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Why Are We Using Our Mouths as an Entrance for Bacteria?

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Carl Goodson Honors Program: Honors Thesis

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ABSTRACT

Background: Foodborne illness can be easily spread through contamination of many difference sources. Oftentimes people are aware of the dangers when it comes to raw meat, poultry, and eggs. However, many people are not aware that foodborne illnesses can occur due to produce. Washing produce can significantly reduce bacteria content, but which washing method really works the best?

Objective: The purpose of this experiment was to look at the difference in bacterial content among properly washed, washed, and unwashed fresh produce from the local grocery store.

Settings: This experiment was conducted in the microbiology lab at Ouachita Baptist University during the fall 2019 semester.

Methods: Fruits and vegetables were purchased from the grocery store and swabbed for bacteria. Each produce item was measured as a control group, washed group, and FDA washed group. All swabs were transferred to petri plates and incubated at 37ºC for 18 hours. Each plate was counted to see the amount of bacteria colonies on each one.

Results and Discussion: For the grapes control group over 208 bacteria colonies were found including mold. For the washed group approximately 110 colonies were found including mold. For the FDA approved washing method, only 49 colonies were found and no mold was detected.

Conclusion: The FDA approved method for washing fruits and vegetables showed to be the most effective in eliminating the amount of bacteria on fresh produce purchased from the store.

PURPOSE STATEMENT

The purpose of this experiment was to look at the difference in bacterial content among properly washed, washed, and unwashed fresh produce from the local grocery store.

SIGNIFICANCE OF THE STUDY

When walking into the produce section at the local grocery store or supermarket, the majority of the fresh produce is laid out in open containers that allows for shoppers to pick and choose which specific fruit or vegetable they want. Most of the produce that is laid out is not in any sort of packaging which means it is not protected from bacteria. Shoppers picking out their produce usually pick through many different bins to find the perfect size, shape, and color of their produce. This allows for bacteria to be spread from the shopper to the produce to another

shopper. This does not take into account the bacteria that could also be on the produce from transportation from farm to store. Oftentimes, shoppers will take that produce home and immediately start cooking with it without washing it first. This is very dangerous because all the bacteria that was on that one piece of produce could cause a person to become very ill. With that being said, some shoppers do wash their produce after purchasing, but is their method of washing really making a difference in the bacteria content that is already on them?

REVIEW OF LITERATURE

For this review of literature section, journal articles were researched to help determine the importance of washing fruits and vegetables in regards to bacteria content. Each journal article was reviewed and assessed on the information provided and the relevance to the topic at hand.

The first article reviewed looked at the United States Food and Drug Administration's (FDA) recommendations on how to properly wash fresh produce to reduce the chances of getting sick. The FDA website states that on average, 48 million people become ill from ingesting contaminated foods each year. The risks that come along with handling raw animal products is known, however the risk of handling contaminated fruits and vegetables is not. Large outbreaks of foodborne illnesses have been traced back to contaminated produce such as lettuce, tomatoes, spinach, and cantaloupe. When purchasing fresh produce, the FDA suggests to avoid those items that are bruised and damaged and to insure pre-packaged produce is properly stored in refrigerated or cooling containers. In terms of washing fresh produce the FDA gives seven recommendations for how to go about proper cleaning. The first one is washing your hands with warm water for 20 seconds. This should be done before and after handling any fresh produce. The second recommendation states that if some of the fresh produce is damaged or bruised, cut away any of those areas and discard before washing. Number three is that it is very important to

rinse the produce before it is going to be peeled. This helps reduce bacteria contamination from the outside of the produce to the inside. Next, while running the produce under running water, gently rub the produce in with your hands. For this step it is not necessary to use any sort of cleaning agent. The next recommendation only applies to firm produce. To properly clean the skin of the produce, use a clean vegetable brush instead of hands. The sixth recommendation is the most important for further reducing bacteria content. When drying off the produce, use disposable towels or a very clean cloth. Dirty cloths have a lot of bacteria harboring in them which can be rubbed onto the produce while trying to dry it. The final one is removing the outer leaves of leafy vegetables.[1]

METHODS

This study was conducted in the microbiology lab at Ouachita Baptist University during the 2019 fall semester. For this experiment, all fresh produce was purchased from the Walmart grocery store in Arkadelphia, Arkansas. Fruits and vegetables were chosen based on the likelihood of people washing it before consumption as well as the likelihood that people had touched the produce multiple times to examine the produce. The fruits and vegetables chosen were grapes, apple, tomato, and lettuce. The grapes were pre bagged green grapes, the tomato was a slicing tomato that was among many other tomatoes, the apple was a honeycrisp apple that was in a container with many other apples, and the lettuce was a pre bagged head iceberg lettuce. All fresh produce purchased in this experiment was handled with gloves to eliminate possible contamination of bacteria that the researcher could have passed in the purchasing process. The fruits and vegetables were placed into plastic produce bags provided in the produce section of the store. Once purchased, the fruits and vegetables were transported to the microbiology lab. Once in the lab, the researcher washed their hands and put on a new pair of gloves. The equipment

