

## Introduction of Genetically Modified Organisms (GMOs) - Health Risks and Benefits for Animals and Citizens of Republic of Macedonia

Zivko Gacovski<sup>1</sup>, Goce Cilev<sup>1</sup>, Biljana Petrovska<sup>1</sup>

<sup>1</sup>*Faculty of Veterinary Medicine, University Kliment Ohridski, Bitola, R. Macedonia*

### Abstract

Genetically modified organisms (GMO) are organisms whose genetic modification of heritable genetic material (DNA) is a planned amendment to the unnatural way by applying modern techniques of genetic engineering, or, a gene or genes from one organism are inserted into another organism, what in nature with a natural breeding would never be created. GMOs are a source of modified laboratory food, supplements and various additives. The subject of this research paper is to see the impact of GM food as a threat or a benefit on the health of humans and animals, as well as its application in the Republic of Macedonia. Comparative analysis of scientific research in the field of modern biotechnology science using the technique of genetic engineering has been used in this paper. From the analysis of previous research, there are no official data on possible effects on human health, and animal tests have shown negative effects on their health.

*Key words:* GM food, GI, health, law

### Introduction

World politics constantly monitor the demographic growth of the world population and therefore the constant need to increase food production. Modern science to achieve the objectives of this policy, engaged in development of genetic engineering techniques (GI) in order to produce genetically modified organisms (GMOs), which will be a source of GM foods, additives and various

accessories. In R. Macedonia prohibition of import of GM food has been regulated by law. For this the Government of Macedonia, has obliged by law the Organs of state, Public facilities and institutions, Scientific research institutions, Educational institutions, Commission control of GMOs under Article 62 of this law, Scientific Committee of on GMOs under Article 64 of this Law, including the Macedonian Academy of Sciences and Arts, as well as other relevant scientific and ethical committees operating in the Republic of Macedonia. The purpose of these institutions is to monitor the impact of GMOs and GM food on human health, animals and the environment.

## Material and Methods

As material and method of work in this paper is used comparative analysis of scientific research in the field of modern biotechnological science by using the techniques of genetic engineering, production of GMOs, which are a source of GM food and feed in the natural way of food production. The purpose is to perceive the impact of GM food as a threat and benefit on the health of people, animals and the impact of the environment with the production process and the use in the food chain.

## Results and Discussion

According to available information, the production of GMO crops began in the U.S. in 1994 with the placement of the first GM product Flavr Savr tomato, developed by the biotechnology company in California Kalgene Engineering (now part of Monsanto). Furthermore GM production expands in other parts of the world: U.S., Argentina, Brazil, Canada, China, Paraguay and India.

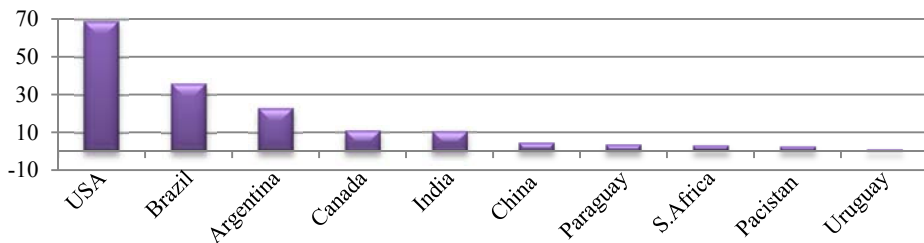


Chart 1, Top GMO crop growing countries, in million hectares (2012)  
*Najzastupljene GMO usevi u zemjama u svetu, izražene u milionima hektara u 2012. godini*

Source: International Service for the Acquisition of Agri-biotech Applications (ISAAA)  
*Izvor: Međunarodna služba za sticanje agro-biotehničkih aplikacije (ISAAA)*

So far, a total of 16 GMO crops has been known: soybeans, corn, cotton, canola, rice oil beet, tomato, potato, sugar beet, wheat, carnation, pumpkin, tobacco, chicory, flax, melon and papaya. Most grown agricultural GMO crops on nearly all surfaces are mainly four crops: soybeans by 60%, corn 23%, cotton 11% and the oil beet with 6%. The research of many scientists with experimental animals (mice, rats, rabbits and sheep) have confirmed that GM food and feed compared with natural, not GM foods, poses a threat since they cause negative phenomena on animal health and environment. Studies have been conducted in the period 1993-2011 year. We will mention just some of the researchers who we analyzed in this paper.

