SAFETY OF FOOD BIOTECHNOLOGY PRODUCTS*

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ABSTRACT

In 2008, 125 million hectares of agricultural crops developed using modern biotechnology were grown in **25 countries.** The safety of foods derived from these rDNA plants is evaluated according to a framework adopted by the Codex Alimentarius Commission **(Codex).** The Codex was established in 1962 under the World Health Organization and Food and Agricultural Organization to establish standards of safety and to ensure fair practices in **trade** for food. In 1999 the Codex directed a special Task Force to develop **standards and** guidelines for the safety of foods derived from biotechnology. The resulting documents on risk analysis, the plant guideline for food safety **assessment,** and accompanying annex on allergenicity assessment of new proteins **were** adopted by Codex in 2003. The approach to food **safety assessment** differs from that used for conventional food additives and pesticides. Foods such as rice, corn, **soybeans** and **other whole** foods **are** composed of complex **mixtures** of chemicals and as such do not lend **themselves** to traditional toxicological approaches to food safety **assessment.** Instead, a paradigm developed previously in OECD (referred to as substantial equivalence) and further elaborated by a 2000 FAO/WHO **Expert** Consultation **was** adopted that relies upon molecular biological, chemical, and nutritional data that permit a comparison to be made between the new rDNA plant variety and a conventional counterpart. The **safety** of the intended modification(s), i.e., newly expressed proteins, are assessed for similarities to known toxins and allergens. Nutritional modifications, if any, are **assessed** for potential effects on the overall diet. The approach also includes steps to reduce **the likelihood** of unintended **effects** that would adversely affect health of consumers. **A** new rDNA variety must be shown to have the **expected key** nutrients, toxicants, and anti-nutrients **within** the range of concentrations that has been typical of safely consumed conventional varieties. **Thus,** any new proteins or other new substances in the new variety must be shown to be **safe** and **the food derived** from **that** variety must not be altered in a manner that would

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adversely affect health. The goal is to establish that food derived from the new variety is as safe as its conventional counterpart food. This approach, which has been adopted internationally, provides a robust, scientifically-based means to assess the safety for human consumption of foods derived from rDNA plants. Foods that pass this assessment are as safe as their counterpart foods and pose no unique hazards for consumers.

INTRODUCTION

Recombinant DNA food or usually introduced as genetically modified food or genetically engineered food were tested vigorously by scientific method. The food supply around the world is solved by using the genetically modified food. The first introduction of foreign genes into plant was done in 1992. In 1999, a small company reported to FDA to support them on marketing the genetically modified food. There was no official process for passing engineered food at that time, but nevertheless, FDA helped in developing testing procedure and policy for genetically modified food. And by 2008 around 125 million hectares in 25 countries (15 developing countries) were planted commercially with new authorized biotech plant varieties by around 1.3 million biotechnology crop farmers (ISAAA Brief 39, 2008). The safety of these food products will be explained in greater details in this paper.

FOOD BIOTECHNOLOGY PRODUCTS AND THE FOOD SAFETY ASSESSMENTS

Some food traits in biotechnology engineered food products are insect resistant (Bt), herbicide tolerant (HT), combined Bt and HT traits (Bt-HT), virus resistant [VR), drought resistant [DR), and papaya ring spot virus resistant (PRSV). There are limited food biotechnology crops such as soybean, maize, potato, tomato, sweet pepper, papaya, squash, canola and sugar beet but because of different variety of traits, big varieties of biotechnology engineered food crops are available throughout the world.

The genetically engineered food crops have their rDNA plant material authorized based on a scientific food safety assessment consistent with the Codex Plant Guideline. The Codex Plant Guideline

provides a robust, scientifically sound, internationally accepted approach to food safety assessment. The food that has been authorized is as safe as its counterpart food. The public information about food biotechnology products needed to be available. The information needs to be timely, factual, objective, understandable, and easily accessible so the public can understand more about food biotechnology products

A lot of people are concerned whether the foods from modern biotechnology safe to eat thirty years from now or whether their children will be healthy in the future if they are consuming it now. However the concern is unnecessary as there are international standards for biotechnology food safety assessment set by Codex. Codex Alimentarius Commission was established in 1962 by FAO and WHO to establish international food standards to protect consumer health and ensure fair practices in food trade. There are technical working groups and FAO/WHO expert consultations as the committees and Ad Hoc task forces.

