

# FOOD ENZYMES AND THEIR APPLICATIONS

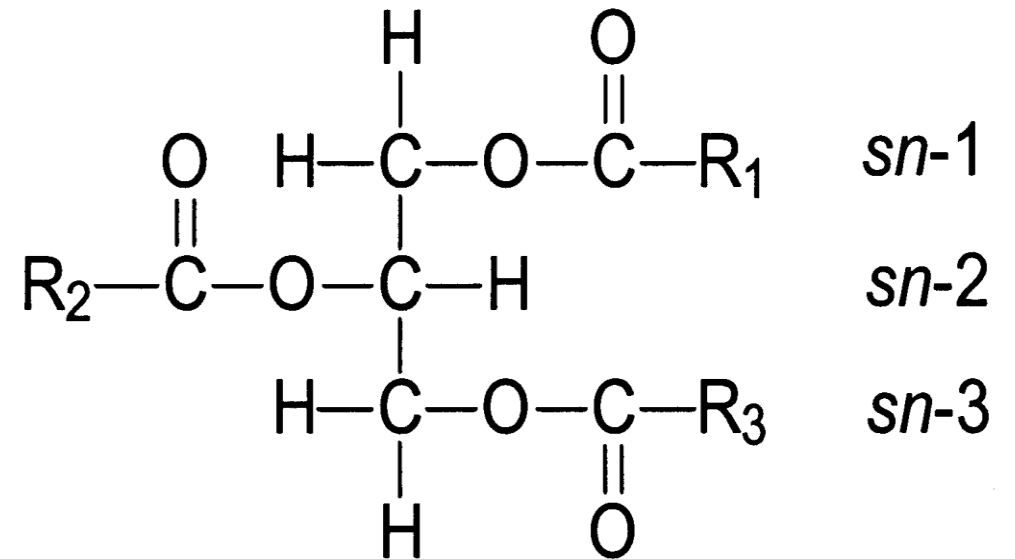
**BA PART I, PAPER 1, Home science department,  
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# Important food enzymes –Glycosyl Hydrolases - Lipases

## IV. Lipases

- Enzymes that hydrolyze ester bonds between fatty acids and a glycerol molecule
  - Work at the water-oil interface

- Two classes
  - a) 1,3-lipases: preferentially hydrolyze ester bonds at SN1 and SN3
  - b) 2-lipases preferentially hydrolyze ester bonds at SN2



# Important food enzymes –Lipases: Impact on quality

A) Lead to hydrolytic rancidity

## **BAD when**

- Free fatty acids released in muscle react to proteins to denature them and give a tough texture (on freezing)
- They are not inactivated in milk; release short chain fatty acids that are very volatile and can also oxidize

