

Testing the Effectiveness of Natural versus Chemical Disinfectants on Gram Positive Bacteria

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Abstract

Due to the on going COVID-19 global pandemic there has been an emphasis on cleanliness and the effectiveness of disinfectants in order to slow/stop the spread of COVID-19.

The effectiveness of two chemical disinfectants (bleach and Lysol) and two natural disinfectants (lemon juice and white vinegar) were compared to each other by determining each disinfectant's ability to inhibit the growth of the gram positive bacteria *Staphylococcus epidermidis*. Zones of inhibition around each of the disinfectants were used as an indicator of their effectiveness in killing gram positive bacteria.

The results showed that the chemical disinfectants produced larger zones of inhibition than the natural disinfectants, thus it can be concluded that the chemical disinfectants were more effective than the natural disinfectants.

Introduction & Research Question

Introduction

Since around the month of February of this year (2020), the United States started to see the beginning stages of what is now, a global pandemic. COVID-19 has affected the world in numerous ways; one way that the general public has been affected is accessibility to disinfectants. Due to the shortage, people have turned to making/using natural or "green"/environmentally friendly disinfectants. An important concern to note is that within the last decade, there has been an alarming increase in the number of bacteria, in various bacterial populations, that are resistant to multiple drugs (Carlie et al., 2020), therefore increasing the importance of effective disinfectant methods

Research Question

Different types of disinfectants may be more or less effective against different types of pathogens. It is suggested that gram positive bacteria can be more resistant to certain chemicals than gram negative bacteria (Rios-Castillo, et al. 2018). We are interested in investigating the relative effectiveness of 'natural' vs. 'chemical' disinfectants on microbes. We will use gram positive bacteria as a model system in this experiment.

Hypothesis

We will be using *Staphylococcus epidermidis* a gram positive bacteria, as a model system to test the relative effectiveness of two natural disinfectants (vinegar and lemon juice), and two chemical disinfectants (Clorox bleach and Fabuloso). We will use the zone of inhibition around different disinfectants as an indicator of their effectiveness in killing gram positive bacteria. We hypothesize that chemical disinfectants will be more effective in inhibiting growth of gram positive bacteria than the natural disinfectants will be.

Research Design & Data Collection

Gram positive bacteria, *Staphylococcus epidermidis*, was used. Bacteria was cultured in liquid Lysogeny Broth media; 200µl of broth was spread using sterilized glass beads over a Lysogeny Broth agar plate. Bacteria was allowed to grow for two hours. The four disinfectants used were: vinegar, lemon juice, Clorox bleach, and Lysol. Small, hole punch sized discs were soaked in 10µl in the four disinfectants. After the two hour growth period, discs were placed on the LB plate with two control discs. The positive control disc was tea tree oil, the negative control disc was sterilized water. Bacteria were allowed to grow for 24 hours, at 37 °C. The zone of inhibition was measured in millimeters after 24 hours of bacterial growth (the greater the diameter of the zone of inhibition, the more effective the disinfectant is). There was three replicates for the experiment (a total of three agar plates split into six parts).

