#P019 & #RF009
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Bard College | Community Sciences Lab

Rapid Detection of Microbial Indoor Air Quality

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Introduction

Indoor air quality is understood by the scientific community to be directly impactful to human respiratory health. Translation of those impacts for communities has yet to occur in a way that leads to regulations regarding indoor mold and bacterial toxin exposure through airborne particulates, particularly as climate change forces changes in microbial habitats and moisture levels in the built environment. People without agency for the conditions of their living environment (renters & subsidized housing) are most impacted by this lack of regulation, and are often the most exposed to poor air quality and environmental risks.

We are investigating novel methods for assessing indoor air quality relative to methods previously developed by the EPA (ERMI method) and other researchers (agar plate, microscopy, particulate matter). We have begun sampling in Emergency and Low-Income Rental and Home-owner occupied residences in the Hudson Valley to test this approach.

Using a Coriolis air sampler (liquid impinger), we assess endotoxin and 1-3 Beta-Glucan concentrations in common indoor living areas using the Endosafe PTS, which is originally designed for use in pharmaceutical settings. Within 15-20 minutes we are able to provide quantification of potential human exposure to these toxins. Protocol optimization and preliminary data using this technology has allowed us to measure indoor endotoxin concentrations ranging from 0.76-4.17 EU m-3 in Kingston, NY residences, coupled with indoor 1-3 Beta Glucan concentrations ranging from 118-1364 pg m-3. Preliminary findings indicate a correlation with structural moisture levels, ventilation access and insulation types, and provide a meaningful possibility for direct support of residents striving to create a clean indoor air environment in their homes.

Research Questions

1. Can we quickly, efficiently, and cost-effectively assess indoor microbial air quality?
2. How do our methods compare to results from other research methods?
3. To what effect does outdoor air quality impact indoor air quality?

Rapid Detection Methods

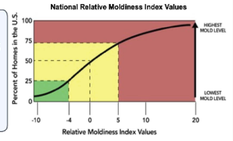
The Bertin Coriolis is a liquid impinger used to sample known quantities of air into an aqueous sample, allowing us to run analyses using equipment designed for water quality research.

We use a handheld Met One Aerocet PM counter to measure particulate matter & humidity indoors, in conjunction with an Met One continuous particulate matter monitor outdoors.

Biotape adhesive microscope slides are used to quickly gather samples of suspected pollution sources that can be cataloged and later analyzed under microscope. Agar plates use gravity to gather suspended particles and growth media to develop visible colonies of fungi and bacteria.

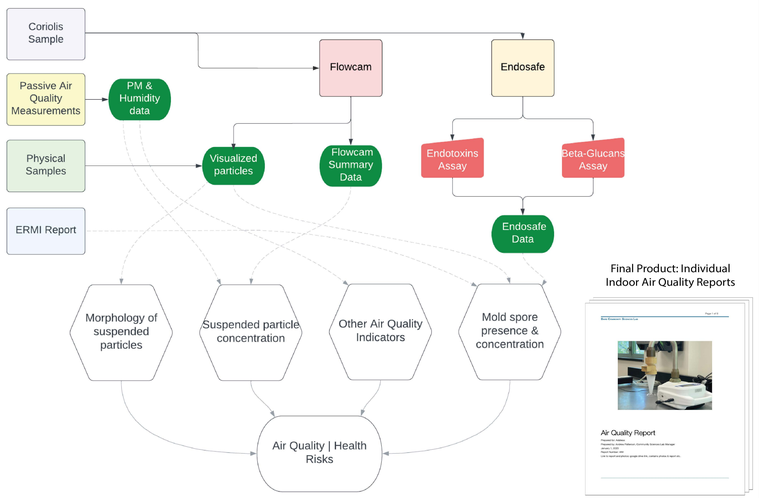
Charles River Endosafe PTS handheld spectrophotometer used to rapidly (15-minutes) quantify airborne endotoxins & beta-glucans using a liquid sample.

The Environmental Relative Moldiness Index (ERMI) was developed by the EPA as a consistent qualification method for determining the mold burden of an indoor environment.



Fluid Imaging Technologies FlowCam is an automated video camera which captures images of subvisible particles suspended in a liquid sample, and hosts a variety of statistical analysis software tools for particle analysis.

