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Recent Concepts of Transgenic Plants and Application

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ABSTRACT:
To date, the world population stands at more than 6.5 billion people, and it is expected to reach 9 billion by 2050. Food production will need to increase at the same rate or more to feed the exploding population. It is now more to one decade since the first transgenic plant was generated experimentally. During that period there have been dramatic advances in our understanding on both basic and applied aspects of plant biology. Twenty years ago, results of 1st experiment describing the successful transfer and expression of foreign genes in plant cell was published. Since then, transgenic plants have become an essential tool for studying plant biology and the development of novel plant varieties.

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I. DEFINITION

No uniformly accepted definitions of biotechnology exists, ACCORDING TO THE National Center for Agricultural Law Research and Information (NCALRI). The center provides several definitions and commentary. Under the broadest definition, the use of biological sciences to develop products-conventional plant and animal breeding techniques, conducted since the dawn of civilization-fall under biotechnology.

In the popular areas, biotechnology generally refers to newly-developed scientific methods used to create products by altering the genetic makeup of organisms and producing unique traits, that are not easily obtained through conventional breeding technique. These products are often referred to as transgenic, bioengineered, or genetically modified because they contain foreign genetic materials.

COMMERCIAL TRANSGENIC CROPS

The transgenic crops commercially released as a product, insect tolerance, disease resistance, herbicide resistance and pharmaceutical compounds.

II. PRODUCTS DEVELOPED

It is essential to conserve quality properties during transport and storage to ensure successful marketing. The main problem is fruit softening results from ripening process. Using plant antisense technology it has been possible to delay ripening by decreasing the expression of genes important in this process, such as those involved in cell wall degradation or the biosynthesis of ethylene. To date, tomatoes have been modified for slower ripening and higher solid content and commercialized by three different companies. The strategy has an enormous potential for tropical fruits such as mango and papaya, grown in many developing countries.

The major source of protein for a large portion of human population are cereal grain and legume seeds. However, a characteristic of these seeds is a deficiency of lysine in cereals and cystine and methionine in legumes. An alternative is to change the seed protein composition of certain crops.

Efforts in this direction include the production of methionine rich proteins in transgenic tobacco crops and canola seeds, which results in an increase of up to 33% in methionine.

A 100 fold increase in free lysine in soybean and canola was possible by modifying the regulatory properties of enzymes involve in synthesis of this essential amino acids.

Potato, the most important vegetable food crop was transformed with a gene from amaranth, that encodes a seed-specific nonallergenic protein (AmA1), with a balanced amino acid composition that promises to improve the nutritional value of this food source. Recently, the Indian government has authorized the cultivation of these transgenic potatoes to help alleviate the serious malnutrition problems in our country.

Vitamin-A deficiency is a very important nutritional problems in many countries, especially in Asia, where 124 million children suffer from blindness caused by deficiency of Vitamin A. as a potential solution to this problem, a strategy has been developed to produce Vitamin A in rice. Rice does not normally produce Vitamin A, but the genes encoding the three enzymes for Gcarotene (pro-vitamin A) biosynthesis that are absent in rice were specially expressed in the endosperm of transgenic rice seeds. Consumption of transgenic so-called “Golden rice” could help alleviate vitamin A deficiency in this region.

Although coffee has no nutritive function in the human diet, it does have an important social and psychological role as it accompanies various social events and is part of the daily habits of many individuals. The consumption of caffeine, however, can adversely affect sensitive individuals by producing insomnia and increasing blood pressure, among other effects. With this in mind, in plants of *Coffea canephora* the gene encoding theobromine synthase, anenzyme involved in the synthesis of caffeine, was inhibited using RNA interference. The caffeine content of these plants was reduced up to 70%, indicating that it would be possible to produce naturally "decaffeinated" coffee seeds. (Table 1)

