
Cross-allergenicity of pollens from the Compositae family: *Artemisia vulgaris*, *Dendranthema grandiflorum*, and *Taraxacum officinale*

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Background: Chrysanthemum, dandelion, and mugwort belong to the Compositae (Asteraceae) family. Their cross-allergenicity has not yet been completely evaluated.

Objective: To investigate the sensitization and cross-allergenicity of these 3 plants.

Methods: We reviewed 6,497 respiratory allergic patients who underwent skin prick tests (SPTs) during the last 10 years (1995–2005) and analyzed the sensitization rates of the 3 pollens. We sorted this population by wheal size and selected the monosensitized or cosensitized patients. Their serum samples were used to evaluate specific IgE (sIgE) and cross-allergenicity of the 3 pollens by CAP, immunoblotting, and inhibition enzyme-linked immunosorbent assay (ELISA).

Results: On SPTs, mugwort, chrysanthemum, and dandelion sensitized 13.4%, 10.0%, and 8.5% of the enrolled population, respectively, and 5.2% of the population was cosensitized to all 3 pollens. Some patients were monosensitized to 1 species (1.5% to chrysanthemum, 1.4% to dandelion, and 4.5% to mugwort). In inhibition ELISA that used a pooled serum sample cosensitized to all 3 pollens, mugwort inhibited sIgE bindings to chrysanthemum, dandelion, and mugwort up to 95%, 86%, and 96%, respectively. The 50% inhibitory allergen concentrations for sIgE to each of the 3 species were not different between solid-phase antigen and mugwort. The mugwort sIgE of this pooled serum was suppressed up to 74% and 27% by chrysanthemum and dandelion, respectively. The 50% inhibitory allergen concentrations of chrysanthemum and dandelion for mugwort sIgE were 0.3 and 57.0 $\mu\text{g/mL}$, respectively, whereas that of mugwort was 0.05 $\mu\text{g/mL}$. We found a patient who was truly monosensitized to dandelion.

Conclusion: Chrysanthemum and dandelion were frequently cosensitized with mugwort in the general population with respiratory allergic diseases. These 2 species also showed extensive cross-allergenicity with mugwort. True monosensitization to these 2 species was possible.

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INTRODUCTION

Weed pollens, the major cause of pollinosis in autumn, are found in the atmosphere of Seoul, Korea, from the beginning of August and increase up to a maximum concentration in September or October.^{1–3} Among the weed pollens, the most common sensitizer was mugwort, followed by ragweed and Japanese hop (*Humulus japonicus*).^{2,3} Mugwort (*Artemisia vulgaris*) is a wind-pollinated, perennial weed that belongs to the Compositae (Asteraceae) family.^{3,4} Asteraceae or Compositae (Aster family) consists of 1,535 genera and 23,000 species.^{4,5} In Korea, wild plants of the Compositae family

number approximately 77 genera and 390 species, including denizens.^{6,7}

Chrysanthemum and dandelion also belong to the Compositae family (Fig 1).^{4,5} Insect-pollinated plants, such as chrysanthemum and dandelion, have fewer chances to be inhalant allergens compared with wind-pollinated plants such as mugwort.^{1,8–11} However, many reports have indicated that chrysanthemum pollens induce contact dermatitis.^{12–15} In Europe, the prevalence of Compositae contact allergy has been estimated as 0.7% to 1.4% in the general population and 4.5% to 14% among occupationally exposed persons.¹⁵ Chrysanthemum is considered to be a major sensitizer among cultivated Compositae plants in Europe (60%).¹⁵ Several studies observed occupational asthma or rhinitis among florists who handle chrysanthemums,^{16–19} and a small number of experimental studies supported chrysanthemum sensitization.^{20,21} Clinicians have used not only mugwort but also chrysanthemum or dandelion for skin prick tests (SPTs) and allergen-specific immunotherapy for respiratory allergies. Interestingly, 1 report mentioned a close relationship between

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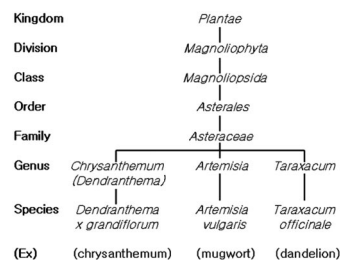


