

2021 Summer

STEM

Academy @ UCA

Final Presentations

June 18, 2021

Some Acknowledgements

Dr. Ramesh Garimella

Program Director

**Dr. Todd Abel, Dr. Mark Doderer, Dr.
Krista Peppers**

Course Instructors

Jennifer Jones

Administrative Assistant

Misty Boatman, Brittany Berumen

Graduate Assistants

**Arkansas Department of Education
AEGIS Program**

Connie Storey, Program Advisor
for Office of Gifted & Talented

Students & Families

Maddox

Madeline

Molly

Parker

A petri dish containing various bacterial colonies of different sizes and colors (yellow, orange, pink, grey) is held by a gloved hand on the left. A pipette is visible on the right side of the image. The background is white.

What is the Disc-Diffusion Method?

By Madeline, Parker,
Maddox, and Molly

Who Are We?



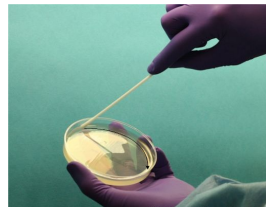
Madeline
left
Molly right



Maddox left
Parker right



The Disc-Diffusion Method



The disc-diffusion method is a way to test and compare the effects of certain substances on microbes. The steps are detailed below.

Step 1. Inoculate the petri dishes to create a lawn of growth with the microbe that's being tested.

Step 2. Create/find an extract to test.

Step 3. Using a pipette, drop the extract onto a small paper disc.

Step 4. Place the disc as well as a control disc that does not contain the extract on the inoculated petri dishes.

Step 5. Let the microbes grow (or not grow) in the incubator.

Step 6. Measure the zone of inhibition.

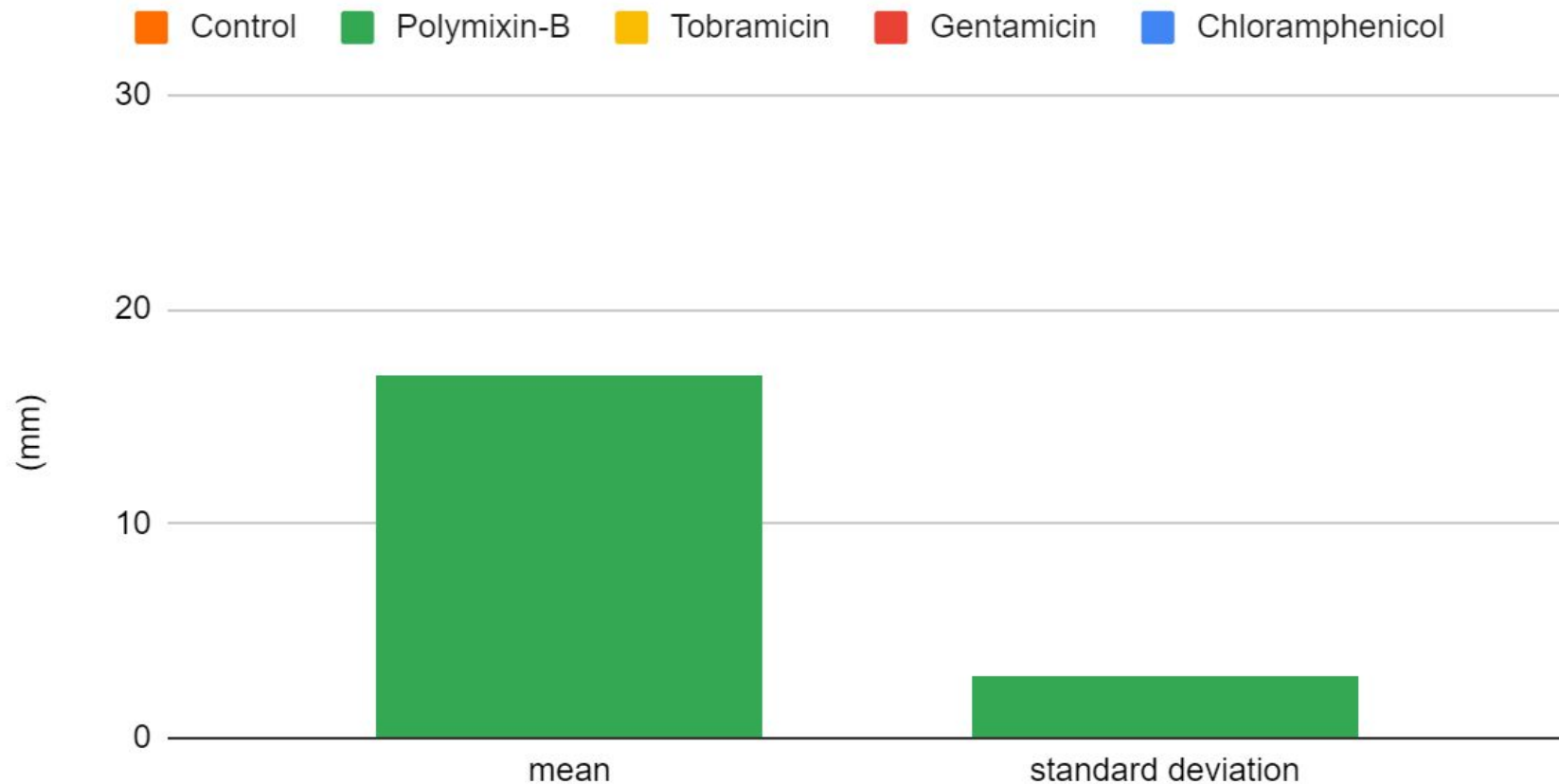


Antibiotic Data

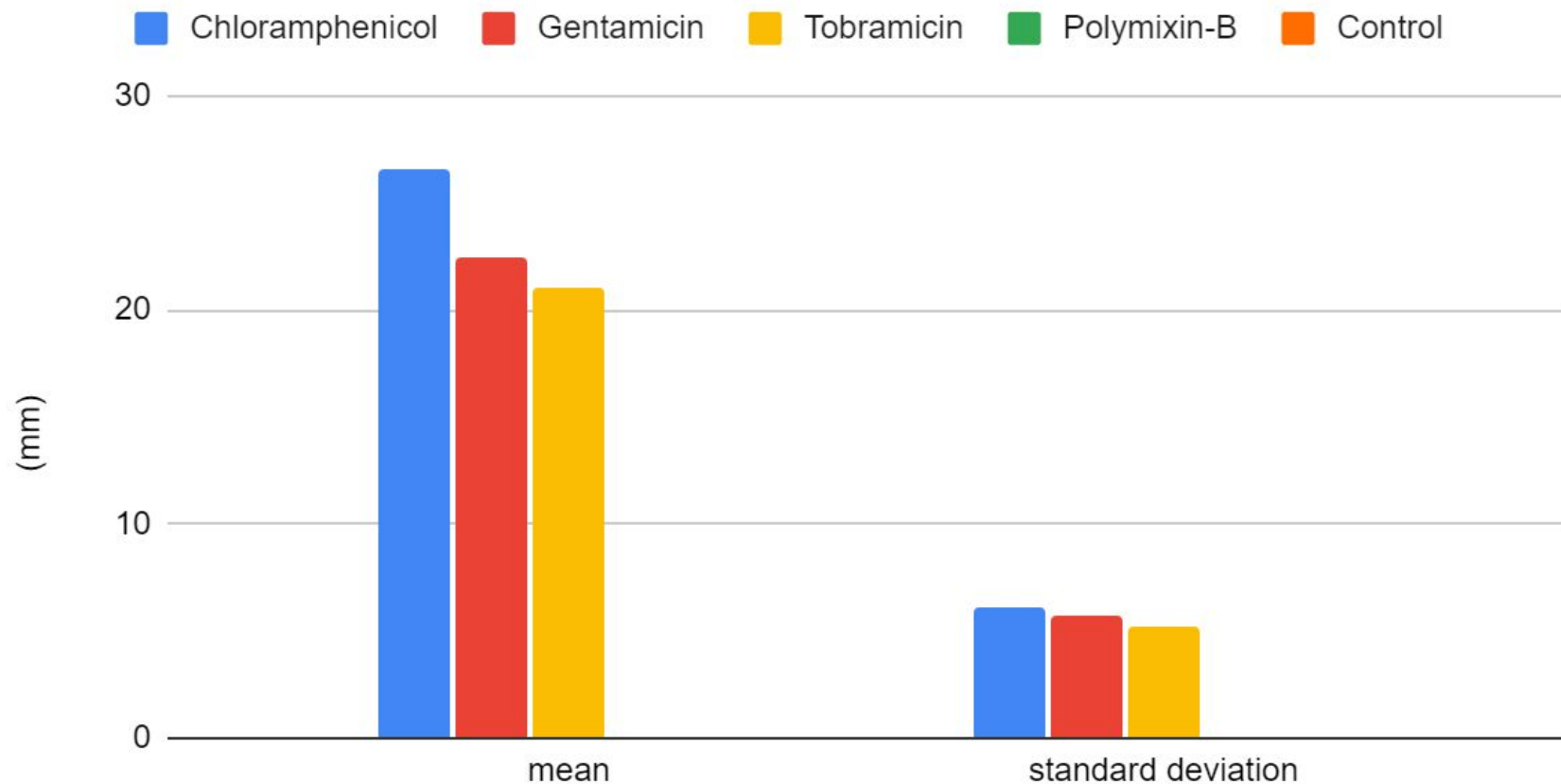
(diameter of Zone of Inhibition, measured in mm)

