Genetically Modified (GM) Foods and Ethical Eating

Francis Dizon, Sarah Costa, Cheryl Rock, Amanda Harris, Cierra Husk, and Jenny Mei

Abstract: The ability to manipulate and customize the genetic code of living organisms has brought forth the production of genetically modified organisms (GMOs) and consumption of genetically modified (GM) foods. The potential for GM foods to improve the efficiency of food production, increase customer satisfaction, and provide potential health benefits has contributed to the rapid incorporation of GM foods into the American diet. However, GM foods and GMOs are also a topic of ethical debate. The use of GM foods and GM technology is surrounded by ethical concerns and situational judgment, and should ideally adhere to the ethical standards placed upon food and nutrition professionals, such as: beneficence, nonmaleficence, justice and autonomy. The future of GM foods involves many aspects and trends, including enhanced nutritional value in foods, strict labeling laws, and potential beneficial economic conditions in developing nations. This paper briefly reviews the origin and background of GM foods, while delving thoroughly into 3 areas: (1) GMO labeling, (2) ethical concerns, and (3) health and industry applications. This paper also examines the relationship between the various applications of GM foods and their corresponding ethical issues. Ethical concerns were evaluated in the context of the code of ethics developed by the Academy of Nutrition and Dietetics (AND) that govern the work of food and nutrition professionals. Overall, there is a need to stay vigilant about the many ethical implications of producing and consuming GM foods and GMOs.

Keywords: autonomy, beneficence, genetically modified food, justice, nonmaleficence

Introduction

Genetically modified (GM) foods are those whose genetic makeup has been altered "in a way that does not occur spontaneously" (WHO 2015). Other names for GM-classified foods include the terms "genetically engineered (GE)" and "transgenic" (Bawa and Anilakumar 2013). In contrast, organisms (for example, *bacteria*) that are GM are referred to as genetically modified organisms (GMOs). The process of genome manipulation involves the translocation of genes from multiple genetic sources, in a process widely known as recombinant deoxyribonucleic acid (rDNA) technology (Bawa and Anilakumar 2013). Three basic rDNA techniques include transformation, phage introduction, and nonbacterial transformation (Kuure-Kinsey and McCooey 2000).According to Kuure-Kinsey and McCooey (2000), transformation involves enzymatically excising a desired fragment of DNA, inserting it into a vector vehicle, and implanting the vector into a host cell (for example, *Escherichia coli*) for DNA reproduction. Moreover, Kuure-Kinsey and McCooey (2000) also explained nonbacterial transformation, where the DNA vector is inserted directly into the nucleus of a cell, instead of a bacterial host cell. A third technique also described by Kuure-Kinsey and McCooey (2000) which was phage induction, incorporates a bacteriophage (that is, *virus*) in place of a bacterial cell, with the same principles as transformation. Using these techniques, rDNA can be used to directly incorporate extraneous genetic material into the food matrix. Furthermore, insertion of rDNA into plant cells for industrial genetic modification primarily includes 2 prominent methods, which are the (1) gene gun method and (2) *Agrobacterium* method. The gene gun method involves bombarding target plant cells using gene-coated particles of gold or tungsten (Hain and Don 2003). Desired rDNA strands are coated on the entire surface of either gold or tungsten micromolecules, which are then propelled towards a plant cell using a vacuum chamber for random insertion into cells. However, the more common of the 2 methods is the use of *Agrobacterium tumefaciens*, a bacterium that parasitizes plants by inserting its DNA plasmid into cells to initiate host colonization (Hain and Don 2003). This process removes the DNA sequence that controls metabolism and replaces it with the bacterial rDNA strand (Hain and Don 2003). Using these 2 methods, scientists are able to implement rDNA technology for a myriad of industrial applications.