Hines (1993) and Pusztai (2000), in the diet of rats as GM foods, they used GM tomato variety Calgene's FlavrSavr and established the occurrence of stomach lesions (sores or ulcers). Prescott et al. (2005), in the diet of rats as GM foods, they used GM Bt peas variety and found that GM insecticidal proteins act of falling immunity and appearance of allergic reactions. Malatesta et al. (2002), Malatesta et al. (2003), Malatesta M et al (2008), Vecchio et al. (2004), Tudisco et al. (2006), Brasil et al. (2009), in the diet of mice and rabbits as GM foods they used GM soybeans and established disorders on the liver, pancreatic and testicular function, disturbances of the function of enzymes in the kidneys and heart changes in the uterus. Séralini et al. (2007), Kilic and Akay (2008), De Vendomois et al. (2009), Finamore et al. (2008), Trabalza-Marinucci et al. (2008), Duggan et al. (2003), in the diet of rats as GM foods they used GM Bt corn and established higher levels of certain fats (triglycerides) in the blood, problems with liver function, the kidneys and was disturbed excretion of certain minerals, changes in biochemical image of blood, disorders in the immune system. Then determined that the DNA of GM Bt corn can survive processing in the digestive tract of the animals, in this case, the horizontal transfer of genes could create antibiotic resistant bacteria that cause intestinal disease called "super bugs". According to observations of US Food and Drug Administration (2002), in rats fed with GM oilseed beet, as a sign on a frequent toxicity is noticed enlargement of the liver. Pusztai and Bardoc (2006), and Ewen and Pusztai, (1999), in the diet of rats as GM foods they used GM potatoes and established excessive growth of the lining of the stomach, pre-cancerous condition, toxic reactions in multiple organ systems and abnormalities in the cells and the structure of the small intestine. Kroghsbo et al. (2008), in the diet of rats as GM foods they used GM Bt rice and established that even low levels of contamination of conventional crops with GM Bt toxin can be harmful to the health of animals. Researchers Diels, et al. (2011), in this analysis included 94 publications selected through objective criteria, where it was determined that during existence of financial or professional conflict of interest, which

were associated with the results of the analysis, genetically modified products are presented subjectively in a positive light. Opposed to this threat, there are benefits in improving positive agronomic traits such as crops resistant to weeds, pests, diseases, pests, getting products with higher nutritional value and resistant to climatic influences. American biotechnological company Monsanto created crops resistant to herbicides, (soybeans, corn, oilseed beet and sugar beet), most often in genetic research, the researchers used a bacterial gene that gives resistance to a particular herbicide variety. In all of mentioned crops, the gene was transformed into a plant cell of the bacterium *E. coli*. One of the most widely used herbicides is glyphosate herbicide known as Roundup, cultures that are resistant to glyphosate are called Roundup Ready, and cultures resistant to this herbicide are called Raundap cultures etc. Resistance to insects, bio pesticides that are produced by living organisms, such as known toxic gene Bt, produced in the bacterium *Bacillus thuringiensis*. Bt gene resistant to insects was engineered in various varieties of corn and cotton. Most varieties of Monsanto corn are resistant on glyphosate. The research on GMO crops are designed to resist diseases caused by viruses, bacteria and fungi, with isolation of genes that are involve in the DNA of various, economic significantcultural plants such as cucumbers, lucerne, potato, tomato, tobacco and etc. Crop production with delayed maturation of the fruits, the first GM food product produced with delayed maturing of the fruits was the variety of tomato Flavr Savr. This variety was produced by blocking the expression of the gene poligalakturonaza(PG), with which it is offered a fresh garden product that will last during the whole year. This product was placed on the market in May 2004 in Chicago by the regulatory control of the United States. (Barnum, 2005). The biggest publicity with improvement of the nutritional alimentary values of GM foods has been achieved with the creation of GM Golden Rice variety, which is enriched with vitamin A, (Paine, et al.2005). According to all warnings about the negative consequences of the inclusion of GM food in the food chain to humans and animals, the pressure of public opinion, today GM food is banned in the following countries: Algeria, Egypt, Sri Lanka, Thailand, China, Japan, Philippines Norway, Austria, Germany, UK, Spain, Italy, Greece, France, Luxembourg, Portugal and Saudi Arabia.

