The status and prospects for genetically modified food in Europe and Croatia

Status i perspektive za genetski modificiranu hranu u Europi i Hrvatskoj

Nada KNEŽEVIĆ[1*], Jelena ĐUGUM[2] and Jadranka FRECE[3]

[1*]Podravka d.d., Food industry, Koprivnica, Croatia, E-mail: nada.knezevic@podravka.hr * *correspondence

[2] Ministry of Agriculture, Zagreb, Croatia

[3] Faculty of Food Technology and Biotechnology, Zagreb, Croatia

Abstract

In the last sixteen years worldwide production of genetically modified (GM) crops has been increased sharply. At the same time, consumer's attitudes toward food products made from GM ingredients have been largely negative. This review considers the global production of GM plants in 2011 and consumer attitudes towards genetically modified foods in Europe and Croatia. While planted areas of GM crops grow worldwide, data from European surveys shows generally negative consumer's perception towards GM food. Eurobarometer survey from 2010 was especially pointed out, where Croatian consumers were included in research for first time. It has been shown that the Croatian, even more than Europeans, do not approve the use of genetically modified food in human consumption. This aversion to GM crops is based on the personal attitude of consumers, whereas the two main risks cited are: potential health risk and preference for natural food, and social risks which include possible adverse effects of GM plants on the environment. Research has shown that the perceived level of risk by consumers can be mitigated if the confidence is built in state institutions and scientific research.

Key words: consumer opinion, genetically modified crops, genetically modified food, GMO, legislation

Sažetak

U posljednjih šesnaest godina u svijetu je naglo porasla sjetva genetski modificiranih (GM) biljaka. Istovremeno, stav potrošača prema prehrambenim proizvodima dobivenim iz GM sastojaka je nepromijenjen i dalje vrlo negativan. U ovom radu daje se pregled svjetske proizvodnje GM biljaka u 2011. godini te stav potrošača prema genetski modificiranoj hrani u Europi i Hrvatskoj. Dok s jedne strane u svijetu rastu površine zasijanih GM kulturama, s druge strane podaci europskih istraživanja pokazuju općenito negativne percepcije potrošača prema GM hrani. Posebno je

istaknuto istraživanje Eurobarometra iz 2010., gdje su po prvi put bili uključeni i hrvatski potrošači. Pokazalo se da Hrvati, čak i više od Europljana, ne odobravaju korištenje genetski modificirane hrane u prehrani ljudi. Ova odbojnost prema GM kulturama temelji se na osobnom stavu potrošača, gdje se kao glavna dva rizika navode onaj zdravstveni i sklonost prirodnoj hrani, te socijalni rizik koji uključuje moguće negativne utjecaje GM biljaka na okoliš. Istraživanje je pokazalo da uočena razina rizika od strane potrošača može biti ublažena ukoliko je izgrađeno povjerenja u državne institucije i znanstvena istraživanja.

Ključne riječi: genetski modificirane biljke, genetski modificirana hrana, GMO, mišljenje potrošača, zakonodavstvo

Introduction

While the application of biotechnology in pharmaceuticals has been largely accepted, the debate on the safety of genetically modified organisms (GMOs) used for food and feed is still very lively throughout the world, more than sixteen years after their commercial release (1996 – 2012). Although some stakeholders claim that a history of safe use of GMOs can be upheld, other thinks that there are not enough human or animal epidemiological studies to support such claim (Spiroux de Vendômois et al., 2010). The most striking advances over the past years have involved engineered plants to produce missing nutrients or increase the level of nutrients in the food (Farre et al., 2010). Several recent reports have demonstrated how GM engineering can increase the level of carotenoids in edible plant tissues or level of folate, ascorbate, iron or calcium (Wirth et al., 2009; Morris at al., 2008). An important trend is to make a distance from plants engineered to produce single nutritional compounds and strive towards those simultaneously engineered to produce multiple nutrients (Naqvi et al., 2010).

