Journal of Asthma and Allergy Dovepress

Open Access Full Text Article CASE REPORT

Fructose-Bisphosphate Aldolase Mediating Pollen-Food Allergy Syndrome

Lisha Li*, Junda Li*, Kai Guan

Department of Allergy, Beijing Key Laboratory of Precision Medicine for Diagnosis and Treatment on Allergic Diseases, National Clinical Research Center for Dermatologic and Immunologic Diseases, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, 100730, People's Republic of China

*These authors contributed equally to this work

Correspondence: Kai Guan, Department of Allergy, Beijing Key Laboratory of Precision Medicine for Diagnosis and Treatment on Allergic Diseases, National Clinical Research Center for Dermatologic and Immunologic Diseases, Peking Union Medical College Hospital, Chinese Academy of Medical Sciences & Peking Union Medical College, Beijing, People's Republic of China, Tel/Fax +86 010-69156346, Email dr_guankai@126.com

Abstract: Pollen-food allergy syndrome is an IgE-mediated allergic reaction arising from cross-reactive homologous allergens found in both food and pollen. Allergens, such as pathogenesis-related protein class 10 and profilin, usually trigger oropharyngeal itching and numbness in patients, whereas lipid transfer proteins tend to induce anaphylaxis. This article presents a case study of an individual with Artemisia pollen allergy who experienced anaphylaxis after consuming red fruit ginseng, a perennial herb belonging to the Campanulaceae family. This study revealed a novel allergen component mediating cross-allergy between Artemisia pollen and food, fructose-bisphosphate aldolase, which has not been documented in the literature concerning the pollen-food allergy syndrome. Fructose-bisphosphate aldolase tends to induce anaphylaxis in patients with Artemisia pollen-allergy and warrants clinicians' attention.

Keywords: allergens, pollen-food allergy syndrome, anaphylaxis

Introduction

Pollen-food allergy syndrome (PFAS) is an IgE-mediated allergic reaction that targets fruits and plants, and is associated with sensitization to inhaled plant allergens, particularly pollen. PFAS originate from cross-reactive homologous allergens found in both foods and pollen. It is noteworthy that 30–60% of food allergic reactions in adolescents and adults stem from pollen allergies. Pathogenesis-related protein class 10 (PR-10) and profilin, which are susceptible to heat decomposition, trigger oropharyngeal itching and numbness. Conversely, lipid transfer proteins (LTP), which are heat-resistant, tend to induce anaphylaxis.[1] This article presents a case study of a patient with Artemisia pollen allergy who experienced anaphylaxis after consuming red fruit ginseng [*Campanumoea lancifolia (Roxb.) Merr.*]. Additionally, it identified a new allergen component, fructose-bisphosphate aldolase, which may facilitate cross-allergies between pollen and food. The manifestation of food allergies induced by red fruit ginseng in Artemisia pollen-allergic patients with anaphylaxis warrants clinicians' attention.

Case Presentation

We report the case of a 35-year-old woman who presented with sudden-onset of edema and dyspnea 1 month ago. She had been experiencing nasal congestion, runny nose, sneezing, and itchy eyes every August and September for the past four years, with effective relief from antihistamines. One month prior, she had consumed red fruit ginseng and developed hand and foot itching, facial edema, and dyspnea 15 minutes later. She was promptly taken to the emergency department, where she received intramuscular epinephrine, resulting in rapid alleviation of her symptoms. She had a history of eczema, but denied any drug allergies or other food allergies. In addition, the patient's son had allergic rhinitis. Physical examination revealed no rash or edema, and breathing sounds were clear on either side. The skin prick test using fresh

Received: 27 August 2024
Accepted: 2 December 2024
Published: 14 December 2024

red fruit ginseng resulted in a wheal of 20 mm × 6 mm and a flush of 35 mm × 25 mm. The serum-specific IgE level to Artemisia pollen was measured at 19.7 KUA/L using ImmunoCAP (Thermo Fisher Scientific Inc., Waltham, MA, USA). Based on these findings, the patient was diagnosed with anaphylaxis and seasonal allergic rhinitis. She was advised to strictly avoid red fruit ginseng and continue taking oral antihistamines to manage her rhinitis symptoms during the pollen season. Moreover, she was advised to carry an epinephrine auto-injector for potential recurrence of anaphylaxis.