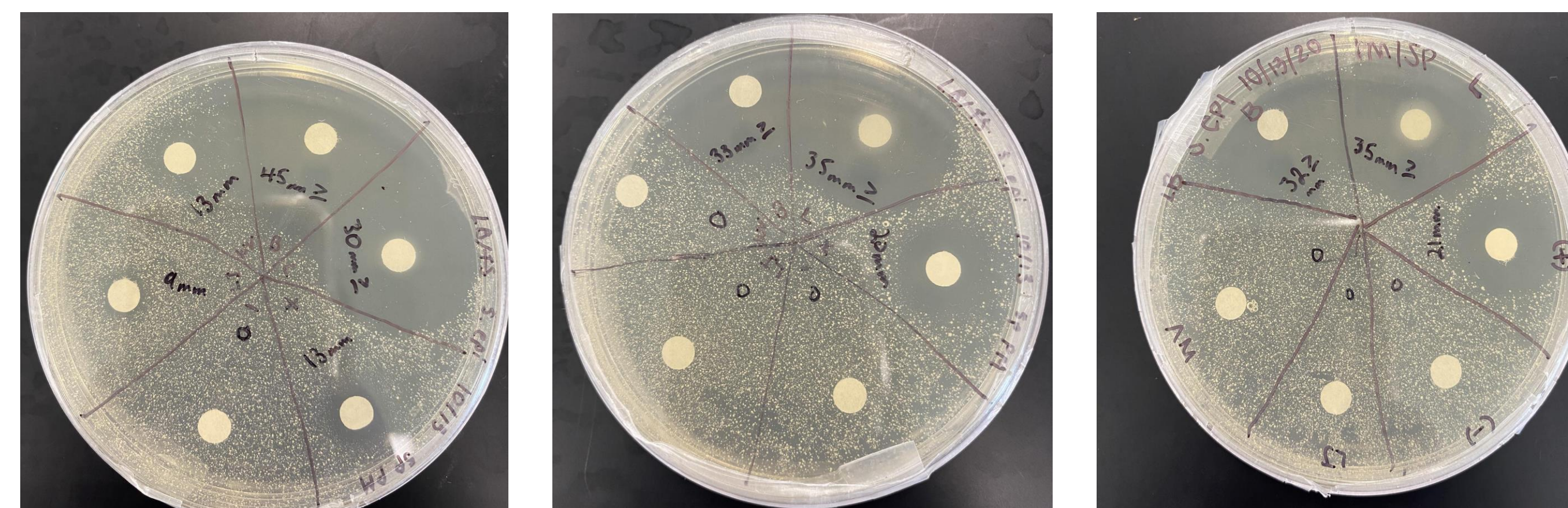


Figure 1: Three replicates of the treatments applied to *S. epidermidis* bacteria.

Table 1: Mean zone of inhibition for two natural chemicals (lemon juice and vinegar), two chemical disinfectants (bleach and Lysol), positive control (tea tree oil), and negative control (water).

Disinfectant	Tea Tree (+)	Lysol	Bleach	Lemon Juice	Vinegar	Water (-)
Mean of Zone of Inhibition	18	33.333	36.667	3	4.333	0
95% C.I.	4.933	3.267	8.186	5.88	8.493	0

Results

The chemical disinfectants (bleach and Lysol) had a significantly higher mean value for the zones of inhibition in comparison to the natural disinfectants (lemon juice and vinegar) ($F = 28.55$, $p\text{-value} = 2.88$, Table 1, Figure 1). Statistical significance between specific disinfectants were obtained using the Tukey's test (Figure 1). The zones of inhibition for both Clorox bleach and Lysol were statistically significant in comparison to both zones of inhibition of the natural disinfectants. Water was used as a negative control in this experiment; the zones of inhibition of both lemon juice and vinegar has no statistical significance when compared to water.

