Effect of irradiation on allergenicity of different food products

Irradiation and allergens

Identification

<table>
<thead>
<tr>
<th>Key words</th>
<th>Irradiation, allergen, food</th>
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How does it work?

Primary objective

Food irradiation objective is the inactivation of microorganisms and through this to prolong the shelf life. As side effect, this technology influences the food allergenicity.
The principle of the effect can be demonstrated in case of ovalbumin and bovine serum albumin in solution (0.2% in 0.01 M phosphate buffer, pH 7.4). These proteins were irradiated with high dose of order of 8 kGy (units for intensity characterization of ionization by gamma irradiation). This process besides inactivation of microorganisms induced production of protein aggregates and degraded fragments with reactivity to the specific antibodies. The main part of conformation-dependent reactivity, spatial antigenic structure (conformational epitope) was lost, but some antigenicity persisted [1].

**Sebastiania jacobinensis bark lectin.** High doses of gamma irradiation (above 1 kGy) induced a significant loss of activity of this protein. There were apparent changes in the hydrophobic surface. Gamma irradiation caused protein misfolding and aggregation [2].

**Milk proteins.** Bovine alpha-casein and beta-lactoglobulin when irradiated changed their allergenicity and antigenicity. Probably, agglomeration of proteins was caused by the treatment [3].

**Egg proteins.** Cakes containing layer of egg white were gamma-irradiated with 10 or 20 kGy. The ovalbumin present decreased its allergenicity by irradiation and processing. Egg white irradiated for reducing the egg allergy could be used for producing a safer cake [4]. Hen egg ovomucoid at basic pH was irradiated at 10 kGy, heated at 100°C for 15 min, or both treatments were applied. The combination of irradiation and heating was very effective in reducing the amount of intact ovomucoid regardless of the pH condition [5].

**Gliadin.** Commercial gliadin powder and wheat flour were irradiated with doses between 2.2 and 12.8 kGy. Surprisingly, irradiated gliadin increased its allergenicity. Gliadin extracted from irradiated wheat flour exhibited higher immunoreactivity than pure gliadin irradiated with the same dose [6].

**Shrimp.** Shrimp heat-stable protein was isolated and gamma irradiated at 0, 1, 3, 5, 7, or 10 kGy in the condition of solution (1 mg/ml), and fresh shrimp was also irradiated. The IgE binding rate was reduced with increasing dose. The main allergenic protein disappeared and the traces induced from coagulation appeared at a higher molecular weight zone as evidenced by special test. The same results were received on proteins extracted from irradiated shrimp [7]. It is very hard to conclude the above information. In some foods (food matrices) the irradiation is beneficial with regard to allergenicity but other allergens can be emphasized in their reaction. Therefore, before each irradiated product market release, a study of allergenicity should be done (if there is the risk of allergenicity of even untreated product, well-known list of food matrices that should be declared on the packaging if presence of which cannot be avoided).

<table>
<thead>
<tr>
<th>Images</th>
<th>Additional effects</th>
<th>Important process parameters</th>
<th>Important product parameters</th>
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<tbody>
<tr>
<td></td>
<td>Inactivation of microbes by irradiation</td>
<td>Intensity of gamma irradiation (kGy).</td>
<td>Water content of food, allergen type, allergen concentration, presence of enzymes</td>
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**What can it be used for?**

**Products**

No limitation is given but irradiation itself is limited in practice mostly to so called dry products: spices, herbs, wheat flour

**Operations**

De-allergization of foods, shelf life prolongation

**Solutions for shortcomings**

This data sheet was not inspired by industrial needs but ev. Need can be formulated as “Advice, what is known about effect of irradiation of foods on present allergens?” or “Can gamma irradiation inactivate present food allergens?”.
What can it NOT be used for?

**Products**
Limitation is given by limitation of gamma irradiation itself. In practice, this process is used for stabilizing (microbe inactivation) in dry products mostly. It is because in these products other stabilizing methods are more complicated (recently removed this limitation by application of dry heat treatment or steaming and subsequent drying) and also because in food with higher water content than about 20 % the irradiation can start-up non-microbial spoilage processes (enzymatic browning, hydrolysis, odour formation etc.).

**Operations**
Food gamma irradiation is limited by the intensity. Dry products can be irradiated by higher intensity than products with high water content.

**Other limitations**
The most important limitation of irradiation is the consumer aspect. This process (irradiation) was extensively used for microbial decontamination of food additives and dry foods as spices and dried herbs. European legislation recently requested that any component irradiated has to be declared on packaging. Since that time, the method is practically not used and steaming or dry heat processing is used for microbial decontamination of these products.

**Risks or hazards**
No, if limited intensity is applied, but in the light of recent events with nuclear power stations, the public is not willing to consume irradiated foods.

Implementation

**Maturity**
No information on the industrial application of food irradiation with objective to deallergize of foods. There are only several scientific studies motivated by legislation requesting to study the effect of irradiation (with aim of microbial decontamination) on most harmful allergens presented in foods.

**Modularity**
Irradiation cannot be installed in the production line. There is need of pre-packaging (even in some bulk packaging), transport these products into the irradiation centre and re-pack it, after treatment in factory of origin (best at aseptic condition to avoid recontamination). Also contamination with untreated or other products should be avoided to eliminate e.g. contamination with other allergens (well-known nuts presence in black chocolate).

**Consumer aspects**
European consumers did not accept the gamma irradiation of foods well.

**Legal aspects**
Directive of European parliament and Council 1999/3/ES and national legislations contain the lists of foods that can be irradiated.

**Environmental aspects**
Food irradiation is a relatively simple and energy saving process that can be done at room temperature without substantial temperature elevation during processing.

Facilities that might be interesting for you

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<th>Title</th>
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<tr>
<td>Auditorium IRTA</td>
<td>IRTA</td>
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<tr>
<td>Clean room – Histocell</td>
<td>Noray</td>
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<tr>
<td>Video observation system for market research and product development tasks - Keki</td>
<td>NAIK EKI</td>
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Further Information

Institutes
Max Rubner Institute, Institute of Applied Radiation Chemistry, Institute of Nuclear Chemistry and Technology, Leatherhead Food International, IFR

Companies
BGS Beta-Gamma-Service, Ionmed Esterilización, Gammaster Provence, GAMMARAD ITALIA SPA

References