used for this experiment consisted of twelve sterile cotton swabs, twelve bacteria culture plates, one incubator, tape, a sharpie, paper towels and water. The first step in the process was to label all of the petri plates being used. Each was labeled with the researchers name, the date, the fruit or vegetable name and which variation it was. The first plate was labeled as the grape control group. The second was the grape washed group, and the third was the grape FDA washed group. This process was repeated for the apple, tomato, and the lettuce petri plates. After labeling the petri plates, the grapes were ready to be swabbed. The researcher took off the previous pair of gloves, washed their hands, and reapplied new gloves to avoid cross contamination of bacteria. For each swab that was taken from the fruits, the researcher dipped a new unopened cotton swab into a sterile solution and then proceeded to swab the fruit. The control grapes were taken out of the bag and swabbed. Once swabbed, the prepared petri plate for the control grapes was opened and the swab was rubbed all over the contents of the petri plate. Once swabbing was complete, the petri plate was sealed with tape to ensure it could not be opened or tampered with. The petri plate was then set aside until all the other plates were completed. The researcher then proceeded to the next variation which was grapes washed. The grapes swabbed in the control group were taken and ran under room temperature water for 30 seconds. They were then swabbed using the exact same method as the control group. One the petri plate was sealed, the researcher moved to variation three. Variation three used the FDA's recommendation on how to properly wash fruits and vegetables. This was done by running the produce under room temperature water and scrubbing all areas of the fruit with your hand for 30 seconds. Once washed the grapes were dried off as best as possible with a paper towel. The washed grapes used for the washed variation were taken and ran under water while also being rubbed lightly to remove excess bacteria. The properly washed grapes were swabbed the exact same way as the control grapes and were

transferred onto a petri plate. These steps were repeated for the apple variations, the tomato variations, and the lettuce variations. When the swabbing was complete, there were three petri plates swabbed for grapes, three for apples, three for tomatoes, and three for lettuce. These plates were placed in a 37º C incubator for 18 hours. After 18 hours, the plates were taken out of the incubator to assess bacteria growth. The three variations of each were compared and documented for the amount of bacteria growth shown. The different groups were compared on the number of colony growths, the color of the colonies, and any other foreign substance such as mold. Pictures were taken of each one to further depict the amount and differences of bacteria growth between the control, washed, and FDA washed groups. After pictures were taken, each plate was disposed of into a biohazard waste bin and the experiment was complete.

RESULTS

There were a total of 12 petri plates that were collected and analyzed. For every petri plate, all the colonies on the plate were counted and written down. The researcher counted each colony to the best of their ability. The plates were also reviewed to see if there were any unusual growth. Unusual growth consisted of discolored areas and fur growing. If unusual growth was found, it was analyzed and identified to the best of the researchers ability.

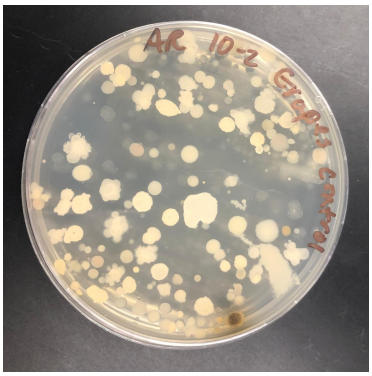


Image 1.

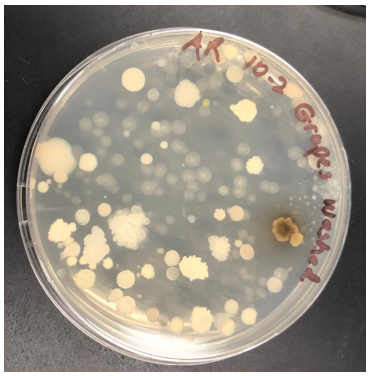


Image 2.

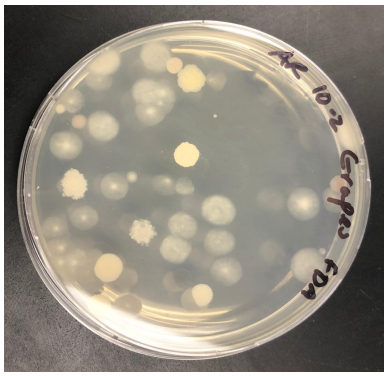


Image 3.

The first variation group that was looked at were the grapes. The first plate that was evaluated and counted was the grapes control. The image of the petri plate is shown above in Image 1. The grapes control petri plate had approximately 208 total colonies on the plate. This plate had a very dark colored green culture which was identified as mold. The second plate evaluated was the grapes washed plate. The image of the petri plate is shown above in Image 2. The grapes washed plate had approximately 110 bacteria colonies on it. The plate also had a very dark green colored culture which was identified as mold. The last plate evaluated for the grape variation was the grapes FDA approved washed plate. The image of the petri plate is shown above in Image 2. The FDA washed grapes had approximately 49 bacteria colonies on it. This plate did not have any mold identified.

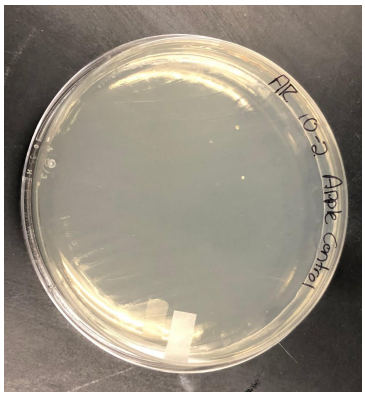


Image 4.

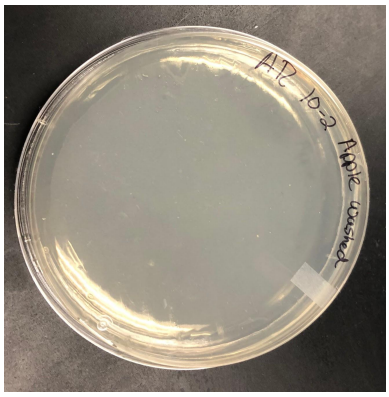


Image 5.

