# Processed Meats Safety - Allergens

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## Introduction

Food sensitivities affect a small number of the consumers in the population. These reactions generally fall into two categories – food intolerance and food hypersensitivity. Food intolerances are non-immunologic in nature and are responsible for most adverse food reactions. They may be idiosyncratic– due to metabolic disorders (e.g. lactose intolerance), or caused by pharmacological substances such as toxins or drugs present in food. Food intolerances are often confused with, and referred to as "allergies." People with food intolerances can usually tolerate modest amounts of the food in their diet - on the other hand, food-allergic individuals cannot tolerate any. The public perception is that many people are "allergic" to foods. The actual number of people who are truly allergic to foods is quite small, illustrating that the term "allergy" is often used erroneously.

## Food Allergy

Food hypersensitivity, or true food allergy, is an adverse food reaction involving immunological mechanisms. The mechanism is illustrated in Figure 1. (See next page.) Food allergies are initiated by production of specific antibodies, otherwise known as immunoglobulins, in reaction to naturally-occurring food proteins. The body manufactures antibodies as part of its regular defense system against foreign invaders such as viruses and bacteria. In certain individuals, the immune system is triggered to elicit a certain type of antibody, called immunoglobulin E (IgE), against food proteins. This mechanism is the same type of immune response as that which gives rise to allergic reactions to honeybee stings or penicillin, and the symptoms of food-allergic reactions can be as severe and life-threatening as those.

In food-allergic individuals, food proteins elicit an immune response, and induce the production of IgE antibodies by white blood cells. The IgE is very specific for the food protein. After manufacture, the IgE is secreted and circulated throughout the body via the circulatory and lymph systems. Upon reaching certain cells known as mast cells or basophils, the IgE becomes fixed to the cell surface of these cells via receptors. Subsequently, when the specific food protein, known as an allergen, is once again ingested, peptides from the proteins are distributed through the circulatory system and come in contact with the IgE bound to the mast cell or basophil surface. This contact causes a complex chain of events to occur in the cells, leading to membrane compromise and secretion of very powerful cellular mediators, such as histamine, from the mast cells or basophils. These cellular mediators are responsible for the symptoms of the allergic reaction.

## Prevalence

The prevalence of true food allergy is probably less than the general population perceives. While surveys have shown that up to 25% of people believe they are food-allergic (Sampson and Metcalfe, 1992), scientific studies indicate that the prevalence of true food allergies is 4-6% of infants (Bock, 1987) 1-2% of young children, and less than 1% of adults (Sampson and Cooke, 1990). Food allergy also is influenced by culture and eating habits. For example, allergies to fish are more common in Japan and Norway than elsewhere because consumption of fish is higher in those countries (Aas, 1966). Other factors may influence prevalence rates. An example is kiwi fruit, which is not indigenous to the U.S. and became available as a result of importing and distribution in the 1980s. After the introduction of kiwi to the marketplace, literature reports of allergic reactions to kiwi fruit began to appear in the literature.

Frequency of food hypersensitivity varies by ethnic group and socioeconomic class (Lieberman and Barnes, 1990). The etiology of food hypersensitivity includes many factors, but genetics seem to play a large role. Studies with children have shown that the risk for food allergy increases if the parents have any type of allergies themselves (Schatz et al., 1983). The prevalence drops as individuals get older, since some food allergies, such as milk and egg, are primarily allergies of childhood, and are outgrown. However,

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**Figure 1. The Allergic Mechanism**

allergies to certain types of foods, such as peanut and tree nuts, are usually life-long. Food allergy is most prevalent between 1.5 - 3 years of age (Kjellman, 1991). Although young children are more likely to outgrow their food allergies, older children and adults may also lose their sensitivity if the offending food is removed from the diet (Sampson and Scanlon, 1989).

### Symptoms

The most common symptoms of food-allergic reactions are gastrointestinal, cutaneous, and respiratory (Table 1); and they represent contact of allergen with sensitized mast cells present in the affected tissues. Gastrointestinal symptoms are common and include nausea and vomiting, cramping, and diarrhea. Skin reactions to food allergens can include itching and swelling of the lips, tongue, gums, oral mucosa, and pharynx. Hives are the most common skin symptom and can be of a general or localized nature. Atopic dermatitis, a chronic inflammatory skin disease, can be exacerbated by food-allergic reactions and is characterized by dry, easily irritated, itchy skin. Respiratory symptoms can include tightening and closing of the throat due to laryngeal edema and asthma. Initial symptoms experienced are very individualistic and diverse - some individuals may experience immediate contact reactions on their lips and tongue, while others do not experience a reaction until the offending food has moved farther down the gastrointestinal tract.