Figure 1. Plant taxonomic classification of the Compositae family: chrysanthemum (*Dendranthema x grandiflorum*, Puma variety), *Taraxacum officinale*, and *Artemisia vulgaris*.

allergens of chrysanthemum and mugwort in 8 cases of pollinosis in chrysanthemum growers.¹⁶

Unlike mugwort, the exact sensitization rate to chrysanthemum and dandelion in Korea is unknown. Although some efforts have been made to identify the constitution of pollen allergens from chrysanthemum,^{22–25} the analysis of allergen sequences and structures remains incomplete. Thus, little direct evidence exists for using chrysanthemum or dandelion pollens in clinical tests or immunotherapy. Because their cross-allergenicity has not yet been completely evaluated, clinicians have had difficulty in the selection of proper pollen allergens for diagnosis and treatment. We investigated the sensitization rate in the general population with respiratory allergic diseases and the cross-allergenicity of the pollens from these 3 Compositae plants.

METHODS

Patients

We evaluated 6,497 respiratory allergy patients (48.7% male and 52.3% female; mean $\pm$ SD age, 38.2 ± 15.3 years) who underwent SPTs at the Severance Hospital Allergy-Asthma Clinic during the last 10 years (1995–2005). This population mainly had bronchial asthma (40.8%), allergic rhinitis (26%), or both (9.2%). The SPTs were performed with commercially available allergen extracts (Prick-Test Solutions; Allergopharma, Reinbek, Germany). Histamine dihydrochloride (1.7 mg/mL) and physiologic saline served as controls (Prick-Test Solution No. 902 and 901; Allergopharma). All SPTs were

performed on the back by fully trained and experienced personnel. Wheal sizes were measured as the mean of the 2 extreme diameters 15 to 20 minutes after the prick. Reactions were considered positive if the wheal was larger than the negative control by 3 mm or more.²⁶ On the basis of this analysis, the sensitization rates of the 3 Compositae family pollens were estimated.

We also sorted all of the 6,497 patients by the order of mean wheal size to mugwort, chrysanthemum, and dandelion. From these sorted patients, we selected 8 patients who were sensitized and showed the largest wheal to mugwort, dandelion, and chrysanthemum pollens. Their serum samples were used for analysis of cross-allergenicity of Compositae family pollens. Demographic features, SPT results, and specific IgE (sIgE) CAP test results are given in Table 1. In the same manner, another 6, 11, and 9 allergic patients who were exclusively sensitized to mugwort, chrysanthemum, or dandelion, respectively, were also recruited for analysis of cross-allergenicity (Table 2). The sIgE for the 3 allergens was measured by UniCAP 100 (Pharmacia Diagnostics AB, Uppsala, Sweden). This study was approved by the institutional review board of the Yonsei University College of Medicine. All patients and control subjects provided oral or written informed consent.

Pollens of 3 Compositae family plants: chrysanthemum (*Dendranthema x grandiflorum*), *Taraxacum officinale*, and *Artemisia vulgaris*

Chrysanthemum pollen was obtained from 20 bunches of white or yellow chrysanthemums (*Dendranthema x grandiflorum*: spray chrysanthemum, Puma variety). Those flowers were picked from March to May and in full bloom at delivery. On the 15th to the 20th day after delivery, we shook the pollen out onto Petri dishes. Then we made a 1:10 (wt/vol) suspension with phosphate-buffered saline (PBS; pH 7.4). This suspension was incubated and shaken in a cold room for 3 days and then dialyzed for 3 days with a Spectra/Por membrane (molecular weight cutoff, 3,500). After dialysis, we quantified the protein content of chrysanthemum, dandelion, and mugwort pollen extracts with the Bradford method. Extracts of dandelion (*T. officinale*, lot 3000 to 6849#143)) and mugwort (*A. vulgaris*, lot 30009982#106) were provided

Table 1. Demographics of Patients Cosensitized to All 3 Compositae Family Pollen Allergens

Patient No./ sex/age, y	Diagnosis	Skin prick test result, mean wheal size, mm			Specific IgE, kIU/L		
		Mugwort	Chrysanthemum	Dandelion	Mugwort	Chrysanthemum	Dandelion
A1/M/31	ARC, BA	15	21	5	93.4	85.4	42.3
A2/M/42	ARC	17	15	10	14.6	9.4	5.2
A3/M/19	AR, AD	15	7	11	26.8	14.0	17.5
A4/F/32	AR	6	14	13	9.6	5.9	5.2
A5/F/21	AR, AD	11	14	14	2.3	1.1	1.5
A6/F/66	AR	12	16	10	5.8	4.1	2.8
A7/M/21	AR	13	6	12	3.9	2.7	2.1
A8/F/59	AR	5	4	5	1.4	0.9	0.9

Abbreviations: ARC, allergic rhinoconjunctivitis; BA, bronchial asthma; AR, allergic rhinitis; AD, atopic dermatitis.