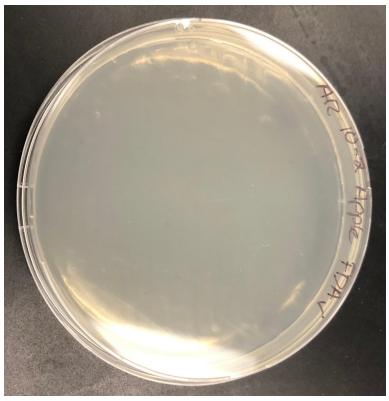
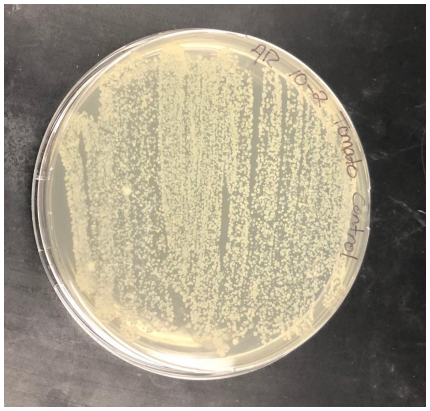


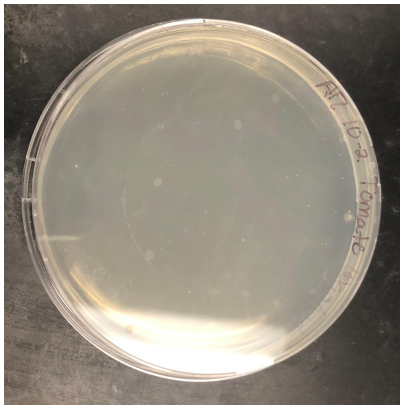
Image 6.

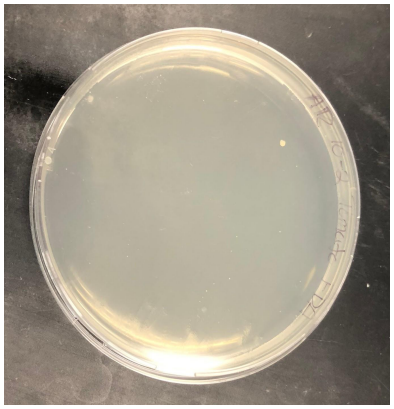
The next variation that was reviewed was the apple. The first plate evaluated was the apple control plate. This petri plate is shown above in Image 4. The apple control had five identifiable colonies on it. The colonies on this plate were small, but they were countable. The second plate for the apple variation was the washed apple. The petri plate evaluated is shown above in Image 5. This plate had three identifiable bacteria colonies on it. The colonies on this plate were very small, but they were countable. The last petri plate for the apple variation was the FDA approved washed group. The petri plate evaluated is shown above in Image 6. The FDA

washed apple had no identifiable bacteria colonies on it. If there were any colonies, they were not visible to the eye in any way.

Image 7. Image 8. Image 9.







The next variation of petri plates evaluated were the plates from the tomato. The first plate that was looked at was the tomato control plate. The petri plate for the tomato control is shown above in Image 7. This petri plate contained an uncountable amount of bacteria culture. The colonies were too small and close together that the researcher was not able to clearly count and obtain accurate data for this plate. The second plate evaluated for the tomato variation was for the washed tomato. The petri plate is shown above in Image 8. There were approximately 35 bacteria colonies on the petri plate. The colonies in this sample were very small but they were countable. The last petri plate evaluated for the tomato variation was for the FDA approved washing method. The petri plate is shown above in Image 9. There were approximately 19 bacteria colonies found on this plate. The colonies were very small but they were countable.

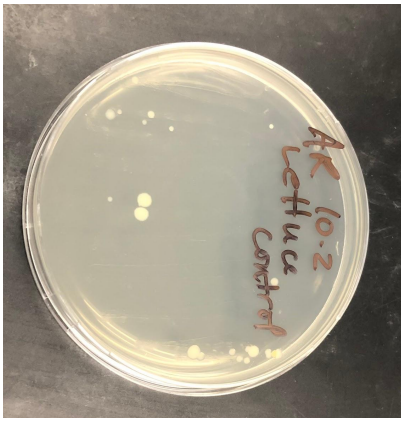


Image 10.

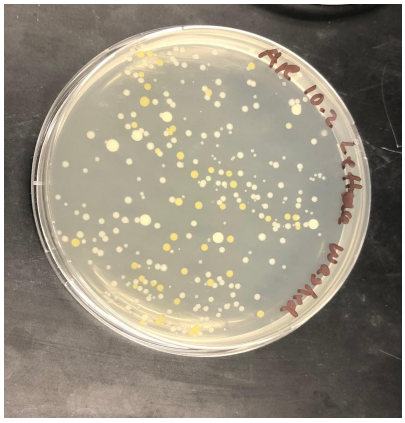


Image 11.

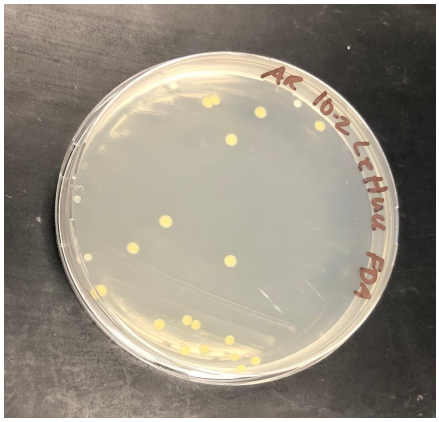


Image 12.

The next group that was examined was the lettuce variations. The first plate that was counted was the lettuce control group. This plate is shown above in Image 10. The lettuce control plate had approximately 23 colonies on it. The second plate in the lettuce variation was the lettuce washed plate. This plate is shown in Image 11.The lettuce washed plate had over 250 colonies on it. The last plate that was reviewed for the lettuce variation was the FDA approved washed. This plate counted is shown above in Image 12. This plate had approximately 23 colonies on it.

