Chapter 10

Introduction to nanotechnology and its application in fisheries and aquaculture sector

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Nanotechnology has emerged as one of the most significant and fascinating fields in recent years. Utilizing materials at the nanoscale to create novel products or processes is referred to as nanotechnology. It is a leading-edge discipline in biology, engineering, physics, and chemistry. Being a new and inventive approach, nanotechnology has paved the way to open up new perspectives for the analysis of bio-molecules, targeted drug delivery, protein or cell production, clinical diagnosis, the creation of non-viral vectors for gene therapy, DNA transporters as disease therapeutics, etc. It will alter the course of technical development in a variety of applications. Although the term "nanotechnology" is still relatively new, the existence of nanometer-sized, functional structures and devices is very old. The measurement unit for nanometers is a billionth of a meter. Nanomaterials' distinctive physical and chemical features can be used for applications that benefit society.

Nanoparticles:

Nanomaterials (NMs) are unique materials with at least one dimension of 100 nm or with a primary size in the 1-100 nm range that have been created by humans. In general, it is believed that nanoparticles are made up of several atoms or molecules that are joined together at a radius of 100 nm. Nanomaterials may be formed into a variety of forms, including nanoparticles (NPs), nanorods, nanotubes, nanospheres, and nanowires. Metal nanoparticles, carbon-based nanomaterials i.e., Carbon nanotubes

(CNTs), and fullerene spheres are having to wide applications in almost all sectors.

Method for nanoparticle preparation:

Two ways are employed to generate nanoparticles i.e. Bottom-up approach and the Top-down approach. In general, the bottom-up technique refers to the creation of nanoparticles by chemical interactions between atoms/ions/molecules. Top-down incorporates mechanical ways of crushing/breaking bulk into multiple sections in order to generate nanoparticles.

Application in fishery and aquaculture sector:

Fisheries and aquaculture may utilize nanotechnologies and generate new uses. Nanotechnology's advantages for fisheries and aquaculture must be weighed against environmental and worker health issues.

Food industry: In the food industry, nanotechnology is already being used. Nano-polymers and coatings could be used in fisheries to strengthen food packaging and protect delicate fish fillets. The use of antibacterial nano-coatings and transparent polymer films that can help exclude oxygen from around the food product can help extend the shelf life of fish and shellfish. Nano-sensors on food packaging can also detect the deterioration of fish or shellfish.

Aquaculture: Nanotechnological applications for fish health in aquaculture include antibacterial surfaces in the aquaculture system, nano-delivery of veterinary products in fish food utilizing porous nanostructures, and nano-sensors for detecting infections in the water.

Aquaculture Engineering: From an engineering standpoint, there are several innovative construction materials, textiles, and fabrics that might be employed in aquaculture engineering and fishing boats. Carbon nano-fibers, which are more than 100 times stronger than steel, might be employed in cage construction, nets, and mooring lines. The antibacterial capabilities of

NMs have the potential to be employed to reduce biofouling on maritime constructions.

Aquaculture feed: Fish will consume NM-containing foods, and nanotechnology may be employed to optimize the delivery of micronutrients or unstable substances in aquafeeds. The employment of nanoencapsulation technology for fat-soluble vitamins, minerals, and fatty acids, for example, may be useful. Some NMs may alter the physical qualities of the meal (for example, buoyancy and hardness).

Purification of water: Measurement techniques for NM environmental monitoring and NM surveillance in goods, particularly food such as fish fillets, are required. Nanotechnology has several uses in water purification, including the removal of bacteria, organic compounds, and metals.

Toxicity of nanoparticles:

There is a substantial corpus of information about NM occupational health and safety. Employers may get guidance notes from many government bodies, including the Health and Safety Executive in the United Kingdom. Few persons will be exposed to raw NMs or free particles, the estimated occupational health effects from NMs are likely to be modest for fishery workers. There is guidance provided for scientific employees in research labs to ensure safe handling. The potential advantages of nanotechnology to the fishing and aquaculture sectors should be evaluated against environmental hazards. The colloidal behaviour of NPs is discussed briefly. Laboratory investigations demonstrate that free NMs at mg l1 levels are hazardous to various fish and invertebrates. Many of the effects seen with classical chemicals, including respiratory distress, gill damage, metabolic abnormalities, and impacts on embryonic development, So far, ecotoxicity statistics imply that produced NMs may be less harmful than certain existing compounds. However, there are several data gaps, including a paucity of data on critical aquaculture and fishery species.

Conclusions

Based on current evidence, the benefits of using nanotechnology in fisheries and aquaculture are considerable, and the Potential risks should not be allowed to hinder innovation. So, the right use of nanotechnology in fisheries and aquaculture should be encouraged with minimal risks.

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