| Pseudomonas aeruginosa (Gram-negative) | | | | | Staphylococcus aureus (Gram-positive) | | | | |
|--|------------|------------|-------------|---------|---------------------------------------|------------|------------|-------------|---------|
| Chloramphenico | Gentamicin | Tobramicin | Polymixin-B | Control | Chloramphenico | Gentamicin | Tobramicin | Polymixin-B | Control |
| 0 | 0 | 0 | 17 | 0 | 30 | 22 | 24 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 32 | 26 | 18 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 30 | 26 | 18 | 0 | 0 |
| 0 | 0 | 0 | 19 | 0 | 30 | 24 | 26 | 0 | 0 |
| 0 | 0 | 0 | 20 | 0 | 14 | 11 | 12 | 0 | 0 |
| 0 | 0 | 0 | 17 | 0 | 32 | 25 | 21 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 28 | 20 | 18 | 0 | 0 |
| 0 | 0 | 0 | 12 | 0 | 31 | 25 | 24 | 0 | 0 |
| 0 | 0 | 0 | 19 | 0 | 30 | 30 | 24 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 28 | 22 | 26 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 29 | 25 | 24 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 20 | 23 | 20 | 0 | 0 |
| 0 | 0 | 0 | 17 | 0 | 29 | 28 | 21 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 24 | 25 | 26 | 0 | 0 |
| 0 | 0 | 0 | 20 | 0 | 30 | 28 | 25 | 0 | 0 |
| 0 | 0 | 0 | 15 | 0 | 26 | 27 | 22 | 0 | 0 |
| 0 | 0 | 0 | 8 | 0 | 31 | 20 | 28 | 0 | 0 |
| 0 | 0 | 0 | 17 | 0 | 27 | 7 | 19 | 0 | 0 |
| 0 | 0 | 0 | 19 | 0 | 14 | 22 | 6 | 0 | 0 |
| 0 | 0 | 0 | 18 | 0 | 32 | 22 | 26 | 0 | 0 |
| 0 | 0 | 0 | 17 | 0 | 24 | 14 | 18 | 0 | 0 |
| 0 | 0 | 0 | 12 | 0 | 12 | | 17 | 0 | 0 |

The Mean and Standard Deviation of the Zones of Inhibition of Four Antibacterials Against *Pseudomonas Aeruginosa* (gram-positive)

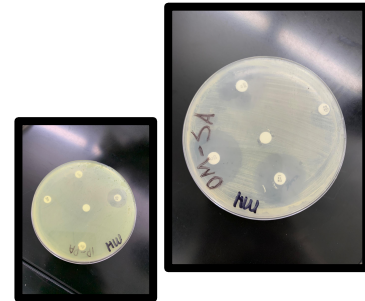


The Mean and Standard Deviation of the Zones of Inhibition of Four Antibacterials Against Staphylococcus Aureus (gram-negative)



Explanation of Graph and Our Plant Experiment

- First experiment based on the disc-diffusion method.
 - The bacteria *Pseudomonas aeruginosa* and *Staphylococcus aureus*, were introduced to four different antibiotics and the control.
- second experiment was seeing which plants have antibacterial effects on bacteria.
 - Ginkgo leaves
 - Ginkgo fruit
 - Hosta flowers.
 - No zone of inhibition (these plants are not effective as antibacterials)



Ginkgo Leaves



Hosta Flowers



Ginkgo Fruit



What We Have Learned

- The differences between bacteria and viruses
- How to create better graphs using Matlab
- New vocabulary terms relating to microbiology
- Practical applications for microbes in medical fields
- The links between different sciences and mathematics

Alex

Ava

Joaquin

Lillian

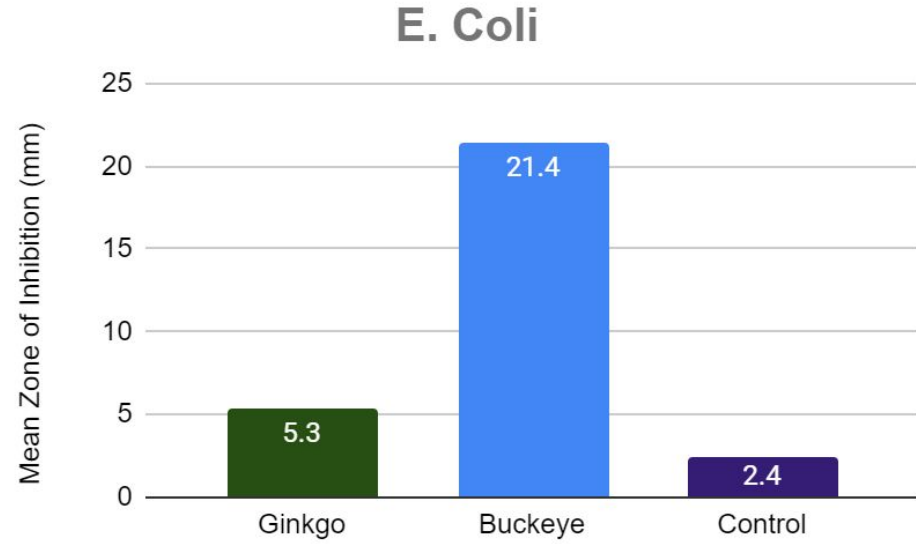
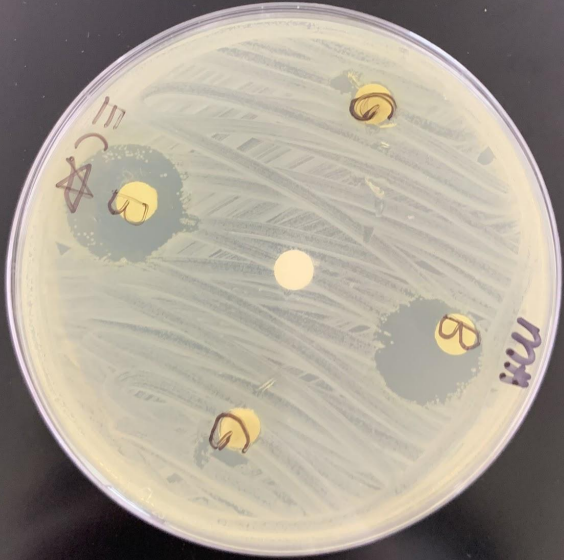
Investigation of how dried Ginkgo and Buckeye interact with various bacteria

By: Ava Clagett, Lillian Held, Alex Gutierrez, and
Joaquin Germain

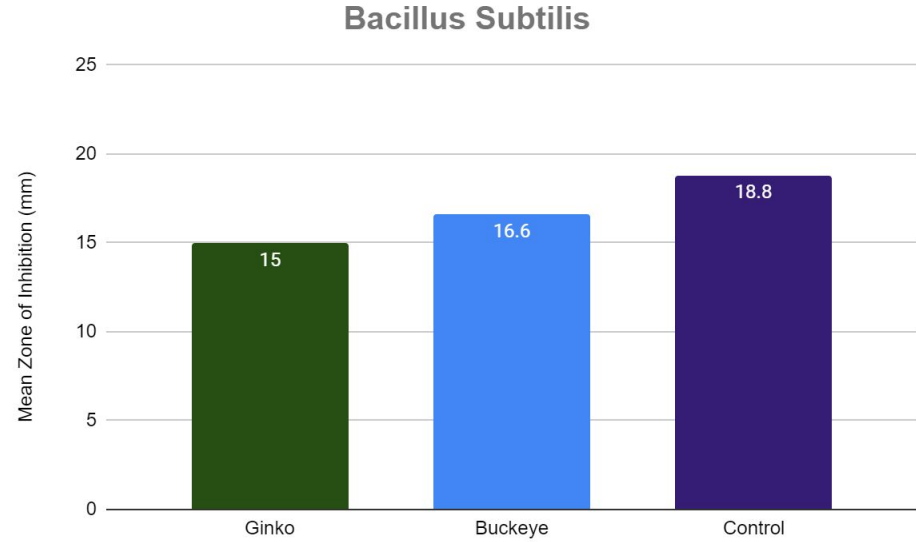
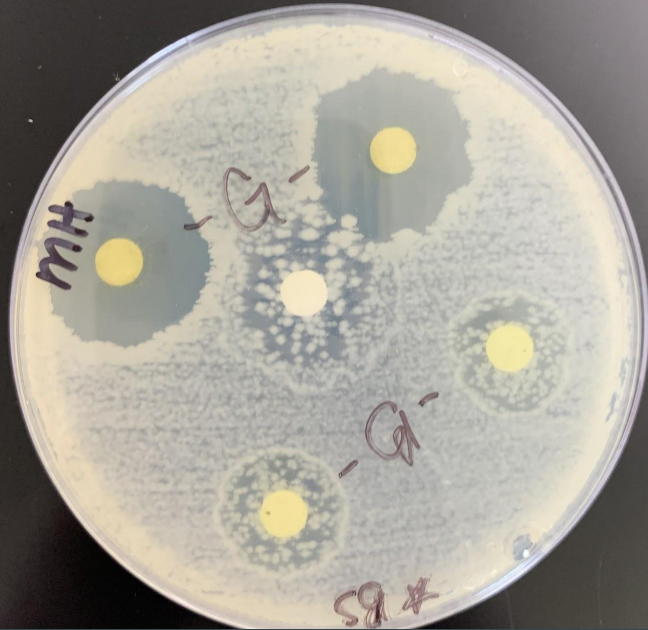
Hypothesis

Dried Ginkgo will inhibit the spreading of *Bacillus Subtilis*, *Micrococcus Luteus*, *E. Coli*, and *Serratia Marcescens* more than dried Buckeye.

