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A CONCEPTUAL REVIEW ON GENETICALLY MODIFIED FOODS

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ABSTRACT

As the benefits for both food producers and consumers are accompanied with potential biomedical hazards and unfavorable environmental consequences, the phrase "genetic modified organisms" (GMO) has proven to be a contentious subject. Growing public worries over GMO, notably in the form of genetically modified (GM) foods, are focused on potential short- and long-term health issues brought on by this cutting-edge science. Independently conducted sophisticated studies are being done all around the world to assess the benefits and drawbacks of GM foods. In this essay, we make an effort to condense the most recent information on the advantages and potential drawbacks of GM food. Additionally, we discuss some recent scientific advancements in GM foods and their effects on the industry.

KEYWORDS: Genetic modified (GM) food, Transgenic Safety etc.

INTRODUCTION

The entire crop of genetically modified wheat was destroyed in July 2011 when a group of protesters from the non-governmental environmental organization Greenpeace broke into an experimental farm run by the Commonwealth Scientific and Industrial Research Organization (CSIRO), an Australian federal government agency for scientific research. In August 2013, anti-GMO (Genetically Modified Organisms) demonstrators destroyed a Golden Rice research field run by the International Rice Research Institute (IRRI) of the Philippine Government and other public sector partners. Due to its altered genetic characteristics, "Golden Rice" expresses large quantities of beta-carotene (a precursor to vitamin A). Golden Rice, a low-cost and efficient means of providing underdeveloped nations with a nutritional supply of vitamin A, was developed after 25 years of bench-work in the lab.[1]

The 2013 event sparked a strong criticism by the scientific community, yet that reaction failed to win support from the general public despite similarities and differences to the 2011 CSIRO break-in. The main cause of the failure is the ongoing dearth of a thorough grasp of the nature of GMOs and present agricultural issues. Starting with the history of GMO, this overview discusses the reasons for GMO (including GM foods), its advantages and disadvantages, as well as the effects of contemporary technological advancements on GMO/GM foods.[2]

Genetic engineering is a biological process that modifies the genetic code of all types of living organisms. According to WHO (World Health Organization), a GMO is a: organisms (plants, animals, or microorganisms) in which the genetic material (DNA) has undergone a change that does not happen spontaneously through mating and/or natural recombination. By using selective breeding, which has been used for millennia to enhance the genetic stock of plants and animals, the definition aims to distinguish between the direct manipulation of genetic material and that method. Genes from one creature can be transferred into another, often unrelated, organism using DNA recombinant technology.

Oliver noted that the aforementioned definitions are a little faulty, using Triticale as an illustration. The grain triticale is frequently used to make pasta and bread. Wheat and rye were crossed to create it in the nineteenth century (a conventional, selective breeding approach). However, the resultant hybrid is sterile, and in the 1930s, the viable polyploid embryo cells were produced using the chemical colchicine. Even though the genetic change is rather simple by current molecular biological standards, triticale would seem to clearly satisfy the criteria of a GMO. Oliver proposes "biotechnologically modified organism" as a better term to describe GMO.[3]

Genetic material transfer between species was first identified by scientists in 1944, which is when DNA modification technology first emerged[4]. The field of molecular biology as we know it today was founded on a number of seminal studies. The "central dogma," which states that DNA gets translated into messenger RNA and then into proteins, was established when Watson and Crick identified the double helix structure of DNA in 1954. By 1963, scientists including Nobel Laureate Marshall Nirenberg had cracked the genetic code. DNA recombination technique was created in 1973 by Cohen et al., demonstrating the ability to transfer genetically modified DNA molecules between different species.[5]

The ideas of Charles Darwin on species variety and selection are where the history really starts. Table 1 offers a kind of historical snapshot of the important findings that helped shape genomics as we know it today.[6]

Three separate research teams created the first genetically altered plants in 1983, including petunias and tobacco that were resistant to antibiotics. Early in the 1990s, scientists in China commercialized the first genetically modified tobacco product. The Food and Drug Administration initially authorized a genetically engineered tomato species with the ability to postpone ripening in 1994, bringing it to the US market (FDA).[7] Since then, the FDA has approved a number of transgenic crops, such as "Canola" with altered oil content, cotton and soybeans resistant to herbicides, etc.

