



## **Minor Challenge Set #4**

**STEM Field:** Food Science

**Level:** Intermediate

**Challenge Name:** A Food Preservation Challenge

**Project Cost:** 0-20 USD

### **Materials Required:**

- 1 apple
- 3 treatment ingredients, chosen from the list below. You will need 1 teaspoon of each of the chosen ingredients.
  - Sugar
  - Water
  - Lemon juice
  - Vinegar
  - Apple juice
  - Milk
  - Honey
- 5 containers / plates / cups / bowls
- Knife, to cut the apple into equal slices
- Teaspoon
- Clock, or timer
- Pen and paper to make labels
- Notebook to record results, or print out table on page 6

### **Safety:**

- Adult supervision and assistance are required when handling knife to cut the apple

### **Duration:**

- The challenge take approximately 3 hours to finish, however, the time guideline is an estimation only, and students and mentors can complete the tasks around their schedules

# Introduction:

At some schools, students often pack apple slices with their lunch. However, while packing lunch, adults are faced with a problem: once apples have been cut into slices, after a few hours, they turn brown and don't look fresh or good to eat anymore.

As a food scientist, your challenge is to experiment with different techniques of preserving apple slices, and to find the best methods to preserve food. We will give some background information, and further resources to help with your research. You will then do some experimentation, and hopefully will arrive at some good techniques to keep these apple slices fresh and tasty, even after a few hours!

**Research Question:**  
**What techniques can we use to preserve apple slices, and prevent them from browning after a few hours?**



## Why do apples turn brown a few hours after being cut?

The browning of fruits or vegetables is a reaction called **enzymatic browning** - which means the browning process is caused by changes to the enzymes inside these plants. **Enzymes** are special types of

proteins, and they control how quickly chemical reactions occur. In plants, there is an enzyme called **polyphenol oxidase (PPO)**.

The air we breathe is made up of different gases. **Oxygen** is one of the gases present in the air - even though we cannot see, smell, or taste it! When an apple is cut, the enzyme called PPO reacts to oxygen in the air, making the fruit's appearance turn brown.

### **So, how can we slow down the process of fruit browning?**

Previous experiments show a few methods which we can use to slow down the process of enzymatic browning.

- 1) Using sugar, or syrup: When the fruit slice is coated using sugar, or syrup, we are creating a layer between the enzymes inside the fruit, and oxygen in the air. This also reduces the amount of oxygen that reacts to the enzymes inside these apple slices. This slows down the reaction between enzyme and oxygen, and therefore, slows down fruit browning.
- 2) Using fruit juices that have high levels of vitamin C: These types of food contain **antioxidants** - substances that fight against oxygen. This means they can reduce the amount of oxygen that reacts to the enzymes inside these apple slices, and can slow down fruit browning.
- 3) Submerge the fruit in water, or salt water for a few minutes, then drain them: This method reduces the exposure of the apple slices to air. If you decide to do this in your experiment, note down how long you submerge your fruit in water, or saltwater for. You can also test if the longer you submerge the fruit in water, or saltwater, the slower the browning process will happen.

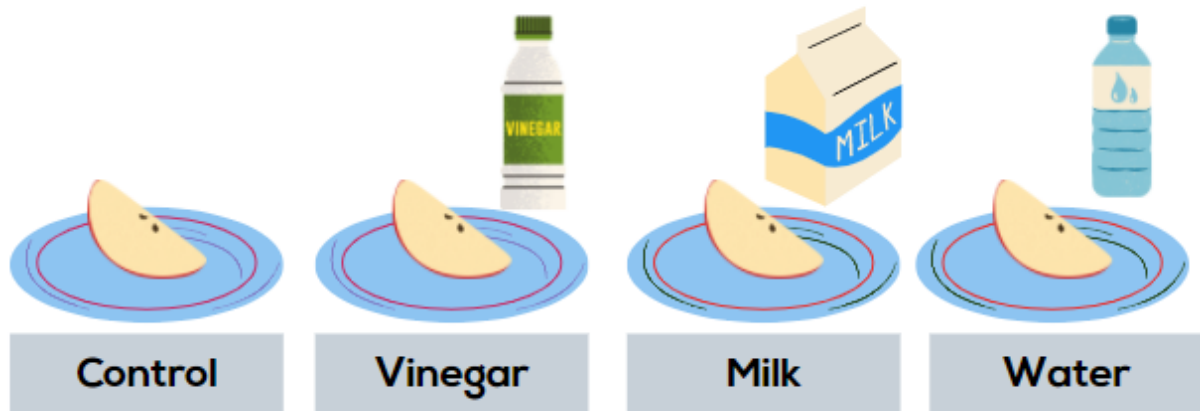
# Instructions:

## Part A: Prepare for the experiment

- 1) Read through the Introduction section, and do more research if needed. Determine which treatment ingredients you will use for the experiment. We recommend selecting 3 ingredients from the provided list on page 1.
- 2) Prepare containers to put in the test apple slices. For this experiment, you need to have an extra container for the **controlled group**. This means you will not add any treatment ingredients to the apple slice in the container.
- 3) Make labels for each container. Remember to create 1 label for the controlled group. You will need 4 labels in total.

