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Synthetic Microbial Research- Challenges and Prospects

First Edition

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Contents

Probiotics and Its application

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Abstract

Probiotics have become very popular now a days due to the continuously expanding scientific evidence on their beneficial effects on human health. It represents a solution of choice to balance gut microbiota, thus helping in treatment and prevention of various gastrointestinal conditions. The chapter mainly focus on the types of probiotics, its characteristics and mode of action, potentional application of probiotics in various fields.

Keywords: Probiotics; Lactobacillus; bifidobacterium; health;

Introduction

Probiotics are live bacteria and yeasts that are good, especially for digestive system. They provide health benefits when consumed, generally by improving or restoring the gut flora.Probiotics are often called "good" or "helpful" bacteria because they help keeps gut healthy. Probiotics may have a variety of effects in the body, and different probiotics may act in different ways. Probiotics help our body maintain a healthy community of microorganisms or help body's community of microorganisms return to a healthy condition after being disturbed, Produce substances that have desirable effects, Influence body's immune response.

What is probiotics?

Probiotics are live microbes that can be formulated into many different types of products, including foods, drugs, and dietary supplements. Probiotic is a relatively new word that is used to name the bacteria associated with the beneficial effects for the humans and animals.(Aso, Y.et al,1995)

The term probiotic means ‘‘for life’’ and it was defined by an Expert Committee as ‘‘live microorganisms which upon ingestion in certain numbers exert health benefits beyond inherent general nutrition’’

Types of Probiotics

Many types of bacteria are classified as probiotics. They all have different benefits, but most come from two groups.

- **Lactobacillus**- This may be the most common probiotic. It's the one you'll find in yogurt and other fermented foods.Different strains can help with diarrhea and may help people who can't digest lactose, the sugar in milk.
- **Bifidobacterium**- It is found in some dairy products. It may help ease the symptoms of irritable bowel syndrome (IBS) and some other conditions. BIFIDOBACTERIUM are anaerobic but some species are aero-tolerant.
- ***Saccharomyces boulardii-*** *IT is* yeast found in probiotics. It appears to help fight diarrhea and other digestive problems.

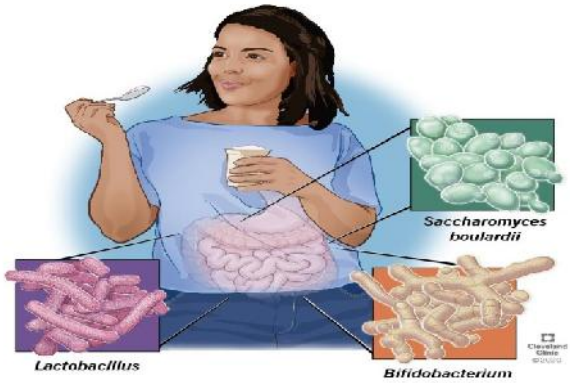


Fig 1 : Common probiotics

The most common probiotics are Lactobacillus and Bifidobacterium. In general most probiotics are Gram-positive, usually catalase-negative, rods with rounded ends, and occur in pairs, short, or long chains. They are non-flagellated, non-motile and non-spore-forming, and are intolerant to salt.(Berg, R.D 1998)

Characteristics of probiotics

- Characteristics of probiotics will determine their ability to survive the upper digestive tract and to colonize in the intestinal lumen and colon for an undefined time period.
- Probiotics are safe for human consumption and no reports have found on any harmfulness or production of any specific toxins by these strains.
- Some probiotics could produce antimicrobial substances like bacteriocins. Therefore, the potential health benefit will depend on the characteristic profile of the probiotics.
- It produces a variety of beneficial compounds such as antimicrobials, lactic acid, hydrogen peroxide, and a variety of bacteriocins. Probiotics should have the ability to interact with the host microflora and competitive with microbial pathogens, bacterial, viral, and fungal.(De Milliano, I .et al 2012)

Mechanisms of Action of Probiotics

Major probiotic mechanisms of action include enhancement of the epithelial barrier, increased adhesion to intestinal mucosa, and concomitant inhibition of pathogen adhesion, competitive exclusion of pathogenic microorganisms, production of anti-microorganism substances and modulation of the immune system.

