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Original scientific paper

THE IMPACT OF THE MINERAL ZEOLITE ON FEED CONVERSION AND MORTALITY RATE ON COMMERCIALLY GROWN RAINBOW TROUT

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A b s t r a c t: The aim of this study was to evaluate the effect of zeolite, added to feed, on feed conversion and mortality rate in commercially farmed rainbow trout. The research was conducted at the Riboexport DOOEL pond in Gostivar, at the Vrutok source. Three pools were included in the study: group A – without zeolite, group B – feed with 1 % zeolite, and group C – feed with 2 % zeolite. The fish were reared under standardized conditions (length 4 m, width 1 m, depth 45 cm, total water volume 1.8 m³, temperature 11 °C, and oxygen concentration 9–11 mg/l). Each pool contained 200 juvenile rainbow trout with an initial weight of 46–48 g and length of 15–16 cm, monitored over a 12-week period. Measurements were taken 8 times, at 14-day intervals. Feed conversion was determined using the Feed Conversion Ratio (FCR), and mortality was recorded numerically. The results are presented using descriptive statistics, showing FCR values of 0.89 for group A, 0.84 for group B, and 0.89 for group C. No mortality was recorded in groups A and B (0 %), while 3 dead fish (1.5 %) were observed in group C. The best feed conversion was observed in the group receiving feed with 1 % zeolite. Fish mortality was not related to zeolite application but was attributed to mechanical injuries during manual handling.

Key words: aquaculture; growth performance; rainbow trout; zeolite; water quality

ВЛИЈАНИЕ НА МИНЕРАЛОТ ЗЕОЛИТ ВРЗ КОНВЕРЗИЈАТА НА ХРАНАТА И ВРЗ СМРТНОСТА КАЈ КОМЕРЦИЈАЛНО ОДГЛЕДУВАНА ВИНОЖИТНА ПАСТРМКА

А п с т р а к т: Целта на истражувањето е да се испита влијанието на зеолитот, додаден во храната, врз конверзијата на храната и стапката на смртноста кај комерцијално одгледувана виножитна пастрмка. Истражувањето е спроведено во рибникот на Riboexport DOOEL од Гостивар, на изворот Вруток. Во студијата беа вклучени три базени: група А – без додаток на зеолит, група Б – храна со 1 % додаток на зеолит, и група Ц – храна со 2 % додаток на зеолит. Индивидуите беа одгледувани во стандардизирани услови (должина 4 m, ширина 1 m и длабочина 45 cm, со вкупен волумен на вода од 1,8 m³, температура 11 °C и концентрација на кислород од 9–11 mg/l). Во секој базен беа одгледувани по 200 млади виножитни пастрмки со почетна маса од 46-48 g и должина од 15–16 cm. Набљудувани беа 12 недели. Мерењата се вршеа 8 пати, на секои 14 дена. Конверзијата на храната беше определувана преку коефициент на конверзија на храната (FCR), а стапката на смртноста беше определувана нумерички. Резултатите се претставени со дескриптивна статистика, при што FCR во групата А изнесува 0,89, во брупата Б 0,84, а во групата Ц 0,89. За време на мерењата, во групите А и Б не беше регистрирана смртност (0 %), додека во групата Ц беа забележани 3 умрени риби (1,5 %). Најдобра конверзија на храната беше забележана во групата чија храна содржеше 1 % зеолит. Причината за смртноста кај рибите не беше поврзана со примената на зеолит, туку со механички повреди предизвикани при рачна манипулација.

Клучни зборови: аквакултура; конверзија на храна; виножситна пастрмка; зеолит; квалитет на вода

INTRODUCTION

Zeolite is natural, safe and absolutely non-toxic minerals used in industry and agriculture with multiple purposes. It does not cause any negative effects or contraindications, which is confirmed by the results obtained from the chemical and toxicological analyzes carried out by numerous professional and eminent experts. The literature indicates that the main and fundamental role of zeolites in everyday life is their application in aquaculture. It has been proven that they realize this role through:

- ensuring pollution control in swimming pools,
- removal of N-compounds from the water of hatcheries, fish transport and aquariums.

