GROUP 7

FOOD BIOCHEMISTRY (FST 208)

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INTRODUCTION

Microorganisms have been used in food fermentation since ancient times and fermentation applied in the preparation of many of the food items

(1). Microbial enzymes play a major role in food industries because they are more stable than plant and animal enzymes. They can be produced through fermentation techniques in a cost-effective manner with less time and space requirement, and because of their high consistency, process modification and optimization can be done very easily

(2). Many of these enzymes find numerous applications in various industrial sectors, e.g. amylolytic enzymes find applications in food, detergent, paper and textile industries

(3). They are used for the production of glucose syrups, crystalline glucose, high fructose corn syrups, maltose syrups, etc. In detergent industry, they are used as additives to remove starch-based stains. In paper industry, they are used for the reduction of starch viscosity for appropriate coating of paper

(4). In textile industry, amylases are used for warp sizing of textile fibres Similarly, enzymes like proteases, lipases or xylanases have wide applications in food sectors. The following sections give detailed and updated information about various food enzymes of microbial origin. The tables below gives an overview of applications of microbial enzymes in food industry.

APPLICATIONS OF ENZYMES IN FOOD INDUSTRY

In this context, we shall analyze different enzymes and their applications in food industries;

AMYLASES

Amylases are starch-degrading enzymes capable of hydrolyzing Î±-1,4 glycosidic bonds of polysaccharides, which results in the production of short-chain dextrins. These enzymes are widely distributed in all living organisms. Majority of Î±-amylases are metalloenzymes and require calcium ions for their activity, stability as well as integrity.

Wide applications of Î±-amylases in food industry include baking, brewing, starch liquefaction as well as a digestive aid. They are widely used in baking industry as flavor enhancement and anti-stale agent to improve bread quality.

During baking, Î±-amylases are added to the dough for conversion of starch to smaller dextrins, which are subsequently fermented by yeast. It improves the taste, crust color and toasting qualities of bread

They are used as a glazing agent for the production of rice cakes and powdery foods. In starch industry, they also find application for starch liquefaction, which converts starch into glucose and fructose syrups. Enzymatic conversion of starch involves three steps: gelatinization, liquefaction and saccharification. Gelatinization involves formation of a viscous suspension by dissolution of starch granules. This is followed by a liquefaction process, which reduces viscosity and involves partial hydrolysis. Glucose and maltose are further produced by saccharification. This requires highly thermostable enzymes and most of the starch saccharification is carried out with Î±-amylases from Bacillus amyloliquefaciencs, Bacillus stearothermophilus or Bacillus licheniformis.

For the production of ethanol, starch is converted to fermentable sugars by the action of Î±-amylases and further fermentation of the sugars to alcohol is carried out by Saccharomyces cerevisiae. Other applications of Î±-amylases include clarification of fruit juices, which is carried out in the presence of cellulases and pectinases to improve yield as well as to make the process cost-effective.

PROTEASES

Plant proteases such as bromelain, ficin and papain are widely used in food industry for various applications such as brewing, tenderization of meat, coagulation of milk and as a digestive aid. In addition, proteases are also used to improve the flavour, nutritional value, solubility and digestibility of food proteins as well as to modify their functional properties including coagulation and emulsification. Proteases are widely used in baking industry for the production of bread, baked foods, crackers and waffles. These enzymes are used to reduce the mixing time, decrease dough consistency and uniformity, regulate the gluten strength in bread and to improve the texture and flavor. The acid protease from Aspergillus usamii has been successfully employed for the improvement of functional properties of wheat gluten. The addition of protease could release sufficient peptides and amino acid levels in the wort to get a proper fermentation. Acidic fungal proteases are used in improving fermentation of beer as they are efficient even at low pH by balancing the amino acid profile of beer. Another major application of proteases is associated with dairy industry. Naturally occurring proteases contribute significantly to the flavor characteristics of cheese. They are used for the acceleration of cheese ripening, to modify the functional properties and reduce the allergenic properties of milk products. In cheese making, proteases are also used to hydrolyze the specific peptide bond to generate paracasein and macropeptides.