Table 2. Demographics of Patients Exclusively Sensitized to Mugwort (Patients M1-M6), Chrysanthemum (Patients C1-C11), or Dandelion (Patients D1-D9) on Skin Prick Tests

Patient No./ sex/age, y	Diagnosis	Skin prick test results, mean wheal size, mm			Specific IgE, kIU/L		
		Mugwort	Chrysanthemum	Dandelion	Mugwort	Chrysanthemum	Dandelion
M1/F/41	AR	8	0	0	3.93	2.47	0.79
M2/F/34	BA	9	0	0	2.87	2.47	1.23
M3/M/42	BA	8	0	0	3.12	3.24	1.50
M4/M/22	AR	10	0	0	0.65	0.58	0.39
M5/M/41	AR	6	0	0	<0.35	<0.35	<0.35
M6/F/28	BA	12	0	0	0.70	<0.35	<0.35
C1/F/42	AR	0	11	0	<0.35	0.52	0.38
C2/M/21	BA	0	5	0	<0.35	<0.35	<0.35
C3/M/63	BA	0	4	0	1.40	1.40	1.60
C4/M/34	BA	0	4	0	<0.35	<0.35	<0.35
C5/M/42	AR, urticaria	0	4	0	<0.35	<0.35	<0.35
C6/M/30	EB	0	4	0	0.50	0.47	<0.35
C7/M/45	EB, CS	0	4	0	<0.35	<0.35	<0.35
C8/F/23	BA	0	4	0	<0.35	<0.35	<0.35
C9/F/24	BA	0	4	0	<0.35	<0.35	<0.35
C10/M/34	BA	0	4	0	0.69	0.65	0.57
C11/M/30	AR	0	4	0	0.37	<0.35	0.41
D1/M/36	BA	0	0	6	<0.35	<0.35	<0.35
D2/F/47	AR	0	0	4	<0.35	<0.35	<0.35
D3/M/30	AR, urticaria	0	0	5	<0.35	<0.35	<0.35
D4/F/28	AR, urticaria, dermographism	0	0	4	0.63	0.68	<0.35
D5/M/41	AR	0	0	4	0.37	0.41	0.41
D6/F/35	AR	0	0	4	<0.35	<0.35	1.78
D7/F/49	BA	0	0	4	0.46	0.42	<0.35
D8/M/39	BA	0	0	4	<0.35	<0.35	<0.35
D9/F/55	AR, urticaria	0	0	4	<0.35	<0.35	<0.35

Abbreviations: BA, bronchial asthma; AR, allergic rhinitis; EB, eosinophilic bronchitis; CS, chronic sinusitis.

by Allergopharma. Remnant chrysanthemum pollen was lyophilized for further studies.

SDS-PAGE of chrysanthemum, dandelion, and mugwort pollen allergens

We performed sodium dodecyl sulfate–polyacrylamide gel electrophoresis (SDS-PAGE) according to Laemmli's protocol.²⁷ Before SDS-PAGE, molecular weight markers (Benchmark Prestained Protein Ladder; Invitrogen Corporation, Carlsbad, California) and allergen samples were mixed with SDS sample buffer and boiled for 5 minutes at 100°C. After electrophoresis, the gel was stained with Coomassie brilliant blue (0.1% Coomassie brilliant blue R 250, 10% glacial acetic acid, 45% methanol) and destained with 10% glacial acetic acid and 45% methanol.

