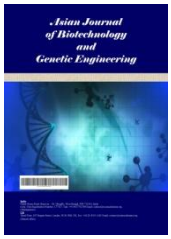

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# GEMS, GMOS and Third Generation Transgenic Plants: Biofactories

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***Author's contribution***

*The sole author designed, analyzed, interpreted and prepared the manuscript.*

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## ABSTRACT

Microorganisms have been used to assist in the processing of food throughout human history, long before humans realized that these organisms were responsible for the fermentation processes. Alterations are prepared to the genetic makeup of microorganisms to either produce a new protein or other food ingredient, to progress /enhance the production of a present protein/ingredient, or to tailor the characteristics of an existing protein to a new application. Numerous procedures are utilized to roll out hereditary improvements in a microorganism, and the term Genetically Engineered Microorganisms (GEMs) explicitly alludes to microorganisms (i.e., microscopic organisms or growths, including yeasts) that people have altered utilizing in vitro atomic science strategies (otherwise known as Modern Biotechnology) to play out a particular capacity. There are several other methods for altering the genetic structure of microorganisms, but not all of them come under the regulatory categories of genetically engineered or genetically modified. Chemical mutagenesis and interspecies crossing, for example, can be used to change the genetic makeup of a microorganism. GEMs are advancing food production by increasing efficiency, reducing waste and resource requirements, and ultimately enabling beneficial innovations such as the cost-effective fortification of food with essential nutrients, vitamins, and amino acids, and delivery of tailored enzymes to achieve unique food processing capabilities.

*Keywords: GMOs; GEMS;Transgenic Plants; Biofactories.*

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## 1. INTRODUCTION

Microorganisms have been used to assist in the processing of food throughout human history, long before humans realized that these organisms were responsible for the fermentation processes [1]. For thousands of years, microorganisms have been important in the production of foods such as beer, yoghurt, kefir, cheese, soy sauce, wine, vinegar, and many others, primarily through the production of endogenous enzymes. Following the discovery of the microorganisms responsible in the 1830s [2] food producers started looking for ways to improve the efficiency of these microorganisms. Although it took thousands of years for humans to discover the microorganisms responsible for the life of many foods, it only took about a hundred years (and the discovery of DNA) for humans to start using techniques to optimize the use of microorganisms, including genetic engineering to make food production with microorganisms more effective.

Alterations are prepared to the genetic makeup of microorganisms to either produce a new protein or other food ingredient, to progress/enhance the production of apresent protein/ingredient, or to tailor the characteristics of an existing protein to a new application. Numerous procedures are utilized to roll out hereditary improvements in a microorganism, and the term Genetically Engineered Microorganisms (GEMs) explicitly alludes to microorganisms (i.e., microscopic organisms or growths, including yeasts) that people have altered utilizing in vitro atomic science strategies (otherwise known as Modern Biotechnology) to play out a particular capacity. There are several other methods for altering the genetic structure of microorganisms, but not all of them come under the regulatory categories of genetically engineered or genetically modified. Chemical mutagenesis and interspecies crossing, for example, can be used to change the genetic makeup of a microorganism [3].

GEMs have become widely used in the production of medical and food substances as a result of extraordinary achievements in biochemistry and molecular biology over the last several decades, particularly as these processes are increasingly recognized as environmentally sustainable, animal-friendly, and cost-effective methods of production. Insulin, for example, is now formed in bacteria rather than pigs' pancreas, which was the initial source of insulin. Similarly, microbially developed trypsin and chymosin are available as an alternative to trypsin and rennet derived from pigs and cows. GEM processing has advantages that go beyond simply replacing animal-based processes. For example, as compared to conventional agricultural production of plant-based substances like stevia extracts and vanilla, GEM-based production of steviol glycosides [4] and vanillin (Brochado et al. 2010) has a number of sustainability advantages, including reduced land use, pro-environmental benefits, and cost savings.

