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Enzymes in the Food Sector: Current Applications

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SUMMARY

All living cells produce enzymes that serve as a natural catalyst for chemical processes. Since many centuries ago, their function in food preparation has also been acknowledged. Prior to the discovery of enzymes, a variety of operations, including the use of papaya leaves to tenderize meat, the brewing, the formation of curds, cheese and even baking, all involved the employment of enzymes. The extraction of enzymes from any living entity, including animals, microbes and plants is possible. More than fifty percent of the enzymes utilized in industry are derived from microorganisms.

INTRODUCTION

The Greek words '*en*' which means within, and '*zume*' which means yeast, are the original sources of the word "enzyme." Enzymes are biological catalysts, also referred to as biocatalysts, which expedite biochemical reactions that occur in living beings (Robinson, 2015). Proteins often referred to as enzymes created by living things to speed up a vast array of chemical reactions that are essential for existence. They are hence exceptionally specialized biological catalysts (Gupta *et al.*, 2023). Humans have utilized enzymes for thousands of years. The use of biological agents in the processing of food has evolved extensively. Due to their potential to serve as catalysts and develop food products from raw materials, enzymes have perpetually been significant in the field of food technology. *Bacillus licheniformi* was (Chaudhary *et al*., 2015) fermented for the first time to create an enzyme (a protease).

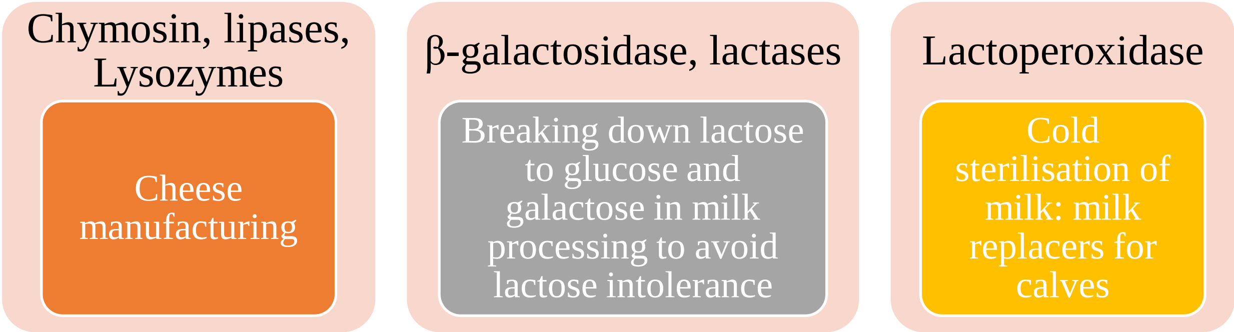
The key attributes of enzymes are their specificity for particular substrates, catalytic efficiency and rate acceleration when operating at benign ion concentration, temperature and pH circumstances. The use of enzymes is widespread in the food industry, which mostly uses three sources: microbes, plants, or animal tissues (Motta *et al*., 2023). In the food industry, 64 enzymes have been utilized for technical purposes, 57 enzymes are used in feeds and 24 enzymes are employed in three distinct industrial fields. Hydrolytic enzymes make up nearly 75% of all industrial enzymes (Binod *et al*., 2008). More than 70% of all enzyme sales are made up of proteases and lipases, which dominate the market.

Classes of Enzymes

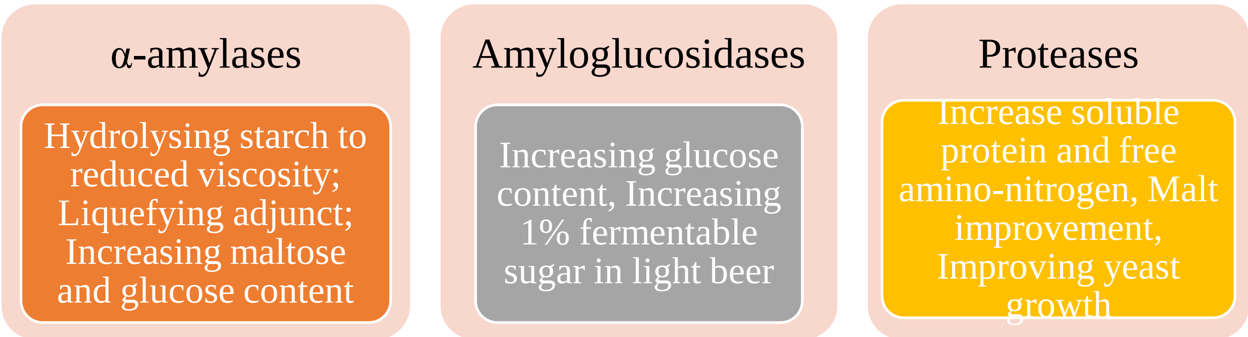
Class	Chemical Reaction Catalyzed	References
Oxidoreductase	Oxidation-reduction involves the gain or loss of oxygen and hydrogen	Motta *et al*., 2023
Transferase	Transfer of specific groups like an acetyl, amino, or phosphate group	Arbige *et al*., 2019
Hydrolase	Hydrolysis (addition of water)	Manoochehri *et al*., 2020
Lyase	Atoms are eliminated from groups without hydrolysis	Motta *et al*., 2023
Isomerase	Rearrangement of atoms within a molecule	Neifar *et al*., 2020
Ligase	Joining of two molecules (in presence of ATP)	Motta *et al*., 2023

