Acta Scientific AGRICULTURE (ISSN: 2581-365X)

Volume 8 Issue 4 April 2024

Review Article

Applications of Biotechnology in Food and Agriculture: An Analysis Review

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Received: March 11, 2024

Published: March 21, 2024

Abstract

The many uses of biotechnology in agriculture and food are examined in this review. The impact of various biotechnology techniques on improvement of crops, food safety, environmentally friendly agricultural practices, and sustainability is examined. This study underscores the crucial significance of biotechnology in augmenting agricultural productivity, guaranteeing food security, and advancing sustainable development by scrutinising contemporary research and commercial practices. It talks about agricultural precision, bioremediation, genetic engineering, and other cutting-edge methods influencing the future of agricultural production. Through the synthesis of significant discoveries and trends, this study provides an understanding of the potential and problems related to the combining bioengineering in the food and farming sectors. The significance of conscientious biotechnology innovation in tackling worldwide food security issues and promoting sustainable farming methods is ultimately highlighted.

Keywords: Biotechnology Utilisation; Genetic Modification; Bioengineering; Agriculture Technology; Food

Introduction

The term "biotech" or "biotechnology" describes a wide range of practices for modifying of organisms that exist for human use, such as gardening, raising animals, and making "improvements" on them through manipulating selection and hybridization in breeding programmes. The field of biotechnology encompasses a vast array of advancements and uses aimed at creating beneficial living products and services. A branch of agricultural biotechnology applies techniques from molecular and cell biology to improve crop plants' genetic makeup and agronomic practices. Green biotechnology refers to the application of biotechnology in agricultural activities. It will be expected that green biotechnology will yield an eco-friendlier outcome than conventional industrial agriculture [1].

Ever since ancient times, natural products have been utilised [2]. So, any scientific era, the goal has been to process natural goods in order to obtain meaningful benefits [3]. An advanced but still evolving technology, biotechnology uses living creatures and/or materials that originate from them to create or alter products for specific uses. It can apply to all taxa of organisms, including more complex taxa including plants and animals as well as simpler taxa such as bacteria and viruses. As a result, biotechnology is now widely used in contemporary industry, agriculture, and medicine. When developing or processing agricultural products, scientists can utilise a variety of techniques made possible by modern biotechnology to identify and manipulate a species' genetic makeup [4].

Application and important role of biotechnology in agriculture

The field of agricultural biotechnology can be defined as a collection of scientific methods based on DNA principles that can be used to enhance plants, microorganisms, and animals. Agrochemical use in agriculture is thought to be less effective than the application of biotechnology. The latter is thought to be rather impractical for farmers and to be creating environmental discomfort [5].

The following outlines the limited applications of biotechnology in agriculture.

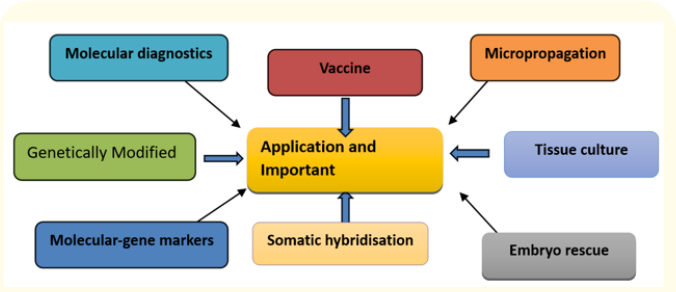

Figure 1

Genetically modified organisms (GMOs)

Genetically modified organisms (GMOs) have been created to give crops like soybeans, maize, and wheat characteristics like insect and disease resistance, resistance to herbicides, and herbicide resistance.

These qualities lessen the need for synthetic herbicides and pesticides by assisting farmers in managing weeds and pests more successfully.

GM Crops	Major difference	References
Rice	Naturally, rice has a low percentage of Zn and Fe. The quantity of iron and zinc is increased as a result of fortification.	[6]
Maize	Production of kinds of maize with increased concentrations about Carotenoid and pro-vitamin A; GM variants have higher concentrations of minerals; reports of bio fortifying maize with β-carotenes.	[7]
Wheat	Given the limited amount of iron and zinc in wheat, GM cultivars with 40–50% higher concentrations of Fe and Zn are produced.	[8]
Cassava	β-carotene is added to cassava as a bio fortified to increase the number of carotenes and maybe increase the quantity of iron and zinc.	[9]
Golden Eating	Golden rice can help prevent vitamin A deficiency since it Rice has the highest content of β-carotene, or pro-vitamin A.	[10]
Cowpea	Minerals such as calcium, iron and zinc content are higher in cowpea. The content of fat has been increased.	[11]

Table 1: Compared to traditional crop breeding, GM crops have a significant nutritional difference.

Tissue culture

Components of tissue from plants or animals are cultivated in a regulated environment in tissue culture in order to ensure their survival and continued growth. To begin with, the tissue needs to be isolated.

Embryo rescue

It is a type of plant in vitro culture method. In order to guarantee its survival, a developing embryo is raised in this setting under strict monitoring. This has the potential to aid in the conservation of endangered seed species. This can include regional grains with cultural significance, heritage seeds, etc.

Somatic hybridisation

This procedure involves manipulating the cellular genome by means of protoplast fusion.