## Part B: Conducting the experiment

- 4) Ask an adult to help cut the apple into 4 equal slices.
- 5) Place 1 slice into the container labelled as “Control”. Do **not** put any liquid in this container.
- 6) Place 3 other slices into the other 3 containers. Sprinkle 1 teaspoon of each ingredient into each container. An example of the experimental set up is shown in the figure below.



- 7) Start the timer when you have finished step 7. You will time the experiment for 2 hours.

### Part C: Record the results

**Note:** You can draw the table below in your notebook, or print out the table, to record your results.

- 8) Record your results and observations in the table below. You will record your results at the 1 hour mark, and again at the 2 hours mark.
- 9) Write your treatment ingredients in the treatment column.
- 10) Note down any other observations you made throughout the experiment on a different page.

Treatment	After 1 hour		After 2 hours	
	Observation of the apple slice	Rate how brown the apple appears (0 = not brown at all; 5 = very brown)	Observation of the apple slice	Rate how brown the apple appears (0 = not brown at all; 5 = very brown)
Control				

## Extension - How else can we slow down enzymatic browning?

In this challenge, we have introduced a few simple methods to slow down fruit browning. How else can we preserve these apple slices? (Hint: consider temperature, exposing the fruit to the air or placing the fruit in an airtight container).

In the food industry, a common technique to prevent browning of fruits is to dry fruits. When drying fruits, you are removing moisture from the fruits, which stops other very small organisms from growing in these fruits. This ensures these fruits are still safe to eat after a long time. The shapes of these fruits also become more compact, and can be stored in packages more easily. However, it is a more complicated process than what we can usually replicate at home!

Another real life example of food science is the development of **Arctic apples**. These apples are modified so that they do not have **PPO enzymes** inside them. With no PPO enzymes present, fruit browning cannot occur. (Note that they can still turn brown when these apples are spoiled! Fruit browning here refers to the apple turning brown a few hours after being cut, and exposed to the air.)

## Reflection Questions:

- Are there any improvements you would make to this challenge?
- What real world application/s can you apply this challenge to?
- Why do you think food scientists research techniques to preserve food?
- Is it better to use treatment ingredients to preserve the apple slices? If so, which treatment ingredient preserves the apple slice the best?
- When preserving food, you will also need to consider the texture, and taste of the food after adding treatment ingredients. What

treatment ingredients do you think are better to add to the apple slices to preserve, and keep a similar texture and taste of the fruit?

- What other treatment ingredients do you want to do an experiment with? Why do you think these ingredients can slow down the process of apple browning?

## Submission Guidelines:

- Submit a photo of the experiment setup, the table of your results, and any other observations you made. Include a short summary that addresses the reflection questions.

Note: Remember, if you want to upload pictures of your Minor Challenge that also include you, please check if it is OK with your parent or guardian first.

- The submission form is on the Minor Challenges page:  
<https://sciencechallenge.org.au/index.php/minor-challenges/>  
Fill out the details and make sure you upload your submission.

## Learn More! Resources:

- If you are interested in learning more about what food scientists do in their job, read more here:  
<https://careerdiscovery.sciencebuddies.org/science-engineering-careers/earth-physical-sciences/food-scientist-or-technologist>
- This article features the career of a food scientist:  
<https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/past-issues/2019-2020/feb-2020/chemistry-in-person.html>



# Bibliography:

- Lohner, S., 2021. *Why Does Fruit Turn Brown?* | *Science Project*. [online] Science Buddies. Available at: <[https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci\\_p082/cooking-food-science/enzymatic-browning](https://www.sciencebuddies.org/science-fair-projects/project-ideas/FoodSci_p082/cooking-food-science/enzymatic-browning)> [Accessed 2 April 2022].
- Scientific American. 2007. *Why do apple slices turn brown after being cut?*. [online] Available at: <<https://www.scientificamerican.com/article/experts-why-cut-apples-turn-brown/#:~:text=When%20oxygen%20is%20present%20in,to%20brown%2Dcolored%20secondary%20products>> [Accessed 10 April 2022].