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Policy Brief:

Necessary Recommendations for Enhancing Food Quality through the Development of Biotechnology in Food Production

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Abstract

Background and Objective: Consumption of low-quality food products has become a serious threat to public health worldwide. Food biotechnology, including the application of microorganisms, enzymes, fermentation processes, and probiotics, can significantly improve quality, nutritional value, and safety of food products. This study aims to provide evidence-based policy recommendations for the targeted development of biotechnology in food production.

Material and Methods: This policy brief reviewed scientific evidence, FAO/WHO reports, and experiences of leading countries (China, India, Brazil). Challenges such as population growth, water scarcity, waste, and climate change were analyzed. Biotechnological solutions (microorganisms, enzymes, fermentation, probiotics) were examined.

Results and Conclusion: Biotechnology increases shelf life, nutritional value, and safety while reducing waste and energy consumption. Developed countries have improved productivity and exports through targeted investment. Main barriers include weak research infrastructure, lack of regulatory frameworks, and insufficient public education.

Conclusion: Targeted development of food biotechnology is a strategic necessity. Policymakers should support knowledge-based companies, strengthen research and regulatory infrastructure, and provide public education to enable safe use of this technology, thereby reducing food dependency and contributing to public health and the knowledge-based economy.

Keywords: Food Biotechnology, Food Quality Improvement, Functional Foods, Probiotics, Food Security, Policy Recommendations

1. Introduction and statement of the problem

The increasing consumption of low-quality food products has become a serious threat to public health and has intensified social challenges worldwide [1, 2]. Despite the existence of numerous food safety and quality standards, the continued prevalence of foodborne diseases indicates that more effective and innovative solutions are urgently needed [2, 3]. Food biotechnology, as one of the most critical technologies of the 21st century, offers significant potential to improve the quality, nutritional value, safety, and shelf life of food products [4, 5]. The application of microorganisms, enzymes, fermentation processes, genetic engineering, and particularly probiotics and functional foods, provides a scientific foundation for producing healthier, safer, and more sustainable foods [6, 7]. Modern approaches such as synthetic and systems biotechnology have also opened new perspectives for addressing complex challenges in food safety [4].

However, contemporary society faces a series of structural and escalating challenges in the field of food security [8, 9]. The most significant among these include

rapid population growth, limitations and depletion of water resources, dependency on imports of certain food additives and raw materials, increasing waste throughout the agricultural supply chain, declining productivity in the food industry, and the consequences of climate change and global food crises [3,7,9]. According to the World Health Organization (WHO) and the Food and Agriculture Organization (FAO), healthy diets are essential for preventing chronic diseases, yet millions of people worldwide lack access to affordable, high-quality food [8, 9]. Developed countries, as well as emerging economies such as China, India, and Brazil, have successfully enhanced their production efficiency and strengthened export capacity through targeted investment in agricultural and food biotechnology [5, 7]. Therefore, this policy brief aims to provide evidence-based recommendations for enhancing food quality through the development of biotechnology in food production, examining structural challenges and offering actionable policies for national and international stakeholders [1, 4, 3].

2. Methods

This study was conducted as a policy brief using a review-analytical approach. Data and information were gathered through systematic searches in reputable scientific databases (e.g., Scopus, PubMed, ScienceDirect) and reports from international organizations (FAO, WHO) [1, 8, 7]. The experiences of leading countries (China, India, Brazil) in the development of food biotechnology were also analyzed [5, 9]. Structural challenges of the food system (population growth, water scarcity, waste, climate change) were examined, and biotechnological solutions (microorganisms, enzymes, fermentation, probiotics, functional foods) were reviewed as the basis for formulating policy recommendations [4, 6]. For detailed methodology and baseline data, readers are referred to the original article number 52052.

3. Findings

- Food biotechnology effectively increases product shelf life, reduces waste, and decreases energy consumption [2, 5].
- The use of probiotics and functional foods not only improves public health but also reduces the economic burden of chronic diseases [6, 3].
- Developed countries, through targeted investment in agricultural and food biotechnology (e.g., China, India, Brazil), have achieved higher productivity, reduced food dependency, and increased their share of global markets [5, 7].
- Despite the existence of numerous standards, the continued prevalence of foodborne diseases indicates that the simultaneous application of advanced biotechnological technologies and innovative approaches in safety assessment remains essential [2, 3, 10].