To investigate the allergen components responsible for cross-allergy between Artemisia pollen and red fruit ginseng, the juice of red fruit ginseng and the whole fruit extract were separated by sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS-PAGE). As shown in Figure 1A, a distinct protein band with a molecular weight of 35–40 kDa was observed in the SDS-PAGE gels of both juice and whole fruit extracts. Subsequently, the protein-binding strips of the whole fruit extract were incubated with sera from an anaphylactic case and seven other patients allergic to Artemisia pollen. The strips were then probed with a horseradish peroxidase-labeled anti-human IgE antibody. The results showed that the serum IgE (sIgE) of 62.5% (5/8) of patients allergic to Artemisia pollen could bind with crude extract of red fruit ginseng. Furthermore, Western blot analysis of the present case and a mixed serum pool from patients with Artemisia pollen allergy revealed that the main allergen component band responsible for cross-reactivity was located within the 35–40 kDa range (Figure 1B).

The 35–40 kD band was sliced and analyzed by mass spectrometry after trypsin digestion. Comparing the obtained protein sequences with the Campanulaceae protein sequence database, the top two proteins with the highest comparison scores were identified as fructose-bisphosphate aldolase and glyceraldehyde-3-phosphate dehydrogenase, both of which fell within the molecular weight range of 35–40 kDa. Further analysis using the WHO / IUIS Allergen Nomenclature database showed that only fructose-bisphosphate aldolase exhibited homology with the allergen components of Art si 14 in Artemisia sieversiana pollen (with 89% homology) and Art an 14 in Artemisia annua pollen (with 90% homology). Conversely, no components homologous to glyceraldehyde-3-phosphate dehydrogenase were found in Artemisia pollen. Thus, it is highly probable that fructose-bisphosphate aldolase serves as an allergen component that mediates cross-allergy between Artemisia pollen and red fruit ginseng.

Discussion and Conclusion

Artemisia pollen-related food allergies mainly include Rosaceae (eg apple, peach), Leguminosae (eg peanut, lentil), Cruciferae (eg cauliflower, cabbage), etc.[2,3] According to a Chinese study, approximately 47% of patients with Artemisia pollen-related food allergies presented with anaphylaxis.[2] Notably, allergen components, such as Art v 3 of Artemisia

