

Synthetic and Systems Biotechnology in Food Sciences

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Abstract

Background and Objective: Food biotechnology significantly impacts the food industry and human health. Many advanced investigations are involved in the ongoing development of food quality and safety. Introducing the critical cutting-edge features of research in food biotechnology is the main aim of this special issue. Application of nanotechnology as a multidisciplinary field to develop food safety and production, using microbiota as the modulators of body immunity against stresses, introducing bioinformatics tools to evaluate food microbial contamination, using systems biology assessment to explore the efficient and safe food preservative agents, evaluating food bioprocess protocols such as fermentation, presentation of advanced bioremediation techniques for detoxification of environmental toxins heavy metals, and highlighting significant progress in engineered edible probiotic vaccines are presented and discussed to provide new perspective of food biotechnology. Understanding and using the close relationship between technology development and food quality and safety improvement is accentuated as a continuous effort in food biotechnology research.

Results and Conclusion: The special issue illustrates the impact of multi-disciplinary research and highlights the need to develop new technologies in the food industry, especially multi-omics systems biology technologies and synthetic biotechnology. The major three topics presented based on systems biology include role of biopreservative agents in food safety. Collaboration between traditional knowledge and newly introduced approaches will accelerate future food biotechnology achievements.

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1. Introduction

The food industry and biotechnology development are associated closely with human health and lifestyle investigations. Indeed, different roles of biotechnology may lead to increased immunity and safety in food sectors, e.g., by incorporating microalgae and/or probiotics into food and microbial metabolites with medicinal and industrial applications [1-10]. So, evaluating the latest technological trends and advancements is critical in food biotechnology. Advanced efficient production, quality maintenance during storage, and achieving food safety standards require alterations and progressions in the related technologies. The human body's response to the intake of certain foods in the short and long term is the best tool to display the quality and safety of diet and the applied

technology. The high throughput methods such as genomics, transcriptomics, proteomics, and metabolomics accompanied by bioinformatics have attracted the attention of experts in biology, medicine, pharmacology, and food sciences and technologies. Application of artificial intelligence, introduction of advanced software and databases, and representation of different models; have provided a new window to solve the complex problems in the various fields of human health. Today, the systems biology approach is a well-known trend for investigating the unsolved complications in the mentioned arenas. It is expected that the mass production of data and optimum organization and interpretation of findings could create a new perspective on human needs and

environmental sources such as food. Collaboration between traditional knowledge and newly introduced approaches will accelerate future food biotechnology achievements. The articles presented in this research topic provide an overview of the impact of multi-disciplinary research and highlight the need to develop new technologies in the food industry, especially multi-omics systems biology technologies and synthetic biotechnology.

Three systems biology-based articles have been presented on this research topic.

Optimizing preservative agents using biotechnology plays a crucial role in food safety. Evaluation of nisin effect on human health versus sodium benzoate (a chemical preservative) depicted in the research by Bandarian et al. [11]. The biological impact of yoghurt fermentation on human health is discussed in the study by Rostami Nejad et al. [12]. It is planned to find a suitable method to decrease the harmful effects of aflatoxin on the human body by Hamzehloo-Moghadam et al. [13].

A review article on this research topic addresses the issue of probiotics as dietary supplements and oral vaccines, which are an effective factor in human health. The potential of edible vaccines has been determined as safe vaccines in possible pathogenicity, good stimulation of mucosal and systematic immunity, and reasonable cost due to the lack of complex purification processes. Therefore, investigating the effectiveness of engineered probiotics based on novel genome editing tools and their challenges in generating edible probiotic vaccines is to be considered [14]. Moreover, probiotics as live microorganisms can improve the gut microbiome to expand the optimistic role of the gut microbiome against the hostile side effects of chemotherapy and radiotherapy [15]. Chemotherapy and radiotherapy, the two common cancer treatment methods are accompanied by considerable side effects. Investigations have demonstrated substantial gastrointestinal disorders associated with chemotherapy and radiotherapy [16,17]. Evidence has pointed out the positive roles of microbiota in modifying these adverse effects and their severity in treated patients [18,19]. Today, probiotics are highlighted in food biotechnology and industry as an essential compound of several foods.

