



PROBIOTICS-A REVIEW

K. Sowjanya¹, Ch. Supriya¹, SK.Rajiya Sultana¹, V.Anusha², B.Meena¹ and D.Subba Reddy¹

¹Department of Pharmaceutical chemistry, ²Department of Biotechnology, ³Department of Pharmacology, Nirmala College of Pharmacy, Atmakur (V), Guntur, Andhra Pradesh, India-522503.

²Department of Pharmaceutical Chemistry, Chilkur Balaji College of Pharmacy, Moinabad, Hyderabad, TS, India

*Corresponding Author Email: ksowjanya.1504@gmail.com

ABSTRACT

Probiotic bacteria have become increasingly popular during the last two decades as a result of the continuously expanding scientific evidence pointing to their beneficial effects on human health. As a result, they have been applied as various products with the food industry having been very active in studying and promoting them. Within this market the probiotics have been incorporated in various products, mainly fermented dairy foods. In light of this ongoing trend and despite the strong scientific evidence associating these microorganisms to various health benefits, further research is needed in order to establish them and evaluate their safety as well as their nutritional aspects. The purpose of this paper is to review the current documentation on the concept and the possible beneficial properties of probiotic bacteria in the literature, focusing on those available in food.

KEY WORDS

Probiotic bacteria, Nutritional aspects

INTRODUCTION:

The association of probiotics with well-being has a long history. More than a century has passed since Tissier observed that gut microbiota from healthy breast-fed infants were dominated by rods with a bifid shape (bifidobacteria) which were absent from formula fed infants suffering from diarrhoea, establishing the concept that they played a role in maintaining health. Since then a series of studies have supported this association but they were originally poorly designed and controlled and faced practical challenges such as strain specificity of properties and the slow growth of probiotics in substrates other than human milk. By time, they have successfully evolved with the more recent ones accumulating more substantial evidence that probiotic bacteria can contribute to human health. These data have coincided with the increasing consumer awareness about the relationship between health and nutrition creating a supporting environment

for the development of the functional food concept introduced to describe foods or food ingredients exhibiting beneficial effects on the consumers' health beyond their nutritive value. The functional food market is expanding, especially in Japan—its birthplace—with further growth prospects in Europe and the United States and in most countries the largest share of its products is held by probiotics [1, 2]. The reported beneficial effects of probiotic consumption include improvement of intestinal health, amelioration of symptoms of lactose intolerance, and reduction of the risk of various other diseases, and several well-characterized strains of Lactobacilli and Bifidobacteria are available for human use [3, 4]. Nevertheless, despite the promising evidence, the role of probiotics in human health as well as the safety of their application should be further investigated as the current knowledge of the characteristics that are necessary for their functionality in the gut is not complete.

Etymology:

Some literature gives the word a full Greek etymology,^{[5][6]} but it appears to be a composite of the Latin preposition *pro* ("for") and the Greek adjective βιωτικός (*biōtikos*), "fit for life, lively",^[7] the latter deriving from the noun βίος (*bios*, "life").^[8] The term contrasts etymologically with the term *antibiotic*.

Definition:

The World Health Organization's (WHO) 2001 defines probiotics as live micro-organisms that, "...when administered in adequate amounts, confer a health benefit on the host."^[9] Following this definition, a working group convened by the FAO/WHO in May 2002 issued the "Guidelines for the Evaluation of Probiotics in Food". This first global effort was further developed in 2010; two expert groups of academic scientists and industry representatives made recommendations for the evaluation and validation of probiotic health claims.^{[10][11]} The same principles emerged from those groups as the ones expressed in the Guidelines of FAO/WHO in 2002. This definition, though widely adopted, is not acceptable to the European Food Safety Authority because it embeds a health claim that is not measurable.^[12]

A consensus definition of the term *probiotics*, based on available information and scientific evidence, was adopted after a joint Food and Agricultural Organization (FAO) of the United Nations and World Health Organization (WHO) expert consultation. In October 2001, this expert consultation defined probiotics as live micro-organisms that "...when administered in adequate amounts, confer a health benefit on the host."^[13] The FAO/WHO consultation was also a first effort towards the assessment of probiotics efficacy and resulted in May 2002 in a document named *Guidelines for the Evaluation of Probiotics in Food*. This effort was accompanied by local governmental and supra-governmental regulatory bodies requirements to better characterize health claims substantiations.