According to the Agency for Food and Veterinary on Republic of Macedonia, this area is regulated by the Law on GMOs, adopted in March 14th, 2008, published in the Official Jurnal of R. Macedonia, no. 35 and amendments to the Law on GMOs, adopted in November 26th, 2013 published in the Official Jurnal of R. Macedonia, no. 163. This law is fully harmonized with the EU legislation, which is considered to be one of the most restrictive and most rigorous in terms of meeting the requirements for safety.

Regulations on the manner and conditions for placing on the market of GM animal feed, which was to come into force in November 26th, 2013, have been withdrawn and it is taken, prohibition or STOP to GM animal feed in the Republic of Macedonia. In R. Macedonia competent authorities claim that there is no GMO food, that none so far has not submitted such a request and that none permit for import has been issued. The food that is imported for feeding animals, must have a certificate confirming that contain GMOs. Due to the latest developments related to GMO food and public debate that are raised in Macedonia on this topic NGO sector seeks to ban the import of genetically modified seeds and feed, as well as any producer of meat, milk and agricultural products to bind to analyzes content of GMOs in food.

In the Law for GM food of R. Macedonia, for proper labeling of GM foods, it was made clear that it should be labeled as GM foods, even foods which contains minimum permitted percentage of GMO of 0.9%, or if the content is determined with traces of GM. In R. Macedonia as GMO-free zones are declared six municipalities: Veles, Chaska, Valandovo, Vasilevo, Mogila and Ohrid and in these areas is not permitted production of GMO foods. The expert public in our country considers that Republic of Macedonia should be declared completely GMO free zone, because despite being a small country, which has a 25 713 km<sup>2</sup> area, agricultural land from 1.121 million hectares and a total population of 2,052,722, has the capacity to produce enough natural healthy food for themselves and for export. Our experts believe that R. Macedonia as a country need to protect indigenous varieties with genetic typing and patenting, because with import of seeds of different crops, there is a risk to our native varieties to disappear in the future.

## Conclusion

Following the demographic growth of the world population, world politics seek opportunities, how to meet rising food needs of the population. Economically developed countries to achieve the objectives of this policy are engaged in developing the techniques of genetic engineering (GI) in order to produce genetically modified organisms (GMOs), which will be a source of GM food or foods that for its genetic composition differs from natural foods, which can only satisfy food needs of the population.

Despite GM's intention to use food for meeting the needs of the population, nonetheless this food on the market, appears with the sole aim of increasing the profit in developed countries, and during that is not taking care of the consequences arising from its involvement in the food chain.

Such a statement is a result of the large number of investigations by competent scientists who noticed many negative consequences of consumption of these foods. Meaning the consequences of the application of this food is far greater than its benefits on the health of people, animals, disturbing the biodiversity of plants with the use of trans-genes and environmental preservation.

That is why a number of countries in the world, among which is the Republic of Macedonia, have enacted laws regulating the production, sale and control of GM food. In our country, the regulations on the manner and conditions for placing on the market of GM animal feed, which was to come into force of 26.11.2013, under the influence of public opinion is withdrawn and it is taken, prohibition or STOP to GM animal feed in Republic of Macedonia.