The processing of riboflavin, which began in the 1990s and continues today, is an excellent example of GEM adoption as a food ingredient production process. Nearly 100% of commercially processed riboflavin is manufactured using a GEM (Schwechheimer et al. 2016). Vitamins, amino acids, and functional proteins (e.g., texturants) are some of the other food ingredients provided by GEMs today. (Adrio and Demain 2010).

Another area where GEMs have found wide application is in the production of food enzymes (Hanlon & Sewalt, 2020). Food enzymes are widely used in the food industry to perform a variety of technical functions, including reducing lactose content in foods (lactase), dough strengthening or starch modification in baking (amylases), vegetable oil refining (phospholipase), and coffee processing (mannanase), fruit- and vegetable processing (pectin esterase), conversion of starches into sugars and specialty products (carbohydrases such as amylase, glucoamylase, and transglucosidase), and hydrolysis of proteins (protease). Last but not least, instead of extracting the enzyme from calf stomachs, cheese can be made with chymosin (the active milk protein coagulating enzyme in rennet) generated with GEMs.

Enzymes are proteins that have catalytic functions that can be leveraged in food processing. The microorganism produces the enzyme from a sequence of amino acid building blocks that define its properties including its catalytic function. Several methods of genetic modification of microorganisms are used to allow enzyme production, increase the yield of enzyme production, and to tailor enzyme functionality and stability via protein engineering if the application conditions (e.g., pH, temperature) differ from the natural conditions under which the source organism evolved.

GEMs used to manufacture food substances (ingredients or enzymes) are known as processing aids in certain regulatory systems as long as the organism is not visible in the food material, which is the case in the examples above. While GEMs could also be incorporated as intact, live organisms into foods such as yogurt, kefir, or kombucha, this use falls outside of the scope of this paper.

## 2. GLOBAL PRODUCTION STATUS OF GM CROPS

According to ISAAA briefs (James 2015), global production status of genetically modified crops increased 100-fold from 1.7 to 179.7 million ha (1996–2015) [5] Following that, the commercialization of GM crops skyrocketed at an unprecedented pace in the history of modern agriculture (James 2015). With 70.9 million ha (39%), the United States is currently the world's largest producer of GM crops, with maize, soybeans, and cotton accounting for 90% of the total. Brazil is the second largest with 44.2 million ha (25% of the total global production) and planted stacked events (HT/IR) on a record 11.9 million ha. Argentina is the world's third leading producer with 24.3 million ha. India has ranked fourth with 11.6 million ha of Bt cotton and has registered phenomenal growth in cotton production and topped the world with 95% resilient adoption rate [5]. Canada has ranked fifth with 11.0 million ha. Hence, the five major global GM crops are soybean, cotton, maize, and canola. In 2015, 82% (90.7 of 111 million ha) of the soybean planted were GM soybean strains, whereas GM cotton accounted for 68% (25.1 of 37 million ha) of global cotton production [5]. Globally, 55.2 million hectares (30 percent) of the 184 million hectares of maize planted were GM maize. Furthermore, in 2015, herbicide-tolerant GM canola accounted for 25% of global planting (9 million ha) (James 2015). The annual total for these four crops was 368 million ha, with GM crops accounting for 181.5 million ha (49%) of the total. According to a recent survey, the agronomic and economic benefits of GM crops are significant, as these benefits are dependent on the modified trait and geographical area (Kamle, Kumar, Patra, & Bajpai, 2017). High-yielding insect-resistant (IR) and herbicide-tolerant (HR) crops are greatly adopted by developing countries. Recently, genetically modified potato (Innate™) generation I with multi-trait resistance to black-spot bruising and browning was developed using RNA interference technology (Simplot Company) and successfully commercialized in 160 ha in the USA [5]. After that, InnateTM II was accepted with a disease resistance trait for late blight of potato. In terms of genetically modified animals, the FDA granted landmark approval of the first GM salmon for commercial food processing and human use in 2012. By 2018, the goods are expected to be available in the United States [1].

