

Allergic sensitization to ornamental plants in patients with allergic rhinitis and asthma

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ABSTRACT

Ornamental plants (OPs) can lead to immediate-type sensitization and even asthma and rhinitis symptoms in some cases. This study aimed to evaluate sensitization to OPs in patients with asthma and/or allergic rhinitis and to determine the factors affecting the rate of sensitization to OPs. A total of 150 patients with asthma and/or allergic rhinitis and 20 healthy controls were enrolled in the study. Demographics and disease characteristics were recorded. Skin-prick tests were performed with a standardized inhalant allergen panel. Skin tests by "prick-to-prick" method with the leaves of 15 OPs, which are known to lead to allergenic sensitization, were performed. Skin tests with OPs were positive in 80 patients (47.1%). There was no significant difference between OP sensitized and nonsensitized patients in terms of gender, age, number of exposed OPs, and duration of exposure. Skin test positivity rate for OPs was significantly high in atopic subjects, patients with allergic rhinitis, food sensitivity, and indoor OP exposure, but not in patients with pollen and latex allergy. Most sensitizing OPs were *Yucca elephantipes* (52.5%), *Dieffenbachia picta* (50.8%), and *Euphorbia pulcherrima* (47.5%). There was significant correlation between having *Saintpaulia ionantha*, *Croton*, *Pelargonium*, *Y. elephantipes*, and positive skin test to these plants. Sensitivity to OPs was significantly higher in atopic subjects and patients with allergic rhinitis, food allergy, and indoor OP exposure. Furthermore, atopy and food sensitivity were found as risk factors for developing sensitization to indoor plants. Additional trials on the relationship between sensitization to OPs and allergic symptoms are needed.

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Sensitization to ornamental plants (OPs) has been described in occupational settings such as plant keepers and flower growers.^{1–4} In 1985, Axelsson *et al.* reported, for the first time, *Ficus benjamina* as a potential occupational inhaled allergen. There have also been case reports of IgE-mediated allergy after occupational exposure to *Ficus lyrata*, *Phoenix canariensis*, *Spathiphyllum wallisii*, *Yucca aloifolia*, and *Schlumbergera cacti*.⁵

The plants can cause sensitization, usually of the immediate type, and also allergic rhinitis and asthma. Allergic symptoms resulting from exposure to OPs may be caused either by primary sensitization to pollen of such plants or from cross-reactivity with pollen of their wild relatives. Allergens have been assumed to be present in the plant sap, diffused to the leaves by water, passed through the dust particles on the leaves, and inhaled when they are aerosolized into the air.^{5,6} IgE-mediated allergic diseases such as asthma, rhinoconjunctivitis, and contact urticaria were described

with the species of Liliaceae (tulip, Easter lily, garlic, yucca, and hyacinth), Lamiaceae (*Molucella laevis*), and Moraceae (*Ficus benjamina*).^{7–11}

Indoor plants are used worldwide for the interior decoration of homes and public spaces. In the last 25 years there has been an increased use of OPs indoors and most people are exposed to indoor plants.¹² Although OPs have been first recognized as a cause of respiratory allergy in occupational settings, more recent data indicate that moderate exposure to these plants in private homes and offices may also cause sensitization.^{5,12} Sensitization to OPs was found to be 39% among atopic patients; moreover, 78% of the subjects with allergic rhinitis were shown to have positive skin-prick tests to OPs.⁵

Patients with allergic rhinitis and asthma frequently ask if it will be useful to remove indoor plants in terms of tertiary prevention. Particularly patients with grass pollen allergy who have OPs at home are the most worried group about the relation of their symptoms and presence of OPs in their homes. However, there are limited data about sensitization rates to OPs in patients with asthma and/or allergic rhinitis.¹² Furthermore, to our knowledge, there is no study to compare the sensitization rates between patients with and without indoor exposure to OPs.

In this study, we aimed to evaluate sensitization to OPs in patients with asthma and/or allergic rhinitis. We also aimed to determine the factors affecting the

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rate of sensitization to OPs such as presence of atopy, pollen, and food allergies and especially owning OPs.

