

# Anaphylaxis Induced by Ingestion of Raw Garlic

Shikun Ma and Jia Yin

## Abstract

Patients allergic to garlic often present dermatitis, rhinitis, asthma, and urticaria after ingestion of garlic, contact with garlic, or exposure to garlic dust. Garlic-related anaphylaxis is rare, and the impact of heating on garlic allergens is not very clear. We report a case of anaphylaxis induced by ingestion of raw rather than cooked garlic with manifestations different from previous reports, and we hypothesized that heating could reduce the allergenicity of garlic. Serum total immunoglobulin E (IgE) and specific IgE were tested using the Phadia CAP System FEIA (Phadia, Uppsala, Sweden). Protein extracts from raw and cooked garlic were analyzed by sodium dodecylsulfate–polyacrylamide gel electrophoresis (SDS-PAGE) and Western blot. Serum-specific IgE for garlic was 8.16 kUA/L. IgE banding proteins could only be detected in raw garlic extract, because allergens in garlic were mostly degraded into small fragments after heating, as shown in SDS-PAGE profile. In conclusion, raw garlic could induce life-threatening anaphylaxis. However, most of its allergens are heat labile, and patients allergic to garlic might tolerate the cooked one well.

## Introduction

**G**ARLIC IS ONE OF THE MOST COMMON SPICES used in cooking all over the world, including in Chinese cuisine, and it also has potential medicinal values in antibiosis (Gupta *et al.*, 2005). However, some atopic or even nonatopic people may suffer from garlic allergy (Vovolis *et al.*, 2010). Patients allergic to garlic often present dermatitis, rhinitis, asthma, and urticaria after ingestion of garlic, contact with garlic, or exposure to garlic dust (Asero *et al.*, 1998; Bassioukas *et al.*, 2004; Couturier *et al.*, 1982; Bojs *et al.*, 1988; McFadden *et al.*, 1992). It is well known that food processing can influence the allergenicity of food allergens, but the effects of heating on garlic is not clear. Asero *et al.* (1998) proposed in their report that the culprit garlic allergen leading to systemic urticaria/angioedema was heat-resistant. Here, we report a case of immunoglobulin E (IgE)–mediated severe anaphylaxis induced by ingestion of raw rather than cooked garlic, and we hypothesized that heating can reduce the allergenicity of garlic.

## Case Report

The patient was a 42-year-old man with a history of drug allergy (penicillin and sulfa) and food allergy (apple and peach). He first came to our department in May, 2006, reporting an anaphylactic episode 3 days before this visit. Approximately 10 min after eating raw garlic, chicken egg, pork, leek, and rice, he had urticaria and facial angioedema, followed by a feeling of dizziness, hypotension, and loss of

consciousness. He was taken to the emergency clinic, and treated with intravenous fluids, epinephrine, and hydrocortisone. About 20 min later, he recovered consciousness, but suffered from headache, abdominal pain, and vomiting. His symptoms resolved over 4 h, and he stayed in the hospital for observation for the next 2 days. All the foods were tested for chemical pesticides, and the results were negative. From medical history review, we found that about 10 days before this episode, this patient had systemic urticaria after ingestion of raw garlic. He then took a pill of chlortrimeton and the rash disappeared. He did not eat raw garlic again thereafter, but he could tolerate pork, egg, leek, rice, and cooked garlic well. He visited our department again in August 2011 for further evaluation of his disease. For the last 5 years, he did not experience another episode of systemic urticaria or anaphylaxis. We conducted some tests to describe the patient's immune response to the proteins in raw and cooked garlic.

## Methods

Eight milliliters of venous blood was collected from the patient, and serum was isolated for further tests. Total IgE and specific IgE for garlic, chicken egg, apple, peach, legumens, peanut, grains, and several kinds of pollens were determined according to the instructions of the manufacturer (Phadia CAP System FEIA; Phadia, Uppsala, Sweden). Raw garlic was purchased from a local supermarket. Proteins of raw garlic and cooked garlic (heated at 100°C for 5 min) were extracted by means described by Kao *et al.* (2004). Protein

Department of Allergy, Peking Union Medical College Hospital, Peking Union Medical College & Chinese Academy of Medical Sciences, Beijing, China.

TABLE 1. RESULTS OF SERUM-SPECIFIC IGE OF THE PATIENT (EXPRESSED IN QUANTITATIVE VALUES AND CLASSES)

|                     | Specific IgE level | Specific IgE value (kUA/L) |
|---------------------|--------------------|----------------------------|
| Garlic              | 3                  | 8.16                       |
| Apple               | 2                  | 2.78                       |
| Peach               | 3                  | 8.92                       |
| Chicken egg         | 0                  | <0.35                      |
| Lentil              | 3                  | 8.79                       |
| Soy bean            | 3                  | 6.15                       |
| Pea                 | 3                  | 6.48                       |
| Peanut              | 3                  | 10.0                       |
| Rice                | 3                  | 10.2                       |
| Wheat               | 3                  | 6.81                       |
| Common millet       | 4                  | 21.8                       |
| Maize               | 3                  | 14.1                       |
| Common sliver birch | 3                  | 4.33                       |
| Mugwort             | 3                  | 7.6                        |
| Japanese Hop        | 3                  | 5.61                       |
| Giant ragweed       | 3                  | 5.19                       |
| Bermuda grass (g2)  | 3                  | 5.70                       |
| Cocksfoot (g3)      | 3                  | 5.07                       |
| Timothy grass (g6)  | 3                  | 5.18                       |

