International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(4): 1104-1107

Received: 01-05-2019
Accepted: 05-06-2019

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Vaccination and shrimp: Can vaccines protect shrimp from pathogens? - A peek

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Abstract
Shrimp aquaculture has been experiencing a tremendous increase without frontiers all over the world since 1970. It is often considered as living dollar as it contributes a lump sum amount to the total aquaculture production by value. Despite this bloom and spread, their intensification has not left them free from disease attacks by pathogens. Every year the sector faces huge economic crisis due to diseases especially the one caused by viruses. Both the viral and bacterial diseases which facilitated the shrimp losses in terms of production and value ushered the aquatic animal health scientists to explore their immune mechanisms and unfold the vaccination attempts in shrimps. Although the shrimps lack a true adaptive immune response, the understanding and discovery of existence of specific memory in innate immune systems led to the burgeoning of several vaccine and vaccination strategies for shrimps against bacterial and viral diseases. There have been quite few reviews on vaccination in shrimps with respect to different mechanisms and factors. Here, in this concise review, we provide a glance on overall vaccination aspects in shrimp aquaculture practices particularly with respect to bacterial (Vibriosis) and viral disease (White spot disease).

Keywords: vaccination, shrimp, vibriosis, wssv, nano-vaccine

1. Introduction

While shrimp yields from capture fisheries expanded only 3-fold, the production of cultured shrimp increased 350-fold from 1970 to 2006. In spite of this amazing development, shrimp aquaculture has not been without issues. In the mid-nineties it was evaluated that around 40% of the overall shrimp production of value over $3 billion, was lost because of maladies. Among the misfortunes because of ailments, viral diseases in cultured shrimp have been assessed to contribute up to 60% of the yearly losses in worldwide productivity. The primary supporters of these viral ailments are white spot syndrome virus (WSSV), yellow head virus (YHV), Taura syndrome virus (TSV), infectious hypodermal and haematopoietic necrosis virus (IHNNV), and monodon baculovirus (MBV). These are essential because of their epizootic spread and financial effect. Comprehension of the immune mechanisms and how the pathogens interact has enabled scientists and researchers of aquatic animal health to develop successful vaccines in aquatic species and these have been reviewed previously. The non-specific antiviral response triggered by dsRNA, the phenomenon and mechanism of vaccination of shrimp against viral pathogens, mechanistic exploration of specific immune priming with special reference to shrimp culture and the factors implicated in the penaeid shrimp immune response to viral infection and challenges associated with future research directions have been comprehensively reviewed by Robalino *et al.* (2007) [11], Johnson *et al.* (2008) [6], Rowley and Pope (2012) [14] and Underwood *et al.* (2013) [16]. Therefore, they won't be shrouded in detail in the present review.

2. Immune response in shrimps

Spineless creatures utilize the natural resistant mechanisms for adequately perceiving and obliterating the foreign materials including pathogens. Inborn immune reactions are thought to be less modern than acquired immunity, however, they may quickly and effectively perceive and devastate foreign materials including pathogens. Innate immune responses comprise of cell and humoral segments. Haemocytes are responsible for most of the cellular responses, such as encapsulation, phagocytosis, nodule formation, melanisation, cytotoxicity, cell-to-cell communication, clotting, cell agglutination and the pro-phenoloxidase activating system. They likewise assume a noteworthy part in directing the physiological functions including hardening of exoskeleton, wound repair, carbohydrate metabolism, transport and storage of proteins and aminoacid, haemolymph coagulation (Kumar and Ramalingam, 2014) [7]. Humoral reaction factors begin from granulocytes and incorporate lectins, guarded catalysts, defensive enzymes, reactive oxygen intermediates, and the synthesis of a wide array of antimicrobial peptides. Invertebrates, by and large, do not have a genuine adaptive immune response nonetheless, specific memory exists in innate immune systems. Although, the real mechanisms have not been assessed, a short memory of antigen as the resistant reaction in shrimp may include a prompted emission of killing/ neutralizing substances or other defensive proteins against WSSV attack. Several peptides acting similar to antiviral agents have been reported in different marine invertebrates including shrimps (Table 1).