DISCUSSION

Overall the most significant amount of bacteria was reduced when using the FDA approved cleaning method for washing fruits and vegetables. The apple group had the biggest improvement because 100% of the bacteria was removed from the control to the FDA washed. When comparing the washed apple to the control apple, 40% of the bacteria colonies were removed. The grapes variation showed the second biggest improvement with 76.45% of bacteria colonies being removed. The washing of the grapes eliminated 47.12% of bacteria colonies, but it did not remove the mold. The FDA washed grapes eliminated 55.5% of the washed grapes bacteria colonies and no mold was present. Since the tomato group had an uncountable amount

of bacteria colonies, data can only be received for comparing the washed tomato versus the FDA washed tomato. However, it is evident that the washed tomato had significantly less bacteria colonies than the control tomato. The FDA washed tomato had a 45.8% reduction in bacteria colonies compared to the washed tomato. Based on the data received for the lettuce variation, there was an error when conducting the swabbing portion of the experiment.

CONCLUSION

After evaluating all of the variations tested in this experiment, research shows that the FDA approved washing method was the most effective in reducing the number of bacteria colonies found on fresh produce. This finding is extremely beneficial because it shows that the FDA recommended method for washing fresh produce is the best method because it does decrease the bacterial content by a significant amount. This finding is important in showing that properly washing produce can protect everyone from ingesting harmful bacteria that could be on the surface. Not only does the experiment show that the FDA method works, it also shows that washing fresh produce significantly reduces the amount of bacteria compared to not washing them. This finding is extremely important in showing how much bacteria can be eliminated just by running produce under water before consumption. The experiment also showed that among the produce tested, the grapes purchased at the grocery store had the most bacteria content compared to other produce as well as mold growth. This finding was surprising due to the fact that grapes come pre-packaged and are not the most common items to be picked through in the produce section. This is important to those who walk around the store eating grapes out of the bag before washing them. Overall, washing fresh produce is extremely beneficial for reducing the amount of bacteria content on fresh produce found at the grocery store.

References

1. FDA June 10th 2018. 7 tips for cleaning fruits, vegetables. Fresh produce can become contaminated in many ways, but following these simple steps can protect you and your family from foodborne illness. https://www.fda.gov/consumers/consumer-updates/7-tips-cleaning-fruits-vegetables#:~:text=Gently%20rub%20produce%20while%20holding,bacteria%20that%20may%20be%20present.

BACKGROUND

When I first began thinking about what I wanted to do my directed study and honors thesis on, there were so many things that popped into my head. Initially I thought of doing big picture topic ideas such as things like obesity, diabetes, eating disorders, and many others. All of these topics were great, but they are all being heavily studied by doctors and researchers all around the world. I wanted my thesis to be something that was not heavily studied and had a gap in research. What ultimately got me on the subject of bacteria content on fresh produce was the experience I had in the Walmart produce section. One day I was in Walmart picking up some fresh fruits and vegetables. As I was walking, around I caught myself picking up and examining multiple different avocados trying to choose the best one. I not only did this with the avocados but also with the tomatoes, apples, cucumbers, and onions. I quickly realized that everyone else in the produce section was doing the exact same thing. This realization led me to think about all the people who had touched it before me, and where their hands have been. My next interaction was a woman walking through Walmart eating directly out of a bag of grapes she had just picked up from the produce section. Knowing she had not washed them, I wondered how many people actually do this with their produce. Then my brain led me to think about how if she was eating them in the store unwashed, more than likely she was not washing them at home. There are always signs up in public bathrooms reminding employees to wash their hands, but how come there are never signs reminding people to wash their produce that were touched by many hands?

This topic is so important because foodborne illnesses are a real and scary thing. Foodborne illness can cause a multitude of physical, mental, and emotional tolls on the

body and recovering from that is difficult. More importantly they can lead to death if not treated or in extreme cases. I have seen first hand the effect that salmonella had on a loved one and I would not wish that upon my worst enemy. When I think of fresh produce, I think of people trying to eat healthy. As a dietetics major, I know there is a great amount of people living in this world with severe health conditions whether that be cancer, obesity, diabetes, heart disease, pulmonary disease, or any other medical condition. These patients are encouraged to increase their intake of fruits and vegetables to help boost their immune system and to promote healthy weight loss. If these patients are trying to do better with their eating habits, but failing to wash their produce can ultimately hurt their health even more. With their underlying health conditions, the effects of a foodborne illness can be life threatening.

This topic is even more important now as we face a global pandemic. Coronavirus is known to be spread by droplet content. This is extremely alarming due to the fact that the majority of produce is not protected by some sort of packaging. Before masks were a requirement, I can only imagine the amount of produce that was affected by unprotected sneezes and coughs. Although the virus can not live on a surface forever, it can live for at least 24 hours. This is enough time for another shopper to come and pick up a contaminated fruit and potentially infect themselves.

I believe that raising awareness on this topic will help protect our communities from the harmful bacteria that can be passed around. I do not feel that there is proper education or knowledge about this topic which is needed to help protect ourselves as humans. Proper education of things like handwashing and produce washing could make a

huge difference. While we may not be able to protect ourselves from all illnesses that are in our world, this is one step that we can take to ensure that our produce is indeed safe.

EXPERIENCE

Due to the coronavirus, my opportunity to go to classes and teach was slim, therefore I presented to two classes that I am currently in. I presented to my human resource management class and my senior seminar class. This audience is a little different than I had intended to teach because they are all nutrition and dietetics majors and minors. Therefore, they already have a very good educational background when it comes to food and knowledge of foodborne illnesses.