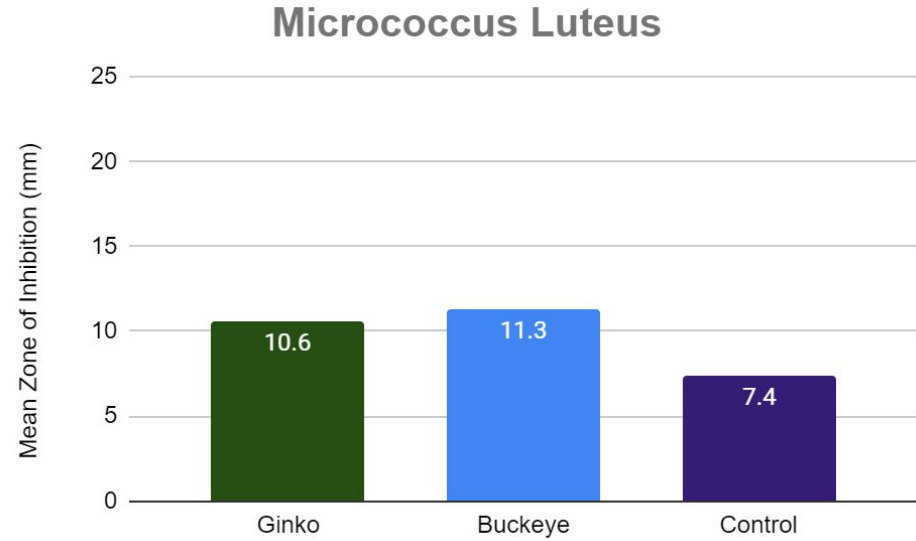
We used the same disk diffusion method that the other group described to test for antibacterial effects on the bacteria.



E. Coli
Gram-Negative



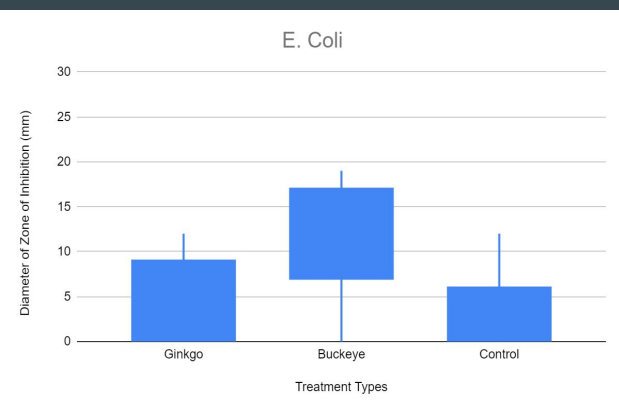
Bacillus Subtilis
Gram-Positive



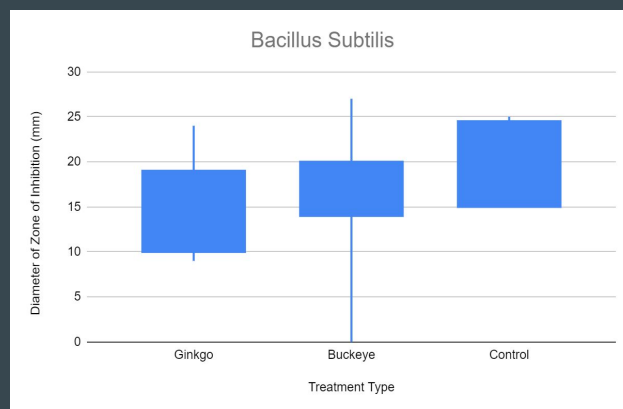
Micrococcus Luteus
Gram-Positive

Results

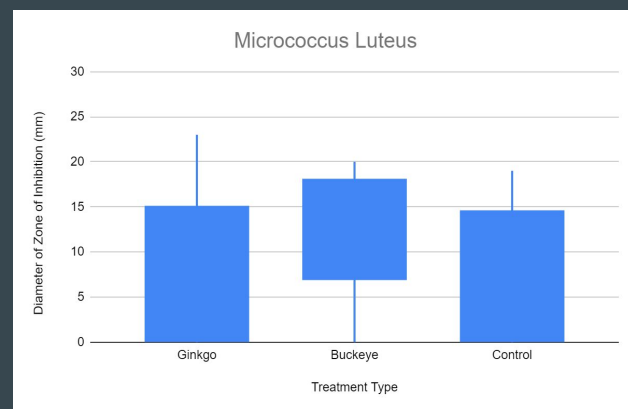
We also tested *Serratia Marcescens* (gram-negative), and the results were inconclusive. We did find one disk of buckeye where the zone of inhibition measured 23 (mm) in diameter.



Mean: Ginkgo 21.4, Buckeye 5.3,
Control 2.4



Mean: Ginkgo 15, Buckeye 16.6,
Control 18.8



Mean: Ginkgo 10.6, Buckeye 11.3,
Control 7.4

What We Have Discovered

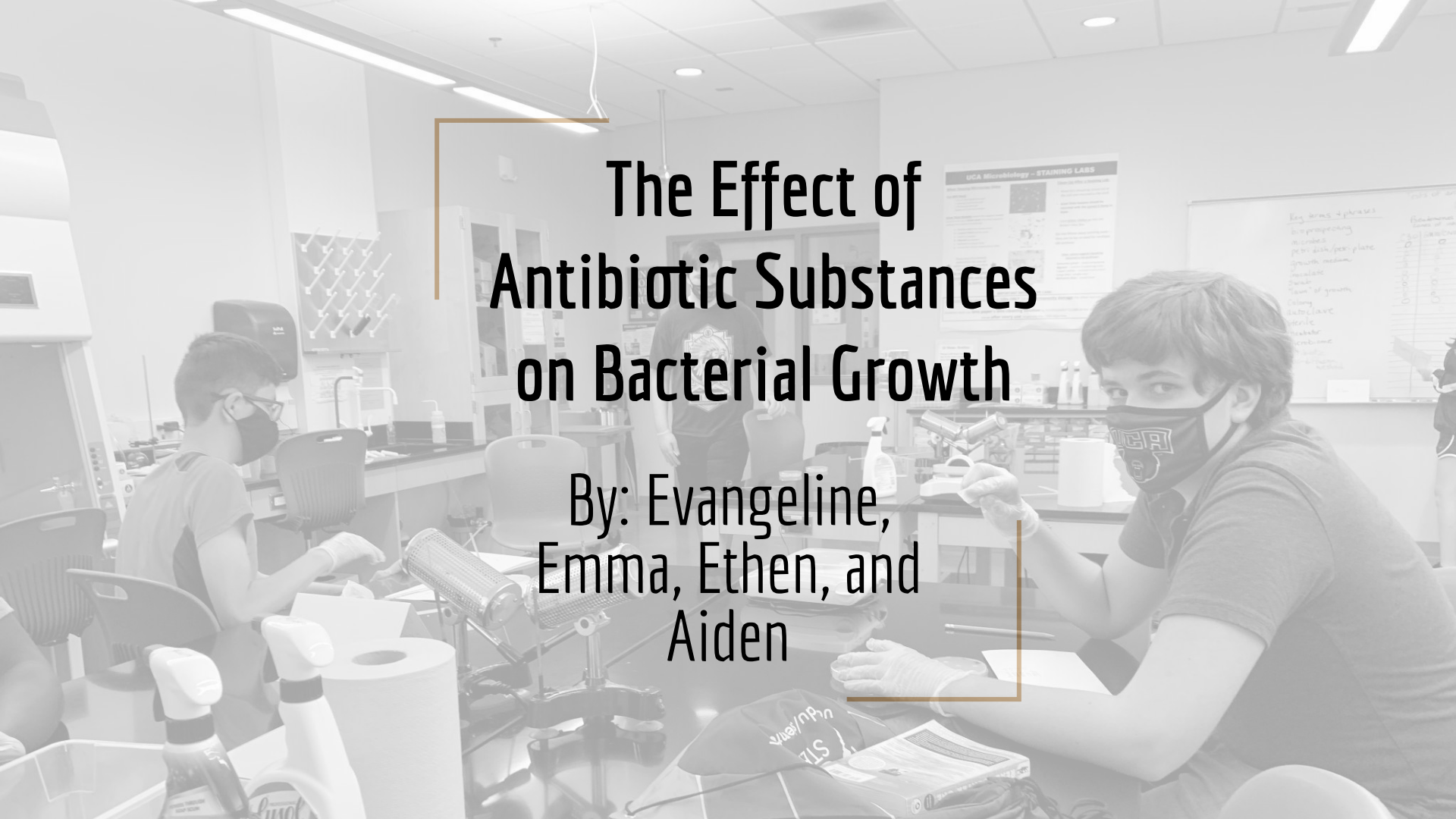
- You need to have a large sample size
- You want to minimize the number of variables
- Everything needs to be labeled clearly
- Buckeye has a greater effect on gram negatives than ginkgo
- How to analyze data
- Creating graphs through code
- How to apply statistics to data

Aiden

Emma

Ethen

Evangeline



The Effect of Antibiotic Substances on Bacterial Growth

By: Evangeline,
Emma, Ethen, and
Aiden

Our Questions

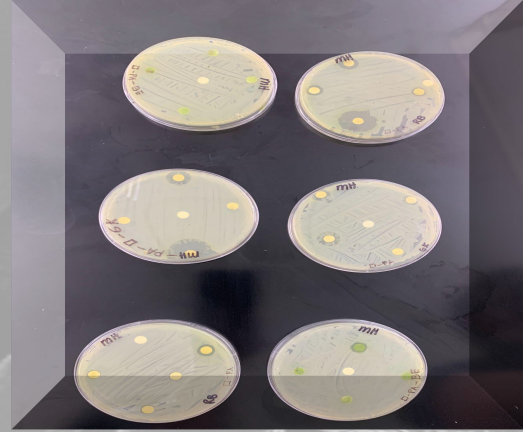
1. Which plants (Buckeye, Redbud, and Ginkgo) have antibacterial properties that are effective against *Pseudomonas aeruginosa*?

