Testable Question

Which method of preventing apple browning, will result in the least amount of browning after 48 hours?

Hypothesis

ccAside from keeping the apple in an oxygen free container, I think soaking the apple in a salt water solution will stop the apple from browning the most after 48 hours compared to the other methods (plain water, lemon juice, honey and baking soda).

From best to worst salt water, honey, lemon juice, baking soda and then plain water

Research

chttps://www.thekitchn.com/skills-showdown-how-to-keep-apples-from-browning-23244847

- Once apples are cut and exposed to air they begin to brown due to oxidation
- The only way to stop oxidation is to create a barrier between the cut fruit and the air
- Acids can form citric juice which is commonly used to slow the reaction
- Tested a total of 8 methods:
    - Untreated - 1/10 - browned within 15 mins
    - Lemon-lime soda - 6/10 - 3 hours - in bag 6 hours
    - Citric acid - 4/10 - Full 12 hours - terribly tart/sour (even hours after being rinsed) - worked for looks, but not good for eating
    - Lemon water - 3/10 - Stayed fresher when sealed in a bag than on the plate - 2 hour mark - in bag - unbrowned 3 hours
    - Plain water - 8/10 - 6 hours sealed - in bowl with water 4 hours
    - Salt water - 10/10 - 12 hours - did not taste salty
    - Honey water - 9.5/10 - 12 hours - both in bag and plate
    - Lemon juice - 5/10 - 7 hours - still sour but not as bad as citric acid

1. https://www.seriouseats.com/how-to-prevent-apple-pear-browning

- Apples contain a large amount an enzyme called polyphenol oxidase
    - These enzymes protect from infection and give pigments
    - Stored in separate areas of the plant and when cells are damaged (e.g. cut open, dropped or bruised) the cells are ruptured
    - The enzyme comes into contact with oxygen
    - With help of oxygen (air around the damaged cell - e.g. cut apple) the enzyme initiates a series of chemical reactions and turns the area brown
    - This is called “Enzymatic Browning”
        - Can affect flavour, scent and nutritional value
- Most solutions involve blocking oxygen in one way or another, reversing the oxidation reaction, changing the pH environment or exposing the produce to high or low temperatures
- Summary - Soak the apples in salt water solution for 10 mins, drain -
- Methods tested:
    - Water - submerge to reduce oxygen exposure
    - Lemon juice
    - Critic acid
    - Salt water
        - Sodium chloride can interfere with oxidation
        - Best method to not impact taste and texture
    - Cooking apples:
        - High heat shuts down the oxidation but makes the apple very soft

Why apples brown

Apples are one of many fruits that contain a large amount of an enzyme called polyphenol oxidase. As its name suggests, it is capable of oxidizing polyphenols, molecules that play a variety of roles in plants, from protecting against infections to giving them their pigments. Polyphenol oxidase and the polyphenols themselves are stored in separate areas of the plant's cells, but when the cells are damaged say, when an apple is sliced open, or dropped and bruised the cells are ruptured, and the enzyme comes into contact with the substrate. With the help of oxygen, which is in the air around the damaged cells, the polyphenol oxidase initiates a series of chemical reactions, transforming the polyphenols and eventually producing melanins brown pigments.The general name for this process is "enzymatic browning," and the problem is that it doesn't just change the appearance of produce; it also alters flavor, scent, and nutritional value and usually not in a good way.

