Effectiveness of Commercial and Homemade Cleaning Products on Preventing White Bread Microbial Growth

BIOL 342
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Abstract

Commercial cleaning agents are regularly used in disinfecting or general cleaning in many households. Two of the most common cleaning products, Lysol and Clorox, were tested against a homemade product made of a simple mixture of baking soda, dish soap, and white vinegar. Their effectiveness was studied by observing the amount of microbial growth on preservative-free white bread over a period of 12 days. The control group with only water showed the highest amount of mold growth. Besides the control, bread that was sprayed with Clorox product showed the most amount of mold growth, followed by Lysol. The homemade mixture was observed to have the lowest microbial growth out of all treatments. The p-value for ANOVA statistical analysis was p=0.1199. This research provides insight to consumers for better understanding of which products to purchase with the goal of best disinfecting results in mind.

Introduction

Household disinfectants and cleaning products are consistently utilized in households for several purposes, whether it's for kitchen surfaces, bathrooms, or general multipurpose cleaning. They constitute one of the most diverse areas of chemical formulation among consumer products (Lemire et al. 2022). Moreover, after the COVID-19 outbreak, the global use for cleaning products is rapidly growing (Koksoy et al. 2021). Commercial cleaning agents are complex mixtures of ingredients, and there is previous research suggesting that prevalent use of these in the household is associated with increased risks for respiratory health. As such, some may choose a common homemade cleaning alternative, which is a simple mixture of baking soda, dish soap, and white vinegar. This study tested the effectiveness of two common commercial cleaning products, Lysol and Clorox, against a homemade product. We visually assessed their efficacy on preventing mold growth on plain, preservative-free white bread.

Lysol is a 50% solution of cresol (3-methyl phenol) in saponified vegetable oil (Gupta, P., 2016). Its chemical formula is $C_6H_{14}N_2O_3$. The original product is based on phenols and is commonly used for disinfection after cleaning. Furthermore, *Clorox* is a broad spectrum disinfectant consisting of a 5/25% sodium hypochlorite solution with 5% available chlorine by weight. It is a bleach product

with a chemical formula of NaClO; under these conditions, we predict that Clorox will be the most effective at preventing mold growth, and the homemade product will be the least effective.

Our research aims to compare the effectiveness of Lysol, Clorox, and a homemade product on the prevention of mold growth on white bread. With our results, we hope to further understand the common use of various cleaning products and potentially give insight into which agent should be used more. Consumers may have better discernment over which products to spend their money on, or they may wish to create their own homemade mixture with simpler ingredients that are less harmful to respiratory health.

Methods

The experiment was conducted over a period of two weeks, during which the bread samples were monitored for mold growth at regular intervals. Three different cleaning solutions were used: Clorox Disinfectant Mist, Lysol All-Purpose Cleaner, and a homemade product. Each cleaning solution was sprayed on three pieces of bread, and mold growth was recorded every 2-3 days. Three control pieces of bread were included in the study with no cleaning solution applied to them. The homemade cleaning solution was prepared by mixing ½ cup of white vinegar, 2 tablespoons of baking soda, ½ cup of dish soap, and 2 cups of warm tap water together. The three cleaning solutions were applied to the bread slices using the same clean spray bottle, and 50mL of each solution was applied evenly to one side of the bread slice surface. The experiment was conducted in a clean, room-temperature environment to prevent sample contamination. The bread slices were placed in a clean, dry area and allowed to air-dry for 30 minutes after being sprayed with the cleaning solutions. After air-drying, the 12 bread slices were then each placed into separate labeled zip-lock bags with a 1cm by 1cm grid drawn on one side of the bag. Mold growth on the bread slices was monitored every Monday, Wednesday and Friday for a period of 2 weeks. The mold growth was visually assessed, a photo of each slice was taken, and the percentage of the bread slice covered in mold was recorded. The percentage of the bread slice covered in mold was calculated by dividing the grid-squares on the plastic bag which contained mold by the total number of grid-squares. The data were then analyzed

using GraphPad Prism to determine the significance of any differences between each of the experimental groups.

