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Application of Biotechnology in Agriculture

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Abstract—*Crop plants provide essential food nutrients to humans and livestock, including carbohydrates, lipids, proteins, minerals and vitamins, directly or indirectly. The level and composition of food nutrients vary significantly in different food crops. As a result, plant foods are often deficient in certain nutrient components. Relying on a single food crop as source of nutrients thus will not achieve a balanced diet and results in malnutrition and deficiency diseases, especially in the developing countries, due mainly to poverty. Agricultural biotechnology is the area of biotechnology involving applications to agriculture. Agricultural biotechnology has been practiced for a long time, as people have sought to improve agriculturally important organisms by selection and breeding. Improved crop disease protection through biotechnology provides a more reliable harvest, which keeps food consistently available and affordable for all consumers. While initial emphasis of agricultural biotechnology has been placed on input traits of crops such as herbicide tolerance, insect resistance and virus resistance, increasing effort and promising proof-of-concept products have been made in output traits including enhancing the nutritional quality of crops since 1990s.In this paper we will be discussing about the application, practical approaches and how we can improve food nutrition by applying biotechnology in agriculture.*

Keywords*: agricultural biotechnology, food nutrition, herbicide tolerance, breeding.*

1. INTRODUCTION

Plants are the primary source of food for humans and feed

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Plants are the primary source of food for humans and feed for livestock. Through domestication and agricultural activities of breeding and selection, plants were developed into food crops that serve as the major source of dietary carbohydrates, lipids, proteins, vitamins and minerals for humans and livestock. The level and composition of food nutrients vary significantly in different food crops. As a result, individual plant foods are often deficient in certain nutrient components. For example, while root and tuber crops are rich in carbohydrates, they are low in protein legumes are usually high in protein, but deficient in essential amino acids methionine; and milled rice is rich in starch but contain little essential amino acid lysine, iron, and no pro vitamin A (ß-carotene). Relying on a single food crop such as cassava or rice as major staple source of nutrients thus will not attain a nutritionally complete diet and result in malnutrition and deficiency diseases, which often occur in populations of developing countries, due mainly to poverty. Effort to improve the nutritional quality of crops by conventional breeding and selection method, in general, has not met with desired success, and even in promising cases, the improvements often associate with undesirable agronomic traits. Recent advancements in plant sciences and agricultural biotechnology offer new opportunities and possibilities to improve the yield, quality, and production economics of food crops. Although the first generation biotech crops have been dominated by input traits since their commercialization in 1996, such as herbicide tolerance, insect and virus resistance soybeans, corn and canola, interest and effort in research and development of crops with output traits including enhancement of food nutrition with output traits including enhancement of food nutrition with output traits including enhancement of food nutrition been generated, demonstrating that it is feasible to improve food nutrition.Agricultural biotechnology has been practiced for a long time, as people have sought to improve agriculturally important organisms by selection and breeding. An example of traditional agricultural biotechnology is the development of disease-resistant wheat varieties by cross-breeding different wheat types until the desired disease resistance was present in a resulting new variety.

2. COMMERCIALIZATION OF TRANSGENIC CROPS

Private companies have produced and sold virtually all transgenic seed currently in use, although agriculture is a small part of the biotechnology industry—barely 20% of U.S. firms are in the field (1). In 2005, genetically engineered varieties of maize (corn), cotton, canola, and soybean were widely planted in North America and Asia while there was minimal use of such varieties in Europe and Africa. Most transgenics have been engineered to confer a single plant trait (2–6), but multiple trait varieties comprised 20% of the total transgenic crops in 2005 (7). The global area of transgenic crops first exceeded 1 million hectares in 1996; over the next four years the area increased to over 40 million hectares, reaching 90 million hectares by 2005 (7). Only a handful of other transgenics, including papaya and squash, are commercially grown (8). Transgenic soybean, cotton, and maize adoption rates have been extremely rapid by historic standards, similar to those of the green revolution in Asia (9) and of hybrid corn in the United States (10).

3. IMPROVEMENT OF FOOD NUTRITION

Advancement in agricultural biotechnology has allowed the exploration and development of technologies to correct the deficiency and improve the nutritional quality of food crops. Increased and more stable yields provide greater quantities of food, and resistance to pests may prevent the formation of toxins that are generated when grain is damaged by insects, a problem of huge, if poorly documented, dimensions (11). The density of micronutrients, such as vitamin A and the minerals iron and zinc, can be increased through genetic approaches (12). "Golden rice," one of the highest profile applications of genetic engineering, attracts kudos from supporters (13–15) and brick bats from critics (16, 17). The opportunity for such a product to alleviate effects of Vitamin A deficiency of an estimated 400 million people (18) was one of the reasons it was identified as a high priority at an early stage of the Rockefeller Foundation's international program in rice biotechnology (19, 20). Transgenic potatoes that contain only amylopectin and devoid of amylose was first demonstrated in 1991; high lauric acid (40-50% in) canola oil produced by transgenic technology was first commercialized in 1995; and transgenic tobacco plants containing protoalkaloid tryptamine as high as 260-fold over the control plants was obtained in 1990.(21-23). Efforts to enhance the synthesis and bioavailability of other vitamins and minerals through biotechnological approaches are also active, including vitamin C, vitamin E, vitamin A, folates, pantothenate (vitamin B5), iron and zinc(24-29)

4. APPLICATIONS OFAGRICULTURAL BIOTECHNOLOGY

- Genetic engineering inserts fragments of DNA into chromosomes of cells and then uses tissue culture to regenerate the cells into a whole organism with a different genetic composition from the original cells. This is also known as rDNA technology; it produces transgenic organisms.
- Tissue culture manipulates cells, anthers, pollen grains, or other tissues; so they live for extended periods under laboratory conditions or become whole, living, growing organisms; genetically engineered cells may be converted into genetically engineered organisms through tissue culture.
- Somatic hybridization removes the cell walls of cells from different organisms and induces the direct mixing of DNA from the treated cells, which are then regenerated into whole organismsthrough tissue culture.
- Marker-aided genetic analysis studies DNA sequences to identify genes, QTLs (quantitative trait loci), and other molecular markers and to associate them with organismal functions, i.e., gene identification.
- Genomics analyzes whole genomes of species together with other biological data about the species to understand what DNA confers what traits in the organisms. Similarily, proteomics analyses the proteins in a tissue to identify the gene expression in that tissue to understand the specific function of proteins encoded by particular genes. Both, along with metabolomics (metabolites) and phenomics (phenotypes), are subcategories of bioinformatics.

5. CONCLUSION

Responsible scientists, farmers, food manufacturers, and policy makers recognize that the use of transgenic organisms should be considered very carefully to ensure that they pose no environmental and health risksor at least no more than the use of current crops and practices. Modern biotechnology represents unique applications of science that can be used for the betterment of society through development of crops with improved nutritional quality, resistance to pests and diseases, and reduced cost of production. Biotechnology, in the form of genetic engineering, is a facet of science that has the potential to provide important benefits if used carefully and ethically. Society should be provided with a balanced view of the fundamentals of biotechnology and genetic engineering, the processes used in developing transgenic organisms, the types of genetic material used, and the benefits and risks of the new technology.

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