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Research paper

Indoor Fungal Growth on Variable Antifungal at Different Wall Finishing on Plasterboard

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Abstract

Various health complaints often been attributed to pollution and the poor quality of the indoor air. If there is good practice in building design, construction, and maintenance, the structures should remain dry. However, when there is moisture damage, the materials may be in contact with water for prolonged times, which inevitably leads to microbial growth or even total deterioration of the building material. Antimicrobial coating is designed to generate a surface that is easy to clean and can also incorporate active agents, commonly called antifungal, that prevent microbial colonization, the subsequent growth and bio-deterioration of the substrate. This paper presents the sustainable treatment for indoor environment quality in buildings by examining the application of potassium sorbate, zinc salicylate, and calcium benzoate that used as food industry preservatives as indoor antimicrobial agents. Four types of wall finishing used on plasterboard substrate: acrylic paint, glycerol based-paint, thin wallpaper, and thick wallpaper. The result indicated that potassium sorbate is the best bio compound to react as antifungal agent to prohibit the growth of indoor fungi. All the antifungal shows difference level of their effectiveness from each other. Only 40% of fungi were able to grow on thin wallpaper by using potassium sorbate as antifungal agent.

Keywords: *Use Antifungal, indoor air contamination, indoor air quality, plasterboard, wall finishing.*

1. Introduction

Indoor air pollution is very dangerous as it poses health problems especially to the kids as their bodies is still developing and they breathe a higher volume of air relative to their body size [1-3, 4]. Some of the common symptoms due to the lack of proper air ventilation are runny nose, nasal congestion, eye irritation, cough, asthma aggravation, fatigue, headaches and difficulty in concentrating [5]. Factors such as temperature and relative humidity plays a major role in pollutant concentration thus affect the indoor air [6, 7]. These indoor pollutants include fungi, mold, allergens and bacteria. Some of the materials used in construction industry such as ceiling tiles, wood, paint, and carpet rugs known for good environment for the growths of fungi. Application of antifungal coatings can prevent and protect the bio-deterioration of the substrates in buildings [8].

The antifungal used should be effective in controlling the fungi growth and safe consumed as concerns rises on the safety of the chemicals used [9]. Antifungal such as potassium sorbate, calcium benzoate and zinc salicylate is safe as food preservatives [1, 10-12]. Therefore, this research conducted to investigate the ability of these antifungal to reduce the growth of indoor fungi on four different types of wall finishing. Thus, it is aimed to determine the best application of these antifungal as protective layer on the four types of wall finishing.

2. Materials and Methods

2.1. Preparation of Indoor fungi Spore

The spores from the cultures transferred to spore suspension Tween 20 (0.005% - w/v), sodium chloride (0.85% - w/v) and distilled water (200 ml) used to prepare spore suspension according to Bellotti, et al. [9]. The spore suspension was prepared from the subculture. By using Neubauer chamber, the concentration of spores then was adjusted to approximately 0.3-0.5 x 106 spores/ml [1, 7, 8, 12].

2.2. Preparation of Bio-Resistance Test

The sample preparation steps was referred based on Vacher et al. [13] and Bellotti et al., [9] studies. The plasterboard cut into total 16 pieces. Each piece was approximately 5 cm x 5 cm. Each type of wall finishing consists of 4 pieces of plasterboard. One sample used as control and the other three samples were applied with

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antifungal. Each of the samples washed with 70 % of ethanol and allowed to dry for 24 hours before application. Two types of wallpaper were used which are thick (THICK W) and thin wallpaper (THIN W) while paint used in this study was acrylic paint (AP) and glycerol-based paint (GBP). For treatment samples, approximately 0.03 grams of potassium sorbate mixed with 100 ml of distilled water before applying onto wallpapers surface. For control samples, no antifungal added to the samples.

The same steps repeated with zinc salicylate, and calcium benzoate as antifungal. The (5cm x 5cm) size sample each then covered with a layer of paint respectively and some glued with wallpapers onto substrate support. All samples dried under laboratory condition for 24 hours before inoculating with indoor fungal spores. All the samples irradiated with UV-light for 40 minutes to avoid contamination before inoculating with fungal spores. Pipette used to inject the indoor fungal spore onto the sample surface and the spore spread with cotton buds.

The sample placed in the petri dish containing malt extract agar (MEA) agar for 27 days of incubation period in a laboratory at 30°C for observation. Degree of indoor fungal growth measured according to the scale provided by American Society for Testing and Materials ASTM D5590-00 standard.

Table 1 Scale for evaluation indoor fungal growth (ASTM D5590-00 Standard Scale) [15]

Scale	Percentage of Fungi Growth	Degree of Fungi Growth
0	0	None trace of growth
1	(<10%)	Trace Growth
2	(10 – 30%)	Light growth
3	(30 – 60%)	Moderate growth
4	(60 – 100%)	Heavy growth

The tests that conducted in laboratory, several parameters recorded to determine the factors affect the rate of mold growth. The physical parameters that are diameter, rating, and percentage referred according to ASTM D5590-00 [15]. The data analysed for free-antifungal substrate and antifungal-applied substrate that consist of difference wall finishing. As the results, the efficiency of the various antifungal in treating the indoor fungal are observed by the rate of the indoor fungal growth until Day 27.

