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| **Abstract** |

Apple slices turn brown over time because of the oxidation of the enzymes on their cut surfaces. You may dip them in certain solutions to prevent browning. Although they look less brown this may not necessarily mean that they’re healthy as well. I will investigate the microorganisms on apple slices after dipping them in different solutions, sealing in plastic bags, and refrigerating them for a week.

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| **Question** |

How can I keep apple slices healthy for a week?

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| **Hypothesis** |

Apple slices will stay the healthiest if I dip them in salt water and keep them in a sealed bag in refrigerator for a week. Salt will act as a general food preservative and the sealed bag will minimize contact with oxygen and prevent oxidation. Therefore, salt water and Ziploc should provide the best environment to keep the apple slices healthy.

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| **Research** |

When you cut an apple into slices, they soon turn brown. A process called oxidation takes place when a certain enzyme in the apple meets the oxygen in the air. This causes the apple surfaces to turn brown as well as dry out.

There are several techniques to minimize this oxidation process. Lemon juice, salt water, and ginger ale are the most common solutions to keep apple slices from turning brown. However, there was no guarantee that they would also stay healthy at the same time.

I decided to conduct an experiment to find out the effects of these solutions on browning, dryness, and bacteria growth after seven days. I also wanted to see whether the results can be improved by putting the apple slices in a sealed bag.

I did some more research on what I could use to test the bacteria growth on each apple slice, and came across nutrient agar plates. An agar plate is a Petri dish that tests the growth of microorganisms such as bacteria and fungus that grow on a surface. The dish with the least development of bacteria will prove to be the healthiest.

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| **Materials** |

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| * 6 apples | * Knife | * Cutting board |
| * Measuring cup | * 2 mixing spoons | * 3 bowls |
| * 1 tablespoon of salt | * 1 lemon | * Bottle of ginger ale |
| * Nitrile exam gloves | * 4 Ziploc bags | * 4 plates |
| * Tape | * Labels | * Permanent marker |
| * 8 nutrient agar plates | * 8 cotton swabs | * Refrigerator |

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| **Procedure** |

1) Prepare 3 bowls:

Bowl 1: Add 3 cups of water, one tablespoon of salt, and mix them.

Bowl 2: Add 3 cups of water, squeeze one lemon, and mix them.

Bowl 3: Add 3 cups of ginger ale.

2) Peel 6 apples, and slice each of them into 4 pieces to have 24 slices.

3) Build 8 groups of 3 apple slices from 24 slices:

Group 1: (Control Group) No dipping and leave open on a plate (Plate 1)

Group 2: No dipping and place in a sealed bag (Plate 1)

Group 3: Dip in salt water for 15 minutes and leave open on a plate (Plate 2)

Group 4: Dip in salt water for 15 minutes and place in a sealed bag (Plate 2)

Group 5: Dip in lemon juice for 15 minutes and leave open on a plate (Plate 3)

Group 6: Dip in lemon juice for 15 minutes and place in a sealed bag (Plate 3)

Group 7: Dip in ginger ale for 15 minutes and leave open on a plate (Plate 4)

Group 8: Dip in ginger ale for 15 minutes and place in a sealed bag (Plate 4)

4) Place the plates at the same level in the refrigerator, and leave for 7 days.

5) Label 8 agar plates, one for each group.

6) Allow agar plates to warm to room temperature for the agar surface to be smooth and moist.

7) Rub a cotton swab on the apple slices in each group separately, and swipe the swab across the surface of an agar plate labeled for that group.

8) Seal the plates and take them to the science lab at school.

9) Place the plates in the incubator, set the temperature to 87° Fahrenheit, and leave them in the incubator for 2 days.

10) Remove the plates from the incubator, open them, and observe the colonies of bacteria and fungus with naked eye.

11) Put the agar plates under a microscope, and examine the bacteria in a close-up view.

12) Dispose the used plates, swabs, and gloves as follows:

- Soak the used materials in a bleach solution (1 bleach:3 water) for 24 hours.

- Place the materials in the disposable bag and seal it.