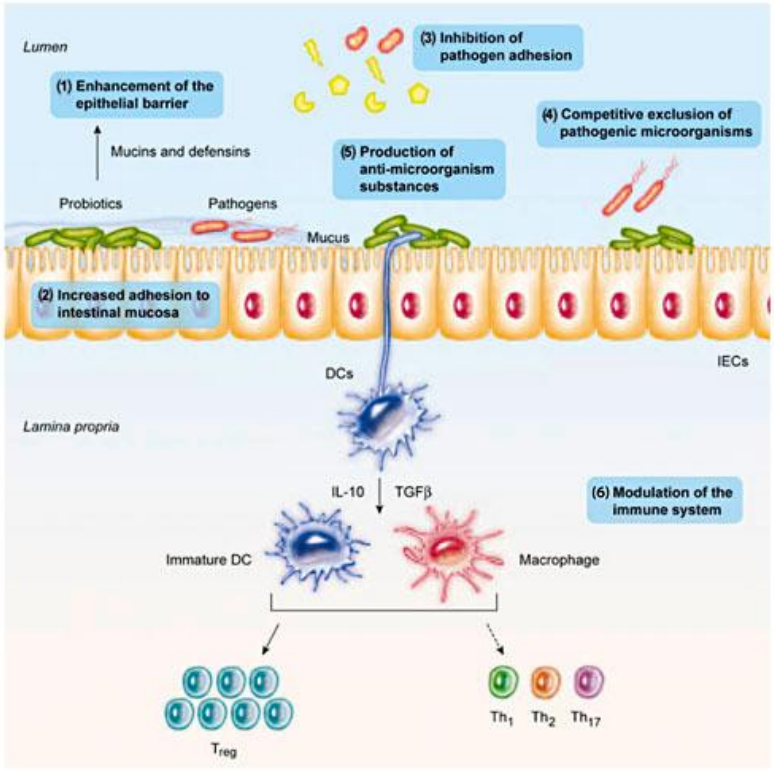


Fig 2 : Mechanisms of action Probiotics

Probiotic **Supplements:** Probiotics are available as supplements, though there is not yet enough evidence to prove that a specific brand or type will help with a particular condition. The Food and Drug Administration (FDA) regulate probiotics for medical purposes. However, they do not consider probiotic supplements to be medication and so do not monitor claims about probiotic contents. (Giannini, E.G .et.al 2006)

Applications of Probiotics: Food

Dairy-based probiotic foods: Milk and its products is good vehicle of probiotic strains due to its inherent properties and due to the fact that most milk and milk products are stored at refrigerated temperatures. Probiotics can be found in a wide variety of commercial dairy products including sour and fresh milk, yogurt, cheese, etc. Dairy products play important role in delivering probiotic bacteria to human, as these products provide a suitable environment for probiotic bacteria that support their growth and viability.(Gill, H.S.et.al 2004)

Drinkable fresh milk and fermented milks: Functional dairy beverages can be grouped into two categories: **fortified dairy beverages** (including probiotics, prebiotics, fibers, polyphenols, peptides, sterol, stanols, minerals, vitamins and fish oil), and **whey-based beverages**. Among the probiotic bacteria used in the manufacture of dairy beverages, L. RHAMNOSUS GG is the most widely used, this probiotic is very suitable for industrial applications. Factors affecting the viability of probiotic cultures in fermented milks includes;

- Acidity,
- pH,
- dissolved oxygen content,
- redox potential,
- hydrogen peroxide,
- starter microbes,
- potential presence of flavoring compounds and
- Various additives (including preservatives) .

Yogurt: Yogurt is one of the original sources of probiotics and continues to remain a popular probiotic product today. Yogurt is produced using a culture of L. delbrueckii subsp. bulgaricus and Streptococcus salivarius subsp. thermophilus bacteria. Yogurt has been widely used as probiotics vehicle; most commercial yogurt products have low viable cells at the consumption time.(Szajewska, H et.al,2001)

Cheese: Cheeses have a number of advantages over yogurt and fermented milks because they have higher pH and buffering capacity, highly nutritious, high energy, more solid consistency, relatively higher fat content, and longer shelf life. Probiotics in cheese were found to survive the passage through the simulated human gastrointestinal tract and significantly increase the numbers of probiotic cells in the gut. Based on the process, a commercial probiotic cheese was first developed by the Mills DA, Oslo, Norway. Nowadays, there are over 200 commercial probiotic cheeses in various forms, such as fresh, semi-hard, hard cheese in the marketplaces. Fresh cheese like cottage cheese has high recommended daily intake, limited shelf life with refrigerated storage temperature. It may, thus, serve as a food with a high potential to be applied as a carrier for probiotics.

Vegetable-based probiotic products: Fermentation of vegetables has been known since ancient time. Fermented vegetables can offer a suitable media to deliver probiotics. Probiotic of *L. rhamnosus*, *L. casei* and *L. plantarum* are better adapted to the vegetable during fermentation.