Immunoblotting for chrysanthemum, dandelion, and mugwort pollen allergen sIgE

We performed SDS-PAGE for each of the 3 pollen allergens according to the preceding method. Then gels were transferred to nitrocellulose membranes (Hybond-C Extra, 8 × 8 cm; Amersham Biosciences, Buckinghamshire, England) with transfer buffer (2 L of distilled water, 5.8 g of Tris, 29 g of glycine, and 200 mL of methanol) at room temperature and

200 V for 2 hours. After transfer, protein bands were confirmed by Ponceau S staining. Then the membrane was cut into several strips and blocked in 2 mL per lane of 5% skimmed milk (diluted by phosphate buffered saline with 0.1% Tween 20 [PBST] solution) for 1 hour. Strips were incubated overnight with 6-fold diluted (by volume) patient serum samples then washed 3 times with 2 mL per lane of PBST solution. The sIgE levels were detected by alkaline phosphatase–conjugated goat anti-human IgE antibodies (A3525; Sigma, St Louis, Missouri) diluted to 1:1,000. After 2 washes in PBST, 1.5 mL per lane of a buffer of 1M Tris, 1M sodium chloride, 1M magnesium chloride, and distilled water was applied to each lane for 5 minutes and discarded. Finally, color reactions were developed with NBT/BCIP (S380C 14968004 and S381C 17814602; Promega, Madison, Wisconsin) in this buffer and incubated with agitation at room temperature. The color reaction was stopped with distilled water.

Inhibition ELISA evaluation of cross-allergenicity among pollens from 3 Compositae family plants

Cross-allergenicity of pollen from 3 Compositae family plants (chrysanthemum, dandelion, and mugwort) was inves-

tigated using inhibition enzyme-linked immunosorbent assay (ELISA) and the following procedures. Allergens were diluted to 10 µg/mL in 0.1M carbonate buffer, and 50 µL per well was distributed into 96-well plates (Costar, Cambridge, Massachusetts) and incubated for 18 hours at 4°C. Plates were then blocked for 1 hour with 200 µL per well of 1% bovine serum albumin, 137-mmol/L sodium chloride, 1.8-mmol/L KH₂PO₄, 10-mmol/L Na₂HPO₄, 27-mmol/L potassium chloride, and 0.1% Tween 20 (pH 7.4).

Pooled serum samples of patients sensitized to all 3 Compositae family pollen allergens (n = 6) or exclusively to chrysanthemum or dandelion (n = 9 each) were made and diluted 1:4 in 1% bovine serum albumin (AMRESCO, Solon, Ohio) and PBST. Each of the 3 Compositae family pollen allergen extracts (20-µg/mL concentration) was diluted 4-fold serially so that the inhibitory concentrations of these extracts ranged from 20 to 0.02 µg/mL. The serially diluted allergen extracts were mixed with the pooled serum samples and incubated for 12 hours at 4°C.

The serially inhibited serum-allergen mixtures were added to allergen-coated plates (50 µL per well) and incubated for 1 hour at room temperature. Plates were washed 3 times with PBST (150 µL per well) and incubated with 1:1,000 (vol/vol) diluted biotinylated goat anti-human IgE (Vector, Torrance, California) for 30 minutes. After another 3 washes with PBST, plates were incubated with streptavidin-peroxidase (1:1,000 [vol/vol]; Sigma) for 30 minutes, washed 5 times with PBST, and developed with 3,3',5,5'-tetramethyl-benzidine(B)-peroxidase (KPL, Gaithersburg, Maryland) and

100 µL per well of hydrogen peroxide for 5 minutes at room temperature. The reaction was stopped with 1% sulfuric acid. Optical densities at 450 nm were measured by a microplate reader (Dynatec Lab, Alexandria, Virginia).

RESULTS

Sensitization rates to 3 Compositae family allergens on SPTs

Of the 6,497 allergic patients who underwent SPTs, 17.0% showed positive responses to at least 1 of the 3 allergens. Mugwort, chrysanthemum, and dandelion sensitization rates were 13.4%, 10.0%, and 8.5%, respectively. A total of 5.2% of the patients demonstrated positive reactions to all 3 pollen allergens, whereas some responded exclusively to a single allergen (1.5% to chrysanthemum, 1.4% to dandelion, and 4.5% to mugwort; Fig 2).

