Industrial uses of enzymes

Enzymes are biological catalysts that lower the activation energy for chemical reactions, thereby speeding up the rate of reaction by several folds.

Enzymes area unit generally isolated from microorganism, animal, or plant sources. Microbial sources are particularly useful because they can be quickly grown into large colonies and are easy to store in vats prior to isolation. The separation and purification of enzymes require multiple separation steps involving filtration, centrifugation, chromatography, and more frequently bio-magnetic separation.

Cellulases:

Cellulases are enzymes that break down the cellulose found in plant cell walls into simple sugars that can serve as the raw materials for biofuels, as well as many of the biobased chemicals, plastics, and successful application of cellulases is in textile industry where these are used for jeans biostoning, biopolishing of fabrics and cotton and to improve appearance of fabrics.

Function of cellulases:

Cellulose —cellulase (Break down)→ shorter chains → cellobiose + B-glucose

- Commercial Sources: *Aspergillus, Trichoderma , Penicilium* .

- Advantages of cellulases:

1) Production of fermentable sugars in brewer's mashes .

2) Clarification of orange and lemon juices .

3) Improving the release of colours from fruit skins .

4) To clear the haze from beer and to tenderize green beans.

* Saccharification : The processing of waste materials such as straw , sugar cane bagasse , saw dust and news paper to produce sugars from the cellulose .

Pectinases :

Pectinases are defined as mixed enzymes that hydrolyze pectic substances, mostly present in microorganisms and higher plants

- Function of pectinases :

Pectins $\xrightarrow[\text{(degradation)}]{\text{pectinases}}$ shorter molecules (galacturonic acid) + other compounds + sugars

- Commercial sources: *Aspergillus , Penicillium*

-Industrial uses of Pectinases:

1) Extraction and clarification of fruit juices .

2) Pectinases are added to crushed fruit such as apples and grapes to increase the yield of juice extracted and improve colour .

3) They act by removing the pectin around charged protein particles , which then clump together and settle out of the liquid .

4) Pectinases can also be used to prevent jelling when fruit juices are concentrated .

Amylases :

Amylase is a digestive enzyme predominantly secreted by the pancreas and salivary glands and is present in other tissues at minimal levels

Function of Amylases :

Starch or glycogen —(Hydrolyse / Amylases)→ Dextrin's or maltose.

- Commercial sources : *Bacillus* spp. (Bacteria), *Aspergillus* spp, *Rhizopus* spp. , *Streptomyces* spp.

- Industrial uses of Amylases :

1) Amylases are used to clarify fruit juices by removing starch
2) In bread making and brewing, addition of amylases can yield more sugars from starch in flour.
3) Production of sweet glucose syrups from starch which are used in food industry .

Glucose isomerase (GI)

Catalyzes the reversible isomerization of D-glucose and D-xylose to D-fructose and D-xylulose, respectively. The enzyme has the largest market in the food industry because of its application in the production of high-fructose corn syrup (HFCS)

* glucose —(Glucose isomerase)→ Fructose (which is sweeter than both sucrose and glucose)

* High fructose corn syrups (HFCS) derived from hydrolyzing corn (maize) starch . (HFCS) used as source of sweeteners in food and drinks in the USA.