A group of scientific experts assembled in London, UK, on October 23, 2013, to discuss the scope and appropriate use of the term probiotic. The meeting was motivated by developments in the field since 2001. The panel's conclusions were published in June 2014.^[14]

Probiotics must be alive when administered.^[15] One of the concerns throughout the scientific literature resides in the viability and reproducibility on a large scale of the observed results, as well as the viability and stability

during use and storage, and finally the ability to survive in stomach acids and then in the intestinal ecosystem.^[12] Probiotics must have undergone controlled evaluation to document health benefits in the target host. Only products that contain live organisms shown in reproducible human studies to confer a health benefit can actually claim to be probiotic.^{[12][6]} The correct definition of health benefit, backed with solid scientific evidence, is a strong element for the proper identification and assessment of the effect of a probiotic. This aspect represents a major challenge for scientific and industrial investigations because several difficulties arise, such as variability in the site for probiotic use (oral, vaginal, intestinal) and mode of application.^[15]

The probiotic candidate must be a taxonomically defined microbe or combination of microbes (genus, species, and strain level). It is commonly admitted that most effects of probiotics are strain-specific and cannot be extended to other probiotics of the same genus or species. This calls for a precise identification of the strain, i.e. genotypic and phenotypic characterization of the tested microorganism.

Probiotics must be safe for their intended use. The 2002 FAO/WHO guidelines recommend that, though bacteria may be generally recognized as safe (GRAS), the safety of the potential probiotic should be assessed by the minimum required tests. 1. Determination of antibiotic resistance patterns. 2. Assessment of certain metabolic activities (e.g., D-lactate production, bile salt deconjugation). 3. Assessment of side effects during human studies 4. Epidemiological surveillance of adverse incidents in consumers (after market). 5. If the strain under evaluation belongs to a species that is a known mammalian toxin producer, it must be tested for toxin production. One possible scheme for testing toxin production has been recommended by the EU Scientific Committee on Animal Nutrition^[16]. 6. If the strain under evaluation belongs to a species with known hemolytic potential, determination of hemolytic activity is required

In Europe, EFSA has adopted a premarket system for safety assessment of microbial species used in food and feed productions, to set priorities for the need of risk assessment. The assessment is made for a selected group of microorganisms, which if favorable, leads to the "Qualified Presumption of Safety" status.^[17] Finally,

probiotics must be supplied in adequate numbers, which may be defined as the number able to trigger the targeted effect on the host. It depends on strain specificity, process, and matrix, as well as the targeted effect. Most of reported benefits demonstrated with the traditional probiotics have been observed after ingestion of a concentration around 10^7 to 10^8 probiotic cells per gram, with a serving size around 100 to 200 mg per day.

TYPES OF PROBIOTICS:

Probiotics must be identified by their genus, species, and strain level. The majority of probiotics in clinical use are species from three genera: *Lactobacillus*, *Bifidobacterium*, and *Saccharomyces*. Both *Lactobacilli* and *Bifidobacteria* are saccharolytic bacteria that can ferment carbohydrates to lactic acid that inhibits growth of pathogenic bacteria. In addition, pyruvate produced from fermentation can be utilized by certain colonic anaerobes to produce beneficial SCFA. *Lactobacilli* are normally found in healthy gut but are present in relatively low numbers even in individuals consuming probiotics. *Lactobacilli* are also found in the vaginal secretions of healthy women. Some of the *Lactobacilli* commonly found in yogurt and probiotic supplements include *L. acidophilus*, *L. acidophilus* DDS-1, *L. bulgaricus*, *L. rhamnosus* GG, *L. plantarum*, *L. reuteri*, *L. salivarius*, *L. casei*, *L. johnsonii*, and *L. gasseri*. *Bifidobacteria* are the constituents of normal gut flora and can also be found in the vagina and oral cavity. *Bifidobacteria* that are used as probiotics include *B. bifidum*, *B. lactis*, *B. longum*, *B. breve*, *B. infantis*, *B. thermophilum*, and *B. pseudolongum*. *Saccharomyces boulardii* is the only yeast probiotic. It was previously identified as a unique species of yeast but is now believed to be a strain of *Saccharomyces cerevisiae* (baker's yeast). Commercially marketed probiotics are available either as single species or combination of multiple species. Some of the more commonly used probiotics in the US are listed in the Table.

Probiotic mechanisms of action:

There are a number of mechanisms of action for probiotics that confer potential beneficial effects on the gut. By transiently colonizing the gastrointestinal tract, probiotics serve to correct dysbiosis that contributes to underlying disease. This may occur as the consequence of colonization resistance, a term that refers to the ability of certain bacteria to interact with gut epithelial

cells to prevent adherence of enteric pathogens to binding sites on the epithelial surface. Colonizing probiotics may also exert a direct antimicrobial effect by secreting products such as bacteriocins that inhibit the growth and virulence of enteric pathogens. Certain probiotics have been demonstrated to increase the release of antibacterial peptides called defensins from Paneth cells (a type of epithelial cell present in the crypts of the small intestine). Lactic acid-producing probiotics (e.g., *Lactobacillus* spp. and *Bifido bacterium* spp.) may exert an antimicrobial effect on pathogens by reducing the local

pH of the gut lumen. Some strains of probiotics have been discovered to interfere with quorum sensing, a mechanism by which bacteria enhance their virulence. Probiotics have also shown the ability to enhance the production of mucins from gut epithelial cells. Mucins serve as antibacterial barriers that prevent binding of pathogens. Probiotics promote the production of secretory IgA in gut that binds to pathogens; they also exert an anti-inflammatory effect in the gut.