Yields from GM crops yearly rises around the world, but consumer's attitudes toward GM food products are largely negative in many of the developed countries in the European Union (Kaluđerović, 2008). Consumer scepticism is usually attributed to the unknown health and environmental consequences of genetically modified food (Alagić et al., 2005; Fagan, 2008; Pusta et al., 2009). Such consequences include unanticipated allergic responses, the spread of pest resistance or herbicide tolerance to wild plants, and inadvertent toxicity to wildlife. According to scientific data collected until today, there were no records of negative effects of GM food on human health, except its possible allergenicity, which is the possible risk in a non-modified food as well; so many scientists agree that this should not be a reason against (Bachas-Daunert and Deo, 2008).

In this review some of the recent surveys and consumer's attitudes towards food products in developed countries in Europe are summarized. Particular emphasis is given on the last Eurobarometer survey conducted in 2010, when the first- time survey was conducted in countries that are non-members of the European Union, and Croatia is one of them. This is even more interesting, while there is no official research on the acceptance of GM food by consumers in Croatia.

Status of genetically modified crops

The genetically modified (GM) plants, as well as feed/food produced from them, have been present in fields and markets worldwide. GM crops were first grown on a large scale in 1996 when US farmers started to grow Monsanto's Roundup Ready soya. In 2011, according to International Service for the Acquisition of Agri-Biotech Applications, GM crops were planted on the 160 million hectares, what is significant 8% growth rate of all 1.7 billion hectares of cropland in the world and 94-fold increase in hectares between 1996 and 2011 (James, 2010). Today the largest producers of GM crops are the USA (69 million hectares), Brazil (30.3), Argentina (23.7), India (10.6), Canada (10.4) and China (3.9). The number of countries which grow GM crops has increased to 29 and in 2010 for the first time there were three new countries reported planting GM crops officially in 2010: Pakistan, Myanmar and Sweden (James, 2010).

According to the survey of James (2011), eight EU countries planted GM crops in 2011, six countries planted 114.49 hectares of Bt maize, led by Spain, two countries planted small hectares of new starch potato called “Amflora” - Sweden and Germany. Totally 60 countries have granted regulatory approvals for importing biotech crops for food and feed use, of which 30 countries planted commercialized GM crops. Crops where the most events are approved are: maize (65), cotton (39), canola (15), potato and soybean (14 for each). Herbicide tolerant soybean and maize and insect resistant maize and cotton are the events that have received regulatory approval in most of the countries.

Although many questions regarding usage and cultivation of genetically modified plants remain open, their growing increases continuously every year.

Regulations related to genetically modified food

Whereas the United States has embraced products approach to GM agriculture, the European Union has tended to adopt the more precautionary process approach; in 1990 the European Council adopted the first measure aimed specifically at controlling environmental aspects of GMOs - Directive 90/220/EEC. The inherent tensions between these two divergent regulatory philosophies first produced open conflict in the 1990s.

In 1996, farmers in the USA began growing Monsanto’s GM soybeans. New seeds had easily passed regulatory muster in the United States, and the EU authorized their import without segregation or labelling requirements under Directive 90/220/EEC. In 1997 the EU revised its legislation, giving “substantial equivalence” a statutory role. Regulation 258/97 on Novel Food established a legal duty to seek approval before commercialisation of any novel food, e.g. GM food (Regulations (EC) No 258/97 of the European Parliament and of the Council of 27 January 1997 concerning novel foods and novel food ingredients). Unlike Directive 90/220, this new law had simplified procedures for novel food substantially equivalent to existing food or food ingredients in regards of their composition, nutritional value, metabolism, intended use and the level of undesirable substances contained therein. If a GM product was substantially equivalent to a conventional counterpart, then no risk assessment was required (Levidow et al., 2007).

EU member states granted no new approvals of GMOs after 1998. In the meantime, the EU negotiated new environmental and food-safety rules for GM crops, including