3. Results and Discussion

The bar graph for overall indoor fungal growth on plasterboard treated by potassium sorbate shown (Fig.1). Acrylic paint shown to have the highest growth percentage that is 100% on Day 27, followed by glycerol-based paint with 83%. The growth of indoor fungi found on thick wallpaper was 47% and on thin wallpaper was the growth by 40% on the 27th day. Thus, thin wallpaper is effective compared to other types of wall finishing on potassium sorbate treatment as antifungal agent. Acrylic paint has the bigger percentage of indoor fungal growth due to different chemical contains in each paint. It might affect the effectiveness of potassium sorbate as an antifungal agent.

On the other hand, the overall percentage of indoor fungal growth on different wall finishing treated by calcium benzoate shown (Fig. 2). The highest percentage of indoor fungal growth found on acrylic paint that rose dramatically from Day 6 to Day 9 at 100%. However, it becomes constant after Day 12. Glycerol based paint was observed to have uniform growth of indoor fungi from Day 6.

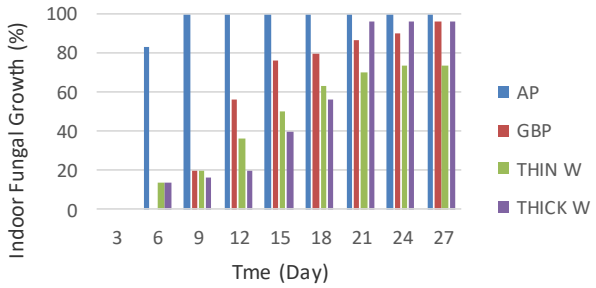

Fig. 1: The percentage of indoor fungal growth in variable wall finishing treated by potassium sorbate

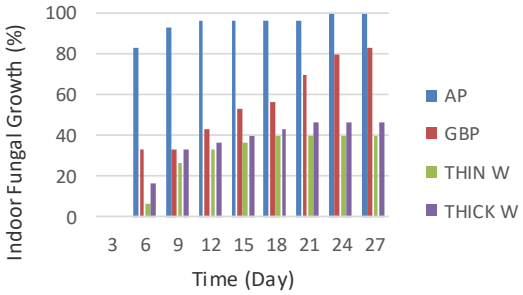

Fig. 2: The percentage of indoor fungal growth in variable wall finishing treated by calcium benzoate.

Thick and thin wallpaper too shows the uniform growth of fungi. Eventually, calcium benzoate is effective as an antifungal agent on thin wallpaper compared to other wall finishing by 78% at Day 27. This is because the application of calcium benzoate on thin wallpaper covers the top layer of the wallpaper and penetrates deep into it. The overall percentage of indoor fungal growth on different wall finishing of plasterboard treated by zinc salicylate shown (Fig. 3).

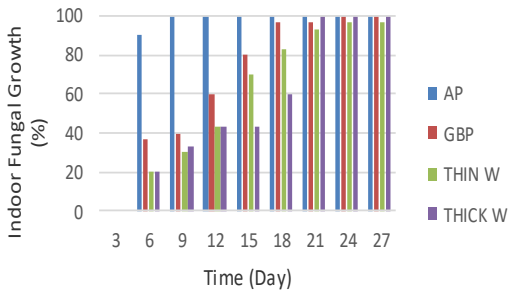

Fig. 3: The percentage of indoor fungal growth in variable wall finishing treated by zinc salicylate.

The percentage of fungi growth on acrylic paint achieved 100% by Day 9. Glycerol based paint and thick wallpaper shares the same percentage of fungi growth that is 97% on Day 27. Thin wallpaper is the best medium to apply with zinc salicylate as it showed the lowest growth of fungi by Day 27. While the less effective wall finishing is the acrylic paint as the fungi achieved its maximum growth by Day 9 on this wall finishing. This is because the efficiency of acrylic paint is influenced by the humidity and temperature of its surrounding when applied [16-17]. The temperature of indoor environment mainly influences growth of indoor fungal.

The maximum growth of indoor fungal attained at the temperature of 25°C to 30°C [18]. As for this study, all the samples incubated in 30°C temperature. Although all the samples were stored at 67% of relative humidity, this study proved it is suitable condition for indoor fungal growth.

4. Conclusion

Indoor fungi are dangerous growth formed inside the buildings at suitable temperature and relative humidity. Their presences post threat to the occupants or users of the room. Therefore, they must be eradicated. The fastest growth of indoor fungi on plasterboard-based material with four wall finishing marked rapid growth as on acrylic paint, followed by glycerol based paint and thick wallpaper. The slowest fungi growths for all the samples found on thin wallpaper. It suggested that antifungal added to avoid indoor fungi from growing and to act as a protective layer for the wall finishing. In this case, the best antifungal is potassium sorbate; and the best application is the potassium sorbate-treated thin wallpaper on plasterboard. Fungi inhibited to grow by only 40% until Day 27 of the study on thin wallpaper by using potassium sorbate as antifungal. This concludes that the exponential fungi growth phase able to be interrupted by potassium sorbate. It is recommend the use of biological antifungal should implemented in wall finishing of a building as it is proven in its effectiveness on plasterboard substrate.

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