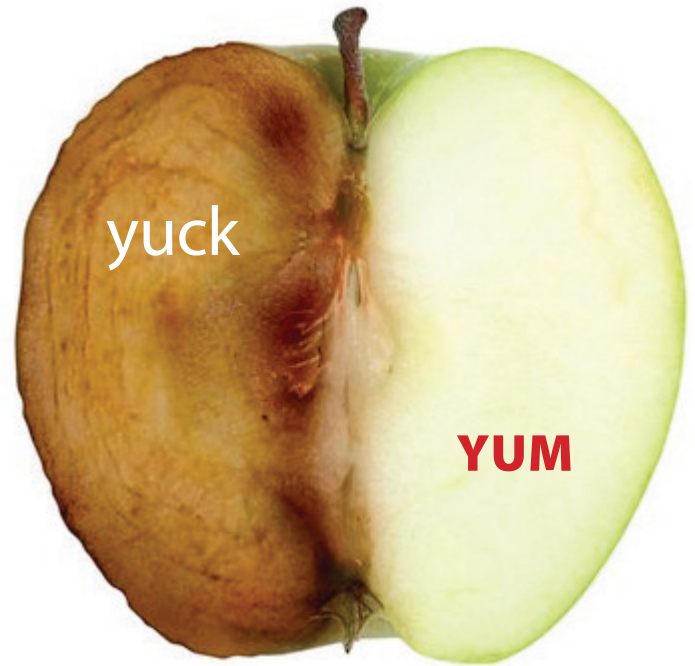


Keeping it Fresh

We all enjoy eating fresh fruits and vegetables that are bright and crispy. Fruits and vegetables that are brown, limp, or mushy probably end up in the trash or compost. Farmers and grocers want to keep trainloads of fruits and vegetables fresh during long trips across the country. You may just want to keep apple slices fresh in your lunchbox for a few hours.



What does “fresh” really mean?

When talking about food, the word “fresh” might mean unprocessed (as opposed to dried, pickled, canned, or frozen). Fresh also means “unspoiled.” When food spoils, the original nutritional value, texture, flavour of the food are changed, and eventually the food becomes extremely unappetizing... even harmful... to eat. The chemical reactions that cause food changes or spoilage can be a result of bacteria or fungus from the environment coming into contact with the food or a result of many different enzymes naturally found in the cells of plants or animals.



Enzymatic browning

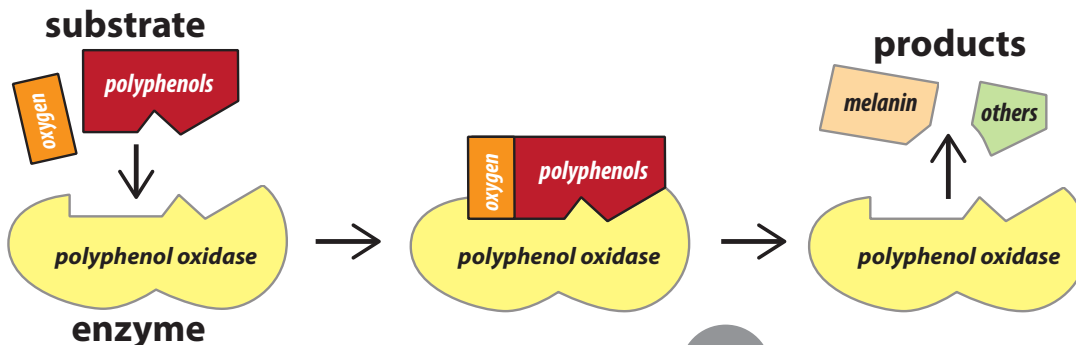
One of the chemical reactions that changes food is called “enzymatic browning.” Certain fruits and vegetables brown quickly when cut or mashed. Enzymatic browning is quite different from the rotting that comes with decay, and browning foods can be safely eaten. Even though enzymatic browning can make foods such as avacados, potatoes, bananas, and apples become “yucky” when cut, the same chemical reaction also develops the colors and tastes of tea, coffee, and chocolate that many people love.

How does enzymatic browning work?

Enzymatic browning is a chemical reaction that requires an enzyme called polyphenol oxidase (PPO), a substrate from a family of chemicals called polyphenols, and oxygen. The products of this chemical reaction cause the brown color. The PPO and polyphenols are present in the plant cells and are released when the cells are cut or mashed. The oxygen comes from the air.