BENEFITS OF PROBIOTICS:

1. Probiotics Help Balance the Friendly Bacteria in Your Digestive System:

Probiotics include "good" bacteria. These are live microorganisms that can provide health benefits when consumed. These benefits are thought to result from the ability of probiotics to restore the natural balance of gut bacteria. An imbalance means there are too many bad bacteria and not enough good bacteria. It can happen due to illness, medication such as antibiotics, poor diet and more. Consequences can include digestive issues, allergies, mental health problems, obesity and more. Probiotics are usually found in fermented foods or taken as supplements. What's more, they appear to be safe for most people.

2. Probiotics Can Help Prevent and Treat Diarrhoea:

Probiotics are widely known for their ability to prevent Diarrhoea or reduce its severity. Diarrhoea is a common side effect of taking antibiotics. It occurs because antibiotics can negatively affect the balance of good and bad bacteria in the gut. Several studies suggest probiotic use is associated with a reduced risk of antibiotic-associated diarrhoea. In one study, researchers found that taking probiotics reduced antibiotic-associated diarrhea by 42%. Probiotics can also help with other forms of diarrhea not associated with antibiotics. A large

review of 35 studies found certain strains of probiotics can reduce the duration of infectious diarrhea by an average of 25 hours. Probiotics reduced the risk of travelers' diarrhea by 8%. They also lowered the risk of diarrhea from other causes by 57% in children and 26% in adults. Effectiveness varies, depending on the type and dose of the probiotic taken. Strains such as *Lactobacillus rhamnosus*, *Lactobacillus casei* and the yeast *Saccharomyces boulardii* are most commonly associated with a reduced risk of diarrhoea.

3. Probiotic Supplements Improve Some Mental Health Conditions:

An increasing number of studies link gut health to mood and mental health. Both animal and human studies find that probiotic supplements can improve some mental health disorders. A review of 15 human studies found supplementing with *Bifidobacteria* and *Lactobacillus* strains for 1–2 months can improve anxiety, depression, autism, obsessive-compulsive disorder (OCD) and memory. One study followed 70 chemical workers for 6 weeks. Those who consumed 100 grams of probiotic yogurt per day or took a daily probiotic capsule experienced benefits for general health, depression, anxiety and stress. Benefits were also seen in a study of 40 patients with depression. Taking probiotic supplements for 8 weeks decreased depression levels and reduced levels of C-reactive protein (a marker of inflammation) and hormones such as insulin, compared to people who did not take a probiotic.

4. Certain Probiotic Strains Can Help Keep Your Heart Healthy:

Probiotics may help keep your heart healthy by lowering LDL ("bad") cholesterol and blood pressure. Certain lactic acid-producing bacteria may reduce cholesterol by breaking down bile in the gut. Bile, a naturally occurring fluid mostly made of cholesterol, helps digestion. By breaking down bile, probiotics can prevent it from being reabsorbed in the gut, where it can enter the blood as cholesterol. A review of 5 studies found that eating a probiotic yogurt for 2–8 weeks reduced total cholesterol by 4% and LDL cholesterol by 5%. Another study conducted over 6 months found no changes in total or LDL cholesterol. However, the researchers did find a small increase in HDL ("good") cholesterol. Consuming probiotics may also lower blood pressure. A review of 9 studies found that probiotic supplements reduce blood pressure, but only modestly. In order to experience any benefits related to blood

pressure, supplementation had to exceed 8 weeks and 10 million colony-forming units (CFUs) daily.

5. Probiotics May Reduce the Severity of Certain Allergies and Eczema:

Certain probiotic strains may reduce the severity of eczema in children and infants. One study found eczema symptoms improved for infants fed probiotic-supplemented milk, compared to infants fed milk without probiotics. Another study followed children of women who took probiotics during pregnancy. Those children had an 83% lower risk of developing eczema in the first two years of life. However, the link between probiotics and reduced eczema severity is still weak and more research needs to be done. Some probiotics may also reduce inflammatory responses in people with milk or dairy allergies. However, the evidence is weak and further studies are needed.