SDS-PAGE and sIgE immunoblotting of chrysanthemum, dandelion, and mugwort pollen allergens

Proteins of chrysanthemum, mugwort, and dandelion pollens were separated by SDS-PAGE, and sIgE immunoblots were made using serum samples sensitized to all or only 1 of the 3 pollens. Individual patterns of sIgE binding were different for each Compositae family pollen (Fig 3). Of the 6 serum samples sensitized to all 3 Compositae pollens, 3 (patients A1, A2, and A3; Table 1) showed relatively strong sIgE binding to each pollen (patients A1, A2, and A3; Fig 3). In addition, their sIgE bindings to mugwort, chrysanthemum, and dandelion tended to be strong at approximately 20 to 25 kD (patients A1, A2, and A3; Fig 3). In 1 serum sample,

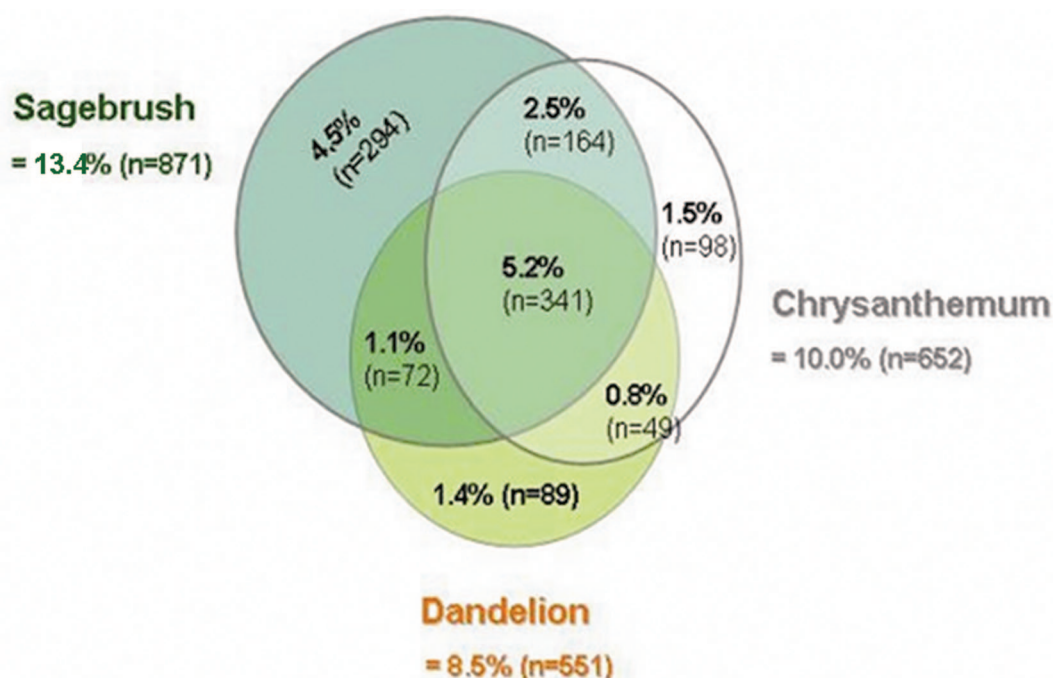


Figure 2. Proportion of positive responders to mugwort (sagebrush), chrysanthemum, and dandelion in 6,497 respiratory allergic patients who underwent skin prick tests.