Table 1. List of genes used for transgenic crops

Sl. No.	Gene	Gene source	Product
Trait: 2,4-D herbicide tolerance			
1	aad-1	*Sphingobium herbicidovorans*	Aryloxyalkanoate dioxygenase 1 (AAD-1) protein
2	aad-12	*Delftia acidovorans*	Aryloxyalkanoate dioxygenase 12 (AAD-12) protein
Trait: Altered lignin production			
3	ccomt	*Medicago sativa* (alfalfa)	dsRNA that suppresses endogenous S-adenosyl-Lmethionine: trans-caffeocyl CoA 3-O-methyltransferase (CCOMT gene) RNA transcript levels via the RNA interference (RNAi) pathway
Trait: Anti-allergy			
4	7crp	Synthetic form of tolerogenic protein from *Cryptomeria japonica*	Modified cry j 1 and cry j 2 pollen antigens containing seven major human T cell epitopes
Trait: Antibiotic resistance			
5	aad	*Escherichia coli*	3"(9)-O-aminoglycoside adenylyl transferase enzyme
6	aph4(hpt)	*Escherichia coli*	Hygromycin-B phosphor transferase (hph) enzyme
7	bla	*Escherichia coli*	Beta lactamase enzyme
8	spc	*Escherichia coli*	Spectinomycin adenyl transferase enzyme (not expressed in plant tissue)
Trait: Coleopteran insect resistance			
9	Cry34 Ab1	*Bacillus thuringiensis* strain PS149B1	Cry34Ab1 delta-endotoxin
10	Cry35 Ab1	*Bacillus thuringiensis* strain PS149B1	Cry35Ab1 delta-endotoxin
11	Cry3A	*Bacillus thuringiensis* subsp. tenebrionis	Cry3A delta-endotoxin
12	Mcry3A	Synthetic form of cry3A	Modified Cry35Ab1 delta-endotoxin
Trait: Delayed fruit softening			
13	acc	*Lycopersicon esculentum*	Modified transcript of 1amino-cyclopropane-1carboxylic acid(ACC) synthase gene
14	accd	*Pseudomonas chlororaphis*	1amino-cyclopropane-1carboxylic acid deaminase enzyme
15	Anti-efe	*Lycopersicon esculentum*	Antisense RNA of 1-amino-cyclopropane-1carboxylate oxidase (ACO) gene
16	Sam-k	Bacteriophage T3	S-adenosylmethionine hydrolase enzyme
Trait: Dicamba herbicide tolerance			
17	dmo	*Stenotrophomonas mltophilia* strain DI-6	Dicamba mono-oxygenase enzyme
Trait: Drought stress tolerance			
18	Csp B	*Bacillus subtilis*	Cold shock protein B
Trait: Visual marker			
19	uidA	*Echerichia coli*	Beta-D-glucuronidase (GUS) enzyme
20	dsRed2	*Discosomasp*	Red fluorescent protein
Trait: Volumetric wood increase			
21	cell	*Arabidopsis thaliana*	CELL1 recombinant protein
Trait: Viral disease resistance			
22	ac1	Bean Golden Mosaic Virus (BGMV)	Sense and antisense RNA of viral replication protein (Rep)
23	Cmv cp	Cucumber mosaic Cucumo virus (CMV)	Coat protein of cucumber mosaic cucumo virus
24	ppvcp	Plum pox virus (PPV)	Coat protein of plum pox virus
25	Zymv-cp	Zucchini Yellow Mosaic Potyvirus (ZYMV)	Coat protein of ZYMV
Trait: Multiple insect resistance			
26	API	*Sagittaria sagittifolia (arrowhead)*	Arrowhead protease inhibitor protein A or B
Trait: Modified starch/carbohydrate			
27	pR1	*Solanum tuberosum*	Double stranded RNA
Trait: Male sterility			
28	dam	*Escherichia coli*	DNA adenine methylase enzyme

Trait: Lepidopteran insect resistance			
29	Cry1F	*Bacillus thuringiensis var. aizawai*	Cry1F delta-endotoxin

III. DISEASE RESISTANCE

Tobacco mosaic virus (TMV) causes the leaves of some important plants to wither and die. Incorporation into the plant of a gene that encodes the coat protein of the virus protects it from disease (Clark *et al.* 1995). More progress in development of disease resistance transgenic plant will be seen in the near future. Over the past decade, many efforts were focused on understanding plant-pathogen interactions in molecular terms. This led to the identification of disease resistant plant genes that specify race-specific resistance to pathogens.

Insect Tolerance

Several varieties of cotton and tobacco have been developed utilizing a gene from the bacterium *Bacillus thuringiensis* toproduce a protein (Bt protein) that is specially toxic to certain insect pest including bollworm, but not to animal. This protein has been used as a pesticide spray for many years. Cultivation of plants should reduce the use of chemical pesticide in cotton production, as well as in the production of many other crops, which could be engineered to contain the *Bacillus thuringiensis* gene.

Herbicide Tolerance

Herbicide tolerance in transgenic plants has been accomplished exploiting at least three different mechanisms: Overexpression of target enzymes, modification of target enzymes, and herbicide detoxification.

[1]. REFERENCE:

[2]. Kumar A. (2015) Cloning: A vital tool for production Transgenics. *Clon Transgen*., 4:119-126

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