## References

- Barnum, R. Susan. (2005). *Biotechnology*. Thomson Brook/Cole, a division of Thomson Learning, inc. ISBN 978-0-49501-927-5.
- Brasil, FB., Soares, LL., Faria, TS., Boaventura, GT., Sampaio, FJ. & Ramos, CF. (2009). The impact of dietary organic and transgenic soy on the reproductive system of female adult rat. *Anat Rec (Hoboken)*. 292(4): 587–594.
- Duggan, PS., Chambers, PA., Heritage, J., Forbes & J. Michael. (2003). Fate of genetically modified maize DNA in the oral cavity and rumen of sheep. *Br J Nutr*. 89(2): 159–166.
- De Vendomois, JS., Roullier, F., Cellier, D. & Seralini, GE. (2009). A comparison of the effects of three GM corn varieties on mammalian health. *Int J Biol Sci.*, 5(7), 706–726.
- Diels, J. & et al. (2011). Association of financial or professional conflict of interest to research outcomes on health risks or nutritional assessment studies of genetically modified products. *Food Policy*, 36, 197–203.
- Ewen, SW. & Pusztai, A. (1999). Effect of diets containing genetically modified potatoes expressing *Galanthus nivalis* lectin on rat small intestine. *Lancet*. 354(9187): 1353-1354.
- Finamore, A., Roselli, M. & Britti, S. (2008). Intestinal and peripheral immune response to MON810 maize ingestion in weaning and old mice. *J Agric Food Chem.*, 56, 11533–11539.
- Facts and figures. (2010). MAFWE. Ministry of Agriculture, Forestry and Water Economy. Retrieved from <http://www.mzsv.gov.mk>

- Hines, FA. (1993). Memorandum to Linda Kahlon the Flavr Savr tomato (*Pathology Review PR- 152; FDA Number FMF-000526*): Pathology Branch's evaluation of rats with stomach lesions from three four-week oral (gavage) toxicity studies (IRDC Study Nos. 677-002, 677-004, and 677-005) and an Expert Panel's report. US Department of Health & Human Services. Retrieved from <http://www.biointegrity.org/FDAdoks/17/view1.html>.
- Kroghsbo, S., Madsen, C. & Poulsen, M. (2008). Immunotoxicological studies of genetically modified rice expressing PHA-E lectin or Bt toxin in Wistar rats. *Toxicology*. 245(1-2): 24-34.
- Kilic, A. & Akay, MT. (2008). A three generation study with genetically modified Bt corn in rats: Biochemical and histopathological investigation. *Food Chem Toxicol*. 46(3): 1164-1170.
- Martin, H. (2001). Herbicide resistant weeds. *Ontario Ministry of Agriculture, Food and Rural Affairs*.
- Malatesta, M., Caporaloni, C. & Gavaudan, S. (2002). Ultrastructural morphometrical and immunocytochemical analyses of hepatocyte nuclei from mice fed on genetically modified soybean. *Cell Struct Funct*. 27(4): 173-180.
- Malatesta, M., Biggiogera, M., Manuali, E., Rocchi, MBL., Baldelli, B. & Gazzanelli, G. (2003). Fine structural analyses of pancreatic acinar cell nuclei from mice fed on genetically modified soybean. *European Journal of Histochemistry*. 47: 385-388.
- Malatesta, M. & et al. (2008). A long-term study on female mice fed on a genetically modified soybean: effects on liver ageing. *Histochem Cell Biol*. 130: 967-977.
- Pusztai, A. (2000). Witness's Brief-Flavr Savr tomato study in Final Report (*IIT Research Institute, Chicago, IL 60616 USA*) cited by Dr Arpad Pusztai before the New Zealand Royal Commission on Genetic Modification: *New Zealand Royal Commission on Genetic Modification*.
- Pusztai, A. & Bardocz, S. (2006). GMO in animal nutrition: Potential benefits and risks. In: Mosenthin R, Zentek J, Zebrowska T, eds. *Biology of Nutrition in Growing Animals. Vol 4: Elsevier Limited*; 513-540.
- Prescott, VE., Campbell, PM. & Moore, A. (2005). Transgenic expression of bean alpha-amylase inhibitor in peas results in altered structure and immunogenicity. *J. Agric Food Chem.*; 53 (23): 9023-9030.
- Paine, JA., Shipton, CA. & Chaggar, S. (2005). Improving the nutritional value of Golden Rice through increased pro-vitamin A content. *Nat Biotechnol. Apr*; 23(4): 482-487.

