Original Research Article

Safety and quality control in the food industry through biotechnology

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Abstract: In the development of modern society, the application of biotechnology is becoming increasingly widespread, involving many fields, including the food industry. The practical application of biotechnology has brought about significant changes to the food industry, not only enriching product varieties and extending shelf life, but also optimizing nutritional content and enhancing production efficiency. This article analyzes the practical application of biotechnology in the food industry, the safety issues existing in the application of biotechnology in the food industry, and focuses on the quality control measures of biotechnology in the food industry, hoping to provide reference for the healthy development of the food industry.

Keywords: Food industry; Biotechnology; Safety; Quality; Strategy

In the real society, although biotechnology has brought many development opportunities to the food industry, a series of issues concerning safety and quality control that it has triggered cannot be ignored. Ensuring the safe application of biotechnology in the food industry and strictly controlling food quality are of significant importance for protecting consumer health and promoting the sustainable development of the food industry.

1. The practical application of biotechnology in the food industry

1.1. The practical application of traditional biotechnology

1.1.1. Fermentation technology

Fermentation technology, as one of the earliest applied technologies in the development of biotechnology in the food industry, has an extremely wide range of applications. Taking the bread-making process as an example, the yeast fermentation stage plays a key role in it. During this process, yeast decomposes the sugars contained in flour, producing carbon dioxide and alcohol. The production of carbon dioxide causes the dough to expand, giving the bread a soft texture. Differences in yeast species, fermentation temperature, and fermentation duration can all affect the quality of the final bread. If the yeast activity is poor, or the fermentation conditions do not meet the appropriate standards, the bread may very likely have insufficient fermentation and a hard texture.

1.1.2. Enzyme technology

In the field of food processing, enzymes play a crucial catalytic role. From the practice of meat processing, proteases can be used for meat tenderization. In the practice of beef processing, adding specific types of proteases can decompose the collagen in the meat, making the texture more tender. However, if the dosage of enzymes is unreasonable, it may lead to over-tenderization of the meat, thereby losing the original texture and chewiness. In the production of fruit juice, pectinase is used to decompose pectin, thereby increasing the juice yield and improving the clarity. Pectinase can destroy the structure of pectin substances in the fruit cell wall, making the juice easier to extract.

1.2. The application of modern biotechnology

1.2.1. Genetic engineering technology

Genetic engineering technology has achieved remarkable results in crop improvement. For instance, the de-

velopment of insect-resistant genetically modified crops, where scientists have introduced the insecticidal protein gene from Bacillus thuringiensis(Bt)into crops such as cotton and corn, enabling the crops to produce toxic proteins against pests, thereby reducing the degree of pest infestation. This method can effectively reduce the amount of pesticide used and lower the threat of pesticide residues to food safety. In the case of Bt gene-modified cotton cultivation, the damage from bollworms has significantly decreased, and cotton yields have also increased substantially. Moreover, genetic engineering technology has been applied to enhance the nutritional value of crops. A typical case is"Golden Rice,"where theβ-carotene synthesis gene has been introduced into rice through genetic engineering techniques, effectively improving people's nutritional status.

1.2.2. Cell Engineering technology

In the field of plant tissue culture, cell engineering technology is used for the rapid propagation of superior plant varieties. Taking the tissue culture of orchids as an example, by selecting the shoot tip tissue of orchids and placing it on a culture medium containing appropriate nutrients and plant growth regulators, a large number of orchid seedlings can be rapidly propagated. This technology not only ensures that the superior characteristics of orchids are maintained but is also not limited by seasons and regions, allowing rare orchid varieties to better meet market demand.

In the field of animal cell engineering, monoclonal antibody technology has potential application value in food detection. Monoclonal antibodies can specifically detect specific pathogens or harmful substances in food. If monoclonal antibodies against foodborne bacteria can be successfully developed, it will enable rapid and precise detection of these bacteria in food, providing a strong guarantee for food safety.

2. Safety issues in the application of biotechnology in the food industry

2.1. Allergic reactions

In daily life, genetically modified foods may contain new proteins that could trigger allergic reactions. When a protein gene that does not exist in a certain crop is introduced into it, the newly generated protein is highly likely to be allergenic. Consumers allergic to such proteins may experience allergic symptoms, including rashes, difficulty breathing, and gastrointestinal discomfort, upon consuming genetically modified foods containing these proteins. For instance, in a study involving the genetic transfer from Brazil nuts to soybeans, researchers initially attempted to introduce a methionine-rich protein gene from Brazil nuts into soybeans to enhance their nutritional value. However, it was later discovered that this Brazil nut protein was an allergen, and the study was consequently terminated to prevent genetically modified soybeans containing this protein from entering the market, thereby avoiding the risk of allergies.

Additionally, the microorganisms used in fermented foods may also produce allergens. Some molds may generate allergenic metabolites during the fermentation process. In the production of some traditional fermented soy products, if the fermentation process is not well controlled, the allergens produced by mold growth may remain in the food, posing a threat to the health of consumers with allergic tendencies.

