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Using Biotechnology And Genetic Engineering To Improve The Quality And Sustainability Of Plants And Livestock

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Abstract

Plants and livestock are essential sources of food for humans. However, crop and livestock productivity and health are often compromised by various factors such as pests, disease, drought, salinity, temperature extremes and pollution. Effective and sustainable breeding and conservation measures are needed to solve this problem. One option that can be used is biotechnology and genetic engineering. Biotechnology and genetic engineering are sciences that allow the genetic material of plants and livestock to be manipulated to obtain desired characteristics. This article discusses several examples of biotechnology and genetic engineering to improve quality and resistance in plants and livestock, such as transgenes, cloning, CRISPR-Cas9, gene editing and DNA synthesis. This article also discusses ethical, social, economic and environmental challenges and implications related to the application of biotechnology and genetic engineering in agriculture.

Keywords: Biotechnology, Protection of agriculture and breeding, Genetic engineering

1.Introduction

Plants and livestock are essential sources of food for humans. According to the Food and Agriculture Organization (FAO), plants produce about 80 per cent of the calories humans consume. In comparison, livestock accounts for about 40 per cent of human-animal protein. In addition, plants and livestock have high economic, social, cultural and environmental value. Therefore, increasing the productivity and health of plants and livestock is one of the priorities of the agricultural sector. However, crop and livestock productivity and health are often compromised by various factors such as pests, disease, drought, salinity, temperature extremes and pollution. These factors can cause farmers to lose production, quality and income. In addition, these factors can also threaten food security and biodiversity. According to the FAO, around 20-40% of the world's crops are lost to pests and diseases yearly. At the same time, about 20 per cent of the

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world's livestock die from the disease every year. Effective and sustainable breeding and conservation measures are needed to solve this problem. Breeding plants and animals select individuals with desired characteristics such as yield, quality, abiotic and biotic stress resistance, environmental adaptation, etc.

Plant and animal protection is preventing or controlling pests and diseases that can damage crops. And cattle. Reproduction and conservation of plants and livestock can be done in various ways, such as traditional selection, hybridization, mutagenesis, genetic engineering, biotechnology, etc. Biotechnology and genetic engineering are one way to improve the quality and sustainability of plants and livestock. Biotechnology is the science of using living organisms or parts of them to produce products or processes helpful to humans. Genetic engineering is the science of manipulating genetic material (DNA or RNA) to change the characteristics of living organisms. Biotechnology and genetic engineering can change the genetic characteristics of plants and livestock to suit human needs.

The Importance of Biotechnology and Genetic Engineering in Agriculture Modern agriculture is faced with increasingly complex challenges, such as climate change, population increase, and environmental degradation. To fulfill the growing demand for food, innovation in agriculture is crucial. Biotechnology and genetic engineering offer innovative solutions to improve the productivity, quality, and sustainability of crops and livestock.

Challenges Facing Agriculture Challenges such as extreme climate change, soil degradation, and pest and disease resistance pose serious threats to modern agriculture. Using biotechnology and genetic engineering approaches, scientists can develop crops and livestock that are more resistant to environmental stress and disease, and sustainably increase productivity.

Social and Environmental Implications The application of biotechnology and genetic engineering in agriculture also has social and environmental implications that need to be considered. The impact of these technologies on environmental sustainability, social justice, and global food security must be thoroughly evaluated to ensure that the benefits can be enjoyed by all parties without harming the environment and society.

The Role of Ethics in Technology Development Ethical aspects also play an important role in the development and application of biotechnology and genetic engineering in agriculture. It is important to ensure that the use of these technologies is done with due regard to ethical values, including fairness, safety, and sustainability. The involvement of all stakeholders in the decision-making process is also crucial.

2. Materials and Methods

The materials used in this article are various plants and livestock that have been genetically modified through biotechnology and genetic engineering. Some examples of crops and livestock used include:

- Transgenic rice plants contain the Xa21 gene, which provides resistance to blast diseases.
- Transgenic corn plants containing Bt (Bacillus thuringiensis) genes that resist caterpillar pests.
- Transgenic tomato plants contain the Flavr Savr gene, which gives better flavour and textural characteristics.
- Transgenic potato plants containing an antisense P.G. (polygalacturonase) gene that confers resistance to soft rot.
- Transgenic soybeans containing the CP4 EPSPS (5-enolpyruvylshikimate-3-phosphate synthase) gene confer tolerance to the herbicide glyphosate.
- Transgenic cows containing the BST (bovine somatotropin) gene, which improves milk productivity.

