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Role of Probiotics in Functional Foods

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Abstract

Probiotics are functional foods that provide many health benefits, protect the body from disease, and improve the immune system to fight against viral infections and keep the body disease-free. Functional foods are a good source of vitamins, protein, minerals, and other bioactive compounds that help to keep our bodies healthy and reduce the risk of disease. Probiotics are the friendly bacteria that offer health benefits to humans and maintain gut microbiota. Natural fermented products include pickles, sauerkraut, yoghurt, kimchi, cheese, etc. These functional food ingredients may enhance immune function and help prevent gastrointestinal disorders. The review paper highlights common probiotic-containing foods, including fermented dairy products, fruit juices, and naturally fermented foods such as yoghurt, kimchi, sauerkraut, pickles, and cheese. It also focuses on some other probiotics in functional foods, such as cereal-based, plant-based, and vegetable-based products. Challenges related to probiotic viability and stability during processing and storage are discussed, along with prospects including novel probiotic strains, symbiotic, personalised nutrition, and emerging functional food products. The increasing demand for health-promoting foods highlights the potential of probiotic functional foods as an important component of future nutrition and disease prevention strategies.

Keywords: fermented products, health-promoting, probiotic foods, sauerkraut, yoghurt

1. Introduction

Functional foods are defined as foods that, in addition to their nutritional properties, can be clearly demonstrated to have positive effects that improve individuals' health or reduce the risk of disease by the European International Life Sciences Institute (EILSI) [1]. Functional foods are among the healthiest worldwide and are associated with various health benefits, including reduced risks of cardiovascular disease, type 2 diabetes, gastrointestinal disorders, and certain cancers [2]. Fermented black garlic is used as a functional food due to its enhanced nutritional value and health- promoting properties [3]. 'The functional foods are not in the form of drugs and capsules.' Functional food serves as a good source of proteins, minerals, vitamins, and other bioactive compounds that promote health and help to prevent disease [4]. Functional foods are offered to consumers in a wide range of products (for instance, dairy products, beverages, cakes, and baby foods) in today's product profile [1]. Food provides the energy required to perform daily functions and maintain normal metabolic processes [5].

The word "probiotic" (Origins: Latin pro meaning "for" and Greek bios meaning "life") was first used in 1954 to identify substances required for a healthy life [6]. The most commonly used probiotics are bacterial genera, such as *Lactobacillus* and *Bifidobacterium*, whereas *Saccharomyces boulardii* are primarily yeasts [7]. We have bacteria residing in the gut microbiota. Some researchers claim the probiotic microorganisms inhibit the growth of pathogenic microorganisms in the intestinal tract. Bacteria also help make vitamin K and keep the immune system functioning [5].

The human body hosts several groups of microorganisms that work collectively to perform several functions. The main functions are those in our digestive system. These microorganisms enhance food consumption and digestion. These microbes reduce the burden on our digestive systems. Probiotics are commercially available in fruit juices, milk, sour milk, oat-based products, and ice cream. Mayonnaise, edible spreads, meat-based products, cheese, and cheese-based dips are recently developed foods that contain probiotics. Probiotic microbes help ferment our food, breaking down complex compounds into simpler byproducts, and can promote our health through several mechanisms. They decrease the additional strain on the human digestive system [8]. Fermented products have higher in vitro antioxidant capacity. For example, fermented milk and yoghurt exhibit higher antioxidant activity than milk. They release biopeptides that follow the proteolysis of milk proteins, particularly α-casein, α-lactalbumin, and β-lactoglobulin [9].

This review aims to examine the role of probiotic functional food in providing nutritional value, boosting the immune system and reducing disease risk [4]. Functional foods are more focused on nutritional value. They contain bioactive compounds that help optimise health, boost immunity, or reduce the risk of chronic diseases such as heart disease and diabetes [1].