I prepared a powerpoint presentation to present to the classes and that can be found in Appendix A. Before starting the presentation, I asked a series of questions to get some background information from the class. The questions consisted of: do you wash your fresh produce before eating, if yes, why do you wash it, and how do you wash your produce? Almost all the students in the class said that they do wash their fresh produce before eating it. One student stated that they wash their fruits and vegetables because they know that other people pick through the produce to find the right one just like she does, and she does not know who all had touched it prior. One student said “I wash mine because I know that they can carry bacteria and foodborne illnesses and I want to protect myself from that.” Others agreed that it was just important to wash them for sanitary reasons. The whole class was in agreeance that the method used to wash fruits and vegetables is just running it under water and wiping it off. I started off the presentation by stating what my thesis and directed study was about and what sparked this topic so they

would have a little bit of background knowledge of why I was presenting to them. The first slide went through the importance of washing fresh produce, which includes protection against foodborne illnesses, residues and pesticides, and common germs that are carried on your hands daily. The next five slides went through the process of my directed study experiment. I explained to them where I bought the produce, showed them pictures of the produce section I purchased from, how the experiment was conducted, and then went through the results. Each set of petri dishes was shown and talked about in terms of color, colonies present, and what method of washing was used. The feedback for those pictures were as expected. There were a lot of bad facial expressions and comments on how gross the pictures were. After concluding the gross portion of the presentation, I went into depth about the FDA recommended washing method. I talked through step by step and explained each step that was stated on the FDA website. The last portion of the presentation was a discussion section. The first discussion was how grossed out the audience was after seeing the bacteria cultures. The whole class was in agreeance that they were all extremely grossed out. The second discussion was if they knew there was a proper way to wash fresh produce. One student stated that she knew there was one, but she did not know what it was or where to find it. Another student stated that he thought just running it under water was the proper way to wash his produce. The third discussion asked about prior knowledge of fresh produce being able to cause foodborne illnesses. Surprisingly, many of the students in the class did not know that this could be caused by fresh produce. They were under the impression that foodborne illnesses could only be caused by raw and undercooked meat products. I then went into discussion about romaine lettuce and how it is currently recalled due to E.Coli contamination. I proceeded to

explain how some cow pastures are close to lettuce gardens and when it rains the water runs from the cow pasture down to the garden and that's how lettuce gets contaminated. The students were very interested in this topic. The next discussion question was how likely were they to wash their produce after seeing the presentation. Since the majority of class already washed their fresh produce this question did not really apply to them, but the two students who did not normally wash their produce said they would start now. When it came to the discussion about using the FDA method versus their own method, the class was divided. Some students said they did not see them changing their washing method just because of habit, and others explained that they would use the FDA method for cleaning in the future. The last question asked how beneficial the presentation was. Since I knew their background, I asked them to put themselves in the shoes of those who aren't well educated in nutrition or in general. They all agreed that the presentation was beneficial and would be extremely beneficial for those in the general community. Since the presentation was modified for a more advanced audience, I asked if the presentation was modified for children would it also be beneficial. The class agreed that it would be.

My overall experience teaching the class was extremely positive. I really enjoyed being able to talk about a topic that I am passionate about and show pictures that represented the experiment that I conducted. One discouraging thing was that some students did not pay attention and or care that I was presenting. They were on their phones, holding their own conversation, and distracting others. Their behavior was very disrespectful, and it was a little hurtful. Before the presentation, I explained how important it would be for my thesis if everyone was actively listening and gave feedback. Everyone in the class nodded their heads that they could give me 10 minutes of their time

for my presentation. Then, to see them not do that was very frustrating. When it comes to teaching or presenting, there are alway going to be those people who choose not to listen, but the majority of the time the presenter is a stranger. These students were my classmates, and I expected a little more respect than what I received. However, I still took away a very positive experience, and I am excited to teach it again.

In the future, I would like to present my work to more students on campus and also to families in the community. For this, I would incorporate a more hands on physical presentation so the families could see my actually washing the produce the correct way. This would be a lot more beneficial than just telling them how they are supposed to do it.

