsorption capacity of CL depending on the time.

However, it was observed that CL application decreased obviously NO_3^- level of water in all term of trial. Toxic NO_2^- rates for rainbow trout were 100 – 300 mg l^{-1} [29, 30]. The results obtained from trial were under of informed values. It was observed that CL added into ponds decreased NO_3^- levels from beginning of the trial to end of, and the lowest NO_3^- rates obtained from Group C.

3.2 Growth Parameters

Obtained results of trial show that CL rates added to pond water (1, 2 and 3 g l^{-1}), didn't affect on W (Table 4) and L (Table 5) averages of rainbow trout.

Table 4. Live weight averages (g) of groups in sampling terms

Groups	Initial Term	1st Term	2nd Term	3rd Term	4th Term
Control	20.899±0.6a*	33.363±0.82a	60.087±1.22a	80.928±0.99b	128.242±4.75a
A	20.899±0.6a	32.453±1.44a	57.214±3.52a	84.207±1.27b	126.623±5.55a
B	20.899±0.6a	32.829±1.61a	60.370±1.16a	80.781±1.21b	126.349±0.34a
C	20.899±0.6a	31.651±1.01a	56.581±0.79a	77.154±1.94a	126.556±7.66a

* The letters in the same column, show the differences in the results of statistical analyses.

Table 5. Total length averages (cm) of groups in sampling terms

Groups	Initial Term	1st Term	2nd Term	3rd Term	4th Term
Control	12.826±0.12a*	14.205±0.21a	16.676±0.09a	18.895±0.11a	21.870±0.36a
A	12.826±0.12a	14.181±0.18a	16.668±0.35a	18.854±0.26a	21.340±0.34a
B	12.826±0.12a	14.244±0.08a	16.586±0.10a	18.850±0.05a	21.783±0.26a
C	12.826±0.12a	13.985±0.18a	16.342±0.16a	18.288±0.19a	21.191±0.19a

* The letters in the same column, show the differences in the results of statistical analyses.

So ever, W averages of control group were higher than other groups and it could be, also, think that this would be affected positively total biomass of fish at the end of rearing term. But, total biomass wouldn't affect, positively because of not being positive results of SR and FCR in control group than in others.

It was determined that there were statistical differences between Groups of Control, A, and B and Group C in only third sampling term ($P<0.05$) and no among groups in all sampling terms ($P>0.05$). In spite of this, Control Group showed, numerically, the best growth performance.

It wasn't obtained statistically differences among averages of all growth parameters (DGR, FCR, SGR, C, SR, HIS, GSI and VSI) (Table 6).

Table 6. Averages of growth parameters

Parameters	Control Group	A Group	B Group	C Group
W (g)	128.242±4.75[a]*	126.623±5.55[a]	126.349±0.34[a]	126.556±7.66[a]
L (cm)	21.870±0.36[a]	21.340±0.34 [a]	21.783±0.26 [a]	21.191±0.19 [a]
DGR (g)	1.073±0.048 [a]	1.057±0.056 [a]	1.055±0.003 [a]	1.057±0.077 [a]
FCR	1.015±0.029 [a]	0.995±0.034 [a]	0.959±0.027 [a]	0.966±0.043 [a]
SGR	1.797±0.048 [a]	1.791±0.044 [a]	1.796±0.003 [a]	1.792±0.061 [a]
C	1.215±0.006 [a]	1.245±0.014 [a]	1.225±0.038 [a]	1.325±0.050 [a]
SR (%)	94.828±5.172 [a]	98.485±1.515 [a]	97.727±2.273 [a]	98.485±1.515 [a]
HSI (%)	1.083±0.100 [a]	1.051±0.056 [a]	0.984±0.007 [a]	1.246±0.082 [a]
GSI (%)	0.153±0.015 [a]	0.133±0.016 [a]	0.157±0.070 [a]	0.159±0.012 [a]
VSI (%)	12.035±0.145 [a]	12.175±0.303 [a]	12.288±0.204 [a]	12.677±0.670 [a]

* The letters in the same line, show the differences in the results of statistical analyses.

It was received any research end trial that was similar and performed to ours, before. So that, in details, the results could not compare with others.

Although there was statistical differences among FCR values of groups, it was compatible with the values notified for rainbow trout by Emre and Kurum [29] (FCR: 1.2-1.3) and by Roberts and Shepherd [34] (FCR: 1.0). On the other hand, FCR was lower than ones of studies that CL added into sea bass [35] and rainbow trout [6].

However, SGR did not affected with adding CL into water like those reported by Dias et al. [35] and by Kanyilmaz [18].

Nevertheless, adding CL into water did not affect HSI like those reported by Dias et al. [35] and Kanyilmaz [18] and VSI, similar to reported by Dias et al. [35], Tore [17] and Kanyilmaz [18].

4. Conclusion

Although NO_2^- levels were decreased with CL rates (1, 2 and 3 g l^{-1}) that treated in our study, to provide the more positive effects on the other water parameters and growth parameters of rainbow trout, it is suggested that higher rates of CL must be attempted and determined its effects.

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