The Application of Transgenic Technology

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Abstract. With the rapid development of biotechnology, transgenic technology has been widely used around the world, especially in agriculture and medical fields showing great potential. However, the safety of Gmos has always been a focus of concern for the public, scientists and policymakers. By analyzing the basic principles and application examples of transgenic technology, this paper evaluates the ecological and environmental risks and food safety issues that may be brought about by genetically modified organisms. In particular, data tables show the potential impacts of GM crops on ecosystems and their assessment of food safety. The study notes that while GM technology has the advantage of improving crop yield and stress resistance, its safety assessment requires a more rigorous scientific approach and a transparent risk management process. In recent years, relevant technologies have been gradually applied in the fields of research on gene function, production of animal bioreactors and construction of human disease animal models, etc., making the research of livestock gene function more efficient. This paper aims to provide a scientific basis for developing more rational regulatory policies, and suggests that future studies focus more on long-term effects and public acceptance.

Keywords: Transgenic technology; GMOs; Bt corn.

1. Introduction

As the global population continues to grow, also the intensification of environment pressures, traditional agriculture and medical models are facing serious challenges. Transgenic technology, which is a major breakthrough of biotechnology in the 21st century has shown a great potential in increasing crop yield, improving food quality, treating diseases and other perspectives. 1983, the world's first genetically modifies plant, tobacco existed. Transgenic technology involves the insertion of a foreign gene into the genome of a target organism to give it a new trait or improve an original trait, so as to achieve the effect of disease resistance, insect resistance or enhance the production and so on. We made the transformation of exogenous genes a top priority, which accompanied by a series of gene selecting and identifying. Thus the core of this technology is the precise modification of genes, for example, the construction of vectors, and common methods include Gene gun, or the Particle Bombardment Technology, bacteria-mediated and gene editing techniques such as CRISPR-Cas9. The first application of the transgenic technology in industrial is the prodution of insulin, till now, the transgenic technology, has been widely used on fields like agriculture, medical and engineering. For example, genetic modified crops such as insect-resistant cotton and drought-resistant maize are already being grown in many countries around the world, significantly increasing crop yields and stress resistance and reducing reliance on chemical pesticides. In the medical field, genetic modified technology has made it possible to mass-produce specific proteins and drugs, such as above mentioned synthetic insulin and growth hormones. Transgenic technology can also be used in research and development of vaccine and drugs, since scientists can clone a virus gene and transfer it into a cell to clarify the virus infection principle by observing the changes of the cell. This could be applied in the disease treatment and prevention as well. It is also frequently use to construct some animal models to simulate human disease, and this allows drugs to be tested on animals to improve the success rate of drugs. However, the safety of genetic modified organisms, particularly their possible long-term effects on ecosystems and the safety of food, remains a major concern for the public and research.

The purpose of this paper is to discuss the basic principle, application status and ecological and health safety issues of the transgenic technology, providing a basis for scientific management and public policy, and enhance the understanding, acceptance and make transgenic technology to be well regarded in society.

2. Application of transgenic technology

2.1. Application of transgenic technology in Agriculture

Agriculture is one of the most noticeable projects in the field of genetic modification. By this, people have the ability to optimize or classify some particular plant character, and then cultivate new crop varieties which have a higher yield and quality. At the same time, it can also realize the characteristics of anti-virus, cold resistance, drought resistance, herbicide resistance and insect resistance of plants, such as herbicide-resistant soybean, Arctic avocado and insect resistant cotton. Here, we take Bt corn as an example [1].

2.1.1 Discovery and development of Bt corn

Bt corn, a type of corn which is being genetic modified, and it is different from other corn since it is insect resisted. While farmers were having long struggle with the pests that ate their crops, scientists had unexpectedly discovered a different kind of corn since they were not being eaten by pests. The scientists put researches on these insect-resist corns, they found there was a type of gene in a soil bacterium called Bacillus thuringiensis (Bt) which can produce a natural insecticide that has been used in conventional and organic agriculture for many years. Thus, scientists had started the cultivation of transgenic insect-resistant corn.