After we recorded the results from our original experiment, it led us to ask more questions;

2. If we use dried Buckeye leaves (the least performing plant) on *Micrococcus Luteus*, will we see different results from our original experiment with *Pseudomonas Aeruginosa*?
3. Do dried Buckeye leaves and dried Redbud leaves work better as an antibiotic against *Pseudomonas aeruginosa* when they are combined?

Our Process

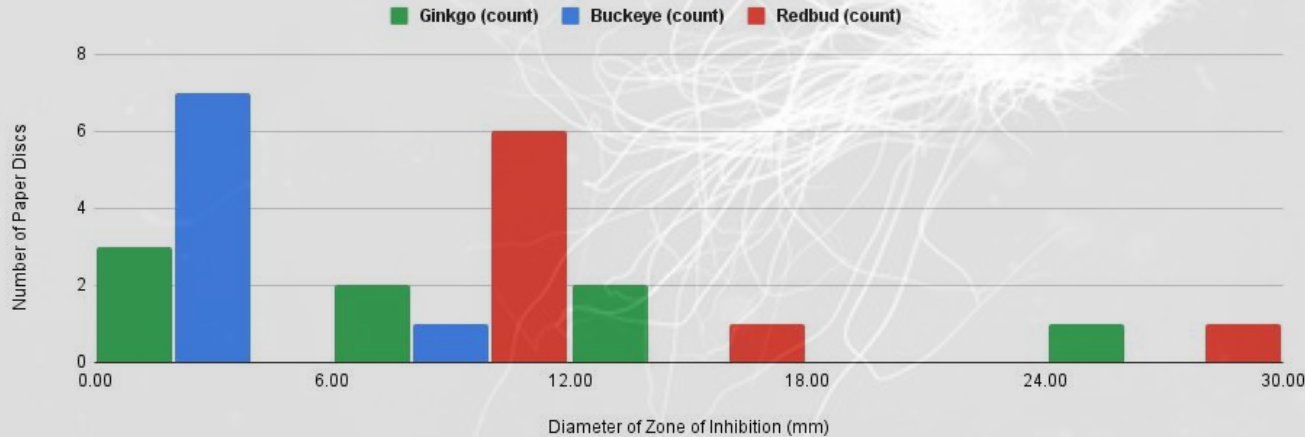
- We swabbed six petri plates with *Pseudomonas aeruginosa*
- Using a mortar and pestle, we crushed up dried Redbud, Ginkgo, and Buckeye leaves with rubbing alcohol
- We put one drop of the resulting substance on paper discs and placed them on multiple petri plates
- Next, we put a blank paper disc in the middle of each petri plate to act as a control
- Finally, we put the petri plates in the incubator.



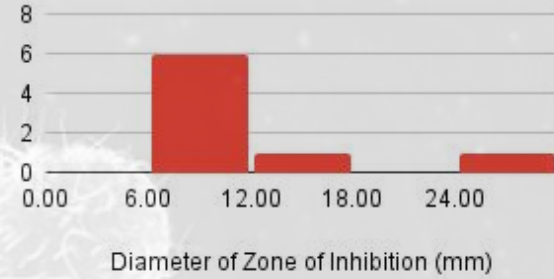
Our Results

When we took the petri plates out of the incubator, we found some interesting results! Here are bar graphs showing what we found:

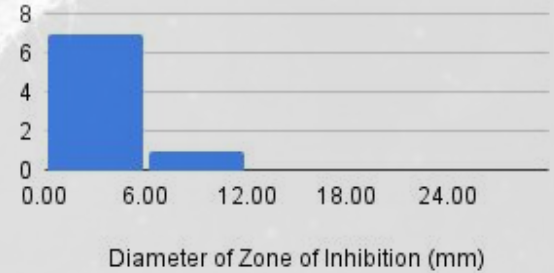
All Antibacterial Substances Compared



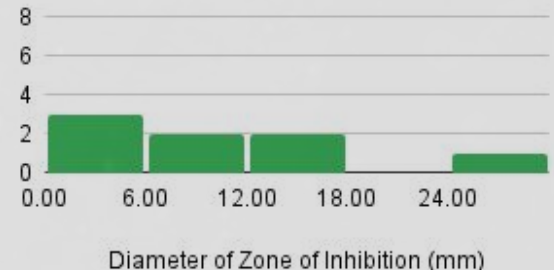
Dried Redbud






Dried Buckeye



Dried Ginkgo



What We Learned

| | Dried Redbud  | Dried Ginkgo  | Dried Buckeye  |
|--|--|--|---|
| MEAN diameter of the zone of inhibition | 10.875 | 9.25 | 1 |
| MEDIAN diameter of the zone of inhibition | 10 | 10.5 | 0 |
| STANDARD DEVIATION diameter of the zone of inhibition | 5.617256575 | 8.892211681 | 2.828427125 |

What We Learned

- Dried Buckeye was not proved effective against *Pseudomonas aeruginosa*.
- Dried Redbud was most effective against *Pseudomonas aeruginosa*.
- Not all of the zones of inhibition were totally clear of bacteria.
- Several zones of inhibition still had some growth of bacteria, but there was definitely much less growth than the surrounding areas.
- These findings showing that dried Redbud and dried Ginkgo kill *Pseudomonas aeruginosa* are especially interesting considering that *Pseudomonas aeruginosa* can grow in a bottle of disinfectant!

These results sparked us to experiment further, so we tried combining the dried Redbud and dried Buckeye to see if they were more effective together.



More Results

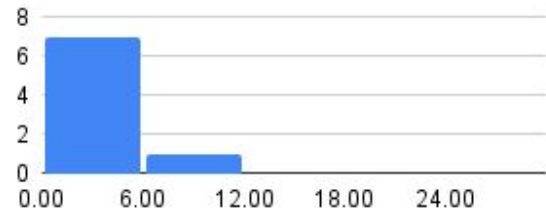
- It was not proved that the efficacy of dried Buckeye and dried Redbud increased when they were combined.
- dried Redbud zone of inhibition: 10.875 mm diameter average
- dried Ginkgo zone of inhibition: 9.25 mm diameter average
- dried Buckeye zone of inhibition: 3.25 mm diameter

Dried Redbud



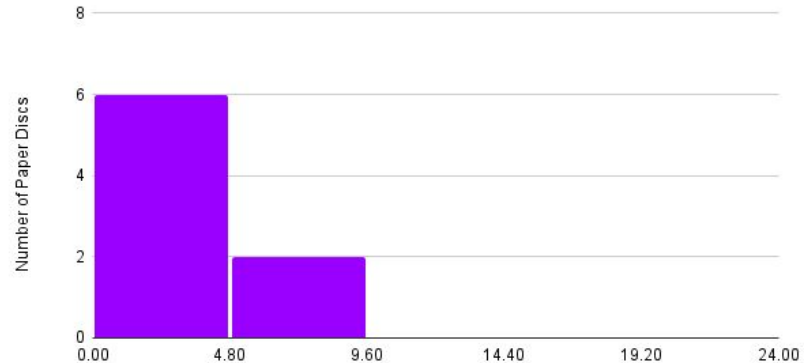
Diameter of Zone of Inhibition (mm)

Dried Buckeye



Diameter of Zone of Inhibition (mm)

Combined Redbud + Buckeye Leaves



Diameter of Zone of Inhibition

We were also curious about the efficacy of dried Buckeye against a Gram-positive bacteria, *Micrococcus Luteus*.

