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The Prevalence of Specific IgE to Common Foods and Dust Mite in the Sera of Allergic Patients in Taiwan

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ABSTRACT

Food allergy refers to an abnormal immunologic response to foods. Food hypersensitivity reactions have become an increasingly troublesome issue over the last few decades. This study aims to investigate the prevalence of food allergies and to collect sera samples for the identification of allergens in foods. A total of 206 subjects from allergy and clinical immunology clinics, Taichung Veterans General Hospital were recruited in this study. The prevalence of food hypersensitivity was determined. The specific IgE to crude extracts of maize, rice, soybeans, broccoli, peanuts, *Dermatophagoides pteronyssinus*, allergen components of pathogenesis related protein-10 (PR-10) and lipid transfer protein (LTP), were measured using a Phadia ImmunoCAP autoanalyzer. A total of 70.4% subjects had specific IgE to *D. pteronyssinus* and close to 10% of all subjects had IgE to soybeans, rice, maize, broccoli, and peanuts. The IgE titer to LTP and PR-10 were low and had cross-reactivity with hazelnuts and wall pellitory. The relationship between allergic diseases and food specific IgE demonstrated that patients with skin allergy had a high prevalence of food hypersensitivity. There was a good correlation between the titer of IgE to *D. pteronyssinus* and food. Regarding the occurrence of skin allergies, there were higher incidences in the male subjects (53.2%) than in the female subjects (35.8%). The food-specific IgE (soybeans, rice, maize, broccoli, and peanuts) in male allergic subjects were apparently higher than female allergic subjects ($p < 0.05$). In the relationship between age and allergy, there were more younger-aged subjects (63.9%) with skin allergies than adult subjects (37.8%). However, there were more adult subjects (48.8%) with airway allergy than younger-aged subjects (27.8%). The percentage of mite specific IgE were apparently higher in the subjects under the age of 18 as compared with subjects over 18 years old. And the occurrence of airway allergy was mostly observed in subjects over 18 years old. However, the occurrence of skin allergy mostly happened in subjects under 18 years old. These results indicated that both food allergen and aeroallergen can be sensitized by the allergic subjects and may cause different degrees of severity of IgE responses. In conclusion, the sera containing allergen specific IgE to edible food can be collected from allergic subjects particularly those patients with skin allergies. These sera can be used for the detection of allergens in both conventional and genetically modified organisms.

Key words: dust mite, food allergen, skin allergy, pathogenesis related protein, lipid transfer protein

INTRODUCTION

Food allergy refers to an abnormal immunologic response to foods. These allergic reactions caused by foods are further classified into IgE-mediated and non IgE-mediated reactions(1). The IgE-mediated symptoms are typically rapid in the beginning, such as anaphylaxis and urticaria. Food hypersensitivity reactions have become an increasingly troublesome issue over the last few decades, affecting 4 to 5% of children and 2 to 3% of adults(2). Food allergy rates vary by age, local diet, gene and many other factors. Although the allergy could be triggered by "major allergens" such as milk, egg, peanuts, fish and shellfish, there are also foods such as fruits, vegetables, maize and soybeans(3) responsible for the allergic reactions.

Peanuts are a major cause of food allergy and the most common cause of fatal food-induced anaphylaxis in the U.S.A.(4) Soybeans are the world's most important legume, and at least 21 allergenic components have been identified to trigger IgE-mediated symptoms after ingestion. It has been reported that soybean allergens showed cross-reactivity with birch pollen(5). Broccoli (*Brassica oleracea*) is a worldwide crop and is one of the popular vegetables in the family Brassicaceae. The major allergen of *B. oleracea*-Bra o 3

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was identified as a lipid transfer protein (LTP) and showed high IgE frequency (86%) from the allergic patients' sera[6]. In the US and Europe, maize is used almost entirely for feeding animals, and it is also used as an important grain and vegetable in the human diet. The maize allergy can be represented by maize-pollen induction, maize flour inhaled, or maize ingestion. The major maize allergen has been identified as a lipid transfer protein, Zea m 14, and it showed extensive cross-reactivity among different species such as peach and apple[7].