In 1999, Codex assigned Codex Task Force on biotechnology to assess the safety of biotechnology enhanced food. Conventional foods have been presumed safe and have not been scientifically evaluated. The food safety assessments typically are only used for specific chemicals in the food such as food additives and pesticide. However, the power of technology has allowed the introduction of new proteins and genomes into foods and also the alteration or introduction of new metabolic pathways in food crops which are genetically engineered. That is why the Codex Biotechnology Task Force considers the elaboration of standards, guidelines or other principles for foods derived from biotechnology. From 1999-2003, the Task Force developed the principles for the risk analysis of foods derived from modern biotechnology, guideline for safety assessment of foods derived from rDNA plants, plus allergenicity annex (plant guideline), and guideline for safety assessment of foods produced using rDNA microorganisms (such as those found in yoghurt). Those principles and guidelines were developed after multiple FAO/WHO expert consultations and working group meetings.

The principles of risk analysis of biotechnology enhanced food are not much different than the risk analysis of Codex for microorganism in food. The safety assessment is used as there is no quantifiable hazard yet. First principle is taking the comparative

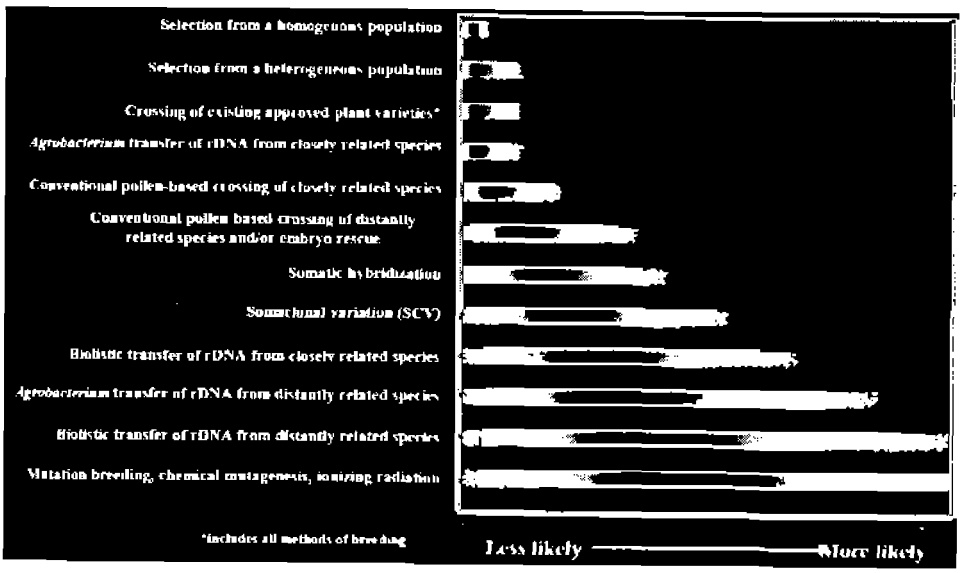
approach or substantial equivalence which is to compare the new food with its natural counterpart and identify the differences (e.g. what genes were introduced). The next principle is to evaluate the safety aspects and nutritional effects by considering the intended (e.g. safe new protein) and the unintended effects (changes in composition such as the levels of known toxicants and the significant nutrients). Plants are pretty complex and it is known that there are changes occurring in plants as it grow. The basis of the food safety assessment will be molecular characterization (chemistry as well as informatics). The first assessment will be to know the new substances that are intentionally introduced (the identity, structure, function, allergenicity (different proteins in food might cause allergies in some people], digestibility, dietary exposure, toxicity and nutritional effect). In terms of unintended effects, there are genetic stability [introducing DNA can cause instability in the genome after several generations) and food composition issues (nutrients, toxicants, anti-nutrients, vitamins and minerals). The biotechnology plants are tested with different analysis to know the range of various components to be safe for public consumption. Usually the biotechnology varieties have different components compared to their parents. But since the components tested are still in the range on what occur naturally in the plants, the biotechnology varieties are certified as safe. Most plants are naturally safe to be consumed. Thus, the plant breeders' assessment of agronomic characteristics [traits of the crops such as resistance to pests or amount of crops) is the first screen for removing the unintended effects in the recombinant plants.

The safety of expressed new substances especially protein is assessed by two approaches; potential toxicity and potential allergenicity. For potential toxicity, scientists need to sequence the homology with known toxins, the function of the protein and to test any unknown proteins in animals if the amino acid sequence or protein function indicates possible toxicity. The potential allergenicity will be tested with comparing it with known allergens, in vitro digestibility, the source of the genes whether the protein is derived from an allergenic food, and test the expression level if relevant.

The central dogma of food biotechnology today is introducing the well-characterized proteins. The structure or function of the

biotechnology proteins is **typical of** food proteins, it is readily digestible. The proteins are not similar to toxins or allergens. There is only low concentration of it in food (e.g. enzymes) and does not cause any long **term** adverse effect.

