

Bacillus Bacteria as Probiotics

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Probiotics are identified as “Live microorganisms which when administered in adequate amounts confer a health benefit on the host”. Although different microorganisms are claimed today as probiotics, usually they represent two main genera – Lactobacillus and Bifid bacterium. Other probiotic bacteria have received limited attention of researchers. Among them are Bacillus bacteria – highly diverse group of microorganisms, known quite 100 years. There are strong scientific data substantiating the validity of the utilization of those bacteria as probiotics. Bacillus bacteria could support digestive function of the gut producing essential enzymes. High amylolytic activity is known for bacilli with the production of acid-resistant enzymes. Pectinolytic enzymes are often isolated from Bacillus bacteria, especially from *B. subtilis*. Some Bacillus strains have lipolytic and cellulolytic activity. Bacilli are characterized by high proteolytic activity. Bacillus proteolytic enzymes stimulate regeneration processes and enhance the fibrinolytic activity in the plasma even after oral administration. Proteolytic enzymes of Bacillus contribute to normal digestion by degradation of the anti-nutritional factors and the allergenic compounds. Bacillus enzymes could stimulate the normal microflora of the gut. Thus subtilisin and catalase, produced by *B. subtilis* (natto) enhance the growth and viability of lactobacilli.

Bacillus enzymes were found to be active in live and in dead cells. Bacilli produce amino-acids, including essential amino-acids and vitamins. Some Bacillus strains effectively degrade cholesterol in vitro and significantly reduce plasma low-density lipoprotein cholesterol, hepatic total cholesterol, and triglycerides after oral administration in animal studies. Bacilli could significantly influence the immunological status of the host. Oral treatment with *B. subtilis* spores increased expression of activation markers on lymphocytes in dose-dependent manner. The effect of lymphocyte activation by *B. subtilis* spores was both quantitatively and qualitatively similar to that induced by the mitogens phytohemagglutinin (PHA) and Concanavalin A (ConA). *B. subtilis* spores stimulated cytokine production in vitro and after oral administration in mice. Adjuvant properties of Bacillus bacteria were confirmed in many studies. *B. subtilis* spores induced systemic antibody response to tetanus toxoid fragment C and ovalbumin in mice. Killed *B.*

Probiotic therapy gains more attention of researchers as alternative approach to conventional antibiotic therapy, especially because of emerging of new multi-resistant pathogens. Efficacy of probiotics against pathogenic bacteria was well documented in many scientific reports. But the variety of pathogens and the limited spectrum of specific activity of existing probiotic bacteria raise the question about improvement of probiotics. The recent advances in the genetic engineering can be used to modify probiotic cultures both to strengthen their existing activity and to create new strains with the desired properties. So it is possible to influence the mechanism of probiotics' action. Bacillus bacteria are promising system for developing of new recombinant probiotics. They are genetically well studied and used as a model for cloning of different pro- and eukaryotic genes. Recombinant Bacillus strains are known as commercial producers of biologically active compounds (enzymes, antibiotics, etc.) Bacilli do not colonize mucous membranes permanently, so the amount of these bacteria and recombinant protein can be controlled by the different doses and schemes of administration. Additionally, this reduces the possibility of gene transfer or any adverse effects dealing with such transfer.

More scientific data indicate the valuable role of these bacteria in the environment and in the host organism. Bacillus bacteria are ubiquitous in nature; they are normal microflora of foods. Bacilli consistently enter the gastrointestinal and respiratory tract of humans and animals with food, water and air and they are component of the normal gut microflora. These bacteria are known as highly effective producers of biotechnologically important products – antibiotics, enzymes, vitamins, amino acids. Strains with unique activity can be isolated among Bacillus bacteria. Bacilli have a great potential for developing of new recombinant probiotics with desired properties. Currently several approaches have been applied to construct recombinant bacilli, producing heterologous proteins for treatment of pathological conditions or for vaccine delivery. Further studies of the mechanisms of Bacillus probiotics' action will lead to elaboration of new probiotics, based on new selected strains or genetically modified strains with predetermined properties.

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