LECTURE 1
NOVEL FUNCTIONAL FOODS BASED ON NEXT-GENERATION PROBIOTICS

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Abstract

Bioprospecting of next-generation probiotics for microbial biotherapy involves the search and discovery of novel microorganisms that can be used as beneficial bacteria in the development of new drugs and functional foods. Next-generation probiotics aim to identify and develop microorganisms that can address specific health conditions or provide enhanced benefits compared to existing probiotic strains. This involves screening for strains that exhibit desirable properties, such as the ability to survive in the gastrointestinal tract, adhere to intestinal epithelial cells, modulate the immune system, and produce bioactive compounds. Functional foods fortified with next-generation probiotics can offer additional health benefits beyond basic nutrition. These foods may include dairy products, fermented foods, beverages, or even supplements. The probiotic strains selected for use in functional foods should be able to survive processing, storage, and the acidic conditions of the gastrointestinal tract to reach the intended site of action. The bioprospecting of next-generation probiotics for microbial biotherapy involves the search for novel microorganisms with potential therapeutic applications. This approach utilizes the human microbiome and advanced technologies to identify strains that can be developed into new drugs or incorporated into functional foods to promote health and well-being.

Keywords: Next-Generation Probiotics, Microbial biotherapy, and functional foods.

Introduction

In the context of the global trend towards functional foods, which are modified through the addition of phytochemicals, bioactive peptides, omega-3 polyunsaturated fatty acids, probiotics, and/or prebiotics, there has been a significant surge in research on next-generation probiotics (Yousaf *et al.,* 2009). Manufacturers are increasingly focused on producing and consumers on consuming such functional foods. This trend is driven by the growing body of scientific literature and clinical studies demonstrating the ability of specific gut-derived probiotic strains to promote a healthy digestive tract and immune system (Kiefer *et al.,* 2020).

Consumer demand for functional foods, especially those containing probiotics, has led to rapid growth in the market (Alves *et al.,* 2016).

This expanding consumer demand is reflected in the projected worth of the global market, forecasted to reach USD 64 billion by 2023. The interest in probiotics, prebiotics, and functional foods is not only driven by consumer demand but also by the potential health benefits they offer (Chaturvedi & Chakraborty, 2020). Research on functional foods has incorporated prebiotics and probiotics, both of which have captured significant attention in recent years. Research on functional foods has incorporated prebiotics and probiotics, both of which have captured significant attention in recent years.

This surge in interest is especially notable in the food industry, where there has been a shift towards utilizing novel functional foods as natural biopreservatives and antimicrobial agents. In line with this, there is a growing trend for the production and consumption of functional foods worldwide, particularly in developed countries (Yousaf *et al.*, 2009). Given the significant impact of next-generation probiotics on the functional food market, it is essential to explore their potential applications in developing novel functional foods (Alves *et al.*, 2016). Several studies have highlighted the potential to utilize nanotechnology for the delivery of natural food preservatives with greater efficacy and fewer undesirable effects (Fahim *et al.*, 2016). It is crucial to consider the potential benefits of incorporating next-generation probiotics into novel functional foods. Additionally, the use of advanced nanotechnology methods for the delivery of natural food preservatives can further enhance the efficacy of these functional foods (Joana *et al.,* 2022).

1.1 Functional Food

The increasing demand for functional foods, especially those containing probiotics, highlights the importance of exploring the applications of next-generation probiotics in the development of innovative food products. As consumers seek products that promote overall health and well-being, the integration of next-generation probiotics into functional foods presents a compelling opportunity for the food industry (Zhang *et al.*, 2022).

Furthermore, the projected growth of the global market for functional foods underscores the potential for next-generation probiotics to play a significant role in shaping the future of the food industry. As research in this field continues to evolve, it is essential to leverage the potential of next-generation probiotics to meet the growing demand for functional foods and address the health-conscious preferences of consumers.

2.1 The Concept of Next-Generation Probiotics

In recent years, there has been a notable surge of interest in next-generation probiotics and their potential applications in the food industry, particularly in the development of functional foods (Alves *et al.*, 2016). The concept of next-generation probiotics represents a significant advancement in the field of functional foods, with the potential to revolutionize the way we approach food production and consumption. Recent advancements in the field of functional foods have led to an increased focus on the potential applications of next-generation probiotics (Sanders *et al.*, 2018)

Next generation probiotics have opened new possibilities for enhancing the functionality of food products. Nanotechnology has emerged as a promising tool for the delivery of natural food preservatives with superior efficacy. Recent studies suggest that the encapsulation of probiotics in phospholipid nanovesicles promotes slow release, which

can extend the shelf-life and enhance their effectiveness. This approach has shown particular promise in maintaining the viability of probiotics under gastrointestinal conditions and throughout the product's shelf-life. Another lipid-based formulation system, Solid Lipid Nanoparticles, has been demonstrated to provide slow-release capabilities for incorporated bacteriocins, further contributing to the preservation and functionality of probiotics in food matrices (O'Toole *et al.*, 2017)

2.2 Design and Development of Novel Functional Foods

Recent studies suggest that the encapsulation of probiotics in phospholipid nanovesicles promotes slow release, extending shelf-life and enhancing effectiveness. Emerging technologies like these have indicated great potential for delivering bioactive compounds to improve human health through functional foods and nutraceuticals. Furthermore, the application of nanotechnology is expected to grow rapidly as it offers significant improvements in food safety, packaging, and novel food ingredients by creating different properties (Cencič & Chingwaru, 2010*; Zhang et al.*, 2022; Kullberg *et al.*, 2021).