2. Mechanisms of Action of Probiotics

The gut microbiome contains a large number of varieties of bacteria. Some of these bacteria colonise in the gut, while others stay as single cells in the gut. The probiotics can be a single form of bacteria, or there can be multiple types of bacteria present. The effects of bacteria can be shown as single cells, or they can show effects in synergy. Some bacteria show their effects by simply being a part of the gut microbiome, such as Bifidobacterium longum, while others, such as *Lactobacillus casei*, influence the existing microbial community. These bacteria stop pathogens from penetrating the intestinal epithelium and also outcompete them for nutrition and space, and thus they strengthen the gut immune system. The growth of probiotics depends on the uptake of nutrients from the gut itself [15-17].

3. Probiotics and Gut Health

Humans have been using probiotics for gut health for hundreds of years. This helps balance the gut microflora. For instance, Gastroenteritis is an illness that can be caused by bacteria and viruses. The most common agent of this illness is rotavirus infection. The infected individual suffers from diarrhoea. The most common treatment of the illness is ORS, which doesn't cure the illness but just rehydrates the body and retains body fluids. But few dairy-based probiotic drinks help in recovering faster in children, but are not very effective in adults. But not all probiotics work in these conditions similarly.

A large number of microbes are present in the gut, but these are generally excluded from the small intestine, where most of the nutrient uptake takes place. This is for preventing the unnecessary nutrient uptake competition between the host and microbes. This is maintained by controlling physiological conditions such as inflammation in the small intestine [18-20].

4. Probiotics in Dairy Products

Nowadays, the market has shifted towards a new trend of healthy eating. Consumers are choosing probiotics and functional foods for health maintenance and recovery. The markets are full of dairy-based and non-dairy-based probiotic drinks and foods. Majorly, the dairy-based fermented products are well known for their health benefits and are widely consumed by consumers. The consumption has increased significantly over the years globally. Some of the dairy-based products are: [21]

4.1 Probiotic Cheese

Probiotic cheese is a type of cheese with living microbial benefits. Cheese is a great food with a high nutritional profile. Cheese contains a high amount of digestible fats, good quality of proteins in high amounts, minerals specifically calcium and phosphorus, vitamins specifically vitamin A, B2 and B12 and other micro and macro nutrients. Other than these, cheese also contains bioactive compounds such as bioactive peptides. These provide great health benefits. Example: cheddar and gouda cheese [1].

4.2 Probiotic Yoghurt

Yoghurt represents one of the most extensively studied probiotic food matrices, largely because its physicochemical characteristics can support the survival of selected probiotic strains. Studies have investigated its potential effects on gastrointestinal health and metabolic outcomes; however, the magnitude of these effects varies according to the probiotic strain, dose, duration of consumption and characteristics of the host. Yoghurt provides various health benefits such as lowering insulin resistance, lowering blood glucose and lipid levels, maintains blood systolic pressure. It contains beneficial microorganisms that promote overall health. Yoghurt contains nutrients such as potassium, calcium, zinc, magnesium, and vitamins B2 and B12. Globally, people consuming yogurt have a healthier and higher-quality diet than non-consumers [22].

4.3 Probiotic Milk

Probiotic or fermented milk is also a well-known probiotic drink. This drink also has a high nutrient profile. It contains a great amount of good fats, proteins and major minerals. Globally, milk is consumed by people of almost every age group. Milk is suggested as a complete food for any individual except infants and is a very nutritious food source. And that's why any product prepared from milk itself has a higher nutritional profile. Fermentation reduces lactose content, making fermented milk products more suitable for many individuals with lactose intolerance, although they are generally not suitable for people with casein allergy [23].

4.4 Probiotics in Fruit Juices

Fruits are great food sources containing antioxidants, minerals, and dietary fibre. Fruits are consumed in higher amounts globally. So, the probiotic drinks made up of fruits have a higher nutritional profile. One major benefit of probiotic fruit juices is that they lack allergens, which are offered by dairy-based probiotic drinks such as casein and lactose. Probiotics fruit juices help lower the serum cholesterol level, improve lactose digestion, improve intestinal infections, and also have anti carcinogenic properties [24].

