Nano Vaccines: New Paradigm in Aqua Health Sector

Keywords: Nano vaccines; Paradigm; Aqua health sector; Gross National Product; dsRNA; Encapsulation; Nanotechnology; Nanocapsules; Aquaculture; Fisheries; Vaccine; Myonecrosis Virus; Vaccination; WSSV; Shrimp

Research Article

Volume 3 Issue 2 - 2015

Vijaya Chalamcherla*

Department of Marine Biology, Vikrama Simhapuri University, India

***Corresponding author:** Vijaya Chalamcherla, Department of Marine Biology, Vikrama Simhapuri University, Nellore, AP, India- 524001, Email: Vijayalch@gmail.com

Received: October 28, 2015 | **Published:** November 17, 2015

Abbreviations: GNP: Gross National Product; WSSV: White Spot Syndrome Virus; IMNV: Infectious Myonecrosis Virus; PLGA: Poly-Lactide-Coglycolide Acid

Editorial

Coastal areas within 100 kilometres of the ocean account for an estimated 61 percent of the world's total Gross National Product (GNP) and are of particular importance for developing countries. FAO estimates that fisheries and aquaculture assure the livelihoods of 10-12 percent of the world's population [1]. In 2012, fisheries produced roughly 160 million tons of fish and generated over US $129 billion in exports and accounting for 16 percent of total global animal protein [2]. Overall, healthy oceans, coasts and freshwater ecosystems are crucial for economic growth and food production in developing countries. However, outbreak of disease is one the major stumbling blocks in the development and sustainability of aquaculture. Further, poor fisheries management costs roughly US$50 billion annually and US$2 trillion in the last 30 years in lost economic potential [3]. The $11 billion shrimp industry continues to suffer major losses each year due to viral disease outbreaks, such as white spot syndrome virus (WSSV) and infectious myonecrosis virus (IMNV) [4].

While there are currently no treatments for these diseases, number of approaches have been taken in attempts to solve disease problem in aquaculture. One of them is vaccination. However, one question with vaccination is how to best deliver the vaccine to the animal in the aquatic environment [5]. The use of oil emulsion as adjuvant in this effort may cause major drawbacks as some fish and shellfish show unacceptable levels of side effects [6].

In this context, in recent years, to meet an urgent need for improved vaccines against viral diseases in aquaculture, nanovaccine is a novel approach to the methodology of vaccination [7]. With a strong history of adopting new technologies, the highly integrated fish farming industry may be among the best to incorporate and commercialise nanotech products [8]. In Nanotechnological intervention dsRNA-based vaccines have shown promise in preventing WSSV and IMNV infections. Unfortunately, dsRNA-based vaccines have limited stability and short in vivo residence times, limiting their implementation in field-relevant scenarios. Alternatively, encapsulating the viruses into biodegradable and biocompatible polymers was suggested to protect viral antigens from premature degradation and gradually expose them to the immune system [9]. Nano vaccines based on polyanhydride nanoparticles have been successfully used for the encapsulation and release of vaccine antigens. Polyanhydrides erode via a surface erosion mechanism that limits the exposure of encapsulation payloads to water, and therefore, enhancing their stability [7,10]. In addition, the nanovaccine platform is capable of mass immunization of shrimp via immersion or milling with feed, making their use in field-relevant conditions possible [11].

Further, researchers have designed a DNA construct vaccine that would causes the shrimp to produce immunologic proteins that protect the shrimp from WSSV for up to 7 weeks per application, but have had to develop a novel delivery system since injecting every with shrimp protein-based vaccines on a continual basis would be economically and physically impractical. In this context to deliver this DNA construct, scientists have developed and tested the use of nanoparticle carriers like chitosan, alginates and poly-lactide-coglycolide acid (PLGA) of vaccine antigens, together with mild inflammatory inducers orally, which showed a high level of protection to fish and shellfish not only against bacterial diseases, but also from viral diseases with vaccine-induced side effects [7]. As carrier particles for nanovaccine preparations, linear polysaccharide chitosan and alginates have found multiple applications in vaccines formulation due to their water-solubility, relative non-toxicity, biocompatibility, biodegradability, bio-adhesive characteristics along with permeability enhancing properties [12].

Researchers have proven this novel vaccine and delivery system to work in cultured tiger shrimp with relative survival rates of up to 85% after scientists administered the vaccine. Further, the mass vaccination of fish can be done using nanocapsules containing nano-particles [13,14]. These will be resistant to digestion and degradation. These nanocapsules contain short strand DNA, which when applied to water are absorbed into fish cells. Ultrasound is used to break the capsules which in turn release the DNA thus eliciting an immune response to fish due to the vaccination. The water soluble DNA is absorbed into the intestinal tract of the shrimp where it migrates to the animal's lymphatic system [15]. Similarly, oral administration of these vaccines and site specific release of the active agent for vaccination will reduce the cost and effort associated with disease management. Briefly stated, nanoparticles are used as oral drug carriers for several reasons like improvement in the bioavailability, residence time and digestive stabilization [16,17]. They also facilitate the efficient absorption delivery of vaccine antigens to gut associated lymphoid tissue [18].