the revised Directive 2001/18/EC on environmental impacts of GMO, which came into force in October 2002 (Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC). New Regulations (EC) No. 1829/2003 and 1830/2003 concerning the authorization, traceability and labelling of GMOs and GMO-derived products went into force in April 2004 (Regulations (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed, Regulations (EC) No 1830/2003 of the European Parliament and of the Council of 22 September 2003 concerning the traceability on labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC). This new regime now requires full traceability and labels must accompany all GM-derived products, even if the final product lacks foreign DNA or protein if the level exceeds the prescribed threshold. Traceability of GM plants has important part in quality control and monitoring of primary and processed plant products. European's countries have issued specific GM labelling regulations, if a food contains or consists of genetically modified organisms (GMOs), or contains ingredients produced from GMOs, this must be indicated on the label. For GM products information must be displayed immediately next to the food to indicate that it is GM. This includes products such as flour, oils and glucose syrups have to be labelled as GM if they are from a GM source. Products produced with GM technology (cheese produced with GM enzymes, for example) do not have to be labelled. The Food and Feed Regulation provides threshold for the adventitious, or accidental, presence of GM material in non-GM food or feed sources. This threshold is set at 0.9% and only applies to GMOs that have an EU authorization. The temporary threshold of 0.5% for the presence of GM material not yet authorized, but that had a favourable assessment from an EU scientific committee, expired in April 2007. This means that such unauthorized GM material cannot be present at any level.

In Croatia, not currently member of EU, in 2005 was authorized by the Parliament new GMO law that applies to all GMOs, except those used in food the feed (Law on Genetically Modified Organisms, Official Gazette No. 70/2005). GM food and feed was regulated by the Food Law and regulations arising from it (Food Law, Official Gazette No. 46/2007). Croatia signed the "Cartagena Protocol", accepting to assure adequate level of safe transfer, handling and use of GMO. Requirements regarding approval placing on the market and labelling of GMO are harmonized with those of European Union. Croatian Ministry of Health and Ministry of Agriculture are in charge for the control of GMOs use in food and feed. The GMOs control in Croatia includes a network of the inspections at the Croatian borders as well as institutions authorized to control the food/feed quality before it is placed on the market. Since establishing appropriate regulations related to GMOs, there is an evident decrease of the positive samples analysed in laboratories in the process of official controls (Cattunar at al., 2011).

Consumer's opinion on genetically modified food in Europe

The introduction of GM crops and food into the existing food production system has generated a number of questions about possible negative consequences which focus on health effects, environmental safety, labelling, consumer choice and ethical

issues. Several articles show the diversity of consumer's approval or refusal of biotechnology based food products. Some surveys carried out in Europe indicated that consumers are very sceptical about the use of GMO in food products (Gaskell at al., 2004). The scientific consensus is that GM food does not pose any risk to consumers. However, there is a distinction between scientifically assessed risk and perceived risk (Johnsons et. al., 2006). The public's beliefs about risk are often very different from the beliefs of experts. Most experts in science have recognized the importance of bringing public deliberation into the process of risk assessment. They acknowledge that such public participation is often crucial for achieving both scientifically and politically reliable results (Winickoff et al., 2005). The determinants of opposition to acceptance of GM food seem to be largely linked to individual attitudes and values where the level of scientific knowledge about biotechnology is of relatively less importance then the formation of individual preferences (Pardo el al., 2004).

Studies in Europe provide strong evidence that consumers are willing to take on the unknown risks of consuming genetically modified food only if these products are offered at significant cost savings over non-GM foods. Nelson (2001) concluded that European consumers generally are focused on the unknown risks associated with genetically modified products, not the benefits. Noussair et al. (2004) conducted an experiment where they auctioned four types of biscuits: "contains GMO", "is GMO free", "no ingredients contain more than 1%GMOs" and "no ingredients contain more than 0,1%GMOs". The data indicated that only slightly more than a third of the population would be unwilling to purchase GMOs and those existing consumers who reveal only mild or no dislike for GM food when information is probabilistic. However, when their food is labelled, their disutility from consuming GM foods is pronounced. Their preferences could be distinguished from consumers who intensely dislike GM foods.

The consumer weighs the expected benefits and expected costs depending on his or her risk tolerance. These perceived risks are seen as potential future costs by the consumer and carries probabilities of occurrence assigned by the consumer, and are thus subjective (Bansal et al., 2010). The probability that the consumer assigns to each potential cost or risk primarily stems from three sources: (a) the level of trust in government regulators regarding food supply safety; (b) attitudes toward scientific discovery; and (c) the influence of media coverage (Curtis et al., 2004). Other analysis indicates that an effort to increase trust in scientists, public authorities and industry would lead to an increase in the acceptability of GM foods (Rousselière and Rousselière, 2010).