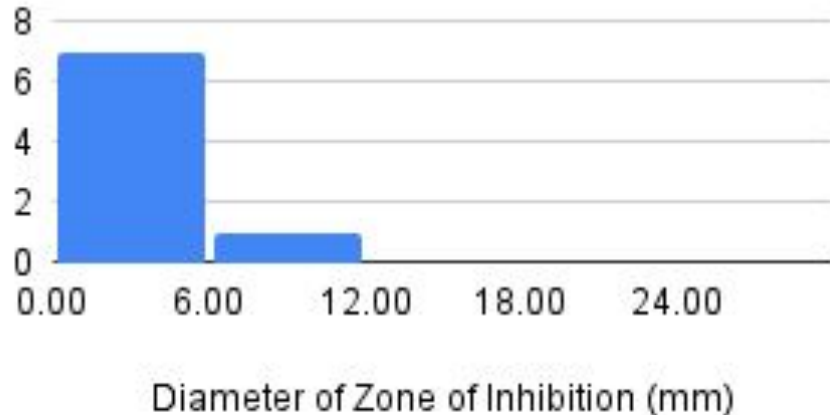




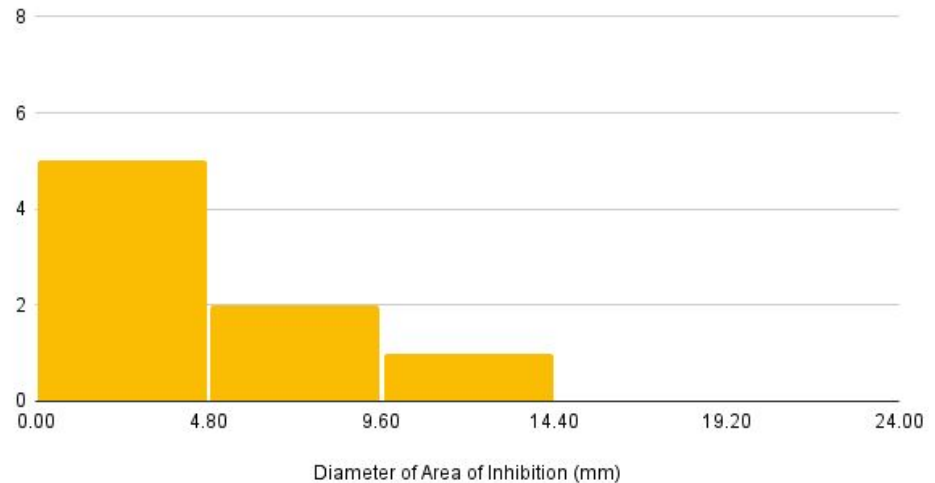
What We Found

- Dried Buckeye's efficacy improved somewhat when used against a gram-positive bacteria
- Both bar graphs have a median of 0
- The mean of the diameter of the zone of inhibition increased from 1 to 3.25.

Dried Buckeye



Buckeye Tested on Gram Positive Bacteria



What we learned

- Ginkgo and Redbud leaves have a greater effect than Buckeye leaves in all the experiments.
- Redbud and Buckeye mixed together didn't have as big of an effect as Redbud alone, but still had more of an effect than just Buckeye on its own.
- During the camp we learned:
 - How to use MatLab to code graphs
 - How to compile data and design experiments
 - And the basics of microbiology, including how to test plants for their antibiotic properties
- We were given the opportunity to explore how Mathematics, Computer Science, and Microbiology are all connected.

Benjamin

Ian

Zeke



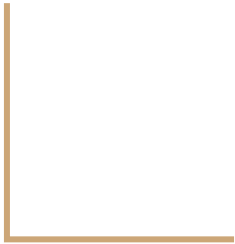
The Effect of Dried Ginkgo and Buckeye Leaves On Bacteria

By: Benjamin, Ian, Zeke



What is the effect of dried
Buckeye and Ginkgo leaves on
bacteria?

The Experiment



How we did it.

We used the disk diffusion method, as explained by the first group, to test dried Ginkgo and Buckeye leaves on thr



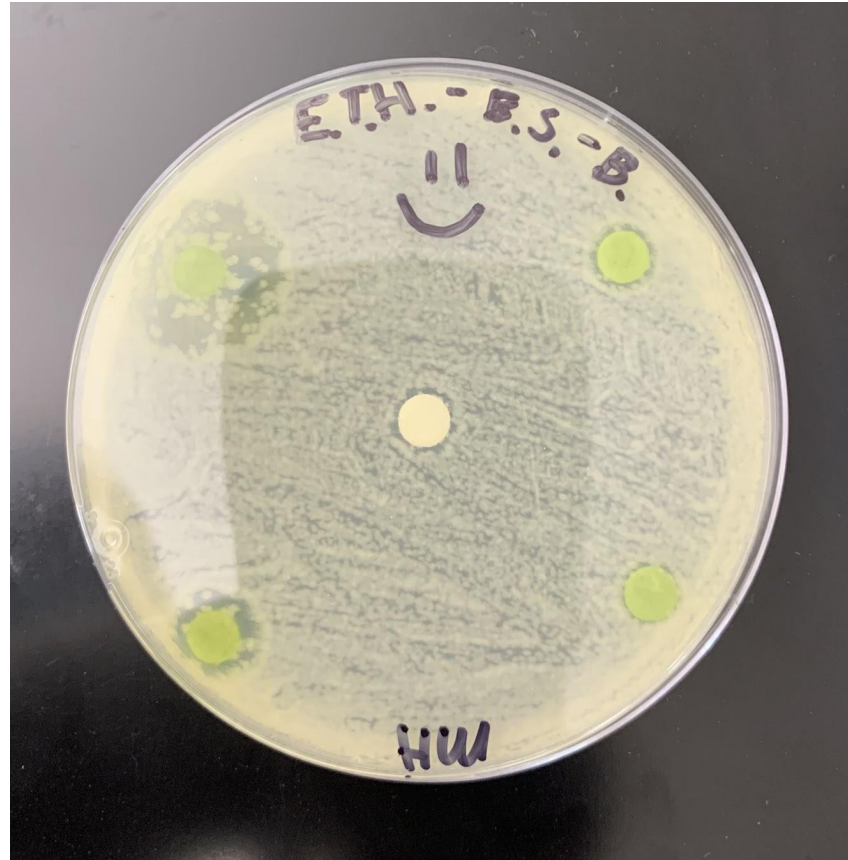
Bacillus Subtilis

This bacteria is our only gram positive. A gram positive bacteria only has one membrane making it easier to kill than a gram negative.



What does dried Buckeye do to Bacillus?

Well as you can see this came with some strange results, it seems to be able to somewhat kill the bacteria, I am guessing that it just isn't strong enough to kill certain generations of Bacillus. In other words they evolved fast enough to get used to this weak antibacterial.



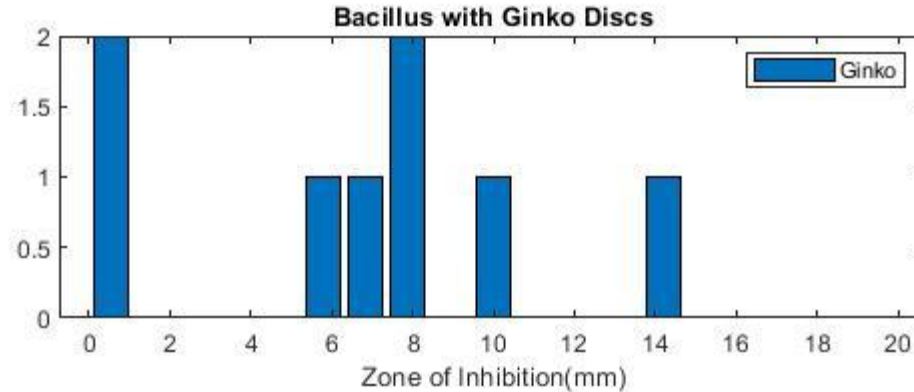
What does dried Ginkgo do to Bacillus?

Ginkgo seems to be stronger than the buckeye but has a smaller area of inhibition.

Well, we now know there is some grounding in the belief that it is healthy, just do not use this as a health drink.

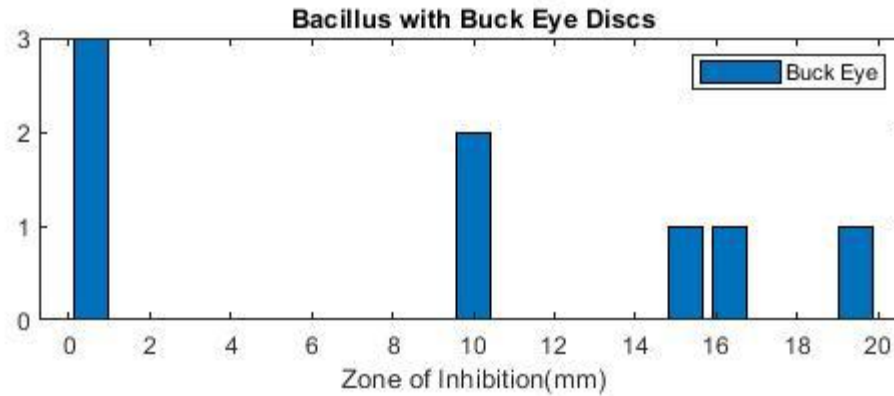


Bacillus Graphs



mean:3.63mm

**Standard
Deviation:
5.13mm**



mean:

