

## Chemistry Through Food: Brown Apples and Muddy Guacamole

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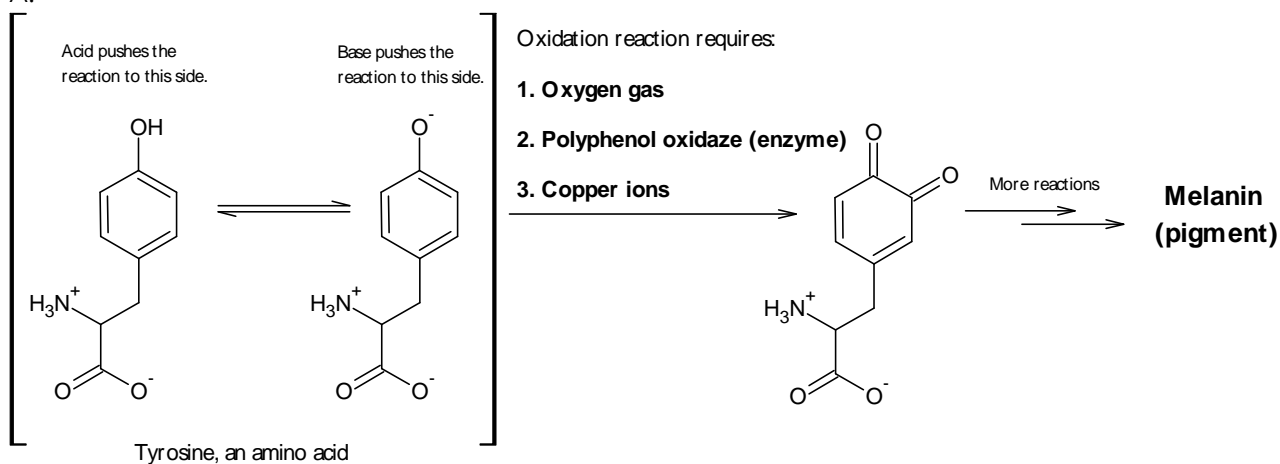
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### Q: What causes browning in fruits and tea?

A: A chemical reaction that produces melanin, a brown pigment - also responsible for skin color.

### Q: What is the chemical reaction?

A:



### Q: How can browning be prevented?

- A:
1. Prevent cell damage that releases the enzyme and exposes the fruit to oxygen (ship hard, unripe fruit quickly and ripen on arrival with ethylene; package carefully; buy unripe fruit and ripen at home with other fruit in paper bag which traps ethylene).
  2. Slow reaction by cooling it in refrigerator or freezer (this can lead to other problems).
  3. Remove the oxygen (seal the fruit in air-free container; leaving the pit in the avocado only works for flesh not exposed to air, which is underneath the pit).
  4. Destroy the enzyme with heat (blanching) or radiation (irradiated food).
  5. Remove the copper metal ("chelation" with citric acid or EDTA).
  6. Make the tyrosine less reactive by shifting the equilibrium in the brackets to the left. (acidifying with citric acid or lemon or lime juice).

### Q: What experiments can we do to prove the requirement for oxygen and copper, etc?

- A:
1. Generate oxygen gas and put it in a sealed bag with cut fruit
  2. Coat the fruit with citric acid solution or lime juice
  3. Coat the fruit with EDTA to bind the copper
  4. Coat the fruit with copper sulfate, copper acetate, or iron oxide solutions
  5. Can a ceramic knife, which lacks copper or iron ions, reduce the rate of oxidation?
  6. Does the type of apple influence the rate of reaction?

In all of these experiments, be sure to run a control at the same time!