Cereal-based probiotic products: Cereal-based probiotic products have health-benefiting microbes and potentially prebiotic fibers.

Meat-based probiotic foods: Probiotic applications are restricted to fermented meats, such as dry sausages. The idea of using probiotic bacteria in fermenting meat products has introduced the idea of using antimicrobial peptides, i.e. bacteriocins, or other antimicrobial compounds as an extra hurdle for meat products. Meat starter culture was defined as preparations which contain living or resting microorganisms that develop the desired metabolic activity in the meat. LAB were identified as *Lactococcus lactis* subsp. *Cremoris*, *Lactococcus plantarum*, Enterococcus *faecium*, *L. fructosus*, *L. amylophilus*, *L. Coryniformis* subsp. *torquens*, and *L. plantarum*. Most strains of LAB had a high degree of hydrophobicity, indicating that these microorganisms have a probiotic potential.(Goldin, B.R.et.al,1984)

Applications of probiotics: Agriculture

Probiotics applications have been extended from human applications to diversity of agricultural application. Agricultural applications include animal and plants.

Animal Probiotics: Probiotics, with regard to animal applications, were defined as live microbial feed supplements beneficially improve the intestinal microbial balance in host animal. They have been approved to provide many benefits to the host animal and animal products production. They are used as animal feed to improve the animal health and to improve food safety with examples of the application in poultry, ruminant, pig and aquaculture.The microflora in the gastrointestinal tracts of poultry plays a key role in normal digestive processes and in maintaining the animal's health. Probiotic has provided a possible natural alternative to antibiotics in poultry production to produce foods of reliable quality and safety. In addition, the application of probiotic to chicken feed was shown to increase the internal and external quality of eggs and it also increased egg weight shell thickness, shell weight, albumen weight, and specific gravity and decreased shape index.

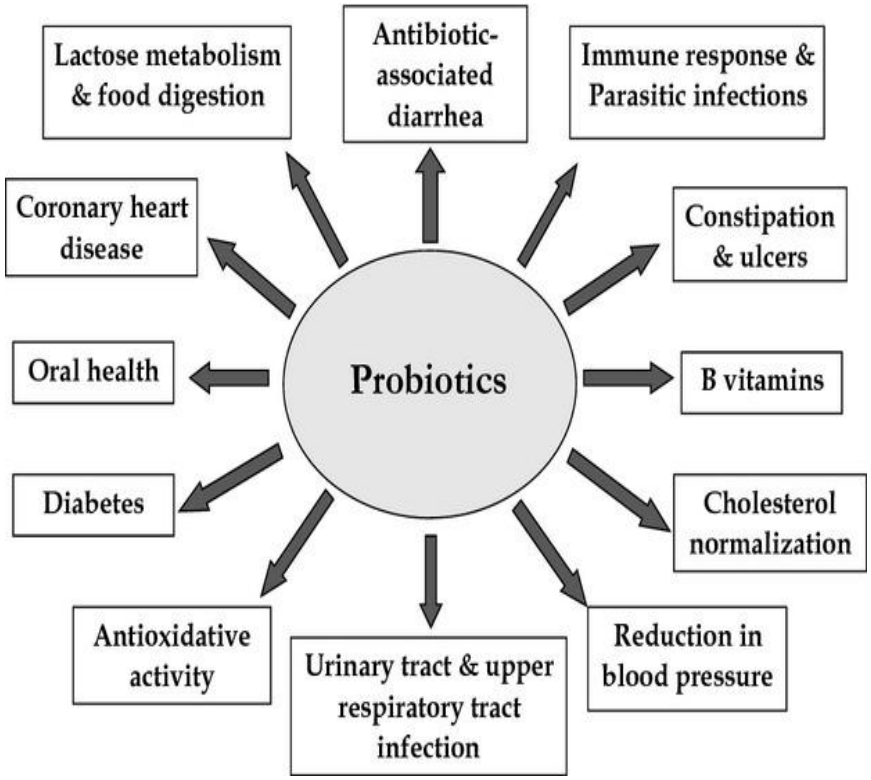
Applications of probiotics in aquaculture generally depend on producing antimicrobial metabolites and their ability to attach to intestinal mucus.

- *Aeromonas hydrophila* and *Vibrio alginolyticus* are common pathogens in fish, however, addition of probiotics strains (isolated from the clownfish, AMPHIPRION PERCULA) were found capable to prevent the adhesion of these microbes to fish intestinal mucus and to compete with the pathogens.
- Feeding probiotics to shrimp was found to reduce disease caused by *Vibrio parahaemolyticus* in shrimp.
- Balcazar and others have reviewed the use of probiotics for prevention of bacterial diseases in aquaculture.