Table 1: Antiviral properties of peptides of marine invertebrates

Sl. No.	Protein	Type	Species	Effect
1.	Anti-lipopolysaccharide factor (ALF), ALF cDNAs and ALFPm3 (rALFPm3)	Antimicrobial protein	Horseshoe crab [*Tachypleus tridentatus* (TALF) and *Limulus polyphemus* (LALF)], shrimps (*P. monodon* and other sp.), crabs, lobsters and crayfish	Antimicrobial activity against both gram-negative and gram-positive bacteria and fungi as well. ALFPm3 protein is conceivably involved in the protection mechanism against WSSV infection in shrimps.
2.	Haemocyanin	Antibacterial and antifungal peptides	Shrimps	Antiviral property against WSSV in the closely related *Marsupenaeus japonicus*.
3.	LvCTL1	c-type lectin	*L. vannamei*	Displays antiviral action against WSSV by authoritative with envelope proteins of the infection.
4.	Mytilin	Antibacterial peptide	*Mytilus galloprovincialis*	Indicates antiviral properties against WSSV in shrimps where it diminishes shrimp mortality following WSSV.
5.	PmAV	c-type lectin	*Penaeus monodon*	Initiated cytopathic impacts in a fish cell culture.
6.	Tachyplesin and polyphemusin	Antimicrobial protein	Horseshoe crab (*Tachypleus tridentatus* and *Limulus polyphemus*)	Antiviral activity against human immunodeficiency virus (HIV). In addition, tachyplesin shows antiviral properties against different infections including herpes simplex virus (HSV), vesicular stomatitis virus (VSV) and influenza A virus (IAV).

3. Immunization against Vibriosis

Affecting the early formative phases of shrimp and also the juveniles and adults, vibriosis is considered as a serious disease in shrimp aquaculture. This vital bacterial malady can be caused by *Vibro anguillarum*, *V. alginolyticus*, *V. penaeicida*, *V. parahaemolyticus*, *V. harveyi* and *V. campbellii*, in hatcheries and grow-out culture and vaccines may thusly offer some help with its control. Advancement of imperviousness to infection by plausible immune reaction like component following immunization has been archived against bacterial pathogens. Shrimps are protected against vibriosis following immune stimulations and vaccinations with inactivated Vibrio spp. Immuno stimulation of shrimp with microbial products showed the generation of microbiocidal substances by their haemocytes. Itami *et al.* (1989) [5] inoculated shrimps with Vibrio spp. what's more, Alabi *et al.* (1999) [1] utilized formalin murdered cells of microorganisms for shrimp immunization against vibriosis with progress. George (1995) [4] revealed a relative percentage survival (RPS) of 34% for *Penaeus monodon* inoculated with *V. alginolyticus* bacterin. On account of post larvae of *P. monodon*, bath vaccination with formalin killed vibrios resulted in elevated survival up to 30 days post-delivery. Additionally, a commercial item (Vibromax™) has been appeared in field trials to enhance the development and survival of shrimp (*Litopenaeus vannamei*) post-larvae (Wongtavatchai *et al.*, 2010) [19]. Aside from reports of vaccination against vibriosis, immunization against viral diseases particularly with respect to white spot disease was additionally detailed in shrimps.

