
PROBIOTICS: USE OF PROBIOTICS IN AGRICULTURE, AQUACULTURE, POULTRY, ANIMALS AND HUMAN

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Abstract: The growth of probiotics as an industry has accelerated over the past decades. Probiotics are live cells refer to beneficial micro-organisms that could have nutritional advantages because of having different beneficiary characteristics. They also provide health when regulated in sufficient sums. This paper reviewed the application and efficiency of probiotic micro-organisms used in various industries. Information was collected from secondary sources like journals, reports, articles, and electronic media and arranged chronologically. The study reveals that, currently many probiotic products extracted from different species of bacteria including *Bacillus* species, *Lactobacillus* species, *Carnobacterium* species and yeast – *Saccharomyces cerevisiae* are commercially available for use in human, poultry, aquaculture and agriculture. The utilization of probiotics has prompted promising outcomes in countless well-designed clinical studies, e.g., gastro-intestinal diseases, allergy, helicobacter pylori infection etc. In human. To get high yield, the agriculture producers are forced to use pesticide and fertilizers having negative effect on water, soil, human and animal health. Plant probiotic micro-organisms (PPM) also known as bioprotectants, biocontrollers, or biostimulants are beneficial micro-organisms that offer a promising alternative and reduce health and environmental problems. Elimination of antibiotics from poultry and animal production has encouraged intensive search for alternatives. In this article we discuss the immense potential of probiotics to fill the gap as alternative growth promoters and evidences of beneficial effects of probiotic application in poultry production. The first application of probiotics occurred in 1986, to test the ability and increase growth of hydrobionts, later it was used to improve water quality, digestibility of nutrients and encourage reproduction in aquaculture.

Keywords: Probiotics, Immunity, Mechanism, Application, Commercial Brands.

Introduction: The term “probiotic” comes from Greek ‘pro’ & ‘bios’ meaning prolife, having different definitions over the years. However the term probiotic was introduced until 1965 by Lilly and Stillwell. Many definations have been proposed for probiotics by researchers and scientists.” **Probiotics are the beneficial microorganisms including bacteria and yeast which confers a health benefit to the host when administered in adequate amount** (WHO 2002)”.The term probiotic was mainly restricted to Gram positive Lactic acid bacteria – particularly representative of the genera *Bifidobacterium*, *Lactobacillus* and *Streptococcus*(Patricia Mart’inez Cruz *et al.*2012).In fact terms like friendly bacteria, healthy bacteria are commonly used to describe them. As the world population increases, soil degradation, environmental contamination, and climate change affect agriculture and forestry, which are crucial activities for human and animal survival . This has led to plant probiotic microorganism (PPM)-based product development, which is an alternative to biofertilizers, biopesticides, and phytoremediation. Aquaculture is the fastest growing and most promising food producing agricultural sector which contributes almost half to the global fish production. The origin of using of probiotics in aquaculture is not clear from the historical perspective and available literatures but, evidence exists on usage of probiotics in extensive finfish and invertebrate culture in China and India.

In addition to human consumption, probiotics are also increasingly applied to animals especially in poultry industries. Probiotics are supplemented into animal feed such as that for ducks, broilers and chickens, cattles Feeding of probiotics have been reported to have beneficial impacts on the commercial animals by enhancing weight gain, increasing feed conversion efficiency, increasing egg/milk production, lowering the incidence of disease as well as lowering mortality rates (Crittenden *et al.*, 2005) Continuing use of antibiotics and chemical growth promoters increases the development of resistant pathogenic micro-organisms and reduces the efficacy of antibiotics and chemotherapeutics in the treatment of some diseases.

Sources of Probiotics: Westerdahl *et al.*1991, preferred the host-derived micro-organisms as probiotics to be used against pathogen. They are derived from intestine or guts of healthy fishes/animals, water of rearing environment, sediments of culture tanks, other animals, and different fermented food products. The major origin of probiotics are fermented non-digestible carbohydrate compounds, food supplements, dairy based compounds, non-dairy fermented food and non-intestinal sources. Probiotic microorganisms can be isolated, screened, identified and characterized from numerous natural substrates.

Administration and Application Strategies of Probiotics: Immunomodulatory activity of probiotics depends on various factors like source of probiotic, dose of probiotic, method of administration and the duration of supplementation (Hai, 2015). Proper administration method is a key factor to use the probiotics, Probiotics can be applied in different form such as using only Probiotic strains, Probiotics with plant products and Probiotics with yeast extracts.