A genetically modified organism (GMO) is an organism whose genetic material has been altered using genetic engineering techniques. Although GMOs provide modern agriculture with improvements in efficiency and the benefits of increased food production[8,9], its impact on human health continues to be investigated. Regulatory guidelines for GMOs had been drawn up by the European Union, WHO/FAO[10,11], and countries including China[12]. GM food over 5% requires mandatory labeling in highly refined products (http://www.fda.gov.tw).

The crops generated by genetically modified techniques should be compared with those conventional crops in terms of protein profile and allergenicity[13,14]. To assess hazardous grades of allergenicity and the unintended effects on the endogenous allergens, allergen specific IgE is required for all methodologies to make an evaluation[15]. Since a high prevalence of asthma and allergic rhinitis has been found world-wide, sensitization to allergens is a risk for the development of allergic diseases[16]. Currently, hypersensitivity to generic drugs has been reported due to the allergenic component of soybeans in the drug[17]. Therefore, the identification of food allergens is clinically important to prevent allergic reactions[18]. The purpose of this study was to construct a comprehensive serum bank, in which a total of 206 allergic subjects were recruited. In this study, we attempted to investigate the prevalence of specific IgE to food in the sera derived from these 206 allergic patients in Taiwan.

MATERIALS AND METHODS

I. *Study Subjects*

A total of 206 subjects who attended the allergy and clinical immunology outpatient clinics at the Taichung Veterans General Hospital (TCVGH) were recruited for this study. There were 126 males and 80 females. The age ranged from 3 and 80 years old, with the mean and standard deviation as 33 ± 16. Among them, 85 subjects suffered from skin allergies, including 73 patients with atopic dermatitis and 12 patients with urticaria. There were 90 subjects that suffered from airway allergies, including 72 patients with asthma and 25 patients with allergic rhinitis; 7 patients had both diseases. There were 41 patients with other immunological diseases. The Institutional Review Board of TCVGH reviewed and approved the ethical nature of this study (IRB No. C06193). Verbal consent and written informed consent were obtained from the participants after detailed explanations were provided. Serum samples were obtained for IgE measurement.

II. *Determination of IgE Antibodies in Sera Against Edible Food and Dust Mites*

The blood samples were obtained from these 206 subjects in our clinics. Each of the 5 mL blood samples were collected in the serum separator tubes (Kendall) and processed within 4 h. The serum samples were stored at -20°C until analysis. The allergen-specific IgE were measured by the ImmunoCap® (Phadia CAP no. k77; Uppsala, Sweden) using the UniCAP 250 system, following the supplier's instructions. A concentration greater than 0.35 KU/L was considered positive. The concentration ranged from 0.35 to 100 KU/L. The titers of antigen-specific IgE were further classified as follows: class 1, 0.35 to 0.7 KU/L; class 2, 0.7 to 3.5 KU/L; class 3, 3.5 to 17.5 KU/L; class 4, 17.5 to 50.0 KU/L; class 5, 50 to 100 KU/L; and class 6, more than 100 KU/L. Class 1, 2 were considered as low, class 3, 4 were medium and class 5, 6 were high. The crude extracts of foods including peanuts, soybeans, maize, rice and broccoli were used for IgE antibody measurement. House dust mites, *D. pteronyssinus*, was used as a control. The assay procedure was automatically performed, and the results were calibrated against the World Health Organization standard for IgE. The allergen components pathogenesis related protein-10, PR-10 (hazelnut- Cor a 1 and carrot-Dau c 1) and lipid transfer protein, LTP (hazelnut- Cor a 8 and wall pellitory- Par j 2) were also measured using the ImmunoCAP ISAC (Immuno Solid-phase Allergen Chip) (Phadia AB, Uppsala, Sweden).

III. *Statistical Analysis*

Pearson's chi-square test was used to analyze the relationship between the presence of edible food specific IgE and the presence of allergic diseases. Spearman's rank correlation test was used to analyze the titers of specific IgE between *D. pteronyssinus* and edible food. A p value of less than 0.05 was considered statistically significant.

