

# **Chemical and Biochemical Aspects of Food Processing and its Effect on Allergen Structure and the Food Matrix**

Angelika Paschke  
University of Hamburg  
Faculty of Mathematics  
Informatics and Natural Sciences  
Department of Chemistry  
Food Chemistry

Food processing splits up into different physical and chemical treatment procedures used exclusively or in combination. Methods of food processing are preparation, mechanical processes, separation, isolation and purification, thermal processes, biochemical processes, genetic engineering or “novel” processes like high pressure or electric field treatment and irradiation.

An example for preparation is the post harvest storage of plant food. Fruits or vegetables change their proteome during storage (Sell et al., 2005). An increase of allergenicity is possible as shown for apples by Vieths et al. (1993) but is not obligatory for every fruit. In mango fruits no difference of IgE binding potency of the proteome was identified (Paschke et al., 2001). When there could be found an alteration of allergenicity during storage and ripening the intensity depends on the atmosphere of storage, the storing conditions e.g. temperature or kind of gaseous atmosphere (Li-Shan et al., 1995).

As the proteins in concentration and in content vary in the different parts of a fruit or vegetable removal of one or more of the parts could lead to reduced allergenicity of the product. In production of peach juice peeling of the fruits aimed in a reduction of allergenic potency of the final juice (Brenna et al., 2000).

Mechanical processes as stirring or homogenisation might have a small influence on the proteins in food . A surface denaturation could be imagined but a clear reduction of allergenic potency is not shown.

Separation, isolation or purification procedures are able to reduce the allergenicity. Separating or isolating the starch from potatoes or wheat, producing butter are a nearly

complete removal of the proteinogenic fraction of the native food. Purification as ultrafiltration is an effective processing example. In production of hypoallergenic infant formulas based on milk enzymatic treatment with proteases leaves small amounts of intact proteins in the formula. By ultrafiltration these intact proteins and allergens can be removed (van Beresteijn et al., 1994).

Thermal processes are used in many different ways in food production: beginning with baking, cooking, roasting, grilling going to drying or pasteurisation and sterilisation. Denaturation of proteins and their reaction with other molecules of the food matrix during thermal treatment of food could result in an effective reduction of allergenic potency of the food product. The denaturation destroys the conformation of the protein and therefore a loss of conformational IgE epitopes may happen. Fiocchi et al. showed 1995 the reduction of allergenicity of beef and purified bovine allergens. But there is also the possibility that the allergen is very thermostable, that the denaturation of the allergen does not reach the thermostable region of the protein and the epitopes still exist after thermal processing like it is proven by Koppleman et al. 1999 for peanut. The proteins unfold but a refolding during cooling is also possible seen in potato (Koppleman et al., 2002). The aggregation of the allergens with other potato proteins was investigated. The reaction of proteins with other food components, of amino acids with sugars, the Maillard reaction, the browning reaction of food during heating or storing being also responsible for development of positive sensorical aromatic compounds in food, may lead to altered allergenicity (Davis et al., 2001). For peanut their Maillard products resulted in higher IgE binding than the untreated peanut allergens (Maleki et al. 2000a and Beyer et al., 2001). The lactosylation of milk, the reaction of beta-lactoglobulin with lactose showed an increase of allergenicity (Bleumink and Berrens, 1966). No Maillard products but other oxidative products let allergenicity increase in pecan nut (Berrens, 1996).

Biochemical food processes include enzymatic treatment of the food products. proteases, oxidases or transglutaminases are used. Wigotzki et al. (2000) showed a decrease of allergenicity of hazelnut after treatment with trypsin, elastase and protease. Rice allergenicity was reduced by actinase (Watanabe et al., 1990a and Watanabe et al., 1990b), proteases reduced allergenic potency in soybean (Yamanashi et al., 1996) and bromelain decreased allergenicity in wheat (Tanabe et al., 1996 and Watanabe et al., 1995). Enzymatic resp. proteolytic treatment was not able to destroy the epitopes of peanut or peach (Maleki et al.,

2000b and Brenna et al., 2000). A cross linking of transglutaminase and casein (Yamauchi et al., 1991) or a linking with wheat proteins (Watanabe et al., 1994) led to a decrease of allergenicity.

