Nazaryan A.O., Molchanov G.D., Kudryakova G.Kh., Danelyan V.Yu.

Environmental aspects of genetic engineering

*FSEI HPE «Moscow State University of Food Production»(MGUPP)
(Russia, Moscow)*

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Abstract

The literature analysis on the issue of transgenic modification of plants, animals and microorganisms was carried out, which shows the advantages and disadvantages of genetic engineering on the ecosystem. The article contains information about the historical aspects of the origin of genetic engineering, the difference between traditional breeding and genetic engineering is also considered. Much attention is paid to the safety of products containing genetically modified ingredients, as well as the rational use of Bt crops.

Key words: Genetically modified organisms. Genetically modified sources.

To solve modern problems of providing humanity with food is used a wide range of technical and technological means based on the results of scientific achievements. One of the most perspective ways to increase food resources is the use of modern biotechnology and genetic engineering methods, which make it possible to pointwise change the genome of an organism to obtain the desired properties. This primarily applies to crop production and the creation of genetically engineered modified (GM) plants with increased productivity, prolonged shelf life, and stability to various natural and anthropogenic factors.

Genetically modified organisms (GMOs) are organisms whose genetic material has been altered using genetic engineering methods, which include the synthesis of genes outside the body, the isolation of individual genes or hereditary structures from cells, copying and reproduction of isolated genes or genetic structures, the connection of different genomes into one cell [1].

For a long period of time, genetic engineering has developed rapidly. Plant breeders artificially altered the number of plant chromosomes, induced mutations with chemicals and radiation, and used tissue and embryo culture to regenerate offspring from crosses between closely related species.

The main task of genetic engineering is in vitro (outside a living organism) construction of new functionally active genetic structures (recombinant DNA) and the creation of organisms with new properties. The use of genetic engineering makes it possible to obtain strains of bacterial yeast, animal cell cultures producing biologically active human proteins, as well as transgenic animals and plants containing and producing foreign genetic information.

In 1983, scientists, studying soil bacteria that form growths on the trunks of trees and shrubs, found that it transfers a fragment of its own DNA into the nucleus of a plant cell, where it is integrated into the chromosome and is recognized as its own. The first, as a result of artificial manipulation of genes, turned out to be tobacco, invulnerable to pests, then a genetically modified tomato (in 1994 by Monsanto), then corn, soybeans, rapeseed, cucumber, potatoes, beets, apples and much more.

It was found that some bacteria have the ability to transfer new DNA sequences to bacteria of other species and genus. Thus, there is a possibility that genetic exchange can occur both between closely related plants and between microorganisms [2].

Now it is routine work to isolate and assemble genes into one structure, transfer them to the necessary organism. This is the same selection, only more progressive and more jewelry. Scientists have learned how to make the gene work in the right organs and tissues (roots, tubers, leaves, grains) and at the right time (in daylight); and a new transgenic variety can be obtained in 4-5 years, while breeding a new plant variety using the classical method

(changing a wide group of genes using crossing, radiation or chemicals, hoping for random combinations of traits in the offspring and selection of plants with the necessary properties) takes more than 10 years (pic. 1).

Pic. 1. Difference between conventional breeding and genetic engineering

Genetic engineering or recombinant DNA (r-DNA) technology offers many opportunities to improve agriculture and public health. This technology goes beyond classical plant and animal breeding, allowing for the rapid transfer of genetic traits between widely different organisms. Potential benefits include higher yields and increased nutritional value of crops, reduced use of pesticides and fertilizers, and improved control of soil and water pollutants.

In recent years, the issue of products, genetically modified ingredients has been increasingly raised. Along with useful traits, plants, for example, can acquire harmful properties (allergic, toxic, carcinogenic effects of a foreign protein). Besides, there is an accumulation of herbicides and their metabolites in varieties resistant to them. It is impossible to exclude the possibility of horizontal transfer of transgenic constructs, primarily in the genome of bacteria symbiotic for humans and animals, and, as a consequence, the spread of antibiotic resistance properties.

The established food safety of transgenic plants is a guarantee of consumer confidence in their harmlessness to health. In various countries, at the legislative level, a regulatory and methodological framework has been developed for assessing food safety and the possibility of selling products from genetically modified sources for food purposes.

Genetic engineering capabilities allow the creation of genetically modified food sources. Plants, animals, microorganisms obtained by means of genetically engineered biotechnology are called genetically modified, and the products of their processing are called transgenic food products, or genetically modified sources (GMOs) [3].

