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-Short communication

ROLE OF PROBIOTICS IN AQUACULTURE : IMPORTANCE AND FUTURE GUIDELINES

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An alternative approach to manage fish health that is fast gaining attention in the aquaculture industry is probiotics, a microbial intervention approach. Probiotics have shown that they can help to increase fish growth by enhancing the feed conversion efficiency, as well as confer protection against harmful bacteria by different modes of action. The present paper shows the current knowledge of the use of probiotics in aquaculture, particularly focusing on their modes of action such as spatial and nutritional emulation, inhibitory metabolites, immunomodulation and stress-alleviating mechanism.

Key words: Probiotics, Microbial intervention, Protection, Aquaculture

Aquaculture is a steadily growing industry world over. The number of species and new technologies are increasing in aquaculture industry for raising production. Intensification has come up as a boon to meet the increasing food demand. However, diseases are stumbling block, causing huge economic loss in millions each year world over (Shankar 2016). To control bacterial and parasitic diseases, antibiotics and drugs were used indiscriminately. Antibiotic has already raised lots of criticism over its negative impact on living biota which may lead to antibiotic-resistant pathogen ((Lakshmi *et al.* 2013). Probiotics is one of the authenticated alternatives that can be very effective to minimize the dependence of the aquaculture industry to antibiotics (Verschuere *et al.* 2000, Nayak 2010, Akhter *et al.* 2015). Overall beneficial effects of probiotics in aquaculture is shown in Fig. 1.

The word probiotic is derived from Greek words, Pro (favour) and Bios (life) meaning 'for life'. Probiotics used in aquaculture have been broadly defined as 'live or dead, or even a component of the microorganisms that act under different modes of action in conferring beneficial effects to the host or to its environment'. The selection process (Venugopal and Suresh 2016) of probiotics can be represented as follows:-

Source
⇓
Isolation of strain
⇓
In vitro examination
⇓
In vivo assessment
⇓
Trials: challenge, performance, cost ratio
⇓
Governmental agent approval
⇓
Probiotic commercialization

Probiotics are mainly of two types: (a) gut probiotics to enhance the useful microbial

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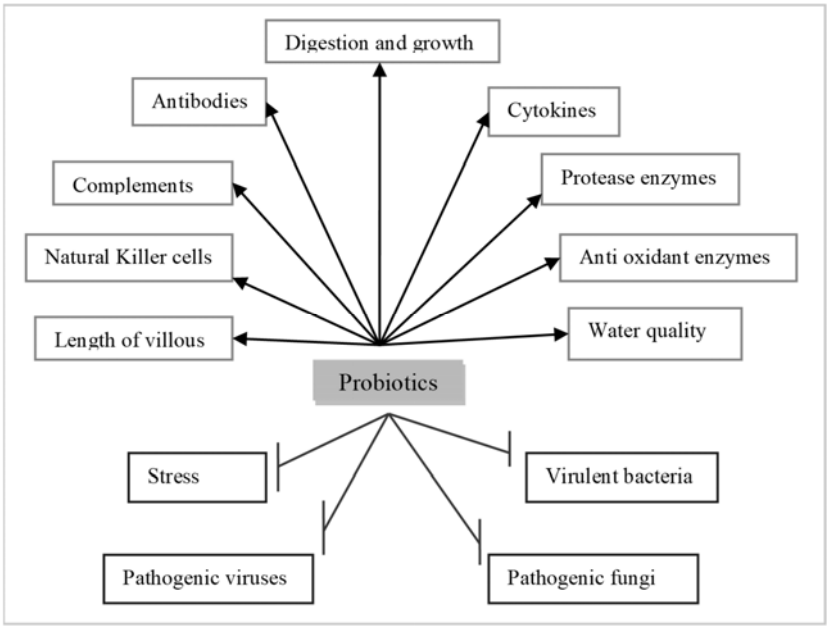

Fig. 1. Overall beneficial effects of probiotics in aquaculture, black arrow (deep black) indicates additive effects whereas light lines indicate inhibitory effects (Zorriehzahra *et al.* 2016).

flora of the gut and, (b) water probiotics and marketed in two forms: (i) Dry forms and (ii) Liquid forms. Liquid forms give positive results in lesser time when compared to the dry and spore form bacteria, though they are lower in density (Nageswara and Babu 2006).

Several probiotic microorganisms have been identified, attributed and applied in aquaculture. The first probiotics in aquaculture discovered long time ago was *Lactobacillus* sp., the lactic acid producing bacteria. Thereafter, many probiotics such as *Aeromonas hydrophila, A. media, Altermonas sp, Bacillus subtilis, Carnobacterium inhibens, Debaryomyces hansenii, Enterococcus faecium, Lactobacillus helveticus, L. plantarum, L. rhamnosus, Micrococcus luteus, Pseudomonas fluorescs* have been discovered.