For agriculture: Most of the PPM,PGPB,PGPR source is soil hence either symbiotic, free living association, microalgae-associated bacteria(Gomez CG *et al.*2012), presence of rhizodeposits and root exudates.

For aquaculture: Dietary administration as pelleted feed, microencapsulation, immobilized probiotics using Lactobacillus species.

For poultry/animals/human: According to Kabir (2009), in order to fit the criteria as functional probiotic, the bacteria must possess the following desirable traits: the bacteria must be a gut inhabitant, it must be able to adhere to the intestinal epithelium and withstand harsh condition such as high acidity environment in stomach and tolerance to bile salts in the intestines, and competes against other gut microorganisms for colonization in the gastrointestinal (GI) tract, as well as able to exert beneficial effects in host and maintain high viability under normal storage condition and after industrial processes such as lyophilisation. Advancement in the research technology has currently enabled more promising selection of functional probiotics as many in-vitro assays have been made available for evaluation of competitiveness of the probiotics.

Mechanism of Actions: Probiotics have various mechanisms of action, although not yet fully elucidated, are described as following (Balcázar *et al.*, 2006; Ng *et al.*,2008; Walker 2008; Sherman *et al.*, 2009).

- Competition for binding sites: It is also known as "competitive exclusion", where probiotic bacteria bind with the binding sites in the intestinal mucosa, forming a physical barrier, preventing the connection by pathogenic bacteria.
- Production of antibacterial substances: Probiotic bacteria synthesize compounds like hydrogen peroxide and bacteriocins, which have antibacterial action on the pathogenic bacteria. They also produce organic acids that lower the environment's pH of the gastrointestinal tract, preventing the growth of various pathogens and development of certain species of Lactobacillus.
- Competition for nutrients: Probiotics competes with the harmful pathogens for nutrition absorption which reduces the amount for nutrients. These lack of nutrients available that may be used by pathogenic bacteria is a limiting factor for their maintenance.

- Stimulation of immune system: Some probiotics bacteria are directly linked to the stimulation of the immune response, by increasing the production of antibodies, activation of macrophages, T-cell proliferation and production of interferon.

Effects of Probiotics: For agriculture: *B.subtilis*, *Arthrobacter* sp.- alleviates the adverse effects of soil salinity on wheat growth (Upadhyay *et al.* 2012), *B.megaterium* – inhibits abscisic acid (ABA) deficient mutant plants (Porcel R *et al.* 2014), *L.plantarum* – reduces soft rot disease severity (Tsuda K *et al.* 2016).

For aquaculture: Nutrients absorption capacity increases when probiotics are added to the feed in appropriate dose (Merrifield *et al.*, 2010). High level of probiotics in fish ponds can minimize the accumulation of dissolved and particulate matters in the growing season and balance the production of phytoplankton (Ibrahim, 2015). Supplemented diet containing *Lactobacillus plantarum* showed significantly increased relative growth rate (RGR), feed conversion ratio (FCR) and survival rate of *Litopenaeus vannamei* (Kongnum and Hongpattarakere, 2012).

For poultry/animals: Effects of probiotics against pathogens infection - bacteriocins produced by probiotic *Escherichia coli* strain have been shown to greatly reduce Salmonella contamination in poultry industry (Stern *et al.*, 2006). Effects of probiotics on immune responses- The dynamics of probiotics related to immune responses evaluated by Kabir *et al.* (2009) demonstrated that antibody production was elevated in broilers fed with probiotics *Lactobacillus* compared to control chickens. Effects of probiotics on intestinal morphology- Dietary treatment with probiotic *Lactobacillus* sp. was reported to influence the villi height and crypt depth in the small intestine of broilers (Bai *et al.*, 2013). Effects of probiotics on meat quality- Improved tenderness which was indicated by decreased shear force was reported by Yang *et al.* (2010) when probiotic *C. butyricum* was added in diet of broiler.

For Human: Role of probiotics in health improvement, infection control and disease treatment.

