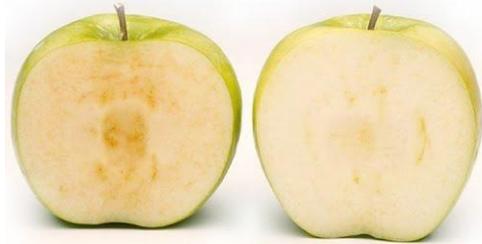


Browning Reactions

Enzymatic Browning

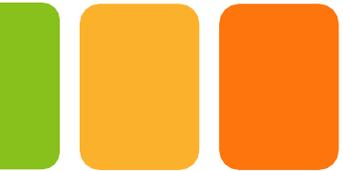
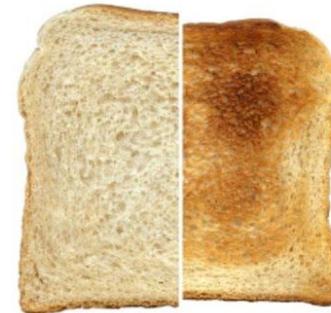


Non enzymatic Browning

Caramelization



Maillard Reaction



What is Browning Reaction ?

Browning is a process in which the food turns brown due to the chemical reactions taking place within the food. It may be desirable or undesirable. In spite of the fact that there are several ways via which food chemically changes over the long run.





Browning specifically falls into 2 main categories:

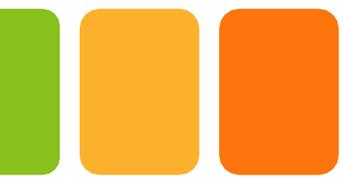
- Enzymatic Browning
- Non-Enzymic Browning



1. Enzymatic Browning

This occurs when enzymes (such as phenolase) react with oxygen and phenols in food, forming brown pigments called melanin. This reaction happens in fruits and vegetables like apples, potatoes, and bananas.





2. Non-Enzymic Browning

This includes reactions that do not require enzymes:

1 Maillard Reaction – Occurs between amino acids and reducing sugars when heated, leading to browning in foods like toasted bread, roasted coffee, and grilled meat.

2 Caramelization – Happens when sugars are heated, breaking down into brown colored compounds, giving a sweet and rich flavor, as seen in caramel and roasted marshmallows.



What is Enzymic Browning?

Enzymic browning is a **chemical reaction** that occurs in fruits and vegetables when they are **cut, bruised, or damaged**. It is an oxidation reaction catalyzed by **enzymes** that results in the formation of brown pigments.

Key Components Involved in Enzymic Browning

1. **Phenols** – These are natural compounds found in plant tissues.
2. **Phenolase (Polyphenol Oxidase, PPO)** – An enzyme responsible for catalyzing the reaction.
3. **Oxygen** – Present in the air and required for the reaction to take place.

How the Reaction Occurs ?

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1. When a fruit or vegetable is cut, bruised, or exposed to air, the **cell structure is broken**, allowing oxygen to come in contact with **phenols** and **phenolase enzyme**.
 2. **Phenolase catalyzes the oxidation of phenols into quinones** (colorless compounds).
 3. Quinones react further with oxygen and other compounds to form **melanin**, which has a brown color.

Factors Affecting Enzymic Browning

1. **Oxygen Availability** – More oxygen speeds up the reaction.
2. **pH (Acidity)** – Enzymes work best at specific pH levels. Acidic environments (like lemon juice) slow down enzymic activity.
3. **Temperature** –
 - o Low temperatures (refrigeration) slow enzyme activity.
 - o High temperatures (cooking) denature enzymes, stopping browning.
4. **Presence of Antioxidants** – Substances like ascorbic acid (Vitamin C) can prevent oxidation by reacting with oxygen before it reaches the phenols.

Preventing or Slowing Down Enzymic Browning

- 1. Use of Acids (Lemon Juice, Vinegar)** – Lowers the pH, making the enzyme less effective.
- 2. Blanching (Boiling briefly)** – Heat destroys the enzyme, preventing the reaction.
- 3. Reducing Oxygen Exposure** – Storing cut fruits in water or sugar syrup limits oxygen contact.
- 4. Refrigeration** – Slows down enzyme activity and oxidation.
- 5. Using Antioxidants (Vitamin C, Honey)** – Compounds that react with oxygen before it affects phenols.



Procedure:

1. Cut the apple or banana into slices.
2. Place one slice in plain water, one in sugar solution, and one in lemon juice.
3. Leave one slice exposed to air on a plate as a control sample.
4. Let the samples sit for one hour.
5. Observe which slice turns brown the fastest and which one stays fresh.

Caramelization

Materials:

- 150g Granulated white sugar (sucrose)
- 75ml Water
- Small saucepan or pot
- Thermometer
- Plate or aluminum foil
- Spoon





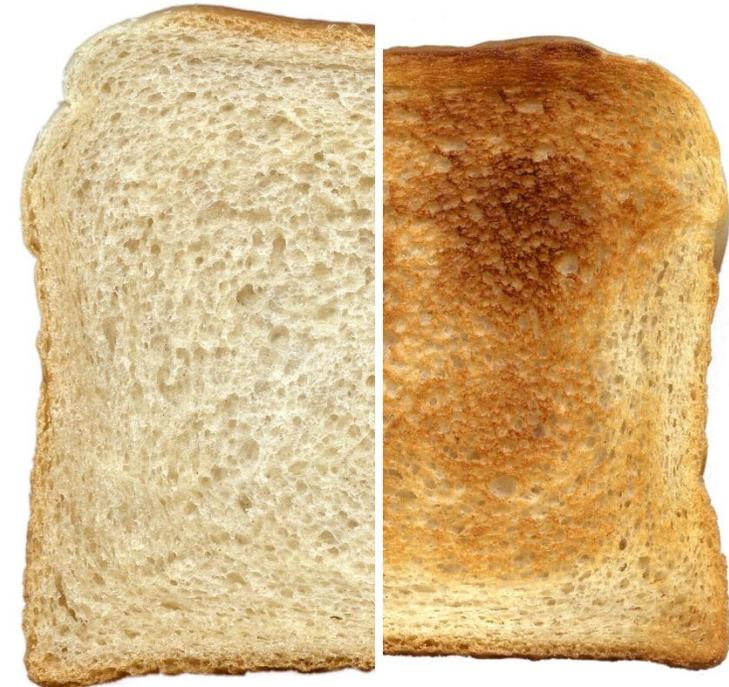
Procedure:

- 1- Mix the sugar and water in the saucepan. Stir over low heat until the sugar is completely dissolved.
- 2- Increase the heat to medium. Once the mixture begins to boil, stop stirring. Stirring at this stage can cause the sugar to crystallize.
- 3- As the water evaporates, the temperature will rise above 100°C.
- 4- Using your spoon, take a small drop of the syrup every 2 minutes and place it on the white plate/foil.
- 5- Watch for the following stages of browning:
 - Clear Stage
 - Light Amber: The sugar begins to break down; a faint yellow tint appears.
 - Medium Caramel: A rich brown color and a nutty aroma develop.
 - Dark Caramel: The color is deep brown at this stage

Maillard reaction in bread

Materials:

- White bread
- Oven
- Plates





Procedure:

- 1- Cut the bread into identical pieces.
- 2- Place the first slice in a 150°C oven for 2 minutes to observe the induction phase.
- 3- Place the second slice or in a 200°C oven for 5 minutes to observe peak Maillard reaction where the bread will gain a golden brown color.
- 4- Place the third slice in on the highest setting or in a 220°C oven for 8–10 minute to see the transition from browning to carbonization (burning

