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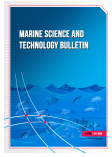

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RESEARCH ARTICLE

Effect of vermicompost supplement on rainbow trout performance

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ABSTRACT

Vermicompost is the product of organic waste digestion by earthworms besides aerobic decomposition at ambient temperature. It is a rich composition containing plant nutrients and beneficial microorganisms. Some fishes, especially predatory species such as rainbow trout, need nutritive feed so that they can be healthy; a useful and cheaper additive such as vermicompost can supply this aim. In this study, the effect of different percentages of vermicompost in the diet of rainbow trout was investigated. For this purpose, 100 rainbow trout with an average weight of 120±3 g were distributed in 5 groups in concrete tanks. Their nutrition and physical and chemical water parameters were determined according to the standard. Vermicompost with confirmable analysis was added to their daily feed (2, 4, 6, and 10%). After 2 months, the feed conversion ratio and survival rate were examined. The results showed that there was a significant relationship between the performance of the control group and the treatment groups ($p<0.05$). The data obtained from this experiment indicated that the 10% of vermicompost in the diet was more effective. Therefore, the use of vermicompost supplements can be recommended for the cultivation of rainbow trout.

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Introduction

Vermicompost (excrete of earthworms) has been recognized as a potential pond fertilizer because it has superior nutritional quality, contains microbes, and is in ready-for-uptake form. Besides, the vermicompost contains humic acid, which has antibiotic properties and promotes fish gut health, stress management, and immune systems (Musyoka & Nairuti, 2024).

Sustainable aquaculture is one in which the goal is permanence, achieved through the utilization of renewable resources. This leads to the development of the concept of

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organic and natural farming. Among various components of organic and natural farming, vermicomposting is a key component for making compost through earthworms (Chakrabarty et al., 2009).

Fisheries and aquaculture are important sources of food, nutrition, income and livelihoods for hundreds of millions of people around the world. Since 2014, more than half of all fish for human consumption came from aquaculture. Its extent, diversification and intensification make aquaculture one of the fastest growing food-producing sectors globally. As a result of the magnitude and intensity of aquaculture production, issues related to its long-term sustainability and environmental impacts have become more pronounced (Kouba et al., 2018; Austin et al., 2022).

Most of the degradable organic waste in the environment can be converted into vermicompost by earthworms. Earthworms can eat these organic wastes and provide fertilizer to the ecosystem. Earthworm excrement contains plant nutrients that are covered in the mucous membrane secreted from the digestive system, and these secretions increase the stability and consistency of excrement, which is used as vermicompost (Karaca, 2010). The earthworm breeding industry has grown considerably due to its role in waste management. The mass production of earthworms and their use in animal feed (using of live or dry earthworms) is important in aquatic animals feeding. The combination of fatty acids and essential amino acids and the presence of omega-3 in this substance make its use different from plant sources (Ng et al., 2001).

Vermicompost contains enzymes such as protease, lipase, amylase, cellulase, and chitinase. These enzymes continue to function in the biodegradation of large molecules in the soil. Vermicompost is also rich in vitamins, antibiotics, and growth hormones. In a study, it has a positive effect on the growth performance of goldfish (Zou et al., 2012). In another study, vermicompost was used as a fertilizer in a fish farm and the results showed that the growth performance and production of phytoplankton and zooplankton in the water tank containing superphosphate fertilizer and vermicompost was significantly different from the control group. This happens due to the presence of various inorganic and organic compounds in vermicompost (Chakrabarty et al., 2010).

Due to the lack of investigation of the effects of vermicompost consumption as a food supplement in the diet of rainbow trout (*Oncorhynchus mykiss*), the initial idea of conducting this study was formed. Also, the above studies showed that consumption of vermicompost can affect some functional factors of fish, so in this study we wanted to investigate the possibility of oral consumption of vermicompost in rainbow trout, the possible anti-nutritional effects of vermicompost and the effect of adding vermicompost in feed on growth rate and feed conversion ratio and survival rate of rainbow trout.

Material and Methods

This research was conducted at the Islamic Azad University in Iran, according to the country's legislation guidelines for the care and use of animals (Ethics approval number: 2916/4/2111, Date: 12/09/2017). All applicable international, national and institutional guidelines for the care and use of animals were followed.

To do this research, 100 rainbow trout with an average body weight of 120±3 g were distributed in 5 groups in tanks (500 l). Physicochemical water parameters including temperature (20±3°C), dissolved oxygen (9 mg/l), and pH (8) were recorded daily. The water flow rate was 120 l/h. The diet based on the formulation of 38% protein, 23% lipid, 11% moisture, 12% ash, and 2050 kJ/kg energy was prepared by extruder in 6 mm size. Fish were exposed to natural photoperiods. After acclimatization for 10 days, vermicompost was purchased from a commercial company with confirmable analysis (Table 1) and it was added to the daily feed (2, 4, 6, and 10%). After 2 months, fish were harvested after anesthesia and their weights were calculated, and then FCR and survival rate were examined.

