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GENE EDITING: A SUSTAINABLE SOLUTION TO PERISHABLE GOODS WASTE

Chetna Pathak* and Abhijeet Kuderiya

PhD Research Scholar, Jawaharlal Nehru Krishi Vishwavidyalaya, Jabalpur – 482004 - (M.P.), India.

**Corresponding Author Mail ID: csapathak@gmail.com*

Introduction

In recent years, the issue of food waste has become a major concern, with billions of tons of perishable goods being discarded every year. In fact, an estimated 30-40% of food produced globally is wasted, much of which happens due to perishability. The environmental, economic, and social implications of this waste are vast, leading to calls for innovative solutions to address the problem. One promising approach that has garnered attention is gene editing, a cutting-edge biotechnological tool that could help reduce waste in perishable goods, particularly in the agricultural and food industries. By using advanced biotechnologies like CRISPR, gene editing allows for precise modifications to the DNA of crops and livestock, ultimately reducing spoilage and waste. Here are five examples of how gene editing can play a pivotal role in waste management in perishable goods.

Understanding Gene Editing

Gene editing refers to the use of biotechnology to modify the DNA of an organism. Tools like CRISPR-Cas9 have revolutionized this field, allowing scientists to make precise changes to an organism's genetic makeup. This can result in crops that are more resilient to pests, diseases, and extreme weather conditions, as well as those that have longer shelf lives or retain nutritional value for longer periods.

In the context of perishable goods, gene editing offers the potential to create varieties of fruits, vegetables, and other products that can withstand transport, storage, and handling better than current varieties. By addressing the issues that cause perishables to spoil such as microbial growth, ripening processes, and sensitivity to temperature fluctuations gene editing could play a pivotal role in reducing food waste on a global scale.

Extending Shelf Life

One of the most direct ways gene editing can help with waste management in perishable goods is by extending the shelf life of produce. Many fruits and vegetables, for example, have a short shelf life due to rapid ripening, oxidation, or susceptibility to microbial contamination. Genetic modifications can slow these processes down, allowing the products to stay fresh longer and thus reducing the likelihood of spoilage before they reach consumers.

For instance, Tomatoes are highly perishable and often suffer from issues like bruising, over-ripening, and decay. These factors lead to significant waste, especially during transportation and storage. By using CRISPR technology, scientists have been able to develop tomatoes with genes that delay ripening and reduce bruising. Gene-editing has produced tomatoes that can remain fresh for days longer than conventional varieties. Similarly, gene editing has been used to develop bananas that can endure longer transportation times without ripening prematurely. These improvements help ensure that food is less likely to be wasted along the supply chain, from farm to table.

Apples are another commonly wasted fruit, often discarded due to browning, which happens after they are cut or damaged. Browning not only makes apples visually unappealing but also accelerates the spoilage process. Through gene editing, varieties like the Arctic apple have been developed, which do not brown when cut. This simple modification has the potential to reduce waste significantly, as these apples can stay fresh longer and can be used in salads,

snacks, and processed foods without the fear of them turning brown. This approach helps reduce the waste that often arises due to aesthetic issues and improves the marketability of apples.

Improving Resistance to Pests and Diseases

Perishable goods are also highly vulnerable to pests and diseases, which can lead to significant losses in both quality and quantity. Crop diseases and insect infestations are major contributors to food waste, particularly in regions with limited access to advanced agricultural practices or pest control technologies.

Gene editing offers the potential to develop crops with enhanced resistance to pests and diseases. For example, crops could be engineered to express certain proteins that deter insect pests or inhibit the growth of harmful fungi and bacteria. This reduces the need for chemical pesticides and lowers the chances of spoilage and waste due to pest damage. Additionally, healthier crops that are less prone to disease will be able to reach the market in better condition, minimizing losses that would otherwise occur during transportation or storage.

For example, Potatoes, a staple food in many parts of the world, are highly susceptible to diseases like late blight, which can cause the crop to rot before it reaches the market. Traditional methods of pest and disease control often involve the use of chemical pesticides, which can be harmful to the environment and human health. Through gene editing, scientists have developed potatoes that are resistant to diseases like late blight. These potatoes not only grow healthier and more robust, but they also have a significantly longer shelf life, reducing waste due to spoilage and pest damage. In addition, they require fewer chemicals, making them more environmentally friendly.

Enhancing Nutritional Value and Reducing Spoilage

Gene editing can also be used to increase the nutritional value of perishable goods, which in turn helps reduce waste. Crops can be modified to have higher concentrations of vitamins, minerals, and antioxidants, ensuring that they remain beneficial even as they age. Moreover, gene editing can target the metabolic pathways that influence the degradation of nutrients over time, allowing perishable goods to retain their nutritional value for longer periods, even after being harvested.

As an example, some research is focusing on genetically modifying fruits like strawberries or spinach to retain higher levels of vitamin C or folate, even as they mature and approach spoilage. Scientists have used CRISPR technology to modify the DNA of strawberries, making them more resistant to fungal diseases and improving their resistance to physical bruising This not only extends their shelf life but also ensures that the food retains its value, reducing the motivation to discard food due to perceived loss of nutritional content.

Reducing the Environmental Footprint of Food Waste

The environmental impact of food waste is immense. Decomposing organic waste in landfills releases significant amounts of methane, a potent greenhouse gas. Additionally, the resources used to grow, process, and transport food that eventually ends up being discarded are wasted, including water, energy, and labour. By addressing the root causes of food spoilage, gene editing could reduce the environmental burden associated with food waste.

Crops that are engineered to last longer and resist pests and diseases would require less pesticide and fungicide use, which can have harmful effects on the environment. Furthermore, by reducing food waste, less land would need to be cultivated to produce the same amount of food, reducing the strain on natural ecosystems and contributing to more sustainable agricultural practices.

Consumer Acceptance and Ethical Considerations

Despite its potential, gene editing in agriculture raises a number of ethical and regulatory questions. Public perception of genetically modified organisms (GMOs) is often skeptical, especially when it comes to food products. However, gene editing differs from traditional GMOs in that it does not necessarily introduce foreign genes into the organism, but rather makes precise changes to the organism's existing DNA. This distinction could lead to greater acceptance, especially as the technology becomes more regulated and understood.

Governments and regulatory bodies are working on guidelines to ensure that gene-edited foods are safe for human consumption and the environment. As with any new technology, it will be essential to balance innovation with caution, ensuring that the benefits of gene editing are maximized while minimizing potential risks.

Conclusion

Gene editing is a promising approach for decreasing waste in perishable items by improving nutritional content, extending shelf life, and improving resistance to illnesses and pests. The food sector might significantly reduce the financial and environmental effects of food waste by utilizing these capabilities. In order to feed the world's expanding population and lessen the burden on our planet's resources, gene editing may prove to be an essential part of sustainable food production systems as technology develops and consumer acceptance increases.