

INTRODUCTION:

Enzymes are present in every cell of every living entity, from simple single cellular organisms to highly complex multi-cellular organisms, including human beings. Enzymes are a critical element in our daily lives. Enzymes are proteins, commonly called as bio-catalysts.

Proteins: Enzymes like other proteins, consist of long chains of amino acids held together by peptide bonds. Enzymes perform the vital function of controlling the metabolic processes in which nutrients are converted into energy and fresh cell material. For example, in the digestive tract, enzymes like pepsin, trypsin, lipase, and amylase break down food compounds into simpler compounds that are then converted into energy for the body.

Bio-catalysts: Enzymes are substances that accelerate chemical reactions without being consumed in the process. Industrial enzymes are most frequently applied to biochemical reactions in which high molecular weight substances, like starches, proteins, celluloses, etc, require hydrolytic decomposition. In nature, enzymes control the build-up and decomposition of essential matter in vegetable and animal organisms.

Specific: Each enzyme catalyses a specific chemical reaction. Essentially, each enzyme breaks down or synthesises one particular compound, or can even be limited to specific bonds in the compound they react in. For example, pectinase can only degrade pectin, not starch or cellulose.

Efficient: Enzymes are efficient catalysts. For instance, one catalase enzyme molecule can catalyse the breakdown of five million molecules of hydrogen peroxide into water and oxygen in just one minute. The enzyme catalase is found in the liver and red blood cells in large quantities.

The three major sources of enzymes are:

Plant enzymes: These enzymes are derived from a variety of plants and are effective within a broad pH range. Papain, bromelain, ficin have predominantly proteolytic activity, but amylolytic enzymes of cereals, soybean lipoxigenase, and specialised enzymes from citrus fruits also fall in this category.

Animal enzymes: Derived from animal glands, this category includes the pancreatic enzymes, trypsin, lipase, rennet, and other enzymes like pepsin. These enzymes are actively limited to a very narrow pH range, are very specific in action, and may have a delayed effect.

Microbial enzymes: These fungal and bacterial enzymes are derived from microorganisms through a process of fermentation. Enzymes amylases, diastases, etc, begin working immediately under broad pH range.

Approximately eighty per cent of all industrial enzymes are hydrolytic in nature and used for depolymerisation of natural substances. (Depolymerisation is the breaking down of complex molecules into simpler molecules.) Of these enzymes, sixty per cent are proteolytic enzymes used by the detergent, dairy and leather industries. Thirty per cent are carbohydrases used in the baking, distilling, brewing, starch, and textile industries. This leaves lipases and highly specialised enzymes for use in pharmaceutical, analytical, and developmental industries.

ENZYMES IN PHARMACEUTICAL INDUSTRY

Every activity in the body such as building new tissues, replacing old tissues, converting food to energy, disposing waste materials and even reproduction requires enzymes. Thus, depleting the body's enzyme capacity is the cause of all the pains, sprains, injuries, inflammation, indigestion, immune deficiency, and degenerative diseases like cancer, cardiovascular disease and infection. Unlike common medicinal products that temporarily relieve some problems, enzymes address the dominant underlying causes of many health problems.

Enzymes for pharmaceutical applications include:

Fungal Alpha Amylase: Fungal Diastase (fungal alpha amylase) has both liquefying and saccharifying actions on starch, liberating a mixture of glucose and maltose as digestion products.

Alpha galactosidase : Alpha galactosidase is produced by the controlled fermentation for *Aspergillus Niger* var. Alpha-galactosidase hydrolyses the alpha 1-6 linkages in melibiose, raffinose and stachyose. These oligosaccharides containing the alpha D-galactosyl groups are widely distributed in plants mainly in seeds, roots and underground stems. These groups are linked to sugar molecules and to certain glycoproteins. Alpha galactosidase is popularly used in mixed enzyme digestive aid formulations.

Beta-Glucanase: An endo-glucanase capable of rapidly hydrolysing the interior linkages of beta-glucans. Prolonged hydrolysis give oligosaccharides with three to four glucose units.

Glucoamylase: AMG 300L (glucoamylase) is an exo-glucosidase which catalyses the hydrolysis of both the a-D-1,4 glucosidic linkages and a-D-1,6 glucosidic branch points in starch. It liberates glucose units from the non-reducing ends of starch chains and dextrans.

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Bile extract: Bile extract is manufactured from the bile obtained from bovine origin. Bile produced in our body helps in the emulsification of fats, which is then acted upon by the lipase in pancreatin secreted by pancreas. Bile salts are either glycine or taurine conjugates of polyhydroxy steroidal acid. Ox bile is the most important commercial source of these acids and contains primarily cholic acid with less amount of deoxycholic acid. Because of their physiological role in the absorption of dietary lipids (fat), the bile salts are widely used for so called replacement therapy in pathological conditions in which the concentration of bile acids in upper intestines low, such as biliary fistula, disease of the ileum, hepatic or extra hepatic cholestasis. Bile salt is available in NF/USP grade.

