

Patient Report

A banana-allergic infant with IgE reactivity to avocado, but not to latex

AKEMI ITO, KOMEI ITO, MASASHI MORISHITA AND TATSUO SAKAMOTO

Department of Pediatrics, Nagoya University Graduate School of Medicine, Nagoya, Japan

Key words avocado, banana, cross-allergenicity, cross-reactivity, immunoblotting, latex.

Banana contains allergens in common with those in latex^{1,2} or pollens.³ Therefore, banana allergy often occurs in patients sensitized to latex^{1,2} or pollens;^{3,4} it is much less common in patients without latex allergy or pollinosis. However, these conclusions are based mostly on observations on banana allergy in adults, because banana allergy in infants appears to be rare. Tokuyama *et al.*⁵ described two cases of infantile banana allergy, in both of which there were no IgE antibodies to latex, and the patients were sensitized to a minor banana allergenic protein of 85 kDa. Among the two patients, one may have been sensitized to banana by ingestion of breast milk. Therefore, the allergenic components causing banana allergy and the route of sensitization to banana in infants may differ from those in adults; it seems that oral sensitization to food occurs more easily in infants than adults because gut mucosal defense including immune system is undeveloped in infants.

We report a 6-month-old boy who developed generalized skin response after banana ingestion for the first time. Interestingly, this patient showed IgE reactivity to avocado as well as banana, but not to latex or pollens. In the present study, we have investigated IgE-binding proteins in banana and avocado by immunoblot analysis, and determined whether cross-allergenicity between these fruits was present by using an immunoblot inhibition method.

Case report

A 6-month-old boy with mild eczema was given a spoonful of mashed fresh banana pulp. At 30 min after ingestion, urticarial rash with erythema appeared on the face and neck, and extended over the whole body; no respiratory or gastrointestinal

symptoms were noticed. The skin response decreased spontaneously during several hours after the peak. He had been breast-fed only, and this was the first time he ate banana. However, his mother had eaten banana frequently during the period of lactation. Allergic examinations were performed 2 weeks after the adverse response to banana (Table 1).

Materials and methods

Extracts of banana, avocado and latex were made by the method of Lavaud *et al.*⁶ Latex extract was made from rubber gloves (Coop, Tokyo, Japan). We carried out skin prick tests with the banana, avocado and latex extracts (1.5 mg/mL of protein) in the patient and five nonatopic adult volunteers in whose sera no IgE antibodies to banana, avocado, or latex were detected in a CAP system (Pharmacia & Upjohn Diagnostics AB, Uppsala, Sweden). A 1 mm standard disposable prick lancets (Ewo Care AB, Gislaved, Sweden) was used.

Samples were fractionated by sodium dodecylsulfate (SDS)–polyacrylamide gel electrophoresis (PAGE), and electrotransferred onto a polyvinylidene difluoride membrane. After washing and blocking with 3% human serum albumin, strips of the membrane were incubated with a 1: 5 dilution of serum samples, then with phosphatase-labeled affinity-purified goat antibodies to human IgE (Kirkegaard & Perry Laboratories, Gaithersburg, MD, USA, 1:1000 dilution), and finally developed using a BCIP/NBT kit (Kirkegaard & Perry Laboratories) as a phosphatase substrate. For immunoblot inhibition, the patient's serum, diluted 1: 5, was incubated with 1 mg/mL of protein of banana, avocado, latex, hen's egg white, or cow's milk extract for 1 h at room temperature. A natural rubber latex serum, provided by the Rubber Research Institute of Malaysia (Kuala Lumpur, Malaysia), was also used as an inhibitor. After this pretreatment, immunoblotting was done as described above. This study was performed after informed consent was obtained from the patient's parents and the control subjects.

Correspondence: Tatsuo Sakamoto, Department of Pediatrics, Nagoya University Graduate School of Medicine, 65 Tsurumai-cho, Showa-ku, Nagoya 466-8550, Japan. Email: tatsuos@med.nagoya-u.ac.jp

Received 4 February 2004; revised 13 December 2004; accepted 10 March 2005.

