

# The Antibacterial Efficacy of Essential Oils

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**Abstract—** Rosemary, eucalyptus, geranium, lavender, and bergamot essential oils were tested for antibacterial properties on *B. cereus* and *E. coli* bacteria by disk diffusion. Geranium had the greatest inhibitory effect among all essential oils tested; equally antibacterial as Dettol™ antiseptic disinfectant.

## I. INTRODUCTION

Essential oils are concentrated plant products, often used for their aroma and natural health benefits, including antibacterial properties. Such properties could provide essential oils as a natural alternative to chemical antibiotics in the treatment of bacteria infections. However, antibacterial properties in essential oils could also disrupt the fragile and beneficial microbiome on human skin.

## II. METHODS

Rosemary, eucalyptus, geranium, lavender, and bergamot essential oils were tested for antibacterial efficacy on one gram-positive bacterium (*Bacillus cereus*) and one gram-negative bacterium (*Escherichia coli*). The oils were tested using the Kirby-Bauer disk diffusion method, in which the oil in question was introduced through a saturated 6 mm paper disk into the newly inoculated bacteria on an agar plate. Zones of inhibition were measured by diameter length. Five disks were introduced into ten plates for a total of fifty zone measurements per oil for each strain of bacteria.

Data was analyzed by comparing the mean sizes of the zones of inhibition. The ANOVA and *post-hoc* Tukey HSD tests were used to determine significance in observed mean differences between the various oils. The Student's t-test was used to determine significance in observed mean differences between *B. cereus* and *E. coli* bacteria.

## III. RESULTS

The differences between the mean sizes of the zones of inhibition (see Table I and Fig. 1) and the results of statistical significance tests indicate the following:

All tested essential oils and Dettol™ inhibited the growth of both *B. cereus* and *E. coli* bacteria. Eucalyptus, lavender, bergamot, and rosemary essential oils were equally inhibitory for *B. cereus* growth. The same pattern was true for *E. coli*, with the exception of rosemary essential oil, which had a lesser inhibitory effect than the other oils. Geranium essential oil and Dettol™ were equally inhibitory and were both more powerful antibacterial agents than the other tested substances.

All essential oils, excluding lavender, had a greater inhibitory effect on the growth of *B. cereus* than that of *E. coli*. Lavender essential oil inhibited the growth of both

bacteria equally, for unknown reasons. Another anomaly in the data was that *E. coli* had small zones of inhibition around dry disks with nothing on them, therefore resulting in greater inhibition in *E. coli* than in *B. cereus*, possibly due to chemicals in the paper disks.

TABLE I. AVERAGE SIZE OF ZONE OF INHIBITION AROUND VARIOUS ESSENTIAL OILS IN *B. CEREUS* AND *E. COLI* BACTERIA

Type of oil	Average Size <sup>a</sup> of Zone of Inhibition (mm±0.05 mm <sup>b</sup> )	
	<i>B. cereus</i>	<i>E. coli</i>
Zero (no oil)	0.000	0.780
Rosemary	6.424	3.188
Lavender	6.660	5.924
Bergamot	7.784	5.812
Eucalyptus	8.292	6.104
Dettol™	14.63	8.536
Geranium	15.54	10.47

a. Size determined by subtracting disk diameter (6 mm) from zone diameter

b. Digital metric caliper instrument uncertainty

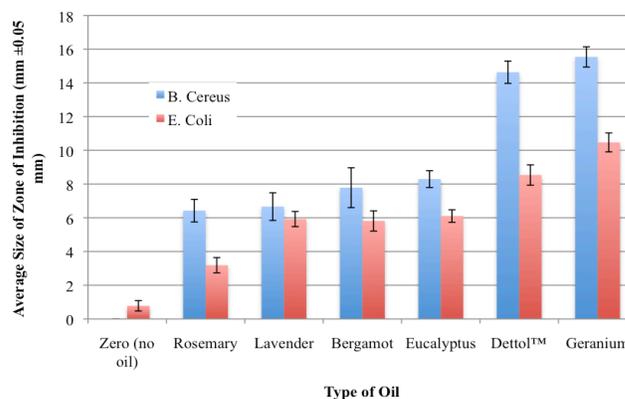


Figure 1. Average size of zone of inhibition around various essential oils in *B. cereus* and *E. coli* bacteria

## IV. CONCLUSION

Rosemary, eucalyptus, geranium, lavender, and bergamot essential oils all inhibited the growth of both *B. cereus* (gram-positive) and *E. coli* (gram-negative) bacteria, indicating antibacterial efficacy against most types of bacteria. This study indicates that geranium essential oil is the most effective antibacterial and rosemary the least of those tested. It can also be concluded that essential oils generally inhibit the growth of gram-positive bacteria more than that of gram-negative bacteria.