## 3. COMMON METHODS FOR MODIFYING THE GENETIC MAKEUP OF MICROORGANISMS

Various strains of microbes are used in the manufacturing of food elements by means of the process defined above. The microbes used in this process generally must be altered unless they already prompt all the features necessary to yield the anticipated food substance frugally, at scale. The usage of original microorganisms is most common in outdated food practices such as those microbes used in the salable manufacture of bread, mauve and cocktail, and yogurt, and is occasionally still used currently in the manufacture of some food enzymes. Though, genetic variation of the microbe is often desired to yield a desired ingredient altogether (e.g., if the source entity that naturally yields the substance of concern cannot be cultured at scale), or genetic alteration can be used to increase the effectiveness and decrease cost of synthesyzing an endogenous enzyme or extra food material. The following section deliberates four procedures that can be used to genetically alter microbes to produce foodstuffs.

### 3.1 Non-targeted Mutagenesis

Until the arrival of Contemporary Biotechnology, microbes were genetically altered for many decades by smearing selection pressure or haphazard mutagenesis tempted by chemicals or UV irradiation. Alteration methods based on classical mutagenesis and assortment are non-targeted as they present haphazard DNA changes, tracked by an wide screening exertion to select the microbes for augmented manufacture of a specific enzyme or for a anticipated phenotypic trait. The final genetic make-up of microorganisms produced with haphazard mutagenesis cannot be forecast earlier, and even today's accessible high-throughput DNA sequencing does not always deliver full lucidity of all the DNA vicissitudes or their penalties [6].

Altogether, the usefulness of this approach today is incomplete to adapting traits for which the

genetic basis is not well-understood and sustained advances in molecular biology will likely lead to it being mainly substituted with more precise methods of introducing genetic modifications via Modern Biotechnology techniques. However, random mutagenesis followed by repeated testing has been the basis for development of several robust, well characterized and safe microbial production platforms (so-called Safe Strain Lineages) for expression of new traits by genetic engineering (see below), such as *Bacillus subtilis* (US FDA [6] *B. licheniformis* [6] and *Trichodermareesei* (US FDA 2018b).

### 3.2 Genetic Engineering/ Bioengineering/ Genome Editing

Today, the primary mechanism for creating GEMs to produce food substances is through in vitro nucleic acid techniques, including the insertion of genes via recombinant DNA or related techniques into a selected, robust and safe microorganism that impart enhanced or new functionality to that organism. The resulting microorganism is said to be genetically engineered, a term differentiated from 'genetic modification' by the United States National Research Council [7], and adopted in the vocabulary of various United States and Canadian regulatory guidance documents.

With genetic engineering, scientists begin by selecting or developing a robust, productive host microorganism that is known to be safe (not pathogenic and does not produce toxins). Once a suitable expression host has been selected/developed, molecular techniques are used to insert or delete one or more DNA sequence(s) into the genome of the microorganism that enhance existing or impart new functionality to that organism. Examples of the kinds of new or enhanced functionality include: production of an enzyme or other functional protein that is meant to be harvested from the microorganism for use in food production (e.g. α-amylase, lipase, protease, ice structure protein, leghemoglobin), production of enzymes that help the microorganism itself produce another food ingredient (e.g. riboflavin, steviol glycoside, or oligosaccharide), or additional modifications such as the deletion of endogenous genes or insertion of transporters aimed at making the microorganism a more effective production platform. Included with the DNA sequences that enable the expression of new or enhanced functionality are sequences that encode elements (e.g. promoter and terminator sequences) that help control the expression of functional genes in the microorganism. Although DNA sequences may be randomly inserted into the genome of the microorganism, often these sequences are intentionally inserted into specific points (called 'loci') of the microorganisms' genome. Regardless, the insertion site can later be confirmed through sequencing of the entire genome.

