

Short Communication

Rice, the Allergen

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Abstract

Rice is the main and most important food taken every day in Eastern Asia. Frequency of IgE- mediated rice allergy is about 10 % in atopic subjects. A multigene family of 14-16 kDa proteins presents the major allergens from rice seeds/grains. Other rice seed/grain allergens are a recently described 33-kDa major and a 60-kDa minor allergens. Rice is a member of the grass family; therefore its pollens become airborne even though it is mainly self-pollinated. Rice can cause hay fever symptoms in areas where it is grown commercially.

Key words: rice, food allergy, hypersensitivity

Introduction

Rice is one of the most important foods in the world, supplying as much as half of the daily calories for half of the world's population. No wonder that in Asian countries, such as Thailand, rice is so highly valued that the translation of the word "to eat" literally means "to eat rice". The scientific name for rice is *Oryza sativa*. Asked to name the types of rice they are familiar with, people may be able to recall one or two. Yet, in actuality there is an abundance of different types of rice – over 8,000 varieties. Oftentimes, rice is categorized by its size as being short grain, medium grain or long grain. Short grain, which has the highest starch content, makes the stickiest rice, while long grain is lighter and tends to remain separate when cooked. The qualities of medium grain fall between the other two types.

Rice allergy is common in countries in Eastern Asia, such as Japan, where rice is commonly eaten. Frequency of IgE-mediated rice allergy is about 10% in atopic subjects in Japan. Prevalences are much lower in Europe and USA, where rice is mostly recognized as cereal-associated allergen source. Now food allergies are much more common in India as compared to the western countries. They quote figures of two to six per cent. In India, we have nine to 10 per cent patients positive to rice.

Allergic reactions to rice can be caused by ingesting it or inhaling its pollen. Rice is a member of the grass family; therefore its pollens become airborne even though it is mainly self-pollinated. Rice can cause hay fever symptoms in areas where rice is grown commercially. Many studies have been done on rice sensitivity. One in particular

showed rice sensitivity was six times higher in adults than in children. The symptoms of rice allergy can manifest in several different ways.

- Asthma (Hoffman 1975, Shibasaki *et al.* 1979, Lezaun 1994, Arai *et al.* 1998)
- Atopic dermatitis (Ikezawa *et al.* 1992b, Uchio *et al.* 1998)
- Atopic dermatitis with ocular complications (Uchio *et al.* 1998)
- Contact urticaria (Lezaun 1994)
- Diarrhea & vomiting (Cavataio *et al.* 1996)
- Eczema (Hoffman 1975, Shibasaki *et al.* 1979)
- Exercise-induced anaphylaxis (Guinnepain *et al.* 1996, Caffarelli *et al.* 1997)
- Food protein-induced enterocolitis syndrome (Sicherer *et al.* 1998)

It is also possible that those who are allergic to rice may also react to the following because they are members of the same botanical family. This is known as clusters of hypersensitivity.

- barley
- corn
- durum wheat
- grass pollen
- oats
- rye
- soybean
- triticale
- wheat

Rice allergy is a potentially deadly response by a person's immune system to rice or foods containing rice. After a susceptible person ingests rice, the immune system reacts with the release of histamines and other chemicals that trigger symptoms that can range from mild to life-threatening. While somewhat rare in the United States, rice allergy still affects a small portion of the population. There is no way to know whether a person with a rice allergy is likely to have a mild or severe reaction after eating rice products. Symptoms that begin as mild to moderate can quickly intensify and lead to potentially life-threatening anaphylactic shock. Therefore, those with this allergy must avoid the grain altogether. There are several foods that can serve as substitutes for rice. A person with a rice allergy who accidentally consumes rice must seek immediate medical attention.

Allergens

In Rice allergy, proteins with molecular masses of 14-16, 26, 33, and 56 kDa have been demonstrated to be potentially allergenic. The 33 kDa allergen was identified as a novel type of plant glyoxalase I that is expressed in various plant tissues, including maturing seeds (Usui *et al.* 2001). The majority of the allergic components are albumins with molecular weights between 14 and 16 kDa (Nakamura & Matsuda 1996). The 15.5, 16, 19, 25, 50, 90 kDa rice protein has been reported to be a major allergen and responsible for cross-allergenicity between cereal grains in the Poaceae family (Urisu *et al.* 1991). A 19 kDa globulin protein has also been identified (Park *et al.* 2000). Although a number of allergens have been identified, only one allergen has been fully characterised: Ory s 1. Other allergens partially characterised have been designated RAP, RAG 1, RAG 2, RAG 5, RAG 14, and RAG 17. RAG 17 is a 16 kDa protein, a member of the alpha-amylase/trypsin inhibitor protein family (Izumi *et al.* 1999, Adachi *et al.* 1993). Although raw rice is more allergenic than cooked, some of the allergens are heat-stable and resist proteolysis (Adachi *et al.* 1993). Rice also contains a lipid transfer protein (Shibasaki *et al.* 1979, Asero *et al.* 2002). LPTs are heat-stable proteins and may account for allergy to cooked rice. A chitinase has been isolated from rice. The substance accumulates to a high level in the roots of the plant, but only low levels are found in stem and leaf tissue (Zhu & Lamb 1991). Whether the chitinase is found

in the seed, and whether this chitinase has allergenic potential, are questions that have not yet been evaluated.