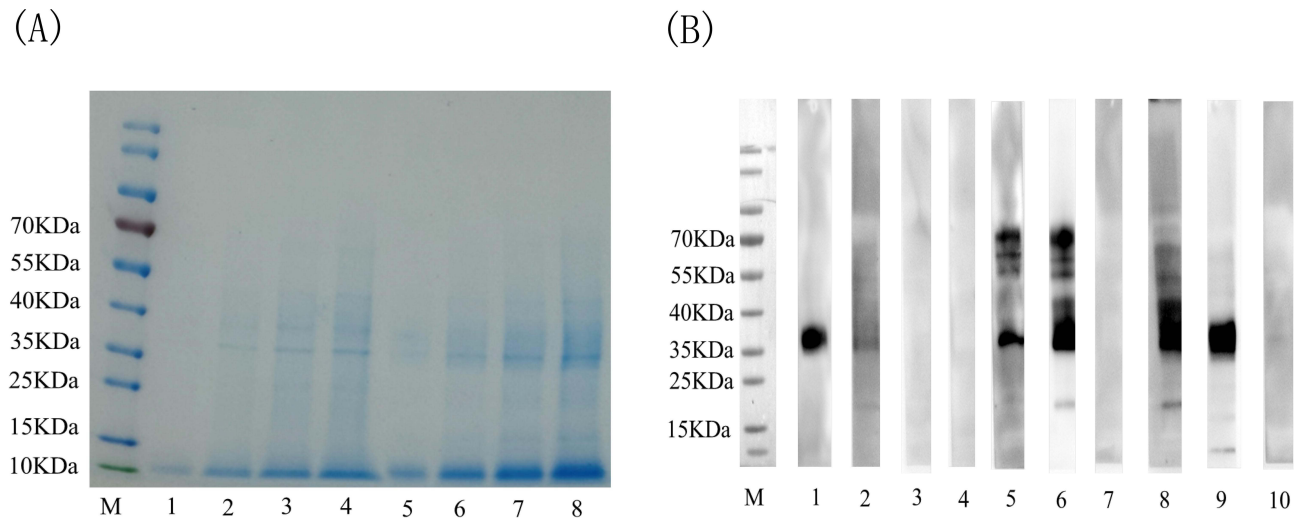

Figure 1 (**A**) SDS-PAGE results of red fruit ginseng juice and whole fruit extracts with different sample volume. M: protein molecular weight marker; line 1–4: red fruit ginseng juice extract with sample of 5, 10, 15, 20 μL; line 5–8: whole fruit extract with sample of 5, 10, 15, 20 μL; (**B**) Western blot results of red fruit ginseng extracts incubated with patient serum. M: molecular weight marker; line 1–8: individual serum of Artemisia pollen allergic patient including the present anaphylaxis case (line 1); line 9: mixed serum pool of Artemisia pollen allergic patients; line 10: sera of healthy controls; secondary antibody: mouse anti-human IgE antibody.

pollen, Pru p 3 of peach, Ara h 9 of peanut, Cor a 8 of hazelnut, and Tri a 14 of wheat belong to the LTP family. This association underscores the importance of LTP in driving the cross-reactivity between Artemisia pollen and various food items.[1]

In this study, we present a novel finding of a cross-allergy between Artemisia pollen and red fruit ginseng. Consumption of red fruit ginseng, a perennial herb belonging to the Campanulaceae family, has been associated with anaphylactic reactions in patients sensitized to Artemisia pollen. Moreover, our investigation revealed that 62.5% of patients with Artemisia pollen allergy exhibited serum sIgE binding to the 35–40 kDa allergen component of red fruit ginseng. This underscores the potential dangers posed by red fruit ginseng to individuals allergic to Artemisia pollen.

This study also revealed a novel allergen component, fructose-bisphosphate aldolase, which has not been documented in the literature concerning the pollen-food allergy syndrome. With a molecular weight of approximately 38 kDa, fructose-bisphosphate aldolase plays a crucial role in the glycometabolic pathway by catalyzing the conversion of fructose 1,6-bisphosphate to dihydroxyacetone phosphate and glyceraldehyde 3-phosphate. Notably, in patients with Artemisia pollen allergic rhinitis/asthma, the sensitization rate to this protein has been reported to range from 50% to 57%, indicating its significance as a major allergen.[4] Moving forward, it is imperative to isolate and purify the fructose-bisphosphate aldolase component from red fruit ginseng, elucidate its amino acid sequence, and determine its spatial conformation. Furthermore, thorough validation is warranted to ascertain its pivotal role in pollen-food cross-allergic reactions.

Declaration of Patient Consent

Informed consent was obtained from the patient for publication. The patient understood that her personal information had not been published. Studies involving human participants were reviewed and approved by the Peking Union Medical College Hospital Review Board. The case details are open access and can be browsed without institutional approval.

Author Contributions

Lisha Li and Junda Li contributed equally to this work and share first authorship. All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Funding

This work was supported by the Natural Science Foundation of Beijing (No. 7222136) and National High Level Hospital Clinical Research Funding (No. 2022-PUMCH-B-089).

Disclosure

The authors report no conflicts of interest in this work.

References

1. Poncet P, Senechal H, Charpin D. Update on pollen-food allergy syndrome. *Expert Rev Clin Immunol*. 2020;16:561–578. doi:10.1080/1744666X.2020.1774366
2. Deng S, Yin J. Mugwort pollen-related food allergy: lipid transfer protein sensitization and correlation with the severity of allergic reactions in a Chinese population. *Allergy Asthma Immunol Res*. 2019;11:116–128. doi:10.4168/aair.2019.11.1.116
3. Lüttkopf D, Ballmer-Weber BK, Wüthrich B, Vieths S. Celery allergens in patients with positive double-blind placebo-controlled food challenge. *J Allergy Clin Immunol*. 2000;106:390–399. doi:10.1067/mai.2000.108711
4. Song LB, Zhang L, Zhu Y, et al. Identification of fructose-bisphosphate aldolase as new pollen allergens. *Allergy*. 2024;79:1368–1372. doi:10.1111/all.16058