IJRAR.ORG E-ISSN: 2348-1269, P-ISSN: 2349-5138

INTERNATIONAL JOURNAL OF RESEARCH AND ANALYTICAL REVIEWS (IJRAR) | IJRAR.ORG

An International Open Access, Peer-reviewed, Refereed Journal

Probiotics and Its Innovative Technics of Fortification in Dairy Products: A Review

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Abstracts:

In recent years probiotics have gained significant attention due to their potential health benefits. Desirable probiotics exhibit various beneficial effects on host health, such as improving digestion, modulating the immune system, producing vitamins, improving nutrient absorption, and maintaining a balanced gut microbial composition. Dairy products, like cheese, yogurt, fermented milk, ice-cream etc. serve as ideal carriers for delivering probiotics to consumers. This review provides an overview of the probiotics, its desirable characteristics, the innovative fortification methods employed and the potential health benefits associated with consuming probiotic- fortified dairy products. Fortifying dairy products with probiotics enhance both the nutritional value and functional properties of the dairy products and thereby offering consumers a convenient and enjoyable way to incorporate beneficial microorganism into their diet.

Keywords: Probiotics, Fortification, Microencapsulation, Genetic Engineering

Introduction

Probiotics are beneficial bacteria that can help in maintaining the healthy balance of gut microflora.The word probiotics (Greek; Pro: promotion, biotic: life) as living microorganisms, which when administered in adequate quantities, can offer a benefit to the health of the host, was established by the United Nations Food and Agriculture Organization (FAO) and by World Health Organization (WHO) in 2001**.** Probiotics are defined by The World Gastroenterology Organization as live microorganisms that, when administered in quantity, confer health benefits on the host **[4].** Probiotic microorganisms have been recognized within different bacteria and yeast phylum. Besides *Lactobacillus* and *Bifidobacterium*, species belonging to the genera *Lactococcus, Enterococcus, Streptococcus and Propionibacterium* are currently known to be probiotic microorganisms, conferring a number of health benefits such as vitamin production **[9].** Dairy foods are a suitable medium for probiotic bacteria since it allows them to be in an optimal physical environment (temperature, pH, time) with an adequate substrate (chemical composition). In addition, these foods buffer probiotics when they pass through the intestinal tract; therefore, they can regulate colonization and provide other bioactive compounds that enhance the functionality of probiotics. Probiotics commonly used in dairy products belong to the genus *Lactobacillus* and *Bifidobacterium*. [**14].** There are several strains commonly used in dairy products, like *lactobacillus acidophilus, lactobacillus casei, lactobacillus rhamnosus,*

Bifidobacterium lactis, streptococcus thermophilus, Lactobacillus reuteri DSM, Lactobacillus johnsonii etc **[12].** Yeast *Saccharomyces boulardii* and some species of *E. coli* and *Bacillus* are also used as new agents.[**4]** The microbial interaction with the matrix depends on when they were added to the product and whether they were added during fermentation or afterward **[11].** It depend on the characteristics of probiotics which help in product fortification. So there are some desirable characteristics of probiotics.

Desirable Characteristics of Probiotics [6,7,13]

The ideal probiotic strain should possess a combination of the desirable characteristics to effectively promote gut health and overall wellbeing in the host. The desirable characters of probiotics are as follows

1. Survivability:-Probiotics should be able to survive in the acidic environment of the stomach to reach the intestines, where they exert their beneficial effects. This often involves having robust cell walls or protective mechanism against gastric acid.

2. Adhesion:-Effective probiotics should be able to adhere to the epithelial cell, allowing them to colonize and interact with the gut microbiota and host tissues. Adhesion helps in establishing a stable population of probiotics in the gut.

3. Colonization:-Probiotics should have the ability to colonize the gut and persist in the intestinal environment, enhancing their effectiveness in providing long term benefits to the host.

5. Safety:-Probiotics should be safe for consumption, with no risk of causing harm or adverse effects, especially in vulnerable populations such as infants, elderly or immunocompromised individuals.