**Table 1. Symptoms of Allergic Reactions to Foods**

| Gastrointestinal | Respiratory |
|---|---|
| nausea | rhinitis |
| vomiting | laryngeal edema |
| cramping | asthma |
| diarrhea | |
| **Cutaneous** | **Anaphylactic shock** |
| hives | generalized shock |
| swelling | hypotension |
| itching of oral mucosa | cardiac arrhythmia/arrest |
| atopic dermatitis | |

Anaphylactic shock is the most severe manifestation of a food-allergic reaction and is rare, acute and potentially fatal. It is a generalized form of shock reaction and can include a number of organ systems. Anaphylactic reactions may advance rapidly, beginning with mild symptoms, but then can progress to cardiorespiratory arrest and shock over a few hours. For example, an individual experiencing an anaphylactic food-allergic reaction may initially notice tongue itching and swelling, then throat tightening, perhaps followed by wheezing and cyanosis. Chest pain and hives may be noted, and the individual may have gastrointestinal symptoms such as abdominal pain, vomiting, or diarrhea. A progression of symptoms can lead to potentially life-threatening hypotension and shock. As there are no official means of reporting anaphylactic episodes, the actual frequency of these reactions is unknown, although it has been estimated that there are 100-200 deaths per year in the U.S. due to food-induced anaphylactic shock.

**Table 2. The "Big Eight" Allergenic Foods**

| | |
|---|---|
| Peanut | Crustacea |
| Tree nuts | Fish |
| Milk | Soybean |
| Egg | Wheat |

## Allergenic Foods

The most common allergenic foods in the world are milk, eggs, peanuts, soybeans, wheat, tree nuts, fish, and crustacea (Table 2). While any food has the potential to cause an allergic reaction, these foods (the "Big Eight") account for over 90% of food-allergic reactions. Other foods associated less commonly with severe food allergy (Table 3) include some of the seeds (cottonseed, sesame, poppy, and sunflower), other legumes besides peanuts and soybeans (e.g. lentils, chickpeas), and mollusks. These commonly allergenic foods can cause equally-severe symptoms in affected individuals, but affect fewer numbers of people in the population. Beef, pork, and chicken are rarely reported as causing allergic reactions (Sampson and Albergo, 1984; Sampson, 1991). Any food can become an allergen if it contains protein. The list of allergenic foods that are responsible for the other 10% of reactions number greater than 160 (Hefle et al., 1996). The causative agents of food allergy are naturally-occurring proteins. The vast majority of these are heat- and digestion-resistant. Allergens are usually the major proteins of the food and foods can have one or many allergens in them. While there are tens of thousands of proteins in any one food, only a few are capable of inducing an allergic reaction.

**Table 3. Other Foods Associated Less Commonly with Severe Food Allergy**

| |
|---|
| Cottonseed |
| Sesame seed |
| Poppy seed |
| Sunflower seed |
| Other legumes |
| Mollusks |

## Issues for the Meat Industry

A major issue for the food industry is that some food-allergic individuals display exquisite sensitivity and trace amounts of their offending food can trigger severe

reactions. The landmark scientific papers documenting deaths and near-deaths from inadvertent food allergen ingestion were by Yunginger, et al.(1988), in which 8 deaths were documented, and Sampson, et al. (1992) documenting 12 deaths or near-deaths from inadvertent exposure to allergens in children and adolescents. These cases involved inadvertent ingestion, as severely-allergic individuals in most cases are well aware of their sensitivity and therefore avoid their offending food at all costs. While these cases did not occur as a result of manufacturing errors, the publication of these articles was concomitant with an increase in the number of recalls of food products due to allergenic cross-contact. Unfortunately, the amount needed to cause a reaction is unknown and more research is necessary to address this issue. A recent study has shown that the minimum amount to cause objective symptoms in peanut-allergic individuals was 2 mg, but subjective symptoms were reported to 100 mg (Hourihane et al., 1997). Much more research is necessary to document the allergic threshold.

There are several strategies that can be employed to reduce the risk of allergenic contact in food-processing settings. These range from product development through operations strategies and sanitation issues. Table 4 shows various practices in food processing that can contribute to allergenic cross-contact and possible inadvertent ingestion by sensitive individuals.

