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Scholars Bulletin

Abbreviated Key Title: Sch Bull ISSN 2412-9771 (Print) | ISSN 2412-897X (Online) Scholars Middle East Publishers, Dubai, United Arab Emirates Journal homepage: <u>https://saudijournals.com</u>

Subject Category: Zoology

# Interaction and Applications of Nanoparticles in Fishes and Aquaculture

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DOI: 10.36348/sb.2021.v07i06.002

| **Received:** 18.04.2021 | **Accepted:** 27.05.2021 | **Published:** 12.06.2021

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### Abstract

There are lots of nanoparticles that have less toxic effects on the different cells of fish immune system. Nanoparticles have low cost as compared to the other materials in delivering of biological materials. Nanoparticles have gained much interest as a specific and sensitive tool for diagnosis of bacterial, fungal and viral diseases in aquaculture. There are different types of nanoparticles such as Cu based nanoparticles, sliver nanoparticles, metal oxides nanoparticles such as ZnO and TiO<sub>2</sub> NPs, or composite of several metals. The applications of nanoparticles in aquaculture has promisingly seen in water quality improvement, aquatic animal nutrition, drug delivery, disease diagnosis and management but very few works and has been done in the greener approach as it is forming a new horizon in the aquaculture era. Silver nanoparticle are employed for the cleaning fresh water inhabiting fishes due to advanced cleaning system and special plates that cleans each drop of water in each direction of movement of water. By improving disease control, feeding formulation, and biofouling control, nanotechnology can improve aquaculture production and shrimp culture.

Keywords: Fishes, Aquaculture, Nanotechnology, Nutrients, Drug Delivery, Water treatment.

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# **INTRODUCTION**

Nanotechnology playing important role in delivery of nutrients, vaccine and other biological materials to different systems of fishes [1-3]. Nanoparticles have found their way into many applications in the fields of medicine, including diagnostics, vaccination, and drug and gene delivery. There are lots of nanoparticles that have less toxic effects on the different cells of fish immune system. Nanoparticles have low cost as compared to the other materials in delivering of biological materials. Hence nanoparticle can be used at large scale for experimental study in animal's systems to investigate the different aspects of food intake through different carriers. Many of the advancements in nanotechnology can be made to decrease the rate of infectious disease caused by viruses as well as bacteria. Nanotechnology in fishes leads to significant construction to synthesis of nanoparticles [4, 5].

Some of biological materials cannot tightly bind to the pathogens due to less specificity and hence cannot be used as major target top the cells of viruses and bacteria [6]. It leads to innovation in the development of nanotechnology that has been revolutionized in preparation of biological materials. Nanoparticles have gained much interest as a specific and sensitive tool for diagnosis of bacterial, fungal and viral diseases in aquaculture [7].

There are different types of nanoparticles such as Cu based nanoparticles, silver nanoparticles, metal oxides nanoparticles such as ZnO and TiO<sub>2</sub> NPs, or composite of several metals [8]. These nanoparticles have less toxicity as compared to their biological materials in contrast to the nutrients and drug delivery in fishes while on the other hand, metal toxicity in fish to compare and contrast the effects of nonmetals can be evaluated in better way to elucidate the effects of nonmetals on the different cells of fishes. These different types of nanoparticles can be designed in order to play the significant role in disease detection, medicine in fishes. Each nanoparticle has its own well defined characteristic designed for drug delivery and other medicine. Among all of the nanoparticles, sliver based nanoparticles are most common in disease detection in fishes and other animal's systems.

Precautions can be made in specific quantification of nanoparticles and excess concertation leads to high level of toxicity can be seen in previous studies [9-11].

Disease is a prime agent affecting fish mortality, especially when fish are young. There are two types of fish diseases according to their infectiousness, pathogenic diseases and non-pathogenic diseases [12, 13]. Different diseases are the main caused of deaths of many fishes that might be either due to bacterial infections and viral infection and sometimes pathogens lead to high level of toxicity. It is related to poor water quality, malnutrition, etc., and not transferrable from one fish to another. High nutrition diet leads to increase potential of fish health. In this way, nanoparticles are main source of transportation as well as supplementation of materials across the membrane. Non-infectious diseases are represented by gas bubble diseases due to extensive aeration, nutritional diseases due to deficiency of certain nutrients as vitamins and minerals, disorders caused by pollutants in the form of agricultural and industrial, and neo-plastic and genetic anomalies referring to abnormal growth in any organ which make organ loses its function and structure[14-18].