Results

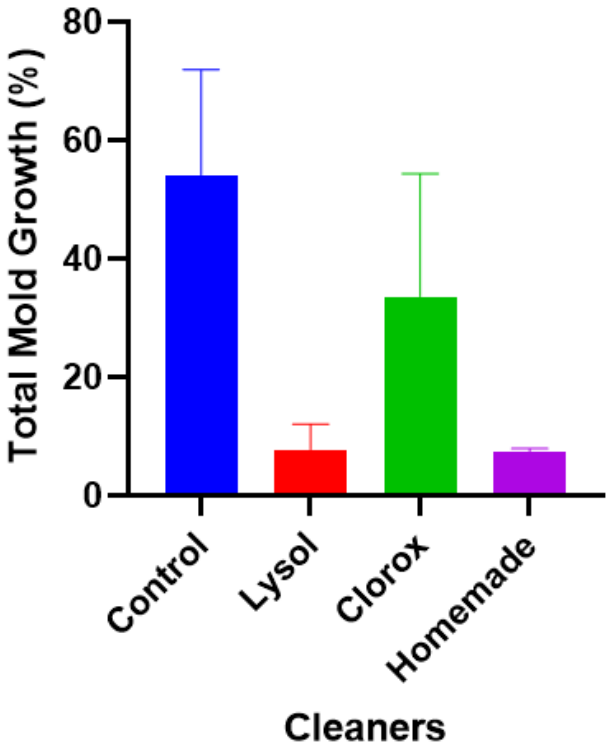

Figure 1. Total percentage of mold growth coverage for each type of cleaner at the end of 12 days. Each column in different colors represents the mean of one cleaning product brand . The total sample size is 12, with a p-value=0.1199.

Figure 1 shows the total percentage of mold growth for each cleaner. There are a total number of 120 squares covering each bread, and the data showed mold was increasing over time for all of the treatments. The control group, the bread with no cleaning product applied, had the highest coverage of all treatments, with a mean of 54.1667%. Among the three cleaning products, Clorox showed the highest mold growth at a mean of 33.6111%, much higher than the other two products, with means equal to 7.7778% and 7.5% respectively for Lysol and Homemade. Both Lysol and Homemade cleaning products showed approximately the same amount of mold growth, with Homemade cleaning

product having slightly lower mold growth. However, in comparison to the control group and the Colorex group, their mold growth was much lower.

The total mold coverage for each treatment was found by calculating the total percent mold coverage for each of the 3 replicates, and finding their mean value in Microsoft Excel. Then, the growth for each replicate was used to calculate the p-value by using the one-way ANOVA with an alpha level of 0.05 in Prism. The p-value for the ANOVA test was 0.1199.

Discussion

Our experiment was conducted aiming to observe the effects of commercial cleaning products and homemade cleaning products at inhibiting mold growth, as one previous experiment has shown high efficiency of both commercial products Lysol and Clorox against potential human pathogens (Rutala et al., 2015). The p-value of the One-Way ANOVA test is greater than 0.05, hence the null hypothesis is not rejected, there is no significant difference between commercial cleaning products and homemade cleaning products. The result of Tukey's Test shows the three cleaning product treatments do not have a significant difference in mold growth compared to the control, and no significant difference was found between the commercial product treatments and the homemade product treatments.