IgE-mediated reactions

Rice may commonly induce symptoms of food allergy, asthma, rhinitis, eczema and urticaria in sensitised individuals in communities where rice is a staple food, e.g., in the Far East, but is not a frequent cause of food allergy in Western individuals, although the allergy is increasing (Wuthrich *et al.* 2002, Gendeh *et al.* 2000, Andre *et al.* 1994, Granel *et al.* 1992, Komatsu *et al.* 1990, Miyakawa *et al.* 1988, van den Hoogenband and van Ketel 1983). Symptoms reported in rice-allergic individuals include abdominal cramping and similar pain, nausea, vomiting, rhinitis, rhino conjunctivitis, dyspnoea, asthma, contact urticaria, atopic dermatitis, dermatitis, angioedema and anaphylaxis. Individuals may be sensitised without being symptomatic (Noma *et al.* 2001, Figueredo *et al.* 1999, Varjonen *et al.* 1995).

The effect of rice allergy on the skin has been documented by many studies. In 200 of 226 patients (90.5%) with atopic dermatitis visiting a Japanese hospital, oral food challenge tests showed that food allergy was involved, and rice allergy affected 2.5% (Ogura Y *et al.* 2001). In 1006 Japanese patients with typical and atypical lesions of atopic dermatitis, who were analysed statistically by correlating the clinical severity to serum IgE values, the suggestion was supported that rice allergy strongly contributed to the development of the severity of this condition. Of 25 patients with severe atopic dermatitis and a positive serum-specific IgE to rice treated by a rice exclusion diet, 9 were remarkably improved, 10 were moderately improved, and no effect was seen in 6 patients (Ikezawa *et al.* 1992). The results of a study suggested that ocular-type atopic dermatitis belongs to the most severe end of the spectrum of atopic dermatitis, and that rice and wheat may contribute to the pathogenesis of severe atopic dermatitis, resulting in ocular complications (Uchio *et al.* 1998).

Individuals may be affected by raw rice and not cooked rice. A report describes how a 30-year-old man with atopic dermatitis had had erythema and itching of the hands after washing rice in water, though he had always eaten cooked rice without problems. Urticarial erythema occurred after several minutes. Skin-specific IgE tests

were markedly positive with water used to wash regular rice but mildly positive with water used to wash allergen-reduced rice. These results suggested that the allergen responsible for contact urticaria in this patient may have been water-soluble and heat-unstable, and that these allergens were not present in allergen-reduced rice (Yamakawa *et al.* 2001).

Contact urticaria from rice has also been reported (di Lernia *et al.* 1992). Similar allergic effects were recorded in a 17-year-old female presenting with acute erythema of the hands, oedema of the eyelids, dyspnoea and cough following contact with raw rice, which occurred from throwing raw rice during a wedding. She was able to tolerate cooked rice by ingestion. The authors suggested that the adverse respiratory and skin reactions resulted from rice dust (di Lernia *et al.* 1992). Occupational contact dermatitis and/or asthma may occur in rice workers and occasionally in bakers (Block *et al.* 1984, Racz and Lengyel 1967, Yang *et al.* 1965).

Other reactions

Food protein-induced enterocolitis syndrome is a symptom complex of severe vomiting and diarrhea occurring several hours after the ingestion of particular food proteins in infants, has been reported to be caused by rice in some instances (Sicherer *et al.* 1998). Although food-sensitive enteropathy is more often caused by milk, rice and ground rice may also temporarily damage the small intestinal mucosa in infancy (Walker-Smith 1994, Vitoria *et al.* 1982;). Reactions may be severe. Shock, nausea, vomiting, and diarrhoea have been reported in 4 infants. Occult blood in stools of these infants was positive. All immunologic tests were negative. Nevertheless, the authors conclude that, based on the clinical findings in these patients, the adverse effects were probably allergic in nature (Cavataio *et al.* 1996).

A distinct clinical syndrome seems to be associated with exposure to Rice husk dust. The manifestations of this "Rice millers' syndrome" include acute and chronic irritant effects on the eyes, skin, and upper respiratory tract; and allergic-like responses such as rhinitis, dyspnoea, bronchospasm, and eosinophilia. Radiological opacities in the chest, probably representing early silicosis or extrinsic allergic alveolitis, have been reported (Lim *et al.* 1984). Similarly, findings suggesting increased asthma prevalence among California Rice farmers and workers

have been reported. Radiologic findings were consistent with dust or fibre exposure, although no association with specific farming activities was identified (McCurdy *et al.* 1996). Individuals working with rice may in fact be allergic to rice pollen and not Rice per se (Tsai *et al.* 1990). The pollen of the Oryzae tribe (Rice) showed the highest positivity among asthma patients of the province producing most of the country's grains (Riggioni *et al.* 1994a, Riggioni *et al.* 1994b).

Conclusion

The researchers say that rice contains an allergy-causing protein, so continuous consumption of the grain could prove harmful to the body. IgE play an important role in allergic reaction. It will be interesting to see if consumer fears, especially in Asia, about using genetically modified food will diminish if they believe they could directly benefit health-wise from the food being produced in alternative ways to their traditional methods.

It is not just health benefits that are driving biotechnology research in Asia. There is hope that farmers can grow crops cheaper, more efficiently and even safer, according to some recent publications. Patients symptomatology can be vast and varied. There are immunological and non-immunological food allergies. Elimination is not the only treatment for these kind of allergies. There is always a hope to find something which can substitute for people having rice allergies in the near future.

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