Variables

controlled

1. Environment - All apples will be kept at the same temperature with same exposure to light
2. Amount of apple - All apples will be around 11-12 grams
3. Type of apple - All apples will be Ambrosia
4. Amount of substance used - 1 tbps
5. Amount and temp. of water used - 5 tbsp - room temperature

Manipulated

1. The substance used in the method to coat the apple
2. The amount of exposure of the apple to air

Responding

1. The amount the apple browns
2. The amount the apple changes texture

Materials

Ccc3 drttycfdcbnhjqpmokxpl’fyeg7y88fuueuhfhndgfgkjghfggfgffjshgafghadfjlsfdahds apple slices per method

- Salt - 1 tbsp
- Honey - 1 tbsp
- Baking soda - 1 tbsp
- Lemon juice - 1 tbsp
- Vacuum seal machine and bag
- Water - 5 tbsp/method
- 5 bowls
- 5 plates
- Cutting board
- Scale
- Measuring cup
- Knife

Procedure

1. cWash and core apples
2. Cut apple to get into 18 equal slices
    a. 3 slices per method
    b. 11-12 grams per slice
    c. Use multiple apples if necessary
3. Mix 5 tbsp with 1 tbsp with substance:
    a. Control group - 5 tbsp water
    b. Lemon juice - 1 tbsp lemon juice - 5 tbsp water
    c. Salt water - 1 tbsp salt - 5 tbsp water
    d. Baking soda - 1 tbsp Baking soda - 5 tbsp water
    e. Honey - 1 tbsp Honey - 5 tbsp water
    f. Vacuum seal - 5 tbsp water
4. Put 3 apple slices into each bowl of solution and stir thoroughly
5. All apples to soak for 1 hour
6. Take out the apple slice and pat dry with a paper towel
7. Put the three slices spread out on a plate
8. Check every 2-4 hours for the first 24 hours, once around 24 hours and again after 48 hours have passed
9.

Data

Time	Control	Lemon Juice	Salt water	Baking soda	Honey water	Vacuum seal
Jan 18 1:10 pm	Crisp - no change	Crisp - no change	Felt very smooth and soft	Felt kind of bumpy	Crisp - no change	Crisp - no change
3:10 pm	Crisp - no change	Kinda squishy No browning Smooth texture	Still very smooth and tiny bit of browning 1/10	Soft and small bit of browning 2/10	Soft and squishy, smells sweet tiny specs of browning 0.5/10	Crisp - no change
6:00 pm	Still felt normal A little bit of browning 1/10	No change	Very smooth, had splotches edges began wrinkling, browning 2/10	Lots of browning and inedible 5/10	No change	Crisp - no change
10:30 pm	Dry with streaks running throughout Browning 2/10	Squishy and edges drying out Browning 1/10	Edges white dots began developing Otherwise no change 2/10	Turned fully brown 8/10	No change	Crisp - no change
Jan 19 3:30 pm	Slightly more browning 3/10	Edges were dry 3/10	Slightly more browning 3/10	Continuing to brown 9/10	Looked stretched out still 0.7/10	Crisp - no change
Jan 20 3:30 pm - After 48 hours	Hard and wrinkled Browning 4.5/10	Turned fully brown, drying out, looks stretched and wrinkly Browning 5/10	Squishy, still drying out 3/10	Looked like a squashed pumpkin 10/10	Peel side was smooth Browning 1/10	Crisp - no change *WINNER

Tables and Graphs

conclusion

cThe vacuum seal was clearly the winner and kept the apple from browning, changing texture and drying out.

Why? Since the vacuum seal prevented any oxygen from getting to the apple, the polyphenol oxidase (enzyme) could not react and therefore the process of enzymatic browning did not occur.

Of the other 5 methods tested I was wrong and salt water was not the best method of keeping the apple from browning for the longest period of time. The winner for the apples exposed to the air was honey water then salt water, lemon juice, plain water and then the baking soda.

Recommendations

cccThe vacuum seal was clearly the winner and kept the apple from browning, changing texture and drying out.

Why? Since the vacuum seal prevented any oxygen from getting to the apple, the polyphenol oxidase (enzyme) could not react and therefore the process of enzymatic browning did not occur.

Of the other 5 methods tested I was wrong and salt water was not the best method of keeping the apple from browning for the longest period of time. The winner for the apples exposed to the air was honey water then salt water, lemon juice, plain water and then the baking soda.