Achievements of genetic engineering

The genetic engineering resembles, to some extent, a jigsaw puzzle. The scientists ascribe a certain function to the DNA fragment of an organism, basing on the observation of its activity. Then they cut out (isolate) a fragment being tested, and place it, chiefly using a transmitter (vector) in the other organism. The next stage is the observation of the effects of this connection. Quite often, the researchers expect defined changes to occur, while it happens that, in parallel with the planned, positive change, an unwanted characteristic also appears, or the effect may not occur at all. Frequently, it is sufficient to work on the isolated gene, in order to obtain the planned effect but often the ‘fault’ is on the side of the recipient, and then it is necessary to resign of the so far investigated living organism towards searching for a new organism to be finally modified.

In the general conception, genetic modifications of the organisms are to serve the human good, through measurable economic and social benefits. The aim of the creation and commercialization of the genetically modified organisms (GMO) is the development of the economy, improvement of technologies of medicines production, enhancing the processes in food processing, and increasing the efficiency of agricultural production. The economic benefits oscillate around reducing the expenses on fertilizers and herbicides, intensification of crops, and utilization for cultivation of the areas unfavourable for agriculture (abiotic). In turn, the social benefits are obtained through enrichment of GM plants in nutritive components, multiplying the chemical substances naturally occurring in the plant, and influence on the appearance and durability. Of vital importance, from the customer’s point of view, is the possibility of reducing the capability of generating the allergies by the alimentary products, through genetic elimination of allergenic plant proteins.

With the aim of emphasizing the diversity of solutions provided by genetic engineering, one should draw attention to several examples of GM organisms. From the economic point of view, one of the most important characteristics of the GM plants should be the resistance to plant diseases, insects, and herbicides. Here, an example of insect-resistant organism can be *Bt* corn, containing in its genetic material a fragment of DNA of the bacteria, being...
responsible for production of protein being harmful to pests. The same gene is also used in genetic modification of potatoes, tomatoes, cotton, and rice. In the case of rice, there has been created a caterpillar-resistant variety, containing in the DNA a gene taken from leguminous plants. Another example pest-resistance is a potato variety with a gene taken from snowdrop. Equally important, from the economic point of view, is the issue of resistance of GM plants to pathogenic microorganisms (pathogens). The achievements of genetic engineering in this field includes, among the other things, the resistance of rice to bacterial disease called spotting of sprouts, and tomatoes being resistant to myotic and bacterial infections. The transplantation of the gene of the ring spotting virus into papaya resulted in the resistance to infection by this pathogene. Other GM plants being resistant to pathogens are banana, pumpkin, courgette and potatoes. Among the characteristics supporting the economic aspect, one can also count the resistance of GM plants to herbicides. Owing to the methods of genetic engineering, it is possible to obtain tomatoes which, through implanting bacterial genes reveal tolerance to the most popular herbicides. The resistance to herbicide preparations was also implanted in sugar beet, colza, oil-yielding rape, chicory, soy, cotton, potatoes, corn, and tobacco. Another problem in the economic dimension is the susceptibility of crop plants to varying environmental conditions. The GMO being resistant to unfavourable conditions are currently in the phase of laboratory tests. The scientists managed to obtain in this way frost-resistant GM strawberries containing the gene of Arctic flounder, rice being resistant to high salinity of the soil, and wheat with high tolerance to low temperatures. At present, most of crop-plant GM varieties reveal the resistance to one of the mentioned stress factors, but the further research is aimed at obtaining the multi-transgenic varieties (with more than one gene) which will be characterized by several properties.

