

DO GENETICALLY ENGINEERED (GE) CROPS IMPACT ANIMAL HEALTH AND FOOD PRODUCTS?

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ABSTRACT

The release of genetically engineered (GE) varieties of alfalfa, a major livestock feedstuff, raises questions about the effects of feeding this product to food-producing animals. There is a wealth of peer-reviewed studies examining the effects of feeding GE crops to livestock. Hundreds of scientific studies have found no difference in the productive performance or health of livestock that have been fed GE feedstuffs, and there has been no documented presence of GE DNA or proteins in the milk, meat, or eggs from animals that have eaten GE feed. Evidence to date strongly suggests that commercially-available GE crops are equivalent to genetically unmodified feed sources in terms of nutrient composition and feeding value. GE alfalfa varieties expressing the 5-enolpyruvylshikimate-3-phosphate synthase protein to confer tolerance to glyphosate raise no unique feed safety concerns; however peer-reviewed studies to verify the absence of anti-nutritional factors or other unanticipated feed attributes in GE alfalfa are not currently available.

Key Words: genetic engineering (GE), transgenic, food and feed safety, Roundup Ready®

In the United States, livestock have been fed genetically engineered (GE) crops since these crops were first introduced in 1996. In 2005, 87 percent of the U.S. soybean crop and 52 percent of the U.S. corn crop were grown from GE seed (see the USDA ERS Briefing Room Web site, <http://www.ers.usda.gov/Data/BiotechCrops/ExtentofAdoptionTable3.htm>). Because the majority of corn (72%) and soybeans (60%) are used for livestock feed, it is clear that the livestock industry is a major user of GE crops.

Feeding Studies. Over 100 digestion and feeding studies examining the effects of feeding GE crops to various food-producing animal species (e.g., beef cattle, swine, sheep, fish, dairy cows, water buffalo, and chickens) have been reported in the scientific literature (see the Federation of Animal Science Societies Communications Web site for a comprehensive listing by species and crop http://www.fass.org/references/Feeding_Transgenic_Crops_to_Livestock.htm). Results have revealed no significant differences in the nutritional value of feedstuffs derived from commercially grown GE crops compared with their conventional counterparts, nor have any peer-reviewed studies documented alterations in feed intake, growth, or other livestock production parameters as a result of including currently available GE feedstuffs in diets of animals (for a comprehensive review, see Flachowsky et al. 2005¹). The published literature also contains no indication of any disturbance to food animal health or the quality of resulting animal products as a result of long-term consumption of GE feeds. Current scientific evidence confirms the concept of “substantial equivalence” for currently available GE feedstuffs. “Substantial equivalence” is a comparative approach to the assessment of food safety that involves comparing

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the feed value and safety of GE crops with those in existing crops (usually the genetically unmodified parent line) that have known feed values and a history of safe use.

Safety of Animal Products. GE crops are digested by animals in the same way as conventional crops. Numerous scientific studies have examined the digestive fate of the GE DNA and proteins that have been introduced into GE feed (see the Federation of Animal Science Societies Communications Web site, http://www.fass.org/references/Transgenic_DNA.htm, for a comprehensive listing). GE DNA, or the novel proteins encoded therein, have never been detected in the milk, meat, or eggs derived from animals fed GE feedstuffs. Nutrients in meat, milk, and eggs from livestock fed GE feeds have been found to be the same as the nutrients from livestock fed conventional feeds. The metabolic processes involved in digestion, absorption, and use of feed proteins by livestock species make it very unlikely for a protein of any plant gene to be found intact in food of animal origin, and none have been detected. For this reason, products derived from animals that have been fed feedstuffs containing the current commercially approved GE crops do not require specific labeling in the United States, where labeling is only required when genetically engineered food products have a detectable difference in nutritional composition or safety when compared with comparable non-genetically engineered products. Labeling that details the process(es) used to create compositionally equivalent food products is currently not required.

Food Safety. The U.S. Food and Drug Administration (FDA) has authority over human food and animal feed safety and the wholesomeness of all plant products, including those produced via genetic modification, under the Federal Food Drug and Cosmetic Act. The FDA has concluded that food and feed derived from GM crops pose no unique safety concerns and, therefore, that the food and feed products derived from these plants should be regulated no differently than comparable products derived from traditional plant breeding or any other genetic modification approach (<http://www.cfsan.fda.gov/~acrobat/fr920529.pdf>). FDA uses a consultation process to work with developers of GE foods to help them meet the safety requirements. The consultation is voluntary, although the legal requirements that the foods have to meet are not (<http://www.cfsan.fda.gov/~lrd/consulpr.html>). To date, all GE foods that have been marketed in the United States have gone through FDA's safety assessments before they have been marketed.