4. Immunizations against white spot disease

Invertebrates do not have a genuine acquired immunity and depend exclusively on innate immunity, so up to this point, inoculation of shrimp against white spot syndrome virus (WSSV) was not viewed as a suitable technique. However, Venegas *et al.* (2000) [17] exhibited the presence of quasi-immune response in *P. japonicus* that had survived past introduction to WSSV. In another investigation, shrimp wound up noticeably impervious to WSSV around 3 weeks after infection and haemolymph from resistant shrimp contained virus neutralizing factors. These outcomes empowered research into the likelihood of immunizing shrimp against WSSV. Also, an investigation on the antiviral resistance in crustaceans has demonstrated the induction of shrimp genes related with its capacity to survive the viral infections. Be that as it may, it is not clear which of these shrimp genes would prompt the generation of the antiviral substances. Within a few years, numerous published investigations led to the development of various WSSV vaccination strategies to secure shrimp, including inactivated WSSV vaccines, subunit recombinant vaccines, oral recombinant vaccines, DNA vaccines and dsRNA. The recombinant proteins vaccine comprises of r-VP26 or r-VP28 protein which prompted resistance against WSSV. In *P. monodon*, WSSV envelope proteins (VP19 and VP28) were applied as bacterial articulation procedure through injection, oral and immersion vaccines. Westenberg *et al.* (2005) [18] utilized extensive dsRNA particles and also siRNAs to instigate a sequence independent anti-viral immunity when infused to shrimp. Namikoshi *et al.* (2004) [9] demonstrated the likelihood of vaccination for kuruma shrimp with recombinant proteins against WSSV. A recombinant protein vaccine has favourable position in that creatures can be immunized with a lot of specific antigens. The protein vaccine is one of the arrangements, particularly for shrimp infections including WSSV, in light of the fact that WSSV can't be refined inferable from the absence of vulnerable cell lines. In this way, recombinant WSSV envelope proteins, rVP19 and rVP466, were created for the immunization of shrimps. Numerous scientists have detailed the advancement of immunization against WSSV utilizing glucan, peptidoglycan and lipopolysaccharide, formalin killed bacterin and anti-lipopolysaccharide factor. Phouc *et al.* (2008) [10] reported the synergistic impact of WSSV and *V. campbellii* on the improvement of the illness in specific pathogen free *L. vannamei* shrimp. As indicated by another investigation, gamma-irradiated WSSV can incite resistant reactions in shrimp infected with WSSV, and probiotic (Gamma-irradiated *V. paraheomolyticus*) can upgrade these reactions.

5. Scene behind the WSSV vaccines

Novel viral control systems, including immunization, are essential owing to the continuous of shrimp aquaculture and the wide host range of WSSV. Endeavours to secure or control the WSSV disease incorporate vaccination of shrimps with viral envelope proteins, using RNA interference to induce viral immunity and direct neutralization by antiviral proteins. As an attachment factor to the receptor and fusion factor to cell membranes enveloped viruses which contain glycoproteins in their viral envelopes play significant roles in the virus-host interaction. In most WSSV immunizations, VP28 has been a noteworthy focus, as the envelope auxiliary proteins of WSSV assume a vital part in beginning viral infection. The envelope proteins are regularly vital for viral growing, passage and gathering. VP28 is a noteworthy envelope protein of WSSV and is associated with the systemic infection of shrimp. This VP28, amid WSSV infection, interacts with host cellular proteins such as PmRab7, heat shock cognate protein 70 and the signal transducer and activator of transcription (STAT) to bring about the viral infection. Past reports have exhibited that VP28-based recombinant vaccine give protection and enhance the survival rate of tested shrimp amid WSSV tests when contrasted with unvaccinated shrimp. In any case, the protection offered by these VP28 inferred recombinant vaccines is not high, and the defensive reaction is definitely low at 10 days post-challenge. Bac-VP28 is an attractive preventative measure for shrimp culture against WSSV infection where VP28 gene is inserted into baculoviral vector under the control of the WSSV ie1 promoter and expressed VP28 gene on baculovirus surface. Henceforth, it might be conceivable to enhance vaccine efficacy by expressing the recombinant VP28 protein in a baculovirus eukaryotic expression system.