Table1. Physicochemical properties of vermicompost

Parameters	Amounts
Ash (%)	20
Total nitrogen (%)	2
C/N (%)	10
P (%)	2.15
K (%)	1.2
Ca (%)	0.5
pH	7.8
EC (μ mho/cm)	3.2
Humidity (%)	30

Statistical analyses followed the methods outlined by Minitab (16). Data were tested for normality and homogeneity of variances using Kolmogorov–Smirnov, and then data were analyzed with analysis of variance (ANOVA) to test differences between dietary treatments.

When this test showed significance, individual means were compared using Tukey's test. Significant differences were considered when $p \leq 0.05$.

Results

There is a significant relationship between the amount of feed conversion ratio in different groups and it indicates the reduction of the FCR with the use of vermicompost. The highest number of deaths was for the control group and treatment 1 and the lowest number was for treatment 4. There is a significant relationship between the survival rates in different groups. The results showed that there is a significant relationship between the performance and survival of the control group and the treatment groups ($p<0.05$).

There is a significant relationship between the amounts of FCR in different groups. There is no significant relationship between the control group and the treatment, but there is a significant relationship between the control group and the rest of the treatment groups, and it indicates the reduction of the food conversion ratio with the use of vermicompost ($p<0.05$) (Figure 1).

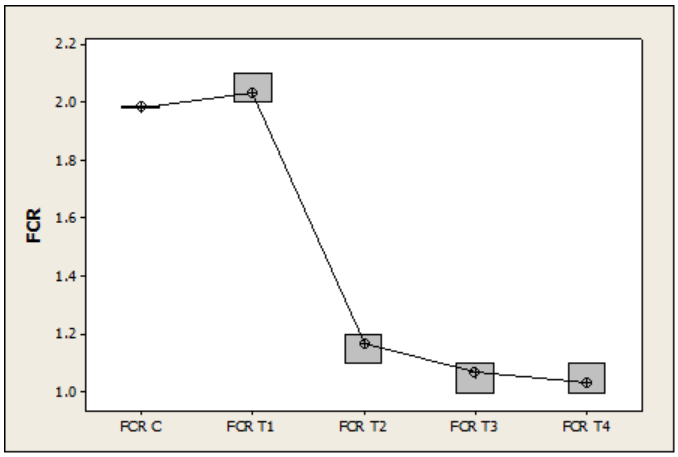

Figure 1. Feed conversion ratio (%) (C=Control, T1=Treatment 1, T2=Treatment 2, T3=Treatment 3, T4=Treatment 4)

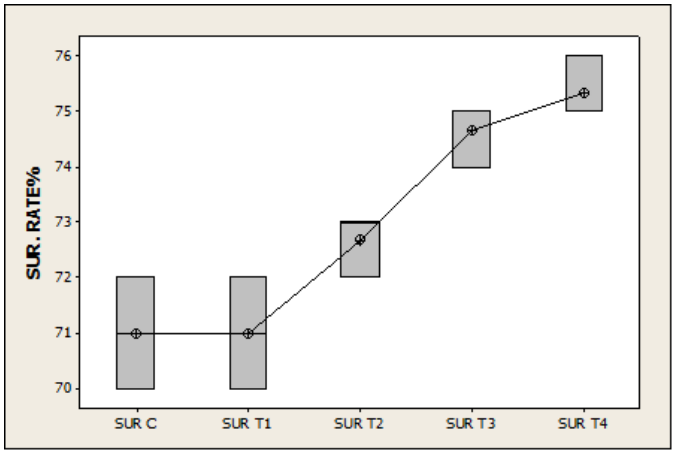

Figure 2. Survival rate (%) (C=Control, T1=Treatment 1, T2=Treatment 2, T3=Treatment 3, T4=Treatment 4)

The results showed that the highest number of deaths was for the control group and treatment 1 (29%) and the lowest number of deaths was for treatments 3 and 4 (25%). There is a significant relationship between survival rate in different groups ($p<0.05$). There is no significant relationship between the control group and treatments 1 and 2, but there is a significant relationship between the control group and the rest of the treatments, and it indicates the effect of the vermicompost dosage on increasing the survival rate (Figure 2).

Discussion

Various researches have been conducted on adding earthworms to the food of different fishes and investigating its effects. They had different and sometimes contradictory results. In a study, by substituting frozen earthworms in rainbow trout food with levels of 0, 25, 50, 75%, no significant difference was observed in final weight among treatments (Pereira & Gomes, 1995). In a study, replacing earthworm (*Eisenia fetida*) powder with amounts of 25 and 50% in the feed of rainbow trout showed that in these amounts, a higher growth rate was created in treatment groups (Velsquez et al., 1991).

Paying attention to the above results makes it difficult to decide on adding earthworms to rainbow trout feed. In these researches, there has not been a discussion about adding vermicompost made from earthworms as a supplement to fish feed, while the secretions of the worm's body surface and the contents of feces from worms can have nutritional effects and are worth investigating. In another research, vermicompost obtained from earthworms was used as a growth stimulant in common carp fish feed and it was found that the quality of fish meat protein increased (Cheng et al., 2012a). The findings of these studies confirm the results of the present study.