Genetic engineering altered rice, soybean and peanut in a positive way for allergic consumers (Adachi et al., 1993, Tada et al. 1996, Ogawa et al. 2000, Suszkiw, 2002). This method is not very well accepted in many countries by the consumers. On the other hand it is an expensive procedure. It is doubtful that it will be used to produce allergene reduced food commercially.

Kato et al. (2000) and Jankiewicz et al. (1997) had a look on novel methods to decrease allergenicity. Kato et al. reduced the allergenic potency of rice by high pressure (100-400 MPa). Jankiewicz et al. worked with celery. High pressure treatment (600 MPa), pulsed electric field treatment (10 kV, 50 Hz) and gamma-irradiation were not successful.

In conclusion the thermal and biochemical processes as well as the genetic engineering have main influence on the food proteins comparing to the other technical procedures. Here, the possibility of reducing the allergenicity by destroying the epitopes is high. Nevertheless there is also the possibility to have no alteration of epitopes and allergenic potency or to induce the occurrence of “new” epitopes which increase the allergenicity. New epitopes which were hidden in the complex native protein molecule and which appear after denaturation on the surface of the protein.

In food science usual technological processes are investigated how they influence the allergenicity of different food products. New processes are also in the interest of research to produce on the one hand food for allergic patients and on the other food for prevention of food allergy. Very important is to keep the identity of the product although processing has changed the protein fraction of the product.

The EU project REDALL QLK1-CT-2002-02687 (Reduced Allergenicity of Processed Foods, Containing Animal Allergens) tried to find technological procedures to reduce the allergenicity of milk, egg and meat and their products. Thirteen partners from six different countries are involved, analytical and food chemists, clinicians, a consumer research institute and food technologists.

After clinical and chemical characterization of the raw products the intermediate and final products of the technological experiments were chemically investigated. New technological products with remarkably reduced IgE binding capacity were clinically tested. First a SPT was performed, negative results led to a DBPCFC test. More sensitive methods are developed for chemical and clinical analytics. Accompanying the consumer research institute investigated the prevalence of food allergy and occurrence of severe food allergic reactions in ten European countries by different survey programs.

The FEI-Project (AiF-FV 12024 N) “Studies on alterations of the allergenicity of fruits and vegetables during technological processing” was worked on by the Food Chemistry of the University of Hamburg and the Food Technology of the University of Hohenheim. Different products of four fruits or vegetables were investigated. The Food Technology worked with different commercial like procedures. Food Chemistry investigated by protein extraction, electrophoretic separation of the proteins and immunoblotting the proteins. EAST inhibition investigations compared the allergenic potency of the raw, intermediate and final products.

Apple puree, decanted and pressed apple juices were produced. In the intermediate products was no effective loss of allergenic potency. The storage of mash over several hours had less influence on allergenicity. Addition of ascorbic acid to the mash showed that no influence of storage is obvious. The final heating step, pasteurisation, led to reduction of IgE binding potency.

Production of mango fruit nectars showed a high heat stability of the mango fruit allergens. No influence of temperature on allergenic potency is detectable. Also enzymes used in nectar production to increase the yield of nectar had no influence on the allergenicity of the intermediate or final products of the nectar production. (Dube et al., 2004)

Production of lychee fruit cans showed less decrease of allergenicity during increase of time of heating . A high heat stability of lychee fruit allergens was observeable only less molecular weight IgE binding proteins of 20-35 kDa were no more detectable. (Hoppe et al., 2006)

Another investigated product have been potato flakes produced under addition of ascorbylpalmitate and monoglyceride. IgE binding proteins have been weakly detectable in the intermediate products, a new IgE binding protein was detectable. By heating IgE binding

potency of proteins is reduced but not completely eliminated. Addition of ascorbylpalmitate and monoglyceride had no influence on allergenicity. (Schubert et al., 2003)

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