- Incinerate the bag in the trash bin.

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| **Preparation** |

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| Lemon Juice | | | Salt Water | | | | Ginger Ale | | | | |
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| Solution Bowls | | | | Fuji Apples | | | | Peel and Slice | | | | |
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| Leave Apple Slices in Solutions for 15 Minutes | | | | | | | | | | | | | | | |

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| **Refrigeration** |

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| Refrigerate Apple Slices for 7 days |

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| **Incubation** |

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| Swipe cotton swabs on slices, and streak zigzags on agar | Place the agar plates in the incubator at 87° Fahrenheit, and leave them for 2 days |

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| **Preparation** |

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| Lemon Juice | Salt Water | Ginger Ale |
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| Solution Bowls | Fuji Apples | Peel and Slice |
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| Leave Apple Slices in Solutions for 15 Minutes | | |

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| **Refrigeration** |

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| Refrigerate Apple Slices for 7 days |

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| **Incubation** |

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| Swipe cotton swabs on apple slices, and streak on agar plates | Place agar plates in the incubator at 87°F, and leave them for 2 days |

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| **Observation 1 (Browning and Dryness)** |

After Removing Apple Slices from Refrigerator

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|  |  |
| Control Group | Ginger Ale |
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| Salt Water | Lemon Juice |

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| **Observation 1 (Browning and Dryness)** |

After Removing Apple Slices from Refrigerator

|  |  |
| --- | --- |
|  |  |
| Control Group | Ginger Ale |
|  |  |
| Salt Water | Lemon Juice |

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| **Observation 2 (Bacteria Growth)** |

Bacteria Growth After 2 Days of Incubation

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|  |  |
| Ginger Ale, No Ziploc | Ginger Ale, Ziploc |
|  |  |
| Salt Water, Ziploc | Control Group |
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| Lemon Juice, Ziploc | Lemon Juice, No Ziploc |
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| Salt Water, No Ziploc | No Solution, Ziploc |

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| **Observation 3 (Bacteria Close-up)** |

Bacteria Colonies Under Microscope (x43)

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| Ginger Ale, No Ziploc | Ginger Ale, Ziploc |
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| Salt Water, Ziploc | Control Group |
|  |  |
| Lemon Juice, Ziploc | Lemon Juice, No Ziploc |
|  |  |
| Salt Water, No Ziploc | No Solution, Ziploc |

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| **Results** |

Apple slices soaked into salt water and   
kept in a Ziploc keep their light color.

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| Apple Slice Group | Browning |
| Salt Water, Ziploc | 1 |
| No Solution, Ziploc | 2 |
| Ginger Ale, Ziploc | 3 |
| Lemon Juice, Ziploc | 4 |
| Salt Water, No Ziploc | 5 |
| Ginger Ale, No Ziploc | 6 |
| Lemon Juice, No Ziploc | 7 |
| Control Group | 8 |

Table 1. Browning (lowest to highest)

Apple slices soaked into salt water and   
kept in a Ziploc look fresh and watery.

|  |  |
| --- | --- |
| Apple Slice Group | Dryness |
| Salt Water, Ziploc | 1 |
| No Solution, Ziploc | 2 |
| Ginger Ale, Ziploc | 3 |
| Lemon Juice, Ziploc | 4 |
| Salt Water, No Ziploc | 5 |
| Ginger Ale, No Ziploc | 6 |
| Lemon Juice, No Ziploc | 7 |
| Control Group | 8 |

Table 2. Dryness (lowest to highest)

Apple slices soaked into ginger ale and   
kept outside the Ziploc turned out to be   
the healthiest with minimum bacteria.

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| --- | --- |
| Apple Slice Group | Bacteria |
| Ginger Ale, No Ziploc | 1 |
| Ginger Ale, Ziploc | 2 |
| Salt Water, Ziploc | 3 |
| Control Group | 4 |
| Lemon Juice, Ziploc | 5 |
| Lemon Juice, No Ziploc | 6 |
| Salt Water, No Ziploc | 7 |
| No Solution, Ziploc | 8 |

Table 3. Bacteria (lowest to highest)

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| **Results** |

Based on Observation 1, apple slices soaked into salt water  
and kept in a Ziploc had the lightest color, while the ones in  
the control group were the brownest.

