Evaluation of Potassium Sorbate as a Biocide to Reduce Viability of Total Airborne Fungi in a Higher Educational Building of Computer Studies

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Keywords: Indoor Air Quality, mold remediation, bioactive compounds.

Abstract. In countries which are humid throughout the year, mold is a common problem that can occur even on a computer keyboard. It is smelly and may damage the computer keyboards. It is caused by fungal spores in the air. It can also affect occupants’ healthiness. This study is aimed to evaluate the efficiency of potassium sorbate to reduce viability of indoor airborne fungus in a higher educational building of computer studies of a university located at Southern Peninsular Malaysia. Malt extract agar (MEA) was incorporated with the biocide and was used for air sampling of fungi at 3 different sites of the building including outdoors. The effectiveness of the biocide was evaluated by comparing the treated agar against the untreated agar. It was clearly shown that the biocide can effectively reduce the numbers of colony forming units of the airborne fungi at all 3 tested sites (>70% averagely) on the treated culture media, while the untreated media at all three sites was colonized by fungi with different concentration.

Introduction

Indoor airborne fungal contamination is a very common issue nowadays. Its presence brings a lot of problems to indoor occupants, building owners or managers as it affects the indoor air quality (IAQ) of those infected buildings and it has been associated with unhealthy symptoms including headache, asthma, allergy and irritant effects, respiratory problems, mycoses (fungal diseases) and several other non-specific health problems [1]. IAQ can be explained as the air quality within an enclosed building that leads to the comfort and healthiness of itsoccupiers [2]. It is a major concern as most people in the developed and developing countries, such as Malaysia, Singapore, Indonesia and others, spent most of their time indoor in either working offices, factories, homes or educational buildings.

The incidence of fungal infection has been increasing in the past 25 years [3]. It has been estimated that approximate 10% of people worldwide and 5% of the population in industrial countries have fungal allergies [4, 5]. Some fungi such as \textit{Aspergillus versicolor} and \textit{Stachybotrys chartarum} are able to produce mycotoxins and have been associated with sick building syndrome [1]. Many animal studies have confirmed that these mycotoxins are associated with carcinogenic, immune-suppressive, and other properties [6]. Fungi release tiny spores that float through the air and land on other locations to reproduce. When they settle moist surfaces, the spores can form new mold colonies. If these airborne fungal spores or mycotoxin are inhaled into bronchia and alveoli, they will be lysed and the human body thereby exposed to the primary and secondary metabolites...
Fungi can grow anywhere over a wide-ranging temperature with sufficient nutrients and moisture [9]. Therefore, indoor mold problem has long existed in yearlong warm and humid countries such as Malaysia and other Southeast Asian countries. In previous research, airborne fungi growth was found in a high humid room (relative humidity ~87%) in a higher educational building of computer studies after conventional remediation such as cleaning using detergent and changing of the affected ceiling boards [10]. It is dangerous since researchers suggested that the chances of transmitting the contaminating microbes through using of computers in a university setting is potentially great due to the enormous usage or touches of computer keyboards that are not routinely sanitized by numerous users daily [11]. The study also shows that the conventional remediation measures are not a long term solution to circumvent the indoor airborne fungal contamination. However, green solutions are needed to reduce the viability of the airborne fungus and thus existence of secondary metabolites of fungi in indoor setting in order to secure the quality of teaching and learning among educators and students in a university building.

Lately, a bioactive compound from food industry, potassium sorbate had been shown to be able to control the growth of two fungus species (Chaetomium globosum and Alternaria alternate) isolated from an indoor waterborne coating [12]. It is suggested to be effective against airborne fungi too. Therefore, this study aimed to evaluate the ability of potassium sorbate as a biocide to render the viability of indoor airborne fungi in a higher educational building of computer studies of a university located at Southern Peninsular Malaysia.

Materials and Methods

Selection of Testing Sites. The indoor airborne fungal samples were taken from a new commissioning higher educational building of computer studies of a university in Johor, Malaysia that had been identified of having microbial growth in indoor environment from previous research [10]. Three sites were selected by walk through inspection. They were each to represent a microbial-contaminated site (A), relatively mildly-contaminated site (B) and outdoors (O) of the building. The location for outdoor sampling was as close as possible to the outdoor air intake for the primary air handling system for the building [13].