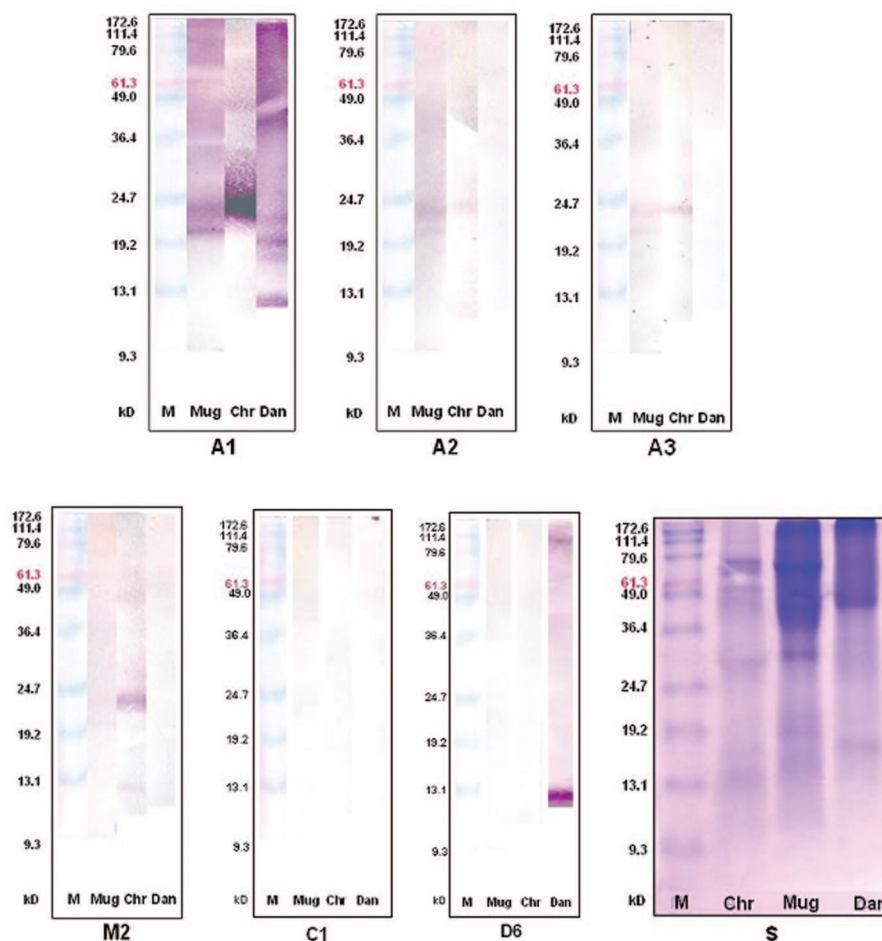


Figure 3. Binding patterns of specific IgE to pollen allergens from 3 Compositae family members by immunoblotting with serum cosensitized to all 3 pollens (A1, A2, A3) or with serum exclusively sensitized to mugwort (M2), chrysanthemum (C1), or dandelion (D6). Sodium dodecyl sulfate–polyacrylamide gel electrophoresis features of 3 pollens are also shown (S). M indicates marker; Mug, mugwort; Chr, chrysanthemum; and Dan, dandelion.

mugwort sIgE binding was also prominent at 36 to 62 kD and 70 to 173 kD (patient A1; Fig 3). Dandelion sIgE bound near 13 kD in 1 case (patient D6; Fig 3). The 6 patients exclusively sensitized to mugwort on SPTs were frequently cosensitized with the other 2 species in the CAP test (Table 2). Among them, only 1 case demonstrated enhanced sIgE binding to mugwort and chrysanthemum at approximately 22 to 23 kD (patient M2; Fig 3). The SPT results were poorly consistent with the CAP test results in the 11 and 9 patients exclusively sensitized to chrysanthemum or dandelion, respectively (Table 2). The serum of a patient exclusively sensitized to chrysanthemum on SPTs failed to show any sIgE binding (patient C1; Fig 3). Another serum sample sensitized to only dandelion on SPTs and CAP tests demonstrated prominent sIgE binding at approximately 13 and 110 kD (patient D6; Fig 3).

Inhibition ELISA evaluation of cross-allergenicity among pollens from 3 Compositae family plants

In inhibition ELISA that used a pooled serum ($n = 6$) sensitized to all 3 allergens, mugwort inhibited the bindings of sIgE to

chrysanthemum, dandelion, and mugwort up to 95%, 86%, and 96%, respectively (Fig 4A through C). No difference was found in the 50% inhibitory allergen concentrations for chrysanthemum, dandelion, and mugwort sIgE between solid-phase antigen and mugwort. However, the mugwort sIgE level was only suppressed up to 74% and 27% by chrysanthemum and dandelion, respectively. The 50% inhibitory allergen concentrations of chrysanthemum and dandelion for inhibition of mugwort sIgE were 0.3 and 57.0 $\mu\text{g/mL}$, respectively, whereas that of mugwort was 0.05 $\mu\text{g/mL}$. However, mugwort failed to inhibit dandelion sIgE in the serum from 1 patient who was exclusively sensitized to dandelion on both the SPT and CAP tests (patient D6; Table 2 and Fig 4D).