The disparity between consumers attitude toward genetically modified food worldwide is obviously large. Compared with consumers in Europe, studies in the United States find consumers to be more accepting of genetically modified foods. This was confirmed by the study of Lusk et al. (2006) in an experimental setting where they showed that the level of compensation required to induce consumers to accept GM food was much higher for European compared to US consumers. Because nutritious food is readily available in both, the United States and Europe, consumers in these countries do not perceive the same benefits from GM foods. In Europe, food scares and scandals have affected consumer trust. Further, Europeans tend to take pride in traditional ways of doing things and do not necessarily see scientific discovery as life-improving (Curtis et al., 2004).

The levels of support for GM food for 27 European's country in 2010 and for comparative purpose 25 European country in 2005 are presented in survey of Gaskell et. al (2011). The comparison between 2010 and 2005 shows no substantial changes in the public's perception of GM food. In 2010, combining 'totally agree' and 'tend to agree' is found 23% in support. By the same token, 61% are not willing to support GM food. It is noticeable that in the countries, in which GM crops are currently cultivated, support for GM food tends to be the highest and levels of support in the countries in which have bans on the cultivation of GMOs, are the lowest in Europe.

In 2010 the Eurobarometer survey (European Commission, 2010) found that 70% of Europeans thought GM food is fundamentally unnatural, 59% Europeans disagree that GM food is safe for their health and that of their family, and 58% disagree that GM food is safe for future generations (Table 1, Figure 1). The survey shows that Europeans do not see the benefits of genetically modified food and consider these to be unsafe or even harmful and they are not in favour of the development of genetically modified food.

Table 1: Attitude towards genetically modified foods

	Agree		***Disagree***		***Don't know***	
	% respondents					
	EU	**HR**	**EU**	**HR**	**EU**	**HR**
GM food is good for the economy	31	15	50	77	10	8
GM food is not good for you and your family	54	61	30	32	16	7
GM food helps people in developing countries	43	37	37	51	20	12
GM food is safe for future generations	21	16	58	72	21	12
GM food benefits some people but puts others at risk	57	56	25	32	18	12
GM food is fundamentally unnatural	70	81	20	13	10	6
GM food makes you feel uneasy	61	77	29	17	10	6
GM food is safe for your health and your family's health	22	11	59	79	19	10
GM food does no harm to the environment	23	19	53	63	24	18
The development of GM food should be encouraged.	23	12	61	77	16	11

Source: made by authors based on data from European Commission (2010)