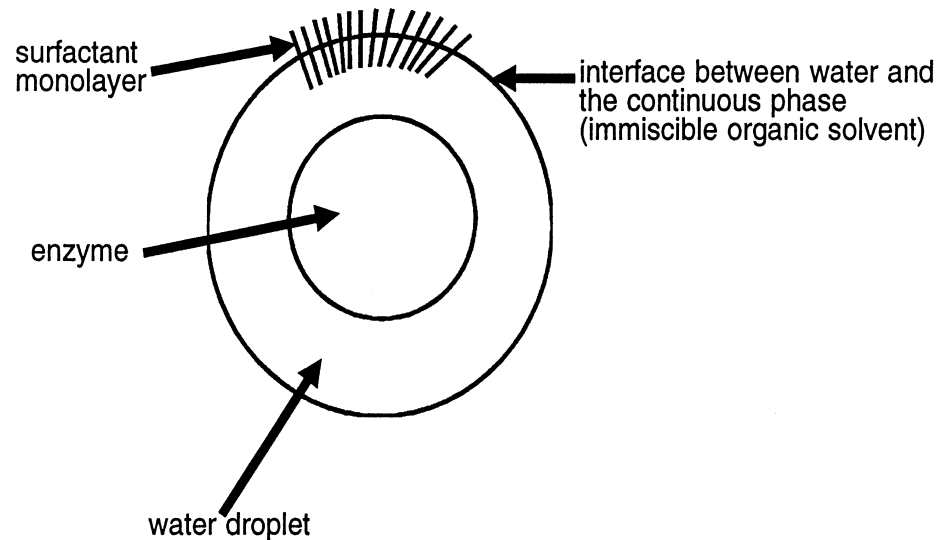
## **GOOD when**

- Used in fermented products
- Extremely important in ripening of cheeses/dry-sausages
- Short chain fatty acids released from milk fat produces the characteristic odor and flavor of these products (C:8 especially)

# Important food enzymes –Lipases modify lipid properties

## B) They can be used to modify the properties of lipids

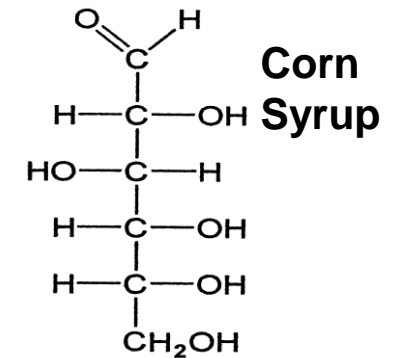
- Very popular application in the margarine industry to modify lipid crystal structure to give different textures and melting points
- Used to produce mono and diglycerides (emulsifiers)
- A very unique reaction system must be used, since the enzymes are soluble in water but act on a lipid substrate



The enzyme is located in the water droplet of a water-in-oil emulsion and acts on the oil surrounding the water droplet

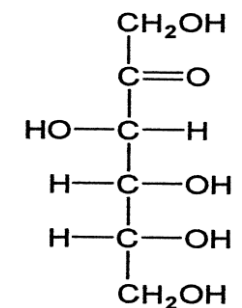
# Important food enzymes –Isomerases

- Catalyze the intramolecular rearrangement
- **Glucose isomerase**
  - The most important for the food industry
  - Catalyzes isomeric rearrangement of glucose (aldose) to fructose (ketose)
    - Gives a sweeter product than corn syrup ( Glc = 70; Fru = 170; Suc = 100)
    - Product called high fructose corn syrup
    - Made from corn syrup (which is made by amylase digestion of starch)
    - Enzymes are immobilized in large columns where the reaction takes place – can reuse them



D-glucose

↓ Glc isomerase  
pH 7  
50-60C



D-fructose

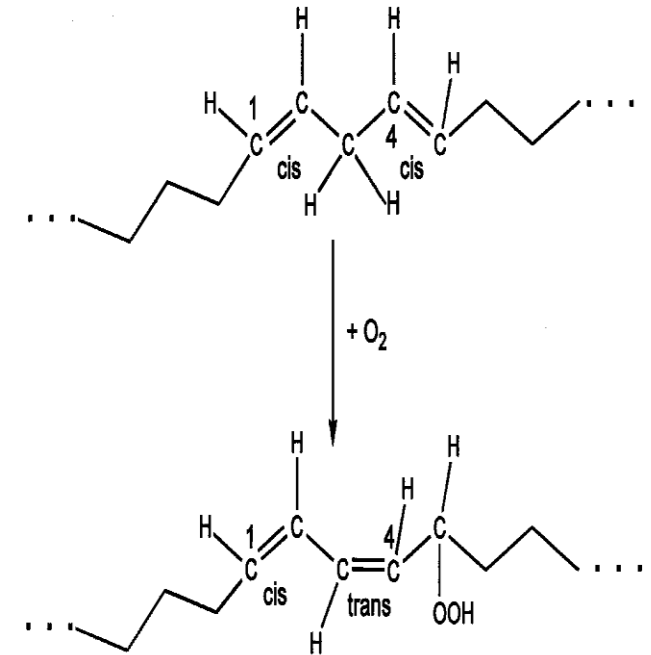
**HFCS**

# Important food enzymes – Oxidoreductases

- Enzymes that catalyze the oxidation or reduction of substrates

## A) Lipoxygenase

- Found in a wide variety of plants (legumes) and in animal tissue
- Specific for the oxidation of fatty acids that have a *cis, cis* penta-1,4-diene unit, so there are three naturally occurring fatty acids that can be substrates
  - Linoleic acid (2 double bonds)
  - Linolenic acid (3 double bonds)
  - Arachidonic acid (4 double bonds)



