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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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Abstract – *In countries that are humid throughout the year, mold is a common problem that can occur even on a computer keyboard. Mold is smelly and may damage computer keyboards. It is caused by fungal spores in the air. It can also affect occupants' health. This study aimed to evaluate the efficiency of potassium sorbate as a biocide to reduce the viability of indoor airborne fungus in a higher educational building of computer studies of a university located at the 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 number of colony forming units of the airborne fungi at all 3 tested sites (>70% in average) on the treated culture media, while the untreated media at all three sites was colonized by fungi with different concentrations.*

Keywords: Indoor Air Quality, Mold remediation, Bioactive compounds

1.0 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 its occupiers [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 approximately 10% of people worldwide and 5% of the population in industrial countries have fungal allergies [4, 5]. Several fungi such as Aspergillus versicolor and 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 on moist surfaces, the spores can form new mold colonies. If these airborne fungal spores or mycotoxins are inhaled into bronchia and alveoli, they will be lysed, and human body is thereby exposed to primary and secondary metabolites [7]. Inhalation exposure has been suggested to cause acute kidney failure, damage of the upper respiratory tract, and central nervous system damage [8]. Thus, the existence of these fungi is intolerable in an indoor environment.

Fungi can grow anywhere over a wide-ranging temperature with sufficient nutrients and moisture [9]. Therefore, indoor mold problem has long existed in year-long 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 by using 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 also the existence of secondary metabolites of fungi in the 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, has 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 as well. 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 in the southern Peninsular Malaysia.

2.0 MATERIALS AND METHODS

2.1 Selection of Testing Sites

Indoor airborne fungal samples were taken from a new commissioning higher educational building of computer studies of a university in Johor, Malaysia, which had been identified of having microbial growth in indoor environment from previous research [10]. Three sites were selected by walk-through inspection. Each of the site represented a microbial-contaminated site (A), relatively mild-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 of the building [13].

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2.2 Biocide Antifungal Activity

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

CFU/m3 = [Number of colonies x 1000] ÷ [Sampling time (min) x Flow rate (L/min)] (1)

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 the 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 the height of 1.0 to 1.5 m above the floor. Every sample was obtained over 5 minutes period. 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 a different week. The samples were analysed for the total airborne fungi count by incubating them at 37°C for 5 days, and counting of the colony formed was done thereafter.

3.0 RESULTS AND DISCUSSIONS

The viability of the total airborne fungi on the biocide-treated MEA was successfully reduced by 76.2% in average 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 the total indoor airborne fungi by 84.2% on biocide-treated MEA. Meanwhile, its performance dropped when the mean concentration of the total airborne fungi on control MEA increase. The percentages of reduction of viability of the total airborne fungi at the contaminated site and outdoors of the building were 63.9% and 80.4% respectively. The results indicate that potassium sorbate shows 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 the Industry Code of Practice on Indoor Air Quality (ICOP-IAQ, 2010) set by the 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 also be 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 the total indoor airborne fungi at an acceptable healthy level for human beings.

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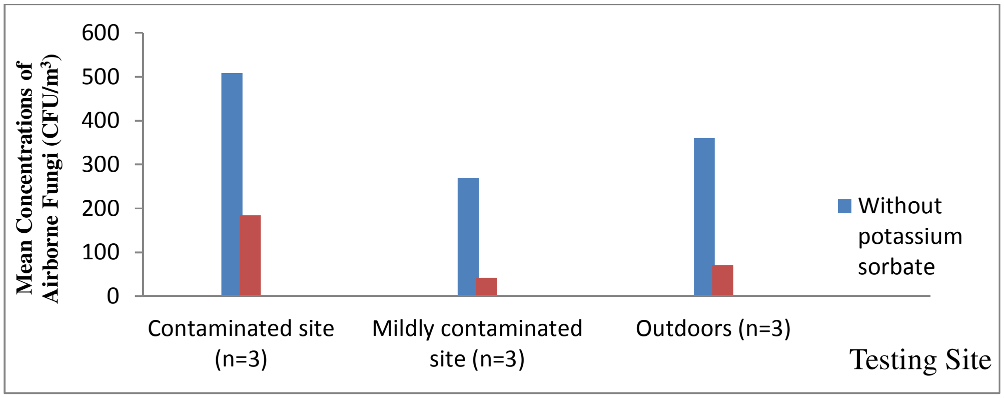

Figure 1: Comparison of viability of total airborne fungi on biocide-treated and untreated MEA.

In a higher educational building of computer studies, computers are always shared and students always touch computer keyboards and other computer parts without the practice of hand hygiene. Sweat or dirt on the hands and fingers of students is left on computer keyboards or other computer parts after they use the computer. 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 is treated with biocide ,and thus suggesting that this biocide can be applied on various wall coatings, surfaces of furniture and electrical appliances, including computer parts.

4.0 CONCLUSION

Overall, the result of this study indicates that potassium sorbate fits 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 amount of secondary metabolites of fungus such as mycotoxins and fungal spores that can induce sick building syndrome and other unpleasant and uncomfortable feeling of indoor occupants.

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