CONCLUSION

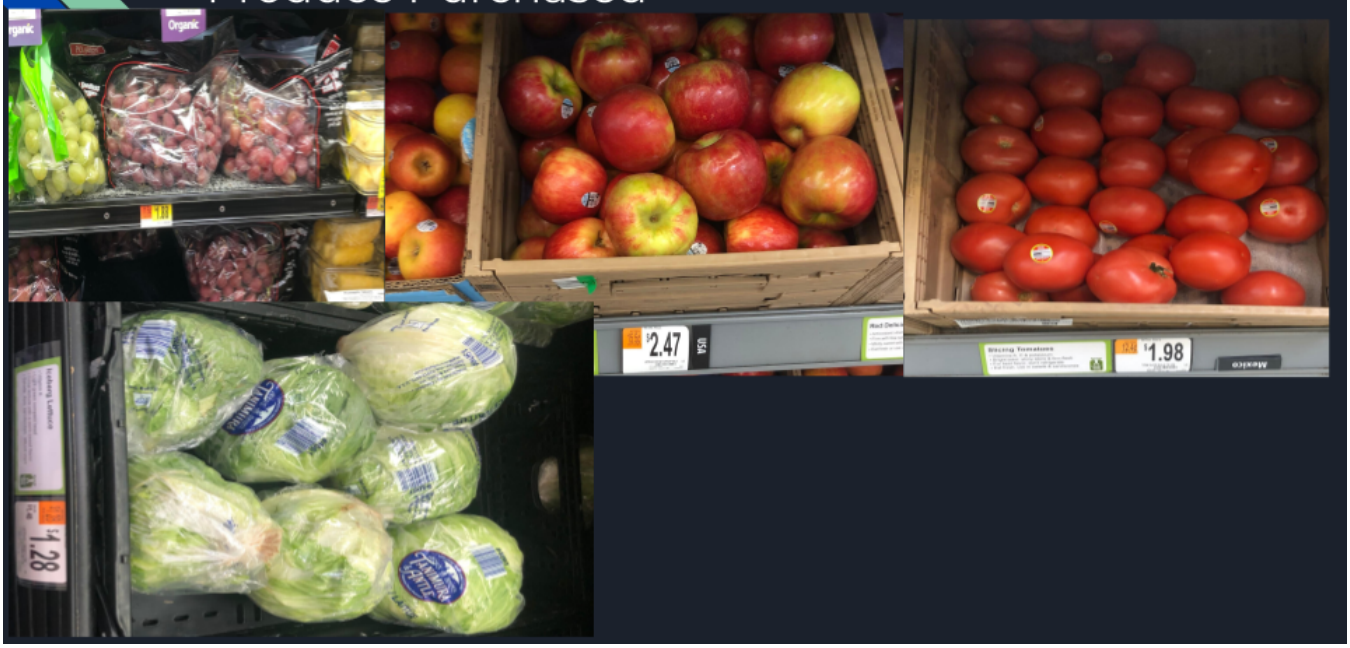
My overall thesis experience was amazing. There were some challenges that I faced due to the coronavirus pandemic, but I was extremely proud of myself for overcoming those obstacles and finishing out what I started. With my degree in dietetics, I would like to someday hold classes or informative presentations on this topic for those people in lower income communities. This could include partnering with the local health department, Women Infants and Children's Program, Supplemental Nutrition Assistance Program, and even school programs. I believe that changes start with the younger generation and being able to implement the importance of washing produce at a young age will help them carry it into their own families some day. One change that I would love to be a part of, is having signs placed in the produce section of grocery stores that show the proper way to wash produce and also just remind customers to wash their produce when they get home. Little reminders such as that can protect a whole family from a deathly foodborne illness.