Molecular-gene markers

Molecular-gene markers in genetic engineering are distinct DNA segments linked to a specific region of the genome.

Molecular diagnostics

A group of methods called "molecular diagnostics" are employed to examine biological markers found in the genetic code and proteome. It aids in figuring out how their cells translate their DNA into proteins.

Vaccine

It is a mixture that is administered into the body of the host in order to trigger the intended immunological response. It aids in the prevention of several illnesses, including polio. Nowadays, a lot of work goes into producing it to combat COVID.

Micro propagation

It is the process of growing plants clonally in a confined container with aseptic and regulated conditions.

Role of biotechnology in agriculture

Biotechnology plays a variety of roles in agriculture. Among the most widely recognised advantages of bioengineering in agriculture are.

Increase in Crop Yield

Agricultural productivity increases significantly as a result of biotechnology because it improves disease control and increases resistance to drought and flooding. This not only meets the rising demand for food but also minimises losses for farmers.

Improved Protection for Crops

Biotechnology methods provide practical and affordable answers to pest-related issues. Crops like cotton, maize and potatoes can now be modified by farmers to produce a protein that efficiently combats pest problems.

An improvement in the nutritional value

Additionally, it has made it possible for farmers to grow foods with improved flavour, texture, and nutritional value. For example, technology has allowed for the cultivation of potatoes with starch, legumes with additional amino acids, and soybeans with high protein content.

Better taste and fresher produce

By increasing the production of enzymes found in plants, it also contributes to the improvement of the flavour and taste of crops. It also aids in prolonging the freshness of the yield.

Tolerance to chemicals

The majority of farmers use herbicides to suppress weed growth, which frequently causes soil erosion. But because food that has been genetically modified is resistant to many substances, including pesticides, soil erosion is far less common.

Resistance to disease

Insect-transmitted viruses are frequently difficult to control, and using pesticides frequently endangers the quality of the food as well as the soil. However, GM plants are simpler for farmers to control crop loss since they are less prone to viral infection. Using biotechnology in agriculture has many advantages, but it is not without its drawbacks. To be more specific, there are concerns over environmental, social, and health issues.

Future opportunities for agricultural biotechnology careers

Global demand for agricultural biotechnology is rising. Employment opportunities in a variety of fascinating vocations are brought about by this increase.

Around the world, public (government or sponsored) organisations and institutions, as well as commercial agricultural firms, employ people with a diverse range of talents and educational backgrounds. Gaining additional knowledge and experience will help you find a job with greater autonomy and a higher income as the industry grows.

Research and Development, or R&D

The process of creating new products and seeing them through to market readiness is known as research and development.

These two procedures are used in agricultural biotechnology to create novel goods that are sold commercially. Senior scientists whose conduct fundamental researches in science at universities, government labs, or businesses are known as research scientists. Often, the inspiration for a new product comes from the researchers themselves. Research scientists contribute specialised knowledge and in-depth understanding of a particular scientific topic. Usually, they are in charge of creating their individual experiments and determining which inventions are patentable [12].

- **Scientist for Process Development:** Your objective is to enhance your manufacturing unit's performance and put process controls in place to guarantee that goods are produced in an excellent and repeatable manner.
- **Independent work:** Produce stores, agribusinesses, and agricultural companies provide employment opportunities for freelancers.
- **Management of agriculture:** Professionals in this field are usually employed in the dairy, agriculture, or animal production industries. In addition to working on machinery and overseeing human resources, they are also responsible for overseeing agricultural administration, designing plans and tactics for high yields, and managing associated operations.
- **Consultants in agriculture:** Agricultural consultants help their clients run their businesses or activities as profitably and efficiently as possible by offering guidance, solutions, and support.
- **Product Creation:** These experts are required by manufacturing organisations to oversee and comprehend the processes that result in the finished product. They are involved in the production of a wide range of goods, including food, decorative dyes, and pharmaceuticals.

- **Biotechnologist for agriculture:** Agricultural biotechnologists are specialists in the manipulation of living things, including plants and animals, using scientific instruments, research, technology, etc. Agricultural biotechnologists are commonly referred to as such, even though some of them only work with crops. Utilising approaches and strategies including genetic engineering, genetic markers, molecular diagnostics, vaccinations, and tissue culture are all part of the job description for a biotechnologist. These methods allow for the transfer of desired features from one crop to entirely different species.

The intended flavour, colour, flowering rate, time to harvest, infection and animal products resistance, etc. are thus present in transgenic crops.

Industries

There are employment opportunities in agricultural biotechnology in public (government-established or funded) organisations and agencies as well as commercial businesses.

Conclusion

The benefits of bioengineering in farming and food production have been carefully studied in this analysis review, demonstrating its critical role in addressing numerous issues and promoting sustainability. It is clear that biotechnology greatly increases agricultural output and assures food security through the investigation of many biotechnological approaches, including gene editing, enhancement of crops, and food safety measures. Furthermore, through reducing environmental effects and increasing resource efficiency, biotechnology supports sustainable farming methods. This evaluation emphasises the significance of responsible biotechnology innovation in fulfilling worldwide dietary demands and addressing new agricultural concerns by synthesising existing research and industry practices. Going ahead, it will be essential to carry out more biotechnology studies and development in order to overcome upcoming obstacles and realise biotechnology's full potential in creating a more resilient as well as environmentally friendly food and agriculture system.

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