MATERIALS AND METHODS

Patient Selection

This study was conducted in the outpatient allergy clinic of our tertiary university hospital. A total of 150 adult patients with asthma and/or allergic rhinitis and 20 healthy controls were enrolled into this study. Asthma diagnosis was based on a prior history of recurrent wheezing, shortness of breath, cough, and demonstration of objective signs of reversible airway obstruction by means of at least $>12\%$ and a 200-mL increase in forced expiratory volume in 1 second after 15 minutes with an inhalation of 400 μg of salbutamol according to the Global Initiative for Asthma guidelines.¹³ Diagnosis of allergic rhinitis was based on criteria in an Allergic Rhinitis and Its Impact on Asthma 2008 update report.¹⁴

Study Design

Evaluation for Disease Characteristics. On entering the study, demographics (age, gender, and occupation) and disease characteristics (diagnosis of asthma and/or allergic rhinitis, presence of atopy, and food allergy history) were evaluated.

Evaluation for Atopy and Food Allergy. Atopy was defined by a positive skin-prick test, which was performed by a standardized panel including *Dermatophagoides pteronyssinus*, *Dermatophagoides farinae*, grass, tree, weed pollens, cat, dog, cockroach, *Alternaria*, *Cladosporium*, and latex antigens (Stallergenes, Antony, France). Food allergy evaluation was made by skin-prick tests with a panel of foods (banana, peanut, hazelnut, potato, celery, strawberry, melon, peach, tomato, kiwi, and apple; Stallergenes), which are known to have cross-reactivity with latex antigen. A wheal diameter of 3 mm greater than negative control was considered positive.

The patients were classified as “atopic” if the skin tests were positive and “nonatopic” if there was no presentation of atopy with these allergen panels.

Selection of the OPs and Evaluation for OP Sensitivity. More than 20 types of OPs, which have been reported to lead allergenic sensitization in the literature, were considered to be tested in this study. This list was checked with the Biology Department of Ankara University to determine the most common ones in our country. Additionally, information on the sale rates was obtained from the flower shops in Ankara to make a panel of OPs that best represent the indoor exposure of our study population (Fig. 1).

Skin tests by “prick-to-prick” method with the fresh leaves of these OPs were performed on all patients. Briefly, a fresh plant leaf was pierced with a lancet, which was then immediately used to prick the skin of a patient. A wheal diameter of 3 mm greater than negative control was considered positive. All test results were evaluated comparatively with patient demographics and disease characteristics.

Environmental Exposure Evaluation. Patients were asked if they had any OPs at home and/or in the workplace. Photographs of the plants were shown to the patients with indoor OP exposure history and asked to mark the ones that they have in their homes or offices. Duration of exposure and localization of the OPs were also evaluated. Additionally, patients were asked if their symptoms were related to exposure to OPs such as handling or cleaning leaves.

The study was approved by the local ethics committee of Ankara University. Written informed consent was taken from all patients.

Statistics

The statistical analyses were performed by a computer software package (SPSS Version 11.0; SPSS, Inc., Chicago, IL). Descriptive statistics were expressed as mean $\pm$ SD and n (%). Categorical data were tested by χ^2 -test. Comparisons between the means of the groups were tested by independent t -test. Independent risk factors were determined by multivariate logistic regression analysis among the significant results of univariate analysis. All directional p values were two tailed and significance was assigned to values <0.05 .

RESULTS

The features of the study group are given in Table 1. Patients' mean age was 40.83 ± 12.81 years (range, 17–75 years). More than one-half of the study group ($n = 110$) owned any kind of OPs at home and/or work. The most common OPs were *Saintpaulia ionantha* (45%), *Dieffenbachia picta* “exotica” (34%), *S. wallisii* (32%), *F. benjamina* (31%), and *Schefflera actinophylla* (30%). The mean duration of OP exposure was 7.37 ± 5.06 years (range, 1–20 years). None of the patients reported respiratory or cutaneous symptoms due to OPs.

