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Research Article

Timeline approach for antimicrobial paints applied on surfaces

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ABSTRACT

Microbial growth in man-made constructions is a planetary problem. Contaminated surfaces can rapidly spread dangerous infectious illnesses, especially in public places. A few microbes can quickly multiply into millions, especially under current circumstances. A hygienic surface is defined as a component that inhibits micro-population increase. Meanwhile, the use of biocides is expanding, as is research into their antibacterial characteristics and components. There are now various antimicrobial substrates on the market. It is worthwhile to investigate the efficacy and precision of these products. In this paper, an experiment has been made on six different wall paints, which are promoted as antimicrobials and are inspected against bacteria. Wooden panels were painted with six different antimicrobial wall paints. Four different microorganisms were sprayed on the surface using a sterile spraying mechanism. The bacteria used in the study were *Escherichia coli*, *Listeria monocytogenes*, *Staphylococcus aureus*, and *Bacillus subtilis*. Each panel was observed for ninety days, and the results were discussed. In contrast, the first paint proved effective on *L. monocytogenes*, *S. aureus*, and *B. subtilis* within the first two weeks and on *E. coli* within the first month. The second paint affected all four bacteria within the first month. The remaining paints proved ineffective until the third month's end.

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1. INTRODUCTION

The humidity of the buildings in which people live, and work has been recognized as an essential issue in the health of individuals in indoor environments during the last 20 years [1–3]. Contaminated surfaces can rapidly spread dangerous infectious illnesses, especially in public places. There are several critical places, such as healthcare buildings and kitchens, where contaminated surfaces induce rapid disease transmission, beginning with a surface and progressing to a person and, finally, among individuals [4]. Antimicrobials kill or prevent the growth of microorganisms such as bacteria, fungi, and algae. Antimicrobial materials should ideally be effective against a broad spectrum of bacteria while being generally environmentally friendly, colorless, odorless, and UV and visible radiation inert [5]. Antimicrobial paint is designed to resist microbes, including viruses, bacteria, and other germs. It can help keep interiors safer, better protected against mold damage, and make them easier to clean [6]. Establishing antimicrobial surfaces could be one of the keys to helping prevent further contagious incidents and breakouts. Therefore, biostatic and dry finish architectural paint mixtures that competently prevent microbial growth or erase them on their dry surface are necessary [4]. An antimicrobial surface must ensure that pathogenic contamination is eliminated or lowered to a minimum. Different biocides are often added to paint formulas to protect the products from microbial assault and to preserve dried films from fungal and algal formations. Microbial growth frequently stains and degrades the qualities of paints [7–9]. There are now various antimicrobial substrates

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Table 1. Paints used within the scope of the study

Ingredient	Concentration
Paint A - Fenomastic Hygiene Silk B Base S2500-N	
Aqueous ammonia solution	%≤0.3
1,2-benzisothiazol-3(2H)-one (BIT)	%<0.1
3-iodo-2-propynyl butylcarbamate (IPBC)	%<0.1
C(M)IT/MIT (3:1)	%<0.025
2-methyl-2H-isothiazol-3-one (MIT)	%<0.0015
Paint B - Fenomastic Stain resistant BB Base S2000-N	
There is no component that is classified as dangerous to health or the environment and required to be reported.	
Consists of 1,2-benzisothiazol-3(2H)-one. May cause allergies.	
Paint C - Fenomastic Pure Silk B Base 3915-G65Y	
There is no component that is classified as dangerous to health or the environment and required to be reported.	
Consists of 1,2-benzisothiazol-3(2H)-one. May cause allergies.	
Paint D - Fenomastic Rich Mat B Base S2500-N	
There is no component that is classified as dangerous to health or environment and required to be reported.	
Consists of 1,2-benzisothiazol-3(2H)-one, 2-methyl-2H-isothiazol-3-one (MIT) and C(M)IT/ MIT (3:1). May cause allergies.	
Paint E - Alpina silan-w Caparol White	
Pyrithione zinc	%≤2,5
1,2-benzisothiazol-3(2H)-one	%≤2,5
3-iodo-2-propynyl butylcarbamate	%≤2,5
Urea tetra methylol acetylene	%≤2,5
2-methyl-2H-isothiazol-3-one	%≤2,5
2-octyl-2H-isothiazol-3-one	%≤2,5
Paint F - Alpina max-w Caparol White	
Pyrithione zinc	%≤2,5
1,2-benzisothiazol-3(2H)-one	%≤2,5
3-iodo-2-propynyl butylcarbamate	%≤2,5
Urea tetra methylol acetylene	%≤2,5
2-methyl-2H-isothiazol-3-one	%≤2,5
2-octyl-2H-isothiazol-3-one	%≤2,5

