Food allergens reactivity as affected by thermal processing

Thermal processing and allergens

Identification

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How does it work?

Primary objective  The heating process (pasteurization, sterilization) made with aim to inactivate microbes, can as side effect change the allergenic protein structure and influence the accessibility of special places in protein structure (epitopes) by antibody substance IgE that cause start up the allergenic reaction of the patient.
Working principle

During thermal processes, such as pasteurization, sterilization, boiling and roasting, some reaction products are generated in foods. Between them, so called Maillard reaction products (protein amino groups vs. saccharides reaction) originate. Some of them can induce severe allergenic reaction [1]. In following text the effect of heating on allergenicity of different foods or individual allergens is briefly described. In most cases, the heating itself cannot de-allergize foods. In some exceptional cases, the lowering of allergenic reaction is described. But, in peanut roasting, this process substantially increased the allergenicity of the final product. Therefore, no general advice can be provided and each product should be considered as specific case.

Eggs. Egg white after boiling exhibited still detectable allergenic reaction as stated in [2]. Cooking of various food extracts including eggs with vinegar substantially decreased size of wheals in prick-to prick test in sensitized individuals [3].

Legumes. Boiled lentils extract kept its allergenicity [4]. Soybean globulin, when heated, lost partly its allergenicity [5].

Fish and seafood. Cooking of fish caused denaturation and conglomeration of proteins but some bands presented IgE binding in WB [6]. Canning of fish caused the reduction in IgE binding [7].

Meat and meat products. Allergenicity of pork sausages digested by using pepsin and trypsin considerably decreased after autoclave treatment, and were also maintained or decreased after enzyme treatment. Accordingly, autoclave treatment represents a promising processing technology for the reduction of the allergenicity of diverse food products [8].

Peanuts and other nuts. First studies on roasting of peanuts proved that this dry heat treatment generated Maillard reaction products that have much more IgE binding properties than untreated control [9], [10]. Roasting, autoclaving, Blanching, microwave heating of almonds indicated antigenic stability of almond proteins when compared with that of the unprocessed nuts in ELISA and Western blot tests [11]. Hazelnut protein with molecular weight less than 14 kDa presented high heat stability and was detected even after treatment at 185°C [12].

Fruits and vegetables. Heat sterilization of peach at 121 °C for 10 and 30 min, chemical lye peeling of fruits and ultra-filtration of juice through membranes with suitable cutoff were tested. The sterilization was not able to decrease the allergenicity of the Pru p 1 protein. Furthermore, the protein band was still present even after 60-min reaction with two different acidic proteases. The chemical lye peeling of fruits and ultra-filtration of juice through membranes with suitable cutoff decreased the major allergen of peach [13]. Chemical peeling, thermal treatment, and syrumping processes were applied on different varieties of cherry. Chemical peeling successfully removed Pru av 3, a lipid transfer protein (LTP) responsible for allergy syndrome in patients without pollinosis. The syrumping process removed almost all allergenic proteins [14].

Pasta, grain and bakery products. Model pasta samples (durum wheat) were dried at temperatures 20, 60, 85, 110 and 180 °C and cooked in boiling water. Digestion process together with previous heat treatment was not able to completely inactivate the IgE-reactive peptides [15]. Almost all proteins of rice were excluded or weakened in the process of boiling but IgE binding activity still remained even in hypoallergenic rice [16]. Wheat dough and the bread crumb and crust, before and after being in vitro digested were tested for presence of allergens [17]. During in vitro digestion, the IgE binding protein components of the unheated dough disappear. The bread crumb and crust isolated proteins saved IgE binding. The effects of baking must be taken into account in studying food allergies to wheat products.

Milk and milk proteins. Raw, pasteurized, and homogenized/pasteurized cow milk and hypoallergenic infant formula as a control were tested [18]. This work provided evidence that heat treatment increased ability of pasteurized and homogenized/pasteurized milk to evoke allergic reactions in patients allergic to milk.

Images

Additional effects

Heating, besides the antimicrobial effect, has a positive effect on food digestibility, food structure and overall quality, namely for animal origin raw materials.
Important process parameters
Holding time at temperature and temperature.

Important product parameters
Composition of food matrix.

What can it be used for?

Products
Eggs, Legumes, Fish and seafood, Meat and meat products, Peanuts and other nuts, Fruits and vegetables, Pasta, Grain and bakery products, Milk and milk proteins.

Operations
Heat pasteurization, sterilization, boiling and roasting.

Solutions for shortcomings
This datasheet can provide answer on simple question “How can heat treatment influence the allergenicity of different food products?”

What can it NOT be used for?

Products
There is also negative experience with influence of heating on allergenicity of some foods. This is caused in most cases by the specific composition of food matrix that contains protein protective substances, e.g. dry heat roasting of peanut increases the allergenicity (tested on patients sensitized to peanut main allergenic protein).

Operations
Not known.

Other limitations
The food structure limits the heating intensity. We can destroy by heating present allergens but the food matrix is so “well done” that it cannot be eaten.

Risks or hazards
The detailed extracted facts from literature (see above) provide evidence that the heating process in many cases cannot inactivate the allergenicity of present proteins. In several cases, the allergenicity is increased by heating.

Implementation

Maturity
The deallergization of foods by heating is not applied yet due to its relation on given food matrix.

Modularity /Implementation
There would be no problem with implementation of a heating process into the existing lines. The deallergization, can be considered as a side effect of heat pasteurization or sterilization.

Consumer aspects
Not known.

Legal aspects
Allergens presence labelling is under the EU legislation regulation. No special legislation on labelling of the heat treated product is presented.

Environmental aspects
Not known.
Facilities that might be interesting for you

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Further Information

Institutes

FRIP, IFR, University of Vienna, Dermatologische Klinik Universitätsspital Zürich, Paul-Ehrlich-Institut_Allergology division, JRC Geel.Inst Ref Mat and Measurements, University of Hamburg, USDA - ARS - SRRC, INRA - UIAA

Companies
References