Methods Visualized



1 Can we quickly, efficiently, and cost-effectively assess indoor microbial air quality?

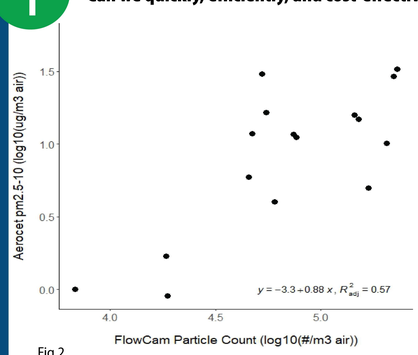


Fig 2.
Scatterplot demonstrating the relationship between aerosol particle mass and particle counts from different methods.

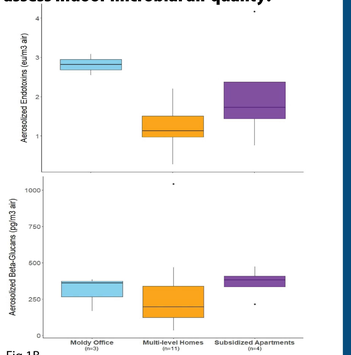


Fig 1B.
Box plots outlining measurements of endotoxins (eu/m3 air) and beta-glucans (pg/m3 air) by housing use type.

- The apparent relationship between Flowcam & Aerocet sampling approaches lends confidence in our Coriolis & Endosafe method for assessing microbial air quality. Our next step will be to compare particle counts and size distributions between the two instruments.
- There are no regulations in the US for air loading of endotoxins or beta-glucans, but our results reflect similar values found in publications including Salonen et. al. & Rando et. al.

2 How do our methods compare to results from other research methods?

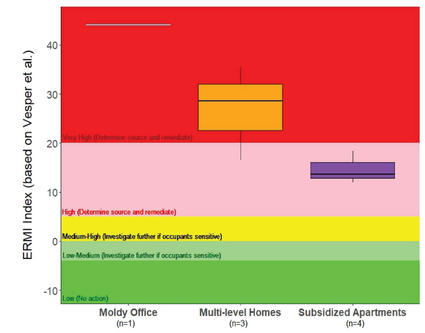


Fig 1A.
Boxplot outlining the mean and range of ERMI scores acquired for each individual housing unit.

- Our results are significantly higher than mean values in the ERMI index, which is based on a nationwide survey.
- This could be due to regional climate, and represent an inherent vulnerability to high mold-burden in Hudson Valley homes.

3 To what effect does outdoor air quality impact indoor air quality?

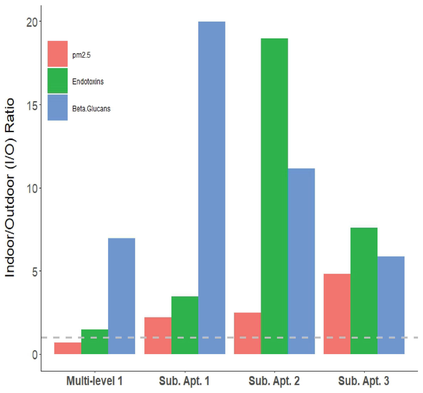


Fig 3.
Barchart demonstrating the relationship between indoor and outdoor pm2.5, endotoxins, and Beta-Glucans

- The variability in these ratios may be explained by the efficiency of the housing ventilation and air control (apartments usually lack control over air sources), and lends itself to further inquiry.

Conclusions

1 Can we quickly, efficiently, and cost-effectively assess indoor microbial air quality?

Seems so! We have implemented several rapid testing methods that have shown promising results, including handheld field equipment for monitoring airborne endotoxin & beta-glucan levels at somewhat low cost, and utilizing fluid microscopy to visualize airborne particles. The use of this equipment represents a potential model for other water-focused facilities to follow and expand to air other resource monitoring.

2 How do our methods compare to results from other research methods?

Our findings from the Hudson Valley of New York for aerosolized endotoxins and beta-glucans fall generally in line with published research, but ERMI values have shown well above values in studies done nationwide. This indicates a potential vulnerability of homes in the area, and climate change could potentially exacerbate the moldiness of an already unhealthy housing inventory.

3 To what effect does outdoor air quality impact indoor air quality?

There is a clear divide between outside the home and inside the home, although this divide appears to be more significant in apartments than multi-level homes as shown in fig 3. Further research will focus on identifying the factors involved in this apparent difference.

Acknowledgments

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