Table 1 Results of allergic examinations

Total serum IgE (IU/mL)	186 [†]		
Specific IgE (UA/mL)			
Banana	21.1 [‡]	Wheat	0.34> [‡]
Avocado	31.8 [‡]	Buckwheat	0.34> [‡]
Hen's egg white	20.1 [‡]	Chestnut	0.34> [§]
Cow's milk	3.0 [‡]	Birch	0.34> [‡]
Apple	0.34> [‡]	Grass	0.34> [‡]
Melon	0.34> [‡]	Mugwort	0.34> [‡]
Strawberry	0.34> [‡]	Ragweed	0.34> [‡]
Soy bean	0.34> [‡]	Mite	0.34> [‡]
Oral provocation test (open trial)			
Carrot	Negative		
Kiwi fruit	Negative		
Celery	Negative		

[†]Gla-O-Zyme [New] kit (Wako Pure Chemical Industries, Osaka, Japan). [‡]CAP system (Pharmacia & Upjohn Diagnostics AB, Uppsala, Sweden). [§]AlaSTAT system (Diagnostic Products Corporation, Los Angeles, CA, USA). Bonsum simusque quem ma

Results

In the patient with the adverse reaction to banana, the mean diameters of wheal induced by banana, avocado, latex, and vehicle were 4, 3, 0 and 0 mm, respectively. In contrast, no significant wheal response was observed in skin prick tests to banana, avocado, or latex in five nonatopic volunteers.

SDS-PAGE of the banana and avocado extracts revealed multiple protein bands (Fig. 1). In immunoblot experiments, sera from the five nonatopic adult patients with negative skin prick tests to banana and avocado, sera from two atopic infants who had a high level of IgE (>1000 IU/mL) but negative banana- and avocado-CAP radio-allergosorbent test (RAST), and sera from two samples of cord blood did not react with blotted banana or avocado proteins (data not shown). In contrast, IgE antibodies in the patient's serum reacted with several proteins of the two extracts. The molecular weights of the IgE-binding proteins in the banana extract were 10, 13, 20, 41, and 70 kDa, and those in avocado extract were 14, 16, 24, 28, 34, and 64 kDa (Fig. 2).

Preincubation with the banana or avocado extract, but not with hen's egg white or cow's milk extract, completely abolished IgE-binding to the homologous blotted antigens (Fig. 2; a-2, b-3). After preincubation with the banana extract, an avocado allergenic protein band of 16 kDa became undetectable, while one of 14 kDa was decreased, and the other avocado allergenic protein bands were not affected (Fig. 2; b-2). In contrast, preincubation with the avocado extract did not inhibit IgE-binding to the banana allergenic proteins (Fig. 2; a-3). When the two kinds of latex extracts were used as an inhibitor, IgE-binding to blotted banana and avocado antigens was not inhibited (Fig. 2; a-4, b-4).

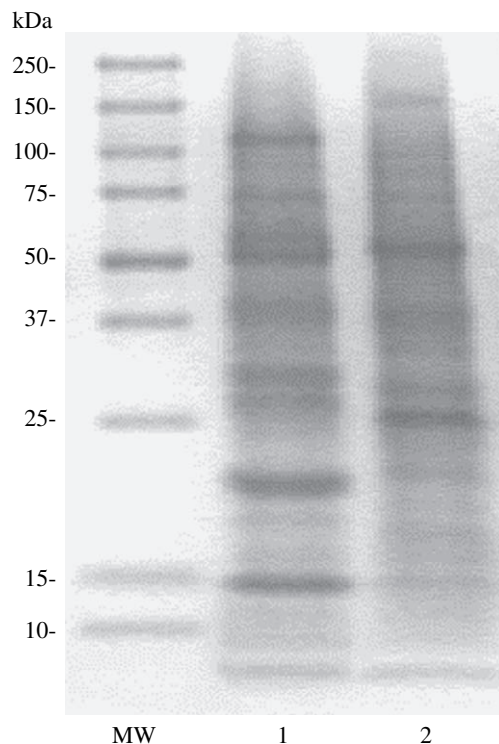


Fig. 1 Sodium dodecylsulfate-polyacrylamide gel electrophoresis separation of crude extracts from banana (column 1) and avocado (column 2). After electrophoresis through a 10–20% polyacrylamide gradient gel, the proteins were stained with Coomassie Blue. MW, protein molecular weight markers.