Skin tests with OPs were positive in 80 patients (47.1%). There was no significant difference between OP-sensitized and -nonsensitized patients in terms of gender, age, number of OPs, duration of OP exposure, and food allergy history. Skin test positivity rate for OPs was significantly high in atopic subjects and in patients with allergic rhinitis, food sensitivity, and indoor OP exposure. When we evaluated the independent risk factors for OP sensitization with multivariate



Figure 1. Skin-tested ornamental plants (OPs) in the study: (1) *Saintpaulia ionantha* (African violet); (2) *Areka* (Areca); (3) *Euphorbia pulcherrima* (poinsettia); (4) *Ficus benjamina* (weeping fig); (5) *Caletia* (Calathea); (6) *Monstera deliciosa* (Philodendron); (7) *Dieffenbachia picta* "exotica" (Dieffenbachia); (8) *Guzmania linguata* (scarlet star); (9) *Ficus elastic* (rubber plant); (10) *Croton* (Croton); (11) *Pelargonium* (Cranebill); (12) *Cyclamen persicum* (sow bread); (13) *Spathiphyllum wallisii* (white sails); (14) *Schefflera actinophylla* (umbrella plant); (15) *Yucca elephantipes* (stick yucca).

logistic regression analysis, atopy and food sensitivity seemed to increase the risk of OP sensitization by an odds ratio of 5.17 (95% CI, 2.19–12.20) and 3.47 (95% CI, 1.102–11.76) folds, respectively (Table 2). The type of sensitized inhalant or food allergen did not affect these results. According to detailed correlation analysis, the type of grass, tree, or weed pollen and latex of sensitizing allergen also did not reveal any difference.

Skin tests with OPs were positive for at least one type of OP in 59% of the patients who owned OPs. Among these patients, most sensitizing OPs were *Yucca elephantipes* (52.5%), *D. picta* "exotica" (50.8%), *Euphorbia pulcherrima* (47.5%), *S. wallisii* (39%), and *S. actinophylla* (37.3%), respectively. There was significant correlation between having *S. ionantha*, *Croton*, *Pelargonium*, *Y. elephantipes*, and positive skin test to these plants ($p < 0.05$).

When the patients who owned OPs were taken into consideration, atopic patients were the most sensitized to OPs when compared with nonatopic patients (47/63 [74.6%] versus 15/47 [31.9%]; $p < 0.001$). Skin tests with foods were positive in 24 patients (21.8%) of this group and 13 (11.8%) patients had a history of allergic reaction with foods. The food allergy history and the skin test result were consistent in only 3 patients.

Among the patients who had no OPs, skin test positivity with OPs was 30%. Most sensitizing OPs were *E. pulcherrima* (52.9%), *F. benjamina* (47.1%), *Y. elephantipes* (41.2%), and *D. picta* "exotica" (35.3%). In this group of patients, atopic subjects were more sensitized to OPs when compared with nonatopic subjects (11/22 [50%] versus 7/38 [18.4%]; $p = 0.01$). None of the patients had a history of food allergy. The healthy control subjects ($n = 20$) were similar to the patients in terms of age and occupation. When compared with the patient group, food allergy history and skin test results with foods were not significantly different in the control group, and the patient group were more atopic (82/150 [54.6%] versus 3/20 [15%]; $p = 0.001$) and more sensitized to OPs (76/150 [50.7%] versus 4/20 [20%]; $p = 0.01$) than the control group.

DISCUSSION

In this cross-sectional study, nearly one-half of the study group with asthma and allergic rhinitis were found to be sensitive to OPs. Sensitivity to OPs was significantly higher in atopic subjects and patients with allergic rhinitis, food allergy, and indoor OP exposure. Furthermore, atopy and food sensitivity were found as