At the beginning interest was focused on the application of probiotics as growth promoters and to improve the health of animals. Several researches have suggested that probiotic microorganisms have a beneficial effect in the digestive processes of aquatic animals. The use of probiotics as growth promoters of edible fishes, ornamental fishes and shellfishes have been tested and found promising results. 'Competitive exclusion' is an important method of probiotic bacteria where they adhere in the mucosal layer of the host and make space unavailable to the pathogenic microorganisms (Adams 2010). Production of inhibitory substances by probiotic bacteria that can prevent growth of opportunistic pathogenic microorganisms (Panigrahi and Azad 2007).

Several research publications revealed that probiotics in aquaculture have been shown antibacterial, antiviral and antifungal activity

against known pathogens. Many microorganisms including the known probiotic group lactic acid bacteria (LAB) consume the nutrients that are essential for the growth of a number of pathogens hence make them unavailable to the pathogen (Brown 2011). Application of Gram-positive bacteria, such as *Bacillus spp*., is beneficial in improving the quality of the water system. Probiotic bacteria have a significant algicidal effect on many species of microalgae, particularly of red tide plankton (Fukami *et al.* 1997).

The disruption and destruction of quorum sensing (QS) is considered as a high potential anti-infective strategy in aquaculture (Defoirdt *et al.* 2004). Some probiotic bacteria such as *Lactobacillus, Bifidobacterium* and *Bacillus cereus* strains degrade the signal molecules of pathogenic bacteria by enzymatic secretion or production of auto inducer antagonists (Brown 2011).

The non-specific immune system can be stimulated by probiotics (Sakai *et al.,* 1995). They reported that oral administration of *Clostridium butyricum* bacteria to rainbow trout enhanced the resistance of fish to vibriosis, by increasing the phagocytic activity of leucocytes. *Bacillus* sp. (strain S11) has provided disease protection by activating both cellular and humoral immune defenses in tiger shrimp (Rengpipat *et al.* 2000).

Stress is the primary contributing factors of fish disease and mortality in aquaculture. Using probiotic bacteria, both as a feed supplement and water can restrain stressful conditions, enhancing immune system and therefore reducing the harmful effects of various stressors (Taoka *et al.* 2006).

The pioneer study on the effect of probiotic supplementation on reproductive performance of fish was carried out by Ghosh *et al.* (2007), using a strain of *B. subtilis* isolated from intestine of *Cirrhinus mrigala*, incorporated at different concentrations to four species of ornamental fishes, in a one-year experiment. The results showed that using *B. subtilis* concentrations of 10^6–10^8 cells g^{-1} of food, produced increase in the gonadosomatic index, fecundity, viability, and production of fry from the females of all four species.

A list of applications of probiotic in aquaculture is given in Table 1.

Though several studies have shown that the probiotic concept has potential in the aquaculture sector, however, satisfactory results could not be achieved by many workers due to the sudden change of environmental factors such as temperature, poor sanitary conditions, improper management practices that lead animals into the stress. A cursory examination has shown that there is little information on the mode of action of the bacterial strain used as probiotics (Mohamed 2005). On the other hand information on the side effects of probiotics in the animal and environmental impact are scanty. Industrial companies have borrowed the probiotic preparations used in animal (veterinary) husbandry, and are directly applied into aquaculture systems without much thinking of the future consequences. Therefore, importance of probiotics in fostering sustainable approaches in aquaculture and provide avenues in furthering its research and development are essential.

Table 1. Different applications of probiotics in aquaculture

Identity of the probiotic	Applied to aquatic species	Reference	Application
Bacillus sp. s11	*Penaeus monodon*	Rengpipat *et al.* 1998	Growth promoter
Bacillus NL 110, *Vibrio* NE 17	*Macrobrachium rosenbergii*	Rahiman *et al.* 2010	
Bacillus coagulans	*Cyprinus carpio koi*	Lin *et al.* 2012	Pathogenic inhibition
L. rhamnosus	*Oncorhynchus mykiss*	Nikoskelainen *et al.* 2012	
L. acidophilus	*Clarias gariepinus*	Abdullah *et al.* 2011	
Bacillus sp.	*M. rosenbergii*	Moreira *et al.* 2012	
Lactococcus lactis	*Epinephelus coioides*	Zhang *et al.* 2012	
Bacillus .sp, Vibrio sp.	*M. rosenbergii*	Rahiman *et al.* 2010	Nutrient digestibility
L. acidophilus	*C. gariepinus*	Dohail *et al.* 2009	
B. coagulans	*Pennaeus vannamei*	Zhou *et al.*2009	Water quality
L. acidophilus	*Clarias gariepinus*	Dohail *et al.* 2009	
L. delbrueckii	*Dicentrarchus labrax*	Carnevali *et al.* 2006	Stress tolerance
Alteromonas sp.	*Sparus auratus*	Varela *et al.* 2010	
Bacillus subtilis	*Poecilia reticulata, Xiphophorus maculatus*	Ghosh *et al.* 2007	Reproductive enhancement

The present state of application of probiotics in aquaculture needs for intensive research and careful application.

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