The source of the DNA that is expressed by the genetically engineered microorganism can be endogenous, from the same organism (e.g., to produce more of an existing enzyme), or exogenous, from a different organism. When the DNA is sourced exogenously from a closely related microorganism capable of natural DNA exchange (often within the same genus). This process is also referred to as 'self-cloning' by some regulatory frameworks. However, the source of the exogenous DNA is frequently another, more distant microorganism that cannot be grown efficiently under industrial conditions. It is through the creation of the new, bioengineered organism where the sum of the inserted sequences reaches its full potential to become a microorganism capable of producing the desired food substances at a commercial scale [1].As such, the term 'bioengineering' is a more narrowly defined term to indicate genetic engineering or genome editing steps that result in a modified organism that does not exist in nature or could not have been produced by traditional breeding and selection. When applied to food, the term 'bioengineered' is a regulatory term that determines consumer labeling requirements.

Whereas initially DNA was isolated from one microorganism, then amplified and transferred into another microorganism, today, synthetic DNA sequences created through other molecular biology techniques can be inserted into microorganisms to impart functionality. The use of synthetic DNA (rather than DNA physically isolated from another microorganism) allows for very fast development of genetically engineered microbes producing many variant enzyme proteins that can be tested in the target application. Moreover, the use of synthetic DNA completely avoids the inadvertent introduction of unintentional sequences such as DNA cloning remnants including even pathogens. The use of synthetic DNA allows molecular biologists to limit the transfer to just the beneficial gene sequence

of interest, without ever being in contact with the pathogen and avoiding the transfer of sequences that could encode for pathogenicity. The safety considerations of one such example of a sequence originating from a potential pathogen are detailed by [1] for an α-amylase sequence from *Cytophaga* sp., safely expressed in *Bacillus licheniformis,* and notified to FDA for use in carbohydrate processing [8].

### 3.3 Protein Engineering

Protein engineering is often applied to optimize functionality of enzymes (or other proteins). This may target increased catalytic activity, but more often is employed to tailor the enzyme to function more effectively under the application conditions that may involve temperature, pH, or salt concentrations well outside the optimum range for the enzyme. For example, baking amylases can be engineered to withstand the high oven temperature longer, such that the same number of catalytic reactions can be achieved with a lower initial enzyme concentration before the enzyme is inactivated in the baking process.

Starting from an endogenous, wild-type enzyme, effective protein engineering often involves the generation of multiple variants by genetic engineering of the production organism (especially when expression levels need to increase as well) or, alternatively, gene editing (to merely test the impact of specific amino acid changes of an endogenous protein). These multiple variants are then tested in the application to produce multiple 'hits' with improved characteristics, sometimes followed by combining those hits in successive generations to maximize the improvement. A final selected variant enzyme protein may differ from the wild-type sequence in one amino acid or multiple amino acids.

### 3.4 Gene and Genome Editing

CRISPR is considered the most recent technique for gene editing. CRISPR is a factious technology that provide precise cutting and pasting of DNA by using specialized proteins—upon inspiration by nature and engineered by researchers. There are three varieties for gene editing of proteins: zinc fingers, TALENs, and CRISPR-Cas. CRISPR-Cas has an appropriate design and simple cell delivery system and now used to treat various genetic diseases, help in growth of climate-resilient crops, and produced designer materials, foods, and drugs. CRISPR stands for Clustered Regularly Interspaced Palindromic Repeats, chunks of regularly recurring bits of DNA produced in certain bacteria against viral invasions as a defense system [9]. CRISPR-Cas is a complex of enzymes (Cas proteins) and genetic guides (CRISPR sequences) that together finds and then edits DNA.

Scientists improved this CRISPR-Cas system by designing a sequences of guide RNA that can identify a specific DNA code in living cell, highlight the genetic defect or an abominable trait, and excise base pairs from that DNA code. Replacement of nucleic acids can be inserted into the exact location where main target is to modify the sequence or introducing a new desired gene instead of deleting the gene function. The researcher at Howard Hughes Medical Institute described the biotechnology application in microbes in 2012 [10]. The way of gene function deletion, restoration or modification is called gene editing. Genome editing is the insertion of new DNA sequences into the genome by CRISPR-Cas.