on the market. It is worthwhile to investigate the efficacy and precision of these products. A few microbes can quickly multiply into millions, especially under current circumstances. Meanwhile, the use of biocides is expanding, as is research into their antibacterial characteristics and components [10]. This study has designed an experiment to test the accuracy of some wall paints, which are currently commercialized for their antimicrobial properties. It has been investigated whether the bacteria will survive or proliferate, and if they do, how long will it take to be diminished into zero on a surface painted with the substances. This study has been conducted on six types of wall paints, observing four types of the most common contaminant bacteria *E. coli*, *L. monocytegenes*, *S. aureus*, and *B. subtilis*.

2. MATERIALS AND METHODS

2.1. Materials

Escherichia coli (ATCC 25922), *Listeria monocytegenes* (ATCC 19111), *Staphylococcus aureus* (ATCC 6538), and *Bacillus subtilis* (ATCC 6633) were used in the evaluation of the paint's antimicrobial effectivity. Six different types of paints were purchased from different paint firms. The paints were indicated to be antimicrobial. The information and the ingredients of the paints investigated are listed in Table 1.

2.2. Samples Preparation

Within the scope of the study, the paints were applied on 6 wood panels sized (50 X 50 cm) and let dry for 10 hours at room temperature. This process was repeated 3 times.

2.3. Microbial Analyses

Painted panels were brought to the laboratory for microbial analysis. *E. coli*, *L. monocytogenes*, *S. aureus*, and *B. subtilis* were sprayed on the surface using a sterile spraying mechanism. Spiking was done with bacteria enriched and 5 log_{10} cfu/ml. All bacteria were sprayed on painted surfaces, let dry, and incubated at room temperature. Surface sampling was made using a sterile swap from 5x5 cm area on days of 1st, 3rd, 5th, 7th, 14th, 21st, 30th, 60th, 90th days after spiking. All microbiological analyzes were held in a commercial laboratory.

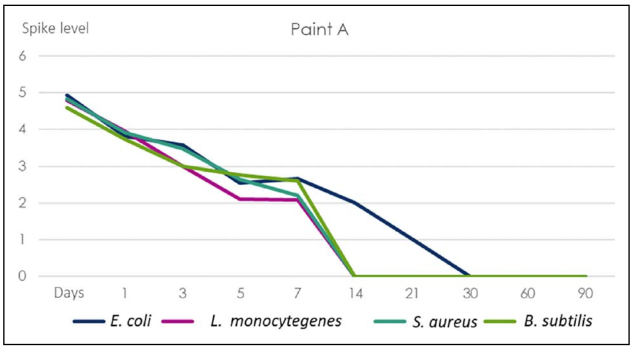

Figure 1. Results of paint A.

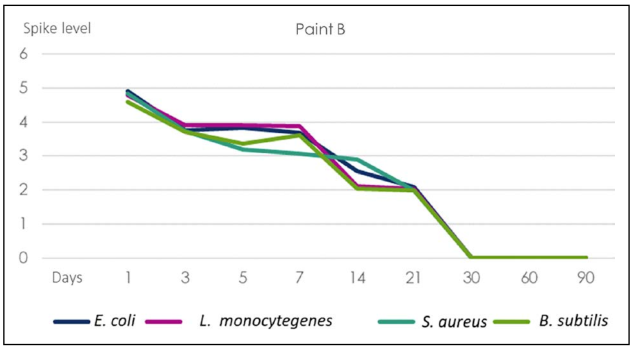

Figure 2. Results of paint B.