Plant Probiotics: Based on the mode of action and effects, the plant probiotics products can be used as biofertilizers, plant strengtheners, phytostimulators, and biopesticides. Plant growth promotion can be achieved by the direct interaction between beneficial microbes and their host plant and also indirectly due to their antagonistic activity against plant pathogens. In the processes of plant growth, probiotic bacteria can influence the hormonal balance of the plant whereas phytohormones can be synthesized by the plant themselves and also by their associated microorganisms.(Hajela, N.et al,2010)

The role of Probiotics in disease treatment

Probiotics could not only improve our health or control pathogenic infections but could also help in real disease treatment and management.



The role of Probiotics in such types of cases will be in removing such deficiencies by different mechanisms such as

(i) supplying our bodies with the products of the missed gene products,

(ii) supplying our bodies with suitable alternative products,

(iii) supplying our bodies with the final products of a complete pathway which will be the best choice and in the case that none of the defective pathway metabolic intermediates will be accumulated in our cells in the case of a single or multiple gene deficiency which could block a certain pathway,

(iv) Probiotics could support a weak (rather than a completely defected pathway) pathway which might be due to a defect in a single allele rather than the defect in both alleles. Exactly like in the case of those who have retinoblastoma.[4] In such a case the critical basis for the Knudson hypnosis's will be completely interfered with while a single gene will not be a subject to excessive stress that could lead to a mutation.

(v) Probiotics will be the best support for us when we become old. It will reduce the load on our biological system and will enable us to do extra activity, particularly those related to improving our ability to utilize food. Here are some roles for Probiotics in maintaining our health, in disease treatment and management:

Applications of probiotics: Biomedical

Prevention of diarrhea: About 4 billion diarrhoeal cases per year were reported worldwide, out of which 4% accounts for deaths and 5% for severe disabilities. Gastroenteritis and acute diarrhoeal episodes can be related to viral, bacterial, or parasitic pathogens. Many studies have evaluated the use of probiotics in the prevention and treatment of diarrhoeal diseases, particularly in children in the developing world.(Hassan Pyar.et al)

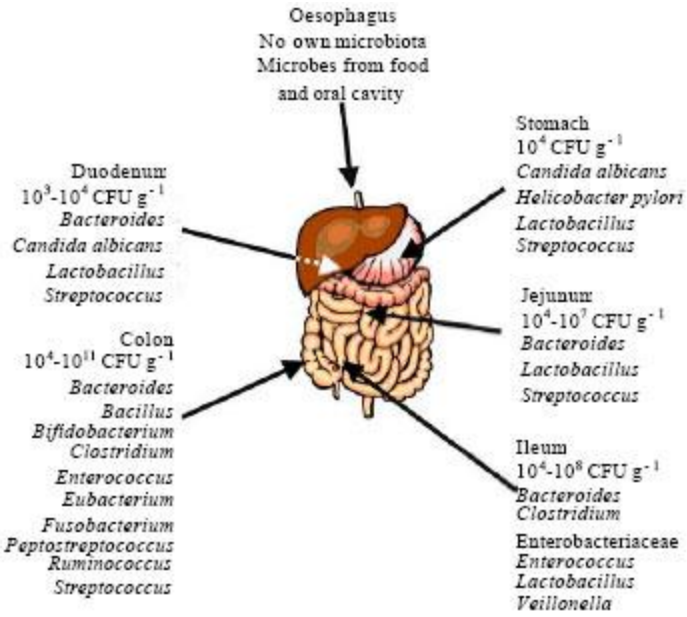


Fig 3 : The numerically dominant microbial genera in the adult human gastrointestinal tract

Several reports and clinical trials have demonstrated the effectiveness of probiotic cultures for controlling diarrhea and decreasing the symptoms or duration of diarrhoeal illnesses among these the *Lactobacillus* strains is the most extensively studied . One of

the justifications for use of probiotics in the treatment of acute diarrhea is that they act against intestinal pathogens and possible mechanism for their **antimicrobial activity** is the increased production of intestinal mucin, inhibition of adhesion of pathogens, modification of toxin and non toxin receptors, stimulation of **immune response**s to pathogens and they prevent the attachment of enteropathogen. Thus, these reports convincingly demonstrate usefulness of probiotics to treat diarrahea.(Kajander, K.et al,2007)

Probiotics in treatment of *Helicobacter pylori* infections: The use of Probiotics in the field of *H. Pylori* infection has been proposed for improving the eradication rate and tolerability and for the compliance of multiple antibiotic regimens used for the infection .