RESULTS AND DISCUSSION

I. *The Prevalence of Positive Specific IgE to Food and D. pteronyssinus in Allergic Subjects*

The prevalence of the specific IgE and its titers in the sera were analyzed. The results in Table 1 showed that 70.4% of subjects were positive to *D. pteronyssinus*, and most of them were at medium to high titers. However, 10.2 and 10.7% of subjects were positive to broccoli and maize, respectively, and less than 10% of the subjects were positive to soybeans, rice and peanuts. Despite the high titer of *D. pteronyssinus* specific IgE, there was only one high titer of

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Table 1. The prevalence of positive specific IgE to food and *D. pteronyssinus* in allergic subject (n = 206)

Titer	peanut	soybean	maize	rice	broccoli	Dp
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Low	16 (7.8)	13 (6.3)	17 (8.3)	12 (5.8)	18 (8.7)	37 (18.0)
Medium	3 (1.5)	3 (1.5)	4 (1.9)	3 (1.5)	3 (1.5)	61 (29.6)
High	0 (0.0)	0 (0.0)	1 (0.5)	0 (0.0)	0 (0.0)	47 (22.8)
Total	19 (9.2)	16 (7.8)	22 (10.7)	15 (7.3)	21 (10.2)	145 (70.4)

Dp: *D. pteronyssinus*.

Table 2. The allergenic component of PR-10 and LTP specific IgE in the sera of allergic patients (n = 54)

Case ID		5	114	13	25	32	112	128	137
PR-10	Hazelnut (Cor a 1)	–[a]	–	–	2+	–	–	–	–
	Carrot (Dau c 1)	–	–	–	–	–	–	2+	–
LTP	Hazelnut (Cor a 8)	2+	2+	–	2+	–	–	–	–
	wall pellitory (Par j 2)	2+	–	1+	2+	1+	2+	1+	1+

a: The titers of antigen-specific IgE were measured by the ImmunoCap®.
"–": class 0, < 0.35 KU/L; "1+": class 1, 0.35 to 0.7 KU/L; "2+": class 2, 0.7 to 3.5 KU/L.

Table 3. The correlation between the specific IgE to *D. pteronyssinus* and food (n = 200)

variable	Mite		*p*-value
	n[a]	Correlation coefficient	
peanut	200	0.329	< 0.01*
soybean	200	0.289	< 0.01*
maize	200	0.312	< 0.01*
rice	200	0.276	< 0.01*
broccoli	200	0.326	< 0.01*

Spearman's rank correlation test. "*" $p < 0.01$
"a": In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis.

specific IgE to maize (Table 1). House dust mites are the most common allergen to induce allergic sensitization in this study. Similar results were shown that more than 90% of primary school children in Taipei city were sensitized to house dust mites[19]. The specific allergenic components of PR-10 (Cor a 1 and Dau c 1) and LTP (Cor a 8 and Par j 2) were analyzed for their cross-reactivity among foods. The results in Table 2 showed the 8 out of 54 subjects had cross-reactivity of LTPs among maize (Zea m 14), hazelnuts (Cor a 8) and wall pellitory (Par j 2). However, there were only two subjects that had cross-reactivity of PR-10 among soybeans (Gly m 4), hazelnuts (Cor a 1) and carrots (Dau c 1) (Table 2).

II. *The Relationships between Titers of Specific IgE to D. pteronyssinus and Food Specific IgE in the Sera.*

When the specific IgE to *D. pteronyssinus* and food were analyzed, a good correlation between the IgE of *D. pteronyssinus* and all foods was observed (Table 3). Similarly, when the titers of *D. pteronyssinus* were analyzed as to their relationship with food specific IgE in the sera, a good relationship between high titers of *D. pteronyssinus* specific IgE to all species of food specific IgE was obtained (Table 4). These results indicated that the subjects with more severe *D. pteronyssinus* hypersensitivity were more susceptible to food hypersensitivity. It has been reported that sensitization to food allergens is less common of children with age under 6 years old, whereas the sensitization rates to inhalant allergens increases in the children with a family history of atopy[20]. 29.7% of children with food allergy accompany hypersensitivities to inhalant allergens. Overall, the incidence of food allergy decreases with age, but the incidence of inhalant allergy increases[21]. Seven-year-old children in the UK are sensitized to aeroallergens, but also to food allergens such as peanuts and tree nuts. More than 95% of subjects with sensitization to any of 29 allergens tested were sensitized to one of grass, *D. pteronyssinus* or cat allergen. There were strong associations of multiple sensitizations both within and between different allergens[22].

