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Recent advances in bioremediation in Aquaculture systems

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Abstract

There is a growing concern in the rate of diseases in the aquaculture industry worldwide. The technique bioremediation is not a new term in this aquaculture industry. Aquaculture has regularly been blamed for unsustainable and non-environmental friendly dude to their impact on effluent discharge and some water quality problems in the culture. Researches on the bioremediation of aquaculture waste have begun past 20 years and now it is in the condition to improve those technologies to enhance the fish health. The technology bioremediation uses microbial metabolism in the presence of optimum environmental conditions and sufficient nutrients to breakdown contaminants. We reviewed some advances on the application of this technology in the aquaculture health management. Comparing to other traditional technique to manage or to degrade the waste, bioremediation is eco-friendly and much cost effective. This article focuses on recent technologies for carrying out bioremediation and biotechnological approaches that are designed to carry out remediation which have received a great deal of attention in recent years.

Introduction

According to Office of Technology Assessment, bioremediation has been defined as “the act of adding materials to contaminated environments to cause an acceleration of the natural biodegradation processes”. The process of bioremediation involves the transfer of the contaminants into harmless compounds such as co_2 and water. This microbial metabolism involves a chemical reaction called oxidation reduction reaction. By breaking the contaminants its chemical bonds and transferring the contaminants electrons into electron acceptor, the contaminants are oxidised. The chemical receiving the electrons is reduced. The energy came from this transfer is then used along the carbon from the contaminant to create new cells. To precisely said, the goal of the bioremediation is to stimulate microorganisms with nutrients and other chemicals that will enable them to destroy the contaminants.

Applications of Bioremediation in aquaculture pond

There involve 3 major common methods on this bioremediation applications which are biological methods**,** bacterial groups and algal biomass in the bioremediation. Apart from this there occurs various technological developments which are described in the following.

Common methods of bioremediation

Biological methods

- IMTA- Integrated Multitrophic Aquacul
- Oxidative bioremedia
- Microbial mats
- Zeolite
- Nitrifying bioreactor

Bacterial groups

- Anammox
- Bacteria to remove geosmin and MIB

Algal biomass

- HRAP- High rate algal pond

Biological methods

The technology named IMTA is not a new term and was followed by 3 productive decades and commonly called as Ecologically engineered Aquaculture and ecological aquaculture and also the name integrated aquaculture was also came across by some

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researchers. This system refers to the combination of species from different trophic levels in the same aquaculture pond and so the fishes share the same biological and chemical processes.

The use of the microbial mats and zeolite were focussed on the removal of the ammonia in the aquaculture ponds and worked as natural filters in the system. In both the case, microbial mats were becoming an alternative for treating shrimp effluents for reducing organic loading (especially BOD5).

Among the above-described biological methods, the nitrifying bioreactors play a vital role in removing TAN and it was recently developed after 16 years of research. This patented new technology is the first of its kind in the world used for any level of salinity and facilitates management of water quality with maximum consistency, and least incidence of diseases and offers reef quality oligotrophic water. In the advent of this invention, 2 types of the reactors have been described which are

- In-Situ Stringed Bed Suspended Bioreactor (SBSBR)
- Ex-Situ Packed Bed Bioreactor (PBBR)

They form the key component for the establishment of Recirculating Aquaculture Systems (RAS). Even though, great efforts have been made on the examination of nitrifying biofilters for aquaculture practices, the research have for the most part been concentrating on performance of an individual component under specific operating conditions utilizing average ammonia removal rate to depict the biofilter nitrification performance

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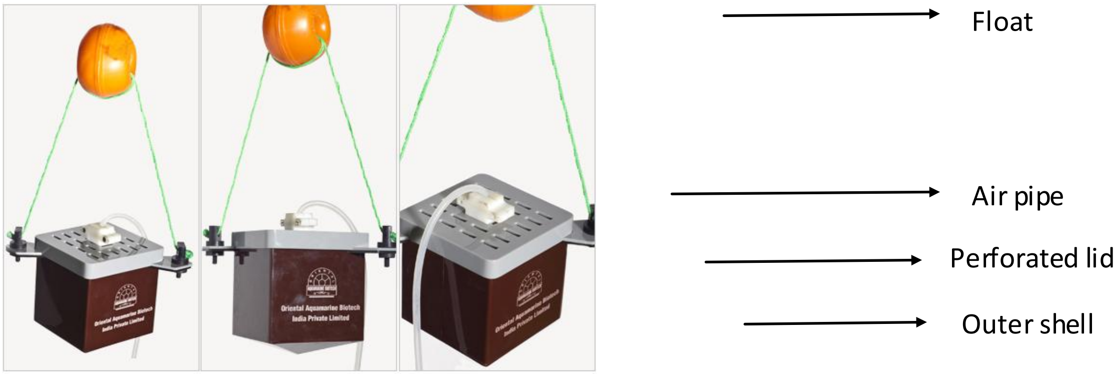

Fig.1. Showing In-Situ Stringed Bed Suspended Bioreactor.