6. Probiotics Can Help Reduce Symptoms of Certain Digestive Disorders:

Over one million people in the US suffer from inflammatory bowel disease, including ulcerative colitis and Cohn's disease. Certain types of probiotics from the *Bifidobacteria* and *Lactobacillus* strains have improved symptoms in people with mild ulcerative colitis. Surprisingly, one study found that supplementing with the probiotic *E. coli* Nissle was just as effective as drugs in maintaining remission in people with ulcerative colitis. However, probiotics appear to have little effect on symptoms of Cohn's disease. Nevertheless, probiotics may have benefits for other bowel disorders. Early research suggests they may help with symptoms of irritable bowel syndrome (IBS). They have also been shown to reduce the risk of severe necrotizing enterocolitis by 50%. This is a fatal bowel condition that occurs in premature infants.

7. Probiotics May Help Boost Your Immune System:

Probiotics may help give your immune system a boost and inhibit the growth of harmful gut bacteria. Also, some probiotics have been shown to promote the production of natural antibodies in the body. They may also boost immune cells like the IgA-producing cells, T lymphocytes and natural killer cells. A large review found that taking probiotics reduced the likelihood and duration of respiratory infections. However, the quality of the evidence was low. Another study including over 570 children found that taking *Lactobacillus GG* reduced the frequency and severity of respiratory infections by

17%. The probiotic *Lactobacillus crispatus* has also been shown to reduce the risk of urinary tract infections (UTIs) in women by 50%.

8. Probiotics May Help You Lose Weight and Belly Fat:

Probiotics may help with weight loss through a number of different mechanisms. For example, some probiotics prevent the absorption of dietary fat in the intestine. The fat is then excreted through feces rather than stored in the body. Probiotics may also help you feel fuller for longer, burn more calories and store less fat. This is partly caused by increasing levels of certain hormones, such as GLP-1. They may also help with weight loss directly. In one study, dieting women who took *Lactobacillus rhamnosus* for 3 months lost 50% more weight than women who didn't take a probiotic. Another study of 210 people found that taking even low doses of *Lactobacillus gasseri* for 12 weeks resulted in an 8.5% reduction of belly fat. However, it's important to be aware that not all probiotics aid in weight loss. Surprisingly, some studies found certain probiotics, such as *Lactobacillus acidophilus*, can even lead to weight gain. More studies are needed to clarify the link between probiotics and weight.

DISADVANTAGES:

1. Infection:

There have been several reports indicating infection caused by probiotics in heart valves of patients. These consumables are also known to cause fungemia and bacteremia in individuals; although such cases occur in rarity. While the chances of fungemia occurring in patients is about 1 in over 5 million cases, the chances of bacteremia occurring in patients is about 1 in 1 million cases. Even though the chances of these occurring to you are remote, there's still a possibility that you cannot ignore. In these cases, you need to take antibiotics to get some relief.

2. Discomfort in the gastro intestinal tract:

When people take probiotics for the first time, they normally experience different feelings like flatulence and bloating. This is normal thing to happen for the first few days. There are also people who have claimed to have experience certain levels of discomfort in taking probiotics; like obstruction during breathing movements, fullness of air within the body, etc. However, there is nothing to worry about these things. Once the

body gets adjusted with you taking probiotics, the discomfort should be a thing of past.

3. Allergy:

Just like the case with most other administered foods or drugs, probiotics too can cause allergic reactions in people. One such allergic reaction people can experience is anaphylaxis. This might look like a simple allergic reaction occurring in few people; however, there have been reports of death due to these allergic reactions. Some of the symptoms that can be seen in patients are low blood pressure, throat swelling and itchy rashes.

4. Drug interactions:

According to researches carried out recently, probiotics are known to react with certain drugs like Sulfasalazine. In fact, probiotics causes these drug forms to get metabolized much quickly than their usual rates and thereby causing higher quantities of them in the body. You need to monitor these situations quite closely, though their occurrences are rare.

SIDE EFFECTS:

Probiotics generally do not cause any significant side effects. Taking them in larger amounts might produce digestive issues, such as gas and bloating, but they are usually temporary. The University of Maryland Medical Center notes a case report of one individual suffering a severe allergic reaction to prebiotics, a supplement similar to probiotics; this type of reaction is very rare.

CONCLUSION:

There are evidences from well-conducted clinical trials of beneficial health effects from probiotics in a range of clinical conditions. The concept of 'synbiotics' has recently been proposed to characterize health-enhancing food and supplements used as functional food ingredients in humans, and with the advent of the functional food concept, it is clear that there is an important niche for these probiotic-based approaches. Although from the ongoing research, more of promising potential health effects of probiotics are being observed, more standardized and verifiable clinical studies are needed to demonstrate the safety, efficacy, and limitations of a putative probiotic, to determine effects on the immune system in healthy and diseased individuals and effects of long-term consumption, and to resolve whether it is superior to existing therapies.

Also, the prospect of GM probiotics targeted for clinical conditions demands a rigorous safety strategy to prevent spread into the environment and dissemination of the genetic modification.

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***Corresponding Author:**

K. Sowjanya*

Email: ksowjanya.1504@gmail.com