Research Journal of Chemical and Environmental Sciences
Res J. Chem. Environ. Sci. Vol 2 [6] December 2014: 01-05
Online ISSN 2321-1040
CODEN: RJCEA2 [USA]

Website: www.aelsindia.com/rjces.htm

RJCES

REVIEW ARTICLE

Genetic Engineering: A Question of Ethics

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ABSTRACT
In today's society, genetic engineering is an increasingly important issue. Many genetically modified organisms (GMO's) and the products of other GMO's are currently used and consumed by humans, and research is continuously conducted on ways to modify the genetic traits of organisms to better suits human lifestyles. This raises question of whether altering an organisms structure for anthropocentric purposes is ethical. The aim of this article is to present the purposes and benefits of genetic engineering and to compare them to ethical arguments against it.
Key words: *Genetically modified organisms (GMO's), Molecular cloning, Genome , Novel organisms etc.*

Received 12.08.2014 Accepted 20.09.2014

INTRODUCTION

Genetic engineering, also called **genetic modification**, is the direct manipulation of an organism's genome using biotechnology. New DNA may be inserted in the host genome by first isolating and copying the genetic material of interest using molecular cloning methods to generate a DNA sequence, or by synthesizing the DNA, and then inserting this construct into the host organism. An organism that is generated through genetic engineering is considered to be a genetically modified organism (GMO).

Genetic engineering is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms. The techniques involve sophisticated manipulations of genetic material and other biologically important chemicals.

Genes are the chemical blueprints that determine an organism's traits. Moving genes from one organism to another transfers those traits. Through genetic engineering, organisms can be given targeted combinations of new genes—and therefore new combinations of traits—that do not occur in nature and, indeed, cannot be developed by natural means. Such an approach is different from classical plant and animal breeding, which operates through selection across many generations for traits of interest. Classical breeding operates on traits, only indirectly selecting genes, whereas biotechnology targets genes, attempting to influence traits. The potential of biotechnology is to rapidly accelerate the rate of progress and efficiency of breeding.

Novel organisms :

Nature can produce organisms with new gene combinations through sexual reproduction. A brown cow bred to a yellow cow may produce a calf of a completely new color. But reproductive mechanisms limit the number of new combinations. Cows must breed with other cows (or very near relatives). A breeder who wants a purple cow would be able to breed toward one only if the necessary purple genes were available somewhere in a cow or a near relative to cows. A genetic engineer has no such restriction. If purple genes are available anywhere in nature—in a sea urchin or an iris—those genes could be used in attempts to produce purple cows. This unprecedented ability to shuffle genes means that genetic engineers can concoct gene combinations that would never be found in nature.

The production and use of genetically modified organisms is increasing steadily. Although there are many potential benefits to human from this process, the risks have not been adequately defined. Researchers are developing new organisms too quickly to accurately determine the effects of this procedure.

There are many people and organizations that are completely against genetic engineering. The reasons for their objections, as well as potential benefits, are both discussed in detail.

It is important to thoroughly examine all of the statements both in favor of and against genetic engineering to determine whether it should have a place in our future. It is equally important to ensure that the public has access to this information , as they are the ones using or consuming the modified products.

APPLICATIONS OF GENETIC ENGINEERING

There are many arguments in favor of the use of genetic engineering in the future. Among these are the promises that genetic engineering will 'feed the world' produce better crops and altogether good for the economy. Many different organisms are being used in today's genetic engineering research and development, including plants, trees , animals , insects , bacteria and viruses. Today even human genes are being used in genetic engineering. The number of organisms used in genetic engineering research is steadily increasing , as is the number of types of animals being used in the research. Genetically engineered organisms are being used in many different sectors today including agriculture , biomedical research and animal farming.

1. Genetic engineering in agriculture :

Genetic engineering in agriculture has the potential to improve crop yields and to greatly reduce the risk of crops being lost to extreme weather conditions. This is the aspect of genetic engineering which has reached the furthest developed stage, with the aspects relating to animals and human genes lagging far behind. There are already commercially available genetically modified foods, although the long term effect of these on the ecology of the planet and even the human body itself remain hard to quantify, leaving many people doubtful as to the wisdom of using them.

There are several dimensions of genetic engineering which can be applied to crops and commercial plants, starting with the obvious consideration of making them more resistant against pests and disease. The use of chemicals in agriculture has at least stemmed the advance of pest driven crop waste, but it has done so at a price. Much of the food which is sold on the open market in developed countries has been treated with chemicals, and these leave a residue which will be consumed by the eater of the food. If crops can be produced which are resistant to these chemicals, agriculture could become much safer.

There are also some uses of genetic engineering in agriculture which are not designed to improve the crop yield, but to use the plants in other ways to grow other resources which are needed. The best example of this is vaccines and other drugs, which can be produced from crops grown in fields using genetic engineering. Many of these drugs are inherently expensive to produce an other way, so this technology offers the possibility of cheaper drugs and a greater supply. This could reduce expenses for medical services in countries which have a state medical system, and also allow more supplies to be diverted to the Third World.