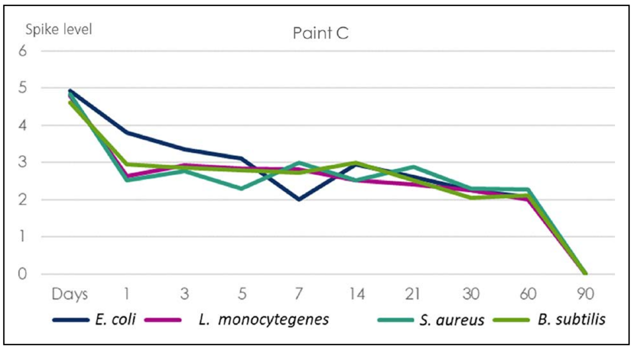

Figure 3. Results of paint C.

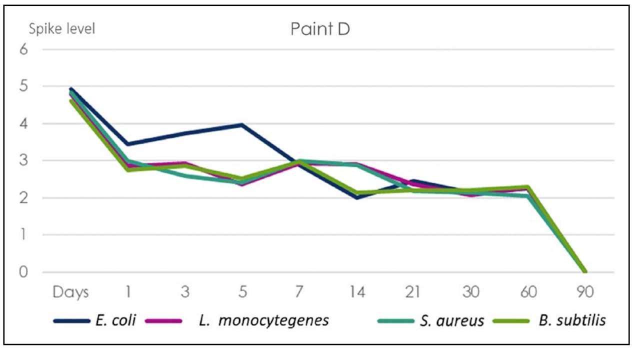

Figure 4. Results of paint D.

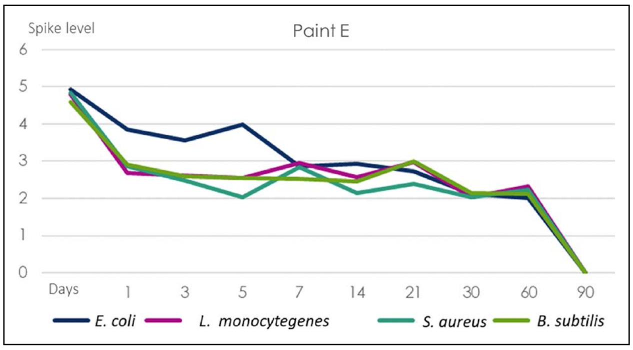

Figure 5. Results of paint E.

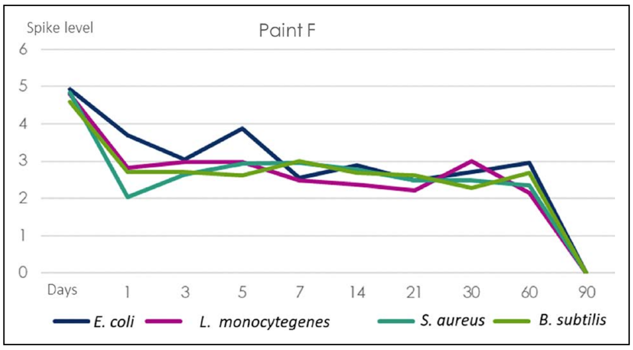

Figure 6. Results of paint F.

3. RESULTS AND DISCUSSION

This study aimed to evaluate and determine the duration of the antimicrobial effect of different paints. All six paints were evaluated for antimicrobial effects on four different bacteria. All paint samples were spiked with approximately 5 log_{10} cfu/ml bacteria. There was a significant ($p<0.05$) decrease in Paint A and Paint B, which decreased bacteria 14^{th} day and 30^{th} day of spiking, respectively. Other paints showed a decrease on the 90^{th} day, possibly due to dehydration of the bacteria of concern. Bacteria need humidity and water to stay alive. As the days pass, humidity and relative water decrease, thus triggering the death of bacteria used in our study. The results obtained from Paint A are shown in Figure 1. According to the results, there was a significant decrease in the numbers of bacteria obtained by the 14^{th} day of spiking where *E. coli* numbers decreased only on the 30^{th} day.

The results obtained from Paint B are shown in Figure 2. According to the results, the number of bacteria significantly decreased by the 30^{th} day.

The results obtained from Paint C to F were similar and were shown in Figures 3, 4, 5, and 6. The overall results suggest a decrease by day 90 due to the bacteria's dehydration.

The most significant amounts of antimicrobial coatings are consumed in the building industry, particularly for producing interior and exterior coatings designed to protect against microorganisms. Other branches in which the consumption of antimicrobial coatings is expected to increase include hospitals, nursing homes, daycares, and medical applications where a high standard of hygiene is required [10, 11]. Various biocides are commonly added to paint formulations to protect the products against microbial attack. Biocides are essential in decreasing the probability of microbial growth on the coated surface [7–9].