It is vital to explain why there has been such a considerable effort put into developing GM foods before beginning to analyze their advantages and disadvantages. We currently face three significant difficulties that drive our use of new technology.[8]

Researchers must insert the gene(s) encoding for certain features into a plant cell in order to produce GM food, and they must then regenerate a plant through tissue culture. Usually, the plan to maximize a product's property includes when and where the transplanted gene will be expressed. In general, there are three methods for altering genes inside of cells.[9]

DIRECTLY TRANSFER DNA

Micro-particle bombardment is the method that delivers foreign DNA the most often. Sanford developed the method in the late 1980s. Engineered DNA is coated on gold or tungsten micro-particles, which are then driven by pressurized helium at high speed into specific tissues, such as embryonic tissues from the seed or meristems. Other methods of introducing DNA into plant cells include microinjection, chloroplast transformation, silicon-carbide slivers, mesoporous silica nanoparticles, electroporation (allowing negatively charged DNA to flow along an electric potential gradient), and others[10]. Particle bombardment, however, continues to be more efficient at concurrently transferring large DNA pieces, even whole chromosomes.

BACTERIAL VEHICLE

Exogenous gene insertion into plant cells entered a new era with the introduction of Agrobacterium tumefaciens. Plants that have been infected by the soil bacterium A. tumefaciens develop a gall at the crown. The bacteria really change the plant's genome, causing the cells to multiply and allowing the plant to create altered amino acids as a specialized food source for itself. Researchers hijack the plasmid by introducing "designer genes" into the T-DNA (transfer DNA) part of the tumor-inducing plasmid (Ti-plasmid), which allows the bacteria to carry out gene-insertion.[11]

DIRECT EDITING OF GENOMIC DNA

The "CRISPR-Cas9" system was created in 2012. It is a ground-breaking tool for genome editing and offers a different way to change the genes in different kinds of cells. This method greatly boosts the effectiveness of genetic engineering and makes working with plants much simpler.[12]

A DNA endonuclease called Cas9 was first discovered in bacteria, where it shields the host organism against invasive DNA molecules (e.g. viruses). A specific "guide RNA" (gRNA), whose sequence is complementary to the invading region to be deleted, directs the endonuclease to the invading/targeting DNA. Cas9 uses its two active sites to break both strands of the double-stranded DNA as a result of being directed by the offensive. Thereafter, two distinct processes are used to repair the recently generated DNA double-strand breaks (DSBs).[13]

The "homologous recombination" (HR) process permits the addition of donor DNA into the endogenous gene at the break site, but the "non-homologous end joining" (NHEJ) method might result in a minor loss or random DNA insertion, resulting to a truncated gene or knockout.[14]

The legislation governing food control has also been put to the test by the quick development of these cutting-edge biotechnologies. The US Department of Agriculture (USDA) decided that some genome-edited crops cannot be grown under the present regulations, thus on November 18, 2015, the USDA revealed tentative proposals to change its regulations for GM crops.[15]

BENFITS OF GM FOODS

Food crop production increased by more than 370 million tones between 1996 and 2012. In the United States, GM crops are responsible for a sixth of the enhanced yield. It is predicted that more than 300 million acres of conventional crops would have needed to be added in order to attain the same gain in yield as provided by GM crops. These extra 300 million acres would invariably be areas that needed more irrigation, fertilizer, or tropical forests that had been cleared. A major ecological and environmental burden would result from such land change. Similar findings were reached in a paper by Graham Brookes and Peter Barfoot, who estimated that biotechnology contributed to an increase in worldwide soybean production of 138 million tones between 1996 and 2013.[16]

ECONOMIC BENEFITS

Global agricultural revenue from GM food increased by $116 billion between 2006 and 2012, almost three times as much as in the prior ten years. According to James and Brookes' assessment, the enhanced yield brought on by improved genetics and pest and weed resistance accounted for around 42% of the economic benefit. The remaining 58 percent came from lower production costs (due, for instance, to less pesticide and herbicide use).[17]

MODIFICATION OF THE CHEMICAL COMPOSITION IN FOOD

Some genetic engineering aims to enhance certain nutrients or compounds with high medicinal and pro-health value, such as probiotics, vitamins A, C, and E, unsaturated fatty acids, and alimentary cellulose. The aforementioned "Golden Rice" is a noteworthy illustration. It effectively and economically treats malnutrition. Similar to this, researchers may modify the composition of proteins' amino acids as well as the amount of carbohydrates utilizing this biotechnology. Sweet lupine, which has elevated methionine content, is a good example of the former. The development of the transgenic potato variety Amflora is a nice illustration of the latter case.[18] transgenic goods' improved nutritional value has been achieved by modifying the proportion of carbs in those items.