In recent years, several studies have supported the idea that zeolite can significantly help improve water quality and fish growth. The study by Ali et al. (2025) shows that zeolite reduces levels of ammonia, nitrates, and nitrites, while water transparency and oxygen saturation improve. As expected, growth and feed conversion improved with higher doses of zeolite, though the economic yield was not highest at the highest dose, indicating that optimization is important. A similar finding is obtained in the study by Grazina *et al.* (2024) in which natural clinoptilolite was used to address ammonium and nitrite under cold water conditions and recirculating systems. There, reductions of 22.7 % for ammonium and 16.7 % for nitrite were achieved, helping to mitigate risks associated with the accumulation of toxic ions in a high-biomass system. In experiments by Ghada *et al*. (2024) with European sea bass, it was also established that zeolite mitigates the negative influence of high stocking density. Use of zeolite led to improvements in water quality, feed conversion, hematobiochemical parameters, and reduction in accumulation of heavy metals in fish tissues. The study by Oz et al. (2023) shows that zeolite, especially when added at around 2–10 % in feed or used as filter/media or in water, can reduce ammonia concentration without significantly affecting mortality. Zeolites increase the concentration of oxygen in the aquarium. Thanks to the nutritional supplement, the values of the fish growth parameters increase (Alp, 2005; Aybal, 2001; Mumpton, 1999). The main objective of this research is to determine the influence of the mineral zeolite added in the food and calculate the feed conversion ratio and mortality rate on commercially grown rainbow trout.

Tasks of the research are:

- to determine feed conversion ratio;
- to determine the mortality rate.

MATERIAL AND METHODS

The research was conducted with an experiment that was carried out in the registered production for raising rainbow trout of Riboexport Ltd. in Gorna Banjica, Gostivar. Three pools were involved in the performance of the procedure, which were named numerically, i.e., pool no. 22 (group A), no. 23 (group B), and no. 24 (group C). The experiment was conducted in standardized conditions, each of the pools had dimensions: length 4 m, width 1 m and depth 45 cm, with a total water capacity of 1.8 m^3, temperature of 11°C at an oxygen concentration of 9 – 11 mg/l. In each of the three pools, 200 juvenile rainbow trout with an initial weight of 46 – 48 g and a length of 15 – 16 cm were monitored for 12 weeks (Figure 1).

Fig. 1. Sampling fish for the experiment

Fish were fed with a commercial diet formulated for aquaculture species (Skretting S.p.A., Italy). According to the manufacturer's feeding instructions, the feed was administered at a rate of 1–2% of the fish biomass per day. The feed had a granulation of 4 mm and contains protein 44%, Ca 1.1%, crude fat 22%, wheat, blood products, fish oil, animal fats from poultry, mono-ammonium phosphate, wheat gluten, hydrolyzed feather meal, poultry protein, fish meal, permeate whey powder, beet oil and wheat flour. The zeolite is a product of the Zeo-Medic D.o.o company from Belgrade, Republic of Serbia, produced in 2022.

Feed preparation and experimental design

For the experimental diet, 22.3 g of zeolite powder were added to heated water and mixed until a uniform suspension was obtained. This suspension was then thoroughly blended with 2.419 kg of commercial feed to ensure homogenous distribution of zeolite. The mixing process was performed manually for approximately 2–3 minutes.

The experimental procedure began with the breeding of rainbow trout samples in group A (control group), group B (experimental group 1) and group C (experimental group 2). In group A commercial food without addition of zeolite was used, in group B, 1% zeolite was added to the commercial fish feed. In group C, zeolite was added in a concentration of 2%.

The following parameters were monitored in all groups:

- feed conversion ratio,
- mortality rate.