Discussion

An adverse response to banana in a 6-month-old boy was elicited via an IgE-mediated pathway, as confirmed by a skin prick test, CAP RAST, and immunoblot analysis, although we did not carry out an oral provocation test with banana because of the possibility of a severe systemic reaction after challenge.

Proteins, 32 kDa and 34 kDa in banana, and a 30 kDa protein in avocado have been shown to be the major allergens, and have been identified as class I chitinases with a hevein-like domain, which generally accounts for the cross-allergenicity between latex and these fruits.^{2,3,7} However, this infant showed no IgE antibodies to latex by CAP RAST or a skin prick test with latex. Moreover, the present immunoblot studies did not detect the corresponding bands in either banana or avocado. Absence of the cross-reactivity to latex was also confirmed by the results of immunoblot inhibition assays using latex as an inhibitor. Tokuyama *et al.*⁵ also reported two infants with banana allergy with no IgE reactivity to latex, although the patients were not sensitized to avocado.

Some pollen allergens such as profilin are the sensitizing agent responsible for many forms of plant-derived food allergies,³ which probably accounts for the fact that banana allergy

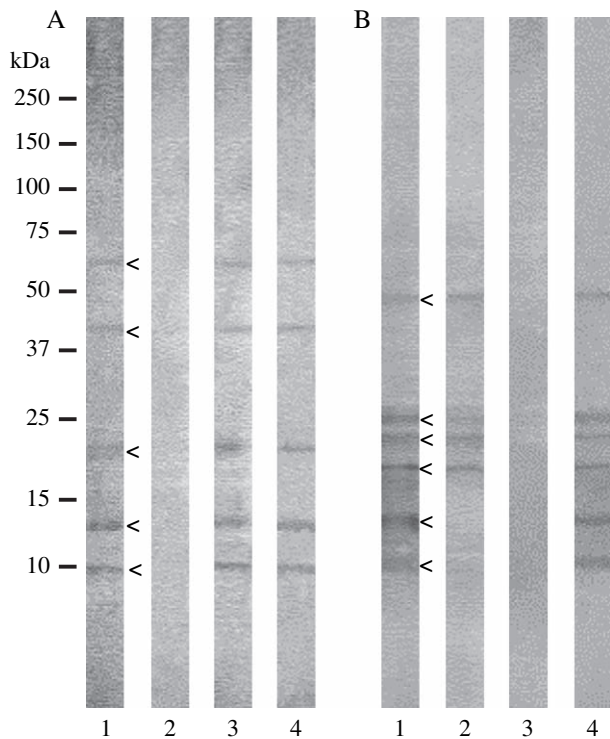


Fig. 2 IgE-immunoblot analyses of crude extracts from (a) banana and (b) avocado pulp. Samples were separated by sodium dodecylsulfate-polyacrylamide gel electrophoresis, electrotransferred onto a polyvinylidene difluoride membrane, and immunoblotted with the serum from the banana-allergic infant (column 1), the patient's serum after preincubation with banana extract as an inhibitor (column 2), the patient's serum after preincubation with avocado extract as an inhibitor (column 3), and the patient's serum after preincubation with latex extract as an inhibitor (column 4). A natural rubber latex serum used as an inhibitor (Rubber Research Institute of Malaysia, Kuala Lumpur, Malaysia) was extracted from fresh latex collected from *H. brasiliensis* rubber trees. Arrows in column 1 show the positions of IgE-binding protein bands of blotted banana and avocado extracts.

occurs frequently in patients with pollinosis.^{3,4} However, in the present patient, CAP RAST for several kinds of pollens was negative. Several cases of banana allergy in childhood have been reported; one such patient had hay fever and oral allergy syndrome to various vegetables and fruits,⁸ and the others were sensitized to latex.^{9,10} The allergenic features of these patients, therefore, seemed similar to those of adults with banana allergy. It is generally assumed that the allergenic components responsible for banana allergy in infants differ from those in adults and older children, although there are very few reports on banana allergy in infants.