- Transgenic sheep containing the gene CSN1S1 (casein alpha S1), which ensures better wool quality.
- Transgenic pigs contain the gene FGF21 (fibroblast growth factor 21), which ensures optimal muscle and fat growth.
- Transgenic chickens contain the ovalbumin gene (OVA), which provides immunity against influenza viruses. In addition to transgenic plants and livestock, the materials used in this article also include various methods of biotechnology and genetic engineering, such as:
- Genetic transformation is the process of introducing foreign DNA into plant or animal cells through vectors (e.g. plasmids, viruses or bacteria) or physical methods (e.g. microinjection, electroporation or biolistics).
- Cloning is the making of identical copies of cells, tissues, organs or individual plants or livestock using the techniques of somatic cell nuclear transfer (SCNT), cell fusion or parthenogenesis.
- CRISPR-Cas9 is a nuclease-based gene editing system that can cut and insert DNA into specific locations in the genome of plants or livestock using guide RNA (gRNA) and the Cas9 protein.
- Gene editing, namely the process of changing the sequence of DNA nitrogenous bases without introducing foreign DNA into plants or livestock's genome, uses site-specific nuclease enzymes (ZFN, TALEN or meganuclease).
- DNA synthesis, i.e. the process of making artificial DNA using a DNA synthesis machine or PCR method. The methods used in this article are various biotechnology and genetic engineering techniques mentioned earlier, namely genetic transformation, cloning, CRISPR-Cas9, gene editing and DNA synthesis. These methods modify the genetic characteristics of plants and livestock for research purposes. Some of the steps in these methods are:
- Genetic modification:

1. Isolate the foreign DNA containing the desired gene from a donor (e.g., bacteria, viruses or other plants/animals).
2. Selection of a suitable vector to transport foreign DNA into plant or animal cells (e.g. plasmids, viruses or bacteria).
3. Introduction of foreign DNA into the vector using restriction enzymes and ligase.
4. Introduction of vectors into plant or animal cells by physical methods (e.g. microinjection, electroporation or biolistics) or biological methods (e.g. agrobacteria or viruses).
5. Select plant or animal cells that have been successfully transformed using selective markers (e.g., antibiotics or herbicides). 6. Development of plant and animal cells converted into transgenic individuals using tissue culture or breeding techniques.

• Kloning:

1. Taking the nuclei of somatic cells from donors with the desired characteristics.
2. To take eggs from a recipient with the same species as the donor.
3. Removal of egg marrow by microinjection or enzymes.
4. Nucleation of the somatic cell into the oocyte by microinjection or electroporation.
5. Activate the egg by electrical or chemical stimulation.
6. Menyisipkan sel telur ke dalam rahim induk pengganti untuk menghasilkan individu kloning.

• CRISPR-Cas9:

1. Design a guide RNA (gRNA) that matches the target DNA sequence you want to modify.
2. Create Cas9 protein capable of cutting DNA at the target location.
3. Using genetic transformation techniques, Introduce gRNA and Cas9 into plant or animal cells.
4. GRNA and Cas9 can interact with the target DNA and cut it at specific places.

5. Uses natural DNA repair mechanisms to add, delete, or replace nitrogenous base sequences at targets.

• Gene editing:

1. Design a site-specific nuclease enzyme (ZFN, TALEN or meganuclease) corresponding to the target DNA sequence you want to edit.
2. Prepare site-specific nuclease using DNA synthesis or recombinant DNA methods.
3. Introduction of site-specific nuclease enzymes into plant or animal cells by genetic transformation methods.
4. Allow site-specific nuclease enzymes to interact with the target DNA and cut it at specific sites.
5. Uses natural DNA repair mechanisms to add, delete, or replace nitrogenous base sequences at targets.

• DNA synthesis:

1. Design the sequence of nitrogen bases from which you want to make artificial DNA (for example, a new or synthetic gene).
2. Using a DNA synthesis machine or PCR method to create short DNA fragments (oligonucleotides).

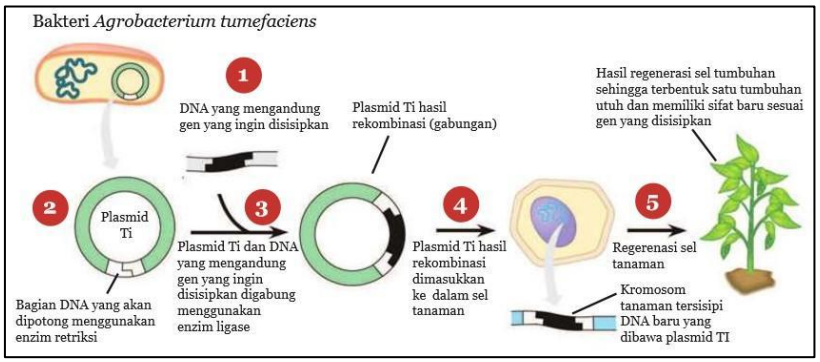

Figure 2. 1 Food bioteknology [8]