In the diet prepared for experimental group B, zeolite was added at a concentration of 1%. Before being incorporated into the feed as a supplement, 22.3 g of zeolite powder were dissolved in heated water and thoroughly mixed until a homogeneous suspension was obtained.

This suspension was then added to 2.4 kg of commercial feed, and mixed manually for approximately 2–3 minutes until a uniform and homogeneous blend was obtained (Figures 2 and 3).

Fig. 2. Zeolite preparat

Fig. 3. Mixing zeolite with fish commercial feed

Statistical analysis

Feed utilization efficiency and growth performance were evaluated by calculating the feed conversion ratio (FCR) and weight gain for each experimental group. The results are presented descriptively.

RESULTS AND DISCUSSION

In order to determine whether there are statistically significant differences between the obtained values of the weight, length, and width of the fish in the three pools during the measurements, a descriptive statistic was conducted.

Feed conversion

The mean feed conversion ratio (FCR) values for all three experimental groups, based on eight (8) measurement occasions, are presented in Table 1.

The table summarizes feed consumption, weight gain, and the corresponding FCR for each group. The FCR is a measure of feed efficiency, indicating the amount of feed required to produce 1 kg of body weight gain. It was calculated using the following formula:

$$\text{FCR} = \frac{\text{Feed consumed (kg)}}{\text{Weight gain (kg)}}$$

Table 1

Feed conversion in groups A, B, and C

	Group A	Group B	Group C
Feed consumed (kg)	20.9	22.9	22.68
Weight gain (kg)	23.43	27.10	25.30
FCR (feed conversion ratio)	0.89	0.84	0.90

Mortality rate and feed conversion in rainbow trout

During the experimental period, groups A and B did not experience any fish mortality, indicating a 0% mortality rate. In contrast, group C recorded a minor mortality of three fish, corresponding to 1.5%. Observations during handling and measurement suggest that these deaths were primarily due to physical injuries rather than diet or water quality. This is consistent with previous findings highlighting that rainbow trout mortality can be influenced by handling practices, stocking density, and overall pond management (Habera et al., 1996; Mordhorst, 2022; Sidoruk & Cymes, 2018).

The study focused on evaluating the effect of zeolite supplementation on feed utilization, as measured by the feed conversion ratio (FCR). Among the three experimental groups, the lowest FCR (0.85) was recorded in group B, which received 1% zeolite in the feed. Group A, the control group, and group C, supplemented with 2% zeolite, had slightly higher FCRs of 0.89 and 0.90, respectively. These results indicate that moderate zeolite inclusion can improve feed efficiency, likely by enhancing nutrient absorption and supporting growth performance.

These observations align with previous research demonstrating variable effects of zeolite on feed conversion and growth. For example, Ghiasi and Jasour (2012) reported significant improvements in both feed utilization and specific growth rates in rainbow trout fed zeolite-supplemented diets. Conversely, some studies found minimal or inconsistent effects on growth and feed efficiency, suggesting that the impact of zeolite may depend on its concentration, form, and method of incorporation (Danbas, 2011; Dias et al., 1998; Kanyilmaz et al., 2010).

Comparative analysis with Burmovska (2018) further supports the notion that moderate levels of zeolite (around 1%) optimize feed efficiency without negatively affecting fish growth or survival. Moreover, the observed improvements in FCR are consistent with trends in selective breeding programs, which have enhanced feed efficiency and growth performance in rainbow trout populations (Kause *et a*l., 2022; Kajbaf et al., 2024; Vandeputte et al., 2022).

CONCLUSION

The study demonstrates that supplementing rainbow trout diets with 1% zeolite improved feed utilization, as evidenced by the lowest recorded feed conversion ratio among the experimental groups. Mortality rates were unaffected by the inclusion of zeolite, indicating that this mineral additive can enhance growth performance without negatively impacting fish survival. These outcomes support the potential use of moderate zeolite supplementation in aquaculture to optimize feed efficiency while maintaining fish health.

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