2.2. Gene transfer risks

During the cultivation of genetically modified crops, there is a risk of gene transfer to wild relatives. For example, the genes of herbicide-resistant genetically modified crops may be transferred to wild weeds through pollen, giving the weeds herbicide-resistant characteristics, which could make weeds difficult to control and thus impact the ecological balance. There is also a risk of gene transfer in the microbial fermentation process. Some genetically modified microorganisms used in the food industry, if they undergo gene transfer with other microorganisms in the fermentation environment, may give rise to unpredictable new microorganisms. These new microorganisms may have potential pathogenicity or produce harmful substances, ultimately having an ad-

verse effect on food safety.

2.3. Production of harmful substances

In practice, in some applications of biotechnology, harmful substances may be produced. Taking certain fermentation processes as an example, if the fermentation conditions are not appropriate, microorganisms may produce mycotoxins. Aflatoxin is a common mycotoxin produced by Aspergillus flavus under poor fermentation conditions, and it is highly carcinogenic. During the fermentation processing of agricultural products such as peanuts and corn, if the storage and fermentation conditions are not suitable, they are highly susceptible to contamination by Aspergillus flavus, thereby producing aflatoxin, which severely endangers food safety. From the perspective of genetically engineered crops, some unexpected metabolic products may also be generated. Although most genetically modified crops that have undergone strict approval are currently considered safe, some studies have found that the metabolic products produced by genetically modified crops under specific conditions differ from those of traditional crops. Whether these unexpected metabolic products have an impact on human health still requires further study.

3. Quality control measures in the application of biotechnology in the food industry

3.1. Establishing and improving the legal and regulatory framework and standards system

In real life, it is necessary for the government to build a comprehensive set of laws, regulations, and standards as the cornerstone for ensuring the safety of biotechnology food. The government should formulate relevant laws and regulations to clearly define the requirements and standards for biotechnology food in various aspects such as production, processing, and sales. Such laws and regulations should comprehensively cover the definition, labeling, safety assessment, and quality testing of biotechnology food. For example, for genetically modified food, the government should require the mandatory labeling of”genetically modified”on its packaging to ensure that consumers can clearly understand the essential attributes of the food. At the same time, the government needs to establish strict safety assessment standards for genetically modified food, conduct strict testing and assessment of genetically modified food to ensure that it does not pose harm to human health and the ecological environment.

3.2. Strengthening the assessment of the safety of biotechnology food

Research institutions and regulatory authorities should deepen the assessment of the safety of biotechnology food, which is a key factor in ensuring food safety. The safety assessment work covers the evaluation of various aspects such as the nutritional content, allergenicity, toxicity, and ecological impact of biotechnology food. For genetically modified food, research institutions need to carry out long-term animal experiments and human clinical trials to assess their impact on health. At the same time, scientific researchers should use advanced detection technologies such as gene sequencing technology and proteomics technology to detect and analyze exogenous genes and proteins in biotechnology food to ensure they meet safety standards. In addition, regulatory authorities also need to build a comprehensive ecological risk assessment system to comprehensively assess the impact of biotechnology food on the ecological environment and take effective measures for monitoring and control.

3.3. Strengthening the quality testing of biotechnology food

Food production enterprises and regulatory authorities should strengthen the quality testing process of bio-

technology food, which is an important measure to ensure food quality. Quality testing should run through the entire food production process, from raw material procurement to the sale of finished products, and each step must undergo strict testing. For biotechnology food, testing personnel should use advanced testing technologies such as high-performance liquid chromatography, gas chromatography, and mass spectrometry to detect and analyze the nutritional content, additives, and contaminants in the food to ensure that the food quality meets relevant standards. At the same time, food production enterprises need to build a comprehensive quality traceability system to implement full traceability for all aspects of food production, processing, and sales. Once quality issues are found, they can be quickly traced back to the source and effectively addressed with appropriate measures.

3.4. Strengthening the labeling management of biotechnology food

Regulatory authorities should strengthen the labeling management of biotechnology food, which is an important means to protect consumer rights to information. Labeling management includes clear requirements for the content, method, and location of biotechnology food labeling. For genetically modified food, regulatory authorities should require mandatory labeling of”genetically modified”on its packaging and provide detailed explanations of the source, use, and safety of genetically modified food. At the same time, regulatory authorities need to strengthen the supervision of labeling, crack down on false labeling and misleading consumer behavior, and effectively protect consumer rights to information and choice.

4. Conclusion

In the development of the food industry, biotechnology plays an increasingly important role, not only improving the yield and quality of food but also enriching the taste of food, extending the shelf life of food, and bringing more convenience to people’s lives. However, in real life, there are some hidden dangers in the safety and quality control of biotechnology in the food industry, which should be given high attention. It is necessary to use regulations for strict supervision and constraints to encourage manufacturers to standardize production and to do a good job in product labeling, further enhancing the safety of biotechnology applications and ensuring the health of the public.

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