In the agricultural sector , plants and crops are engineered to express a resistance to herbicides and specific pests. Scientists promised that genetically modified plants will have better texture , more flavor and higher nutritional value than wild varieties of same crops. There are also plant engineered to last longer on the shelf , appear fresher for longer and survive the shipping process in better condition. Better crop yields may be achieved using genetically modified plants, meaning that land use will become more efficient.

Also in the agricultural sector, research is being conducted to modify certain insects to attack the predators of specific crops. Therefore fewer amounts of pesticides will have to be applied to the crops , allowing for better environmental and human health.

2. Biomedical research and human gene technology :

GMOs have emerged as one of the mainstays of biomedical research since the 1980s. For example, GM animal models of human genetic diseases enabled researchers to test novel therapies and to explore the roles of candidate risk factors and modifiers of disease outcome. GM microbes, plants, and animals also revolutionized the production of complex pharmaceuticals by enabling the generation of safer and cheaper vaccines and therapeutics. Pharmaceutical products range from recombinant hepatatis B vaccine produced by GM baker's yeast to injectable insulin (for diabetics) produced in GM *Escherichia coli* bacteria and to factor VIII (for hemophiliacs) and tissue plasminogen activator (tPA, for heart attack or stroke patients), both of which are produced in GM mammalian cells grown in laboratory culture. Furthermore, GM plants that produce "edible vaccines" are under development. Such plants, which are engineered to express antigens derived from microbes or parasites that infect the digestive tract, might someday offer a safe, cheap, and painless way to provide vaccines worldwide, without concern for the availability of refrigeration or sterile needles. Novel DNA vaccines may be useful in the struggle to prevent diseases that have proved resistant to traditional vaccination approaches, including HIV/AIDS , tuberculosis and cancer.

Genetic modification of insects has become an important area of research, especially in the struggle to prevent parasitic diseases. For example, GM mosquitoe have been developed that express a small protein called SM1, which blocks entry of the malariaparasite, *Plasmodium*, into the mosquito's gut. This results in the disruption of the parasite's life cycle and renders the mosquito malaria-resistant. Introduction of these GM mosquitoes into the wild may someday help eradicate transmission of the malaria parasite without widespread use of harmful chemicals such as DDT or disruption of the normal food chain.

Finally, genetic modification of humans, or so-called gene therapy, is becoming a treatment option for diseases ranging from rare metabolic disorders to cancer. Couplingstem cell technology with recombinant DNA methods may someday allow stem cells derived from a patient to be modified in the laboratory to introduce a desired gene. For example, a normal beta-globin gene may be introduced into the DNA of bone marrow-derived hematopoietic stem cells from a patient with sickle cell anemia, and introduction of these GM cells into the patient could cure the disease without the need for a matched donor.

RISKS OF GENETIC ENGINEERING

Any technology that offers benefits will usually come with risks as well. In order to make wise decisions about using a technology, we must understand its potential impacts well enough to decide whether the risks are acceptably low.

What are the risks posed by the use of genetic engineering (GE) in agriculture? The answers fall mostly into two categories: risks to human health, and environmental impacts.

Genetic engineering health risk :

Health risks of genetic engineering have sometimes been described in exaggerated, alarmist terms, implying that foods made from GE crops are inherently unsafe. There is no evidence, for instance, that refined products derived from GE crops, such as starch, sugar and oils, are different than those derived from conventionally bred crops.

It is also an exaggeration, however, to state that there are no health risks associated with GE. For one thing, not enough is known: research on the effects of specific genes has been limited and tightly controlled by industry.

But we do know of ways in which genetically engineered crops could cause health problems. For instance, genes from an allergenic plant could transfer this unwanted trait to the target plant. This phenomenon was documented in 1996, as soybeans with a Brazil nut gene—added to improve their value as animal feed—produced an allergic response in test subjects with Brazil nut allergies.

Unintended consequences like these underscore the need for effective regulation of GE products. In the absence of a rigorous approval process, there is nothing to ensure that GE crops that cause health problems will always be identified and kept off the market.

Genetic engineering environmental impacts :

Genetically engineered crops can potentially cause environmental problems that result directly from the engineered traits. For instance, an engineered gene may cause a GE crop (or a wild relative of that crop) to become invasive or toxic to wildlife.

But the most damaging impact of GE in agriculture so far is the phenomenon of pesticide resistance. Millions of acres of U.S. farmland are now infested by weeds that have become resistant to the herbicide glyphosate. Overuse of Monsanto's "Roundup Ready" trait, which is engineered to tolerate the herbicide, has promoted the accelerated development of resistance in several weed species.

Looking for ways to fight back against these "superweeds," farmers are now turning to older, more toxic herbicides such as 2,4-D and dicamba. As if on cue, agribusiness companies have begun to develop new GE crops engineered to tolerate these older herbicides—with no guarantee that the Roundup Ready story will not repeat itself, producing a new wave of resistant weeds. And this issue is not confined to herbicides: recent reports suggest a growing problem of corn rootworms resistant to the insecticide Bt, which some corn varieties have been engineered to produce.