LACTASE(Î’-Galactosidase)

Hydrolysis of lactose is an important biotechnological process in food industry The enzyme Î²-galactosidase catalyzes the hydrolysis of lactose. It belongs to the family of hydrolases. Î²-Galactosidase can be obtained from numerous biological systems including plants, animals and microorganisms. The production of Î²-galactosidase from microorganisms such as bacteria, fungi and yeast is a preferred choice due to higher yield and thus relatively low cost of the enzyme. The choice of source depends on the final application of the enzyme Î²-galactosidase, e.g. Î²-galactosidase from yeasts with pH optima of 6.5-7.0 is generally used for the hydrolysis of lactose in milk of whey. In the case of acidic whey hydrolysis, fungal Î²-galactosidase with pH optima of 3.0-5.0 is suitable. Thus the selection of Î²-galactosidase depends on the final application of the enzyme or industry (53, 54). Î²-Galactosidase produced from yeast Kluyveromyces lactis requires ions such as Mn2+ or Na+, whereas Kluyveromyces fragilis requires Mn2+, Mg2+or K+ (55).

In industrial applications, two major classes of Î²-galactosidase are of prime importance. They are cold-active and thermostable Î²-galactosidase (56, 57). On commercial scale, Î²-galactosidase is produced using microorganisms with GRAS status for their application in milk and dairy products. Lactase is used with milk and milk-based products to reduce lactose intolerance in people. The scoopability and creaminess of ice creams improved significantly after the hydrolysis of lactose with lactase. Additional advantage of hydrolyzing lactose into monomers is the reduction requirement of sweeteners as they could improve the sweetness of the products. Another major application of lactase is the lactose hydrolysis in whey. Whey is a byproduct of cheese production and its main components are lactose, proteins and minerals. This causes critical environmental issues associated with dairy industry as lactose is associated with high biological oxygen demand (BOD) and chemical oxygen demand (COD) (59, 60). Another application of lactase is the formation of galactooligosaccharides (GOS) from lactose hydrolysis due to transglycosylation activity of Î²-galactosidase. The GOS could be used as prebiotic food ingredients.

LIPASES

Lipases are enzymes which catalyze the hydrolysis of long-chain triglycerides. They are naturally present in the stomach and pancreas of humans and other animal species in order to digest fats and lipids. In the food and beverage industry, lipases find major application in dairy, baking, fruit juice, beer and wine industries. Although it finds many applications in various industries, the market share of lipase is less than 10% of global industrial enzyme market.

Commercial lipases are mainly used for flavor development in dairy products and processing of other foods containing fat. They can improve the characteristic flavor of cheese by acting on the milk fats to produce free fatty acids after hydrolysis. Different types of cheese can be made by using lipases from various sources, e.g. Romano cheese using kid/lamb pre-gastric lipase, Camembert cheese using lipase from Penicillium Camemberti and cheddar cheese using Aspergillus niger or A. oryzae. Lipase catalysis could improve the texture and softness of cheese. Lipases are also used as flavor development agents in butter and margarine, also to prolong the shelf life of various baking products. In alcoholic beverages such as wine, the aroma can be modified using lipase. They are used to improve the quality of cocoa butter, which has a melting point of 37 Â°C due to the presence of palmitic and stearic acids and can easily melt at 37 Â°C (64, 65). Lipases also find application as a biosensor in food industry. This lipase finds application in the production of ice cream, single-cell protein, carbohydrate esters and amino acid derivatives. In addition to this, lipase could also be used in the processing of different waste streams that are released from food industries.

SUMMARY

The use of enzymes or in food preparations is an age-old process. With the advancement of technology, novel enzymes with wide range of applications and specificity have been developed and new application areas are still being explored. Microorganisms such as bacteria, yeast and fungi and their enzymes are widely used in several food preparations for improving the taste and texture and they offer huge economic benefits to industries. Microbial enzymes are the preferred source to plants or animals due to several advantages such as easy, cost-effective and consistent production. The present review discusses the recent advancement in enzyme technology for food industries. A comprehensive list of enzymes used in food processing, the microbial source of these enzymes and the wide range of their application are discussed.