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The Effects of Dietary Supplements Including Organic Silicon on the Growth Performance, Stress Resistance, Morpho-Histology, Blood Biochemistry, Digestive Enzymes, and Intestinal Microbiota of Juvenile Hybrid Tilapia (*Oreochromis mossambicus* × *Oreochromis niloticus*)

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ABSTRACT

The use of silicon in nutrition has drawn attention from all around the world in recent decades, but little is known about how it affects fish nutrition and metabolism. The aim of the study was to assess how dietary supplementation with organic silicon affected the hybrid Tilapia (Oreochromis mossambicus × Oreochromis niloticus) in terms of growth performance, blood biochemistry, digestive enzymes, morph histology, intestinal microbiota, and stress resistance. Though little is known about how silicon affects fish nutrition and metabolism, the use of silicon in nutrition has garnered attention in recent decades from all around the world. The study's objective was to evaluate the effects of nutritional supplementation with organic silicon on the growth performance, blood biochemistry, digestive enzymes, morphohistology, intestinal microbiota, and stress tolerance of hybrid Tilapia (Oreochromis mossambicus × Oreochromis niloticus). The 16S rRNA gene sequencing analysis of the gut microbiota showed a high diversity and richness of OTU/Chao-1, with Fusobacteria, Proteobacteria, Bacteroidetes and Acid bacteria predominating in the DOS treatments compared to the control ($p<0.05$). Induction of hypoxia stress after the feeding period showed a significant relative survival rate of 83.33% in fish fed 50 mg·kg^{-1} . It is concluded that the DOS treatments performed better than the control treatment in most of the variables analysed. DOS had no negative effects on the fish. The results showed that up to 50 mg·kg^{-1} DOS improved digestive, metabolic and growth performance in hybrid Tilapia.

Keywords: Sports, Public Health, Nutrition Benefit

INTRODUCTION

Approximately 62.2% of the aquaculture industry's total production is produced globally through the in-land aquaculture of various aquatic animal species. Red tilapia, sometimes referred to as "*Mojarra roja*," is one of the species that is grown and is the product of species hybridization. Its origins are in southern Central Africa, and because of its high protein content, variety of unsaturated fatty acids, commercial and social worth, and organoleptic conditions, its distribution has expanded throughout the world. By 2030, the harvest is anticipated to reach 7.3 million tons, with Egypt, China, and Indonesia serving as the primary producers. Since tilapia can be grown in both fresh and saltwater, developing nations like those in Latin America can use it as a substitute for other food sources. Nonetheless, the effective administration of every facet of manufacturing is crucial to its success. Globally speaking, feed may be the most important factor among them all, accounting for 40%-60% of total production costs. Poor feed management or nutritional imbalances can encourage the growth of opportunistic pathogens, which can result in extremely high concentrations of those pathogens, stress, and low survival rates that have an impact on productive performance, particularly in intensive systems with high densities of Tilapia in culture. Alternatively, different manufacturers employ substances and medications like antibiotics.

These medications, however, have a narrow range of action, and long-term, careless use leads to the growth of antibiotic-resistant pathogenic microbes as well as adverse environmental impacts. Nonetheless, a number of environmentally friendly approaches are being investigated to enhance and raise feed efficiency and production in tilapia aquaculture. Simple interventions, like dietary

modifications, have been demonstrated in animal studies to produce changes in the microbial profile of the intestinal tract, improved resistance to specific parasitic diseases, and increased stress tolerance. These changes have been shown to improve animal health and welfare as well as environmental preservation. In this sense, certain substitutes, such prebiotics or bio stimulants, comprise dietary minerals that are regarded as trace elements and take part in a number of fish metabolic processes.

The production of organic silica dates back to the 1950s, when silicon therapy first emerged. Currently, a range of products with organic silica are utilized to enhance plant, animal, and human health. Research on organic silicon has demonstrated its essentiality for both humans and animals since the 1930s. Its shortage results in changes and deformities in the growth of bones. It can also cause a number of disorders, including growth retardation issues, coronary pathologies, osteoarticular changes, weakened defenses, fragile bones, fibrosis, and flaccidity in the joints. Furthermore, it has been established that people with illnesses including cancer and tuberculosis are silicon deficient. When fed silicon nanoparticles, Nile tilapia showed increases in their growth, digestibility, and digestive physiology.

Furthermore, it has the potential to minimize vulnerability to illnesses and microorganisms, even in situations of extreme crowding. Moreover, structural activity has been discovered, and it plays a role in cell proliferation and the production of bone cartilage. Furthermore, studies have demonstrated the efficacy of silica in enhancing the quality of water. It has been reported to strengthen the effects of copper and zinc in humans in a more synergistic role. According to reports, silica and other metals, such as aluminium, can combine to form hydroxy aluminosilicates $AlOSi(OH_3)^{2+}$, which protects against the toxicity of aluminium.

To prove that supplementing fish diets with organic silicon is beneficial, a thorough investigation based on species and physiological stage is necessary. There are few reports on how organic silicon affects tilapia's physiology, biochemistry, growth, and metabolism. To prove that supplementing fish diets with organic silicon is beneficial, a thorough investigation based on species and physiological stage is necessary. There are few reports on how organic silicon affects tilapia's development, biochemistry, physiology, and metabolism.

DISCUSSION

It is challenging to achieve improved zoo technical and health outcomes in tilapia aquaculture. Despite the efforts made in tilapia to address this issue, there hasn't been much research on the use of organic silica as a food supplement. The results of the study show that organic silica in farmed tilapia has potential nutritional applications and provides empirical evidence for its safety and effects on gut microbiota, stress resistance, blood biochemistry, and digestive enzymes in *O. mossambicus* × *O. niloticus*

CONCLUSIONS

This study found that adding organic silicon to the diet had no detrimental effects or significant changes on the physiology, metabolism, or gut morphology of hybrid Tilapia (*O. mossambicus* × *O. niloticus*), as measured by growth performance, blood biochemistry, digestive enzymes, morphohistology, intestinal microbiota, and stress resistance. The findings demonstrated that red tilapia can be fed up to 50 $mg \cdot kg^{-1}$ of organic silicon without experiencing negative health effects. More research is still needed to fully understand the relationships between the physiological, digestive, and metabolic capacities of hybrid juvenile red tilapia and growth performance. Since this differs depending on the species, developmental stage, culture circumstances, and nutrition, each instance needs to be looked into independently. To gain a better knowledge of the levels of supplementation with organic silicon in the diet, a study that takes into account the usage of the optimal diet with larger specimens or specimens under different physiological situations should be carried out.