1.88mm

**Standard
Deviation:
3.48mm**

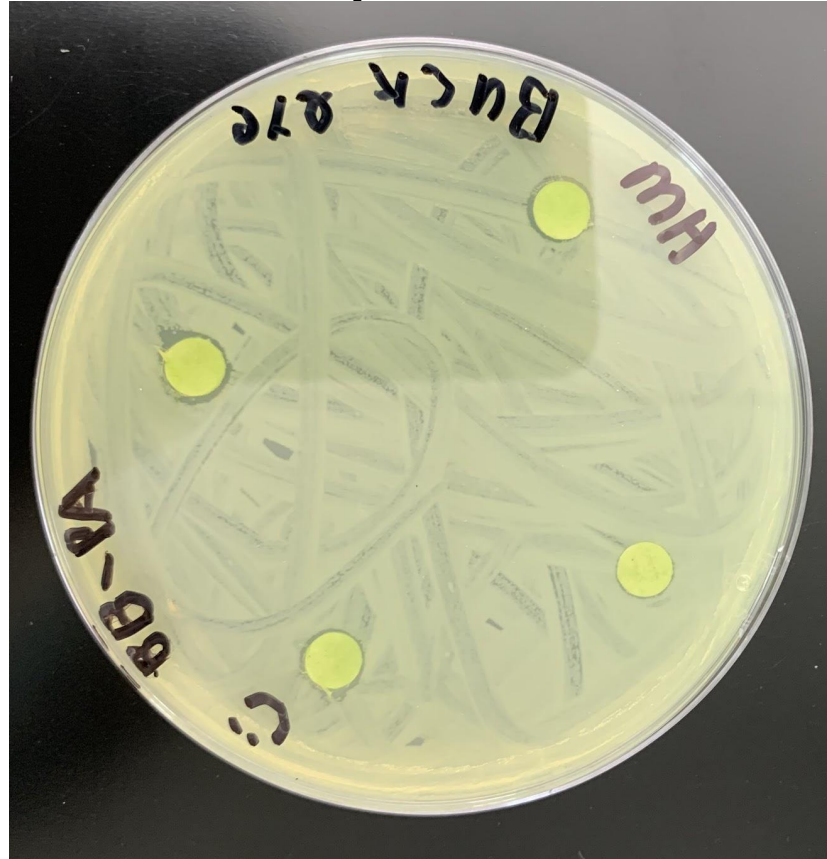
Pseudomonas Aeruginosa

This our first gram negative bacteria. This means that is has an extra membrane making it more resistant to antibiotics.



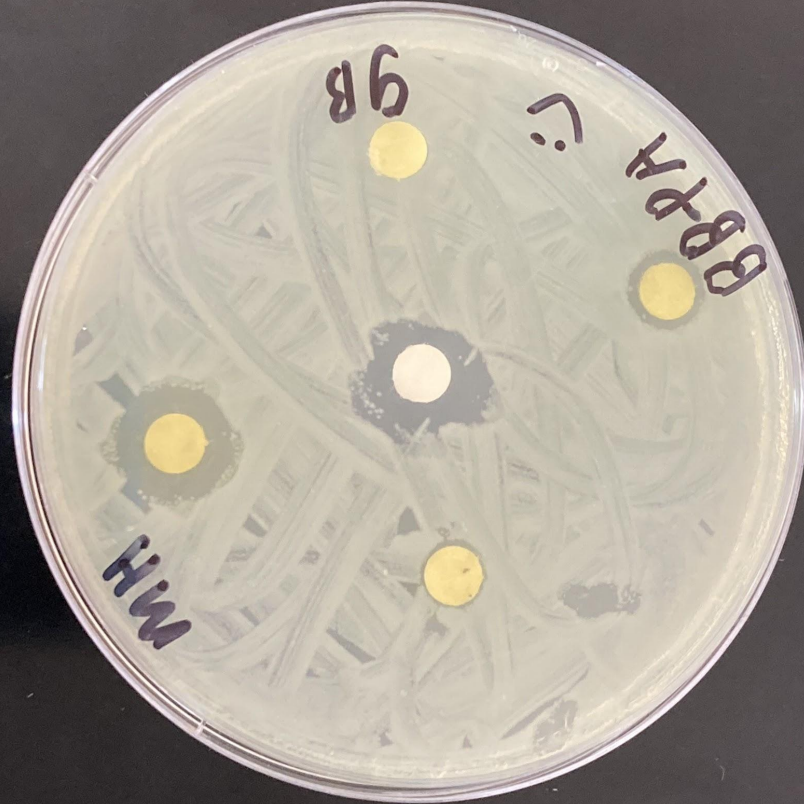
What does dried Buckeye do to Pseudomonas?

As you can see it didn't really do anything, but as Albert Einstein said, "A person who never made a mistake never tried anything new."

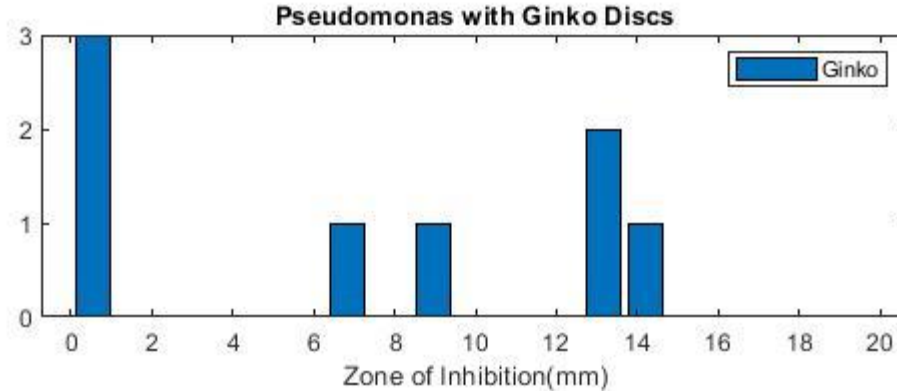


What does dried Ginkgo do to Pseudomonas?

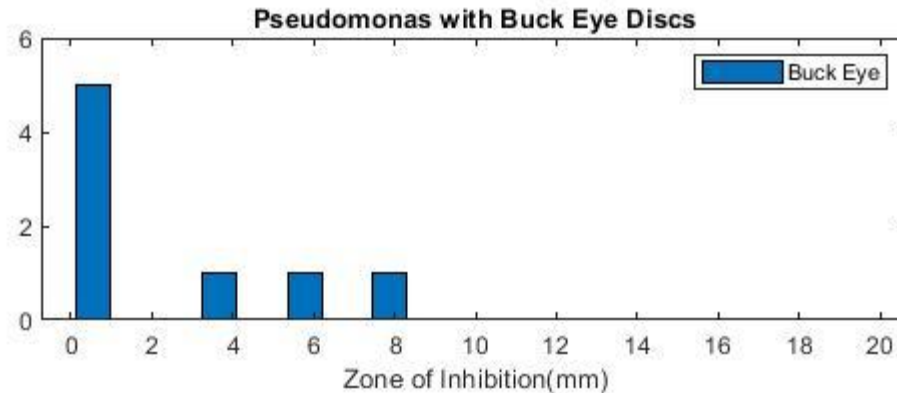
This time it worked quite well! Ginkgo is yet again proving superstitions, but I repeat it is not good for your microbiome either.



Pseudomonas Graphs



**mean:7m
m
Standard
Deviation:
6.23mm**

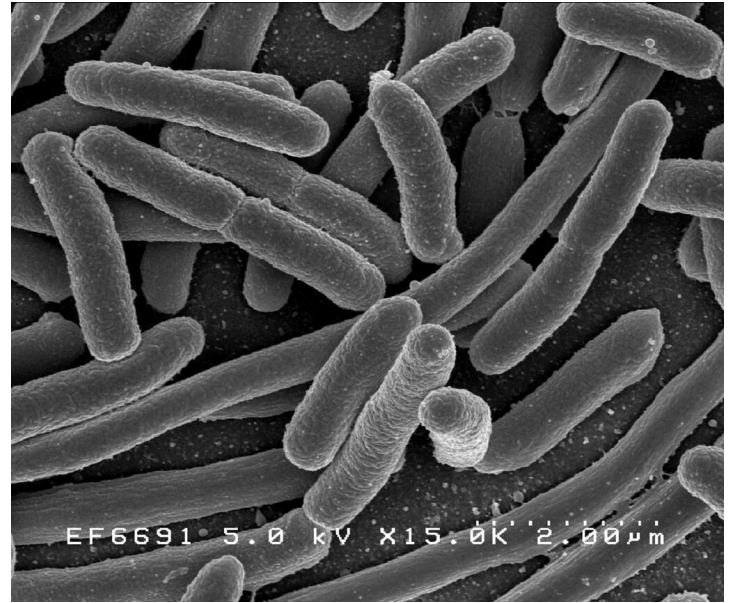


**mean:2.25mm

Standard
Deviation:
3.28mm**

Escherichia coli (E. coli)

This is our second gram negative bacteria. E. coli is commonly used for experiments on gram negative bacteria, kind of like the lab rat of the bacterial world.



What does dried Buckeye do to E. coli?

Buckeye once again wasn't too effective, but it did provide a small area of inhibition in the lower corner.

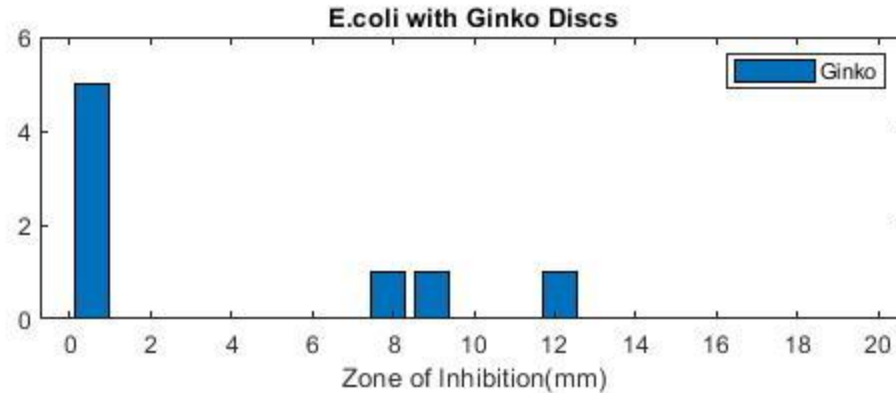


What does dried Ginkgo do to E. coli?