6. Nanoparticulate vaccines-A way forward

In case of vaccines, the manner by which to best convey the immunization to the creature in the aquatic environment is a big dilemma. The utilization of oil emulsion as adjuvant in this exertion may cause significant downsides as some fish and shellfish demonstrate unsatisfactory levels of reactions. In this specific circumstance, as of late, to meet a dire requirement for enhanced vaccines against viral diseases in aquaculture, nano vaccine is a novel way to deal with the system of immunization. dsRNA-based immunizations have indicated guarantee in avoiding WSSV and IMNV diseases in nano technological intercession, sadly, dsRNA-based antibodies have constrained solidness and short in vivo habitation times, restricting their execution in field-important situations (Chalamcherla, 2015) [3]. On the other hand, exemplifying the infections into biodegradable and biocompatible polymers was recommended to shield viral antigens from untimely debasement and step by step open them to the immune framework. Scientists have composed a DNA construct vaccine that would make the shrimp create immunologic proteins that shield the shrimp from WSSV for up to 7 weeks for each application, however have needed to build up a novel conveyance system since infusing each with shrimp protein-construct vaccinations in light of a ceaseless premise would be monetarily and physically unreasonable. In this setting to convey this DNA construct, researchers have created and tried the utilization of nanoparticle transporters like chitosan, alginates and poly-lactide-coglycolide acid (PLGA) of vaccine antigens, together with mild inflammatory inducers orally, which demonstrated an abnormal state of assurance to fish and shellfish against bacterial illnesses, as well as from viral ailments with immunization incited symptoms. After the application of nanocapsules to water, an ultrasound mechanism is utilized to soften the cases which in turn discharge the DNA contained in them therefore evoking an immune response to fish because of the immunization. The water dissolvable DNA is consumed into the intestinal tract of the shrimp where it moves to the creature's lymphatic system. Owing to the improvement in bioavailability, residence time and digestive stabilization, nanoparticles are utilized as oral medication transporters which additionally encourage the effective assimilation conveyance of immunization antigens to gut associated lymphoid tissue (GALT). In addition, nanoparticles present in nanocapsules are found efficient in mass vaccination of post larva and juveniles of cultured shrimps. As bearer particles for nano vaccine arrangements, because of their water-dissolvability, relative non-poisonous quality, imperviousness to assimilation, biocompatibility, biodegradability and bio-adhesive attributes alongside porousness improving properties, linear polysaccharide chitosan and alginates have discovered different applications in immunizations plan.

7. Conclusion

Studies about the shrimp immune response against the viral contaminations are constrained, however the virus inhibiting proteins and specific up-regulation of shrimp genes upon viral diseases have been illustrated (Rojtinnakorn *et al.*, 2002; Roux *et al.*, 2002; Baron, 2000) [12, 13, 2]. Vaccination, a prophylactic measure and a defensive administration is intended to help in the counteractive action of malady. Chemicals or anti-infection agents utilized as a part of keeping the ailment in shrimp aquaculture could prompt improvement of resistance in the microorganisms and render them incapable. Considering the earnestness of the disease, wide host range and nature of cultivating hones, vaccination, because of its inalienable focal points should be created as a viable device for the anticipation of viral and bacterial disease in shrimps. While there is confirm that vaccinating shrimp against viral and bacterial infection indicates guarantee, the common sense of such procedures and their advantage to shrimp requires further encouragement and assessment.

8. References

1. Alabi AO, Jones DA, Latchford JW. The efficacy of immersion as opposed to oral vaccination of *Penaeus indicus* larvae against *Vibrio harveyi*. Aquaculture. 1999; 178:1-11.
2. Baron S. Broad antiviral activity in tissue of crustaceans. Antiviral Research. 2000; 48:39-47.
3. Chalamcherla V. Nano Vaccines: New Paradigm in Aqua Health Sector. J Aquac Mar Biol. 2015; 3(2):00061. DOI: 10.15406/jamb.2015.03.00061
4. George MR. Pathogenic vibrios associated with cultured shrimps *Penaeus indicus* and *P. monodon*, Final report of the project funded by Asian Fisheries Society,