## 4. CURRENT USE OF GENETICALLY MODIFIED ORGANISMS

Agricultural plants are considered as the good examples of genetically modified organisms (GMOs). Genetic engineering provides the various benefits in agriculture as crop yields increased, cost reduction in food or drug production, reduction in pesticides usage, improvement in nutrient and food quality, provide resistance against pests and disease, high food security and other medical advantage to the world's population. Improvement also made in making crops that mature rapidly and tolerate various condition like aluminum, boron, salt, drought, frost, and other environmental stress, made plants able to grow in environment where they might not otherwise flourish [11]. It also has other applications in the production of non-protein (bioplastic) or nonindustrial (ornamental plant) products. Genetic engineering also played good role in the animals engineering to increase yield level and decrease vulnerability of disease. For example, salmon engineered to grow larger and mature rapidly than previous, cattle become almost resistance to disease like mad cow [12]. The GMOs also played a good valuable role in pharmaceutical industry. In 1986, first protein for human growth hormone was formed in plants (Barta *et al*., 1986). In 1989, the first antibody was developed [4].

The researcher used tobacco for the expression of foreign genes in plant [13]. As of 2003, several other antibodies types produced in plants had made it available to clinical trials. Genetically modified animals also have incredible role in medical research. Transgenic animals are reproduced for observing mutations in human gene, and make it enable to find the progression and genetic determinants of different diseases.

## 5. POTENTIAL GMO APPLICATIONS

Many industries decided to get benefits from GMO research. As in future there is a number of microorganisms will play a vital role as clean fuel producers and biodegradable ability. The genetically modified plants may also use for the production of recombinant vaccines.The development of plant and fruits based oral vaccine may have played a vital role against the disease and the cost of vaccination campaign especially in developing country.There is working also observed on the development of the plant based vaccine against the hepatitis B virus, Norwalk like virus and Enterotoxigenic *Escherichia coli* in potatoes and lettuce.Scientist also planning to make valuable protein like silk protein and polymer that may play good role in medical facilities like surgery and tissue replacement for commercial purpose. Xenotransplantation concept also observed due to the production of human transplant tissue and organ in genetically modified animal. Despite of many advantage of GMOs to human there is also need to think about the potential risk observed due to usage of these organism.

### 5.1 GMOs in Agriculture

In United States in 1994, genetically modified (GM) foods were approved for human usage. And in 2014–15 almost 90 % of the corn, cotton, and soybeans produced in US by GM.

GM crops in the end of 2014, covered almost 1.8 million square kilometers of worldwide. The major part of GM crops was produced in the Americas.Engineered crops may increase the crop yields and make minimum usage of chemical insecticides.

For example, the usage of insecticides in different crop like potatoes, cotton, and corn declined, that were treated with a gene from the *Bacillus thuringiensis*bacterium due to the naturally production of insecticide called Bt toxin. According to studies in India, the comparison of Bt cotton with non-Bt cotton illustrated a 30–80% high yield from the GM crop.This increase was due to improvement in the ability of GM plants' to combat with bollworm infestation, that was otherwise commonly observed. Studies shown that in Arizona, U.S. Bt cotton production get a small gains in yield—about 5% with almost cost reduction of $25–$65 (USD) per acre due to the decreased pesticide usage. In China the farmers successfully gained first access to Bt cotton in 1997. Farmers who experimented to plant Bt cotton decrease the pesticide usage by 50–80 % and increased earning to 36 percent. In 2004, farmers observed that the production of Bt cotton many years attacked by populations of secondary insect pests, such as mirids that destroy the benefits gained without the use of pesticide. Farmers need to think about the spray broad-spectrum pesticides through all the season, that decrease the advantage to Bt growers 8 % that was lower than growing conventional cotton.

Now the Bt resistance evolved in both cotton bollworm (*Helicoverpaarmigera*) and the pink bollworm (*Pectinophoragossypiella*).