For this one we do not have a picture but, just imagine it looks like the Ginkgo for Pseudomonas.

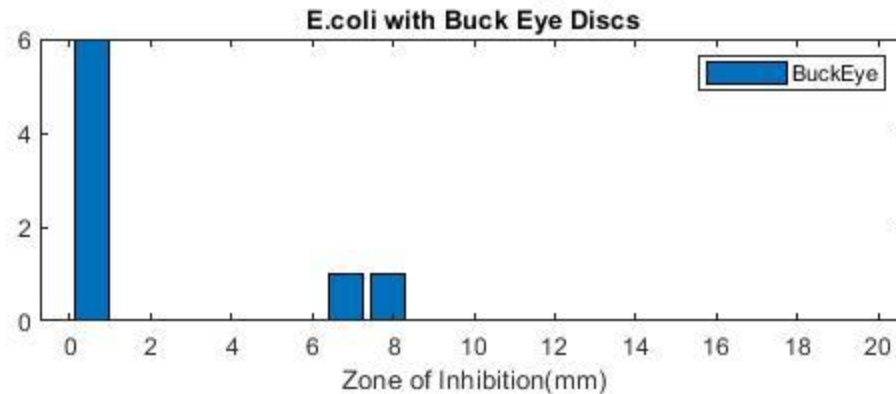


E. coli Graphs



mean:5.625mm

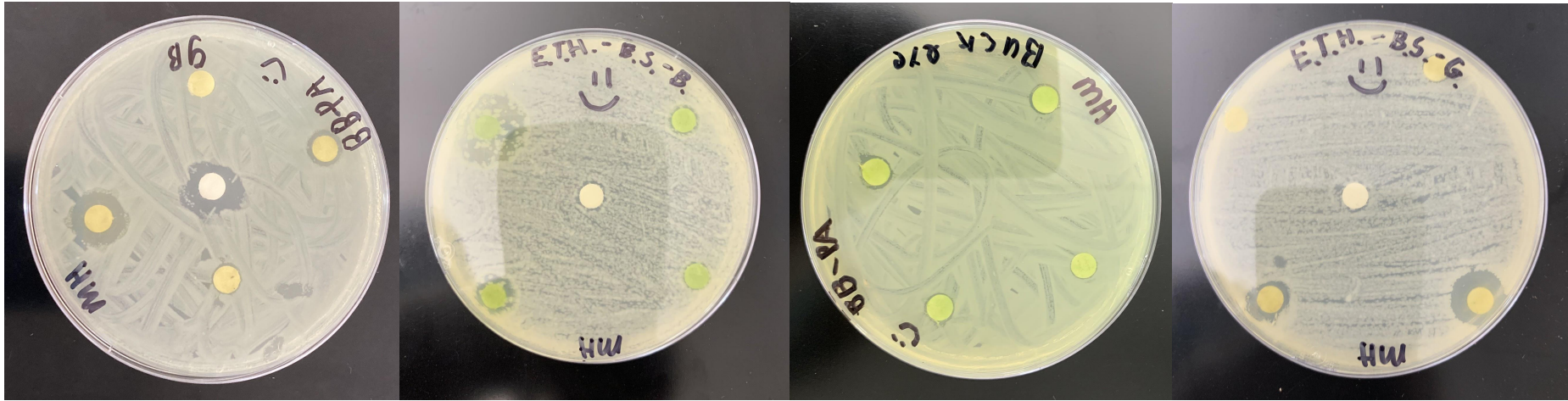
**Standard
Deviation:
5.24mm**



mean: 8mm

**Standard
Deviation:
7.63mm**

In conclusion Ginkgo seems to be more effective than buckeye against these three bacteria species.



Ginkgo: Yellow
Buckeye: Green

Isani

Jillian

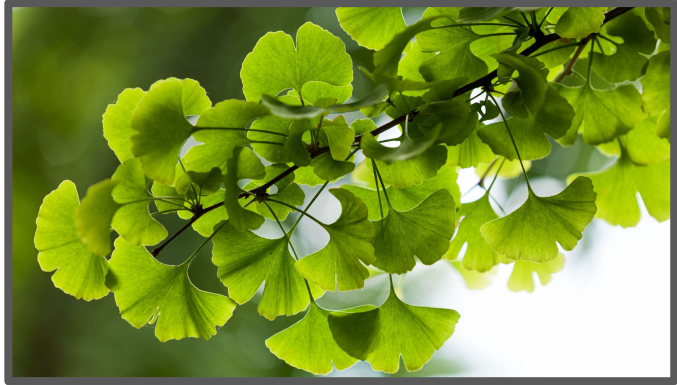
Octavio

Todd

Antibiotics in Plants

By: Octavio, Todd, Isani, and Jillian

Are Ginkgo Leaves, Buckeye Fruit, or Poison Ivy Leaves Effective in Preventing Different Types of Bacterial Growth?



Ginkgo tree leaves



Buckeye tree nut



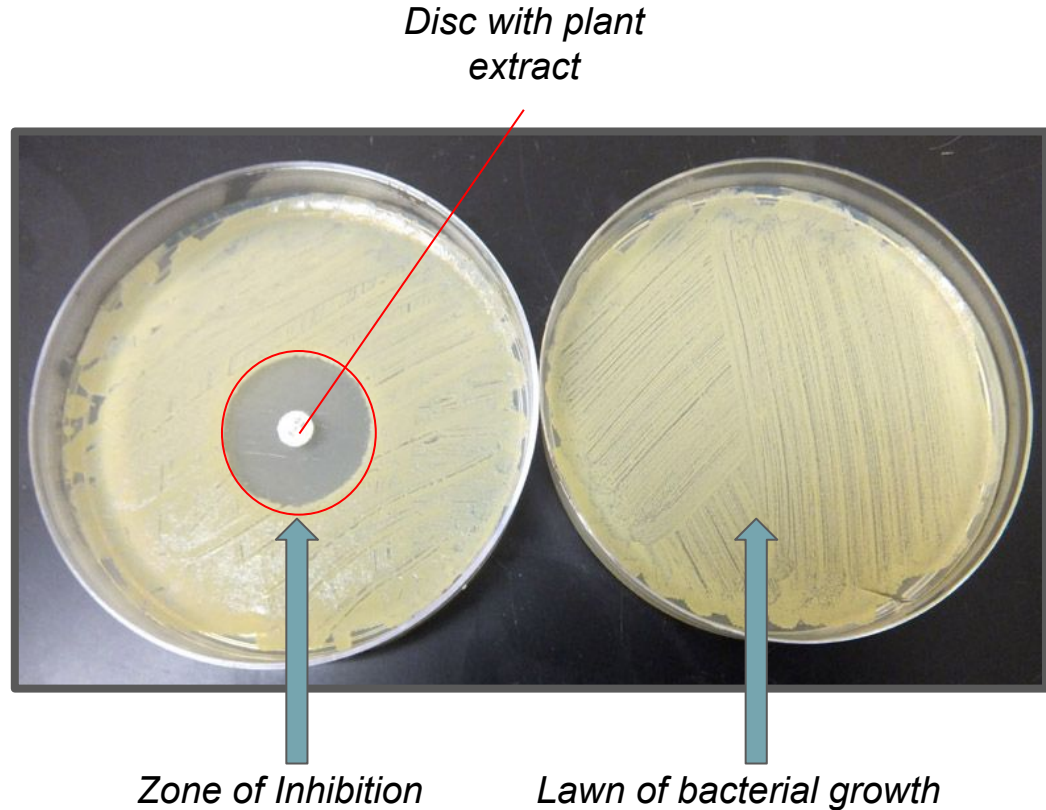
Poison ivy leaves

Setup of the Experiment

Bacteria used:

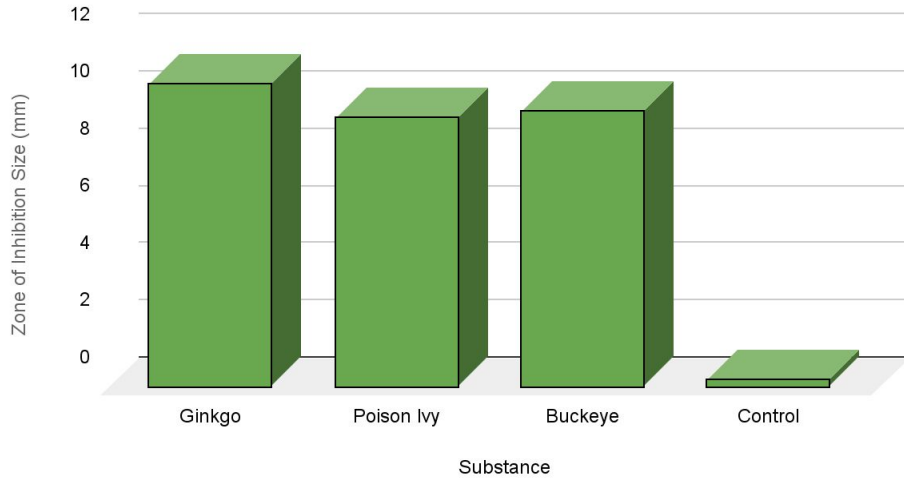
- *S. aureus* (gram -)
- Buckeye fruits
- *E. coli* (gram +)
- Poison ivy leaves