6. Stability:-Probiotics should remain viable and active throughout their shelf life and transit through the gastrointestinal tract. This includes stability under different environmental conditions, such as temperature and moisture variations

7. Stain specificity:-Different probiotic strains may have unique effects and mechanisms of action. Desirable probiotics are well characterized with documented health benefits supported by scientific evidence.

8. Resistance to antibiotics:-Probiotics should ideally not be susceptible to common antibiotics, as they may be administered alongside antibiotic treatments or consumed by individuals on antibiotic therapy.

9. Production of bioactive Compounds:-Some probiotics produce bioactive compounds such as short chain fatty acids, bacteriocins, and enzymes, which contribute to their beneficial effects on host health and microbial balance

10. Quality control:-Manufacturing processes should ensure consistency and quality in probiotic products, including accurate labelling of bacterial strains, viable cell counts, and absence of contaminants.

Dairy probiotic foods

Dairy functional foods beyond its basic nutritional value has physiological benefits. Milk has an outstanding position in the development of functional foods because it has Omega-3, phytosterols, isoflavins, conjugated linoleic acid, minerals, and vitamins. Dairy products such as ice cream, cheese, yogurt, Acidophilus-Bifidus-milk, Kefir, Kumis, spray-dried milk powder, dairy beverages (both fermented and non-fermented) have long been considered as important vehicles for the delivery of probiotics. In fermentation process, acids such as lactic acid, acetic acid and citric acid are naturally produced. These acids are commonly used as organic acids

to enhance organoleptic qualities as well as safety of food products. Lactic acid bacteria are found to be more tolerant to acidity and organic acids than most of the pathogens and spoilage micro-organisms**.[11]**

Fortification in Dairy Products

The process of introducing nutrients to foods is known as fortification. Fortification is unique from restoration and standardization in that the nutrient given and the food selected as a carrier have met certain criteria, assuring that the fortified product will be a good source of the nutrient for a particular demographic**.[12]** Fortification of probiotics refers to the process of adding probiotic bacteria to various food products or supplements to increase their health benefits. Adding the probiotics to dairy products like milk, Yogurt, Cheese, Ice-cream, etc to enhance their nutritional value. Fortified probiotics can help in improve digestion, boost immune function, and support overall gut health when consumed regularly. Fortification of dairy products with probiotics involves various techniques to ensure the survival and efficacy of probiotic strains. Following are the some innovative techniques used in the fortification of probiotics.

Fermentation

Fermentation is a traditional method used to produce dairy products like yogurt and kefir where probiotic bacteria ferment milk sugars (lactose) into lactic. This lowers the pH of the product, creating an acidic environment that inhibits the growth of harmful bacteria while promoting the growth of probiotics. Controlled fermentation processes allow for the incorporation of specific probiotic strains, ensuring high levels of viable cells in the final product. **[12]**

Coculturing

Co-culturing involves fermenting dairy products with multiple strains of probiotics, prebiotics, or symbiotics combinations. This approach can enhance the health benefits of the product by synergistically promoting the growth and activity of beneficial gut bacteria. Co-cultured dairy products may offer a broader spectrum of health promoting effects compared to products containing a single probiotic strain**.[5]**

Post Ferment Fortification

Some dairy products undergo post fermentation fortification, where probiotics are added after the primary fermentation process. This method allows for the incorporation of higher concentration of probiotics or specific strains that may not survive the initial fermentation. Post fermentation fortification techniques may include blending probiotic powders to the finished product. **[8]**

Symbiotics

Combining probiotics with prebiotics (non-digestible fibers) to create symbiotic formulations, promoting the growth and activity of probiotic in the gut**.[9]**

