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LL601 Rice
What Is It & What Does It Mean?

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What is Genetically Engineered (GE) or GMO rice?

The genetic information in rice that determines how tall the plant is, how much it yields and how the grain tastes is like a collection of books written on many topics. The entire collection is referred to as a genome. Entries in the collection, or genes, specify what features rice will have. Each plant species has its own collection of books, all written in the same language and, while many genes are similar in different plant species, some are dissimilar. Information in a rice cell is made up of DNA that is a series of chemical units. If an alphabetic letter were to represent each chemical unit, it would require 40 books, each of 1,000 pages, to hold all the information in a single rice cell. In 2005, the whole rice genome was read and found to contain ~37,500 genes.

One method used to modify plants is classical breeding, which involves crossing two closely related plants. This process combines the DNA from the two parents. However, genetic rules dictate that only half the information from each parent is kept – and which parts are kept from each parent is random, making the outcome rather unpredictable. The process is also very time-consuming, often taking ten years or more to produce a new rice variety. Another approach uses more precise methods to produce a genetically engineered (GE) plant, also referred to as a GMO (genetically modified organism). This process involves finding a specific gene, "cutting it out" and "pasting it" in back into the DNA of the same species or another species, like a corn gene being pasted into the rice DNA. Genes from any organism, including a bacterium, can be put into plant DNA because genes from all organisms are written in the same language. That is, DNA from all living organisms is basically the same, just written in a different order.

What is LL601 rice and how is it different from other rice varieties?

In the mid 90's, AgrEvo (subsequently Aventis CropScience, which was purchased by Bayer in 2002) developed LL601®, a genetically engineered (GE) long grain rice that is tolerant to glufosinate ammonium, the active ingredient in the herbicide, Liberty®. LL601®, like other commercialized "Liberty Link®" crops, contains a bacterial gene encoding the PAT protein (phosphinothricin acetyl transferase), that interacts very specifically with, and provides tolerance to, Liberty® herbicide. Two other Liberty Link® rice varieties, LL62® and LL06®, were also developed.

Before a GE crop is grown commercially in the U.S., it must be deregulated by USDA/ APHIS (Animal and Plant Health Inspection Service) and examined by FDA and EPA for food and environmental safety. Deregulation is based on field test results that assess, for example, any effects on birds, beneficial insects and mammals. LL62® and

LL06® were declared safe as food and for the environment and deregulated in 1999, but never commercialized. To get field test data to deregulate LL601®, a variety virtually identical to the other LL varieties, plots were grown from 1998 to 2001, after which development of the variety stopped for business reasons.

Food safety of LL601® rice

The amount of PAT protein in LL601® is very low, making up only 0.000034%, or 3 parts per 10 million, of all the protein in a Liberty Link® rice grain (http://www.aphis.usda.gov/brs/aphisdocs/06_23401p.pdf). The EPA determined that the PAT protein and its gene are not a health risk (40 CFR Part 180, Sec. 180.1151); and an evaluation of its health safety was published (Hérouet *et al*. 2005. *Regulatory Toxicology and Pharmacology*). The PAT protein also has no characteristics that would indicate it might pose a health risk. For example, it is not like any known allergens or toxins and has no glycosylation sites, which are commonly found on food allergens. And, it is quickly broken down in the human digestive system, providing limited opportunity to trigger an immune response. Furthermore, the same gene was used to create Liberty Link® corn that is widely grown and has been consumed since its commercial introduction in 2003. As with Liberty Link® rice, there have been no human or animal food safety issues identified in Liberty Link® corn (http://www.agbios.com/docroot/decdocs/a375.pdf).

Consequences of LL601® in U.S. rice supply

Although commercial development of LL601® ended in 2001, Bayer informed the USDA and FDA in July 2006 that LL601® was detected in rough rice grain samples from the 2005 harvest and in August 2006 USDA reported LL601® was detected in rough rice samples from storage bins in Arkansas and Missouri. (http://pewagbiotech.org/newsroom/summaries/display.php3?NewsID=1030). Although FDA confirmed the food safety of LL601® and USDA attested to its environmental safety, these assurances did not help US rice farmers. Japanese and Norwegian officials quickly suspended US long grain rice imports. The European Union rapidly adopted a “zero tolerance for LL601®” for all rice imports and instituted a screening procedure to certify U.S. shipments of long grain rice as free of LL601®.

By September 2006, there were reports of detection of LL601® in at least nine EU countries based on random checks in food and retail supply chains. The level of LL601® in rice supplies was very low, with most positive tests reporting levels ranging from 0.01 to 0.06%. A draft decision by the European Commission said that, in addition to certification, all U.S. long grain rice had to be tested at its entry point, even though the UK Food Standard Agency, the Canadian Food Inspection Agency, and Dutch authorities confirmed LL601®’s food safety.