Further exploration of the history of GM foods shows the advancement of the science in rDNA technology as it applies to food technology. The first food industrial application was the development of the Flavr Savr™ tomato. Introduced in 1994, the Flavr Savr™ exhibited longer shelf -life due to its ability to suppress the polygalacturonase (PG) gene, which initiates the upregulation of the enzyme PG, that ripens plant products (Krieger and others 2008). This modification allowed for tomatoes with delayed ripening after harvest (Bawa and Anilakumar 2013). Unfortunately, the Flavr Savr™ tomato received little economic stimulation and consequently its production by Calgene was discontinued (Martin 2013). Other applications developments in GM foods include herbicide tolerance and insect resistance (Stone 2010), micronutrient enrichment, and pathogen resistance to bacteria, fungi and viruses (Weale 2010). While GM foods offer numerous health and agricultural benefits (Verma and others 2011), the public outlook on the consequences of genetic pollution and the ethical notions of genetic modification have given well-known infamy to GM foods (Kwieciński 2009).

With the surge of GM foods, the notion of ethical eating has surfaced. Ethical eating focuses on the "moral consequences of food choices" and food product development (Unitarian Universalist Association 2014). Issues regarding the ethics and morality of

MS 20150778 Submitted 5/10/2015, Accepted 11/22/2015. *Authors are with the 1250 Bellflower Boulevard, Dept. Family and Consumer Sciences, California State Univ., Food Science and Nutrition Laboratory, Long Beach, Calif, 90840, U.S.A. Direct inquiries to author Rock (E-mail: cheryl.rock@csulb.edu).*

doi: 10.1111/1750-3841.13191

Journal of Food Science
A Publication of the Institute of Food Technologists

genetic modification and its industrial uses have echoed through both public and expert opinions. Most prevalent are (1) concerns surrounding the safety of GM food consumption, (2) the interference of the natural evolution of organisms, and more recently, (3) the potential benefits of GM foods increasing food insecurity (Weale 2010). Another major ethical concern surrounding GM foods is the disruption of natural biodiversity (that is, *a result of cross-pollination of genes from GM crops to natural foods*), and the potential impact on ecosystems (Murnaghan 2012). These concerns are pitted against various codes of ethics (AND 2009), which mandates that nutrition and food professionals contemplate the health and safety of the public in their practice. Thus, food scientists and nutrition professionals should exercise total autonomy, an ethical standard that must be abided by, when providing advice to clients or patients about the incorporation of GM foods into products, meal plans and diet changes. A rising issue is weighing the disadvantages of GM foods against the benefits, especially since GM foods have the potential to help developing nations in need of economic stimulation and food security. If such benefits do exist, the responsible use of GM foods should be employed, as failing to do so would be "contrary to the principles of justice and solidarity" (Weale 2010). The ethical principle of justice, in regards to GM foods, is concerned with providing fair and equal access to foods. On top of this principle, solidarity in the context of GM foods is the notion of "collaborative action" (Food and Agricultural Organization [FAO] 2015), working towards the end of food insecurity in developing nations. Ethical eating focuses on the morality and consequences of consuming GM foods, and thus encompasses many controversial and perplexing issues. GM foods are perceived as a double-edged sword in the food science community, the food industry, and by the public for the following reasons: (1) the need for transparency of the food-labeling regulations and (2) the moral dilemmas affiliated with the concerns of tampering with "Mother Nature"; both of which are weighed against (3) the advantages of food biotechnology which are discussed in this paper.

Labeling of GMOs

Since their conception, GM crops and GMO-containing food products have been the center of the public's attention and is continuing to grow as more of these products enter the market. Approximately, 85% of corn is GM followed by 88% of cotton and 91% of soybeans all of which are now present in 75% to 80% of conventional processed foods in the United States (Center for Food Safety 2014).

With many GMO-containing food products available in the marketplace, mandatory labeling of these products is debated. It is a general notion that it is the consumer's right to know (that is, *autonomy*) what contains GM ingredients, the Food and Drug Administration (FDA), however, does not have evidence concluding that GM foods differ from other foods in any meaningful or uniform way, or that foods developed by rDNA techniques present any different or greater safety concern than foods developed by traditional plant breeding (FDA 2001). Consequently, in the United States, labeling of GM products is not required. U.S. law only requires GM food labeling when "there is a substantial difference in the nutritional or safety characteristics of a new food" (Byrne and others 2014). From an ethical point of view, this policy may contradict the principle of autonomy, which in this context the ability to provide to those who want detailed information about genetic modifications made to their food products. As evidenced by an average of 91% in favorable responses in opinion polls since 1992, an overwhelming majority of the American public supports GM food labeling (Wohlers 2013). Therefore, those seeking more information about their food may believe that food labeling of GM products would respect their autonomy, giving them the opportunity to make their own informed decisions.