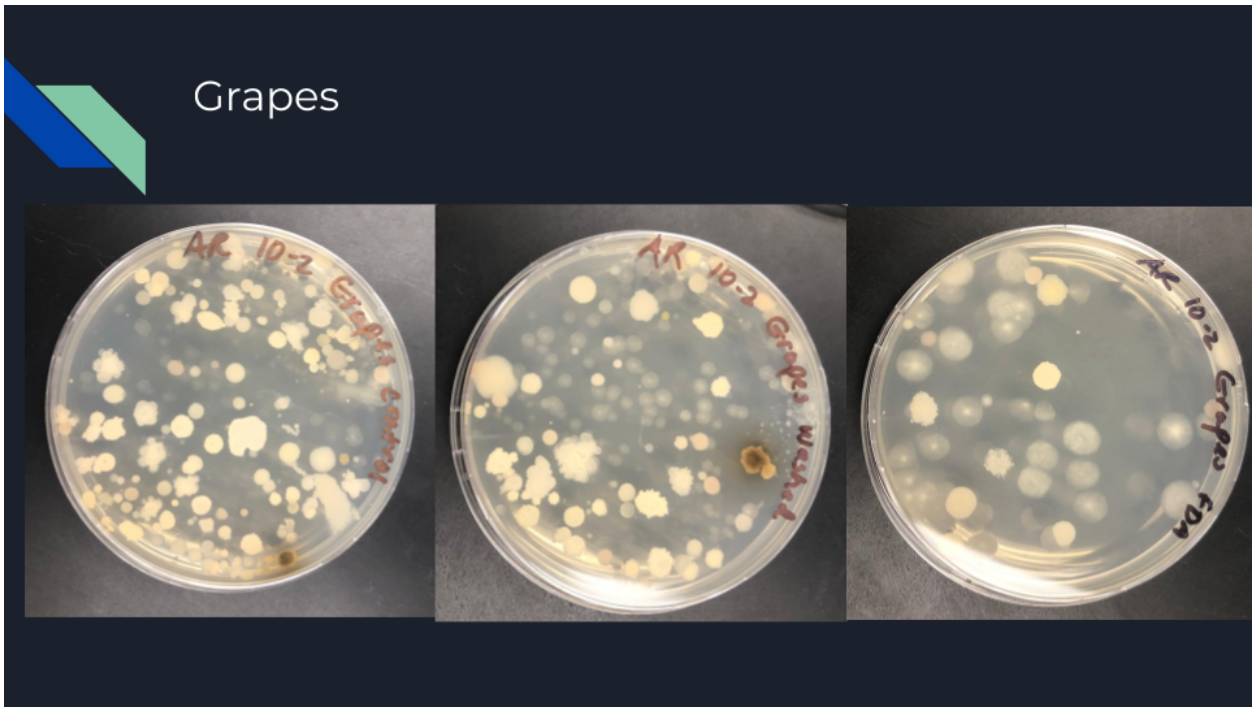
Appendix A

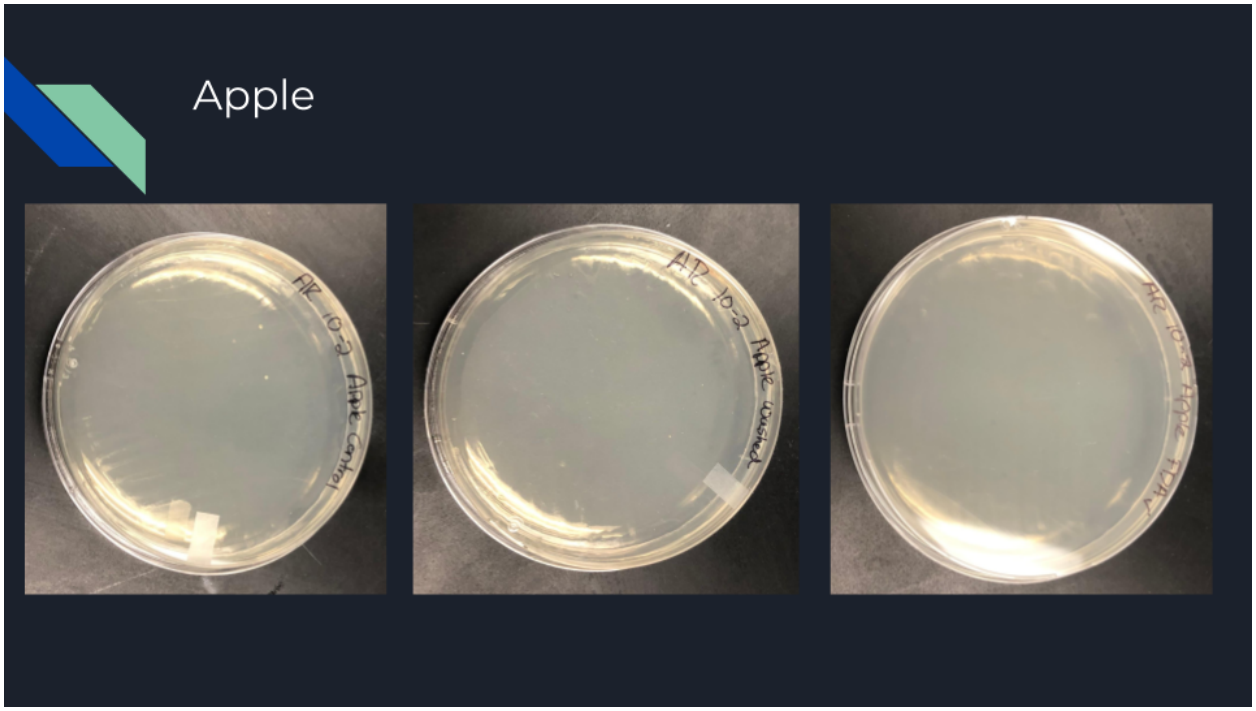
Why is it important?

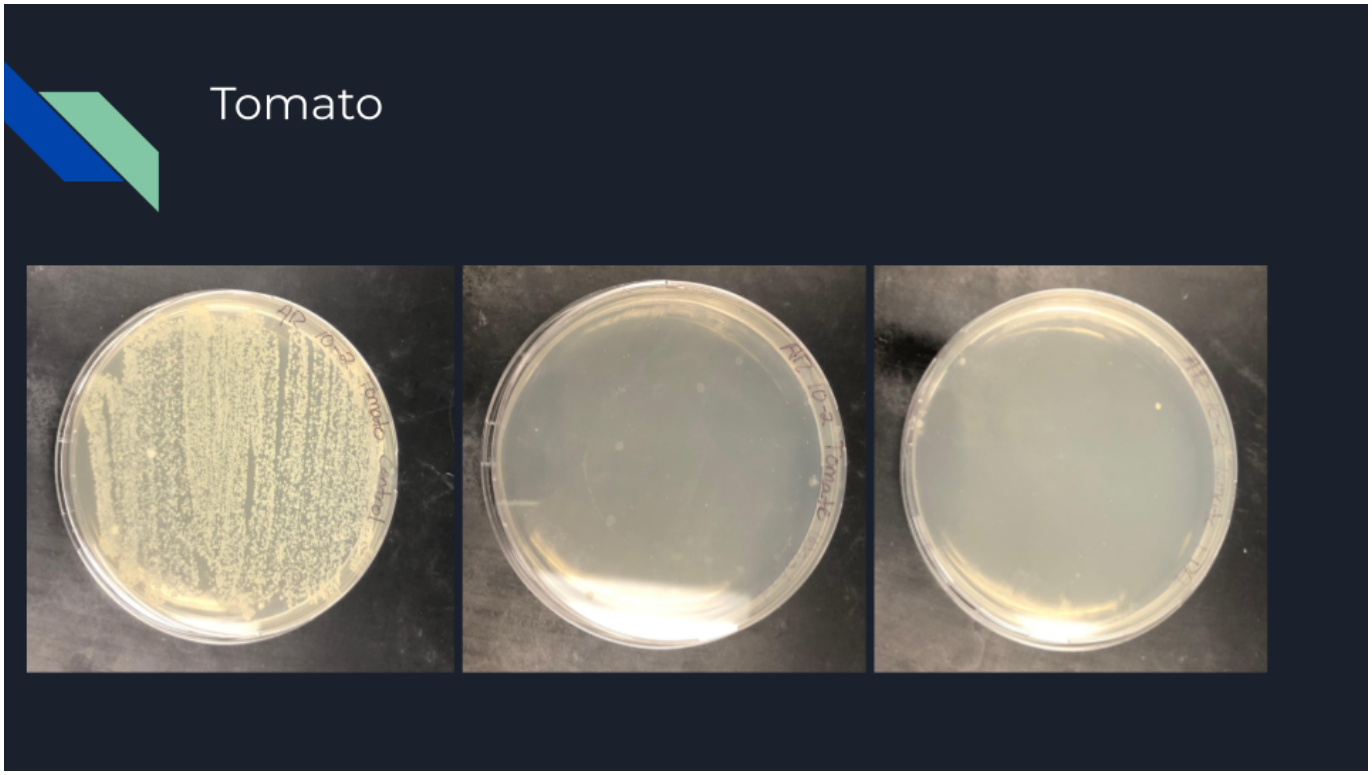
- Helps reduce the risk of getting foodborne illnesses such as:
  - E. Coli
  - Norovirus
  - Salmonella
  - Campylobacter
  - Staphylococcus aureus
- Helps protect you from ingesting harmful residues and bacteria from the soil
- Washes away germs from other people handling it.