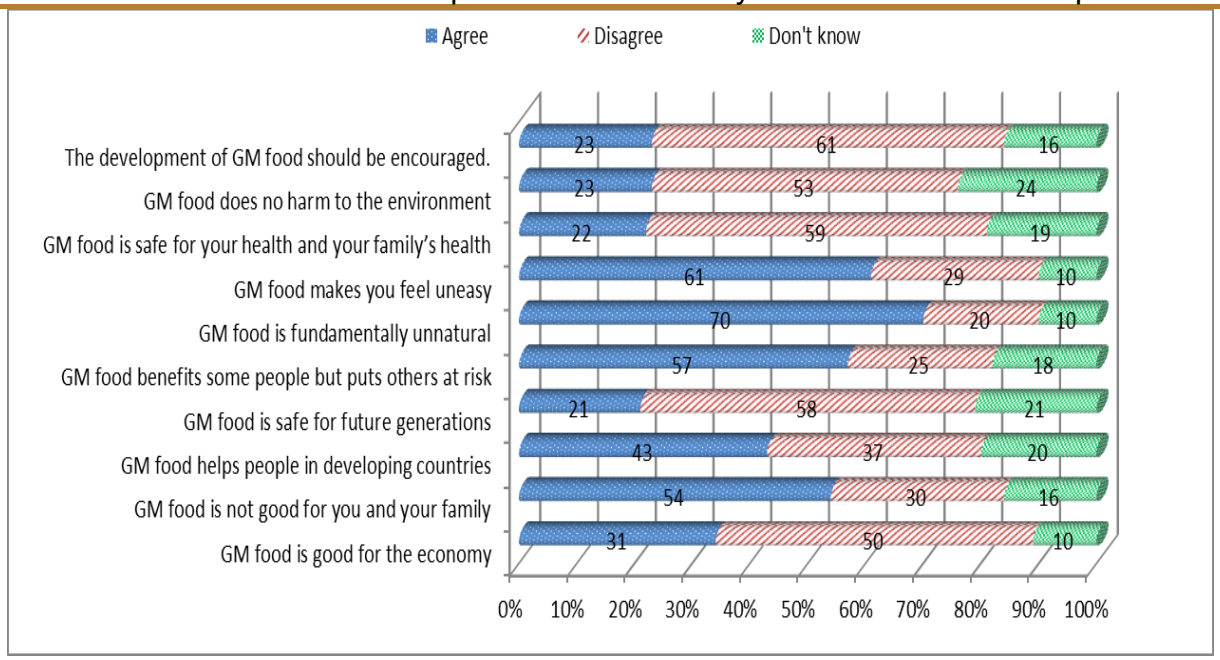

Figure 1: The attitude of the respondents from the European Union (EU 27) to genetically modified food (Source: made by authors based on data from European Commission (2010))

Consumer opinion on genetically modified food in Croatia

The first survey of consumer's attitude towards GM food on the Croatian territory was conducted throughout Eurobarometer survey in 2010 (Table 1, Figure 2). The results showed that Croatian consumers, as well as European, have a very negative attitude towards GM food.

The Table 1 and Figure 2 show that 77% of Croats (and just 50% of Europeans) disagree that GM food is good for their national economy, 61% (54% Europeans) agrees that GM food is not good for themselves or their family, and a slim majority of 51% (37% Europeans) of respondents agree that GM food do not help people in developing countries. A majority of Croats (72%) feels that GM food is not safe for future generations. Most of them agree that GM food is fundamentally unnatural (81%), is not safe for health (79%) and the environment (63%). Croats do not see benefits of genetically modified food, they consider genetically modified food as unsafe or even harmful. According to the Eurobarometer survey is evident even greater resistance of the Croatian's consumers towards GM food, sometimes higher than in the European Union.

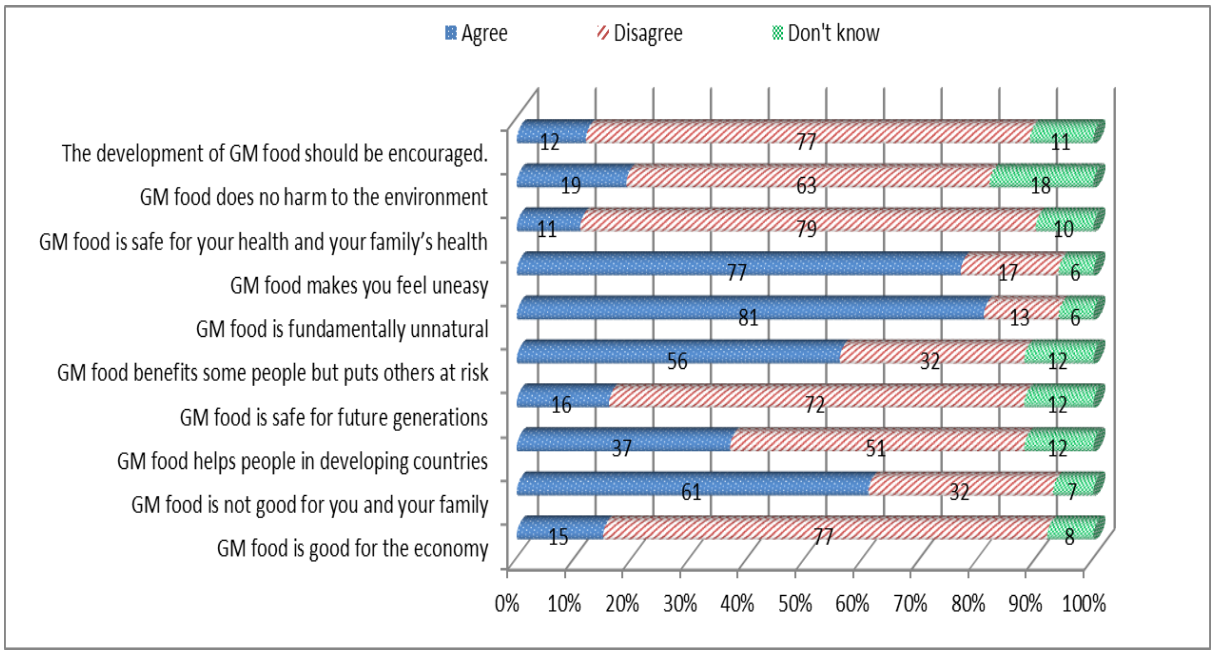

Figure 2: The attitude of the respondents from the Croatia to genetically modified food (Source: made by authors based on data from European Commission (2010))

