**Targeting gut microbiome to control shrimp disease: role of postbiotics**

**Introduction**

Shrimp are one of the foremost aquaculture commodities with an excess of 7 million tons (both captured and farmed) marketed each year, worth around 30 billion US$ (FAO, 2020). Shrimp aquaculture has been practiced for many decades over 50 countries worldwide and shrimp culture is intensified in developing nations in Asia and Latin America (C.C.Holt et al., 2020). Pacific whiteleg shrimp, *Litopenaeus vannamei* is reported as the main commercial species contributing more than 70% representing 4.1 million tons of production in the shrimp industry (Huang et al., 2020, F Cornejo-Granados et al., 2017). At present, Black tiger shrimp (*Penaeus mondon*) is gaining popularity in South Asian countries given its higher growth rate. While the shrimp industry relies mostly on a single species, there is a possibility to culture genetically improved lines as shrimp have a comparatively short lifespan (Jamal et al., 2019). Virtuous flavor with high monetary value of shrimp leads to get the business entities (Chen et al., 2020a) and it has a faster growth rate than many foods production sectors. As cultured shrimp has a high market demand, its production adheres to the intensive culture systems with high densities, offering an ideal situation for disease outbreaks and thus causing severe economic losses (T Pérez-Sánchez et al., 2018). Hence, the shrimp industry has experienced supply chain disruption of due to episodic disease outbreaks and health management issues (Chen et al., 2020a). Environmental deterioration also impacts disease prevalence, as it disturbs the host-pathogen interaction (T Pérez-Sánchez et al., 2018).

Shrimp has a poorly evolved nonspecific innate immune system with both cellular and humoral defenses working together to detect and remove of pathogens (B Lakshmi et al., 2013). Phagocytosis, nodulation and apoptosis via shrimp hemocytes can be considered as important cellular defenses, while functions of the humoral system are carried out by non-specific enzymes or molecules in the hemolymph, including i.e., antimicrobial peptides, phenoloxidase, toll receptors, oxidative enzymes, lectins, ferritin, respiratory protein, nitric oxide (Zhang et al., 2021, F Cornejo-Granados et al., 2017). Furthermore, shrimp has the ability to identify a pathogen with pattern recognition receptors involving signaling pathways (i.e., JAK/STAT signaling pathway; NF-kB/Relish signaling pathway) to stimulate the cellular and humoral immunity functions (Zhang et al., 2021). However, their inability to produce immunoglobulins indicates the absence of adaptive memory for defense and some studies indicate the possibility of specific immunity induction in shrimp (B Lakshmi et al., 2013).

**Main constraints for development**

Different types of diseases (viral, bacterial and fungal), feed cost, the environment and market issues are the major tailbacks for the shrimp industry (Van Doan, 2021, Jamal et al., 2019 Defoirdt et al., 2011). Periodic losses due to disease outbreaks are considered as the primary constrain for many farmed shrimp species (B Lakshmi et al., 2013). Various diseases, caused by opportunistic bacteria such as *Vibrio sp.* causing vibriosis, have the capability to immobilize shrimp farming with substantial financial losses (Jamal et al., 2019). The major diseases caused by *Vibrio* are Early mortality syndrome /Acute Hepatopancreatic Necrosis Disease (EMS/AHPNS), Loose shell syndrome (LSS), White gut disease (WGD), Tail necrosis, red disease, Shell disease and Luminous vibriosis which are responsible for mass mortality in farmed shrimp (Jamal et al., 2019). Although shrimp farming is continually defeated by diseases with different drivers from the start of their culture, it the industry keeps growing by coexisting with diseases.

**Disease outbreaks**

The incessantly growing shrimp industry has encountered major disease outbreaks, including Early Mortality Syndrome (EMS/AHPND), White spot syndrome virus (WSSV), Hepatopancreatic microsporidiosis (HPM/EHP). These outbreaks may be due to sharing of hatchery products, trade liberalization and introduction of novel species (Subasighe, 2009, B Lakshmi et al., 2013). EMS is found mainly in shrimp farms in Southeast Asian countries and was first recorded in Southern China, 2009 (Zorriehzahra MJ and Banaederakhshan R, 2015). Since its first detection in 1992 in Taiwan, White spot syndrome virus (WSSV) has spread to almost all Asian countries. Two microspordians discovered in 1992 in Thailand are primarily responsible for negative impacts to shrimp farming (Mukta Singh and Paramveer Singh 2018). Intending to effectively manage shrimp diseases, the producing countries are taking different actions including proactive measures, in addition to biosecurity and genetic selection. Furthermore, significant attempts have been made in this sector to improve disease resistance using different bacterial strains including probiotics and prebiotics.

**Gut microbiome as an important driver of cultivation success**

Shrimps are active grazers on substrates which are present in the culturing systems due to the high exchange of microbiota with its surrounding. The colonization of shrimp by enteric microbiota, mainly with aerobes and facultative anaerobes, begins with the opening of the mouth and continues throughout life (Md. Shahdat Hossain et al., 2021). Shrimps care for their fertilized eggs which are exposed to the water filled with microbes. Thus, the type of habitat seems to play a significant role in disparity of microbiota between shrimps belonging to various lineages (Cheng-Yu Chen et al., 2017).