Ethical debate :

Genetic engineering is a controversial and complicated subject, as there are not only concerns about the benefits and risks to the environment and human health , but there are also concerns about whether it is right to genetically modify organisms in the first place. Genetic engineering allows scientists to disrupts the natural evolution process by completely changing organisms.

Is it right to assume that a few scientists can improve on the results of billions of years of natural evolution ? Genetic engineering is seen by many people as 'playing God' or putting people in the place of creator as it gives to a few people the ability change the natural world completely. By genetically modifying organism a scientist assumes that this extremely new science is better for populating the world than God or any other creator including natural evolution and natural selection.

Religious groups may be have specific reasons for objecting to genetic engineering. For e.g. vegetarians would surely object to animal genes being inserted into vegetables and fruits as they could no longer eat those products if they felt strongly about not eating meat.

Humans are modifying the world in a way which would never happen naturally. In addition to the above issues, there are concerns about violating animal and human rights, and also about whether genetic engineering is much different from the very old practice of selective breeding.

Environmental Ethics :

Traditional ethics is concerned with the interactions of human beings and societies, and is completely anthropocentric in thought. Over time, ethics gradually evolved to include such things as women's rights, children's rights, and the rights of other minority groups. Until recently there has been little concern over how the environment is treated. The environment was seen largely as a resource that was meant for human domination and use. However, a new field of study has emerged, which attempts to bring attention to the question, "Who speaks for the biosphere?" This assumes that the environment has intrinsic value, above and in addition to other values which society places on it.

Environmental ethics is concerned with responsible personal conduct towards the environment, natural and scapes, natural resources, and all species and non-human organisms [5]. It looks at such matters as animal rights, resource use, over-consumption, and pollution versus profit. Environmental ethics is now being used in many parts of project planning, and many companies now take full, or partial, consideration of the effects of their products on the environment.

It is important to keep environmental ethics in mind when discussing genetic engineering, as many of the arguments against genetic engineering have to do with whether it is 'right' to modify organisms and the natural environment.

Duty of scientists and researchers :

Scientists and researchers have many professional duties, as well as duties to other human beings. Many times, these duties may be conflicting, and it is up to the individual to decide which is the right choice. It is for this reason that the question of duties leads to some complicated discussions.

In their professions, researchers may have a duty to their employers, or to the cause for which they are researching. This may mean that they recognize the duty to continue their research, even if humans or animals may potentially be harmed in the process. However, a conflicting duty would be that to humans. Researchers would have the duty to protect human health, and to not undergo any processes that could place it in any danger.

From all of the risks outlined in the above sections of this report, it is clear that there is the potential for human health to suffer with the introduction of genetic engineering and GMO's. Therefore, it would seem as though by continuing with their work, scientists involved in genetic engineering may be going against their duty to society. Onthe other hand, there are many potential benefits from genetic engineering, including new cures for diseases. Therefore, the scientists would have a duty to society to pursue those possibilities.

CONCLUSION

While the benefits of genetic engineering may be far-reaching, the impacts are not entirely known. When genetically modified organisms are released into the environment, they cannot be removed, and it may take decades or centuries to fully realize the consequences. The impacts will affect the entire world, not only those people who create and release the organisms. Some people are so eager to proceed quickly and develop new potentially beneficial GMO's that they do not stop to fully consider the impacts of their decisions. Researchers are too blinded by the opportunity for wealth that they cannot see the potential disastrous effects.

Ethically, it is very wrong to proceed with genetic engineering. All of the above arguments have shown that it is not right for humans to change the world in an irreversible and radical manner.

While it does not seem wise to proceed with genetic engineering, it is not reasonable to believe that all genetic engineering research with halt. Therefore, if research is to continue in the future, strict guidelines should be created and adhered to. There must be better risk assessments done for the potential impacts of the modifications, adequate testing, and reporting on the actual impacts or outcomes of the modifications.

The public must become informed about the risks and benefits of genetic engineering, in order to make informed decisions about whether of not to use modified products [1]. Furthermore, it is essential that all genetically modified foods be labeled clearly with what genes have been added.

Several questions remain to be answered about genetic engineering. What percentage of human genes must an organism have before it too is considered human? Does the presence of human genes in an

organism change its ethical status? If human genes are inserted in plants and animals for human consumption, does this mean that humans would become cannibals?

In conclusion, genetic engineering research should proceed slowly, and only by following codes of environmental and professional ethics. The precautionary principle should be employed, and genetically modified organisms should not be produced, sold, or consumed until the effects are completely known.

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CITE THIS ARTICLE

Harshada K, Resham B and G. D. Mhaske. Genetic Engineering: A Question of Ethics. Res. J. Chem. Env. Sci. Vol 2 [6] December 2014. 01-05