Biocide Antifungal Activity. The antifungal activity of the potassium sorbate as a biocide was evaluated by air sampling with biocide-treated and untreated culture media which takes into account that the concentration of the viable fungi can be represented by colony forming unit (CFU) analysis as the calculation below:

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\text{CFU/m}^3 = \frac{[\text{Number of colonies x 1000}]}{[\text{Sampling time (min) x Flow rate (L/min)]}}. \tag{1}
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The airborne fungi samples were collected using a BioStage single-stage viable cascade impactor (SKC, USA) attached to a SKC QuickTake 30 Sample Pump (SKC, USA) onto Malt Extract Agar (MEA) plates with 0.03% (w/v) biocide at a flow rate of 28.3 L/min as per requirement of National Institute of Occupational Safety and Health (NIOSH) stated in method NIOSH Manual Analytical Standard Method (NMAM 0800). The impactor was located at the centre of the sampling location at a height of 1.0 to 1.5 meter above the floor. Every sample was obtained over 5 minute periods. The same procedure was carried out with control MEA without biocides. Both kinds of sampling with treated and untreated MEA were done in triplicate at each site on the same day during office hours and in the presence of indoor occupants. The air samplings at different sites were carried out on different week. The samples were analysed for total airborne fungi count by incubating them at 37°C for 5 days and counting of the colony formed was done thereafter.
Results and Discussions

The viability of total airborne fungi on the biocide-treated MEA was successfully reduced by 76.2% averagely if compared to their viability on control MEA without biocide (Figure 1). Notably, potassium sorbate showed the best performance at the mildly-contaminated site, which had the lowest total airborne fungi on control MEA, by successfully reducing the viability of total indoor airborne fungi by 84.2% on biocide-treated MEA. Meanwhile, its performance dropped when the mean concentrations of total airborne fungi on control MEA increase. The percentage of reduction of viability of total airborne fungi at the contaminated site and outdoors of the building are 63.9% and 80.4% respectively. The results indicate that potassium sorbate can show the best performance to control total indoor airborne fungi concentrations if it is applied in a clean environment. Hence, it is suggested that this biocide is very suitable to be applied together with and after conventional remediation of indoor fungal contamination periodically.

According to Industry Code of Practice on Indoor Air Quality (ICOP-IAQ, 2010) set by Department of Occupational Safety and Health Malaysia, the maximum exposure limit of total indoor airborne fungi concentrations is 500 CFU/m$^3$. Any value of the concentrations of indoor airborne fungi that approaches 500 CFU/m$^3$ can be also considered as a possible hazard to human health. In this study, this number was successfully reduced to below 100 CFU/m$^3$ at two of the three testing sites and below 200 CFU/m$^3$ at the contaminated site. All of these after-treatment’s numbers suggests that potassium sorbate is a proper biocide to maintain the concentrations of total indoor airborne fungi at an acceptable healthy level for human beings.

In a higher educational building of computer studies, computers are always shared and touches of computer keyboards and other computer parts by students always occur without practicing of hand hygiene. The sweats or dirt on the hands and fingers of students left on the computer keyboards or other computer parts after they using them. This in turn provides nutrients and breeding sites for airborne fungi that settle on these computer parts. The reduction of the viability of indoor airborne fungi on the biocide-treated media indicates that the airborne fungi are unable to grow on the substrate that are treated with biocide and thus suggesting that this biocide can be applied on various wall coatings, surfaces of furniture and electrical appliances including these computer parts.

Conclusion

In overall, the result of this study indicates that potassium sorbate fit to be applied as a biocide in a higher educational building of computer studies to reduce the viability of the indoor airborne fungi. This in turn reduces the amounts of secondary metabolites of fungus such as mycotoxin and fungal spores that can induce sick building syndrome and other unpleasant and uncomfortable feeling of indoor occupants.
Acknowledgement

The authors greatly appreciate Universiti Tun Hussein Onn Malaysia (UTHM) for facilitating the work and National Institute of Occupational Safety and Health Malaysia (NIOSH) for providing technical assistance.

References