### **Different Roles of Nanotechnology**

Nanotechnology playing important role in fish nutrients supply, drug as well as vaccine in efficient ways. Nanotechnology in combination with biological materials leads to increase attention of novel nanoparticles with low cost and efficient production. Nanoparticles synthesis more a niche for researchers, but a really fast growing and impacting key economical field providing new nanolabelled products with novel and unique functions. The new-engineered nanolabelled products, improved by nanoparticles (NPs), have been the key factor for the success of the nanotechnology industry [19-21].

Nanoparticles can be synthesized through different methods such as chemical, biological and physical. The most important methods that used for drug delivery and other supplementation of biological material across the cell membrane is the biological method. This method has database over the chemical and physical methods due to low cost and high efficiency of the synthesis nanoparticles. The green synthesis of nanoparticles increases the attention of other material and their integration with the different parts of the cell. While on the other hand, traditional methods are not reliable for the synthesis of nanoparticles as these required lots of reagents and chemicals at the larger production of nanoparticles both industrial and commercial level. Hence, these traditional methods cannot be employed due to low demand and high cost as compared to the advances in nanotechnology. Different changes can be made in nanoparticles during synthesis and modification before changed into final form while on the other hand, other materials other than nanoparticles required extensive variety of raw materials and time consuming [22-25].

Fishes are heterotrophic, multiple organ- and tissue-based organisms. Depending on the species, fish can be consumers of algae or of other heterotrophs. Various nanoparticles can be used or transported to the different cells of the fishes in order to deliver the right kind of medicine in right direction. Once the nanoparticle reached its target place, it will start perform its functions at the cellular and molecular level due to specific action. The gill affords gas exchange between the external water environment and internal environment of the organism. In this exchange process, other substances, like metal nanoparticles and organic compounds, can interact with fish gill cells and eventually pass into the blood stream[26-28].

Nanoparticles also showed the different the different responses by cell to deceases the rate of death of fishes. Many of the nanoparticles are able to enter the antigen presenting cells by different pathways and induce appropriate immune responses to the antigen. It also depends upon the nature of each nanoparticle designed to perform its function at the specific cell. A number of different nanoparticles are used in fish delivery, which includes biodegradable vaccine polymers, nanoliposomes, carbon nanotubes, calcium phosphate, and immunostimulating complexes (ISCOMs), among which poly (lactic-co-glycolic acid) and chitosan are the most studied form of nanoparticles to date. These nanoparticles are desired in relation to fishes and other organisms through different routes with fewer side effects [29-32].

### Role of Silver based Nanoparticles

Different types of nanoparticles are synthesized according into size, shape and delivery to specific target. Golden, silver, carbon nanoparticles are well known due to specific characteristics and their action to the biological cells. Among of all the nanoparticles, silver nanoparticles (AgNPs) are well known for their commercialization worldwide, due to their sole biological activities, and are being utilized widely in medicine. Despite the biological activities and a wide range application of AgNPs, there is a lack of information regarding human health and environmental toxicity. The extensive use of AgNPs in the world, release into the aquatic environment, has raised concern for a high impact on aquatic life. Silver nanoparticles are most important in cleaning of water in which habitat system of fishes are maintained due to natural environment [33].



Fig-1: Shows the role of silver nanoparticles in disease at cellular level

Silver (Ag) NPs (nAg) are the most nano-based investigated multiple mechanism antibacterial. These nanoparticles have particular surfaces to binding of receptor of the living cells in order to treat the specific diseases also diagnosis. The release of silver ions (Ag<sup>+</sup>) and their binding onto bacterial cell membrane proteins lead to cell membrane disruption and to cell death. The antibacterial function of the chitosan-Ag nanocomposites (CAgNCs) has been pathogenic Aliivibrio investigated against fish salmonicida. Previous literature showed that silver based nanoparticles particularly inhibited A. salmonicida growth indicating minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) at 50 and 100 mg/L, respectively [34-36].

Different nanoparticles are specifically designed in order to check their action at the cellular level. Silver nanoparticles tightly showed binding to the most of bacteria and hence antibacterial activity as compared to the other nanoparticles. The applications of nanoparticles in aquaculture has promisingly seen in water quality improvement, aquatic animal nutrition, drug delivery, disease diagnosis and management but very few works and has been done in the greener approach as it is forming a new horizon in the aquaculture era. Moreover, several reports are available which have shown that AgNPs are effective against organism namely B.subtilis, Vibrio pathogenic cholerae, E.coli and reported that Ag NPs with larger surface area provide a better contact with microorganisms [37].

