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Role of biotechnology in increasing the food production and processing

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Abstract:

Biotechnology encompasses all technological applications that use biological systems, living organisms, or derivatives thereof to create or change goods or processes for specialized use. It frequently overlaps with bioengineering and biomedical engineering, depending on the techniques and applications used. This research highlights the how biotechnology helps on food production and processing in improving its flavor, flavor, lifespan, consistency, and nutritional content. Genetically changed fermentation, genetically modified foods, utilization of all these modern technologies in diagnostics for food testing, a importance of biotechnology in food production through boosting food output, better harvesting, storage, and distribution.

Keywords:

Biotechnology, Bioengineering, Enzymes, Fermentation, Food, Microorganisms.

1. Introduction:

The term "biotechnology" is used to describe the practice of designing and developing new products and processes that make the use biological systems, living organisms, or their derivatives. In order to enhance characteristics like taste, smell, lifespan, consistency, as well as nutritional benefits, biotechnology was widely used in the food processing industries of the world's poorest nations. Using microorganisms and its enzyme, fermentation improves the quality of food sources (Food and Agricultural Organizations (FAO), 2010). Fermentation methods are widely used in the production of numerous products with high added value, such as microbial cultures, enzymes, scents, fragrances, food additives, and so on. These high-value items are being manufactured by developing nations with better technology in order to supply the food and non-food processing sectors in those nations. In addition, many of these high-priced goods are imported by developing nations for use in the food processing industry. The integrity and safety of the final product must be maintained by any processing technology employed in the food sector. To eat is considered safe if it contains no more than a tolerable amount of any physical, chemical, or microbiological dangers that could be harmful to consumers or the general public. Consumption of such food is therefore possible without fear of major adverse health effects. Consumers are increasingly worried about the safety of the food they eat in light of recent food crises like mad cow disease as well as the melamine poisoning of food products. The Food and Agricultural Organization (2010) found that when per capita income raises, customers' willingness to pay a premium for superior product characteristics such as safety, sustainability, and ease of use increases.

1.1. Research aim:

The research aim is to analyze the potential applications of biotechnology inside the production as well as processing of food products.

1.2. Research Objectives:

- To give the knowledge on the fundamentals of the food-growing and processing industries.
- To inform public about the issue in food safety as well as its planning
- To learn more about the laws and rules that regulates the food industry.

1.3. Research Questions:

1) How might biotechnology helps increase foods supply?
2) What is the role of biotechnology in the storage of food?

3) Which are the three ways that food biotechnology is helping to cut down on wasted food?
4) How has advanced biotechnology affected agricultural output?
5) What are the five ways that biotechnology has boosted the food supply?

2. Literature Review:

Here we provide a summary of the most helpful resources that were consulted during the study process. All of the most important aspects of the research are addressed in this chapter's several sections.

2.1. Applications of Biotechnology to Food Processing:

Genetic modification of microorganisms used in the fermentation of food there is evidence that fermentation using bacteria, yeasts, and molds dates back thousands of years. Traditional approaches to strain development by means of selection and mutation are prone to inaccuracy and lack of control, because it's difficult to screen for all conceivable mutations and the screening procedure is time-consuming and arduous (Ciurzyska and Lenart, 2011). Even more so, one can only work with the DNA that is already in the body. Because it permits the selection as well as transfers the single, well-defined features from nearly any live organism inside a precise, controllable, and predictable manner, genetic engineering presents a means for addressing many of these restrictions. The processing, nutritional content, microbiological safety, and shelf life of fermented foods are only a few examples of the many ways in which genetic innovations have an effect. Figure 1 shows the Application of biotechnology in food processing

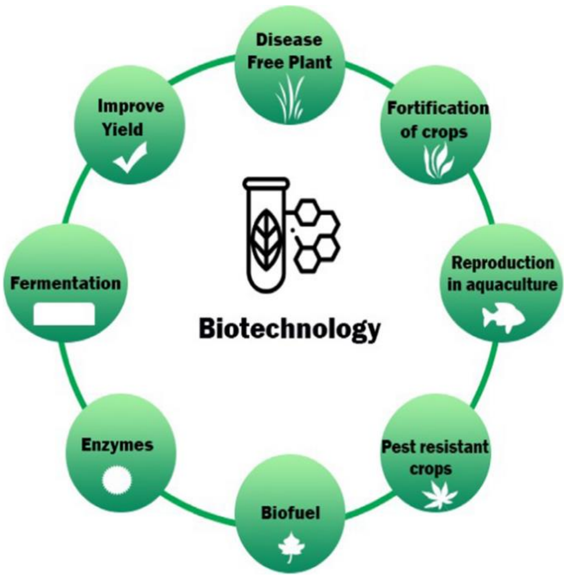

Figure. 1: Application of biotechnology in food processing (source: Ranjha et al., 2022)

2.2. Biotechnology in food preservation:

Bio preservation, also known as biological preservation, is a technique used to maintain the nutritional value and shelf life of foods without altering their taste by utilizing "desired" microbes (cultures) and/or their metabolites.