There are four main steps in the cultivate process. At the beginning, scientists first determine the insect resistant traits they want the corn to have. And then they search for corns that already possessed the insect resist trait, the target is their specific genes. The second step, after finding the target gene, they replicate the gene with insect resistant trait in Bt. Third, using genetic tools to insert gene into the corn's DNA so that corn is then endowed with the trait of insect resistance, and this won't change other exiting traits. It is worth noting that when adding new traits to crops, there's not just genetic code that's being inserted, still need some extra genetic material like a promoter sequence. This part may determine how the new trait is expressed in the plant, and the promoter may cause the protein to be expressed in certain parts of the plant or at certain times. (Martin-gatton college of agriculture and environment) Last, scientist do experimental planting plan in the laboratory to make sure the corn have the insect-resistant ability. If successful, they will first test new corn plants (now corn with Bt corn gene)in greenhouses, then they do field test and further expand the test. Only after a series of in-depth reviews and safety tests, Gm plants can be sold to farmers. This will take years of time[2].

2.1.2 The Benefits od Bt corn

Bt corn is much easier to grow because of their trait to resist some pests. Therefore, farmers can use smaller amounts of chemical pesticides depending on their situations. according to Brookes and Barfoot's data(2010), from 1996 to 2008, the cumulative global use of insecticide active ingredients in Bt corn decreased by 35%, or about 29.9 million kilogram. So in an ideal situation, there would also be less food available to pests. As a result, affecting pest population in fields where Bt corn is grown.

Meanwhile, there is a positive impact on the health of both farmers and environment since there is less insecticide, and the most important thing is protecting farmers' profits and ensuring the quality of corn[3].

2.1.3 The Disadventages of Bt corn

It is undeniable that as time goes by, some pests may appear to be drug resistance, so it should be noted that insecticide is still necessary. Below is a simplified data table showing the results of a study on the effects of GM cotton pollen on non-target insects.

Table 1. Effect of transgenic insect-resistant cotton on non-target insects [4]

Caste	Survival rate of control group	Survival rate of transgenic group	Significance level (p value)
Apis mellifera	92	88	0.05
Coccinella septempunctata	85	83	0.20
Ceratitis capitatal	90	86	0.10

As shown in the table 1, the response of transgenic insect-resistant cotton to three types of non-objected insects is different, as we can see from the significant level, only the effect on bees were close to statistically significant. This suggests the need for more rigorous testing of potential effects on non-target organisms before GM crops are widely used. Through this type of data-driven research, it is possible to better understand and manage the ecological risks that may arise from GM technologies, so that appropriate management strategies can be developed to protect biodiversity and ensure the health and stability of ecosystems.

2.1.4 The Safety of Bt corn

Genetically modified crops have been proven safe through testing and use, and can even increase the safety of common foods. Many global studies have affirmed the safety of genetic modified crops. Trillions of meals containing GMO ingredients have been eaten by humans, with zero verified cases of illness related to the food being genetically altered. GMOs can help address food scarcity with genetic engineering to improve crop yields and help farms grow food in drought regions or on depleted soil, thereby lowering food prices and feeding more people, helping to alleviate world hunger. They can also lead to environmental benefits such as reduced pesticide use, and lower carbon emissions. Growing GMO crops leads to environmental benefits by reducing the need for pesticides and herbicides, conserving water, lowering greenhouse gas emissions, and supporting sustainable farming particles, which help protect ecosystems and biodiversities.

Below is a table of data showing the results of a study that compared the nutritional content of genetically modified corn with that of non-genetically modified corn.