- Séralini, GE., Cellier, D. & Spiroux de Vendomois, J. (2007). New analysis of a rat feeding study with a genetically modified maize reveals signs of hepatorenal toxicity. *Archives of Environmental Contamination and Toxicology*. 52(4): 596–602.
- Séralini, GE., Mesnage, R., Clair, E., Gress, S., de Vendômois, JS. & Cellier, D. (2011). Genetically modified crops safety assessments: *Present limits and possible improvements*. *Environmental Sciences Europe*. 23(10).
- Tudisco, R., Lombardi, P. & Bovera, F. (2006). Genetically modified soya bean in rabbit feeding: Detection of DNA fragments and evaluation of metabolic effects by enzymatic analysis. *Animal Science*. 82: 193–199.
- Trabalza-Marinucci, M., Brandi, G. & Rondini, C. (2008). A three-year longitudinal study on the effects of a diet containing genetically modified Bt176 maize on the health status and performance of sheep. *Livestock Science*. 113(2): 178–190.
- US Food and Drug Administration. (2002). Biotechnology consultation note to the file BNF No 00077. Office of Food Additive Safety, Center for Food Safety and Applied Nutrition. Rats fed GM oilseed rape developed enlarged livers, often a sign of toxicity. Retrieved from <http://www.fda.gov/Food/Biotechnology/Submissions/ucm155759.htm>.
- Vecchio, L., Cisterna, B., Malatesta, M., Martin, TE. & Biggiogera, M. (2004). Ultrastructural analysis of testes from mice fed on genetically modified soybean. *Eur J Histochem*. 48(4): 448-454.
- Законот за Генетски Модифицирани Организми. (2008). *Службен весник на Република Македонија*, 14. Март, 2008, 35/08.
- Дополнување на Законот за Генетски Модифицирани Организми, (2013). *Службен весник на Република Македонија*, 11. Ноември, 2013, 163/13.

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# Uvođenje genetski modifikovanih organizama (GMO) - rizici ili prednosti po zdravlje životinja i građana Republike Makedonije

Živko Gacovski<sup>1</sup>, Goce Cilev<sup>1</sup>, Biljana Petrovska<sup>1</sup>

<sup>1</sup>Univerzitet "St. Kliment Ohridski" Bitola,  
Fakultet veterinarske medicine, R. Makedonija

## Sažetak

Genetski modifikovani organizmi (GMO) su organizmi kod kojih je došlo do planske modifikacije naslednog genetskog materijala (DNK) na neprirodan način uz primjenu savremenih tehnika genetskog inženjeringa, a ta izmjena se prirodnim načinom razmnožavanja nikada ne bi desila. GMO su izvor laboratorijski modificirane hrane, raznih veštačkih dodataka i aditiva. Predmet istraživanja u ovom radu je sagledavanje uticaja GM na hranu, kao pretnje ili dobiti po zdravlje ljudi i životinja, kao i njezinu primenu u R. Makedoniji. Korišćena je komparativna analiza naučnih istraživanja iz oblasti savremene biotehnoške nauke sa korišćenje tehnike genetskog inženjerstva. Iz analize dosadašnjih istraživanja, oficijalni podaci za eventualne posledice po zdravlju čoveka nema, a ispitivanja na životinjama pokazala su negativne posledice po njihovo zdravlje.

*Ključne reči:* GM hrane, GI, zdravlje, zakon

Zivko Gacovski  
E-mail address: zivko.gacovski@uklo.edu.mk

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