DISCUSSION

Coincidental positive skin responses to 3 Compositae family plants (mugwort, chrysanthemum, and dandelion) have been relatively common in clinical situations.^{16,17,28} Since chrysanthemums and dandelions are commercially available and are widely

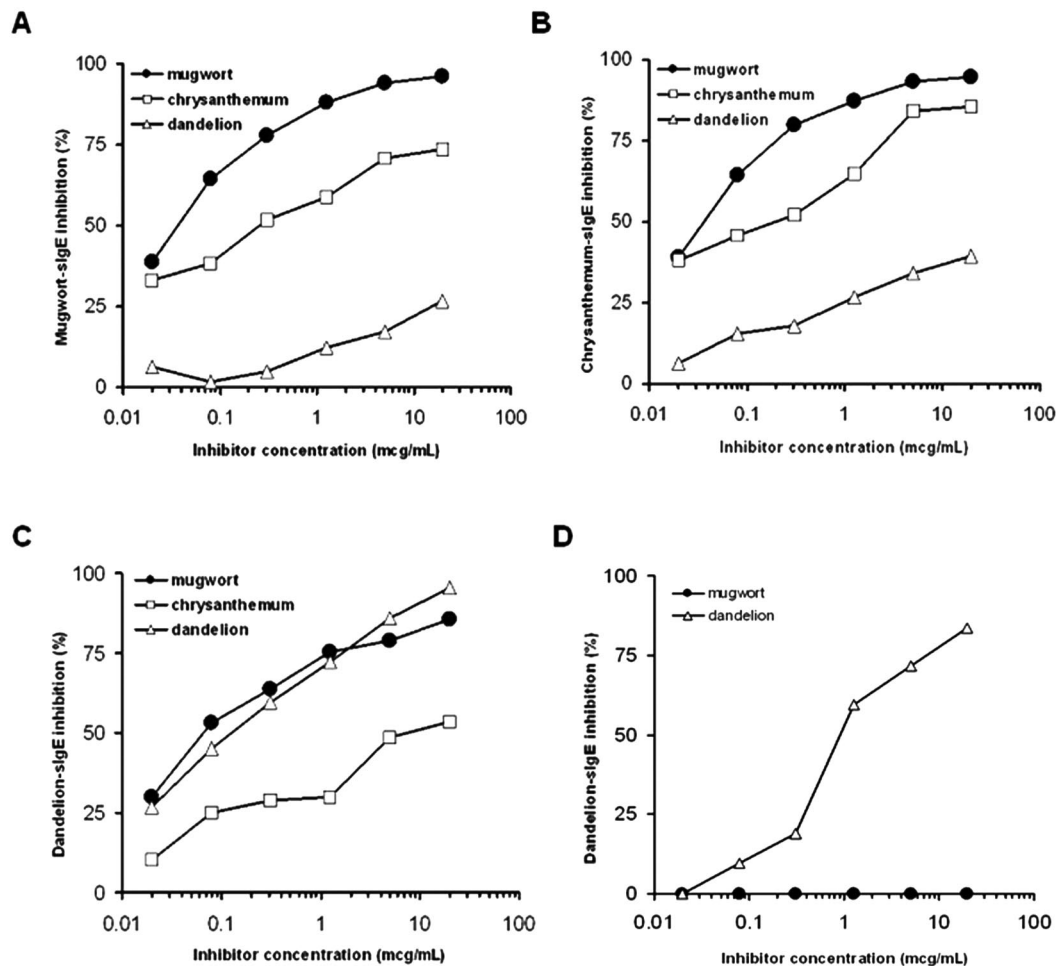


Figure 4. Enzyme-linked immunosorbent assay inhibition by 3 pollens (chrysanthemum, dandelion, and mugwort) using pooled serum sensitized to all 3 pollens (A, B, C) or serum exclusively sensitized to dandelion (D). Solid-phase allergens were mugwort (A), chrysanthemum (B), and dandelion (C, D).

grown flowers, allergies to them have been reported to be associated with the florist occupation.^{12-20,29,30} Even though most of the reports described contact allergy and dermatitis as main symptoms,^{13-17,28,31} de Jong et al¹⁷ described 14 patients with various symptoms associated with handling flowers. According to Groenewoud et al,¹⁹ 20.2% of 104 greenhouse workers were sensitized to 1 or more of 7 species in the Chrysanthemum family. Their main symptoms were rhinitis or conjunctivitis.¹⁹ Several studies had reported frequent cross-sensitization between chrysanthemum and mugwort,^{16-18,28} but their cross-allergenicity has never been fully investigated.