Probiotic Strains	Types of diseases or disorder	Probiotic outcomes/results
<i>Oxalobacter formigenes</i> <i>Lactobacillus</i> and <i>Bifidobacterium</i> species, (<i>Lactobacillus plantarum</i> PBS067, <i>Lactobacillus acidophilus</i> LA-14, <i>Bifidobacterium breve</i> PBS077, <i>Bifidobacterium longum</i> PBS078)	Kidney/Urinary stones	(i)Modify or utilize several types of urinary stone. (ii) Act as a key tool to manipulate, metabolize and degrade a toxic compound.
<i>L. casei</i> , <i>L. rhamnosus</i> , <i>S. thermophilus</i> , <i>B. breve</i> , <i>L. acidophilus</i> , <i>B.infantis</i> , <i>L. delbrueckii</i> subsp. <i>Bulgaricus</i> , <i>L. reuteri</i> DSM 17938	Colic	Very effective in reducing colic in breastfed infants and children.
<i>Lactobacillus</i> , <i>Bifidobacterium</i> and <i>L. johnsonii</i>	<i>Helicobacter pylori</i> infection	Destruction the adverse effects of <i>H. pylori</i> through the release of bacteriocins, production of organic acids, and competitive colonization in epithelial or mucosal cells. At that time can hinder its growth, adhesion and bacterial load.
<i>Lactobacillus rhamnosus</i> , <i>L. rhamnosus</i> GG, <i>B. animalis</i> subsp. <i>lactis</i> alone or	Acute and antibiotic associated diarrhea	(i)Competitive blockage of receptor site signals regulating secretory and motility defenses. (ii) Enhancement of

<p><i>in combination with S treptococcus. thermophilus, and L. reuteri, L. rhamnosus (not GG), and L. acidophilus, Saccharomyces boulardii. Lactobacillus casei</i></p>		<p>the immune response, and production of substances that directly inactivate the viral particles. (iii) Inhibit the growth by preventing adhesion and invasion of pathogens.</p>
<p><i>Bifidobacterium species, Bifidobacterium lactis, Bifidobacterium longum, Bifidobacterium breve, Bifidobacterium infantis, Lactobacillus casei, Lactobacillus rhamnosus, Streptococcus thermophiles, Lactobacillus acidophilus, Lactobacillus bulgaricus</i></p>	<p>Constipation</p>	<p>(i) Altering microflora and restoring disturbed community in side GIT, (ii) Participating and solving undesired gastro intestinal problems. (iii) Improving/ managing whole gut transit time, stool frequency and consistency.</p>
<p><i>L. acidophilus, L. plantarum, L. casei, B.lactis, S cerevisiae</i></p>	<p>Irritable bowel syndrom</p>	<p>(i) Reduction of irritable bowel syndrome symptoms. (ii) Effective in alleviating and managing symptoms of this unpleasant condition.</p>

Available Commercial Probiotics:

For agriculture: Rhizo power, VAM power, Amulya (biological stimulant), Asthra (PGPR), Magic gro plus.
 For aquaculture: Nitrocare, Microlact (feed probiotic), Impact pro, Aqualact, Gutgold.
 For poultry/animals: Immune power, PGCF Gold, Growlive forte, Biprocin.
 For Human: Sporlac plus sachet, Zeoba capsules, Novatic capsules, EnteroPlus capsules, Nestle Actiplus dahi, Amul prolife, Yakult,

Limitations and Prospects of Probiotics: Probiotics may be responsible for four types of side effects in susceptible individuals: systemic infections, deleterious metabolic activities, excessive immune stimulation, and gene transfer. When the dose of intake is very high extends to causes of infections in humans not only in all age groups but also in immunocompromised individuals. The possible mechanism of action of probiotics largely depend on probiotic–host interactions (Sharifuzzaman and Austin, 2017). But, there is uncertainties about the longevity of protection conferred by probiotics (Newaj-Fyzul and Austin, 2015). Now a day, technological innovations contribute a mechanism to solve the problem of probiotic stability and viability. Pure and active viability of cells is very necessary in food processing and gastro intestinal transit to reach the intended site of action in sufficient numbers. The future attitude regarding to improve overall characteristics of the strain and to get power full desired trait is apply genetic engineering on the area.

Conclusion: The consumption of probiotics helps to lead a healthy life. Currently, this is globally a well-accepted concept and guarantee for the next generation. Probiotics are widely used in order to solve and simplify particular diseases. In the future highly emphasize further *in vitro* and *in vivo* experiments should be designed and conducted to identify true probiotics and to select the most suitable ones for the prevention/ treatment of diseases. Lastly recommend further practical studies need confirmation about its effect in human health with in high quality research and well-designed clinical trials.

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