The first GMI, a shelf-stable Flavr Savr tomato (Calgene Inc., USA), appeared on the US food market in 1994 after 10 years of preliminary testing. In subsequent years, the number of GMI approved for use in the USA, Canada, Japan and the countries of the European Union

increased significantly: these are corn, potatoes, soybeans, pumpkin, sugar beet, papaya. In 1999, the first genetically modified soybean line 40-3-2 ("Monsanto Co", USA) was registered in Russia. At the moment, hundreds of GMIs have been created and approved for use in human nutrition, the number of which continues to increase.

As a result of transgenic modification, plants become resistant to herbicides, insecticides, viruses, acquire new consumer properties (for example, an orange with an apple peel). At the same time, the amount of pesticides used decreases, their residual content in products decreases, the time of technological operations during processing decreases, losses decrease, product quality increases, money and material resources are saved.

More than 150 types of GMO are produced in the USA. The most widespread is soy, which is used in the production of more than 3000 food products: soups, baby cereals, potato chips, margarines, salad sauces, canned fish, etc. Cottonseed and rapeseed oils are made from GMI cotton, rapeseed, French fries are made from GMI potatoes, ketchup is made from slow ripening tomatoes, etc.

Transgenic products that do not differ in composition and properties from traditional analogue products and do not contain DNA and protein are allowed to be used without conducting studies of their safety as GMI sources. They belong to the first class of safety and are considered harmless to the health of consumers. These products include: food and flavoring additives, refined oils, modified starches, maltodextrin, glucose syrups, dextrose and others.

New technologies for the production of transgenic farm animals and poultry, aimed at increasing the productivity and optimization of individual parts and tissues of the carcass (carcasses), which has a positive effect on the quality and physical-chemical parameters of meat, its manufacturability and industrial suitability.

The possibilities of genetic engineering make it possible to change the structure and color of muscle tissue, its pH, hardness, water-holding capacity, the degree and nature of fat content (marbling), as well as the consistency, taste and aroma properties of meat after technological processing. In addition, with the help of genetic engineering, it is possible to increase the adaptability of animals and birds to harmful environmental factors, to obtain resistance to diseases, and to directly change hereditary signs.

Based on the above, it should be noted that an increase and improvement in the quality of products of animal origin (meat, wool and milk) may be the result of genetic engineering.

In the field of genetic engineering of microorganisms, most of the research is aimed at selecting producers of enzymes, vitamins, antibiotics, organic acids and other useful substances.

Known enzymes obtained with the help of genetically modified bacteria, which are used in baking bread (the flour is clarified, and the bread becomes more fluffy). In Germany, transgenic pectinases have been obtained for the production of juices and wine, and it has been shown that these pectinases are absent in finished products.

In many countries, for example, the countries of the European Union, Australia, New Zealand and others, registration of products obtained using such "non-traditional" enzymes is mandatory [4].

The creation of genetically modified plants that can withstand harsh temperatures, low light, and at the same time that are filled with all the necessary nutrients that humans and animals need to survive, allows farmers to expand agriculture outside traditional areas and use vacant land for other purposes, while this, increasing the productivity of crops. So, for example, humanity has the opportunity to re-green the desert.

However, the introduction of GM plants into the environment can have devastating consequences for biodiversity. Some birds, insects or animals depend on crops for their survival, but may be unable to feed on crops due to the introduction of genes into these varieties. This can somehow affect the food chain and the relationship between predator and prey. For example, the effect of Bt corn pollen on no-purpose lepidoptera species. Many Bt

crops evolve the toxin from their roots into the soil. These toxins are sometimes very harmful and affect the soil ecosystem [5].

Genetic engineering technology has exceptional prospects for improving agricultural production and maintaining its ecological purity. The commercialization of transgenic plants is likely to expand in the future and to include a much greater variety of plants and signs than it currently does. These include plants with increased stress resistance; changes to improve post-harvest handling, such as lower lignin in trees; altered food quality, new foods and increased nutrient content for human consumption. The new plant species will include grasses, grazing and woody species, and aquatic plants. Along with the potential benefits to agriculture, there are some risks. The public must be educated about the risks and benefits of genetic engineering that to decide whether to use modified products or not. In addition, it is very important that all genetically modified foods are clearly marked as to which genes were introduced. Genetic engineering researches should be carried out slowly and only in accordance with the norms of environmental and professional ethics. The precautionary principle should be applied, and GMOs should not be produced, sold or consumed until the consequences are fully known.

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