We postulated that the frequent concordance of sensitivity to mugwort, chrysanthemum, and dandelion on SPT results from the general (not confined to horticultural professions) population with respiratory allergic diseases might be associated with cross-allergenicity. According to our statistical analysis, during the last 10 years, the concordant sensitization rate was 5.2% (Fig 2). Mugwort, chrysanthemum, and dandelion sensitized 13.4%, 10.0%, and 8.5% of the total population ($n = 6,497$), respec-

tively. We found that cosensitization to all 3 Compositae pollens was frequent and that the mugwort sensitization rate was higher than the others. However, some patients were sensitized to only 1 pollen species (4.5% for mugwort, 1.5% for chrysanthemum, and 1.4% for dandelion) on the SPTs. These results were poorly consistent with CAP test results (Table 2). Although skin tests reflect clinically relevant sensitization to a higher degree than in vitro findings,¹ we are uncertain whether positive skin responses to chrysanthemum or dandelion are due to real sensitization or false-positive reaction in such patients. Furthermore, SPTs showed only borderline positive responses and CAP tests demonstrated frequent mugwort cosensitization in them. Such frequent cosensitization to mugwort might be caused by cross-allergenicity among these 3 species. These results also suggest that false-negative responses to mugwort are possible in SPTs, and mugwort might be useful in screening tests to detect Compositae pollen sensitizations. In one study, homemade flower extracts were used to confirm IgE-mediated flower allergy, and mugwort was suggested to be used for the screening test.¹⁷

In the pooled serum from patients cosensitized to all 3 species, sIgE to chrysanthemum, dandelion, and mugwort was markedly inhibited by the mugwort extract (Fig 4A through C). However, mugwort sIgE was only partially suppressed by chrysanthemum or dandelion. These results confirm that chrysanthemum and dandelion pollens have extensive cross-allergenicity with mugwort in such patients. However, we also observed that mugwort failed to inhibit dandelion sIgE from the serum of a patient monosensitized to dandelion on the SPT, CAP test, and Western blotting (patient D6; Table 2, Fig 3, and Fig 4D). This serum showed peculiar dandelion sIgE binding at approximately 13 kD. Dandelion sIgE binding similar to this was also observed in 1 patient cosensitized to all 3 species (patient A1; Fig 3).

Until now, 6 of the mugwort (*A vulgaris*) allergens have been identified: Art v 1 (28 kD, major allergen), Art v 2 (20 kD, 35 nonred), Art v 3 (12 kD, lipid transfer protein), Art v 4 (14 kD, profilin), Art v 5 (10 kD, polcalcin), and Art v 6 (44 kD, pectate lyase, Amb a 1 homolog).^{32–44} However, chrysanthemum and dandelion allergens have not yet been identified. In SDS-PAGE results (Fig 3), our mugwort pollen extract had protein bands similar in molecular weight to those mentioned. Chrysanthemum and dandelion showed several protein fractions similar in molecular weight to Art v 1, Art v 4, or Art v 6. In immunoblotting, serum samples from 3 patients cosensitized with all 3 species showed similar sIgE bindings to both mugwort and chrysanthemum at approximately 20 to 25 kD (patients A1, A2, and A3; Fig 3).

Some previous reports have indicated that mugwort has cross-allergenicity with other species because of common lipid transfer protein allergens such as Art v 3.^{29–31,42–46} Restricted cross-reactions could be attributed to the defensin-like Art v 1 family from mugwort.³⁹ Extensive cross-reactivity within weeds and among other allergenic plants is likely caused by 3 families of widely distributed pan-allergens: profilins, polcalcins, and lipid transfer proteins.³⁸ For example, ragweed and mugwort pollen contain the pan-allergen profilin and calcium-binding proteins, which are responsible for cross-reactivity among pollen-sensitized patients.³⁸ Some studies related to Compositae dermatitis suggest that sesquiterpene lactones are the main sensitizers of the Compositae family and that thiophenes or benzofuran derivatives possessed not only phototoxic activity but also some sensitizing properties.^{15,31} These results may provide us with clues on how to find the causative and proper allergens for the diagnosis and treatment of Compositae family pollinosis.

In conclusion, we found frequent cosensitization to mugwort, chrysanthemum, and dandelion, all belonging to the Compositae family, and a higher mugwort sensitization rate than the others among the general (not confined to horticultural workers) population with respiratory allergic diseases. In respiratory allergic patients cosensitized to all of these species, we observed that mugwort allergens were extensively cross-reactive to chrysanthemum and dandelion pollen allergens. These results suggest that mugwort sensitization might be more important than the

other 2 species in such group. True monosensitization to chrysanthemum or dandelion was possible.

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