International requirements and regulations of labeling GMOs

In contrast to the U.S.'s flexible labeling protocol regarding GM foods, as of 2013, 64 countries require GM labeling; with more than a third of these under a single European Union (EU) ruling, such as: the United Kingdom (UK), Italy, Croatia, Finland, and Greece (Davison 2010). GM organisms as well as processed foods, and ingredients that are produced from GM plants or GMOs are required to all be labeled. Many of these countries require mandatory labeling of nearly all GM foods and a labeling threshold of 0.9% to 1% GM content by weight (Center for Food Safety 2014). The threshold may refer to content per ingredient in each food item or GM ingredients which total 1% in the entire product (Center for Food Safety 2014).

Although there are no mandatory labeling requirements in the United States as previously mentioned, voluntary labeling has been in effect in the United State for some time. In 2001, the FDA proposed voluntary guidelines for companies that chose to label foods as to whether they do or do not contain GM ingredients if they see sufficient market opportunities for doing so (FDA 2001). The Non-GMO Project is the only third party verification nonprofit organization that exists in America, which facilitates the labeling of non-GM/GMO food and products. Their mission is to preserve and build sources of non-GM/GMO products, as well as to educate consumers about consumption of GM/GMO products (Non-GMO Project 2015). This project directly relates to the ethical principle of autonomy, as the organization seeks to provide the opportunity for consumers to make more informed decisions about their food choices. Other than these efforts of the Non-GMO project product verification, there is no known regulation in place that facilitates or mandates the labeling of GMO foods.

Standard for labeling GM food

In April 2014, the Safe and Accurate Food Labeling Act (SAFLA) of 2015 was proposed by Congressmen Pompeo and Butterfield in order to keep American-produced food safe, nutritious, and affordable. The SAFLA of 2015 is an amendment to the 1938 Federal Food, Drug, and Cosmetic Act (FDCA), which makes the following provisions for the FDA to regulate: (1) a more uniform labeling system for the premarketing of GM food in the U.S. to avoid labeling inconsistencies in interstate commerce, (2) all new GM crop varieties and products before being commercialized, (3) special labeling for GM products if necessary to ensure their health and safety, (4) the use of the labeling terms such as "natural" on GM food products, and (5) label claims on products to be certified "GMO-Free" through a USDA accredited program. This new act can facilitate a consistent legal framework that companies could use to guide them in regards to labeling thus making the integrity of the food supply more transparent.

Ethical Implications of GM Foods and GMOs

Generally, ethics is defined as the well-founded standards of what is right and wrong that appeal to a person's beliefs and values. In the food industry, ethics is defined as "a set of standards that govern or influence the conduct of behavior of a food/nutrition professional or organization and can be influenced by food customs and societal customs." (Academy of Nutrition and Dietetics [AND] 2009). These standards have further influenced the development of the code of ethics established by AND and the Institute of Food Technologists (IFT) which are to be reinforced by all registered dietitians (RDs), diet technicians, registered (DTRs) as well as food scientists. Namely, the 4 ethical principles to be upheld by food professionals as mandated by the AND are the following: (1) autonomy, (2) justice, (3) nonmaleficence, and (4) beneficence (AND 2009). Ethics apply to the food industry, especially regarding food labeling, as it is the duty of the food industry to exercise total "autonomy"; the consumer has a right to know what they are purchasing to make informed decisions. According to AND (2009), "autonomy ensures that a patient or client, or professional has the capacity to engage in individual decision-making specific to personal health or practice". The FDA and the U.S. Department of Agriculture (USDA) have legal written standards for labeling the composition and ingredients of foods, but they do not currently have any specific requirements to specify if a product contains a GM byproduct. Without mandatory labeling requirements, food companies are able to continue selling GM foods those consumers cannot identify, which seemingly goes against the ethical principle of autonomy. Consequently, several states have had ballot initiatives to mandate the labeling of foods that contain GM products, although most have been unsuccessful. Some states with a degree of success include Connecticut and Maine, where they have made some progress in labeling laws that will go into effect if a certain number of states agree to pass similar laws. Presently, Vermont has been the only state successful to pass a mandatory GM-labeling law (Costanigro and others 2014).