4.5 Fermented Food Products

The food with complex substrate is converted into simpler products by the agency of microbes or enzymatic activities, which are called fermented food products, and this mechanism is called fermentation. These products are better in nutritive profiles than the raw substrate and also contain probiotics, which are then again very beneficial for the gut microbiome and overall health. Fermentation can change the food colour, texture and smell. The fermentation process destroys the pathogens and breaks down the antinutrients present in the food, and enhances the nutrition profile of the food. For instance, Lactobacillus sp. breaks down the milk lactose into simple sugars and lowers the pH of the milk to curdle it. By this process, curd is obtained, which is simpler yet complex in composition. This product can be consumed by the lactose-intolerant population as well, and having these probiotics makes it more beneficial to health. Very common food products that are fermented all over the world are dairy products, soy products, some vegetables, tea and grains [12-14].

5. Probiotics in Other Functional Foods

5.1 Cereal-based products

Cereals are staple foods and are a major source of affordable calories throughout the world. They are available throughout the year and are rich in bioactive compounds [26]. Cereal-based baked foods (CBBF) are consumed daily and can provide functional ingredients such as probiotics. Probiotic cereal-based products are an alternative to typical probiotic dairy foods, and they do not require refrigerated temperatures for their distribution and storage. Selected studies have demonstrated the health benefits of probiotic bread consumption. Cereal grains are milled to produce flour and mixed with water and other ingredients to prepare dough to form bread for baking. Examples of probiotic cereal products include Probiotic bread, Fermented oat beverages, Cereal-based snacks, and fermented rice products [29]. They have antioxidant properties and hence are considered good for health as they can scavenge free radicals in the body, known to cause cancers and cardiovascular diseases [26].

5.2 Vegetable-based products

There is a growing demand for fresh foods such as fruits and vegetables that are ready to eat, nutritious, safe, free of additives, and can be included in a healthy diet. However, the convenience and attractiveness of these high-in-demand fresh foods and beverages are affected by rapid spoilage and short shelf life due to changes that can be physical, chemical, microbiological, and enzymatic. Vegetables are served as a non-dairy carrier for probiotics microorganism. And Fermented vegetable products, such as kimchi, sauerkraut, and probiotic vegetable juices, provide beneficial bacteria that offer health benefits associated with improved gut microbiota and digestive health [27].

5.3 Plant-based probiotic foods

Probiotics are delivered mainly through dairy products, which serve as effective carriers. However, lactose intolerance, allergies, cholesterol concerns, and the rise in vegetarianism have increased demand for plant-based probiotic alternatives. Fruits, vegetables, grains, and legumes that are rich in nutrients and free of cholesterol, offer promising options that combine nutritional value with health benefits [28].

6. Conclusion

Probiotic functional foods have emerged as an important component of modern nutrition because of their potential to promote health and reduce the risk of various diseases. This review paper discusses the role of probiotics in maintaining gut microbiota composition, improving digestive health, enhancing immune function, and reducing disease risk. There are several types of probiotic foods, for example, cereal-based, vegetable-based, dairy-product-based, and plant-based probiotics food. These probiotic foods provide vitamins, calcium, protein, carbohydrates, and other bioactive compounds that contribute to overall health and well-being. It provides several types of health benefits. Firstly, and most importantly, they improve the immune system,

helping our body fight various diseases and viral infections and maintain digestive health and a balanced gut microbiota. They support digestive health by improving nutrient digestion and absorption.

This review highlights the usually used probiotic microorganisms, their applications in functional foods, and these are some probiotic bacteria, such as *Lactobacillus* and *Bifidobacterium*, although Saccharomyces bouvardii and several strains of *Lactobacillus acidophilus* mainly represent yeasts. And they help to improve or restore health to our gut microbiome. Probiotic bacteria are found in fermented dairy products like yoghurt, sauerkraut, etc. Overall, probiotic functional foods represent a promising approach for improving human health and supporting disease prevention.

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Role of Probiotics in Functional Foods

This book explores the vital role of probiotics in functional foods, highlighting their scientific foundations, health benefits, applications and future potential. It brings together current research and practical insights to serve as a valuable resource for students, researchers, food industry professionals and health enthusiasts interested in the intersection of nutrition, microbiology and wellness.



KEY HIGHLIGHTS

- Scientific basis and characteristics of probiotics
- Health benefits and mechanisms of action
- Applications in functional foods
- Challenges and future perspectives

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