An enzyme is a chemical that starts or speeds up a chemical reaction.

A substrate is the chemical that the enzyme acts on.



How can enzymatic browning be stopped?

Enzymatic browning can be slowed or stopped by removing or changing the chemicals required for the browning reaction or changing the environment where the reaction is happening.

- Higher acidity, such as a pH below 4.0, inhibits the activity of the polyphenol oxidase (PPO) enzyme. Adding citric, ascorbic or other acids, such as vinegar, lowers the pH and prevent enzymatic browning.
- During enzymatic browning, polyphenols react with oxygen. If something else reacts with the oxygen, enzymatic browning won't occur. A chemical like this is called an antioxidant. Vitamin C (ascorbic acid) is an antioxidant. The colorful chemicals in fruit and vegetable skins and peels are also antioxidants.
- Cooks often put cut apples or potatoes in a water bath until they are ready to be cooked. The water reduces contact with oxygen and prevents enzymatic browning.
- Cooking fruits or vegetables inactivates (destroys) the PPO enzyme, and enzymatic browning will no longer occur.
- Refrigeration can slow enzymatic browning. At temperatures below 7 °C the PPO enzyme activity is inhibited (but not inactivated). Home refrigerators are usually between 3 and 5 °C (37 to 41 °F).

DesiGrub: Adventures with Food is a blog by Bindesh Shrestha, a chemist working in Washington, D.C. In one article, Bindesh writes

"I love guacamole but don't dare to make it for everyday use because, unless you eat it all, it soon turns into bad, unappetizing brownish chunks."

Bindesh goes on to show the results of his experiments to prevent enzymatic browning in guacamole. Some of his treatments even made the browning worse! Check it out: <http://desigrub.com/2010/12/avocado-browning/>

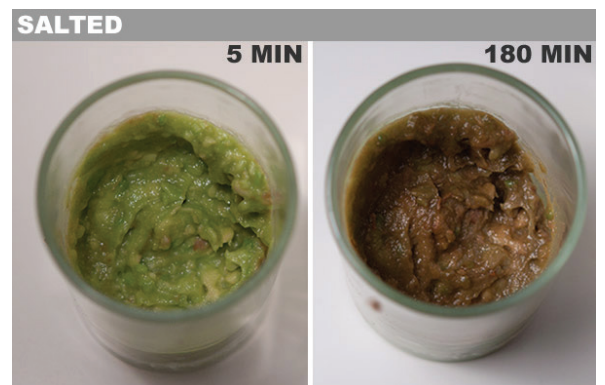
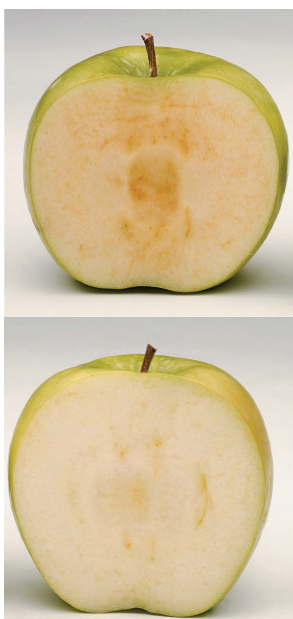


Photo courtesy of Bindesh Shrestha.

Is genetic engineering the answer?



Even though enzymatic browning does not make foods unsafe to eat, fruits and vegetables can be less appetizing when browned. A company called Okanagan Specialty Fruits promises to end the browning of cut apples with their genetically modified variety called Arctic apple. To make the Arctic apple, scientists created a new gene using DNA from other genes found in apples that control production of polyphenol oxidase (PPO). By adding this new gene to apples, the production of PPO is greatly reduced, and much less browning occurs.

The U.S. Apple Association, which represents the American apple industry, objects to the Arctic apple, feeling it will affect the apple's image as a healthy food, since many consumers are worried about the safety of genetically modified foods. Other people just feel the Arctic apple is silly, saying "Why not just squirt some lemon juice on apple slices to keep them from browning?" Read what Okanagan Specialty Fruits has to say [on their website](#), and see what you think. Once Arctic apples are in stores, you can decide whether to buy.

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