3. Results

This article discusses the use of biotechnology and genetic engineering to improve the quality and resilience of plants and livestock. This article shows that biotechnology and genetic engineering are rapidly developing scientific fields with great potential to meet various agricultural, livestock and food challenges. This article also provides several examples of transgenic plants and livestock successfully created using various biotechnological and genetic engineering methods, such as genetic transformation, cloning, CRISPR-Cas9, gene editing, and DNA synthesis. From the examples given, it can be seen that transgenic crops and livestock have several advantages over conventional crops and livestock, such as:

- Improves product quality, taste, texture, colour, smell, nutrition, and health.
- Increases resistance to various biotic (e.g. pests, diseases or weeds) and abiotic (e.g. drought, salinity or temperature extremes) stress factors.
- Increases productivity and production efficiency in quantity, quality and time.
- Increases adaptation to different or changing environments.
- Increasing the genetic diversity and phenotypic variability of plants and livestock. However, transgenic plants and livestock also have some challenges and risks that must be anticipated and minimized,

such as:

- cause ethical, social, cultural, religious or legal disputes related to intellectual property rights, consumer safety, animal welfare or environmental impact.
- raise technical, financial or political issues related to production costs, distribution, regulation or market acceptance.
- Causes potential ecological hazards, such as the spread of foreign genes to wild animals or non-target species, changes in ecosystems or food chains, or development of resistance or allergies. Therefore, this article recommends that the development and application of biotechnology and genetic engineering in agriculture, breeding and nutrition be done carefully and responsibly. This article also emphasizes the importance of collaboration between different actors in the field, such as researchers, farmers/breeders, consumers, industry, government, NGOs, media or academics. This collaboration aims to increase knowledge, skills and awareness of biotechnology and genetic engineering and to develop policies, standards or guidelines that adhere to ethical, safety, health and environmental principles. This article also provides several suggestions and recommendations for development and the future. Biotechnology and genetic engineering applications

such as:

- Conduct more innovative, creative and comprehensive research and development to create better, safer, and beneficial transgenic plants and livestock for humans and the environment.
- To carry out more accurate, objective and transparent tests and evaluations to assess the performance, effectiveness, efficiency and impact of transgenic plants and livestock on various technical, economic, social, cultural, religious, legal or ecological aspects.
- Conduct more intensive, extensive and comprehensive outreach and education activities to increase public understanding, appreciation and participation in biotechnology and genetic engineering and reduce stigma, fear or unjustified rejection of transgenic plants and livestock.
- Implement stricter, more flexible and fair supervision and control to ensure the acceptable, ethical, safe, healthy and sustainable use of biotechnology and genetic engineering and to prevent or overcome various problems or conflicts arising from using biotechnology. Transgenic plants and livestock.
- Risks and proposals related to biotechnology and genetic engineering in agriculture, breeding and nutrition. This paper hopes that biotechnology and genetic engineering can be used responsibly and cooperatively to create better crops and livestock for human and environmental well-being.

4. Discussion

Genetic engineering of plants is carried out by transferring the genes of foreign species into plant cells, after which the plant cells are regenerated to become plants. Plant genetic engineering aims to improve plant quality and resistance to diseases, pests, drought and other environmental factors. Some examples of genetically engineered plants are corn, soybeans, cotton, tomatoes and bananas.

This article also emphasizes the importance of collaboration between different actors in the field, such as researchers, farmers/breeders, consumers, industry, government, NGOs, media or academics. This collaboration aims to increase knowledge, skills and awareness of biotechnology and genetic engineering and to develop policies, standards or guidelines that adhere to ethical, safety, health and environmental principles. This article also contains several development and implementation recommendations and recommendations. In the field of biotechnology and genetic engineering in the future.

5. Conclusions

Biotechnology and genetic engineering are scientific fields with great potential to improve the quality and sustainability of plants and livestock. Using various biotechnology and genetic engineering methods such as genetic transformation, cloning, CRISPR-Cas9, gene editing and DNA synthesis, scientists have succeeded in creating transgenic plants and livestock with different advantages such as taste, texture, colour and aroma. , diet. , health, productivity, efficiency, adaptation and diversity. However, transgenic crops and livestock also have challenges and risks that must be anticipated and minimized, such as ethical, social, cultural, religious or legal controversies, technical, economic or political issues, and potential ecological threats. Therefore, developing and applying biotechnology and genetic engineering in agriculture, animal husbandry and the food industry must be done carefully and responsibly. In addition, it is essential to collaborate with various actors in the field and to carry out more innovative, creative and comprehensive research and development activities, more accurate, objective and transparent tests and evaluations, and more socialization and training. - comprehensive and stricter, more flexible and fair supervision and control. Thus, biotechnology and genetic engineering can be used wisely, ethically, safely, healthily and sustainably to create better crops and livestock for human and environmental well-being.

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