Despite assurances of food and environmental safety, some U.S. rice mills and exporters have had difficulties due to the presence of LL601® in long grain rice supplies. This is due in large part to the fact that the presence of the PAT gene in this rice variety was not approved in other countries, and it was found unexpectedly in rice supplies bound for countries opposed to using biotechnology to modify crops, particularly the European Union. The U.S. rice industry has estimated that the LL601® issue in U.S. long grain rice supplies impacted about 41% of the rice export market at varying levels, but did not affect the domestic markets (U.S. Rice Federation). A few other mills, like those serving the pet food industry, may have benefited temporarily because the price of long

grain rice dropped in the weeks following the initial announcement of LL601 presence in commercial stocks.

How did mixing occur?

It is not exactly known how LL601 entered the commercial rice supply. All of the LL experimental lines were field-tested over the years at multiple sites in the southern rice growing regions, following USDA/APHIS and EPA guidelines to prevent outcrossing or movement of LL seed into commercial rice production. It has been reported that a sample of the 'Cheniere' variety of long grain rice grown in 2003 on the Louisiana State University (LSU) research station had detectable levels of LL601®. The affected Cheniere rice plot had been used to grow foundation seed and subsequently distributed to seed-producers. While 'Cheniere' was the only cultivar where LL601® was initially detected, more recently BASF's Clearfield 'CL 131' rice variety was also confirmed and removed from the market. The exact source(s), path, or mechanism of mixing into the commercial rice supply will likely never be known in part because the pattern of detection has been so erratic across the South.

Deregulation of LL601

On Nov. 24, 2006, after reviewing scientific evidence (http://www.aphis.usda.gov/brs/aphisdocs/06_23401p_ea.pdf), USDA APHIS deregulated LL601®. Among those favoring approval was the USA Rice Federation, an organization that promotes U.S. rice around the world, but now opposes LL® rice and genetically engineered rice in general, because of problems with the EU and other foreign markets since LL601® was unexpectedly detected in 2006.

Lingering issues

Food companies have to face the public and deal with product removals and their consequences. While LL601® does not pose any known risks, its presence in the food chain demonstrates what the consequences can be from our inability to maintain separation between GE and non-GE varieties, and our inability as a society to understand the benefits and risks of modern science and technology in the global marketplace. Because of the many perceived problems created by the 2006 LL601® discovery, a number of attorneys representing various rice farmers in U.S. rice-producing states have filed lawsuits, at this time primarily against Bayer, although Riceland Foods and the LSU AgCenter have also been named in certain actions.

On Nov. 28, 2006, the USA Rice Federation released a recommended plan of action (http://www.usarice.com/industry/communication/SeedRecs.pdf) to remove LL601® rice from the U.S. supply, based on the finding that 'Cheniere' rice contained the only detectable level of contamination of all stocks tested. They requested that state authorities take actions to ensure that commercial seed for 2007 tested negative for LL® traits. The plan also requested that all segments of the rice industry further ensure that LL® traits not appear in the rice. In 2007, 'CL131', a nonengineered, herbicide tolerant rice variety, was also removed from the market by USDA/APHIS due to detection of the LL® gene.

In spite of assurances of the environmental and health safety of Liberty Link® rice, there is resistance among the public for a variety of reasons to the use of GE technology to modify rice. It now appears likely that LL® rice will not be made available to U.S. rice farmers in the near future. This is unfortunate for farmers, as it represented the next generation of management technology for red rice, the most important weed of rice in the

southern U.S. and one that is difficult to control with herbicides given its close genetic relationship with commercial rice varieties. Since red rice has already developed resistance to the Newpath herbicide, used in conjunction with the popular Clearfield® rice production system, weed scientists are uncertain about what future control options will be available for controlling red rice.

And, because of the strong reaction of the marketplace to the LL® rice issue, companies and universities are reportedly reluctant to pursue certain advanced technology research projects for U.S. rice. This may cause problems for U.S. rice production in the future, as other major rice-producing countries continue to develop GE and other advanced technology traits in rice. Nevertheless, the severity and worldwide scope of the market response to the presence of LL601® in rice shipments highlights the importance of the necessity for precision in conducting research, regulating carefully and improving public understanding with regard to the applications of science and technology in agriculture.

References

On October 5, 2007 USDA released two documents on investigations by APHIS into the Liberty Link GE rice situation:

http://www.aphis.usda.gov/newsroom/content/2007/10/content/printable/RiceReport10-2007.pdf. Report of Liberty Link Rice Incidents.

http://www.aphis.usda.gov/newsroom/content/2007/10/content/printable/LessonsLearned10-2007.pdf. Lessons Learned and Revisions under Consideration for APHIS' Biotechnology Framework.

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General Information

http://www.usda.gov/2006/08/0306.xml
Notification of USDA and FDA by Bayer CropScience that company detected trace amounts of regulated genetically engineered (GE) rice in samples from commercial long grain rice (Aug 2006)

http://www.usarice.com/industry/communication/GIPSARiceTestingStmt070220.pdf
Description of quantitative test methods for detecting Liberty Link trait in rice (from USA Rice Federation).

http://www.cfsan.fda.gov/~lrd/biorice.html
U.S. Food and Drug Administration's Statement on Report of Bioengineered Rice in the Food Supply (Aug 2006)

http://www.aphis.usda.gov/newsroom/content/2006/11/rice_deregulate.shtml
USDA deregulates LL601 rice variety (Nov 2006)

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