Conclusion

This aspect of aquaculture and Fisheries is still in infancy and require attention of the scientific fraternity for its widespread use to harness its potential benefit. Although much of development research is needed to enhance the potential use of nanotechnology in aquaculture, at present, there are numerous glimpses of the future application of this technology in fish health management. Overall, the adoption of nanotechnology into different aquaculture procedures seems to be inevitable and will surely bring more advances to this activity in the future and perhaps our next fish filet or shrimp cocktail will have been raised on the benefits of nanotechnology.

References

1. Defra (2009) A strategic review of the potential for aquaculture to contribute to the future security of food and non-food products and services in the UK and specifically England.

2. Mohd Ashraf, Md Aklakur, Rupam Sharma, Shabir Ahmad, Mujhid Khan (2011) Nanotechnology as a Novel Tool in Fisheries and Aquaculture Development: A Review. Iranica Journal of Energy and Environment 2(3): 258-261, 2079-2115.

3. Rather MA, Sharma R, Aklakur M, Ahmad S, Kumar N, et al. (2011) Nanotechnology: A Novel Tool for Aquaculture and Fisheries Development, A Prospective Mini-Review. Fisheries and Aquaculture Journal 2011: FAJ-16.

4. World Wildlife Fund (2014) Farmed Shrimp.

5. Florence AT, Hillery AM, Hussain N, Jani PU (1995) Nanoparticles as carriers for oral peptide absorption: studies on particle uptake and fate. Journal of Controlled Release 36(1-2): 39-46.

6. Kuzma J, Verhage P (2006) Nanotechnology in Agriculture and Food Production: Anticipated Applications. Project on Emerging Nanotechnologies and the Consortium on Law, Values and Health and Life Sciences. Centre for Science, Technology and Public Policy (CSTPP).

7. Rajeshkumar SC, Venkatesan M, Sarathi V, Sarathbabu J, Thomas K, et al. (2009) Oral delivery of DNA construct using chitosan nanoparticles to protect shrimp from white spot syndrome virus (WSSV) Fish and Shellfish. Immunol 26(3): 429-437.

8. Milani M, Sharifi Y, Rahmati-Yamchi M, Somi MH, Akbarzadeh A (2015) Immunology and Nanovaccines for *Helicobacter pylori* infection. Expert Rev vaccines 14(6): 833-840.

9. Brigittev Osterath (2015) Nano vaccines: vaccines that don't need refrigeration in developing countries. ACS.

10. Carrillo-Conde B, Schiltz E, Yu J, Chris Minion F, Phillips GJ, et al. (2010) Encapsulation into Amphiphilic polyanhydride microparticles stabilises *Yersinia pestis* antigens. Acta Biomater 6(8): 3110-3119.

11. Ross KA (2014) JBMR 102(11): 4161-4168.

12. Roy K, Mao HQ, Leong KW (1997) DNA-chitosan nanospheres: Transfection efficiency and cellular uptake. Proceedings of the Controlled Release Society 24: 673-674.

13. Dutkiewicz J, Kucharska M (1992) Advances in Chitin and Chitosan. Brine et al. (Eds.), Elsevier Science 31(4): 54-60.

14. Florence AT, Hillery AM, Hussain N, Jani PU, (1995) Nanoparticles as carriers for oral peptide absorption: studies on particle uptake and fate. Journal of Controlled Release 36(1-2): 39-44.

15. Peters SE, Brain CH (2009) Benefits of a Soy Lecithin Based Nanotechnology for the Animal and Human Food Industry. Micro/nanoencapsulation of active food ingredients 1007(12): 183-197.

16. Mohanraj VJ, Chen Y (2006) Nanoparticles-A Review. J Pharmacy Res 5(1): 561-573.

17. Jani PGW, Halbert J, Langridg, Florence AT (1990) Nanoparticles uptake by rat gastrointestinal mucosa: quantitation and particles size dependency. J Pharm and Pharmacol 42(12): 821-826.

18. Handy RD (2012) FSBI briefing paper: Nanotechnology in fisheries and Aquaculture. Fisheries Society of the British Isles.

Citation: Chalamcherla V (2015) Nano Vaccines: New Paradigm in Aqua Health Sector. J Aquac Mar Biol 3(2): 00061. DOI: 10.15406/jamb.2015.03.00061