# Important food enzymes – Oxidoreductases- Lipoxygenase

- Desirable
  - Enzyme plays a role in bleaching of wheat / soybean flours
  - It contributes to the formation of S-S bonds in gluten in dough, thus one does not have to add chemical oxidizers
- Undesirable
  - Lipid oxidation and reactions of its products
  - Breakdown products of hydroperoxides give off-flavor/odors
  - Oxidation products (the free radicals or hydroperoxide) can bind and/or oxidize proteins to lead to textural problems
  - Lipid oxidation also leads to nutritional loss of essential polyunsaturated fatty acids
  - Vitamins may also be oxidized by the oxidation products
  - Chlorophylls and carotenes can be bleached
  - Its action can be effectively delayed by using antioxidants

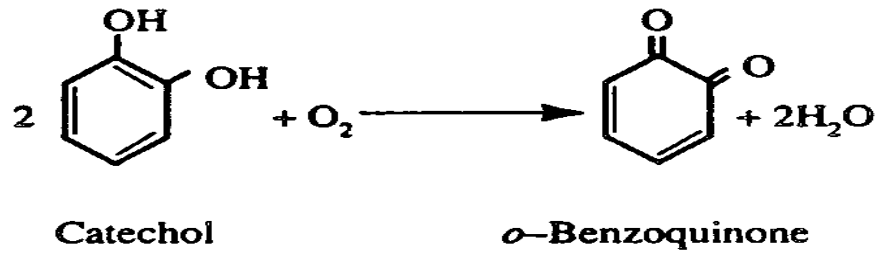
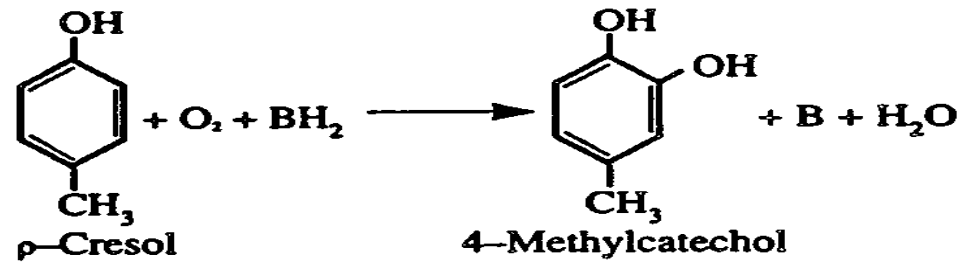
# Important food enzymes – Oxidoreductases- PPO

## B) Polyphenol oxidase (PPO)

- Found in plants (fruits and vegetables), animals (including humans), insects and microbes
- Catalyzes the oxidation of phenolic compounds (mono and/or diphenols) in the presence of O<sub>2</sub> to give quinones which polymerize into melanin pigments (desirable or undesirable)
- Its activity can be inhibited by:
  - Removing O<sub>2</sub>
  - pH < 4.5 (lemon juice)
  - Ascorbic acid (vit-C, lemon juice)
  - Bi-sulfites
  - EDTA



# Important food enzymes – Oxidoreductases- PPO reactions



Polymerizes → Melanins

Undesirable browning of apples, bananas, mushrooms, shrimp, lobster..

Up to 50% economic loss of tropical fruit due to PPO activity

Desirable browning of tea, coffee, cocoa, raisins, prunes, tobacco.....