The development of functional foods is vital for addressing the growing consumer demand for products that not only provide nutrition but also offer additional health benefits. Research has shown that the encapsulation of probiotics in phospholipid nanovesicles promotes a slow release, extending the shelf-life and enhancing effectiveness. This innovative approach has demonstrated promising results in maintaining probiotic viability under gastrointestinal conditions and throughout the product's shelf-life. Additionally, the utilization of Solid Lipid Nanoparticles has also been observed to provide slow-release capabilities for incorporated bacteriocins, contributing to the preservation and functionality of probiotics in food matrices (Sarkar & Chandra, 2019; Phoem *et al.*, 2015).

Furthermore, emerging technologies like these have indicated great potential for delivering bioactive compounds to improve human health through functional foods and nutraceuticals. The application of nanotechnology is expected to grow rapidly as it offers significant improvements in food safety, packaging, and the development of novel food ingredients with different properties (Rocchetti *et al.*, 2021). As the development of functional foods continues to gain traction, it is evident that there is a growing consumer demand for products that not only provide basic nutrition but also offer additional health benefits. Embracing the potential of next-generation probiotics and leveraging advanced nanotechnology methods for the delivery of natural food preservatives stands to provide innovative solutions to address this escalating demand and meet the health-conscious preferences of consumers. This suggests that the evolving landscape of functional foods in the twenty-first century is poised for exciting advancements that have the potential to reshape the industry profoundly (O'Toole et al., 2017).

2.3 Benefits of Functional Foods Based on Next-Generation Probiotics

Emerging research in the field of functional foods based on next-generation probiotics has highlighted several benefits. Adopting next-generation probiotics in functional foods offers several advantages. These probiotics have the potential to enhance gut health, immune function, and overall well-being. Through their advanced capabilities, next-generation probiotics promote a healthy lifestyle and address the health-conscious

preferences of consumers (Zhang *et al.*, 2022; Cencič & Chingwaru, 2010). As the research in this field continues to evolve rapidly, the potential for functional foods based on next-generation probiotics to positively impact human health and well-being remains promising. Most of the cited sources focus on the emerging concepts of paraprobiotics, postbiotics, and next-generation probiotics. The incorporation of advanced nanotechnology methods for the delivery of natural food preservatives further amplifies the effectiveness of these functional foods (Otchere et al., 2023).

3.0 Scientific Research and Studies on Novel Functional Foods

The development of novel functional foods, supported by next-generation probiotics and advanced delivery systems, offers significant promise in promoting human health. The emerging technologies not only improve food safety and packaging but also provide novel food ingredients with enhanced properties, leading to the creation of healthier food options for consumers. The incorporation of paraprobiotics and postbiotics has also gained attention in the functional foods field for their potential health-promoting benefits (Nataraj *et al.*, 2020). This holistic approach to functional food development encompasses various elements, including nanotechnology, paraprobiotics, postbiotics, and next-generation probiotics, to create innovative products that cater to the evolving demands of health-conscious consumers.

4.1 Challenges in the Development of Next-Generation Probiotic Foods

Despite the potential benefits of next-generation probiotics, there are challenges in their development. While the incorporation of advanced nanotechnology methods has shown promise in delivering natural food preservatives, there are still challenges in the development of next-generation probiotic foods (Alves *et al.*, 2016). In recent years, new probiotic-related concepts such as paraprobiotics and postbiotics have garnered attention for their potential to provide health benefits beyond the traditional live probiotics (Nataraj *et al.*, 2020).The incorporation of paraprobiotics and postbiotics has also gained attention in the functional foods field for their potential health-promoting benefits .

4.2 The Future of Functional Foods and Probiotics

While the future of functional foods and probiotics is undoubtedly promising, challenges loom on the horizon. Issues such as standardization, regulatory frameworks, and the need for more robust clinical evidence must be addressed. Researchers, clinicians, and industry stakeholders must collaborate to establish a solid foundation for the growth of this field. In summary, the integration of emerging concepts such as paraprobiotics and postbiotics alongside next-generation probiotics and advanced nanotechnology methods is propelling the development of functional foods with unprecedented health-promoting properties. The collective effort to navigate challenges, pioneer new methodologies, and capitalize on scientific research is crucial in shaping the future of functional foods and probiotics, ultimately contributing to an elevated standard of human health and well-being.

5.0 Conclusion and Perspectives on Novel Probiotic Foods

In conclusion, the future of functional foods and probiotics holds immense potential to revolutionize the way we approach nutrition and well-being. By understanding and manipulating the microbiome, incorporating functional ingredients, and embracing

personalized nutrition, we embark on a journey towards a healthier, more resilient society. As we stand on the brink of this nutritional frontier, the fusion of science and food promises a future where what we eat becomes a proactive and personalized approach to wellness.

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