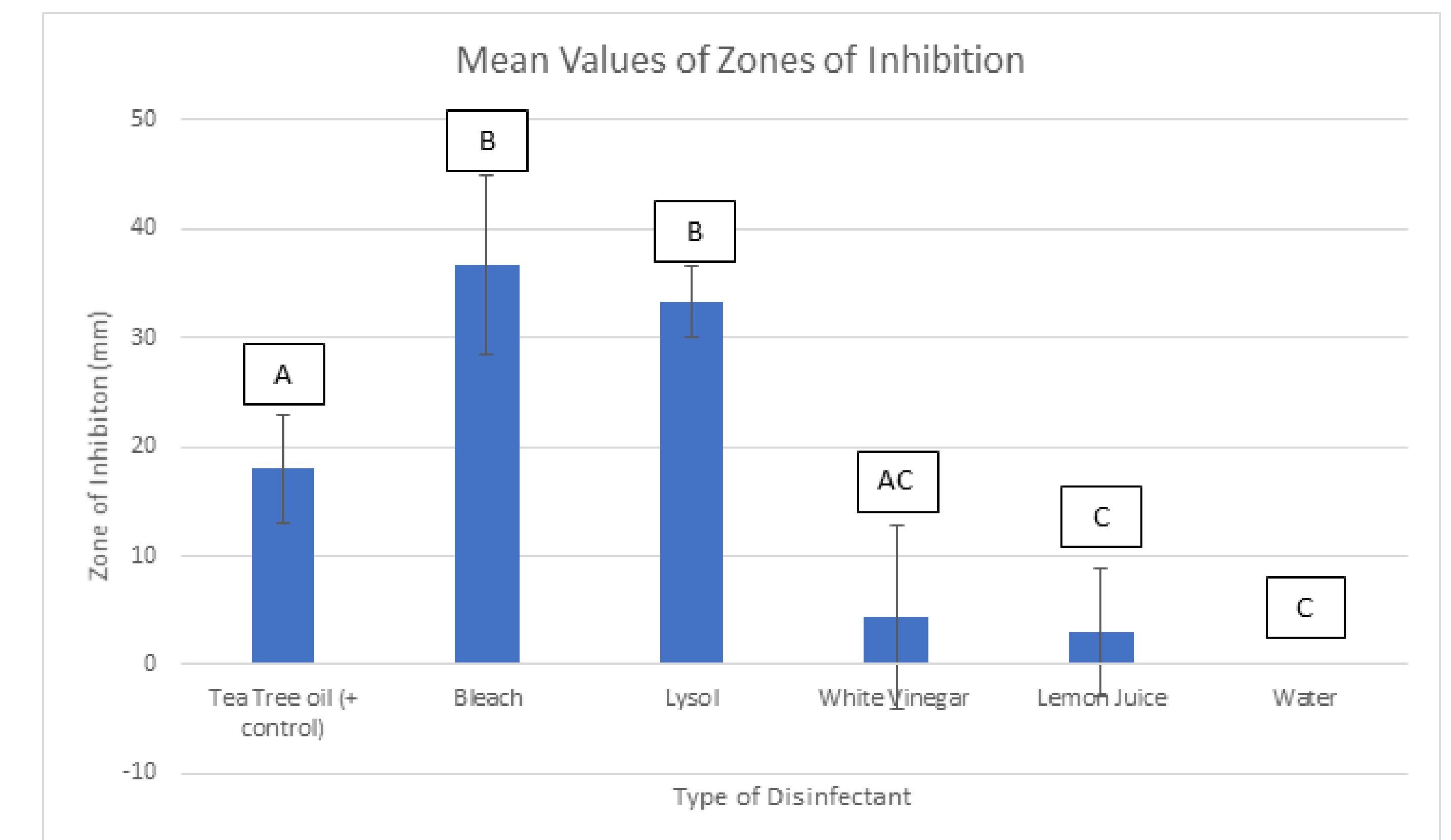


Figure 2: The mean (\pm 95% CI) zone of inhibition for each disinfectant. The letters above the bars demonstrate significant difference ($p\text{-value} < 0.05$) based on Tukey's Comparisons

Discussion

The purpose of this experiment was to determine the effectiveness of chemical and natural disinfectants against the gram positive bacteria *Staphylococcus epidermidis*. We hypothesized that the chemical disinfectants would be more effective than the natural disinfectants. The chemical disinfectants were concluded to be more effective than the natural disinfectants because the zones of inhibition generated by the chemical disinfectants were larger than the natural disinfectants. It can also be concluded that because the zone of inhibition for the natural disinfectants were not significantly different from the negative control (sterile water) the natural disinfectants were ineffective at inhibiting the growth of *S. epidermidis*. A source of error may have come from the placements of the chemical disinfectant soaked paper disks because the zones of inhibition produced by these of these disks overlapped. Possible solutions to this error would be to change the placement of the disks or have larger agar plates.

Conclusions

The results from this study support the hypothesis that chemical disinfectants are more effective at preventing the growth of the bacteria *S. epidermidis* than natural disinfectants. Further research would be needed in order to demonstrate the effectiveness of these disinfectants against other infectious pathogenic microbes like: the influenza virus, the gram negative bacteria *Escherichia coli*, and SARS-CoV-2 the virus responsible for the current global pandemic.

Contact

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