Unintended effects *are* normally occurring in all methods of plant breeding, and biotechnology processes are **not** exceptional. In conventional breeding, the **unintended** effects rarely affect human health and there **are** no documented health effects for modern biotechnology. The food safety assessment means that the unintended effects are unlikely to adversely affect health.



The above **image depicts** the likelihood **of** unintended effects in plant breeding according to NRC/IOM Report (2004). The most interesting things here are all the unintended **effects** are not unique to biotechnology. **As** far **as** anyone has tested, there is nothing unique to biotechnology in terms of **hazards** or risks. The assessments of unintended adverse effect on health are breeders assessment of agronomic traits, stability of introduced **genetic** material (to reduce any defects or unintended **effects),** comparative studies on food compositions (must be in normal range) **such** as key nutrients, anti-nutrients & toxicants that are native **to** each crop.

If the safety questions are unresolved, the assessment agency needs to be open to additional **tests.** The tests are for unusual protein *function* (e.g. not typical of proteins safely consumed in food, food composition changes **outside** the normal **range** that **may** adversely affect health, characteristics similar to known toxin or allergen (e.g. Brazil nut protein) and **new chemical.**

The goals of safety assessment **are** food **will** not cause harm based on its intended use, new food is as safe as its conventional counterpart (standard goal), account for dietary impact of any nutritional changes and risk managers can determine **if** any **special** measures **(such** as market entry) are needed.

In several countries, nutritionally and health enhanced biotechnology crops are developed. Some examples are lettuce with calcium (*Arabidopsis* gene), purple tomato with high anthocyanins (snapdragon flower genes; antioxidant properties], modified soybean oils which are low in saturated fat or contain no trans fat and contain **omega-3,** high lysine maize [feed corn) and golden rice. The **safety** of those plants are also included in several **Codex** guidelines. The current guidelines for nutritionally enhanced crops are Codex Guideline for Safety **Assessment** of Foods **Derived** from rDNA Plants; **Annex** on allergenicity, Codex Guideline for Safety Assessment of Foods Derived from rDNA Plants Modified for Nutritional or Health **Benefits,** and ILSI Monograph 2004. The development of safety assessment of nutritionally enhanced foods is very case-specific. There will be special considerations by **taking** in **the bioavailability, dietary levels and** the intended effects (additional nutrition).

The development of genetic engineering has developed from a long **time** ago. In 1970s, scientists' develop the technique to introduce new genes to **cells.** Then, the scientists' concerns for introducing more pathogens instead of functional cells developed into **careful** research and guidelines. In 1982, the FDA approved recombinant insulin **and** other pharmaceuticals. The genes function as expected after transfer to diverse organisms. There **is** no **unique** hazards and risks regarding the biotechnology crops.

SUMMARY

Over the past 12 years, new biotech plant varieties that have completed regulatory requirements have been grown commercially. A comprehensive, science-based approach for food safety assessment has been accepted globally. No adverse health effects from changes have been found. After a decade of experience, all bioengineered foods on the market are as safe as conventional foods. Public information is important. It needs to be factual, objective, understandable, and easily accessible.

Question & Answer

Q: How can we assess the safety of CM food products that are imported into my country? Because I heard that if the biotechnology varieties are then the assessment will be based n that approval. Please comment on that.

A: Generally there are different requirements in different country. From my evaluations with various regulatory agencies, if every single gene are already evaluated under Codex kind of process, and those are combined with traditional engineering methods, unless there are interactions among the expressed proteins, the safe assessments can be based on the existing safety assessments. The question is whether the genes will produce any other metabolites when interacting with each other. In Japan there are examples of plants with combined traits, and those were assessed with the existing safety assessments. In the USA, FDA has a registration for new proteins (because there ae different pesticides which can introduce different proteins to the plant). But for now, I think most assessments will be based on the existing data.

Q: How are the acceptance of GMF products in our country, and how did you assure people in your country that the GMF products are safe as any other common food?

A: In terms of assuring the public, it is important to have the information presented to the public in the way that they can understand and they know that the government is acting responsibly. Part of the process is opening some of our scientific findings open to the public and having some public comments in the FDA and other agencies.

We first made the decision in 1994 to introduce biotechnology in foods and **market the** products. **In** the late 1990s, concerns started to arise in Europe. The result of that was Americans started to **ask** FDA **and** American government on what **is** going on. FDA decided to inform the public on this technology and also listen to the public. We conducted 3 public intermediates in Washington, Chicago, and California. **We** also had panels of scientists and public information who will talk to the public and we also invited people to make comments. Their comments were taken seriously so they feel that they are in the process. We can never satisfy the people who arc against the technology. It is a very and intricate issues but the government can provide the information for all the citizens.