Conclusions

As a result of mandatory labelling or consumer resistance, most EU retailers have stopped selling GM food. It is evident declining support to GM food across many of the EU Member States and in Croatia, too. Public concerns about safety are paramount, followed by the perceived absence of benefits and GM food is seen as unnatural. High potential risk perceptions, coupled with minor benefits of GM foods, provide a strong argument for the anti-GM food sentiments in Europe and Croatia. There has been a larger breakdown in society's trust of both scientific applications and the regulatory process safeguarding people and the environment against potential risks. This breakdown in trust could have much more far-reaching consequences for science and the acceptance of other emerging scientific innovation (e.g. in medicine, nanotechnology etc.).

Results published in referred reviews lead to the conclusions that prospects for GM crops in Europe and Croatia depend on:

- Consumer acceptance, which depends on the perception of the benefits GM crops offer and on confidence in the legislative framework and regulatory procedures designed to identify and quantify any potential disadvantages,
- The relative profitability of GM crops in relation to conventionally bred varieties, and
- Further technological advances, which might reduce any adverse consequences and enhance the benefits from GM crops.

Controversy on biological interpretations is a usual way of advancement in science. It would however have been beneficial for the acceptance of biotechnologies by the

public at large, to close this scientific debate by longer, more detailed and transparent tests on GMOs.

References

Alagić, D., Smajlović, F. and Čaklovica, F., (2005) Genetically modified organisms (GMOs) in human nutrition. Meso, 7 (5) 48-54

Bachas-Daunart, S., Deo, S.K. (2008): Should genetically modified foods be abandoned on the basis of allergenicity? Anal Bioanal Chem 392:341-346

Bansal, S., Chakravarty, S. and Ramaswami,B., (2010) Weak Aversion to GM Food: Experimental evidence from India. Discussion Papers in Economics, 10 (2) 1-29

Cattunar, A., Capak, K., Žafran Novak, J.,Mićović, V. Doko-Jelinić, J. and Malatestinić,D.(2011) Monitoring the Presence of Genetically Modified Food on the Market of the Republic of Croatia. Collegium Antropologicum 35 (4), 1231-1236

Curtis, K.R., McCluskey, J.J. and Wahl, T.I., (2004) Consumer Acceptance of Genetically Modified Food Products in the Developing Word, AgBioForum, 7 (1&2), 70-75

Directive 2001/18/EC of the European Parliament and of the Council of 12 March 2001 on the deliberate release into the environment of genetically modified organisms and repealing Council Directive 90/220/EEC, Official Journal (2001) L 106, 1–39 with subsequent amendments

European Commission (2010) Biotechnology, Special Eurobarometer, 341/ Wave 73.1, October 2010, http://ec.europa.eu/public_opinion/archives/ebs/ebs_341_en.pdf, Accessed on 07.08.2012.

Fagan, J., (2008) Impacts of GMOs on organic agriculture, Agronomski glasnik 3, 211-234

Farre, G, Twyman, R.M., Zhu, C., Capell, T. and Christou, P., (2010) Nutritionally enhanced crops and food security: scientific achievements versus political expediency. Current Opinion in Biotechnology, 22, 1-7

Food Law, Official Gazette No. 46/2007, http://narodne-novine.nn.hr/clanci/sluzbeni/297990.html, Accessed on 07.08.2012.

Gaskell G., Allum N., Wagner W., Kronberger N., Torgersen H., Hampel J . and Bardes J .(2004) GM foods and the misperception of risk perception. Risk Analysis 24 (1), 185-194.

Gaskell, G., Allansdottir, A., Allum, N., Castro, P., Esmer, Y., Fischler, C., Jackson, J., Kronberger, N., Hampel, J., Mejlgaard, N., Quintanilha, A., Rammer, A., Revuelta, G., Stares, S., Torgersen, H., Wager, W., (2011) The 2010 Eurobarometer on the life sciences, *Nature Biotechnology* 29, 113–114

James, C. (2010) Global Status of Commercialized Biotech/GM Crops: 2010. *ISAAA Brief* No 42, ISAAA: Ithaca, NY.

