



# ENZYMES IN THE FOOD INDUSTRY



# FOUNDAMENTALS OF ENZYME ACTIVITY

- Is a protein with catalytic properties due to its power of specific activation
- Not all biological molecules capable of catalytic activity are proteins – RNA molecules
- Enzymes of current and foreseeable use in food industry are proteins hence definition above will remain in use



# FOUNDAMENTALS OF ENZYME ACTIVITY

- Enzyme remains unaltered at the end of the reaction
- Does not mean the enzyme plays an inert role. Any alterations are reversible – intermediate complexes
- Enzymes are not used up in the reaction but can be used over and over again – turnover number



# FOUNDAMENTALS OF ENZYME ACTIVITY

- Many enzyme reactions do not proceed under general environmental conditions
- There is always need to be energized to reach the intermediate stage – “energy of activation” –heating
- Enzymes are very specific in their reactions (lock and key) Fischer model of stereo specific link between enzyme and substrate



# FOUNDAMENTALS OF ENZYME ACTIVITY

- Specificity may be demonstrated in structurally similar compounds – glucose oxidase – D-glucose into D- gluconate. 2 deoxy – D- glucose 25% while 6-methyl D-glucose -2%
- Some other are more specific for bonds occurring in similar molecules –  $\alpha$  amylase for  $\alpha$ - linkages between adjacent glucose units in starch. Cellulase for  $\beta$ - linkages in glucose in cellulose



# FOUNDAMENTALS OF ENZYME ACTIVITY

- Enzymes important in food are mainly hydrolases

## ENZYME KINETICS

- ❖ Enzyme reactions are directly proportional to ***enzyme concentration***
- ❖ Not always the case – inhibitors (heavy metal ions) or dissociable activator, the curve is not linear but curved upward

# ENZYME KINETICS

- Downward curve – saturation at higher rates, inhibitors or essential co- factors
- Over time, the relationship is not linear and a decline sets in. Time for decline varies with enzymes from few minutes to hours
- Beneficial if the enzyme presence in the product is undesirable
- Explanation is substrate depletion

# ENZYME KINETICS

- Other reasons are – inhibition by product, enzyme inhibition by instability in enzyme
- Substrate concentration***
- Obviously dependent on substrate concentration. The velocity is not linear
  - Reason is enzyme forms a one to one stoichiometric complex with substrate. Its only this complex can be broken down. Increase in substrate concentration saturates the enzyme



# ENZYME KINETICS

- Environmental conditions – temperature, pH, ionic strength and moisture
- Rate of reactions increases with increase in temperature
- Heat used to denature endogenous deleterious enzymes – blanching
- Bell shaped – higher temperatures denature the enzymes
- Low freezing temperatures – lipases
- Enzymes capable of renaturing after heating



# ENZYMES IN FOOD INDUSTRY

- Enzymes play a vital role in food industry
- Cheese and brewing rely on enzyme activity in various stages of processing
- Trial and error been able to optimize conditions –malting, resting animals prior to slaughter
- Traditional products like yoghurt depend on enzymes –but whole organisms



# ENZYMES IN FOOD INDUSTRY

- Whole organisms give characteristic notes in the product that can not be achieved by purified enzymes
- Enzymes used may be endogenous like in amylase in mashing, or in yoghurt

## **Accessibility of substrate by enzymes**

- Some enzymes found free in cytoplasm but many are bound to membrane and almost in contact with substrate



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- If exogenous enzymes are to be used = cross the membrane barrier. Intact membranes are impermeable to large molecules like exogenous enzymes
- Tenderization of meat – not able to effect CT unless during cooking, penetration – dips, injections prior to slaughter





# ENZYMES IN FOOD INDUSTRY

## Reaction conditions

- Enzyme reactions occur not under ideal conditions (temperature, substrate, pH) . It is difficult to predict the amount of enzyme required
- Substrate concentration is another problem of applying biochemical criteria- commercial enzymes operate at 50-100°C as opposed to 25°C



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- Physical factors affect enzyme action, Cf reaction rates in solution and those that are bound to membranes

## **Sources of enzymes**

- Most organisms have certain core enzymes – Embden Meyerhof pathway, amylase in human saliva and seeds potential source



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- Others are specific- nitrogen fixing, allilase in onions – precursor for peptide breaking – release sulphur containing volatiles –aroma – limited source
- Animals have produced some enzymes for food and medical purposes – rennin stomach of pre- weaned calves. Problem wasteful and emotive. Alternative is microbial derived.



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- Animal and plant sources – impracticable

## **Legal and safety implications**

- Legal status depends on application-enzymes left in product which are not found in food proper regulated as additives
- Consumers view of food and risk. Air ticket, food in airport café.



# ENZYMES IN FOOD INDUSTRY

- Cause allergies if in powder –solutions
- Injurious to health – in stomach- attacking body tissue
- Microbial and fungal –toxins (consumer view)

## **Use of enzymes in meat**

- Found their use in tenderization of meat
- Dates back in 500yrs ago when Mexican Indians wrapped meat in papaya leaves during cooking



# ENZYMES IN FOOD INDUSTRY

- Enzyme causing tenderization –papain – cysteine proteases (ficin and bromelain)
- Introduction of these exogenous enzymes
- Use of bacterial collagenases during cooking
- Endogenous enzymes ( Cathepsin Band D and CAF)
- Mechanically Recovered meat -15-40% of bone weight –used in soups and gravies (bacterial Alcalase and neutrase) or animal feeds