Applications

Dairy industry- The world's major producer of milk is India. Due to the abundance of milk in our nation, the dairy and food industries have been forced to use biochemical and enzymatic procedures to transform the liquid milk into commodities with additional value. Rennet was one of the first exogenous enzymes used in food processing for manufacturing high quality cheese with flavour and texture. In the intervening years, proteinases have been utilized in dairy technology for a variety of additional purposes, including hastening the ripening of cheese, transforming its functional characteristics and developing diet-related goods. The milk coagulates as a result of two distinct ways that rennin interacts with the milk protein: enzymatically and non-enzymatically. In fermented milk products, aminopeptidases play a crucial role in flavour formation (Law and Haandrikman, 1997). In the dairy food sector, lipases and proteases play a vital role. Glucose oxidase, superoxide dismutase, sulphydryl oxidase, catalase, lactoperoxidase and lysozymes are some of the less prominent enzymes with sporadic uses in the processing of dairy products.



Brewing- The most popular alcoholic beverage drunk worldwide is beer, which is ranked third in popularity following water and tea. Beer is usually made from barley, while wine is made from grapes (Nelson, 2005). Barley endures starch that must be converted into fermentable sugars prior the yeast can generate alcohol, mature grapes already possess the sugars necessary for the fermentation. Enzymes play a crucial part in the brewing process, especially when it comes to leavened starch, which encourages specific modifications throughout the saccharification process. With the goal of speeding up fermentation, brewing enzymes are required for the starch's saccharification, disintegration of barley linked glucan (β-glucanase) and protein's hydrolysis (Aastrup *et al*., 2004). Papain is added in the final post-fermentation phases of brewing beer to avoid the formation of the "chill-haze" that would otherwise occur when the beer is cooled.



Meat Processing- The most significant quality distinguishing factor of beef in consumer evaluation is its tenderness (Zor *et al*., 2009). Meat is tenderized and marinated with the help of enzymes like proteases, which additionally impart it flavour. Meat tenderness is influenced by a number of pre- slaughtering and post-slaughtering factors as well as their interactions (Destefanis *et al*., 2008). Enzymes that break down proteins are mostly utilized in the meat industry and in food service. Meat from older animals retains its toughness despite hanging, which allows native proteases to generate aromas and tenderize the meat. A few minutes before the animal is slaughtered, it's possible to tenderize it by injecting papain in inactive form into its jugular vein. Free thiols build up in the muscle after slaughtering, which activates papain which ultimately tenderizes the flesh (Whitehurst and Oort, 2010). Due to papain's moderate heat tolerance, its activity is maintained while cooking. 5% of the meat is still stuck to the bones and cannot be removed mechanically. The meat is digested by the enzyme and is recovered as slurry.

Acid proteases
Improve flavouring, nutritional and functional properties of proteins

Papain/ficin/bromelain
Meat tenderization, Increases protein dispersability, palpability, solubility and digestibility.

Lipase
Hydrolyze triglycerides; Improves flavour in sausages.

Starch Processing- The leaves, tubers, seeds, and roots of numerous plants contain it as a storing chemical. Usually, the starch undergoes chemical or enzymatic modification to produce a wide range of derivatives. Amylases, a relatively prevalent enzyme in microorganisms, generally commence the commercial breakdown of starch (Synowiecki, 2007). Another starch-degrading enzyme is called pullulanases, which are classified into types I and II (Doman-Pytka and Bardowski, 2004). Type I pullulanases only hydrolyze α-1,6 linkages as well as generate branched dextrins, while Type II pullulanases hydrolyze both α-1,4 and α-1,6 linkages and predominantly generate maltose and maltotriose.

α-amylases
Cleaving α-1, 4-glycosidic bonds in the inner region of the starch, causes rapid decrease in substrate molecular weight and viscosity.

β-amylases
Producing low-molecular weight carbohydrates, such as maltose and β-limit dextrin.

Isoamylases
Hydrolysing α-1, 6-linkages in glycogen and amylopectin.

Bakery Technology- With the advent of agricultural mechanization in the late 19th century, bread's quality improved while its cost decreased, making white and rye bread an affordable staple for practically everyone. The use of industrial enzymes in the baking process was a significant factor in the development of the baking market. In the process of making bread, enzymes are typically added to alter the rheology of the dough, gas retention, and crumb softness (Di Cagno *et al*., 2003). During the mixing stage of the bread-making process, enzymes are typically added to flour as a technological aid. Enzymes are typically incorporated into dough to alter product softness while developing cakes and to minimize acrylamide generation in bakery products (Cauvain and Young, 2006). They are also typically introduced into dough to change gas retention, crumb softness and dough rheology during the production of pastry and biscuits. The α-amylases are the enzymes that are most frequently used in the baking of bread. Hemicellulases, xylanases, lipases, and oxidases are a few examples of the enzymes that might enhance the quality of the final loaf of bread by directly or indirectly strengthening the gluten network.

α-amylases
Degrading starch in flours and controlling the volume and crumb structure of bread

Lipases
Improving stability of the gas cells in dough

Lipoxygenase
Bleaching and strengthening dough

CONCLUSION

The widespread use of enzymes in the food sector commenced a trend for the generation of procedures and products that rely on the inclusion of enzymes have flourished significantly. The biotechnology sector presently relies predominantly on these enzymes. This market comprises products used in dairy, drinks, brewing and other areas specifically for use in the food and feed industry. Enzymes are also employed in various industries, such as those that deal with paper, textiles, detergents and other products.

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