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Assessment of airborne bacteria and fungi in food courts

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ABSTRACT

A study was undertaken to determine the effect of variations in temperature, relative humidity, occupancy density and location (indoor/outdoor) on the concentrations of viable airborne bacterial and fungal spores at an air-conditioned and a non air-conditioned food stall in Singapore. Typically, bioaerosols consisted of 50.5% bacteria and 49.5% fungi in the indoor environment. In contrast, for the outdoor environment, bacteria on an average only accounted for 20.6% of culturable airborne microorganisms whereas fungal concentrations were 79.4%. Results on bioaerosol size distributions revealed that 67% of indoor bacteria and 68% of outdoor bacteria, 85% of indoor fungi and 68% of outdoor fungi were associated with fine mode particulates (<3.3 μm). Occupant density was the key factor that affected indoor airborne bacteria concentrations while concentrations of outdoor airborne bacteria depended strongly on ambient temperature. Indoor fungal concentration was positively correlated to relative humidity whereas outdoor fungal concentration was positively correlated to relative humidity and negatively correlated to temperature. The study also compared the biological air quality between a non air-conditioned food stall (Stall A) and an air-conditioned food stall (Stall B). The dining area of the former had lower bacterial concentrations as compared to the latter, while fungal spore's concentrations showed a reverse trend. The dominant airborne bacteria genera were *Staphylococcus*, *Pseudomonas*, *Alcaligens*, *and Corynebacterium* whereas *Penicillium*, *Aspergillus* and *Cladosporium* were the most common fungal genera and groups in both food stalls.

1. Introduction

The microbial fraction of aerosols present in both outdoor and indoor environments is of concern from environmental and public health perspectives. This fraction of aerosols is commonly referred to as bioaerosols, and includes a mixture of viable and nonviable microorganisms (e.g. pollen, algae, bacteria, fungi, yeasts) as well as antigenic compounds, dander, plant and insect debris, microbial toxins, and viruses [1]. Both cultivation-dependent and molecular methods have shown that the atmosphere harbors a diverse assemblage of bacteria and fungi, including taxa commonly found on leaf surfaces and in soil habitats [2]. The abundance and composition of airborne microbial communities are variable across time and space [3–9]. There is great concern about the potential health hazards of bioaerosols, particularly allergenic or toxigenic fungi, and their association with indoor air quality [10]. Bioaerosols usually refer to airborne particulate matter with the attachment of microbes (bacteria, fungi and viruses) or organic dust (dust mites particles, skin fragments and pollen grains) [11,12]. Bioaerosols, together with other non-biological factors (e.g. volatile organic chemicals, inorganic particulate matter, ventilation problems, etc.) can result in infections, allergenic responses and sick building syndromes. Densely populated countries in the tropics such as Singapore offer a favorable environment for the proliferation of microorganisms because of high annual average temperature (24 °C–30.7 °C) and high relative humidity (60%–99%) and high building density [12].

Bioaerosols vary considerably in size from approximately 0.02–100 μm [13]. They are present in the air as single cells or aggregates of cells as well as in fragments. They are often attached to other particles such as soils and dust and/or to saliva and water droplets, and can be easily transported. As compared to outdoor environments, studies dealing with levels of bioaerosols and their size distribution in residential indoor environments are relatively sparse [14–19]. Studies conducted in a variety of indoor environments showed a great variation in total concentrations of bioaerosols. In addition to the concentration of microbial aerosols, their size distribution is also needed in order to understand their fate in the air and their deposition in the human respiratory system. The size distribution of bioaerosols depends upon the type of specific

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