

## Industrial Applications of Probiotic Lactic Acid Bacteria and Future Works on Health Claims

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### Probiotics : historical background

The ready availability of antibiotics in the 1950s resulted in their widespread use as therapeutic agents and growth stimulants for farm animals. Since that time, there has been growing concern that the use of antibiotics as growth promoters was resulting in the development of resistant populations of bacteria which made subsequent use of antibiotics for therapy difficult. There is also a reaction against the use of antibiotics as therapeutic agents because of the intestinal upsets which often follow oral treatment with these agents. Although they are effective in curing the disease for which they are prescribed, the effect on the indigenous gut flora may persist after cessation of the treatment. The possibility of antibiotics ceasing to be used as growth stimulants for farm animals and the concern about the side-effects of their use as therapeutic agents has produced a climate in which both consumer and manufactures are looking for alternatives. Probiotics are being considered to fill this role and already some farmers are using them in preference to antibiotics. Indeed, probiotics are selected cultures of microorganisms which are able to survive stomach/duodenum passage and which are able to multiply in the small and the large intestine. Otherwise, prebiotics are selected substrates which can not be digested in the upper intestinal tract, which enforce the growth of autochthonous microorganisms in the bowel, and which stimulate bowel movement(ballast substrates). In addition, synbiotics are mixtures of probiotic cultures and prebiotic substrates in dairy products.

### Definition and characteristics

Probiotics might be described as follows ; substances produced by one protozoan which stimulated another(Lilly and Stillwell,1965) ; animal feed supplements which had a beneficial effect on the host animal by affecting its gut flora, that is, organisms and substances which contribute to intestinal microbial balance(Parker,1974). However, this definition is unsatisfactory because it is too imprecise and it would include antibiotics ; a live microbial feed supplement which beneficially affects the host animal by improving its intestinal microbial balance(Fuller,1989). This revised definition emphasizes the importance of live cells as an essential component of an effective probiotic and removes the confusion created by the use of the word 'substances'.

Practical results with probiotics might be described as follows ; growth promotion of farm animals ; effects on intestinal infections ; alleviation of lactose intolerance ; relief of constipation ; antitumor activities ; anticholesterolaemic effects. In addition, possible modes of action of probiotics are as follows ; suppression of viable count by production of antibacterial compounds, competition for nutrients, and competition for adhesion sites ; alteration of microbial metabolism by increased and decreased enzyme activity ; stimulation of immunity by increased antibody levels and increased macrophage activity.

Features of a good probiotic ; should be a strain which is capable of exerting a beneficial effect on the host animals, e.g. increased growth or resistance to disease ; should be non-pathogenic and non-toxic ; should be present as viable cells, preferably in large numbers considering the minimum effective dose ; should be capable of surviving and metabolizing in the gut environment, e.g. resistant to low pH and organic acids ; should be stable and capable of remaining viable for long periods under storage and field conditions.

### **Desirable properties of probiotic bacteria**

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#### Health and clinical properties

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- Human origin
  - Resistance to acid and bile
  - Adherence to human intestinal cells
  - Colonization of the human gut
  - Production of antimicrobial substances
  - Antagonism against cariogenic and pathogenic bacteria
  - Safe for human consumption
  - Clinically validated health effects
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#### Stability and technical properties

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- Ability to maintain verified viability
  - Maintenance of good flavor and aroma profile after fermentation
  - Maintenance of mild acidity throughout storage : good acidity profile
  - Maintenance of colonizing properties throughout processing and storage
  - Development of good storage stability in fermented products
  - Stability after freeze drying and other drying methods
  - Accurate strain identification
  - Dose-response data for required effects
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Requirements for good clinical studies of demonstration of unique probiotic properties for functional foods use are as follows ; defined and well-characterized strains of bacteria ; well-defined studies and well-designed clinical trials ; double-blind placebo controlled, randomized human studies ; results confirmed by different groups ; publication in peer-reviewed journals ; each strain documented and tested independently on its own merit ; extrapolation of data from closely related strains not acceptable.

## Classification and safety aspects

Classification of probiotic organisms and their safety status

Organisms	Infection potential
<i>Lactobacillus</i>	Mainly non-pathogens, some opportunistic infections(usually in immunocompromised patients)
<i>Lactococcus</i>	Mainly non-pathogens
<i>Leuconostoc</i>	Mainly non-pathogens, some isolated cases of infection
<i>Streptococcus</i>	Oral streptococci mainly non-pathogens(including <i>Str. thermophilus</i> ) : Some may cause opportunistic infections
<i>Enterococcus</i>	Some strains are opportunistic pathogens with haemolytic activity and antibiotic resistance
<i>Bifidobacterium</i>	Mainly non-pathogens, some isolated cases of human infection
<i>Saccharomyces</i>	Mainly non-pathogens, some isolated cases of human infection

### Important studies for the safety assessment of probiotics

Type of property studied	Safety factor to be assessed
Intrinsic properties of lactic acid bacteria	Adhesion factors, antibiotic resistance, existence of plasmids and plasmid transfer potential, harmful enzyme profiles
Metabolic products	Concentration, safety, and other effects
Toxicity	Acute and subacute effects of ingestion of large amounts of tested bacteria
Mucosal effects	Adhesion, invasion potential, intestinal mucus degradation, infectivity in immunocompromised animals(e.g. following lethal irradiation)
Dose-response effects	Dose-response studies by oral administration in volunteers
Clinical assessment	Potential for side-effects, careful evaluation in healthy volunteers, and disease specific studies
Epidemiological studies	Surveillance of large populations following introduction of new strains and products

## Industrial applications and future works on health claims

Probiotic cultures of lactic acid bacteria such as *Lactobacillus*, *Streptococcus*, *Leuconostoc*, *Pediococcus*, and *Bifidobacterium*, yeasts and molds(only or mainly for animals) are used for man and animals nowadays. And many kinds of yoghurt-like products, yoghurt drinks, pharmaceuticals, and baby foods are commercialized in Europe, USA, and Asian countries. For future works on health claims, researched effects of probiotic bacteria should meet target health benefits such as aid in lactose digestion, resistance to enteric pathogens, anti-colon cancer effect, small bowel bacterial overgrowth, immune system modulation, allergy, blood lipids/heart disease, antihypertensive effect, urogenital infections, infection caused by *Helicobacter pylori*, and hepatic encephalopathy.

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