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| Apple Slice Group | Browning |
| Salt Water, Ziploc | 1 |
| No Solution, Ziploc | 2 |
| Ginger Ale, Ziploc | 3 |
| Lemon Juice, Ziploc | 4 |
| Salt Water, No Ziploc | 5 |
| Ginger Ale, No Ziploc | 6 |
| Lemon Juice, No Ziploc | 7 |
| Control Group | 8 |

Table 1. Browning (lowest to highest)

Based on Observation 1, apple slices soaked into salt water  
and kept in a Ziploc had the freshest look, while the ones in  
the control group were the driest.

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| Apple Slice Group | Dryness |
| Salt Water, Ziploc | 1 |
| No Solution, Ziploc | 2 |
| Ginger Ale, Ziploc | 3 |
| Lemon Juice, Ziploc | 4 |
| Salt Water, No Ziploc | 5 |
| Ginger Ale, No Ziploc | 6 |
| Lemon Juice, No Ziploc | 7 |
| Control Group | 8 |

Table 2. Dryness (lowest to highest)

Based on Observation 2, apple slices soaked into ginger ale  
and kept outside the Ziploc turned out to be the healthiest with  
minimum bacteria, while the ones in no solution and kept in a  
Ziploc were the least healthy with maximum bacteria on them.

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| Apple Slice Group | Bacteria |
| Ginger Ale, No Ziploc | 1 |
| Ginger Ale, Ziploc | 2 |
| Salt Water, Ziploc | 3 |
| Control Group | 4 |
| Lemon Juice, Ziploc | 5 |
| Lemon Juice, No Ziploc | 6 |
| Salt Water, No Ziploc | 7 |
| No Solution, Ziploc | 8 |

Table 3. Bacteria (lowest to highest)

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| **Graphs** |

Figure 1. Browning (lowest to highest)

Figure 2. Dryness (lowest to highest)

Figure 3. Bacteria (lowest to highest)

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| **Conclusion** |

My hypothesis of dipping apple slices in salt water and keeping in a sealed bag to keep the apple slices the healthiest turned out to be wrong. I was expecting salt to be the best option as it’s being heavily used in the food industry as a preservative. Although it performed the best to prevent from browning and dryness, it only took the third place to keep the bacteria development at a minimum. Meanwhile, ginger ale turned out to be the best choice to keep apple slices healthy.

Ginger ale commonly contains carbonated water, mix of spices, fruits, lemon, lime, and cane sugar. Pineapple and honey are also occasional ingredients. Ginger ale can also contain yeast, when carbonated with natural fermentation. This mixture that contained carbonic acid proved to be the best protector against microorganism development in a cold environment.

Although the control group (no solution, no Ziploc) performed the worst in the browning and dryness observations, it was the fourth healthiest group. This might be due to the dryness of apple slices. Fruits are usually dried to preserve them from spoiling, and apple slices protected themselves naturally by drying their cut surfaces. The same apple slices showed the highest bacteria growth when kept in a sealed bag because they couldn’t dry inside a Ziploc, and they were not soaked in a solution to protect them from microorganisms.

The most important finding of this experiment is that browning of apple slices does not necessarily mean that they are spoiled. Likewise, keeping apple slices from browning and dryness doesn’t prove that they will stay healthy either. So, we shouldn’t be fooled by the looks of the apple slices. Instead, we should know how exactly they’re being protected.

In summary, if you want to keep your apple slices healthy, you should soak them in a carbonated drink such as ginger ale. If you also want to keep them from browning and getting dry, you should put them in a Ziploc. Even though ginger ale and Ziploc combination was the second healthiest option, for all practical purposes, it is the optimum choice. Keeping apple slices in a Ziploc will protect against contamination, and your apple slices will taste fresh and watery at the same time. So, ginger ale and Ziploc is the ultimate winner of this experiment.

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| **Acknowledgements** |

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