Transgenic goods' improved nutritional value has been achieved by modifying the proportion of carbs in those items. Let's continue to think about the Amflora case. Two forms of starch, amylose and amylopectin, combine to make the majority of the polysaccharides in the potato bulb. While amylopectin is extensively utilized in the production of non-food starch, paper, and textile processing, amylose is exclusively beneficial as a food starch. Granule-bound starch synthase (GSBB), whose main function is the generation of amylose, is one of the enzymes needed for the synthesis of starch.[19] only amylopectin is generated when GSBB is absent. Utilizing this understanding has produced approaches to alter the structure of potato starch.

IMPROVEMENT IN FOOD PROCESSING

Food processing can also be facilitated by using GM technology. The development of "Flavr Savr" tomatoes is noteworthy. They were created in 1992 by the Calgene firm in California. The genetic modification entails the insertion of an anti-sense gene, which inhibits the polygalacturonase enzyme. As a result, tomatoes mature more slowly, extending their shelf life. Gene editing has also changed the makeup of potato bulbs. For instance, potatoes with the cyclodextrin glycosyltransferases gene have more stable brightness factors and a more appealing look.[20]

Animal products can also be modified genetically, in addition to plants. To increase the production of growth hormones to hasten development and body mass, several researchers are investigating transgenic fish. The first genetically modified animal, a fast-growing salmon called "Aqu Advan-tagea," has now received FDA (US Food and Drug Administration) approval for human consumption in the country. After two decades of regulatory ambiguity, the decision was made. Farming "Aqua Advantagea" may lessen strain brought by by intensive fishing of wild populations since the fish reach their full size in 18 months rather than 3 years and with less demand for food resources per kilogramme of caught fish.[21]

PRODUCTS FOR THERAPEUTIC PURPOSES

The edible section of plant cells can produce viral or bacterial antigens thanks to genetic engineering approaches. Thus, in principle, transgenic foods may act as oral vaccines that could trigger the production of antibodies by the immune system through mucosal immunity. The potential for edible vaccines against many illnesses, such as Escherichia coli toxins, rabies virus, Helicobacter pylori bacteria, and type B viral hepatitis, is being studied in a number of crops (such as rice, maize, soybean, and potatoes).[22]

POTENTIAL RISKS OF GM FOODS

Concerns about GM foods' possible negative impacts on human health and environmental safety dominate discussions about them. Consumer anxiety can be attributed to four factors: the scientific community's difficulty in succinctly describing the biological techniques involved to the general public; worries about the improper distribution of GM foods; the ethical principles inherent in traditional food processing; and consumers' concerns about the appropriateness of the evaluation of the GM foods.[23]

HEALTH RISKS ASSOCIATED WITH GM FOODS

Toxicology, allergen city, and genetic hazards are the three main health problems that might be linked to GM food. The inserted gene and its expressed proteins alone, the secondary or pleiotropic effects of the gene-expression products, and the potential disruption of native genes in the modified organism are three potential causes of these.

An illustration of a food hazard directly brought on by the expression of the inserted gene is "Starlink" maize. The genetic material from Bacillus thuringiensis was used in the genetic engineering of the modified plant to provide it insect resistance. The inserted gene produces the pesticidal protein Cry9c, which also has a severe unexpected allergenicity.[24] Consumers who ate the "Starlink" maize have experienced allergic reactions in certain occasions, according to reports.