Ethical implications of GM foods and food security

Labeling foods that are GM or GMO becomes an issue of ethics also due to the fact the health effects of consuming GM foods remain a grey area. However, when GM food is examined from the perspective of meeting the food-security needs of an ever-growing population, it seems that the benefits may outweigh the possible health side effects. This is grounded by the ethical principle of beneficence, which is defined by AND (2009) as "taking positive steps to benefit others, which includes balancing benefit, risks and costs when determining a policy". Many countries import the majority of their food supply due to the to weather, climate and pests which may hinder the availability or production of food crops respectively. Therefore, recognizing the need to incorporate GM foods or GMOs in the food supply chain has relieved them from paying such high prices for foods and well as concerns of food security (Dibden and others 2011). Such initiatives could appeal to the ethical principle of justice, where a fair and equitable food supply is encouraged (AND 2009).

Advantages of GM Foods in Production

The advantages of GM foods are very widespread, encompassing a variety of aspects of (1) increased food production and (2) health benefits, and are becoming increasingly more prevalent. Ethically, the advantages of GM foods relate to the principles of beneficence and justice in the hope that GMO technology will be able to help others in improving food security and minimizing health disparities as the possibilities of creating food with higher nutritional content and overall quality, as seen with the golden rice discussed later in this paper (Verma and others 2011). GM crops were originally introduced into commercial production over 17 y ago and have been adopted faster than any other agricultural advancements (Alberts 2013). With the world's population increasing at an alarming rate, especially in developing countries, there is a major threat posed to food security (Amofah 2014). Therefore, the magnitude of the introduction of GM crops may have a huge positive impact as it pertains to the ethical guiding principle of justice where a fair, equitable food supply is maintained. Climate change is also another environmental factor threatening food security, which may lead to malnutrition and other health problems due to the lack of food (Amofah 2014). Both the increasing population and changing climate poses the ethical dilemma of maintaining stewardship and utilizing available natural resources in a conscientious manner to ensure that they are available for future generations. Food biotechnology can be used to genetically modify agricultural produce to become pest-and weather-resistant, produce higher yields, improve quality and nutrition (Verma and others 2011).

Decreasing the usage of pesticides

Pests, diseases, and weather are all natural phenomenon that commonly affect farmers when growing produce, causing them to rely on the use of chemical pesticides. However, consumers are less inclined to eat food that has been treated with pesticides due to their potential health hazards. Also, the runoff of agricultural waste from excessive pesticide and fertilizer usage can also contaminate the water supply, causing additional harm to the environment (Verma and others 2011). To counteract the aforementioned concerns of using pesticides and herbicides, scientists have been able to use the *Bacillus thuringiensis* (B.t), a naturally occurring soil bacterium that produces crystal proteins or delta endotoxins, that are lethal to insect larva (Verma and others 2011). These toxic crystals react with the cells in the lining of the gut and paralyze the digestive system of the insect, causing them to stop feeding within hours. As a consequence, the infected insects often die from starvation in a few days (Cranshaw 2014). The B.t gene is incorporated in the genome of corn and other crops such as cotton and potatoes enabling them to produce the toxin against the insects. This eliminates the need for excessive pesticide use. B.t. crops are currently cultivated in 23 countries and were originally commercialized in the U.S. in 1996 (Verma and others 2011).