**Table 4. Possible Processing Oversights That Can Lead to Allergen Cross-contact**

| |
|---|
| Inadequate cleaning of shared equipment |
| Inaccurate use of re-work |
| Switching of ingredients |
| Formulation mistakes |
| Wrong labels/packaging |
| Use of confusing labeling terms |

## Product Development

When formulating products, the use of commonly allergenic foods and ingredients derived from these foods should be avoided when possible, if they contain protein. While the introduction of a novel flavor, for example, peanut sauce-Thai seasoning, to a sausage product may be of interest, the subsequent cleaning issues can present a problem for the manufacturer. Therefore, avoiding the use of peanut would help to decrease the risk of allergen cross-contact of non-peanut-containing product. It is suggested that the Big Eight foods not be used in food products if other ingredients will work equally as well. For example, if something other than egg protein would work well as an emulsifier in a particular product, the use of that alternate is preferable.

While the source of hydrolyzed proteins from the Big Eight (e.g. milk, soy, wheat) is labeled in the United States,

it is always a good idea to indicate the presence of these hydrolyzed ingredients in products for international markets too. These preparations can vary in their extent of hydrolysis and may present a hazard to food-allergic individuals. Also, while it is not required in the United States to disclose the individual components of flavoring preparations, it is recommended. Allergenic proteins can comprise a substantial amount of flavors in some cases. The term "natural flavors" does not give the food-allergic individual enough information to know whether or not that product is safe for their consumption. Some manufacturers have decided to declare the presence of flavoring agents derived from allergenic sources on their ingredient labels.

## Manufacturing Practices

In the food industry, there are certain processing errors that can contribute to cross-contact and result in allergenic residues being present in foods. Inadequate cleaning of shared equipment and the inaccurate use of allergen-containing rework are two of the major contributors to cross-contact problems. Manufacturing various products on shared equipment is common practice in the food industry but inadequate cleaning between allergen-containing and non-allergenic containing products can spread unlabeled, potentially-hazardous allergenic residues into products that do not declare their presence on the ingredient label.

For example, if a sausage or loaf-type product containing soy protein is manufactured first followed by a non-soy-containing product, and careful cleanup is not done, the second product can contain levels of soy residue that could be hazardous to soy-allergic individuals. To circumvent problems associated with shared equipment, some companies have resorted to dedication of production lines when possible. Formulating products so that allergens are added to the line late in the process, thereby exposing less of the line to allergen residue and making it easier to clean, can assist in reducing potential for cross-contact. In addition, scheduling like-allergen products together, running longer productions with less changeovers, and scheduling production of allergen-containing products just prior to end of shifts after which major cleanup is scheduled have helped some companies to decrease the risk of cross-contact.

Rework is another common source of allergen cross-contact. A "like-into-like" policy regarding rework is the only sensible policy. Care should be taken to isolate rework for easy identification. Documentation is essential and tracking rework use is imperative. For example, totes or bins could be color-coded or label-coded for allergen-containing rework.

## Labeling

Food-allergic consumers must educate themselves about label designations, terms, and ingredient names and always perform diligent readings of ingredient lists. This can be difficult, as particular terms used by food manufacturers can disguise the presence of allergens. For example, "natural flavorings" may contain soybean and/or milk proteins, and "caramel flavoring" may contain milk proteins. Manufacturers should always declare the presence of any allergenic food contained in the product on the ingredient label. Switching of ingredients can cause problems - in one case a hot dog manufacturer decided to make a formulation change, switching from autolysed yeast to hydrolyzed casein. Casein is one of the major allergens in milk, and the amount of hydrolysis in this case was not enough to remove the allergenicity. The hydrolyzed casein fell under the proviso of "natural flavors", and the label designation therefore did not flag the presence of milk in the product. The manufacturer was not aware that parents of milk-allergic children bought their brand of hot dogs in particular because of its lack of milk ingredients. Several milk-allergic children became ill after ingestion of the hot dogs (Gern et al., 1991).

Labeling the sources of ingredients when they are derived from allergenic foods is therefore recommended. However, if the ingredient contains no protein residues it will not be a problem for allergic individuals, as the proteins are the causative agents. For example, it has been shown in clinical studies that soybean- and peanut-allergic individuals can safely consume edible oils made from these sources if the oils are solvent-extracted, highly-refined, bleached and deodorized (Taylor et al., 1981, Bush et al., 1987). However, cold-pressed edible oils can contain protein and have been shown to cause reactions in allergic individuals (Hoffman et al., 1994). Information on the protein content of ingredients or flavors should be solicited from suppliers.

## Summary

In summary, allergen cross-contact can occur in food-processing environments resulting allergenic residues may be hazardous to a small number of food-allergic individuals in the population. However, a review of processing procedures, labeling practices, production scheduling, and validation of cleaning procedures with regard to allergenic residues can help to control allergenic cross-contact. This will decrease the risk of injury to a food-allergic person and the chance of an expensive recall for the company.

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