Effect of Air Flow Rates in Versatrap Slit Impactor Cassettes on the Collection of Atmospheric Mold Spores in a Rural Community

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INTRODUCTION

• Change in air flow rates in an impactor change the sampling efficiency for airborne fungal spores of different size range, according to the theory of aerosol particle impaction. To our knowledge, the degree of this change is unknown for the allergenic mold spores present in an ambient environment.

• This information is important for exposure assessment of mold allergens including mold spores and hyphal fragments, which are associated with allergic sensitization and atopic asthma in a community.

• This information is particularly important for spores of smaller aerodynamic size (<10 µm) because such spores penetrate and settle in the lower airways of humans and release damaging byproducts (such as, allergens, glucans, mycotoxins, and other immunomodulators).

• Usually, mold spores in ambient atmosphere are collected by impactors in air monitoring stations. In most cases these impactors are operated in a single standard air flow rate and thus may underestimate some spore levels.

• Furthermore, spore aerodynamic sizes may vary in different temperature and humidity levels of ambient air leading to variations in impactor’s sampling efficiency. Thus, an evaluation of this change in real outdoor environment warrants thorough investigations.

PURPOSE

• This study primarily aimed at testing the degree of differences in sampling efficiency of an impactor for airborne fungal spores at different air sampling flow rates. This comparison would allow obtaining a better estimate of ambient airborne fungal flora, particularly for the airborne spores relevant to respiratory allergy and atopic asthma in a rural community.

• The second aim addressed the question: does the spore count for airborne fungal flora obtained based on impaction based sampling method in outdoor environment differ at different temperatures and humidity levels?

METHODS

• Sampling and data collection: We collected atmospheric molds spores simultaneously at three different air flow rates of 5 liter, 10 liter, and 15 liter per minute.

• These samples were collected from four ambient rural locations in Statesboro, Georgia, at different days with different climatic conditions.

• Spores were collected by the VersaTrap® spore trap cassettes, which provide the sampling versatility to capture mold spores of wide size range from 1.5 to 3.9 µm.

• The narrow slit inlet of the VersaTrap® focuses particles toward the clear glass slide coated with a sticky substrate.

• We collected air sample using three pumps - AirchekXR 5000, OMNI 400 and OMNI 480 - with air flow rates of 5 liters/minute, 10 liters/minute and 15 liters/minute, respectively. Samples were collected for one hour by each pump during the morning, noon and early evening (just before sunset) time of the day at four different locations.

• All pumps were calibrated before sampling by using a DryCal defender calibrator.

• Temperature, relative humidity, wind directions were measured at the start of sampling and at the end of sampling each time of the day.

• Analytical Methods: All the VersaTrap® spore trap cassettes were opened and sticky collection media of the samplers were placed on glass slides.

• These slides were then stained with lactophenol and cotton blue and examined observed under a high resolution light microscope at 400X and 1000X magnifications.

• Spores were identified using identification manuals and reference slides.

• Data were collected and entered in the excel sheet for analysis purposes.

• Raw spore counts were converted into diurnal volumetric concentrations (spores per cubic meter of air) based on air flow rate and the time of the sampling (morning, noon, evening).

RESULTS

Figure 1. Total concentration of spores in four sampling locations collected at different air sampling flow rates.

Figure 2. Total concentration of spores in four sampling locations collected at different times of the day.

Figure 3. The relationship between total concentrations of spores and average humidity levels in all sampling locations.

Figure 4. The relationship between total concentrations of spores and average temperature levels in all sampling locations.

INTERPRETATIONS AND CONCLUSIONS

• As hypothesized, we found (Figure 1) a substantial difference between spore concentrations collected at different air flow rates: 1,306 ± 960, 1,709 ± 1,430, 1,081 ± 923 spores/m³ at 5L, 10L, and 15L per minute (for one hour).

• Sampling at higher flow rate of 15L/min can underestimate actual total spore exposure in the rural community investigated in this study.

• Preliminary results indicate that 10L/min flow rate is preferable for sampling atmospheric fungal spores in a rural community.

• We also found (Figure 2) diurnal variations of spore concentrations at different times of the day and maximum spore concentration levels were observed between late afternoon and evening.

• Our results (Figure 3) show that the association between temperature and spore count is not linear. The trend line, however, shows a weak but positive association.

• We also found (Figure 4) that the association between average humidity and spore count is relatively stronger. The trend line shows that with the increase in humidity, spore count tends to increase.

• Spores of Aspergillus, Penicillium, Cladosporium, Periconia, and smut spores were most common in air samples, which were reported as allergenic in other studies.

• We also identified numerous thin-walled ascospores, allergic implications of which are currently unknown.

PUBLIC HEALTH SIGNIFICANCE

• Accurate estimation of airborne fungal spores is imperative given their impact on respiratory allergy and atopic asthma and in turn the public health implications of asthma outbreaks.

• Our results can be used by public health professionals to understand the importance of sampling air flow rate for mold exposure assessment and diurnal variations of allergenic fungal spores in their disease investigations and reporting for atopic asthma.

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