Table 1 Features of the study group

	<i>n</i> (%)
Gender (female)	146 (85)
Profession	
Housewife	85 (50)
Working at any professional job	48 (28.2)
Others	27 (21.8)
Diagnosis	
Asthma	73 (42.9)
Allergic rhinitis	46 (27.1)
Asthma + allergic rhinitis	31 (18.2)
Healthy control group	20 (11.8)
Atopy rate	85 (50)
Sensitizing allergen (<i>n</i> = 85)	
Pollen	56 (65.9)
House-dust mite	10 (11.8)
Polysensitization with more than one allergen	13 (15.9)
Latex	3 (3.5)
other	3 (3.5)
OP location	
At home	99 (90.6)
At work	5 (4.5)
Both	6 (5.5)
OP type	
One plant	33 (30)
More than one plant	77 (70)
Food allergy history	13 (7.6)
Food sensitivity	27 (15.9)

OP = ornamental plant.

risk factors for developing sensitization to indoor plants.

Occupational rhinoconjunctivitis, asthma, contact dermatitis, and urticaria due to OP species is well documented.^{3,4,15–19} In a population-based study it is reported that 8% of the flower and/or OP growers working inside greenhouses had occupational asthma and 21% of the study population was sensitized to flower allergens in the workplace.¹ Exposure to pollen of OPs is thought to be much less common in the general population. However, sensitization to OPs *via* nonoccupational exposure has also been reported. Goldberg *et al.* reported that the incidence of positive skin-prick test responses to 11 species of OPs were 17–23% among the general public, and it was 52% among flower growers.² Similarly, we evaluated non-occupational sensitization and found that 47% of the study population were sensitized to at least one species of the OPs. This was a higher rate when compared with the previous studies.

It is well known that exposure to a potential allergen is important for sensitization to that allergen. The find-

ings of Goldberg's study emphasize the role of exposure to high amounts of allergen in the development of sensitization to OPs. Our study is unique regarding the evaluation of sensitization to OPs in exposed and non-exposed patients, although exposure to OPs was not an independent risk factor for indoor plant sensitization.

In our study a significant correlation between having any OP and positive skin tests to the same plant was found only for *S. ionantha*, *Croton*, *Pelargonium*, and *Y. elephantipes*. However, our results show that among the most frequently owned plants *Dieffenbachia*, *Spathiphyllum*, and *Schefflera* were also the OPs that caused high rates of sensitization. Although these findings do not explain the exact role of exposure on sensitization to OPs, we suggest taking this data into consideration while managing a patient with allergic rhinitis and/or asthma who has plants at home.

Previous studies indicated that sensitization to OPs was higher in atopic subjects than nonatopic subjects. Piirila *et al.* reported that skin test results for OPs were positive in 39% of the atopic patients versus 2% of the nonatopic subjects.⁵ In another study the incidence of positive skin-prick tests was found to be 52% in flower growers, and sensitivity rate reached 82% when only atopic subjects were evaluated.² Mahillon *et al.* reported that besides atopic subjects, patients with allergic rhinitis were found to be more sensitized to OPs than the nonatopic subjects.¹² Consistent with these data, subjects with allergic rhinitis and atopic patients had higher rates of sensitivity to OPs in our study.

Skin test positivity to OPs in nonatopic subjects has also been previously reported. Sensitization to OPs among nonatopic flower growers (8%) was attributed to a possible role of OPs as a primary sensitizing agents in a previous trial.² In our study, 22 (25.8%) of the nonatopic patients had skin test positivity to OPs. The role of OPs as primary sensitizing agents may be acceptable for patients with indoor OPs and have been explained by exposure. On the other hand, in nonexposed patients, several explanations can be suggested. First, the OPs might have caused a positive reaction because of a skin irritant effect. Several irritants such as calcium oxalate crystals, acrid oils, and saponins exist in plant sap.²⁰ To clarify this situation, we performed skin tests in healthy controls who were never exposed to OPs and the sensitization rate was found to be significantly higher in the patient group than in the controls (50% versus 20%). Despite the fact that the number of the control group was low in making strong comments, we believe irritant effect could not be the only explanation because of the significant difference between patients and the control group. Second, a cross-reactivity with an unknown or untested allergen/food may exist. Third, the patients may not be aware of a previous exposure to OPs as a recall bias.