The production of GM B.t. crops poses ethical dilemmas of both nonmaleficence and beneficence. In efforts to do no harm (that is, nonmaleficence) to the environment and the consumers, the benefits must outweigh the potential risks (that is, beneficence) of these new chemicals. The safety of B.t. has been well documented, as (1) community exposure within the last 6 decades has not resulted in any adverse effects, (2) the lack of homology to any allergenic protein makes B.t. toxins nonallergenic, and (3) the human digestive system lack receptors that bind to the toxins, resulting in their instant degradation and causing no toxicological effects (Verma and others 2011).

Increasing weather tolerant crops

Weather-tolerant and the development of new crops that can withstand inhospitable environments have been another advantage developed through the use of GM technology. The needs for higher yields have become drastically more prevalent as the acreage available for agriculture is diminishing (Barnes 2008). Farmers are not only dealing with reduced amounts of land available for agriculture due to the expanding population's needs for housing, but also because of reduced amounts of land suitable for cultivation under their current conditions as a result land being exhausted of nutrients or unsuitable terrain (Goldbas 2014).

With the use of biotechnology, GM plants are being propagated for increased yields that can grow in useless geographical areas plagued with droughts (Goldbas 2014). Farmers will have crops that can survive through longer periods of drought, cold, or high salt content in soil and groundwater (Verma and others 2011). A clear example of increasing weather tolerance can be seen with an antifreeze gene from cold-water fish that has been introduced into plants like tobacco, potatoes and initially tomatoes (Verma and others 2011). These proteins were discovered by Dr. Arthur Devries from fish that he collected at McMurdo Station in the early 1960s and have several commercial applications National Science Foundation (NSF 2015). These antifreeze compounds are also found to be about 300 times more effective in preventing freezing those conventional chemical antifreezes at the same concentration (NSF 2015). Currently, investigators funded by the NSF have successfully introduced 2 of the 4 fish antifreeze genes into yeast and bacteria through recombinant DNA technology (NSF 2015). Researchers compared the crop yields obtained from crops that expressed the antifreeze gene from the flounder fish as compared to the conventional tomatoes and found that they were able to survive in lower temperatures and consequently resulted in higher crop yields. Gene technology enables the increase of production in plants, as well as their increased resistance to pests, viruses, and frost (Verma and others 2011). The introduction of pest-resistant, herbicide-tolerant, cold-, and drought-tolerant crops create potential for increased crop yield each growing season and helps to increase the overall food supply and food security (Amofah 2014) which exemplifies the ethical principles of justice and nonmaleficence.

Increasing nutritional content and quality

The nutritional content and quality of food crops such as rice and cassava are one of the largest areas of emerging interest for GM foods. Malnutrition is a continuing problem in developing countries, where people rely on a single crop such as rice for the main staple of their diet (Verma and others 2011). Rice is a major staple for almost half of humanity, and unfortunately white rice grains are a poor source of vitamin A (Alberts 2013). Research scientists, Ingo Potrykus and Peter Beyer, have developed a rice variety that has β-carotene in its grains, a precursor to vitamin A. It took them 25 y in collaboration with the International Rice Research Institute (IRRI) to develop and test varieties that have sufficient amounts of β-carotene to eliminate the morbidity and mortality of vitamin A deficiency (Alberts 2013). This strain of rice, called "Golden Rice," was hypothesized to potentially prevent blindness due to vitamin A deficiency (Verma and others 2011). Vitamin A deficiency is a preventable disease and is as a result of a poor diet and poverty, responsible for 1.9 to 2.8 million deaths annually, with most occurring in women and children under 5-y-old (Albert 2013). Not only does vitamin A deficiency cause blindness, but also a compromised immune system, exacerbating many kinds of illnesses (Verma and others 2011). Research is also being conducted to develop Golden Rice that also has an increased iron content (Verma and others 2011). The ethical standard that this relates to is beneficence, as researchers are using GM technology in the hopes of helping others who are lacking nutritional sufficiency. Also nonmaleficence applies here as well, as researchers must consider whether or not their product will cause harm to the consumers and if an increased vitamin A and iron content in foods may have a negative side effect. Moreover, it may be worth noting that Golden Rice has been stabilized, safety-proven and is ready-to-use, but misplaced fear and misinformation may have prevented its authorized release to combat vitamin A deficiency.