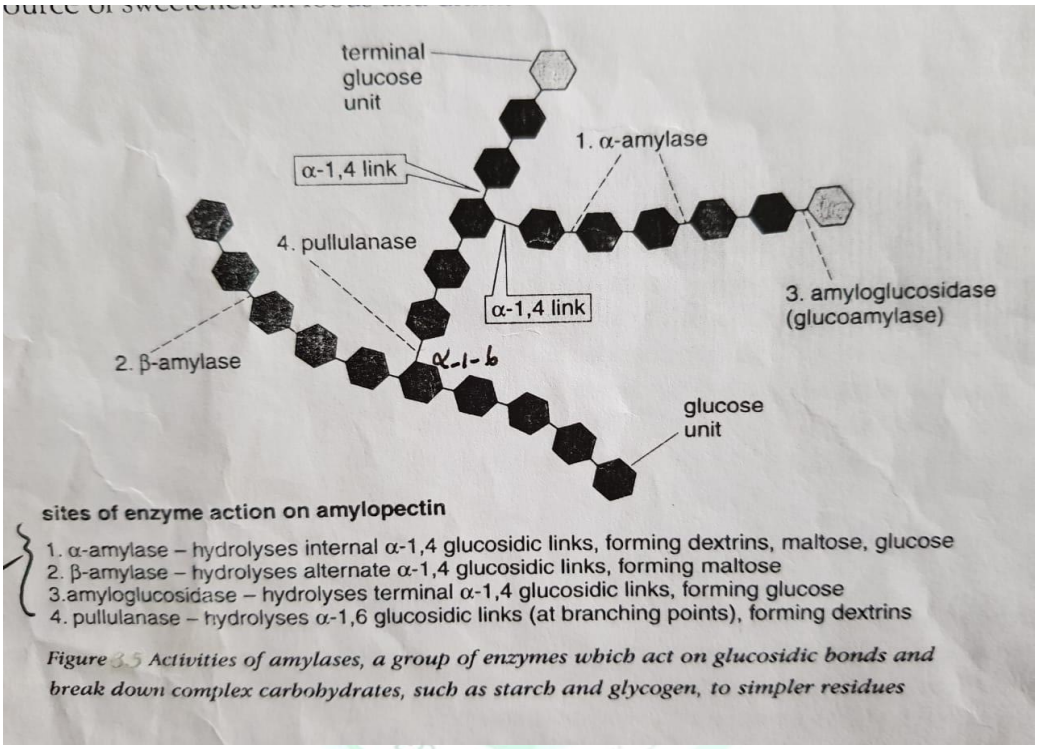

Figure 3.5 Activities of amylases, a group of enzymes which act on glucosidic bonds and break down complex carbohydrates, such as starch and glycogen, to simpler residues

Proteases : or Proteinases and peptidases .

Proteolytic enzymes (proteases) are enzymes that break down protein. These enzymes are made by animals, plants, fungi, and bacteria. Proteolytic enzymes break down proteins in the body or on the skin.

- Function of proteases :

Hydrolyse peptide

Protein ⟶ small peptide or Amino acids.

Bonds by proteases

- Commercial sources : *Aspergillus* , *Mucor* , *Rhizopus* (Fungi) *Bacillus* spp. (Bacteria).

- Industrial uses :

1) Enzymes are used in cheese making as a substitute for rennet to help clot milk .

2) Clarification of fruit juices and beer by removing the protein haze .

3) Thinning egg white so it can be filtered before drying .

4) Tenderisation of meat .

5) Digestion of fish livers to allow better extraction of fish oil .

6) Used in biological detergents industry for breaking down of protein stains

Lactases : (B-galactosidases)

Lactase is an enzyme produced by many organisms and is essential to the complete digestion of whole milk. It breaks down the sugar lactose into its component parts, galactose and glucose. Lactase is found in the brush border of the small intestine of humans and other mammals

Function of lactase:

Lactases

Lactose ⟶ glucose + galactose

(Disaccharide)

Commercial sources: *Aspergillus* spp. (fungi) , *Kluyveromyces* spp. (yeast)

Advantages of Lactases

1)The lactase used for hydrolyzing the lactose in milk to make it suitable for people who are unable to digest lactose.

2) Lactase is used to increase sweetness in ice cream and to produce a sweet syrup from whey .

3) Lactase is used in ice cream manufacture to remove lactose which crystallizes at low temperatures (Sandy texture).

Lipase:

Lipase is an enzyme that breaks down triglycerides into free fatty acids and glycerol by catalyzing the hydrolysis of the ester bonds in triglycerides

- Function of Lipases:

Lipases

Lipid (glyceride) ⟶ Fatty acids + glycerol

- Advantages of Lipases

1) Enzyme is used to enhance the ripening of certain cheeses .

2) To help break down fatty materials in waste .

3) Lipases are used in biological detergents industry for breaking down of Lipid stains .