concentrations were determined using Bradford protein assay. Extracts of raw and cooked garlic were then analyzed by sodium dodecylsulfate–polyacrylamide gel electrophoresis (SDS-PAGE) and Western blot. For immunoblotting, patient's serum was diluted threefold. Mouse anti-human IgE Fc (HRP) secondary antibody was bought from Abcam (Cambridge, UK) and diluted 1:1000.

## Results

Serum total IgE of the patient was 220 kU/L, which was slightly higher than normal. Results of specific IgE for garlic, chicken egg, apple, peach, legumens, peanut, grains, and pollens are shown in Table 1. Protein concentration of extract from raw garlic was much higher than that from cooked garlic (4.8 vs 1.0 mg/mL). The SDS-PAGE profile of raw garlic

extract showed a number of bands ranging from 3.5 kD to 160 kD. The most intense were the ones at around 10 kD and 50 kD (Fig. 1a, lanes 1, 3, and 5), whereas the bands representing proteins from cooked garlic were mostly at under 10 kD (Fig. 1a, lanes 2, 4, and 6). Immunoblot analysis performed with the patient's serum showed a strong signal at around 50 kD on the lane of raw garlic, and also some weak signals at 10 and 30 kD (Fig. 1b, lane 7). But no evident signal was detected on the lane of cooked garlic (Fig. 1b, lane 8).

## Discussion

Here, we report an anaphylactic reaction caused by ingestion of raw garlic in China. Besides manifestations in skin/mucosa and consciousness, our patient also experienced gastrointestinal symptoms such as abdominal pain and vomiting after eating raw garlic, which was quite different from what was described elsewhere (Vovolis *et al.*, 2010; Asero *et al.*, 1998). Kao *et al.* (2004) had identified alliin lyase with molecular weight of 56 kD as the major allergen of garlic. In our research, the strongest IgE binding band of raw garlic appeared at around 50 kD, the same place as alliin lyase was located. Thus, it could be postulated that the culprit allergen responsible for the life-threatening reaction in this patient might be the alliin lyase. Unfortunately, there was not enough serum for us to carry out further experiments to make a confirmation. Heating for 5 min was enough to degrade proteins in garlic to small fragments with molecular weight under 10 kD. This might be the best explanation for why ingestion of raw garlic induced severe reaction, but cooked garlic could be tolerated well.

Effects of heating on allergenicity can differ among different food allergens (Nowak-Węgrzyn *et al.*, 2009; Anaphylaxis Campaign, 2009). Heat can destroy the allergenicity of whey proteins from milk and ovalbumin from egg, or just partially deplete the allergenicity of celery and hazelnut. However, food allergens like major allergens of mustard, parvalbumin from codfish, gliadins from wheat, ovomucoid from egg, and casein from milk can survive heating. Heating can even enhance the allergenic properties of some foods like peanut, lentil, and shellfish. In our study, we found that most allergens in garlic appear to be heat labile, especially the one leading to serious anaphylaxis.

## Conclusion

Patients allergic to raw garlic can tolerate cooked garlic well, because most of the allergens are degraded after heating.

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## Disclosure Statement

No competing financial interests exist.

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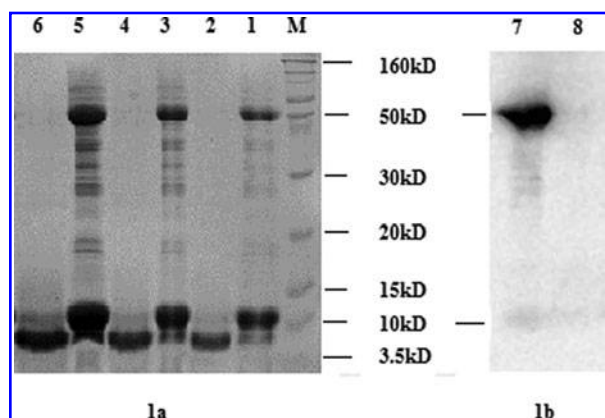


FIG. 1. (a) 15% sodium dodecylsulfate–polyacrylamide gel electrophoresis (SDS-PAGE) with incremental loading amount of protein extracts. Lanes 1, 3, and 5, raw garlic; lanes 2, 4, and 6, cooked garlic; M, molecular weight. (b) Serum-specific IgE immunoblotting study. Lane 1, raw garlic; lane 2, cooked garlic.

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Address correspondence to:

Jia Yin, M.D.

Department of Allergy

Peking Union Medical College Hospital

Peking Union Medical College &

Chinese Academy of Medical Sciences

Beijing, 100730, China

E-mail: doctoryinjia@163.com