When the food material passes through the gut of the earthworm, changes are made in it and the remaining material is rich in nutrients and microbial organisms. Earthworms can transform waste into valuable material through a kind of biological alchemy. The intestinal activity of the worm is like a miniature composting tube that mixes different materials and creates a stable synergistic relationship with the enzymes of the digestive system in the humidity, pH and microbial populations of the intestine in a favorable way and finally, a wonderful by-product is produced which it is called vermicast and it is rich in nitrate, phosphate, and potash, and other micronutrients are excreted from the body along with bacteria (Adhikary, 2012). These components can be suitable and useful for fish, for example, enzymatic components of vermicompost can be effective in increasing the efficiency of digestion of feed and help decrease FCR. Also, other non-living and living compounds of vermicompost can have a positive effect on the

thickness of the intestinal mucosa of fish and increase the efficiency of absorption, increase the population of beneficial bacteria, and increase local and humoral immunity, all can increase fish survival and we can see in the results of this research.

Vermicomposting is a complex biological and ecological process of accelerated bio-oxidation and stabilization of organic material. In contrast to traditional composting, it involves the joint action of earthworms and microorganisms without a thermophilic phase, exhibiting reduced emissions of greenhouse gases (Nigussie et al., 2016). The applicability of this biotechnology has been shown for a wide range of organic matrices. Vermicomposting allows the transformation of potentially problematic organic solid waste into highly valuable end-products vermicompost and biomass of earthworms (Lim et al., 2016). The results of one study showed that adding 6% vermicompost to the diet increases the activities of pepsin, pancreatic protease, amylase and lipase of hepatopancreas and foregut can significantly improve digestibility and work better. Also, using paraffin sections technique to watch the foregut intestinal internal structure of grass carp in each test group showed significantly increase in the intestinal mucosa height, width and thickness of roots (Cheng et al., 2012b). In this research the greatest effect on FCR and survival rate was at the concentration of 10% vermicompost, which considering that no other supplement was added to the fish food and only with vermicompost we observed good results in FCR and survival rate in all groups. It can be concluded that adding vermicompost has not a significant effect on decreasing of nutritional parameters of the diet.

In the present study, the results were in the same direction, and with the increase in the amount of vermicompost, a significant decrease in the feed conversion ratio was observed, which can show the existing nutritional potential and the effect of earthworm body secretions and the compounds in their feces. The feed conversion ratio is one of the most important nutritional factors and the reduction of it in this study can have various reasons, but it can be related to the surface secretions of the worm's body and the enzyme compounds in the feces and the changes made in the worm's food. Probably, the reason for the high death in all groups and the observation of low survival can be related to the high water temperature (20±3°C), and because this situation is also seen in the control group, it does not affection the statistical analysis and is ineffective on the interpretation of the results.

These results showed that, unlike earthworms, the addition of which, especially in high amounts, to the diet of trout caused a decrease in efficiency, in the case of vermicompost, this was not the case, and the highest efficiency was observed in the highest dose (10%).

Conclusion

Considering the presence of various organic and inorganic compounds in vermicompost and their similarity with the nutritional needs of fish and the relative confirmation of this issue by the results of the above research, it is possible to add vermicompost to rainbow trout feed to increase production efficiency and to help to optimize nutrition. Also, vermiwash can be used as a food supplement for rainbow trout and the effects of vermicompost and vermiwash in extruded foods as a binder or attractant in the preparation of fish feed and the effect on the level of bioavailability and safety of fish and the changes in the intestinal microbial flora can be investigated. The data obtained from this experiment indicated that the 10% vermicompost in the diet was more effective and it can be a sustainable method for aquaculture and proves vermicompost to be a promising addition to fish feed for better nutrition and betterment of microflora of fish intestine. The comparison of the effects of adding vermiwash with vermicompost in rainbow trout feed and investigating the effect of adding vermicompost during feed production by extruding method and the effect of adding vermicompost to feed on the rate of fish fecundity and investigating the effect of feeding with vermicompost on the intestinal microbial flora population and effects of vermicompost in performance of carp, mullet, tilapia and crustacean can be suggested. Although we have obtained evidence that vermicompost may be a useful addition to trout feeds, further research into its best uses and potential benefits is warranted.

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Compliance With Ethical Standards

Authors' Contributions

AP: Investigation, Methodology, Data analysis, Writing – original draft

EC: Supervision, Writing – review and editing

All authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

This research was conducted at the Islamic Azad University in Iran, according to the country's legislation guidelines for the care and use of animals (Ethics approval number: 2916/4/2111, Date: 12/09/2017). All applicable international, national and institutional guidelines for the care and use of animals were followed.

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Data Availability

The datasets generated during the current study are available from the corresponding author on reasonable request.

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