



Letters

Grasshopper sensitization in patients allergic to crustaceans, mites, and cockroaches

Should grasshopper-containing products carry a warning?

We have previously described anaphylaxis after first-time ingestion of grasshopper and chapulines, *Sphenarium purpurascens*, in patients who had a history of anaphylactic reactions after eating crustaceans.¹ These patients were also highly allergic to the house dust mite (HDM) and German cockroach. Radioallergosorbent test inhibition, sodium dodecyl sulfate-polyacrylamide gel electrophoresis, and western blot analysis identified a common cross-reacting allergen, tropomyosin. Our findings suggest that patients who are allergic to HDMs, crustaceans, and cockroaches are at risk for anaphylaxis from eating grasshopper and chapulines owing to the presence of a tropomyosin-specific IgE antibody. In this study, we report skin test (ST) sensitivity to grasshopper and chapulines in patients who are allergic to crustaceans, mollusks, HDMs, and cockroaches.

Patients who were referred to the allergy clinic for rhinitis or asthma and/or reactions immediately after the ingestion of crustaceans or mollusks were asked to participate in the study. A total of 72 patients agreed to participate and signed a witnessed informed consent. The study consisted of prick-puncture STs to grasshopper, chapulines, HDM (*Dermatophagoides pteronyssinus* and *Dermatophagoides farinae*), cockroach, shrimp, crab, lobster, and clam. Statistical analysis used Student's *t* test.

All the study patients reacted positively with a (≥ 3 mm) wheal to histamine and negatively to saline and glycerin. A positive ST was any wheal greater than or equal to 3 mm greater than the saline control. On the basis of the results of the ST, these 72 patients were divided into the following 4 groups: group I (25 patients) showed negative reactions to all allergens; group II (16 patients) showed positive reactions to HDM and negative reactions to cockroach, crustaceans, and mollusks; group III (19 patients) showed positive reactions to HDM and cockroach and negative reactions to crustaceans and mollusks; and group IV (12 patients) showed positive reactions to HDM, cockroach, and any/all crustaceans and mollusks.

The results of the ST to grasshopper and chapulines in these 4 groups are shown in Table 1. The 25 patients in group I showed no reaction to grasshopper and chapulines. Three of 16 patients in group II showed positive reactions to grasshopper and chapulines (18.7%). Thirteen of 19 patients in group III showed positive reactions to grasshopper and chapulines (68.4%). All the patients in group IV ($n = 12$) showed positive reactions to grasshopper and chapulines (100%).

The 12 patients in group IV had all experienced repeated systemic reactions to crustaceans and mollusks (12/12 grade 1, 4/12

grade 2, 3/12 grade 3, 1/12 grade 4).² The patients were mostly women (10/12) and younger (mean 31.7 years, range 19–45) than those in the other 3 groups (mean 46.7 years, range 18–63; $P < .05$). The IgE levels of the patients in group IV were also higher (mean 204.1 [nl 0.0–87.0 IU/mL], range 66–335) than those in the other 3 groups (mean 28.4, range 5.5–47.2; $P < .001$). Furthermore, the wheal size of the ST to grasshopper and chapulines was larger in the patients in group IV than that in the patients in groups II and III (mean 10.4/20.1 wheal/flare vs 5.2/12.1 wheal/flare in groups 2 and 3, respectively; $P < .005$). Nine of the 12 patients in group IV reacted to all crustaceans, but 3 patients reacted to only 1 seafood; yet all 12 showed 100% ST reactions to grasshopper and chapulines. Tryptase levels in all the patients were within the normal reference range.

Our results revealed 100% ST reactivity to grasshopper and chapulines in patients who had no occupational or recreational exposure to grasshopper but were allergic to crustaceans, cockroaches, mollusks, and HDM. In addition, patients who had any reaction to crustaceans or mollusks, whether to all or only one, showed 100% ST reactions to grasshopper or chapulines. Of course, a positive ST does not necessarily correlate with a clinical reaction, and we did not perform chapuline challenges on the patients. However, the 12 patients in group IV showed ST reactivity to grasshopper and chapulines of equal magnitude to our previously reported patients who experienced anaphylactic reactions on first ingestion of chapulines.¹

The cross-reacting antigen in our patients is likely to be the panallergen tropomyosin. Tropomyosin is a highly conserved polypeptide found in all eukaryotic cells and all 9 allergens tested in this study. In our previous study, sodium dodecyl sulfate-polyacrylamide gel electrophoresis, and western blot identified tropomyosin in German cockroach, grasshopper, and chapulines, corresponding to the known tropomyosin band in shrimp.³

The surprising finding in this study is that patients presensitized by inhalation to only HDM and cockroach reacted much more strongly to grasshopper and chapulines (68.4%) than those with only HDM sensitivity (18.7%), which suggests that allergens in addition to tropomyosin may be involved in the cockroach testing.⁴

Although occupational or natural sensitization through inhalation of grasshopper is rare, ingestion of grasshopper is common. Eating of insects (entomophagy) is practiced in 80% of the countries worldwide by approximately 2 billion people who eat more than 1900 different insects. Grasshoppers are the fourth most frequently ingested insect, followed only by *Hymenoptera* (ants, bees, and wasps) at #3, *Lepidoptera* (caterpillars, butterflies, and moths) at #2, and *Coleoptera* (beetles) at #1.⁵ Entomophagy is widespread in Asia, Africa, the Middle East, Australia, South America, and Mexico.