Carica Papaya and Musa paradisiacal (banana) has developed and tested plants against Aeromonahydrophila. Biogenic Ag-NP using tea leaf extract (Camellia sinensis) showed bactericidal against Vibrio activity harveyi in juvenile Feneropenaeus indicus, but only at high doses of the nanoparticles. Among them, synthetized nanoparticles with Carica papaya (papaya) show antimicrobial activity with 153.6 μg mL-1 concentration [38]. In 2015, research on biogenic CuO NPs shows enhanced antibacterial activity against all the fish pathogens even at lower concentrations, i.e. which above 20 mu g/mL, was tested Pseudomonas against Aeromonas hydrophila, fluorescens and Flavobacterium branchiophilum.

#### Silver nanoparticles for the cleaning fresh water

Silver nanoparticle are employed for the cleaning fresh water inhabiting fishes due to advanced cleaning system and special plates that cleans each drop of water in each direction of movement of water. Silver nanoparticles to improve water quality in aquaculture. The intensive intervention which aquaculture practices produced, impact directly over the environment, because it needs higher water quantities, and this source every day is scarcer around the world. Also, not consumed food for fishes, excretion products, feces, chemical products, and antibiotics, generated higher quantities of waste during organism's production and was released to environment around these production farming. Hence, Nanotechnology has become the most significant for human life in treating and diagnosis of diseases [39].

Silver nanoparticles also used to remove the toxic heavy metals in water that are main threat to life of fishes. These nanoparticles bond to the heavy metals and remove them in specific concentration. Through the use of silver based nanoparticles, heavy metals and environmental pollutants can be easily removed at high concertation through integrative approach. Water quality is, of course, a critical factor in fish health. The standard concerns include ensuring water quality for the immediate needs of the species e.g. dissolved oxygen levels, temperature, salinity), removal of nitrogen wastes as well as the interactions of these parameters[40].

### **Role of Nanoparticles in Delivering of Nutrients**

Nanotechnology as multidisciplinary science to the pharmaceutical and nutraceuticals playing significant role in delivery of nutrients to specific parts of fishes. While the other biological materials cannot properly have reached to the site of target where action is necessary. Undoubtedly nutraceuticals are known to play a significant role in scaling up growth and immunological parameters in fish. However, instead of minimal requirements, their incorporation requires higher costs. Therefore, intense care should be taken in their usage to avoid wastage and maximize their utilization. Hence, nanoparticles can be employed as major source for supply of drugs, nutrients and biological fees in right ways [41].

A huge literature is available supporting the role of nanotechnology in effective delivery of dietary supplements and nutraceuticals in fisheries. These systems are basically aimed to enhance the bioavailability, bio accessibility and hence efficacy of the nutrients by improving their solubility and protection from harsh environment of the gut. In this perspective, it was found that adding 1 mg of nano-Selenium (Se) per kg of diet showed significant improvement in common carp (Cyprinus carpio) growth and antioxidant defense system as compared to the control ones[42].



Fig-2: Shows the potential applications of nanotechnology in reducing toxicity, nutrients delivery and water purification

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#### **Role of Nanoparticles Biofouling Control**

Biofouling due to bacterial attack can be interacted through the action of various nanoparticles that act as main oxides if the metals. Sometime, this biofouling appears to be more dangerous due to severe accumulation of other pollutants in water such as toxic metals in water that ultimately leads to deaths of many fishes and other animals inhabiting water. By improving disease control, feeding formulation, and biofouling control, nanotechnology can improve aquaculture production and shrimp culture. Biofouling is unwanted bacteria (as biofilm), and it is possible to monitor invertebrates such as mussels and barnacles and algae such as seaweeds and diatoms by coating or painting nanostructures through the incorporation of metal oxide nanoparticles such as ZnO, CuO, and SiO<sub>2</sub>. Hence, nanotechnology as the main scientific technology through thick environmental pollution can be controlled [43].



Fig-3: Shows the role of nanotechnology in controlling of pathogens toxicity

## **CONCLUSION**

Nanoparticles can be used in detection of different diseases caused by bacteria as well as viruses in fishes. Nanoparticles particularly binds to the specific antigen of the pathogen and inhibit their replication at the cellular level. While on the other hand, some other expensive biological materials required high cost and hence cannot be used for transportation and drug supply.

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