Bacterial groups

Anaerobic ammonium oxidation (Anammox)

An innovative technological advancement in the removal of ammonia nitrogen is the Anammox. This is a bacterial consortium considering to have a unique property of removing ammonium ions instead of passing through a two-stage process of aerobic nitrification and anaerobic denitrification, it combines nitrate or nitrite with ammonia and form dinitrogen gas. The main advantage of this innovation is that they don't require any organic carbon source and moreover it saves costs as less energy for aeration.

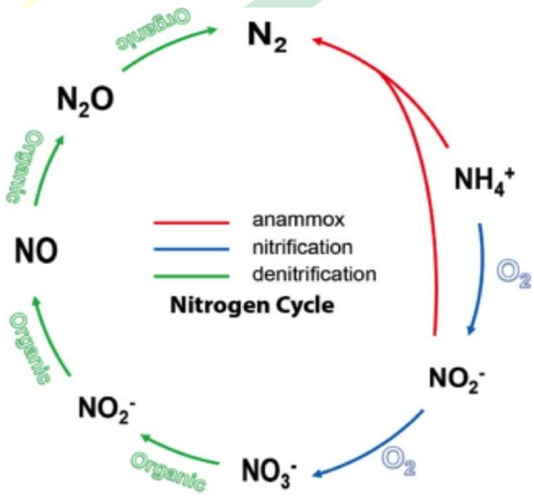

Fig 2. Showing the process of Annamox in detail.

The main problem in the freshwater aquaculture ponds is the Geosmin and MIB whichare terpene-type compounds produced by algae. To elucidate this smell, many bacterial strains were tested and found that Rhodococcuswratslaviensis DLC-cam, Pseudomonas putida G1, and Rhodococcus sp. T1 had the ability to transform geosmin or MIB. In addition to these researchers are in the verge to improve the activity of these organisms with a help of a key enzyme in the degradation of terpene-like compounds. There is an option to raise a question on the bacterial toxicity of the fishes. In context to that, they have found that, Rhodococcuswratslaviensis DLC-cam was found to not be pathogenic against fish, even at very high concentrations. These bacterial strains have the capacity to grow in the minimal media with fish feed as the sole carbon source, a condition typical of aquaculture environments. Finally, all three strains can be frozen without significant loss in viability, which is desirable for storage and transport to a treatment area

Algae a new green energy

Basically, there are two main types of algal pond systems: static algal ponds and high-rate algal ponds (HRAP) which can be used for effluent treatment. This HRAP which is a low-energy wastewater treatment made the second loop for the water treatment of flow through or recirculating aquaculture systems. They are characterized by a continuous water circulation and mixing in a culture tank, either by a paddlewheel or by strong aeration, and by a short residence time (days). The main advantage is that the final outcome of this effluent treatment which is wastewater solids can be used for recovering energy and the harvested algal mass can be used for biofuel production. This perforated algal species can assimilate nutrients from the wastewater and thereby providing both secondary and partial tertiary-level treatment.

Conclusion

Aquaculture production has expanded relentlessly in late years and is the quickest developing sustenance creation part and has turned into an important segment of national development. It was once viewed as an earth sound practice on account of its polyculture and integrated aquaculture where they incorporated the optimal utilization of land and water resources with restoring the water quality. Due to intensification of the farming activities, we are in the verge to remediate the present aquaculture systems. Bioremediation play an important role in this process with the view to improve the water quality by introducing macro and microorganisms and /or their products as additives, which are referred to as bio remediators or bioremediating agents. The application of bio remediators in aquaculture shown promise, but further investigations may be expected with propagation of molecular approaches to analyse bacterial communities.

References

1. Ahmad, M.A.S.O.O.D. and Ahmad, I.R.S.H.A.D., (2014). Recent advances in the field of bioremediation. *Biodegradation and Bioremediation. Studium Press LLC*, pp.1-42.
2. Focht, D.D and W. Verstraete. (1977). Biochemical ecology of nitrification and denitrification. Advances in Microbial Ecology. 1: 35 - 214.
3. Jones, G.L and A.R. Paskins. (1982). Influence of high partial presence of carbon dioxide and lor oxygen in nitrification. J. Chem. Technol. Biotechnol. 32: 213 - 223.
4. Kuenen, J.G., (2008). Anammox bacteria: from discovery to application. *Nature Reviews Microbiology*, *6*(4), p.320.
5. Kumar, V.J., Joseph, V., Philip, R. and Singh, I.S., (2010). Nitrification in brackish water recirculating aquaculture system integrated with activated packed bed bioreactor. *Water Science and Technology*, *61*(3), pp.797-805.
6. Tal, Y., Watts, J. E., and Schreier, H. J. (2006). Anaerobic ammonium-oxidizing (anammox) bacteria and associated activity in fixed-film biofilters of a marine recirculating aquaculture system. *Applied and environmental microbiology*, *72*(4), 2896-904.
7. Thapa, B., Kc, A.K. and Ghimire, A., (2012). A review on bioremediation of petroleum hydrocarbon contaminants in soil. *Kathmandu university journal of science, engineering and technology*, *8*(1), pp.164-170.