The cassava plant is an example of another crop that has been altered to improve nutritional content in an effort to prevent diseases and morbidity in developing countries. The cassava is a starchy root eaten by peoples in tropical Africa, with approximately 40% of the food calories in the diet coming from it (Goldbas 2014). The GM variety boasts increased minerals, vitamin A, and protein content, which can prevent childhood blindness, iron deficiency anemia, and infections due to damaged immune systems, while also being pest-resistant due to GM technology (Goldbas 2014). This modified crop have increased nutritional content, but also increased pest resistance making it a more reliable and stable food supply for the people of tropical Africa. With the use of agricultural biotechnology, the nutritional properties of crops such as golden rice and cassava can be improved to enhance health by the fortification of desired vitamins and minerals and potentially prevent countless deaths.

Conclusion

This paper reviewed GM foods as it relates to ethical eating in the recent literature. Throughout its history, GM foods have been widely debated as (1) a result of their industrial applications and (2) potential consequences of their use. While their advantages are conceivably numerous (that is, *ranging from herbicide, pest, and weather tolerance to increased nutritional value to edible vaccines*), GM foods are criticized because of their application. Such ethical concerns involve adverse effects on human health, regulation of GM foods, cross-pollination, and a decrease in overall biodiversity. These concerns can affect whether one feels morally tarnished when consuming GM products. Particularly, the issue of GM food labeling has garnered great debate in the U.S. which does not provide for strict regulation on labeling of GM products and ingredients (that is, *contrary to 64 other world nations*). Also of recent interest is the potential application of GM foods in developing countries, where their production may spur economic activity and alleviate food insecurity. Further studies should perform more case analyses of the application of GM foods in developing countries and their ethical implications, as well as examine the public opinion of GM foods in U.S. culture compared to other nations.

References

Academy of Nutrition and Dietetics (AND). 2009. American Dietetics Association/Commission on Dietetic Registration Code of Ethics for the Profession of Dietetics and Process for Consideration of Ethics Issues. J Acad Nutr Diet 109:1461–7.
Alberts B. 2013. Standing up for GMOs. Sci Mag 341:1320.
Amofah G. 2014. Recommendations from a meeting on health implications of genetically modified organisms. Ghana Public Health Assoc 48(2):117–9.
Barnes B. 2008. To GMO, or Not to GMO? Cotton Intl Mag 6(6):14–5.
Bawa A, Anilakumar K. 2013. Genetically modified foods: safety, risks, and public concerns–a review. J Food Sci Technol 50(6):1035–46.
Byrne P, Pendell D, Graff G. 2014. Labeling of genetically engineered foods. Available from http://www.ext.colostate.edu/pubs/foodnut/09371.pdf. Accessed 2015 April 9.
Center for Food Safety. 2014. Genetically engineered food labeling laws. Available from http://www.centerforfoodsafety.org/ge-map/. Accessed 2015 April 28.
Costanigro M, Lusk JL. 2014. The signaling effect of mandatory labels on genetically engineered food. J Food Policy 49:259–67.
Cranshaw WS. 2014. *Bacillus thuringiensis*. Available from http://www.ext.colostate.edu/pubs/insect/05556.html. Accessed 2015 April 28.
Davison J. 2010. GM plants: science, politics and EC regulations. Sci Direct 178(2):94–8.
Dibden J, Gibbs D, Cocklin C. 2011. Framing GM crops as a food security solution. J Rural Studies 29:59–70.
Food and Drug Administration (FDA). 2001. DRAFT guidance for industry: voluntary labeling indicating whether foods have or have not been developed using bioengineering; draft guidance. Available from http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/LabelingNutrition/ucm059098.htm. Accessed 2015 April 9.
Food and Drug Administration (FDA):FSIS. 2014. Meat and poultry labeling terms. Available from: http://www.fsis.usda.gov/wps/portal/fsis/topics/food-safety-education/get-answers/food-safety-fact-sheets/food-labeling/meat-and-poultry-labeling-terms/meat-and-poultry-labeling-terms. Accessed 2015 April 30.