Considering these issues, an experiment has been designed to test the efficiency of some of the wall paints in the market, which are currently commercialized for their antimicrobial properties. It has been investigated whether the bacteria will survive or proliferate, and if they do, how long will it take to be diminished into zero on a surface painted with the substances. This study has been conducted on six types of wall paints, observing four types of the most common contaminant bacteria. *E. coli*, *Listeria monocytegenes*, *Staphylococcus aureus* and *Bacillus subtilis*.

There have been varying kinds of studies to investigate the antimicrobial activity of paints over hygiene-related bacteria. In a study held by Hochmannova and Vytrasova, TiO_2 and zinc oxide consisting of aqueous acrylic dispersion interior paints were tested for their photocatalytic activity on *E. coli*, *S. aureus*, *P. aeruginosa*, fungi *Aspergillus niger* and *Penicillium chrysogenum*. This study reveals the hypothesis that zinc oxide and anatase titanium dioxide can be paired in formulations of interior paints [12]. Nano ZnO was the most effective photocatalytic substance on various microorganisms [13].

In a study by Kumar et al. [14], metal nano particle dispersed oil paints were examined for an environmentally friendly paint. Silver nano-particle paint has been observed to be highly effective on both gram-positive (*S. aureus*) and gram-negative bacteria (*E. coli*). These studies have shown that the improvement of the paint can diminish pathogen proliferation on surfaces. Even though the active ingredients are unknown in this paper, Paint A and Paint B are proven to be nearly as effective as the studies that held with similar concerns. Paint A and Paint B has succeeded in diminishing the most common biofilm-forming pathogenic bacteria.

All six of the paints consisted of isothiazole derivatives, known to be an agent with antimicrobial characteristics. Isothiazole derivatives possess antibacterial activity. Multiple 3(2H)-isothiazol one derivative have been synthesized in the previous decade, and the majority of them have antibacterial action against both Gram-positive and Gram-negative bacteria, depending on the substitution pattern [15].

1,2-benzisothiazol3(2H)-one (BIT) is a commonly utilized biocide applied to industrial products with broad antimicrobial activity [16, 17]. BIT has been shown to react with thiol-containing proteins on target microorganisms and is especially effective against actively metabolizing bacteria [18, 19]. It is widely used in food packaging, industrial and consumer products like adhesives, laundry and dish detergents, cleaning and disinfectants, air fresheners, personal care products and sunscreens, paints, and industrial lubricants [20, 21].

4. CONCLUSION

In this study, six different wall paints have been tested for the effectiveness of their antimicrobial properties. While Paint A proved effective on *L. monocytogenes*, *S. aureus*, and *B. subtilis* within the first two weeks and on *E. coli* within the first month, Paint B was effective on all four bacteria within the first month. Paint C, D, E, and F showed to be ineffective until the end of the third month. It is also plausible that the bacteria on paint C, D, E, and F have been eliminated due to various conditions, such as dehydration, other than the components of the paints. All six of the paints consisted of isothiazole derivatives, known to be an agent with antimicrobial characteristics. Although there is insufficient information about the exact formulation of the paints; it can be said that not all the wall coatings in the market that are promoted to be antimicrobial, hygienic, or biocidal are as effective as advertised.

When it comes to finishing constructions and repainting, the preference for antimicrobial paint is a must for selecting a dependable and suitable one. These paints may not be inexpensive but will be cost-effective in the long run. Acknowledging the necessity of antimicrobial paints and their efficiency has been proven to be necessary. Human populations are becoming more vulnerable to contagious diseases as circumstances evolve and the quantity of life increases. Building components with antimicrobial properties such as wall paints can ensure a safer environment against disease-causing bacteria. More tests, informative research, and reliable commercial sources are needed to manage that idea.

ETHICS

There are no ethical issues with the publication of this manuscript.

DATA AVAILABILITY STATEMENT

The author confirm that the data that supports the findings of this study are available within the article. Raw data that support the finding of this study are available from the corresponding author, upon reasonable request.

CONFLICT OF INTEREST

The author declare that they have no conflict of interest.

FINANCIAL DISCLOSURE

The author declared that this study has received no financial support.

PEER-REVIEW

Externally peer-reviewed.

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