CHAPTER 4
PROBIOTICS IN SHRIMP AQUACULTURE

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4.1 INTRODUCTION

The term probiotic originates from the Greek word 'pro' and 'bios' which mean 'for life' and is currently used to name bacteria related to beneficial effects for humans and animals (Farzanfar, 2006). Fuller (1992) developed the definition as, "A live microbial feed supplement that beneficially affects the host by improving its intestinal microbial balance." On the other hand, the term probiotic was created as an antonym of antibiotics, since probiotics are beneficial microorganisms that selectively proliferate to exclude competitively harmful microbes. It may be because of this positive and general claim of definition that the term probiotic was subsequently applied to other subjects and gained a more general meaning whereby the success rely on viable probiotic cells in the product (Selvamani et al., 2022). Probiotics have become highly recognised as supplements for their beneficial effects on health for food, feed and agriculture industries (Dailin et al., 2019a; 2020; Hashim et al., 2021). Various genera of probiotic bacteria have the ability to produce secondary metabolites such as exopolysaccharides in large quantities (Awasthi et al., 2022; Dailin et al., 2022; Eyahmalay et al., 2020; Kepli et al., 2019). The use of biotechnological approaches to serve industrial

needs and issues is getting high interest with time (Dailin et al., 2019b; Nordin et al., 2019; Rashidi et al., 2023).

In aquaculture, probiotics are live microbial feed supplements that are administrated to increase the yield of culture and their immune responses as well as a substitute for chemicals and antibiotics (Van Hai & Fotedar, 2010). The use of probiotics in shrimp aquaculture has become common in this millennia era, especially in developed countries like Asia and Latin America. It provides not only enhance the economy of the owner and high-quality food product but also provides employment to hundreds of thousands of professional and unprofessional workers (Kumar et al., 2016). Aquaculture will be essential in catering due to the increasing demand for food in another 30 years later to the prediction (Godfray et al., 2010).

Shrimp aquaculture has been the main essential in aquaculture industries due to shrimp's richness in protein supply (Food and Agriculture Organisation [FAO], 2016). It comes up with 50% of global shrimp production as reserved shrimp unserved the export demand for shrimp worldwide and it is regarded as the most valued aquaculture business (Jamal et al., 2019). Unfortunately, due to the emergence of viral pathogens, many farmers changed from black tiger shrimp (*Penaeus monodon*) to imported pacific white leg shrimp (*Litopenaeus vannamei*) which has been genetically selected and has become a domesticated stock since 2003 (Flegel, 2012). So, a promising emerging alternative approach to preventing shrimp diseases is the use of probiotics, which helps shrimps to fight against pathogens by various mechanisms (Zaidel et al., 2022). The significance probiotics used in aquaculture does not only play a major role in the improvement of the overall health of an organism, such as it acts as a growth promoter, preventing diseases and enhancing immune responses but also reduce the use of chemicals and antibiotics (Mehrabi et al., 2018). This chapter aims to provide useful knowledge about the application of probiotics in shrimp aquaculture, their possible mechanism of action as well as their advantages.

4.2 PROBIOTICS IN SHRIMP AQUACULTURE

Formerly, shrimp aquaculture faces several challenges to enhance production yield while maintaining sustainability. For almost two decades, several diseases from viral, bacterial, and fungal infections have been continuously affecting this sector as well as increasing demand for environmentally friendly aquaculture and the pressure from customers for safe and traceable products which essentially modify the culture practices of shrimp (Castex et al., 2014). After much consideration with evidence of the benefits of using probiotics from extensive research, the application of probiotics in aquaculture has been developed as one of the solutions to cater to this issue. This application is now widely applied in shrimp aquaculture as a complementary tool for the management of disease (Castex et al., 2014). Probiotics are increasingly becoming essential and common in organic shrimp farming (Van Hai & Fotedar, 2010). Several studies stated that a combination of probiotics results in better outcomes for the host than individual probiotics (Bachruddin et al., 2017; Hossain et al., 2013; Pooljun et al., 2020). Surprisingly, probiotics improve water quality while reducing pathogenic bacteria and show positive effects through an improvement in the physiological and immune responses of shrimps (Van Hai & Fotedar, 2010).

The probiotic bacteria used in aquaculture are from many phylogenetic lineages; however, most of the probiotics studied belong to two bacterial divisions, the Firmicutes (e.g. *Bacillus sp.*, *Lactobacillus sp., Lactococcus sp., Carnobacterium sp.* etc.) and the Gammaproteobacteria (e.g. *Vibrio sp., Pseudomonas sp., Shewanella sp.* etc.), while yeasts remain rarely studied (Gatesoupe, 2007). The first probiotic bacteria used in shrimp aquaculture is *Bacillus* genus (Castex et al., 2014). *Bacillus* sp. is the most studied probiotic for shrimp applications and selected to apply in shrimp culture due to its antimicrobial activities toward pathogenic *Vibrio* sp. based on in vitro antagonism assays (Farzanfar, 2006). *Bacillus* sp. is saprophytic Gram-positive spore-forming bacteria that naturally exist in air, water, dust, soil and sediment (Castex et al., 2014). Most Bacillus sp. are harmless to mammals and are producers of high and various amounts of secondary