Food and Agricultural Organization. 2015. The role of ethics. Available from http://www.fao.org/docrep/008/y6634e/y6634e03.htm#fnB1. Accessed 2015 April 26.
Food and Drug Administration (FDA). 2015. FDA's role in regulating safety of GE foods. Available from:http://www.fda.gov/forconsumers/consumerupdates/ucm352067.htm. Accessed 2015 April 30.
Goldbas A. 2014. GMOS: what are they?. Intl J Childbirth Educ 29(3):20.
Hain P, Don L. 2003. Transformation 2 – Transformation Methods. Available from http://passel.unl.edu/pages/printinformationmodule.php?idinformationmodule=958077 244. Accessed 2015 July 28.
International Dairy Foods Association (IDFA) 2014. IDFA Commends Reps. Pompeo and Butterfield for Bill to Establish Federal Standard for Voluntary GMO Labeling. Available from http://www.idfa.org/news-views/news-releases/article/2014/04/09/idfa-commends-reps.-pompeo-and-butterfield-for-bill-to-establish-federal-standard-for-voluntary-gmo-labeling. Accessed 2015 April 9.
Krieger EK, Edwards A, Gilbertson LA, Roberts JK, Hiatt W, Sanders RA. 2008. The Flavr Savr tomato, an early example of RNAi technology. HortScience 43(3):962.
Kuure-Kinsey M, McCooey B. 2000. The Basics of Recombinant DNA. Available from from http://www.rpi.edu/dept/chem-eng/Biotech-Environ/Projects00/rdna/rdna.html. Accessed 2015 April 7.
Kwieciński J. 2009. Genetically modified abominations? EMBO Reports 10(11):1187–90.
Maghari BM, Ardekani AM. 2011. Genetically modified foods and social concerns. J Med Biotechnol 3(3):109–17.
Martin, C. 2013. The psychology of GMO. Curr Biol 23(9):R356–9.
Murnaghan I. 2012. Ethical Concerns and GM Foods. Available from http://www.geneticallymodifiedfoods.co.uk/ethical-concerns-gm-foods.html. Accessed 2015 April 7.
National Science Foundation. 2015. Fish Antifreeze Proteins. Available at http://www.nsf.gov/pubs/1996/nstc96rp/sb3.htm. Accessed 2015 April 28.
Pă curar DI, Thordal-Christensen H, Pă curar ML, Pamfil D, Botez C, Bellini C. 2011. *Agrobacterium tumefaciens*: from crown gall tumors to genetic transformation. Physiol Mol Plant Pathol 76(2):76–81.
Santa Clara University. 2010. What is ethics. Available from http://www.scu.edu/ethics/practicing/decision/whatisethics.html. Accessed 2015 April 30.
Stone GD. 2010. The anthropology of genetically modified crops. Ann Rev Anthropol 39: 381–400.
Unitarian Universalist Association (UUA). 2014. Ethical eating: food and environmental justice. Available from http://www.uua.org/environment/eating/. Accessed 2015 April 7.
United States Center for Food Safety. 2015. International labeling laws. Available from http://www.centerforfoodsafety.org/issues/976/ge-food-labeling/international-labeling-laws#. Accessed 2015 April 9.
University of Minnesota: School of Public Health: Environmental Health Sciences. 2003. GMO: harmful effects. Available from http://enhs.umn.edu/current/5103/gm/harmful.html. Accessed 2015 April 30.
Verma C, Nanda S, Singh RK, Singh RB, Mishra, S. 2011. A review on impacts of genetically modified food on human health. Open Neutraceut J 4:3–11.
Weale A. 2010. Ethical arguments relevant to the use of GM crops. New Biotechnol 27(5):582–7.
Wohlers A. (2013). Labeling of genetically modified food. Polit Life Sci 32(1):73–84.
World Health Organization. 2015. Food, genetically modified. Available from http://www.who.int/topics/food_genetically_modified/en/. Accessed 2015 April 7.