The purpose of the safety assessments of transgenic crops is to compare the overall safety of genetically modified plants with the safety of the traditionally bred food plants. The task is to establish whether the food derived from a GM crop is as safe and nutritious as its conventional counterpart based upon its predicted usage². There have been extensive international studies into the health and safety issues of GM crops. Several comprehensive overviews of the food safety assessment of GE crops have been published in the scientific literature²⁻⁴. The U.S. National Academy of Sciences (NAS) concluded that GE food is no more likely to produce unintended health effects than food derived from crops developed using conventional technologies - indeed the greater precision and more defined nature of the changes introduced by GE may actually afford a higher degree of food safety⁵. A recent commentary released by the Council for Agricultural Science and Technology (<http://www.cast-science.org>) entitled "Crop Biotechnology and the Future of Food: A Scientific Assessment" concludes that "After 10 years of safe use, it is fair to conclude that the inherent safety of the technology (GE) and the

premarket case-by-case safety assessments conducted by regulatory agencies around the world have ensured that foods from transgenic crops are as safe to eat as any food”⁶.

Historically, toxicity tests in laboratory animals (i.e. dose response experiments looking at the effects of a single chemical) have played a significant role in ensuring the safety of chemicals present in foods, including food additives and contaminants that typically are consumed by humans in very small amounts. Animal tests of whole GE foods can present challenges because of the need to prevent dietary imbalances associated with administration of large quantities of test diets with specific whole foods. A balance must be met between feeding enough of the test material to have the possibility of detecting a true adverse effect, while avoiding the induction of a nutritional imbalance. Despite this problem, there have been rodent toxicology studies carried out with the major proteins that are currently being expressed in GE crops (summarized in Table 3.3 of Chassy et. al. 2004³). These studies have not revealed unintended health effects resulting from the consumption of GE food crops or the process of genetic engineering.

Safety of GE Alfalfa. Of particular relevance to the release of Roundup Ready[®] alfalfa are studies that have examined the health and toxicological effects of the enzyme 5-enolpyruvylshikimate-3-phosphate synthase (EPSPS) isolated from the CP4 *Agrobacterium tumefaciens* strain, as this is the protein that is expressed in glyphosate-resistant crops. The EPSPS enzyme is part of the shikimate pathway that is involved in the production of aromatic amino acids and other aromatic compounds. When conventional plants are treated with glyphosate, the plants cannot produce the aromatic amino acids needed to grow and survive. EPSPS is present in all plants, bacteria, and fungi. It is not present in animals, which do not synthesize their own aromatic amino acids. Because the aromatic amino acid biosynthetic pathway is not present in mammals, birds or aquatic life forms, glyphosate has little if any toxicity for these organisms. The EPSPS enzyme is naturally present in foods derived from plant and microbial sources. The safety of consuming the CP4 EPSPS protein was established based on its similarity to the structure and function of the naturally occurring plant EPSPS enzymes; the lack of toxicity or allergenicity of EPSPS proteins from plants, bacteria and fungi; and by direct laboratory studies on the toxicity and characteristics of the CP4 EPSPS protein⁷⁻¹³.

Although there have been no documented studies suggesting that expression of the CP4 EPSPS protein in GE crops is toxic, some activist web sites often cite selected alarming studies about the safety of Roundup itself, and then go onto argue against the safety of GE crops. The safety of herbicides is an issue independent of the safety of GE crops, and although the objective of this article is not to review the safety of Roundup, it has been extensively tested in higher order animals^{14,15}. Furthermore, studies with surfactants in Roundup agricultural herbicides have demonstrated no target organ toxicity or effects on the embryos, fetus, or placenta¹⁴.

Feeding Studies with GE Alfalfa. There are currently no published peer-reviewed feeding studies using Roundup Ready[®] alfalfa. However, there are many feeding studies using glyphosate-resistant varieties of other crops fed to various food-producing animal species (e.g., cattle, swine, fish, poultry)¹⁶⁻³¹. These studies show no evidence to suggest that the performance of animals given feed derived from GE glyphosate-resistant crops differs in any respect from animals fed conventional feedstuffs. Because the expression of the CP4 EPSPS protein has not altered the nutrient composition, digestibility, and feeding value in other crops; there is currently

no reason to suspect that it will affect these feed attributes when expressed in alfalfa. However, peer-reviewed feeding studies to verify livestock performance and document the absence of anti-nutritional factors or other unanticipated feed attributes in GE alfalfa would be highly desirable.

CONCLUSION

Evidence to date strongly suggests that feeding livestock with GE crops is equivalent to feeding unmodified feed sources in terms of nutrient composition, digestibility, and feeding value. Hundreds of scientific studies have found no difference in the productive performance or health of livestock that have been fed GE feedstuffs, and there has been no documented presence of GE DNA or proteins in the milk, meat, or eggs from animals that have eaten GE feed. No evidence exists for unexpected harm or risk associated with the consumption of food derived from commercially available GE crops. This opinion, supported by scientific evidence, is shared by the vast majority of experts in the field; by national and international agencies, such as the National Academy of Science of the United States and of several other countries, OECD, FAO, WHO and many others, and by dozens of scientific societies. Glyphosate-tolerant GE alfalfa raises no unique feed safety concerns, and there is no reason to anticipate its nutrient composition, digestibility, and feeding value will differ from conventional alfalfa varieties. However, peer-reviewed studies to document the feeding attributes of GE alfalfa varieties are not yet available.

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