Philosophy that stuck with me throughout the recent years of my life. And I've explored many aspects of my life with using that philosophy. But one aspect I really wanted to look further into was medicinal. How do [inaudible 00:00:23] antibiotics in inhibiting the growth of Staphylococcus aureus for treating skin infections? Now, these were the objectives of my study. Staphylococcus aureus [inaudible 00:00:31] contagious bacterium that causes infections.

It poses significant threat throughout the world. The United States with 20,000 deaths in 2017 alone. This bacterium is a diverse bacterium, meaning it does not discriminate. Healthy humans like you and I are already a reservoir for S. Aureus flourishing. In 2016, Kong's team observed that 75% of the community cases were acquired by children. People who have autoimmune diseases, diabetes undergone, recent surgery or drug use history are even higher risk of contracting S. Aureus. Unfortunately, since the 1960s, when S. Aureus was first characterized, treatment hasn't changed much.

What has changed is the bacterium susceptibility to antibiotics. Now, an astonishing 92% of staphylococcus aureus strains were completely resistant to penicillin. What is even more concerning is that the type of antibiotic that we are using these days are becoming exponentially more harmful. Current synthetics such as benzo peroxide are our current options. However, they still present with a myriad of side effects. So what can we use that won't have so many adverse effects in our bodies, which leaves me to essential oils.

Now, essential oils are pure oils of flora and they've been used for their medicinal properties since antiquity. Cubezeca 2020 research noted that people have been using essential oils for its naturally healing and medicinal properties, but it seems to just disregard them and turned to the world of synthetics. This is the four essential oils that I've chosen. So, the first one to your left is tea tree oil.

Does that sound familiar? That's because this is a globally recognized antiseptic and antimicrobial product. In 2011, Edmonson's team established this oil's efficacy further when it applied to topically infected wounds. The trial actually showed, within days of application, there was a sharp decline in the microbial load. The next one at the bottom you see is clove oil.

Now I included clove oil in my research because it had already attracted countless researcher's attention. This is because of its high antimicrobial and anti-inflammatory properties. This is all thanks to a naturally occurring compound in clove called eugenol. Walsh in 2003 found that eugenol exhibited excellent antibacterial activity against a wide range of organisms like E coli and S. Aureus. Now this one to your right, you may know what this is, it's gross, and it's an aromatic use substantially in cooking, but it also has to be proven to have high antioxidant and antimicrobial properties. In 2007, 2011 and 2015, Fu, Dejanine and Muhammad's team found that rosemary had MIC between 0.125 to 1%.

So this real spark conversation that rosemary could potentially be a new treatment for S. Aureus. Now, the last one you see at the top is known as cedarwood. I chose this one because there are only handfuls of published research that suggests cedarwood does have antimicrobial properties. In Maya's 2017 disk diffusion assay, it showed that cedarwood had an MIC of 15.1, much higher than rosemary, but still shows potential for antimicrobial properties.

These four essential oils have never been experimented under the same conditions in previous research. Without testing these four essential oils in the same conditions, there is no way of accurately evaluating and comparing their effectiveness to essential oils and the antibiotic benzo peroxide that I'm using in my experiment. Now, this is kind of how I structured my... Sorry, my process, research process. The first one being gaining a lot of basic information about my variables but also evaluating the different methods used in each of the papers.

And then I moved on into a pilot study. So, I conducted this pilot study because it allowed me to make refinements to my method, assess any avoidable errors, but also practiced the practical method, enhancing the accuracy and reliability of the data collected in the full study.

So, after reviewing many different experimental methods, the one I had taken is known as the Kirby-Bauer disk diffusion method, which is a standardized method to assess the antimicrobial properties for organisms in clinical laboratories since the 1950s. On the left is a diagram of how I did my experiment. So, I had these little plates with this jelly-like substance called nutrient agar. I'd spread my staphylococcus broth on top, have these little paper discs, dip them into my variables, my essential oils, benzoyl and water, put them in their respective quadrants, seal it up, place it upside down into an incubator 37 degrees, 48 hours, because that is an optimal time for S. Aureus to flourish in.

And after I take it out, I would measure the inhibition, if you can see here, it's just the diameter from left to right. And that is my data that I collected. And I did each of these plates five times to ensure reliability and accuracy. And these were my findings. What was really interesting to see was that across the five trials, clove consistently recorded a larger stone of inhibition, averaging 15.4 millimeters.

The result I have found strongly aligned with Fu's 2007 experiment which found that clove have an MIC of 0.062%. MIC known as the minimum inhibitory concentration, basically the lower that percentage, the more effective that substance is. So this [inaudible 00:06:10] by the antibacterial properties and susceptibility of S. Aureus of clove oil. Further in 2011, Panda and Sing's disk diffusion assay reported an average zone of inhibition of 16 millimeters, which coincides with my data.

So these results tell us clove oil has extremely high potential to be further developed and research to produce a treatment for S. Aureus. Now coming in at second, we have Rosemary, which averaged a zone of inhibition of 13.2 millimeter. This is really similar to Emma's 2000 research, which found an MIC of 0.125% and Fu's 2007 research which found an MIC of 0.75 to 1%. So this MIC tells us yes, it's a little bit higher than cloves but still considerably low on the MIC spectrum, indicating a high degree of antimicrobial potency. Interestingly enough though, the other three tea tree, benzoyl and cedarwood didn't yield high antimicrobial values. For example, tea tree. I recorded an average zone of inhibition of 11.5 millimeters. This contradicted both Castin and Riley's 1998 research and Olivia's 2018 study, which found a zone of inhibition of 21.3 to 33.3 and 16 millimeters respectively.

It was also really fascinating to see that both clove oil and rosemary are before a globally recognized antibiotic benzoyl peroxide. Now with experimentation, there come limitations. And I categorized my limitations into three different sections. The first one being experimental conditions. I did my experiment in an in vitro condition, meaning in a controlled environment, in a laboratory, sterilized.

And I thought Yap's 2006 statements summed up really well that it was written, an in vitreous susceptibility of a clinical isolate to a particular antibiotic does not guarantee the success of a clinical use of a therapeutic agent. The next one being materials. Now I had two little problems here. The first one being my benzoyl peroxide and my essential oils were two different concentrations. In the end, I was able to find a way to dilute my essential oil down but keeping its purity to be the same concentration as my benzoyl.

Another challenge I faced was, if you remember I said I used something like a jelly-like substance, nutrient agar for my experiment. However, in samples 2017 study and Olivia's 2018 study, they actually use something called a Mueller-Hinton agar, which is a loose powdered agar that allows for antibiotic diffusion, better antibiotic diffusion. This actually explains why for tea tree, I only recorded 11.5 millimeters on average, and Olivia recorded 16 millimeters on average.

And the last would be equipment because I didn't access to specialized equipment, I could not perform a chemical analysis using a spectrometer such as Fu's 2007 experiment. But if I did, that would be what I would be doing next. Now, where does that leave us?

So, we know clove oil and rosemary are two essential oils that really need to be further researched. Researchers have to trial and error, put the two together, put them with other low gray antibiotics, maybe experiment them with other different essential oils in hopes they formulate a product that can go into clinical trial, be successful, more sustainable way for consumers to defeat such a vicious bacterium called S. Aureus. Thank you.