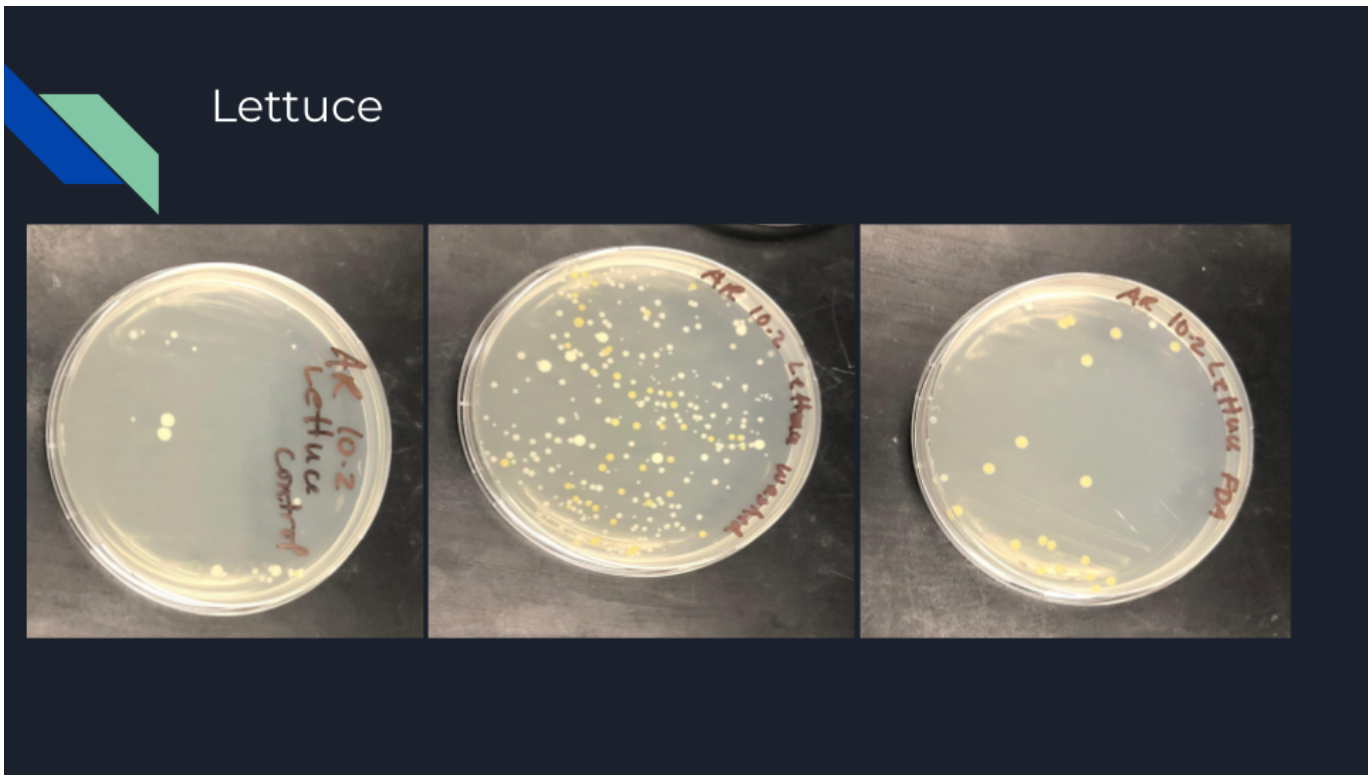
Produce Purchased




Grapes
AR 10-2 Grapes control
AR 10-2 Grapes washed
AR 10-2 Grapes FDA


Apple
AR 10-2 Apple control
AR 10-2 Apple washed


Tomato


Lettuce

YUCK!!

FDA Recommendations

1. Wash your hands under warm water for 20 seconds. Do this before and after handling fresh produce.
2. If you purchased something that is damaged or bruised, cutaway that area before preparing or eating.
3. Always rinse produce before peeling it. The bacteria can spread from the peeler or knife onto the flesh of the fruit or vegetable.
4. While rinsing the produce under running water, it is important to rub the produce with your hands. No cleaning soap or wash is necessary.
5. If cleaning something that is firm, use a clean vegetable brush. This would include things like cantaloupe, watermelon, cucumbers, and oranges.
6. After washing the produce, it is important to dry it with a paper towel or a clean cloth. Dish cloths can house a multitude of bacteria.
7. If preparing a leafy vegetable, remove the outermost layer of leaves.

Discussion Time!

1. How many of you are grossed out by the images shown today?
2. Did you know there was a proper way to wash fruits and vegetables?
3. Prior to this presentation, did you know that fresh produce could lead to a foodborne illness?
4. Based on the illustrations in this presentation, are you more likely to wash your fruits and vegetables before consuming them?
5. How likely are you to use the FDA's method of washing fresh produce?
6. Last but not least, how beneficial was this presentation on showing the importance of washing fruits and vegetables?

SENIOR THESIS APPROVAL

This Honors thesis entitled

Why are we using our mouths as an entrance for bacteria?

written by

Alyssa Reece

and submitted in partial fulfillment of
the requirements for completion of
the Carl Goodson Honors Program
meets the criteria for acceptance
and has been approved by the undersigned readers.

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