Microencapsulation

Probiotics are encapsulated in microspheres or microcapsules, providing protection from moisture, heat, and acidic conditions in the stomach, thus improving their survival rate and delivery to the intestines. Microencapsulation involves coating probiotic cells with a protective layer of material such as alginate, gelatine or Whey protein. This shields probiotics from adverse conditions like acidic pH and bile salts in the stomach, enhancing their survival during transit to the intestine. In dairy products microencapsulated

probiotics can be added during the production process, ensuring their uniform distribution and stability throughout storage**.[1]**

microencapsulation technology much more frequently, particularly to preserve probiotics in dairy products. As such, the rise of several dairy food items that are enhanced and fortified results in improvements in malnutrition abatement. One of the primary benefits is the ability to inhibit microbial growth, ensuring that the food remains safe for consumption. In addition, microencapsulation could be applied to enhance the sensory and rheological features of food, such as texture, mouth feel, flavor release, as well as food structure, and prevents the incompatibility between different target biological compounds. **[12]**

Genetic Engineering

Modifying the genetic makeup of probiotic strains to enhance their survival, adherence to the gut lining, and production of beneficial metabolites. Advances in genetic engineering allow for the development of probiotic strains with enhanced survival, adherence and functionality in dairy products. Engineered strains may exhibit improved resistance to acidic conditions, bile salts and other stresses encountered during digestion. Genetic modification can also be used to enhance the production of bioactive compounds or metabolites with health promoting properties in dairy products**.[11]**

Nanotechnology

Utilizing nanoparticles to encapsulate probiotics, enhancing their stability and targeted delivery to specific regions of the gastrointestinal tract.**[12]**

Electrospinning

Creating nanofibers loaded with probiotics, which can be incorporated into various food products or used as standalone supplements.**[2]**

Spray Drying

Spray drying probiotics into fine powder particles, improving their stability and allowing for easier incorporation into food and beverage products**.[2]**

Biofilm Formation

Engineering probiotics to form biofilms, protective communities of microorganism that enhance their survival and persistence in the gut environment.[**15]**

Health Impact of probiotics.

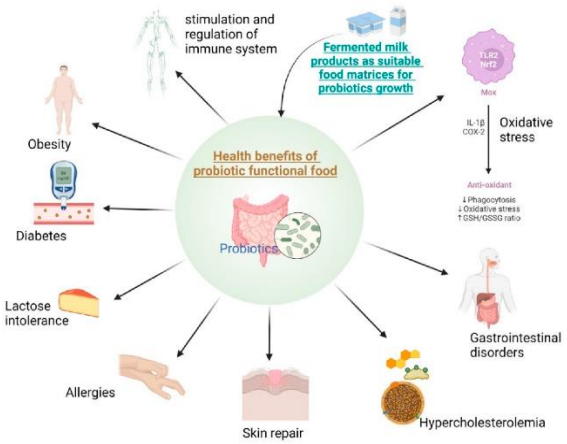

Fig 1. Health Benfits of probiotics **[15]**

A growing public awareness of diet-related health issues and mounting evidence regarding health benefits of probiotics have increased consumers demand for probiotic foods. It has been suggested that approximately 109 CFU per day of probiotic microorganisms is necessary to elicit health effects **[9]**. After passing the biological barriers (pH, digestive enzymes) of the gastrointestinal tract, probiotics take action and impact human health. Some biological activities include antimicrobial, antimutagenic, antigenotoxic, improvement of lactose tolerance, cancer prevention, and immunomodulation. **[10]** Some major health benefits of probiotics and their proposed mechanisms are, anti-pathogenic, anti-diabetic, anti-obesity anti-in, flammatory, anti-allergic, anti-cancer, angiogenic activity of probiotics, activity in Brain and CN systeme **[3]**

Several probiotic bacteria have been introduced in the market, and the range of products in which probiotic bacteria are added is increasing.

Conclusion

The fortification of dairy products with probiotics represents a valuable strategy to meet consumer demand for functional foods that promote gut health and overall well-being. By offering consumers convenient and enjoyable options to incorporate beneficial microorganism into their diet, probiotic-fortified dairy products have potential to contribute significantly to the improvement of public health and nutrition.

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