III. *The Relationship between Allergic Diseases and Food Specific IgE in the Sera.*

In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis. When 200 allergic subjects were analyzed for the presence of food specific IgE in the sera, the results showed that there was a good relationship between all food specific IgE with skin allergies (Table 5). However, only broccoli specific IgE had a good relationship with airway allergies (Table 6). These results indicated that skin allergy subjects tended to suffer from food allergies. In clinical observation, airway allergy is more relevant to airborne allergens; however, skin allergy is more relevant to food-related allergens. Based on the result that a high prevalence of food specific IgE can be obtained in subjects with allergic skin diseases, especially in subjects with a high titer specific to *D. pteronyssinus*, this suggests that food allergens might play a more important role in the pathogenesis of allergic inflammation of patients with skin allergies than airway allergies.

Table 4. The relationship between the presence of food-specific IgE and the titers of specific IgE to *D. pteronyssinus* in the sera (n = 200)

variable	Dp (Nil$^+$)		Dp (Low$^+$)		Dp (Medium$^+$)		Dp (High$^+$)		*p*-value
	n[a]	(%)	n	(%)	n	(%)	n	(%)	
peanut									
−	59	(98.3)	32	(97.0)	58	(95.1)	32	(69.6)	< 0.001*
+	1	(1.7)	1	(3.0)	3	(4.9)	14	(30.4)	
soybean									
−	59	(98.3)	32	(97.0)	59	(96.7)	34	(73.9)	< 0.001*
+	1	(1.7)	1	(3.0)	2	(3.3)	12	(26.1)	
maize									
−	59	(98.3)	30	(90.9)	58	(95.1)	32	(69.6)	< 0.001*
+	1	(1.7)	3	(9.0)	3	(4.9)	14	(30.4)	
rice									
−	59	(98.3)	32	(97.0)	59	(96.7)	35	(76.1)	< 0.001*
+	1	(1.7)	1	(3.0)	2	(3.3)	11	(23.9)	
broccoli									
−	59	(98.3)	32	(97.0)	56	(91.8)	32	(69.6)	< 0.001*
+	1	(1.7)	1	(3.0)	5	(8.2)	14	(30.4)	

Pearson's chi-square test. "*" $p < 0.001$
Dp ( ): Titers of *D. pteronyssinus* specific IgE.
"a": In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis.

Table 5. The relationship between skin allergy and food specific IgE in the sera (n = 200)

variable	skin allergy		Non-skin allergy		*p*-value
	n[a]	%	n	%	
peanut					
−	71	(83.5)	110	(95.7)	0.008**
+	14	(16.5)	5	(4.3)	
soybean					
−	73	(85.9)	111	(96.5)	0.013*
+	12	(14.1)	4	(3.5)	
maize					
−	70	(82.4)	109	(94.8)	0.009**
+	15	(17.6)	6	(5.2)	
rice					
−	74	(87.1)	111	(96.5)	0.025*
+	11	(12.9)	4	(3.5)	
broccoli					
−	69	(81.2)	110	(95.7)	0.002**
+	16	(18.8)	5	(4.3)	

Yate's correction of contingency. *$p < 0.05$,**$p < 0.01$.
"a": In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis.

Table 6. The relationship between airway allergy and food specific IgE in with sera (n = 200)

variable	airway allergy		Non-airway allergy		*p*-value
	n[a]	(%)	n	(%)	
peanut					
−	85	(94.4)	96	(87.3)	0.139
+	5	(5.6)	14	(12.7)	
soybean					
−	86	(95.6)	98	(89.1)	0.157
+	4	(4.4)	12	(10.9)	
maize					
−	84	(93.3)	95	(86.4)	0.171
+	6	(6.7)	15	(13.6)	
rice					
−	86	(95.6)	99	(90.0)	0.225
+	4	(4.4)	11	(10.0)	
broccoli					
−	86	(95.6)	93	(84.5)	0.022*
+	4	(4.4)	17	(15.5)	

Yate's correction of contingency. *$p < 0.05$.
"a": In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis.

VI. *The Relationship between Gender or Age and Edible Food Specific IgE in the Sera.*

Among these allergic subjects, the gender or age were analyzed for the presence of mite or food specific IgE in the sera. The results of gender analysis showed that the percentages of food specific IgE (peanuts, soybeans, maize, rice and broccoli) and skin allergy were apparently higher in male subjects than in female subjects (Table 7). The relationship between age and allergen specific IgE in the sera were further analyzed, and the results showed that the percentage of mite specific IgE were apparently higher in subjects under 18 years old than in the subjects over 18 years old. The occurrence of airway allergy mostly observed in the subjects with age over 18 years old. On the other hand, the occurrence of skin allergy mostly occurred in the subjects under 18 years old (Table 8).

