ISSN: 2572-3308

Sugiura and Sugiura. Int J Aller Medications 2023, 7:043
DOI: 10.23937/2572-3308.1510043
Volume 7 | Issue 1
Open Access

International Journal of
Allergy Medications

REVIEW ARTICLE

Soybean, Gly m 4, and Birch Pollen Allergy

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Abstract

Several types of soy foods are consumed worldwide. Soybean products have shown some potential benefits for health, but soy allergy can cause life-threatening allergic reactions. Pollens of birch trees can be associated with food allergy-related disease such as pollen/food allergy syndrome. Birch pollen/food oral allergy syndrome is mainly caused by the immunological cross-reaction between pathogenesis-related protein (PR)-10 family such as Gly m 4 and the *Rosaceae* family. Foods that contain PR-10 protein are a main trigger of PFAS. Many patients with birch allergy were sensitized to Glym4, it needs to exam Gly m 4 and soy.

Keywords

Soybean, Gly m 4, Birch, Pollen, Allergy

Introduction

Soybeans are often used for meals, seasonings, and processed foods in Asian countries, and several types of soy foods are consumed worldwide. As members of the *Fabaceae* family, soybeans are common and important food crops. Soybeans and soybean products have shown some potential benefits for health, but for people with a soy allergy, the consumption of soybeans or soy-based food can be life-threatening. There are six classifications of food allergies, based on the pathogenesis: Class 1 allergy, class 2 allergy, inhalant allergy, contact urticaria, protein contact dermatitis, and others [1]. The allergic reactions induced by soybeans and soy products are principally class 1 and 2 allergies. Class 1 soy allergy is often caused in young children with high IgE scores in response to soy, and this type of allergy is caused by oral sensitization after the consumption of soy products such as tofu, boiled soybeans, and soybean paste. Class 2 soy allergy is caused by the inhalation or contact sensitization of pollen in adults with low IgE scores in response to soy after drinking soy milk [1].

Pollens of the order Fagales, especially birch trees [2], can be associated with food allergy-related disease conditions. The frequency of pollen/food allergy syndrome (PFAS) is increasing, and a relationship between soy foods and birch pollen is common among individuals with PFAS. Among cases of PFAS, there is a condition known as oral allergy syndrome (OAS) in which symptoms such as itching in and/or around the mouth, swelling of the lips and/or tongue, a 'wrong' feeling or itching in the throat and/or neck, and (rarely) anaphylaxis develop [3]. The ratio of OAS among individuals with birch pollen allergy was reported to be approx 70% [4,5].

OAS is caused by allergic conditions after the ingestion of some fruits or vegetables by an individual who is sensitized to tree or weed pollens [6]. Birch pollen in particular is a common allergen among individuals with OAS. Birch pollen/food OAS is caused mainly by the immunological cross-reaction between members of the pathogenesis-related protein (PR)-10 family and the *Rosaceae* family (apples, pears, peaches, and cherries), legumes, and peanut [7]. PR-10 protein, profilins, and non-specific lipid transfer proteins are three allergen protein families. Foods that contain PR-10 protein (such as members of the *Rosaceae* family) are a main trigger of PFAS [8].

The molecular weight of PR-10 is 16-17 kDa [6], and PR-10 proteins are 154-163 amino acids long [9]. Over 100 PR-10 proteins have been identified in > 70 species of monocotyledonous and dicotyledonous flowering plants [10-12], and 17 of the 53 known PR-

Citation: Sugiura K, Sugiura M (2023) Soybean, Gly m 4, and Birch Pollen Allergy. Int J Aller Medications 7:143. doi.org/10.23937/2572-3308.1510043

Accepted: January 11, 2023: **Published:** January 13, 2023

10 proteins from the order Fagales are homologous to foods such as apple, celery, kiwi, and carrot [13]. PR-10 proteins expressed in many types of vegetation used for plant breeding and development play roles in defense mechanisms of plants against environmental variation and various biotic or abiotic stressors such as pathogens, temperature, oxidative stress, and UV radiation [14-19]. PR-10 proteins are affected by heat and pepsin, and they exhibited a change in structure and the inactivation of IgE binding ability [20,21]. Ligand binding of PR-10 proteins is associated with many allergens [22-26].

A major birch allergen, Bet v 1, is homologous to proteins of some food allergens [6,27,28] and *Rosaceae* family fruits [27,29]. Bet v 1 is a member of the PR-10 family, and it has 18 different isoallergens and isoforms [30]. As a major birch pollen allergen, Bet v 1 has a 17-kDa protein [31,32], and the cross-reactive allergens were related with birch pollen-associated (OAS). The structure of food allergens such as hazelnut (Cor a 1.04) [33], apple (Mal d 1) [34], peach (Pru p 1) [35], celery (Api g 1) [36,37], kiwi (Act d 8) [38], alder pollen (Aln g 1) [39], and soybean (Gly m 4) [40] are similar to that of Bet v 1 [41,42].

The ratio of sensitized Bet v 1 in patients with birch pollen allergy is > 90% [43], but not all cases of sensitization to Bet v 1 are caused by allergic reactions to foods that contain Bet v 1 allergens. The IgE reactivity to PR-10 proteins varies [44], and Bet v 1 has shown the highest reactivity. The hierarchy of reactivity is: > Mal d 1 > Cor a 1.04 > Ara h 8 > Pru p 1 > Aln g 1 > Api g 1 >Act d 8 > Gly m 4 [45].

Glycine max 4 (Gly m 4) soybean allergy is a notable issue in countries with high consumptions of soy. The relationship between birch and soy allergy was first reported in 2008 [38], and Kosma and Fukutomi then reported that Gly m 4 allergy is related to tree pollen allergy [46,47]. Eight allergens of soybean have been reported: Gly m 1 [48], Gly m 2 [49], Gly m 3 [50], Gly m 4 [7,51,52], Gly m 5 [53], Gly m 6 [53], and Gly m 7 and Gly m 8 [54]. In each of these allergens, the structure of Gly m 4 is homologous to that of Bet v 1.

Allergic reactions due to soybean allergens are divided into three types: (i) Systemic, severe allergic reactions due to gastrointestinal sensitization in young infants, mediated by Gly m 5, Gly m 6, and Gly m 8; (ii) Oropharyngeal or systemic allergic reactions in atopic patients due to a cross-reaction between Bet v 1 and Gly m 4; and (iii) Respiratory reactions associated with IgE-mediated allergy by Gly m 1 and Gly m 2 in occupational conditions [55]. The soybean allergens differ between pediatric patients and adults; Gly m 5 and Gly m 6 are often detected in pediatric patients, whereas soybean allergic reactions in adults were associated with Gly m 4 [47].

Food-dependent exercise-induced anaphylaxis (FDEIA) due to soybean products has been described as two types: One is associated with a storage protein such as Gly m 5 and Gly m 6, and the other is associated with a PR-10 protein, Gly m 4, which is related to pollen allergy. Roughly 80% of patients with birch allergy were reported to be sensitized to Gly m 4 [44]. Because the homogeneous ratio of amino-acid sequences between Bet v 1 and Gly m 4 is 53%, allergic reactions could be caused after the ingestion of soy by specific IgE antibodies' cross-reactions with these proteins [56]. Not all individuals who are sensitized to Gly m 4 develop soy allergic reactions, but individuals who have both Bet v 1 and Gly m 4 allergies can experience severe pollen/food allergy syndrome reactions [5]. We have described a soy sauce allergy [57,58] but did not identify the allergens in the patients with this allergy. We are investigating the relationship between soy sauce allergy and Gly m 4.

Conflicts of Interest

There are not any conflicts of interest.

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