Table 2. Comparison of nutritional composition between transgenic maize and non-transgenic maize [5]

nutritional ingredient	Non-GMO corn content	GMO corn content	Significant level(p value)
Total protein(g/100g)	9.4	9.5	0.65
Total fat(g/100g)	4.8	4.7	0.70
Vintamin B1(mg/100g)	0.28	0.27	0.80
Calcium(mg/100g)	7	7	0.90

As shown in the table 2, there is no significant difference in major nutritional components between transgenic corn and non-transgenic corn, indicating that transgenic variation has no negative impact on the basic food properties of corn at the nutritional level. This type of data is an important part of food safety evaluation, helping regulators and the public understand the level of safety of GM foods.

2.2. Application of trangenic technology in Medicine

2.2.1 Applicaion of transgenic technology in insulin production

Genetically modification are already in use in medicine. The easiest and the most typical one was the production of insulin drugs. Traditional insulin was secreted from the pancreas of cattle, but it takes many cows to supply the daily dose of insulin needed for one diabetic patient, which lead to a high price that ordinary people couldn’t afford it. Until now, the dominate approach to get insulin was to use microbes to produce it. Recently there’s news that scientists have created genetically

modified cows that can directly produce insulin-containing milk, by using somatic cell nuclear transfer (SCNT)technology to introduce human DNA that accociated with insulin secretion into cow embryos, thereby quickly obtaining large amounts of insulin. Similarly, transgeneic technology can also be used in research and development of drugs and vaccines. When it comes to interpreting a virus, scientists may clone a virus gene and transfer it into a cell to understand the virus's infection mechanism by observing the cell's changes.

2.2.2 Application of transgenic technology in Gene therapy

Gene therapy is a new type of treatment method, which introduces therapeutic foreign genes into human target cells through delivery carriers, and access or replace some abnormal genes or cells in the patient's body to improve and correct gene defects or abnormalities. This therapy breaks through the limitations of traditional drugs to achieve precise treatment of a variety of diseases, and is expected to fundamentally cure diseases (Shuyi). This will involve the treatment of many congenital genetic diseases. In August 2024, the gene therapy began to show results. Research teams at several hospital institutions have used adeno-associated virus (AAV) therapy to inject normal AP4M1 genes into patients using intravaginal injection techniques using AACV9 as a carrier. After a period of treatment, the patient's symptoms improved a lot[6].

2.3. Application of transgenic technology in Industrial engineering

On the industrial side, the performance of GM technology can not be underestimated. In industrial production and environmental remediation, modifying the genome of microorganisms through transgenic technology can make them have the ability to efficiently synthesize specific compounds. The brewing industry, for example, has introduced artificially isolated and modified genes into the genomes of yeast used in beer to improve the traits of the yeast. By inserting the LTP1 gene into beer yeast and making it produce a lot of LTP1 protein, even if the barley is not of high quality, it can produce beer with a rich foam [7].

3. Conclusion

3.1. Main discoveries and research limitations

By analyzing the rationale, current application, and potential environmental and health impacts of GM technology, this study confirms the significant benefits of GM technology in increasing crop yields and improving health care. For example, to increase the pest resistance of corn and cotton to improve production, increase income, to a greater extent to ensure people's life needs, to ensure the safety of products. At the same time, transgenic technology also has drawbacks that cannot be ignored. The human and financial resources that need to be invested, and which products to optimize genetically modified are all issues that need to be taken into account. Then there are the ethical issues that have always been at the forefront of the use of GM. The study also points to the risks that Gmos can pose to ecosystems and food safety. Despite extensive risk assessments and nutritional analyses, further monitoring and research on long-term ecological and health effects are needed.

3.2. Research recommendations

In view of the complexity and potential risks of GM technology, it is suggested that future research should focus on the following aspects: First, strengthen the systematic research on the long-term ecological impact of GM products, especially its impact on biodiversity. Second, more independent and long-term health assessment studies should be conducted to more fully understand the impact of GM foods on human health. In addition, it is recommended to enhance public education and communication strategies to enhance society's understanding of the science and safety of GM technology, so as to promote the sustainable development of science and technology and social acceptance.

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