### 5.2 GMOs in Medicine and Research

GMOs have appeared as one of the strengths of biomedical research since the 1980s. As GM animal model used for genetic diseases of human allowed scientist to perform studies on the new therapies for the developing a modifiers and risk factors against a specific disease.Genetic modified microbes, plants and animals also developed the production of complex pharmaceuticals by giving cost effective and safer vaccine and other therapies.Pharmaceutical products include the recombinant hepatitis B vaccine obtained from GM baker's yeast , injectable insulin (for diabetics purpose ) developed from Genetic modified *E. coli* ,factor VIII (for hemophiliacs) and tissue plasminogen activator (for heart patients) are produced in GM mammalian cells that was obtained by growing in laboratory culture.

Furthermore, Now the working is observed for producing "edible vaccines" from GM plants. The "Edible vaccine" is actually a antigenic protein that is formed in the edible part of the plant (Fruit) and enter in the human blood stream upon fruit consumption. As protein is absorbed, stimulation for antibodies production is started against antigen of respective pathogen. These

types of vaccine are conferring many advantages like safe usage, cost effective, pain free especially in developing countries in which the vaccine storage at refrigerated temperature and sterile needle for injecting vaccine become a major issue in vaccine campaign. The novel DNA vaccines may provide a valuable alternative to conventional vaccine for treating HIV/AIDS, tuberculosis and cancer.

### 5.3 Role of GMOs in Environmental Management

GMO may also play a vital role for resolving the environmental issues.For example, biodegradable plastics production from laboratory grown microbes become a large scale helper of plastics industry. In 1990, British company, biodegradable plastic produced from the microbe called Biopol (polyhydroxyalkanoate, or PHA).

The plastic were made by using the GM bacterium, *Ralstoniaeutropha*, that utilize glucose and various organic acids into a flexible polymer that ultimately lead to biodegradable plastic.GMOsbacteria also have ability to metabolize oil and heavy metals to provide help in the bioremediation strategies.

## 6. THIRD GENERATION OF GM PLANTS: BIOFACTORIES

### 6.1 The Third Generation of Transgenic Plants: Molecular Farming

Crops engineered to be used as biofactories or living reactors for the production of pharmaceuticals and industrial chemicals represent the “third generation” of transgenic plants. The use of plants for this so-called “molecular farming” has several advantages, as compared to other production systems based on bacterial, yeast or mammalian cell cultures: i) production systems are easily established and maintained, at a relatively low cost, since they are based on common agricultural techniques. ii) production can be easily and cheaply scaled up or down to adapt rapidly to market requirements (which is not the case for reactor-based production in cell cultures). iii) synthesis of the recombinant protein in the plant can be directed to specific organs (e.g., seeds, tubers), facilitating its stable storage, transport and distribution. iv) specific expression methods can be developed to facilitate purification of the protein (i.e., in oil bodies as an oleosin fusion protein), but for some applications, such as edible vaccines, purification is not even necessary. v) The protein is generally produced in a bioactive form, including correct post-translational modifications, contrary to bacterial cultures. vi)There is no risk of contamination with human pathogenic agents (animal viruses, prions, etc.) as could be the case in animal cell culture systems. Since 1991, only in the USA, perhaps more than 200 applications have been approved to grow genetically engineered pharma/industrial crops. Some transgenic plant lines, which produce compounds for specific industrial applications, are already commercialised, and many more are at different stages of development in biotechnology companies, research institutes and universities. In the following paragraphs, we will refer to just a few representative examples.

### 6.2 Pharmaceutical Uses

So far, no substance produced in transgenic plants has been approved as pharmaceutical, although several are reportedly in clinical trials. At present, many crops are being developed to produce drugs or biologics for the diagnosis, treatment, or prevention of diseases in human and animals. These include enzymes, hormones, anticoagulant factors, vaccines, and monoclonal antibodies targeted at a variety of disease, such as cystic fibrosis or non-Hodgkin’s lymphoma [14]. For example, Apo AI, the major lipoprotein associated with HDL (“good cholesterol”), which naturally removes plaque from arteries, is being developed as a drug for prevention and treatment of cardiovascular disease; the recombinant protein has been produced in safflower by SemBioSys Genetics Inc. (Canada) and proved to be functional in mice; this company has also produced human insulin in the same crop, and has initiated a toxicology study in animals (Oram & Heinecke, 2005). ProtalixBiotherapeutics (Israel) is producing active and functional recombinant glucocerebrosidase in a transgenic carrot cell suspension culture, and has already completed phase I clinical trials of the drug (Oram & Heinecke, 2005); this enzyme is used for the treatment of Gaucher’s disease (a lysosomal storage disorder). Probably the first “medical food” to reach the market, at the end of 2008, will be Ventria Bioscience’s rice, genetically modified to produce two human milk proteins which are thought to help children to recover from diarrhoea; the rice is processed into a powder to make oral rehydration solutions [15].