Main barriers to the development of food biotechnology in resource-limited countries include: weak research infrastructure, lack of efficient regulatory frameworks, insufficient public education, and hidden costs resulting from unsustainable agricultural practices (including environmental degradation and intensified climate change) [7, 9].

4. POLICY

1. **National Priority Setting:** The development of food biotechnology (including fermentation, microorganisms, enzymes, probiotics, and functional foods) should be considered a main policy priority within the national food system.
2. **Support for Knowledge-Based Companies:** Provide financial facilities, export incentives, and strengthen research and development infrastructure.
3. **Strengthening Regulatory Frameworks and Risk Assessment:** Develop evidence-based quality standards and ensure strict monitoring of their implementation.
4. **Public and Professional Education:** Enhance social acceptance and consumer trust through transparent communication regarding the safety and benefits of food biotechnology.
5. **Integration of Economic, Environmental, and Health Considerations:** Incorporate these dimensions into macro-level planning to ensure safe, sustainable, and cost-effective development of biotechnology.
6. **Knowledge-Based Export Development:** Produce high-quality biological products in accordance with international standards to increase foreign exchange revenues and strengthen the knowledge-based economy.

5. Declarations

5.1. Acknowledgement

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Ethical Approval: Not required (policy brief based on literature review).
Data Availability: All data from published sources.
Reference: Detailed methodology available in reference paper No. 52052.

5.2. Conflict of Interest

The authors report no conflict of interest.

5.3. Using Chatbots

We used an AI academic search engine for scientific research (https://consensus.app/).

5.4. Authors' Contributions

All authors reviewed and edited the manuscript.

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خلاصه سیاستی:

ضروریات ارتقای کیفیت مواد غذایی از طریق توسعه بیوتکنولوژی در تولید غذا

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چکیده

زمینه و هدف: مصرف مواد غذایی کم‌کیفیت، سلامت عمومی را با خطر مواجه کرده است. بیوتکنولوژی مواد غذایی می‌تواند کیفیت، ارزش تغذیه‌ای و ایمنی محصولات را بهبود بخشد. هدف این مطالعه، ارائه توصیه‌های سیاستی برای توسعه بیوتکنولوژی در تولید مواد غذایی است.

روش: این گزارش سیاستی با بررسی شواهد علمی، گزارش‌های FAO و WHO و تجربیات کشورهای پیشرو (چین، هند، برزیل) انجام شد. چالش‌هایی نظیر رشد جمعیت، کمبود منابع آبی، ضایعات و تغییرات اقلیمی تحلیل گردید و راهکارهای بیوتکنولوژیکی (ریزسازواره‌ها، آنزیم‌ها، تخمیر، پروبیوتیک‌ها) بررسی شد.

یافته‌ها: بیوتکنولوژی ماندگاری، ارزش غذایی و ایمنی مواد غذایی را افزایش و ضایعات و مصرف انرژی را کاهش می‌دهد. کشورهای توسعه‌یافته با سرمایه‌گذاری هدفمند، بهره‌وری و صادرات خود را افزایش داده‌اند. موانع اصلی شامل ضعف زیرساخت‌های تحقیقاتی و نظارتی و کمبود آموزش عمومی است.

نتیجه‌گیری: توسعه هدفمند بیوتکنولوژی مواد غذایی یک ضرورت راهبردی است. پیشنهاد می‌شود سیاست‌گذاران با حمایت از شرکت‌های دانش‌بنیان، تقویت زیرساخت‌های پژوهشی و نظارتی، و آموزش همگانی، زمینه بهره‌برداری ایمن از این فناوری را فراهم کنند تا ضمن کاهش وابستگی غذایی، به سلامت عمومی و اقتصاد دانش‌بنیان کمک شود.

واژگان کلیدی: زیست‌فناوری مواد غذایی، بهبود کیفیت مواد غذایی، غذاهای کارکردی، پروبیوتیک‌ها، امنیت غذایی، توصیه‌های سیاستی