Cultures are characterized as protective and antagonistic micro-organisms introduced to food solely to suppress infections and/or to increase the shelf-life, while minimally altering the product's sensory attributes (Barbosa and Teixeira, 2022). There is a distinction between these cultures and the starting cultures in terms of their intended purposes. Because starter cultures are employed in food fermentations to alter the raw material and impart novel sensory qualities, the culture's metabolic activity (acid generation) is prioritized over its ability to preserve the food from spoiling by microorganisms (Barbosa and Teixeira, 2022). The functional goals of a protective culture are the exact opposite of those of a non-protective one.

There are two primary approaches to biopreservation in the food industry:

- Including unrefined, refined, or refined microbial metabolites.
- The incorporation with live, clean microorganisms.

Microorganisms and their metabolites are used as a supplement to the hurdle method of food preservation rather than as a replacement for conventional preservatives.

2.3. Biotechnology in Food Fermentation:

Microorganisms play an important part in the production of fermented foods. Academics and businesses devote a lot of time and energy to studying how to improve bacteria, yeasts, and molds, and microbial cultures can undergo genetic improvement using both conventional and molecular techniques (Leuchtenberger, Huthmacher and Drauz, 2005). One of the characteristics considered for commercial food applications in both developed and developing countries is sensory quality (flavor, visual look, texture, consistency including general acceptability). Resistance against viruses (bacteriophages) in the context of dairy fermentations; the ability to synthesize antimicrobial compounds (such bacteriocins and peroxide) to reduce undesirable bacteria. Many poor nations place a premium on eliminating or mitigating the effects of natural toxins (like cyanogenic glycosides found in cassava), mycotoxins (by grain fermentations), or anti-nutritional factors (e.g. phytates). Fermented foods are those that have gone through a process of fermentation using either raw or cooked plant or animal materials. Their unique taste and nutritional benefits, as well as characteristics impacting life span, cleanliness, and practical usefulness, are all profoundly impacted by microorganisms and/or enzymes (from the raw material).

2.4. Biotechnology in the Production of Enzymes:

In living organisms, enzymes play the role of biological catalysts, aiding and speeding up metabolic reactions. Because they are proteins, they can only function when bound to a certain substance. Their catalytic conditions, such as optimal temperature, pH, and oxygen concentration, are constrained to specific ranges. Temperatures exceeding 42 degrees Celsius denature most enzymes. Some bacterial enzymes, however, can function at a wider temperature range. The food and beverage industries make extensive use of enzymes because of their importance to metabolic processes in all forms of life. Historically, enzymes were isolated solely from animal and plant sources, leaving the food processor with a small, expensive pool of options. In modern times, microorganisms like bacteria and fungus are being employed in the industrial manufacturing of various enzymes (Olempska-Beer, Merker, Ditto and DiNovi, 2006). Several microbial strains have been genetically engineered or chosen for enhanced enzyme production. The changed genes usually come from microbes, but they might come from anywhere in the animal kingdom.

2.5. Biotechnology in the Production of Food Ingredients:

In order to improve the quality of a food product (in terms of taste, texture, and/or nutritional value), several substances are utilized as additives (Leuchtenberger, Huthmacher and Drauz, 2005). Natural chemicals, typically derived from plants or microorganisms, are used extensively in the food and cosmetics industries. Both xanthan gum as well as guar gum are made by microorganisms. Many of the vitamins, minerals, and amino acid additions found in breakfast cereals are created through bacterial fermentation (Wu et al., 2009). Prior to ultimate food manufacturing, all microorganisms are eliminated using high-purification systems (Braunschweiger, and Conzelmann, 2007). During the food production process, enzymes play an important role as processing aids. The enzyme chymosin, for instance, is found in abundance in animal stomachs and is what is utilized to make cheese. The production of chymosin by yeasts, molds, and bacteria was pioneered by biotechnology researchers many years ago, rendering the use of animals superfluous.

2.6. Importance of Food Processing and Preservation:

As has been noted, food processing is a type of manufacturing in which scientific knowledge and advanced technology are applied to raw materials in order to create intermediate foodstuffs or finished edible goods (ncert, 2022). Food resources that are large, perishable, and occasionally inedible can go through a number of transformations to become condensed, shelf-stable, and edible in a variety of forms. Adaptations to the ingredients usually cut down on the cook's work. Food processing usually improves the value of the final product by making it more convenient to store, transport, consume, and enjoy. Raw material characteristics, principles for food preservation, processing elements influencing quality, packaging, pollution and sewage management, good manufacturing practices, and sanitary procedures are all topics that professionals inside the food processing industry should be well-versed in (ncert, 2022). Let's take a quick look at why food processing exists, what goes into it, how it works, and how it's evolved in the current era. To put it simply, foods can become bad for a number of reasons (ncert, 2022). Loss of freshness, unpleasant flavors, mushy or slimy textures, off colors, and diminished nutritional content are all signs of food deterioration, which also diminishes the food's aesthetic value and makes it dangerous to eat.