### 6.3 Industrial Uses

Industrial, non-food uses of GE crops include the synthesis of a very wide array of products such as industrial enzymes (e.g., trypsin, used in detergents and for tanning leather or laccase, used in the detergent and paper industries), several proteins commercialised for experimental research purposes (avidin, β-glucuronidase, aprotinin, trypsin, lysozyme, etc.), or biodegradable plastics [polyesters of 3-hydroxyacids, for example polyhydroxybutyrate (PHB)]. Other approach relays on metabolic engineering to modify some specific properties of the crop and adapt it as a more convenient raw material for particular industrial processes. For example, soybean oil, apart from their food applications and its direct use as lubricant or industrial oil, is also a renewable raw material for a wide variety of industrial products, including inks, plasticizers, and paints; the range of its potential applications would be expanded by altering, through genetic engineering, the fatty acid composition of the oil [16]. On the other hand, transgenic trees with reduced lignin content (by inhibition of enzymes involved in lignin synthesis, such as cinnamyl alcohol dehydrogenase) are very convenient for the paper industry, reducing the high costs of the separation of lignin from the cellulose fibers during pulping, a highly energy-consuming process [17]. Modification of cotton fibers for clothing could include the synthesis of pigment compounds or plastics (PHB) in the lumen of the cotton fiber, to obviate the need for the dying of cotton, or to obtain fibers containing a plastic core with improved thermal properties, respectively [17].

### 6.4 Biofuels

Crops can also be genetically engineered to facilitate biofuel production. For example, expression of α-amylase in maize helps to degrade starch to mono and disaccharides, the starting material for ethanol production through alcoholic fermentation by yeast. However, as the present international food crisis clearly shows, it is not a good idea to make fuel out of food. In addition, all agricultural land available will be necessary for food production, to feed a still growing human population, and should not be switched to biofuel production. Now that fructose-rich syrups obtained from maize have substituted sucrose as industrial sweeteners, an interesting alternative would be to use sugar cane (there is overproduction of it in Brazil) and sugar beet for the direct production of bioethanol. In the latter case, development of transgenic, stress-resistant (e.g., draught and salt tolerant) varieties would allow to grow sugar beet in marginal soils, not used at present for agriculture.

## 7. CONCLUSION AND FUTURE PROSPECTS

The enlarged yields and improved nutritional value, distinctive traits of the 1$^{st}$ and 2$^{nd}$ generations of genetic engineering plants, may possibly not be high attention for customers in urbanized countries, but also are very significant for civilizing living circumstances in numerous developing countries. Nevertheless, in our estimation, these deprived countries supposed to not be only a resource of benefit for large translational companies advertising them their seeds or migrating them their original technology. Agricultural biotechnology depend on Genetic modification plants is comparatively easy and do not need extremely complicated infrastructure; it can be recognized and develop in-situ in 3$^{rd}$ World countries, and practical to their narrow customary yields to resolve their precise troubles, with the assist of government, worldwide bodies (UN, FAO) and not beneficial organization. To keep away from reliance on original methodology and the sum of IPR , the apparatus to be engaged for this job (gene, promoter, and transformation vector) be supposed to develop or finance by the above mention communal and non-beneficial organizations, and provide freely to the concerned developing countries.

## DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

## COMPETING INTERESTS

Author has declared that no competing interests exist.

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