Bacterial “lawns” of growth created on petri dishes
Plant extracts soaked onto paper discs
Soaked discs placed on petri dishes
6 petri dishes for each bacteria
One day later the Zone of Inhibition is measured to determine effectiveness of the plants’ antibiotic properties

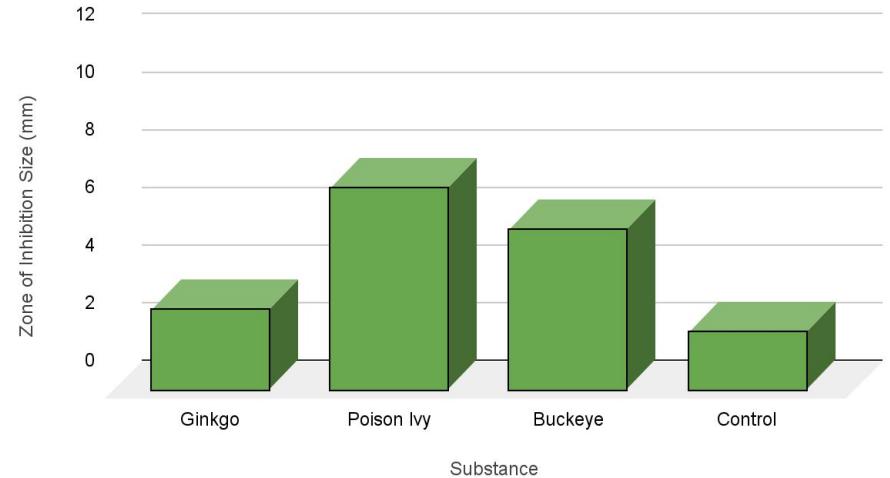


Data/Results

Natural Substances Against *Bacillus subtilis*



Natural Substances Against *E. coli*



Analysis and Conclusion

- **Ginkgo Leaves**

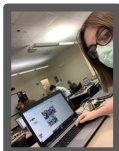
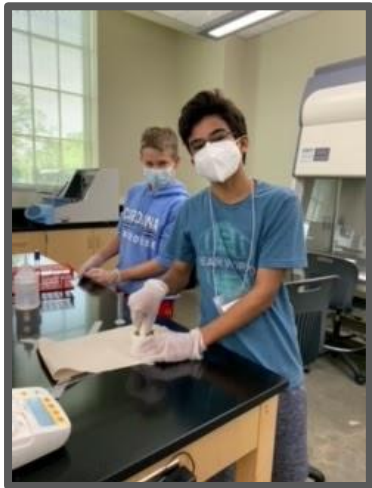
- Ginkgo definitely has antibacterial components
 - Effectively killed *Bacillus subtilis* (g-), but struggled against *E. coli* (g+)

- **Buckeye Fruit**

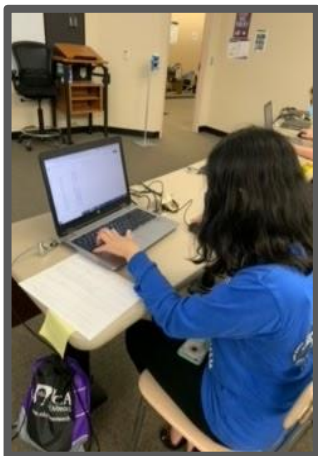
- Premature fruit used
 - More effective against *Bacillus subtilis*
 - less effective against *E. coli*

- **Poison Ivy Leaves**

- Not extremely effective in fighting *E. coli* or *Bacillus subtilis*



**Thank
You!**



Benjamin

Cody

Gavin

Lyndsey

Investigating Antibacterial Activity in Plants

By: Gavin Law, Lyndsey Mcdonald, Benjamin
Bannerman, and Cody Wright

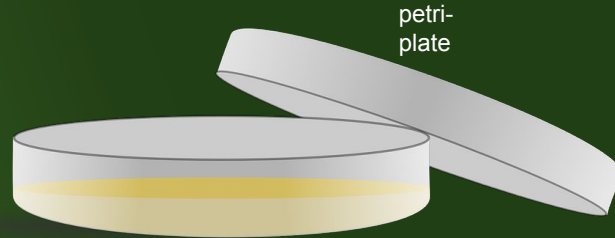
Our Research Question:

Does the Purple Giant Hyssop or the Umbrella Magnolia have the strongest antibacterial activity?

Purple Giant Hyssop



Scientific Name: *Agastache scrophulariifolia*



Method:

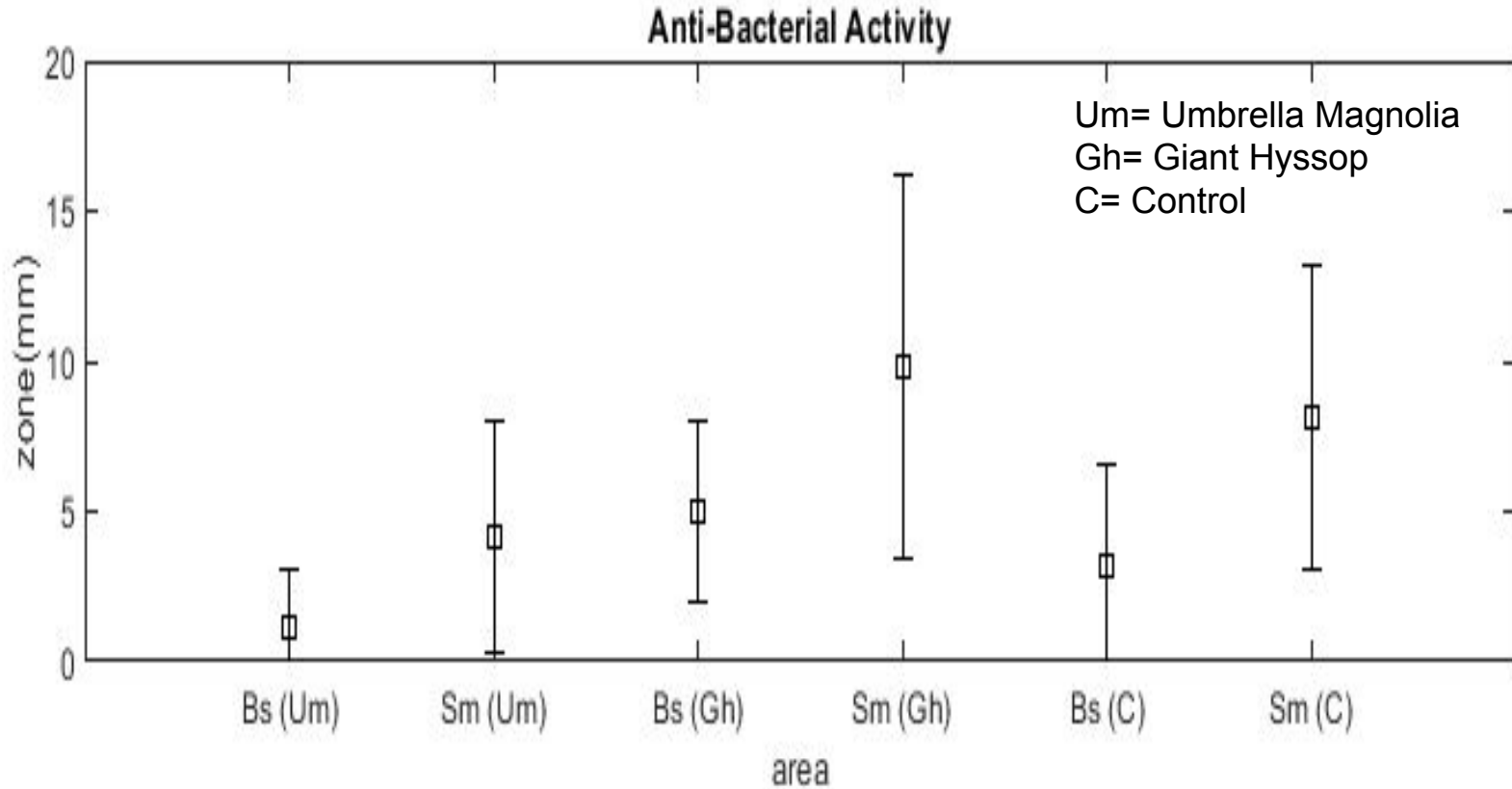
- We used the disk-diffusion method
- We inoculated petri-plates with swabs
- We used *Bacillus subtilis* and *Serratia marcescens*
- We used fresh Umbrella Magnolia leaves and fresh Purple Giant Hyssop flowers
- We used 10 dishes of each bacteria, each dish contained one disk of Gh, one disk of UM, and one disk of our control

Umbrella Magnolia



Scientific Name: *Magnolia tripetala*

Experiment Results



Data Analysis

As seen in the graph in the previous slide, the control did better than the Umbrella Magnolia (UM), but worse than the Purple Giant Hyssop towards both substances. This shows us that the alcohol has stronger antibacterial activity, which means that the Umbrella Magnolia leaf somehow contradicted the alcohol in the control. Overall, the Giant Purple Hyssop did better than the control and the Magnolia leaf.

What We Learned

We learned a lot throughout the week! Here is some of what we learned:

- How to set up experiments involving bacteria
- Vocabulary: petri-plates and inoculation
- How to graph statistics using a coding program
- Differences between bacteria and viruses
- The Giant purple Hyssop did the best.

Overall, we learned a lot of interesting information about coding, analyzing data, and Microbiology!