In the immunoblot inhibition assay using the patient's serum, banana inhibited IgE-binding to some avocado antigens, suggesting the presence of cross-allergenic components between banana and avocado. In contrast, avocado did not

inhibit IgE binding to banana antigens at all, suggesting that shared IgE epitopes may be a major feature of the IgE-binding properties of avocado, but play only a minor role in the allergenicity to banana. Unfortunately, we have not verified the cross-allergenicity using RAST inhibition due to lack of the patient's serum.

This patient had been exclusively breast-fed, and he had never eaten banana or avocado directly. His mother had eaten bananas frequently, but not eaten avocado at all. Therefore, it is reasonable to assume that this patient had been sensitized to banana through his mother's breast milk that contained antigenic components of banana, whereas the IgE antibodies to avocado had been induced by antigenic components in the breast milk that had cross-antigenicity to avocado. However, there is no experimental evidence to support this assumption.

Conclusion

We have reported here an infant with banana allergy. The patient had IgE reactivity to avocado, but not to latex or pollens, partially due to the cross-allergenicity between banana and avocado. Therefore, even a banana-allergic patient without IgE antibodies to latex or pollens may have a risk of possessing IgE reactivity to avocado.

References

- 1 Makinen-Kiljunen S. Banana allergy in patients with immediate-type hypersensitivity to natural rubber latex: characterization of cross-reacting antibodies and allergens. *J. Allergy Clin. Immunol.* 1994; **93**: 990–96.
- 2 Sanchez-Monge R, Blanco C, Diaz-Perales A *et al.* Isolation and characterization of major banana allergens: identification as fruit class I chitinases. *Clin. Exp. Allergy* 1999; **29**: 673–80.
- 3 Breiteneder H, Ebner C. Molecular and biochemical classification of plant-derived food allergens. *J. Allergy Clin. Immunol.* 2000; **106**: 27–36.
- 4 Enberg RN, Leickly FE, McCullough J, Bailey J, Ownby DR. Watermelon and ragweed share allergens. *J. Allergy Clin. Immunol.* 1987; **79**: 867–75.
- 5 Tokuyama K, Takei K, Arakawa H *et al.* Banana allergy in infants. *Allergy* 1997; **52**: 350–51.
- 6 Lavaud F, Prevost A, Cossart C, Guerin L, Bernard J, Kochman S. Allergy to latex, avocado pear, and banana: evidence for a 30 kd antigen in immunoblotting. *J. Allergy Clin. Immunol.* 1995; **95**: 557–64.
- 7 Chen Z, Posch A, Cremer R, Raulf-Heimsoth M, Baur X. Identification of hevein (Hev b 6.02) in Hevea latex as a major cross-reacting allergen with avocado fruit in patients with latex allergy. *J. Allergy Clin. Immunol.* 1998; **102**: 476–81.
- 8 Matheu V, Zapatero L, Alcazar M, Martinez-Molero MI, Baeza ML. IgE-mediated reaction to a banana-flavored drug additive. *J. Allergy Clin. Immunol.* 2000; **106**: 1202–3.
- 9 Jensen VB, Rasmussen KB, Jorgensen IM, Prahl P. Latex allergy in children. *Ugeskr Laeger* 1997; **159**: 3172–4 (in Danish).
- 10 Cinquetti M, Peroni D, Vinco A, Zoppi G. Latex allergy in a child with banana anaphylaxis. *Acta Paediatr.* 1995; **84**: 709–10.