Roundup Ready® Cotton: Food & Feed Safety

Since Roundup Ready® herbicide-tolerant cotton was introduced in 1997, it has redefined weed management in global cotton production. Roundup Ready cotton withstands over-the-top applications of Roundup® or Roundup Ultra® herbicide, providing growers with superior weed control, along with excellent crop safety and yield performance.

Food and feed safety overview

The safety of biotech products such as Roundup Ready cotton is established through comprehensive studies, which are reviewed by national and international regulatory authorities. These studies demonstrate that the introduced proteins in Roundup Ready cotton are safe, and that the genetic enhancement has not changed the plants' fundamental characteristics such as food, feed or environmental safety.

Roundup Ready cotton has cleared food, feed and environmental reviews by the U.S. Department of Agriculture, the U.S. Food and Drug Administration and the U.S. Environmental Protection Agency. Roundup Ready cotton also has been approved following regulatory reviews in Australia, Indonesia, Mexico and South Africa. In addition, Roundup Ready cotton has received regulatory import approval for food and feed use in Canada and Japan.

“Substantially equivalent” to conventional cotton

A basic principle in the regulation of foods and feeds produced from plant biotechnology is the concept of “substantial equivalence.” This concept was established in the early 1990s by the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD).

In demonstrating the equivalence of Roundup Ready cotton to conventional cotton, more than 2,000 compositional analyses were performed on the components of the cottonseed and oil. Levels of nutrients (protein, fat, fiber, ash, carbohydrates, calories, amino acids and fatty acids) and moisture in Roundup Ready cotton were confirmed to be substantially equivalent to those of conventional cotton varieties. Levels of anti-nutritional factors (gossypol and aflatoxin) also were confirmed to be present at similar levels for Roundup Ready cotton as compared to conventional cotton varieties.

In addition to compositional studies, animal feeding studies with rats, quail and catfish confirm that Roundup Ready cotton is nutritionally equivalent to conventional cotton and that animals perform comparably when their feed includes Roundup Ready cotton.

Plant breeders also have evaluated agronomic traits such as the cotton plant’s establishment, vigor, morphology, susceptibility to diseases, fiber characteristics and yield. Assessments have confirmed that the agronomic properties of Roundup Ready cotton are comparable to their conventional counterparts except for the introduced herbicide-tolerance trait.

Safety history of the CP4 EPSPS and NPTII proteins

The genes inserted into Roundup Ready cotton are well understood and have been thoroughly evaluated. The inserted DNA produces the CP4 EPSPS protein that confers herbicide tolerance, as well as the neomycin phosphotransferase II (NPTII) protein that was used in the transformation process.

The combination of the composition, animal feed performance and agronomic data confirms that Roundup Ready cotton is substantially equivalent to conventional cotton except for the Roundup Ready trait.

Roundup Ready cotton is compositionally equivalent to conventional cotton

<table>
<thead>
<tr>
<th>Component</th>
<th>Equivalent</th>
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<tbody>
<tr>
<td>Amino acids</td>
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<tr>
<td>Ash</td>
<td>✔</td>
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<td>Calories</td>
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<td>Fiber</td>
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<td>Gossypol</td>
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<td>Moisture</td>
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<tr>
<td>Protein</td>
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Roundup Ready cotton is tolerant to Roundup herbicide due to the CP4 EPSPS protein produced from the inserted DNA. The protein is derived from Agrobacterium sp. strain CP4, a common soil microorganism. The native EPSPS protein present in cotton is sensitive to glyphosate (the active ingredient in Roundup herbicide). However, the CP4 EPSPS protein is much less sensitive to glyphosate inhibition, thereby providing plants with built-in tolerance to Roundup herbicide. The CP4 EPSPS protein also is similar to other EPSPS proteins found in plants, bacteria, fungi and microorganisms such as baker’s yeast, establishing a history of safe consumption.

NPTII is the selectable marker used in the process to identify which plants have been successfully transformed to insert the herbicide-tolerance trait. The NPTII protein, which occurs naturally in bacteria residing in the human and animal gut, works by inactivating the antibiotics kanamycin and neomycin. A number of approved biotechnology products in several crops have been produced using this technology. The safety of the NPTII protein has been confirmed by regulatory agency reviews in the United States, the European Union, Canada, Argentina, Australia and Japan, as well as in a scientific review by the World Health Organization.

The safety of the CP4 EPSPS and NPTII proteins has been thoroughly evaluated and tests confirm that these proteins:

- **Pose no toxic concerns.**
  - Are from sources with no history of toxicity.
  - Are not structurally similar to any known toxins.
  - Show no adverse effects to mice when fed at very high levels.

- **Pose no allergic concerns.**
  - Are from sources with no history of allergy.
  - Show no similarity to known allergens.
  - Are rapidly degraded under conditions that mimic human digestion.
  - Are expressed at very low levels in Roundup Ready cottonseed and are not detectable in cottonseed oil.

**Environmental impact assessment**
The overall safety assessment of Roundup Ready cotton also includes an environmental component. Roundup has been long recognized as an effective herbicide that can be used with no unreasonable adverse effects on non-target organisms. Its active ingredient, glyphosate, is known for its nonpersistence, limited mobility and low toxicity. Glyphosate degrades over time in the environment and does not accumulate in mammals, birds or aquatic species. Environmental studies of Roundup herbicide have been reviewed by scientists and regulators around the world, and the product is approved for many different uses, ranging from crop protection to restoration of delicate ecosystems.

In addition, studies have confirmed that Roundup Ready cotton’s built-in herbicide tolerance offers a number of benefits that conventional cotton does not. For example, the Roundup Ready cotton system helps to provide superior weed control and crop safety. It also has the potential to reduce the amount of residual herbicides and hand labor required to grow cotton.

And the Roundup Ready cotton system helps to facilitate the adoption of conservation tillage practices, which improve the soil and conserve moisture and nutrients. Conservation tillage sustains the environment by:

- Reducing soil erosion.
- Improving water quality.
- Increasing carbon retention in the soil.
- Reducing fuel use and CO₂ emissions.
- Improving wildlife habitat.

**Summary of the food and feed safety assessment**
In summary, Roundup Ready cotton:

- Is substantially equivalent to conventional cotton.
- Produces the CP4 EPSPS and NPTII proteins that are safe for consumption.
- Enables growers to use a herbicide alternative with a favorable environmental profile.
- Offers a number of agronomic and environmental benefits, including superior weed control, improved crop safety and compatibility with conservation tillage systems.