Food-induced allergic reactions are responsible for a variety of symptoms involving the skin, gastrointestinal and respiratory tracts, and they can generally be attributed to IgE-mediated and cellular mechanisms[23]. Most common allergies in children are induced by the allergens milk, eggs, wheat and peanuts; whereas in adults most common allergies are related to fish, shell-fish, fruit and peanuts. For both children and adults, peanuts are a frequent cause of food allergy and the most common cause of fatal anaphylaxis in the U.S.A.[23] However, the number of peanut allergy cases was not particularly high among Taiwanese in this study. The reasons for the different prevalence are perhaps caused by the different degrees of consumption or processing methods. The peanut allergy is uncommon in China, as boiled or fried peanuts are eaten more often rather than dry roasted peanuts which are commonly consumed in the U.S.A.[24] This study can serve as a background reference regarding the prevalence of edible food allergies in Taiwan. In addition, the sera of allergic subjects who had positive food specific IgE from

Table 7. The relationship between gender and allergen specific IgE in the sera (n = 200)

	female (n = 123)		male (n = 77)		
variable	n[a]	%	n	%	*p*-value
mite					0.067[y]
−	42	(34.1)	18	(23.4)	
+	81	(65.9)	59	(76.6)	
peanut					0.010*[y]
−	117	(95.1)	64	(83.1)	
+	6	(4.9)	13	(16.9)	
soybean					0.020*[y]
−	118	(95.9)	66	(85.7)	
+	5	(4.1)	11	(14.3)	
maize					0.002*[y]
−	117	(95.1)	62	(80.5)	
+	6	(4.9)	15	(19.5)	
rice					0.009**[y]
−	119	(96.7)	66	(85.7)	
+	4	(3.3)	11	(14.3)	
broccoli					0.036*[y]
−	115	(93.5)	64	(83.1)	
+	8	(6.5)	13	(16.9)	
airway allergy					0.530[y]
−	65	(52.8)	45	(58.4)	
+	58	(47.2)	32	(41.6)	
skin allergy					0.022*[y]
−	79	(64.2)	36	(46.8)	
+	44	(35.8)	41	(53.2)	

y: Yates' correction for continuity. f: Fisher's exact test.
"*": $p < 0.05$, "**": $p < 0.01$
"a": In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis.

Table 8. The relationship between age and allergen specific IgE in the sera (n = 200)

	Age < 18 (n = 36)		Age ≧ 18 (n = 164)		
variable	n[a]	%	n	%	*p*-value
mite					0.033*[y]
−	8	(22.2)	52	(31.7)	
+	28	(77.8)	112	(68.3)	
peanut					0.119[f]
−	30	(83.3)	151	(92.1)	
+	6	(16.7)	13	(7.9)	
soybean					0.496[f]
−	32	(88.9)	152	(92.7)	
+	4	(11.1)	12	(7.3)	
maize					0.226[f]
−	30	(83.3)	149	(90.9)	
+	6	(16.7)	15	(9.1)	
rice					0.481[f]
−	32	(88.9)	153	(93.3)	
+	4	(11.1)	11	(6.7)	
broccoli					0.226[f]
−	30	(83.3)	149	(90.9)	
+	6	(16.7)	15	(9.1)	
airway allergy					0.022*[y]
−	26	(72.2)	84	(51.2)	
+	10	(27.8)	80	(48.8)	
skin allergy					0.004**[y]
−	13	(36.1)	102	(62.2)	
+	23	(63.9)	62	(37.8)	

y: Yates' correction for continuity. f: Fisher's exact test.
"*": $p < 0.05$, "**": $p < 0.01$.
"a": In the 206 subjects, only 200 subjects with enough serum and information could be admitted into further analysis.

allergy and clinical immunology outpatient clinics can serve as a test platform to evaluate whether the allergenicity of genetically modified peanuts, soybeans, maize, rice and broccoli has been affected.