James, C. (2011) Global Status of Commercialized Biotech/GM Crops: 2011. ISAAA Brief No 43, ISAAA: Ithaca, NY

Johnson, K.L., Raybould, A.J., Hudson, M.D. and Poppy, G.M., (2006) How does scientific risk assessment of GM crops fit within the wider risk analysis? Trends in Plant Science, doi:10.1016/ j.tplants.2006.11.004

Kaluđerović, Ž., (2008) GMOs: The first twelve years – status and perspectives. Soc.ekol. Zagreb, 17 (2) 167-181

Levidow, L., Murphy, J.and Carr, S., (2007) Recasting „Substantial Equivalence“: Transatlantic Governance of GM Food, Science, Technology and Human Values 32 (1), 26-64

Law on Genetically Modified Organisms, Official Gazette, No. 70/2005 with subsequent amendments, http://narodne-novine.nn.hr/clanci/sluzbeni/288895.html, Accessed on 07.08.2012.

Lusk, J.L., Traill, W.B., House, L.O., Valli, C., Jaeger, S.R., Moore, M. and Morrow, B. (2006) Comparative Advantage in Demand: Experimental Evidence of Preferences for Genetically Modified Food in the United States and European Union, Journal of Agricultural Economics, 57 (1), 1-21

Morris J, Hawthorne K.M., Hotze T., Abrams S.A., Hirschi K.D., (2008) Nutritional impact of elevated calcium transport activity in carrots, Proc Natl Acad Sci USA, 105, 1431-1435

Naqvi S, Farre G, Sanahuja G, Capell T, Zhu C, Christou P., (2010) When more is better: multigene engineering in plants, Trends Plant Science 15, 48-56.

Nelson, C.H., (2001) Risk perception, behaviour, and consumer response to genetically modified organisms. American Behavioural Scientist, 44 (8), 1371-1388

Noussair, C., Robin, S. and Ruffieux B., (2004) Do consumers really refuse to buy genetically modified food? The Economic Journal, 114, 102-120.

Pardo R., Midden C. and Miller J., (2004) Attitudes toward biotechnology in the European Union, Journal of Biotechnology, 98, 9-24

Pusta, D., Pascsa, I., Morar, R., Sobolu, R., Răducu, C. and Odagiu, A., (2009) The transgenic plants – advantages regarding their cultivation and potentially risks concerning the food safety. Journal of Central European Agriculture, 9 (4) 785-788

Regulations (EC) No 258/97 of the European Parliament and of the Council of 27 January 1997 concerning novel foods and novel food ingredients, L 43, 1-6

Regulations (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed, Official Journal, L 268, 1–23

Regulations (EC) No 1830/2003 of the European Parliament and of the Council of 22 September 2003 concerning the traceability on labelling of genetically modified organisms and the traceability of food and feed products produced from genetically modified organisms and amending Directive 2001/18/EC, Official Journal, L 268, 24–28

Rousselière D. and Rousselière S., (2010) on the impact of trust on consumer willingness to purchase GM food: Evidence from a European survey. Review of Agricultural and Environmental Studies, 91 (1), 5-26

Spiroux de Vendômois, J., Cellier, D., Vélot, C., Clair, E., Mesnage, R., and Séralini, G.E., (2010) Debate on GMOs Health Risks after Statistical Findings in Regulatory Tests. International Journal of Biological Science 6 (6) 590-598

Winickoff, D., Jasanoff, S., Busch, L., Grove-White, R., Wynne, B., (2005) Adjudicating the GM Food Wars: Science, Risk, and Democracy in Word Trade Law, The Yale Journal of International Law, 30, 81-123

Wirth J., Poletti S., Aeschlimann B., Yakandawala N., Drosse B., Osorio S., Tohge T., Fernie A.R., Gunther, D., Gruissem W., Sautter C., (2009) Rice endosperm iron biofortification by targeted and synergistic action of nicotianamine synthase and ferritin. Plant Biotechnology Journal 7, 1-14