Prevention of Intestinal Infections: The intestinal environment is host to billions of good bacteria and these play a critical role in the body's health .Several probiotic strains have been observed *in vitro* for their ability to avoid intestinal colonization of pathogens and found that probiotics have an ability to inhibit colonization by a large variety of pathogens using a model with intestinal Caco-2 cell lines.Besides producing antimicrobial agents probiotic bacteria also interfere with adherence of several human pathogens to intestinal cells.

Prevention of Constipation: Constipation is a very common condition in which one has a hard time passing wastes out of the body. The most common symptoms of chronic constipation are abdominal bloating and bad breath. The prolonged chronic constipation may increase the risk of getting colon cancer. Irritable Bowel Syndrome (IBS) results in abdominal problems, bloating, diarrhea, constipation and flatulence most of these are due to motor as well as sensory dysfunction of the gastrointestinal tract.(Marchand, J.et al,2000) Probiotics almost certainly have at least two modes of action in improving constipation:

1. Dysbiosis in the gut flora plays a role in constipation and might be improved by probiotics.

2. Probiotics are capable of lowering the pH of the colon through the production of lactic, acetic and other short chain fatty acids which in turn enhances peristalsis and helps in constipation.

Probiotics might also be effective in the intervention of constipated pregnant women.

Prevention and treatments of vaginitis: Bacterial vaginosis is the most common urogenital disease in women, affecting about 19-24% of them in reproductive ages. Candida vaginitis, bacterial vaginosis and other gynaecological infections are a result poor colonization of vaginal flora imbalance. Normal vaginal flora balance can be restored by administration of probiotics. The desquamated vaginal epithelial cells release glycogen which supplies probiotics bacteria with nutrients. These probiotics degrade glycogen and create an acidic environment which restricts the growth of pathogenic microorganisms. (Parent, D.et al,1996)

Weight gain improvement in premature infants: One randomized and controlled trial investigating the effects of probiotics on the weight of infants showed that infants feed with supplements with *B. breve* had higher rates of fecal bifidobacterial colonization, decreased gastric aspirate volume, improved feeding tolerance and enhanced weight gain.(Rafii, F et.al,2008).

Reduction of incidence of respiratory tract infections: Respiratory Tract Infections (RTIs) include the common cold, tonsillitis, acute rhino sinusitis, acute pharyngitis, acute croup (laryngotracheobronchitis), inflammation of the trachea, acute supraglottitis (epiglottitis), laryngitis and acute otitis media with symptoms including fever, cough, pain and headaches are a major cause of morbidity, especially in children and adults .They are caused by many viruses and bacteria.(Solis, B et.al,2002)

Probiotics can confer a health benefit to the patient when administered in adequate amounts on the severity and duration of symptoms of Respiratory Tract Infections (RTIs).The administration of probiotics may have a beneficial effect on the severity and duration of symptoms but does not appear to reduce the incidence of RTI

Prevention of colon cancer: The colon is one of the most common sites for tumor formation. It is in the area of prevention of one of the most deadly cancers of the colon that probiotics offer stellar benefits. Probiotics acidify the colon with the production of short chain **fatty acid**s. However, low incidence of colon cancer is associated with low colon pH. Further, the level of procarcinogenic enzymes such as beta-glucuronidase, nitroreductase and azoreductase are reduced by probiotic bacteria. The ability of intestinal bacteria to biotransform

primary bile salts into secondary by the biochemical effects of probiotics resulting in the inhibition of tumor formation.(Sazawal, S.et.al,2006)

Prevent the development breast cancer: Breast cancer is one of the most serious diseases throughout the industrialized world and in many developing countries. *Lactobacillus* strains inhibit beta-glucuronidase, a fecal bacterial enzyme that prevents the body from detoxifying more potent forms of estrogen (for instance estradiol) into nontoxic forms (e.g., estriol).Hence, probiotics may possibly play a major role in normalizing the digestive tract flora that would help to defuse noxious estrogen.(Vanderhoof, J.A et al. 2000)

Prevent the development liver cancer: Hepatic cancer is the sixth most commonly diagnosed cancer worldwide. The liver, a major organ of the body, is involved in many processes of the body. These include the manufacture of various essential proteins, processing and storing nutrients and the destruction of toxins and poisons. Probiotics are effective and helpful to patients for a number of conditions. Probiotics have a promising future in the prevention of several cancers and researchers are turning their attention to the use of probiotics to treat liver cancer.(Gill, H.S.et al, 2004)

Conclusion

Probiotics has remarkable contribution in various fields and is been widely accepted, it is considered as risk free. Researches support the healthful benefits of Probiotics. It can be used to improve the quality of food, health and living of every individual.

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