We found the major allergen in allergic patient from clinics of allergy and clinical immunology was the house dust mite, *D. pteronyssinus,* about 70% of patients with IgE positive responses to *D. pteronyssinus*. The notable appearance and abundance of *D. pteronyssinus* may be influenced by the warm and humid climate in Taiwan. Even some of the allergic rhinitis patients allergic to the storage mite *Tyrophagus putrescentiae* were caused by cross-reactivity from *D. pteronyssinus*[25]. Although *D. pteronyssinus* was the most predominant allergen, approximately 10% of allergic subjects had positive food specific IgE. Since the specific IgE to *D. pteronyssinus* can be easily obtained in allergic subjects, it may be used for food allergen determination in food allergies. The lipid-transfer proteins (LTPs) are low-molecular-weight (9 kDa) proteins, one member of pathogenesis-related proteins (PRP-14) which facilitate the transfer of phospholipids and lipids across membrane. These proteins are important plant allergens and widespread in plants. The IgE-triggered hypersensitivity to LTPs has primary been described from southern Europe in patients with severe reactions to peaches and other fruits belonging to the *Rosaceae* family and were not associated with pollen allergy[26]. The results of our allergen component analysis showed that 14.8% of subjects (8 out of 54) had pathogenesis related protein LTP positive in the sera which may cause cross-reactivity among foods. The pathogenesis-related (PR)-10 proteins are intracellular proteins which had been isolated from various species such as apples, peas, potatoes and pollen. The major allergen component Bet v 1 from birch pollen belongs to PR-10, the most frequent cross-reactive allergen among the pollen allergy for triggering oral allergy syndromes[27]. In this study, we found that the LTP positive rate was higher than the proportion of PR-10 in the food-allergic subjects. More cases of food-allergic subjects will be recruited for further analysis in the near future. Since the specific IgE to *D. pteronyssinus* and foods were well-correlated, it may also indicate that there is cross-reactivity between them. With the high titer of *D. pteronyssinus* specific IgE having a good relationship with the presence of food specific IgE, these results suggested that many subjects were sensitized by both aeroallergens and food allergens, but that they caused different severities of IgE response.

The airway allergies are important factors in the genesis of asthma and allergic rhinitis. There is increasing evidences that exposure to airborne allergens including house dust mites, pollens and animal dander leads to airway allergy. In most parts of the world, sensitivity to inhaled-allergen house dust mites is the most consistent risk factor for the development of asthma or allergic rhinitis[28]. Some allergenic components of mites like Der p 1 and Der p 3 that have been demonstrated to possess proteolytic activity, may have some effects on allergenicity by the activation of protease-activated receptor-2 on lung epithelial cells[29]. The atopic dermatitis is a chronic, recurrent skin allergy which commonly occurs in infants and children, but can continue in adults. Clinical studies have revealed that more than 50% of allergic patients that had atopic dermatitis could have their conditions exacerbated by certain foods and they will react with a worsening of clinical eczematous symptoms, including IgE associated and independent T-cell mediated responses[30].

Recently, the amount and category of GMOs are expanding greatly and becoming quite diverse. The application of new methods of crop breeding and food production is an extension of traditional agricultural technology. Many international organizations and countries have a set of safety assessment principles, and testing methods for such products including toxicity, allergenicity, anti-nutrition and unintended effects. However, there are some difficulties in assessing the safety of GM crops. For instance, there are no genetically modified DNA for protein production and no sera available to identify these proteins. The GMOs of peanuts, soybeans, maize, rice and broccoli have been constructed by several research groups in recent years, and some of them are already sold on the market. Although potential differences in endogenous allergen expression exist, especially with regards to pathogenesis related proteins in GM crops, there are still no qualitative and quantitative comparisons between transgenic and isogenic/conventional lines using allergic serum samples. It is therefore important to investigate the prevalence of hypersensitivity to common foods and to set up a serum bank which can provide sera to examine the allergens in all GM crops. Fortunately, we do have a suitable platform to evaluate whether allergenicity of GMO been affected.

In conclusion, although aeroallergen *D. pteronyssinus* was most commonly identified in the sera, there were sera containing specific IgE against many foods that could be identified. The sera containing allergen specific IgE to edible food can be collected from allergic subjects, particularly those patients with skin allergies. These sera can be used for the detection of allergens in not only conventionally raised, but also genetically modified crops.

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