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Table 1
Prick-Puncture Skin Test Results to Grasshopper and Chapulines in 72 Patients

Patient groups	Number of patients	Grasshopper P-P ^a	Chapuline P-P ^a	Percent positive
I. All skin test –	25	0/25	0/25	0
II. HDM +	16	3/16	3/16	18.7
III. HDM + Cockroach +	19	3/19	13/19	68.4
IV. HDM+ Cockroach + and Crustacean or Mollusk +	12	12/12	12/12	100

Abbreviations: HDM, house dust mite (*Dermatophagoides farinae* and *Dermatophagoides pteronyssinus*); P-P, prick-puncture.

^a+ indicates 3 mm wheal above the saline by P-P skin testing.

In Mexico, eating chapulines dates back to the pre-Columbian era.⁵ Today, chapuline cultivation and harvesting is a cash crop in Oaxaca Mexico, where the delicacy is prepared and shipped all over Mexico to be served in restaurants as meals, at soccer matches and at parks as snacks, similar to popcorn sold in the United States. Southern California is known as the chapuline capital of North America.⁶

Eating grasshopper and chapulines can produce allergic reactions varying from mild to fatal depending on the patient's sensitivity, allergenicity of the insect, and the amount eaten. Studies from China,⁷ Thailand,⁸ and Singapore⁹ have reported anaphylactic shock and death from ingestion of grasshopper. These patients were primarily sensitized to insects in entomophagous societies. In Western culture, where entomophagy is uncommon, patients are unaware of the cross-reactivity between HDM, cockroach, crustaceans, and insects and only discover their sensitivity after unwittingly ingesting insects for the first time and experiencing allergic reactions.

Despite the fact that eating insects is uncommon in Western culture, it exists and is increasing. The average European or American already unknowingly ingests 500 g of insect residues per year.¹⁰ In the United States, where ingestion of whole insects is objectionable to many, grasshopper- and chapuline-containing products can be found in protein additives, nutrition drinks, and protein shakes sold in health food stores. Chapuline flour is sold over the internet, and numerous books and publications contain

recipes for their preparation. Even whole insect eating is becoming more acceptable. Chapuline snacks are now sold at diners in Atlanta, pizzerias on the Strip in Las Vegas, and, since 2017, at Safeco Field restaurants during Seattle Mariners home baseball games.

In conclusion, patients who are allergic to crustaceans, cockroach, HDM, and mollusks, and those who are allergic only to cockroach and HDM are at risk for allergic reactions upon ingestion of chapulines and grasshopper. At the same time, insect consumption is growing in Western societies, which increases the risk of cross-reactions in these unsuspecting patients. To guard against this looming problem, it may be beneficial for products that contain chapulines and grasshopper to come with a warning for patients with allergy.

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References

1. Sokol WN, Wunschmann S, Agah S. Grasshopper anaphylaxis in patients allergic to dust mite, cockroach, and crustaceans. Is tropomyosin the cause? *Ann Allergy Asthma Immunol*. 2017;119:91–92.
2. Cox LS, Sanchez-Borges M, Lockey RF. World Allergy Organization systemic allergic reaction grading system: is a modification needed? *J Allergy Clin Immunol Pract*. 2017;5(1):58–62.e5.
3. Reese G, Ayuso R, Lehrer SB. Tropomyosin: an invertebrate pan-allergen. *Int Arch Allergy Immunol*. 1999;119(4):247–258.
4. Arruda KL. Cockroach allergens. *Curr Allergy Asthma Rep*. 2005;5(5):411–416.
5. Gahukar RT. Entomophagy and human food security. *Int J Trop Insect Sci*. 2011;31(3):129–144.
6. Cabral J. Eat your crickets: Los Angeles is the chapulin capital of the U.S. Available at: <https://www.latimes.com/food/dailydish/la-dd-eat-your-crickets-los-angeles-chapulin-capital-20130709-story.html>. Accessed September 11, 2019.
7. Ji K, Chen J, Li M, et al. Anaphylactic shock and lethal anaphylaxis caused by food consumption in China. *Trends Food Sci Technol*. 2009;20(5):227–231.
8. Piromrat K, Chinratanapisit S, Trathong S. Anaphylaxis in an emergency department: a 2-year study in a tertiary-care hospital. *Asian Pac J Allergy Immunol*. 2008;26(2-3):121–128.
9. Jinapongsananuruk O, Bunsawansong W, Piyraphaonee N, Visitsunthorn N, Thonggarm T, Vichyanond P. Features of patients with anaphylaxis admitted to a university hospital. *Ann Allergy Asthma Immunol*. 2007;98(2):157–162.
10. Doberman D, Swift JA, Field LM. Opportunities and hurdles of edible insects for food and feed. *Nutr Bull*. 2017;42(4):293–308.