Super Antimicrobials Save the Day!

Aim:

The aim of the experiment is to investigate the effectiveness of half and full dilutions of Dettol, Betadine and Tea Tree Oil as Anti-Microbial agents.

Hypothesis:

It is predicted that Dettol will be the most effective Anti-Microbial agent due to it containing an OH group that is able to bind to cell surfaces and kill them. Tea tree oil is expected to be the second most effective anti-microbial agent, as it also contains an OH group, and betadine is expected to be the least effective because it does not contain an OH group. Furthermore, it is expected that the substances that have zero dilution will have the most anti-microbial action due to the strength of the substance.

Introduction:

Antimicrobial products kill or slow the spread of microorganisms, including bacteria, viruses, protozoans, and fungi (NPIC, 2016). These products play a fundamental role in our everyday lives as they are used to treat or prevent diseases on people, pets and other living things (NPIC, 2016). The active ingredient of most antimicrobial products differs, indicating that a lot of molecules can have antimicrobial action. However, most antimicrobial products contain a hydroxyl (-OH) group. This is a group of a molecule which contains a covalently bonded oxygen atom and hydrogen atom (Encyclopedia Britannica Inc., 2016). The hydroxyl group has antimicrobial action because it attaches to particular proteins located on the bacteria's cell membrane (RSC, 2016). This causes the loss of integrity and structure of the cell membrane, which allows the contents of the cell to leak out (Carson *et. al.*, 2016). This can be deadly to the cells as the loss of its important organelles would mean that the cell would not be able to function properly (Carson *et. al.*, 2016). This experiment will investigate the effectiveness of three antimicrobial agents; Dettol, Betadine and Tea Tree Oil. Firstly, the main active ingredient in Dettol is 4-chloro-3, 5-dimethylphenol (Figure 1). Secondly, Betadine's main active ingredient is povidone-iodine (Figure 2). Lastly, the main active ingredient in Tea Tree Oil is Terpinen-4-ol (Figure 3).

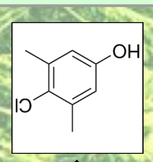


Figure 1:
4-chloro-3,5-dimethylphenol
Dettol

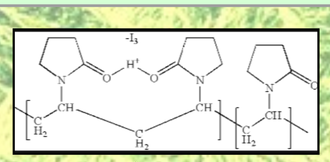


Figure 2:
Povidone-iodine
Betadine

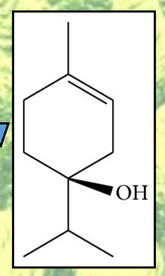
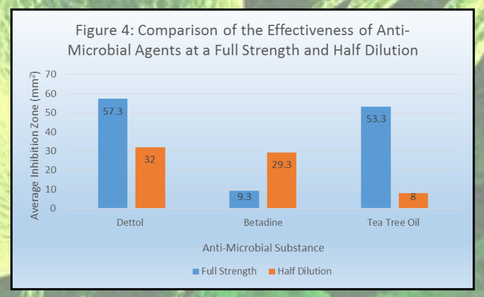
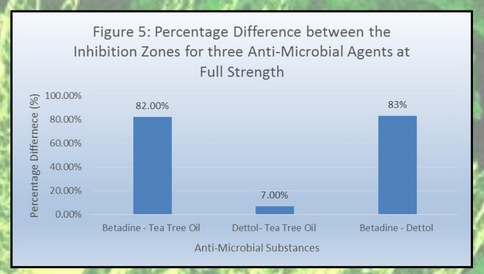


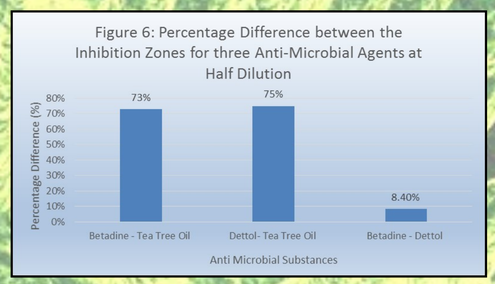
Figure 3:
Terpinen-4-ol
Tea Tree Oil

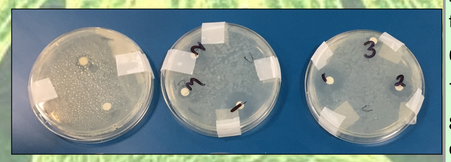
Materials:

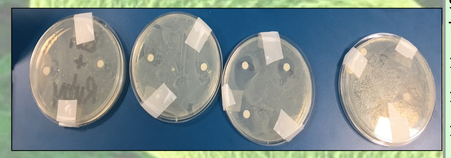
- Nutrient agar
- Bacteria (E. coli)
- 9x petri dishes
- Dettol antiseptic
- Betadine antiseptic
- Tea tree oil antiseptic
- Water
- 18x Paper discs
- 1x Porcelain spot plate
- 1x Sterile forceps
- 1x Spreader
- Sticky tape
- 1x Marker pen
- 1x Hole puncher
- 1x Page of graph paper
- 1x Gilson's *PIPETMAN Classic*®
- 4x Pipette
- Latex gloves











Method:

1. The experiment was set up with correct equipment and materials.
2. Nine petri dishes with nutrient agar set in them were gathered.
3. A PIPETMAN Classic and a spreader was used to apply E. coli to nutrient agar petri dishes.
4. Each disk was numbered to be able to recognize each substances.
5. Testing solutions were made up in a ceramic dish with a dropper and correct amount of water for dilution.
6. A whole puncher was used to make paper disks.
7. Paper disks were then placed in substance to soak up liquid.
8. Sterile forceps were used to get paper disks out of the substance and placed onto the petri dishes.
9. Steps one to eight were repeated three times for each substances- Dettol, Betadine and Tea Tree Oil.
10. Each dish were sealed shut with sticky tape to contain bacteria.
11. The disks were left in an incubate for 2-3 days
12 After the 3rd day take dishes out of the incubator.
13. Graph paper was used to measure the zone of inhibition.