Table 2 Results of OP-sensitized and -nonsensitized patients

	OP-Sensitized Patients n (%)	OP-Nonsensitized Patients n (%)	Univariate Analysis (p value)	Multivariate Analysis (p value)	Multivariate Analysis OR (95% CI)
Age (yr, minimum–maximum)	41.5 (17–75)	43.5 (17–70)	0.086	>0.05	
Gender					
Female	68 (46.6%)	78 (53.4%)	0.755	>0.05	
Male	12 (50%)	12 (50%)			
Diagnosis					
Asthma	26 (35.6%)	47 (64.4%)	<0.001	>0.05	
Allergic rhinitis	30 (65.2%)	16 (34.8%)			
Asthma + allergic rhinitis	20 (64.5%)	11 (35.5%)			
Healthy controls	4 (20%)	16 (80%)			
Atopy status					
Atopic	58 (68.2%)	27 (31.8%)	<0.001	<0.001	5.17
Nonatopic	22 (25.8%)	63 (74.2%)			(2.19–12.20)
Presence of OP					
Yes (patient group)	59 (59.0%)	41 (41.0%)	= 0.001	>0.05	
No (patient group)	17 (34.0%)	33 (66.0%)			
Yes (control group)	3 (30%)	7 (70%)			
No (control group)	1 (10%)	9 (90%)			
OP number					
1	18 (54.5%)	15 (45.5%)	0.801	>0.05	
>1	44 (57.1%)	33 (42.9%)			
Duration of OP exposure (yr)	5 (1–20)	10 (1–20)	0.137	>0.05	
Food allergy history					
Positive	8 (61.5%)	5 (38.5%)	0.276	>0.05	
Negative	72 (45.9%)	85 (54.1%)			
Food sensitivity					
Positive	22 (81.5%)	5 (18.5%)	0 < 001	0.046	3.47
Negative	58 (40.6%)	85 (59.4%)			(1.02–11.76)

OP = ornamental plant; OR = odds ratio.

There is accumulating evidence for sensitization to *F. benjamina* in moderately exposed subjects. Studies, to date, found sensitivity rates between 2.5 and 12%.^{21–23} The rate of positive skin-prick tests to *Ficus* was 15% in our study group regardless of the presence of the plant at home; our result is in accordance with the findings of Piirila *et al.* reporting a sensitivity rate of 21% in their study. Apart from differences in exposure, the material used for prick tests could lead to the discrepancy between trials because some investigators used crude extracts possibly with different protein content.

In our study we also investigated a possible relation between sensitivity to OPs and latex, food, and pollen allergy. Sensitization to certain inhalant allergens may be associated with secondary food hypersensitivity due to the occurrence of cross-reactive allergens in some foods. Pollens are the most common elicitors of secondary food allergies, but mite and latex allergies may be associated as well as with particular food hy-

persensitivities. Hemmer *et al.*²¹ described a *Ficus* fruit syndrome, which they reported to have its origin in primary respiratory sensitization to *F. benjamina* and succeeding cross-sensitization to fruits such as fig, kiwi, banana, and papaya. We skin tested the study group with suggested cross-reacting foods as well as latex and pollens in this study. Thirteen patients who had food allergy history and positive skin tests with foods had exposure to OPs. The findings of these patients with sensitivity to OPs and certain fruits suggest the necessity of future research in the immunologic cross-reactivity between fruits and different species of OPs other than *F. benjamina*.

Our study is one of the limited studies investigating sensitization rates of various species of OPs in a population with rhinitis and asthma. We found atopy and food sensitivity as risk factors for the development of sensitivity to OPs. Second, sensitization to OPs was higher in patients with allergic rhinitis and in patients

who had indoor exposure to OPs than in patients without exposure. We conclude that sensitivity to OPs should be evaluated in patients with respiratory allergic diseases who describe indoor exposure. We are not certain about the relation between sensitization and clinical implications of this sensitization because our study group had no respiratory or other symptoms that can be related to OPs. Additional studies on patients who experience an aggravation of airway allergic symptoms are needed to clarify this relationship and discover whether allergen avoidance in patients sensitized to OPs plays a role in clinical improvement.

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