TANUVAS, Fisheries College and Research Institute, Tuticorin, 1995, 64.
5. Itami T, Yan Y, Takahashi Y. Efficacy of vaccination against vibriosis in cultured kuruma prawns *Penaeus japonicus*. J. Aquat. Anim. Health. 1989; 1:234-242.
6. Johnson KN, van Hulten MCW, Barnes AC. Vaccination of shrimp against viral pathogens: Phenomenology and underlying mechanisms. Vaccine. 2008; 26:4885-4892.
7. Kumar TS, Ramalingam K. Trial Vaccine and immune function analysis of *Penaeus monodon* against *Vibrio harveyi* and *Vibrio parahaemolyticus*. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2014; 5(3):1-11.
8. Motamedi Sedeh F, Afsharnasab M, Heidarieh M, Shafaee S, Rajabifar S, Dashtiannasab A, *et al*. Titration of the Iranian White Spot Virus isolate, on Crayfish *Astacus leptodactylus* and *Penaeus semisulcatus*. Iranian Journal of Fisheries Sciences. 2012; 11(1):145-55.
9. Namikoshi A, Wu JL, Yamashita T, Nizhizawa T, Nishioka T, Arimoto M, *et al*. Vaccination trials with *Penaeus japonicus* to induce resistance to white spot syndrome virus. Aquaculture. 2004; 229:25-35.
10. Phuoc L, Corteel M, Nauwynck H, Pensaert M, Alday Sanz V, Van Den Broeck W, *et al*. Increased susceptibility of white spot syndrome virus infected *Litopenaeus vannamei* to *Vibrio campbellii*. Environmental microbiology. 2008; 10(10):2718-2727.
11. Robalino J, Bartlett TC, Chapman RW, Gross PS, Browdy CL, Warr GW. Double-stranded RNA and antiviral immunity in marine shrimp: inducible host mechanisms and evidence for the evolution of viral counter-responses. Dev. Comp. Immunol. 2007; 31:539-547.
12. Rojtinnakorn J, Hirono I, Itami T, Takahashi Y, Aoki T. Gene expression in haemocytes of kuruma prawn, *Penaeus japonicus*, in response to infection with WSSV by EST approach. Fish and Shellfish Immunology. 2002; 13:69-83.
13. Roux MM, Pain A, Klimpel KR, Dhar AK. The lipopolysaccharide and β-1, 3-glucan binding protein gene is up-regulated in white spot syndrome virus-infected shrimp (*Penaeus stylirostris*). J Virology. 2002; 76:7140-7149.
14. Rowley AF, Pope EC. Vaccines and crustacean aquaculture - A mechanistic exploration. Aquaculture. 2012; 334-337:1-11.
15. S SM, Kwang J. Oral Vaccination of Baculovirus-Expressed VP28 Displays Enhanced Protection against White Spot Syndrome Virus in *Penaeus monodon*. PLoS ONE. 2005; 6(11):e26428. doi:10.1371/journal.pone.0026428
16. Underwood J, Darren J, Cowley AJ, Johnson NK. Antiviral immunity and protection in penaeid shrimp. J. Inv. Immunol, 2013, 2-14.
17. Venegas CA, Nonaka L, Mushiake K, Nishizawa T, Muroga K. Quasi-immune response of *Penaeus japonicus* to penaeid rod-shaped DNA virus (PRDV). Diseases of Aquatic Organisms. 2000; 42:83-89. doi: 10.3354/dao042083
18. Westenberg M, Heinhuis B, Zuidema D, Vlak JM. siRNA injection induces sequence- independent protection in *Penaeus monodon* against white spot syndrome virus. Virus Research. 2005; 114(1):133-139.
19. Wongtavatchai J, López-Dóriga MV, Francis MJ. Effect of AquaVacTM VibromaxTM on size and health of post larva stage of Pacific White shrimp *Litopenaeus vannamei* and Black Tiger shrimp *Penaeus monodon*. Aquaculture. 2010; 308(3-4):75-81.