Evaluation on removal performance of air cleaning devices against airborne allergen particles using an optical particle counter and ELISA method

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In this study, we evaluated the aerodynamic characteristics of airborne allergen particles both with and without air-cleaning devices, i.e., a dehumidifier and an air conditioner, using artificially created allergen powders that contained the proteins Del p 1 and Fel d 1 which are believed to play important roles in the etiology of asthma by dogs and cats. Figure 1 shows the experimental set-up for this sutudy. Measurements were taken using a real-time optical particle counter and a closed chamber (4 x 3 x 2.5 m^3). The CADR (Clean Air Delivery Rate) was measured both with and without operating air-cleaning devices for a variety of particle sizes. Time- and size-dependent particle-removal performance was evaluated using an optical particle counter, and the results were compared with measurements taken using the ELISA (two-site enzyme-linked immunosorbent assay) method, which is commonly used for allergen measurements but can not analyze the real-time size-dependent aerodynamic properties of the removal devices.

Figure 2 shows the CADRs with and without an operating dehumidifier and air conditioner. The CADRs, which are a universal air-cleaning performance metric, were linearly proportional to particle size, and the removal of airborne allergen particles was significantly enhanced, by 4 and 7 times on average, by the operation of a dehumidifier and an air-conditioner, respectively.

Shown in Figure 3, the removal efficiency of the air conditioner obtained by ELISA and the optical particle counter based on particle number in the peak size and on total volume were 1.06, 1.14, and 1.05 times higher than comparable values for the dehumidifier. Also, the difference between the removal efficiencies of the air-cleaning devices for allergen particles calculated from total mass measured by ELISA and from total volume measured by an optical particle counter were 0.32% for the dehumidifier and 5.97% for the air conditioner.

These results indicate that our simple measurement method, which used an in-situ optical particle counter, could easily predict values of air-cleaning performance against airborne allergens that were obtained by the time-consuming ELISA method. Also, the performance of the test for air-cleaning devices using these in-situ measurements is more realistic because airborne allergen particles cause allergic diseases via respiratory organs, such as the nose. This method is a promising tool for measuring air-cleaning performance for airborne allergen particles in indoor environments.

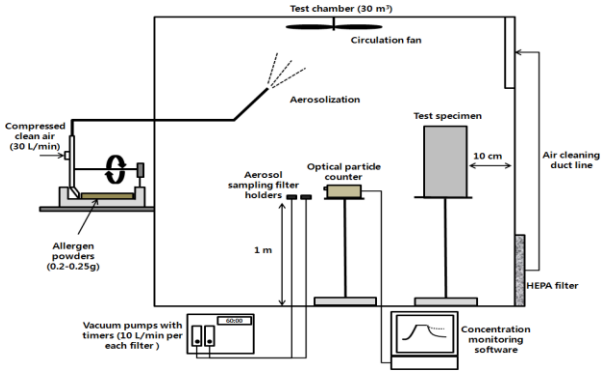

Figure 1. Experimental set-up for this study.

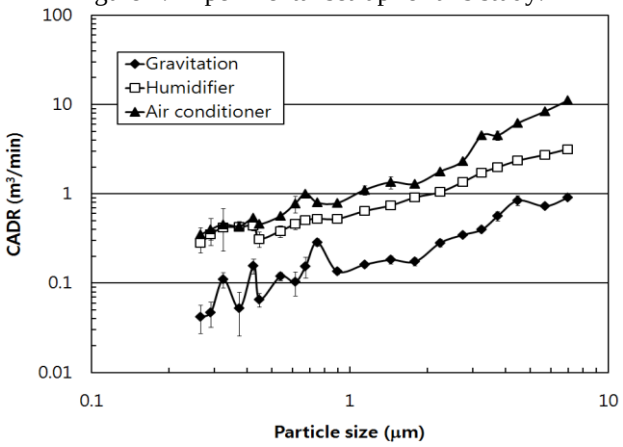

Figure 2. CADRs with and without an operating dehumidifier and air conditioner

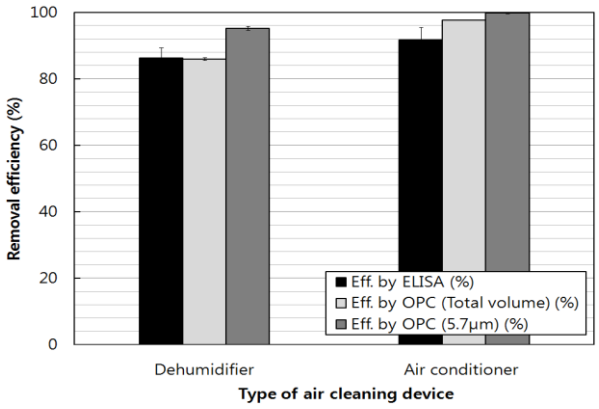

Figure 3. Comparison of the removal efficiencies of the dehumidifier and air conditioner calculated using mass by the ELISA, numeric concentration of 5.7-μm particles, and the total volumetric concentration by an optical particle counter.

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