The environment contains essential elements for life, but industrialization has worsened pollution, especially from heavy metals, which threaten human health and ecosystems. The discussion presented by Fateminasab et al. highlights the rise of environmental toxins and the limitations of traditional pollution control, emphasizing the urgent need for advanced bioremediation techniques [20]. Toxic heavy metals like arsenic, cadmium, chromium, mercury, and lead

pose serious health risks, particularly to children, with exposure occurring through contaminated food, water, and air. Bioremediation uses living organisms to detoxify pollutants. Probiotics can effectively eliminate these toxins from food. The report showcases microbes' potential in detoxifying heavy metals and notes the success of engineered microorganisms like recombinant *E. coli* in degrading waste and pollutants. Environmental factors such as humidity and temperature also impact microbial degradation. Additionally, various microbial species play a crucial role in detoxifying contaminants in water, soil, and air, with biofilm-mediated bioremediation emerging as a promising strategy for effective pollutant removal [20-24].

Finally, a review by Koushki et al. focuses on nanotechnology applications in the food industry [25]. They highlighted the considerable role of linking food science and nanotechnology as a multidisciplinary scientific field in protecting food safety, production, processing, and quality control.

2. Conclusion

The special issue illustrates the impact of multi-disciplinary research and highlights the need to develop new technologies in the food industry, especially multi-omics systems biology technologies, and synthetic biotechnology. The major three topics presented based on systems biology include the role of bio-preservative agents in food safety. Collaboration between traditional knowledge and newly introduced approaches will accelerate future food biotechnology achievements.

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4. Conflict of Interest

The authors declare no conflict of interest.

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زیست فناوری سنتزی و سامانه‌ای در علوم غذایی

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چکیده

سابقه و هدف: زیست فناوری مواد غذایی تأثیر بسزایی بر صنایع غذایی و سلامت انسان دارد. بسیاری از تحقیقات پیشرفته در توسعه مداوم کیفیت و ایمنی مواد غذایی دخیل هستند. هدف اصلی این ویژه نامه معرفی تحقیقات مهم در لبه دانش در حوزه زیست فناوری غذایی است. استفاده از فناوری نانو به عنوان یک موضوع چند رشته‌ای برای توسعه ایمنی و تولید مواد غذایی، استفاده از میکروبیوتا به عنوان تعدیل کننده ایمنی بدن در برابر استرس‌ها، معرفی ابزارهای بیوانفورماتیک برای ارزیابی آلودگی میکروبی مواد غذایی، استفاده از ارزیابی زیست سامانه‌ای برای کشف مواد نگهدارنده کارآمد و ایمن، ارزیابی پروتکل‌های فرآیندهای زیستی غذایی از قبیل تخمیر، ارائه تکنیک‌های پیشرفته زیست پالایی برای سم زدایی سموم محیطی، فلزات سنگین مختلف، و برجسته کردن پیشرفت قابل توجه در واکسن‌های پروبیوتیک خوراکی مهندسی شده ارائه و مورد بحث قرار گرفته تا چشم انداز جدیدی از زیست فناوری غذایی ارائه گردد. درک و استفاده از رابطه نزدیک بین توسعه فناوری و بهبود کیفیت و ایمنی مواد غذایی به عنوان تلاشی مستمر در تحقیقات بیوتکنولوژی مواد غذایی مورد توجه قرار گرفته است.

یافته‌ها و نتیجه‌گیری: ویژه‌نامه تأثیر تحقیقات چند رشته‌ای را نشان می‌دهد و ضرورت توسعه فناوری‌های جدید در صنایع غذایی، به‌ویژه فناوری‌های زیست‌شناسی سیستم‌های چند-امیکس و زیست‌فناوری سنتزی را برجسته می‌کند. سه موضوع اصلی ارائه شده بر اساس بیولوژی سیستم‌ها در علوم زیست‌فناوری غذایی مطرح شده است. همکاری بین دانش سنتی و رویکردهای جدید معرفی شده، دستاوردهای بیوتکنولوژی مواد غذایی آینده را تسریع خواهد کرد.

تعارض منافع: نویسندگان اعلام می‌کنند که هیچ نوع تعارض منافع مرتبط با انتشار این مقاله ندارند.