Fungal hemicellulase and cellulase : Fungal hemi-cellulase and cellulase enzyme system contains many unique side activities, which help in rapid hydrolysis of cellulose, hemicellulose and beta-glucan polymers in food. The gummy substances take up a lot of water and swell up to about ten times, thus hindering the action of enzymes on other biomolecules.

Invertase : Invertase converts sucrose to invert sugar, which is an equimolar mixture of glucose and fructose. It is 15 to 20% sweeter than sugar syrup of equivalent strength. Invertase is used in several product formulations in pharmaceutical industry for preventing sugar crystallisation. Invertase is available in different grades as per customer's specifications.

Fungal Lactase: Lactose intolerance is a very common disorder in infants and older persons. Lactazyme (lactase) helps in digestion of lactose. Lactazyme is a purified enzyme preparation isolated from selected strain of *Aspergillus Oryzae* by fermentation process. Lactazyme hydrolyzes lactose to produce beta-D-galactose & alpha-D-galactose. Lactazyme is available in FAO/WHO FCC (III) specifications.

Yeast Lactase: Lactase enzyme from yeast acts in near neutral pH and can be used in combination tablets with other enzyme formulations.

Fungal Lipase: Fungal lipase has the ability to hydrolyse triglycerides and is an excellent digestive aid and goes well in combination with amylases and proteases. Being entirely from vegetable origin, it can be used safely in all formulations. Pancreatic Lipase: Pancreatic Lipase USP hydrolyses triglycerides to glycerol and fatty acids. It is most active against fats containing fatty acids higher than C12. Besides lipase, it also has protease and amylase activities.

Pectinase: Pectinase help in hydrolysis of pectins abundantly present in fruits and vegetables. This enzyme is used in combination along with amylases and proteases.

Acid Fungal Protease: Acid fungal protease enzymes hydrolyse proteins in acidic pH. This can be safely used in combination with amylases in liquid oral formulations and tablets.

Alkaline Protease: Bacterial alkaline protease is capable of hydrolysing interior peptide bonds in protein molecule in a wide pH range from near neutral to highly alkaline.

Alpha Chymotrypsin: Alpha chymotrypsin is one of the most well known anti-inflammatory enzymes. The strong proteolytic action helps in digesting the proteinaceous matter and breaking down the drug barrier thereby enabling the drug to reach the site of action. Chymotrypsin is used parenterally or orally in prevention and treatment of inflammatory conditions to promote the dispersion of blood extravasates and effusion.

Bromelain: Bromelain is a proteolytic enzyme obtained from pineapple stem and has very good digestive & anti-inflammatory properties. Bromelain helps to inhibit pro-inflammatory compounds, similar to non-steroidal anti-inflammatory drugs reducing swelling & pain without side effects. Most of the available information is due to the major interest of scientists and doctors in the area of digestion and inflammation.

Papain: Proteolytic enzyme preparation derived from Papaya fruits. Papain is characterised by its ability to hydrolyse large proteins to smaller peptides and amino acids at a very high rate.

Pepsin: Pepsin is derived from the naturally occurring stomach liners from bovine origin. Pepsin is an acid protease acting at low pH and is an enzyme of choice for use with amylase.

Serratiopeptidase: Serratiopeptidase is an excellent anti-inflammatory enzyme derived from bacteria belonging to genus *Serratia*. It improves circulation in the inflammatory focus by breaking down abnormal exudes like protein by promoting the removal of the decomposing products through the blood and lymphatic vessels. It also accelerates the elimination of sputum, puss and haematoma with its mucolytic and fibrinolytic activities and thereby increasing the bioavailability of the drug at the site of action.

Trypsin chymotrypsin mix: Trypsin and Chymotrypsin occur in nature in combination. It is isolated from pancreas and has been used locally like Streptokinase-Streptodomas. They act on more proteins than the latter and also on mucus. Given orally both enzymes are useful for allaying inflammation, haematomas and bruising. Trypsin: Trypsin is one of the most well known anti-inflammatory enzymes. Therapeutic application is as a debriding agent for cleaning of necrotic wounds, ulcers, empymas, and fistulas. Trypsin enzyme can be employed in ointment or as a wet or dry dressing. In solution trypsin may be used as aerosol to liquefy tenacious sputum in bronchial disorder.

Other enzymes available alpha galactosidase, beta galactosidase, catalase, glucose oxidase, malt diastase, sucrase, super oxide dismutase.

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