

Plant food allergens homologous to pathogenesis-related proteins

In general, pathogenesis-related (PR) proteins are expressed by plants in response to stress conditions like infection, exposure to certain chemicals, wounding and environmental conditions. In some plant tissues, however, PR proteins are constitutively expressed, e.g. in pollens or fruits, tissues that are more likely to be attacked (by insects or fungi) or exposed to atmospheric conditions (e.g. UV irradiation). PR proteins display multiple effects within the plant and possess antimicrobial activity, and can thus be regarded as a part of the plant's defense system. Analyzing known amino acid sequences and functions of characterized (cloned) food allergens, it is remarkable that many of these molecules can be classified as PR proteins. Many PR proteins are stable at low pH, and display considerable resistance to proteases, requirements to act as food allergens. According to sequence characteristics and their enzymatic or biologic activity, PR proteins can be divided into 14 groups. Seven of these 14 groups contain proteins with allergenic properties, six groups contain food allergens.

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Food allergens with homology to PR-2 type proteins

Beta-1,3-glucanases are monomeric proteins with a molecular mass of 25–35 kDa (5). These pathogen-induced enzymes cleave and degrade β -1,3-glucans, components of fungal and plant cell walls. Hev b 2, an allergen of *Hevea brasiliensis* (latex), has been identified as β -1,3-glucanase. Homologous proteins can also be found in banana, where the expression of glucanases is related to fruit ripening. Hev b 2 obviously plays a role in the banana hypersensitivity associated with latex allergy.

Food allergens with homology to PR-3 type proteins

PR-3 type proteins include basic class I chitinases, molecules with antifungal activity (6). These enzymes hydrolyze chitin, a component of the exoskeleton of insects and of the cell walls of fungi. Class I chitinases from avocado, chestnut and banana have been identified as cross-reactive food allergens.

Food allergens with homology to PR-4 type proteins

PR-4 type proteins are chitinases similar to potato Win proteins (7). An IgE-binding protein belonging to this group has been identified in turnip and elderberry.

Food allergens with homology to PR-5 type proteins

PR-5 type proteins are also designated thaumatin-like (TLP) proteins (8). Thaumatin is an intensely sweet tasting protein expressed in the plant *Thaumatococcus*

daniellii. TLPs possess anti-fungal activity. Food allergens belonging to the TLP family comprise the 31 kDa minor allergen of apple Mal d 2, the major allergen of cherry Pru av 2, and a 23 kDa allergen from bell pepper (paprika).

Food allergens with homology to PR-10 type proteins

Food allergy to fruits, vegetables and nuts is frequently a consequence of sensitization to birch pollen. The most important cross-reactive allergen in this respect is Bet v 1, the major birch pollen allergen, a PR protein belonging to the PR-10 group (9). Consequently, all homologous allergens in plant-derived food can be attributed to the same functional group. A considerable number of Bet v 1-related food allergens have been cloned and characterized: Mal d1 (apple), Pru av 1 (sweet cherry), Pru ar 1 (apricot), Pur c 1 (pear), Api g 1 (celery) and Dau c 1 (carrot).

Food allergens with homology to PR-14 type proteins

PR-14 molecules are also designated lipid transfer

Table 1. Occurrence of food allergens in plants belonging to PR proteins

PR-2	β -1,3-glucanases	Banana
PR-3	Class I chitinases	Avocado, chestnut, banana
PR-4	Chitinases	Turnip
PR-5	Thaumatococcus-like proteins	Cherry, apple, bell pepper
PR-10	Bet v 1-homologues	Hazelnut, apple, celery, cherry, peach, apricot, pear, carrot, potato, parsley
PR-14	Lipid transfer proteins	Peach, apple, soybean, apricot, plum, cherry, barley

proteins (LTP) as their biologic function consists in the transfer of phospholipids from liposomes to mitochondria (10). Moreover, LTP possess antimicrobial activity. Allergy to LTP is frequent in food allergy to fruits,

when no pollen allergy is involved. LTP with low molecular weight (8–10 kDa) allergens can be found in apple (Mal d 3), peach (Pru p 3), apricot, plum, cherry and barley.

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