Analysis 1:

For the full strength substances, a relationship existed between the presence of a hydroxyl group in the active ingredients, and the effectiveness of its antimicrobial action. This relationship was an increased effectiveness of antimicrobial agents that contained a hydroxyl group, as compared to those that do not. This relationship is particularly obvious in Figure 4, whereby the full strength of Dettol and Tea Tree Oil, both of which contain a hydroxyl group, resulted in inhibition zones of 57.3mm^2 and 53.3mm^2 respectively, whilst Betadine, which does not contain a hydroxyl group, had a much smaller inhibition zone of 9.3mm^2. This is further supported by the data in Figure 5, which shows that the two hydroxyl group containing agents (Dettol and Tea Tree Oil) only had a 7% difference in their effectiveness, whilst these two agents had 82% and 83% differences in effectiveness, respectively, when compared to Betadine (no hydroxyl group). This trend exists because the hydroxyl group that is in both Dettol and Tea Tree Oil is seen to successfully bind to cell surfaces and kill them (Carson et.al. 2006). Therefore, it is evident that the hydroxyl group on Dettol and Tea Tree Oil, is an essential ingredient that should be used in all antimicrobial agents.

Analysis 2:

With a dilution of half strength, the effectiveness of the natural antimicrobial solutions significantly decreased compared to the synthetic antimicrobial solutions. In Figure 4 it is evident that with a dilution of half strength, the effectiveness of the natural antimicrobial Tea-Tree Oil significantly decreased to an 8mm^2 zone of inhibition compared to the synthetic antimicrobial solution with 32mm^2 for Dettol and 29.3mm^2 for Betadine. This is further supported in the data in Figure 6, which shows that the two synthetic antimicrobial agents (Dettol and Betadine) only had a 8.4% difference in their effectiveness, whilst these two agents had 73% and 75% differences in effectiveness, respectively, when compared to Tea Tree Oil (natural antimicrobial). Whilst the trends suggest that natural antimicrobial is worse, no scientific explanation can be provided for this trend, and it is more likely that this can be attributed to an experimental error. Therefore, it is evident that with a half dilution, the effectiveness of natural antimicrobial solutions significantly decreased compared to the synthetic antimicrobial solution.

Evaluation:

Overall, the experiment provided clear results that supported the proposed hypothesis. However, throughout the data collection in Figure 4, there were a few notable anomalies within the data especially with the betadine results. It was noticed that the half strength betadine had 56mm^2 for the first trial while the second and third trials had a result of 16mm^2 each. This could be because while testing the results ink from a pen got onto the paper disk and the betadine was old which could have affected the results of the experiment. Another anomaly for the half strength results was the Dettol. The Dettol had completely different numbers within each three trials like 36mm^2, 16mm^2 and 44mm^2. The suggested reason for these odd results could be because the Dettol used for the experiment was past its expiry date. There weren't any notable patterns between the Dettol and the betadine however the results for the half strength tea tree oil showed a somewhat pattern with its results close together with 4 mm^2, 4 mm^2 and 16 mm^2.This experiment consisted of a few errors that would need to be amended. Firstly, while marking the dishes some ink from a pen got onto the paper disks, which could have affected the relationship between the disinfectant and the paper. Another error including the pen was related to the condensation in the incubator which made the markings rub off slighting making it difficult to read which number went with which substance. This in turn, could have led to the incorrect results being recorded. In order to fix this error perhaps paper could have be attached to the exterior as this would ensure the pen would not fade. A proposed extension to the experiment would be to either test more natural remedies such as honey to see how they compare to the chemical disinfectants. Another possible extension could be to test Dettol and betadine against a more concentrated solution of their main active ingredient which are chloroxylenol and iodine respectively. This would allow a broader understanding of disinfectants and potentially how they work.

Conclusion:

When the experiment was conducted, Dettol full strength was found out to be the most effective antimicrobial agent out of all of the substances and there full strength and half dilution trials. This supports the hypothesis which predicted that Dettol would be the most effective agent due to it containing an OH group that is able to bind to cell surfaces and kill them. Tea Tree Oil was expected to be the second most effective agent, as it also contains an OH group, and Betadine was expected to be the least effective because it does not contain an OH group. Furthermore, it was expected that the substances that had zero dilution would have the most anti-microbial action due to the strength of the substance.

Substances:

- Dettol
- Betadine
- Tea Tree Oil

Bibliography:

Encyclopedia Britannica. (2016). *alcohol | chemical compound*. [online] Available at: https://www.britannica.com/science/alcohol#ref998458 [Accessed 10 Nov. 2016].

Npic.orst.edu. (2016). *Antimicrobials Fact Sheet*. [online] Available at: http://npic.orst.edu/factsheets/antimicrobials.html [Accessed 10 Nov. 2016].

Carson, C., Hammer, K. and Riley, T. (2016). *Melaleuca alternifolia (Tea Tree) Oil: a Review of Antimicrobial and Other Medicinal Properties*.

Rsc.org. (2016). *Chemistry in your cupboard | Dettol*. [online] Available at: http://www.rsc.org/learn-chemistry/resources/chemistry-in-your-cupboard/dettol/3 [Accessed 10 Nov. 2016].