According to our findings, none of the cleaning products show any meaningful effect at inhibiting mold growth on bread. This result is inconsistent with some of our findings prior to the experiment, especially for Clorox that contains sodium hypochlorite solution that showed much less difference to the control group compared to Lysol and Homemade, as Medrano-Félix et al. (2011) have suggested that both 5% and 10% sodium hypochlorite is effective at eliminating pathogens such as E.Coli. This could be due to the property that sodium hypochlorite is highly sensitive to light. Wang et al. (2019) showed by exposing sodium hypochlorite to indoor fluorescent light, it sped up the decomposition of sodium hypochlorite. This explains why modern packaging methods of bleach cleaning products have practically eliminated the influence of light on bleach stability. However, when storing our bread samples in the lab, they were all sealed individually in a transparent zip bag, and all bags were stored in a large tray. And because the Clorox samples tended to be put on the top

level of the tray along with control samples, they faced direct light exposure from the lighting equipment in the lab, which may have altered the desired outcome of these samples. The error could be reduced by storing all samples in a dark room, so that light would not be a factor affecting the chemicals of cleaning products.

Despite the statistical results being not significant, Lysol and Homemade products are observed to have reduced mold growth compared to the control. Such results are consistent with Rutala et al. (2015)'s finding about how Lysol is effective at eliminating common household pathogens, at both 30-second and 5-minute exposure. However, our homemade products consisting of baking soda and vinegar depict a contrary result as the paper. While Rutala et al. (2015) claim both vinegar and baking soda are ineffective against household pathogens and should not be used over commercial cleaning products such as Lysol and Clorox, our homemade cleaning product show a large and consistent reduction in mold growth compared to the control, and even being the most effective of all treatments. The difference can be due to the fact that our homemade product is a mixture of baking soda and vinegar and one of their reaction products is sodium acetate. According to Sallam (2007), sodium acetate can be effective at inhibiting microbial growth and acts as an organic preservative for fish under refrigerated storage, explaining the potential reason for why our homemade product is just as effective as commercial cleaning product Lysol.

Although our experiment has demonstrated the effectiveness of different cleaning products at preventing mold growth, there are factors that may have impacted our result. In addition to the very slight difference of storage condition for the Clorox group mentioned previously, the number of samples in each group and the length of the experiment both contributed to the insignificance of our statistical results. With only 3 samples for each treatment and a total time of two weeks, our experiment may seem less convincing than what we have anticipated. If a similar experiment is to be repeated in the future, sample size for each group and experiment length should both be increased to ensure a significant result.

Conclusion

In this study, we investigated the effect of three different cleaning solutions, Clorox, Lysol, and a homemade product, on microbial growth on white bread. The results of this study did not show any significant difference in mold growth between the bread samples treated with the cleaning solutions and the control group, nor did it find any significant difference between the different cleaning solution groups. While the study failed to find a significant effect of the cleaning solutions on mold growth, it is important to consider the limitations of the study. The sample size used in this study may have been too small to detect any significant differences between the groups. Additionally, other factors such as temperature, humidity, storage conditions, study length, and human error may have influenced the results. Further research is needed to determine the most effective cleaning solutions for controlling microbial growth on white bread and other food surfaces. This may involve using a larger sample size, controlling for additional variables, and examining different types of microorganisms. While this study did not find a significant effect of the cleaning solutions on mold growth on white bread, it highlights the importance of continued research to improve food safety and hygiene practices.

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Appendix. Number of Grids Containing Mold in each sample for each Cleaning Product treatment from Day 0 to Day 12

Control	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
Sample 1	0	0	0	0	0	0	23
Sample 2	0	0	0	4	34	65	93
Sample 3	0	0	0	0	0	12	79

Lysol	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
Sample 1	0	0	0	0	0	0	0
Sample 2	0	0	0	0	0	0	18
Sample 3	0	0	0	0	7	9	10

Clorox	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
Sample 1	0	0	0	5	55	65	90
Sample 2	0	0	0	0	0	4	18

Sample 3	0	0	0	0	11	12	13

Homemade	Day 0	Day 2	Day 4	Day 6	Day 8	Day 10	Day 12
Sample 1	0	0	0	0	0	4	10
Sample 2	0	0	0	0	0	2	9
Sample 3	0	0	0	0	0	0	8