Of no less importance than the economic reasons of genetic modification of organisms is the creation of the GM varieties that give measurable profits to the customers. The GM-microorganisms are characterized by the capability to produce specific enzymes that are indispensable in fruit and vegetable processing and production of nutritive substances needed by humans. Food produced with the use of GMO does not differ considerably in taste and/or smell from the traditional, but can be enriched in components which occur in minor
quantities in the primary variety. Among the examples of modified microorganisms, one can count the bacteria that participate in production of anti-inflammatory component in the human intestine, being added to preparations used in the treatment of ulcers and severe intestine diseases (*in vivo* application). Another example serve GM bacteria that produce natural antibiotics potentially being able to substitute the preservatives (*in vitro* application). Using the genetic engineering methods, there have also been obtained the bacteria which synthesize large quantities of omega-3 acids. The GM microorganisms also serve in production of saccharose, aromatic substances and vitamins. Food processing is based on many enzymatic reactions, for the needs of which the enzyme produce the GMO. The transgenic microorganisms (containing new gene) are used, among other things, in brewing industry, production of wine and other alcohols, bread baking, production of pickles, yoghurt, cheese, and in meat and fish processing industries.

Of equal importance as GM microorganisms are higher organisms improved by means of the genetic engineering. Soy is one of the GM crop plants most frequently subjected to modification. It is used, among the other things, as a rich source of vegetable hormones (phytoestrogenes), being of therapeutic importance in menopause. Phytoestrogenes for the needs of pharmaceutical industry are synthesized owing to the gene of soy by thale cress. For production of tofu, GM soy has been obtained having a lower content of these hormones. They also succeeded in obtaining soy with a high ferritine content (protein responsible for assimilation of iron), and lowered content of allergenic proteins. Soy is the most popular, but it should be emphasized that tomato pioneered this domain. Its variety called Flavr-Savr appeared in regular sale. The characteristic feature of this vegetable was longer durability, decay resistance, greater firmness and cracking resistance. Also tomatoes are subjected to effective modification oriented towards increasing the starch and β-carotene contents, and toward obtaining better taste (sweeter). Rape is another example of plant which was changed by genetic modification to meet customers’ needs. The varieties created do not produce unsaturated fatty acids, but, at the same time, are rich in saturated acids. This modification was aimed at industrial production of margarines and butter substitutes. A very well-known project in genetic engineering was the research on transgenic
variety of rice named Golden Rice, then Golden Rice 2. It is to give more A vitamin and iron, being so important in health prevention in Third World countries.

Among other achievements in the genetic engineering relative to crop plants, one could mention beetroots with lower calorific value, and potatoes with higher or lower starch content. Owing to implanting the new gene it was possible to obtain a sweet variety of potato and cucumber. Also, using these methods, a potato variety has been obtained with a lower content of the toxic compound (solanine), and potatoes resistant to impact darkening. So far, the researchers were able to create peanuts and Brazilian nuts with lower allergene contents, and seedless citrus fruits and grapes. In the laboratory conditions there was also created a transgenic variety of coffee and tea with lower caffeine content. The organoleptic properties of products were improved in the case of carrots and celery. Their GM varieties are characterized by long-term brittleness. Cabbage also deserves special mentioning. It contains the genes isolated from alga and mushrooms, and responsible for production of unsaturated omega-3 and omega-6 fatty acids.

Transgenic plants are being constructed also with the aim of production of substances beneficial from pharmacological point of view. One should mention bioforming, that is trials to create edible vaccines. In the Institute of Bioorganic Chemistry PAN, the GM lettuce has been obtained. That variety, acting like the vaccine, can protect humans against Hepatitis type B. (JB)

References:
- Tańska I.: Awantura o ziemniaka, Wiedza i życie, 2008, 11
- Fober I.: Dla glodnych i bogatych, Przegląd Techniczny, 2008
- Chelstowski J.: Transgeniczne rośliny a organizm człowieka, Aura, 2000, 11
- Simons C.: Inżynierowie od ryżu, Newsweek Polska, 2005, 7
- Wojtasień Z.: Kto głupieje od jedzenia, Wprost, 2008, 11
- Bednarski W., Repa A. i in.: Biotechnologia żywności, Wydawnictwo Naukowo-Techniczne, Warszawa 2001
- Boba A.: Żywność genetycznie modyfikowana - korzyści i zagrożenia; Zakład Żywnienia Człowieka, Uniwersytet Przyrodniczy, Wrocław 2010
- http://www.megapedia.pl/owoc-papaja.html
- http://www.we-dwoje.pl/ziemniak,tag,53869.html