Allergies can potentially be made worse by altering how naturally occurring parts of the altered organism express themselves. The production of soybeans that have been enhanced with the amino acid methionine is one example. A gene discovered in Brazil nuts has improved the production of this amino acid. Because of this, some customers who are sensitive to these nuts also have allergies to the transgenic soybean.[25]

The direct impacts of the gene or its products are considerably easier to spot than secondary and pleiotropic effects. The altered gene may encode an enzyme that is involved in the altered organisms' normally occurring metabolic processes. At some "metabolic distance" from the main metabolic disturbance, such changes may affect the levels of other metabolites, including hazardous ones.[26]

The integrity of the plant's existing genomic information might be compromised by the inserted gene, which could result in the deactivation or other modification of endogenous genes. Once more, such a disruption could be thought to activate (or deactivate) metabolic processes involving products or toxins, or their detoxification - in any case, by events far removed from the known and intended effect of the inserted gene.[27] This complicates our ability to establish a causal relationship between the inserted gene and the alleged effect.

ECOLOGICAL RISKS ASSOCIATED WITH GM FOOD

The bulk of genetically modified foods now on the market attempt to give the changed plant either pest-resistance or herbicide-resistance. Insecticidal crystal proteins (CRY), which are naturally generated by the soil bacteria Bacillus thuringiensis, are often tailored to be expressed in insect-resistant crops (Bt). Crops that are herbicide-tolerant are made to produce enzymes that defend against herbicides, especially the glyphosate in Roundup TM, frequently by being able to break down the herbicide.[28] the innovative method involves using an herbicide that is sprayed by humans to kill weeds while leaving agricultural plants alone.

The adoption of these two technologies significantly lowers the immediate input costs that farmers experience. The fight against weeds becomes considerably less labor-intensive, and the fight against insects requires a lot less costly and dangerous pesticides. But in the long run, can these tactics really thwart Nature's inevitable shift toward better-adapted species? What happens when weeds and insects become more resilient? It almost seems certain that, in a few years, weeds and insects will find a method to undermine our brilliant design of transgenic crops in response to stresses brought about by humans in their environments.[29]

DISRUPTION OF THE FOOD WEB

Another problem is the potential for an increase in small pests with a decrease in large pests due to insect-resistant plants. Here, it is possible that the pest population will change from species that are scared off by the altered plants to other, unfazed species. With new predators for the new bug species and so on up the food chain, this shift in turn might cause a widespread disturbance of the entire food chain. Or the disruption may go the other way, where herbicide or insect-resistant plant residues could have a detrimental impact on nearby soil-dwelling species (such bacteria, fungus, etc.)[30]

RESISTANCE TO ANTIBIOTICS

Medical research is well aware of the issue of antibiotic resistance development, which is linked to the overuse of therapeutic antibiotics in both agriculture and medicine. Antibiotics are commonly used in genetic modification processes, usually as selection markers to separate bacteria that have successfully undergone complete transformation from those in which the transfecting genes did not take hold. Because bacteria, both good and bad, are quite capable of shuttle useful genes - like those that protect them from nasty antibiotics - into the microflora of human and animal gastrointestinal tracts, or, worse yet, to pathogenic bacteria harbored by the consumer of GM a food, the processes used to genetically modify an organism carry the risk of transferring the genes of antibiotics resistance into the benign bacteria.[31]

CONCLUSION

It is obvious that there is no straightforward "yes" or "no" answer to the question of whether or not humans should consume food made from genetically modified organisms, and consequently, whether or not they should create and spread them. A prudent response would include a wide range of scientific knowledge, including molecular biology as well as agricultural economics, animal and microbiological ecology, food technology, and immunology—a depth of knowledge that is unlikely to be possessed by a single person. The debate pits the obvious benefits of planned effect against the murky potential of unintentional impact, reverberating across the whole history of human technological advancement. One merely needs to consider the industrial revolution powered by fossil fuels vs global warming. Or of nuclear power generation—a much-heralded alternative to fossil fuels—in comparison to Tokushima. Even if many of the concerns associated with GM crops are hypothetical, they are still presented in good faith and are supported by science. Equally unscientific is ignoring them in the exhilaration of quick gain.

Based on prior experience, it doesn't appear plausible that the technological trend toward genetically engineered crops can be completely reversed. or ought to be. Because of the known and unanticipated negative effects, it would be foolish to dismiss or disregard the immediate advantages. We propose examining cautiously and always with sharp (and collective) circumspection at the earliest indications of issues. This is not Hamlet-like indecision.

Conflicts of Interest- Nil

Source of Interest-Nil

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