3. Methodology:

3.1. Data collection:

Newspapers or the Internet are few examples of secondary sources that have been used for long. The transgenic detection method as well as the food pathogen detection method is used to uncover the impact of biotechnology in the food production as well as processing processes. The technology employed to detect transgenic material in food products poses a risk of contamination to non-transgenic material and must be shielded from it. Bioengineered have become a lightning pole for concerns about food safety. For the sake of public health and safety, the ability for food detection of pathogens is employed promptly to detect live microorganisms in food.

3.2. Data analysis:

3.2.1. Transgene detection method:

It is necessary to take precautions when consuming transgenic food products due to the risk of contamination. Bioengineered corns have become a lightning rod for concerns about food safety. Despite the fact that these occurrences can have a detrimental effect on consumer acceptability of GM foods, real-time quantitative PCR is the most influential, convenient, and cost-efficient tool for increasing their potential success and approval. Antibiotic resistance markers like promoters are now the most widely used tools for detecting genetically modified organisms (GMOs). However, these methods are far from ideal, as the same characteristic sequences could be found in a wide variety of GMOs. The use of such identifiers was outlawed in the European Union in 2004. A set 1 percent threshold level for the presence of transgenic material mandates the mandatory labeling of GMO foods. Icon Genetics, a German biotech firm, had an innovative notion for the global labeling of genetically modified organisms, which was offered by its research and development department. They developed a standard encoding approach for adding technical data based on DNA sequences that have not been transcribed to the transgene before it is inserted into the genome. The nucleotide triplet is the building block of the encoding system, and it can be represented by any one of all 26 letters of the Latin alphabet, followed by an Arabic numeral between 0 to 9, and finally a space character.

3.2.2. Food athogen detection:

Salmonella, Vibrio, Listeria, or E. coli are some examples of toxin-producing bacteria that can cause food poisoning. The Shiga toxins produced by the E. coli strain are the most dangerous kind (stx1 and stx2). These Shiga toxins cause damage to the lining of the large intestine, which in turn leads to severe diarrhea as well as dehydration and, if the toxin is absorbed into the bloodstream, can be fatal. Ground beef, raw milk, and cooked beef were linked to 73,480 illnesses including 61 deaths in the United States. Inadequate storage of these items can lead to contamination and the spread of food-borne illness. Because of its speed, sensitivity, and dependability, PCR was utilized to detect the infection. Typical PCR runs analyze a small amount of samples using the gel electrophoresis method. It was found that a PCR-ELISA technique might speed up the detection for E. coli as well as other STEC (Shiga toxin-producing Escherichia coli) by a factor of one hundred. Rapid, sensitive, accurate, and massive screening of microbes that produce Shiga toxins is now possible with the use of robots, and also the process could be automated in the near future. This technique can be used to identify other food-borne infections by replacing the aforementioned PCR primers with explicit biotin-labeled versions of the primers.

4. Discussion:

Many food crops have seen increased output at reduced costs thanks to the creation of transgenic plants that are resistant to herbicides, insects, and pathogens. Transgenic salmon, created by inserting foreign genes in salmon, can develop three times quicker than conventional salmon. In the next phase of modern biotechnology, the goal is to create altered foods that are superior in every way, including nutrition, flavor, quality, and safety. Bioextraction for plant bioactive nutraceuticals that provide good health advantages but are found in a small quantity in plants; fabrication a new vegetable solid fat with a lower level of saturated fatty acids; manufacture of much more nutritious healthier meat. Foods that have been transformed by biotechnology contribute to the development of novel chemicals, the enhancement of existing ones, and the provision of food security and safety. As a whole, biotech provides a wide variety of cutting-edge resources, like DNA probes, PMCA, and ELISA tests, as well as new sensors for identifying microbes and their toxin employing a number of biosensors. The polymerase chain reaction (PCR) was designed to identify infectious pathogens such bacteria, viruses, fungus, and others. It has been demonstrated that by incorporating biotechnology into today's food supply, a wider range of foods that are better for you and the environment can be made available to people all over the world at lower costs without sacrificing taste or convenience.

5. Conclusion:

Today, the upsides of biotechnology much outweigh the risks. Therefore, it is crucial to raise food output to satisfy the expanding human population. Countries should emphasize measures to ensure the safety, quality, and availability of fermented foods after realizing their potential. This work has outlined a variety of potential paths forward for developing nations looking to employ biotechnologies to ensure the safety of their food supply. Upstream fermentation processes, such as the manufacture of high-value fermented goods like enzymes, functional-food components, and food additives, require a government that is conducive to their expansion and development. There needs to be a coordinated effort to get the word out about the benefits of fermented foods and the field of food biotechnology. The benefits of fermented food items need to be promoted, and producers need to be taught how to make their goods safely and effectively.

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