Food spoilage

Most natural foods have a limited life. Perishable foods such as fish, meat, milk, bread, tomatoes and potatoes have a short life span. Other foods keep for a considerably longer time but decompose eventually. Once food has been harvested, gathered or slaughtered it begins to deteriorate until eventually it becomes unfit for consumption. This deterio-ration is known as decay and leads to food spoilage.

Now let's look at the picture below and describe the change that you can see on each food item.

Enzyme action in the food spoilage

Food spoilage can also come about through the action of enzymes presents in the food. Enzymes are chemicals which are present in all food. They speed up chemical changes that result in loss of flavour, colour and texture. As enzymes are mainly composed of protein, they are sensitive to heat. They are active in temperatures found in a kitchen on a warm sunny day. They can remain very slightly active at very low temperatures such as those found in the freezer. This is why there is a limit to the time food can be stored in a freezer. The activity of these enzymes stops when they are heated above 70 ^{o}C. Heat treatment by blanching (i.e. pouring boiling water on the food) is recommended. Some enzymes remain inactive until the food is harvested or slaughtered. Once activated, such enzymes speed up the process of decay by breaking down the tissues and components of the food in the various ways such as oxidation, browning and ripening.

- Oxidation

When Oxidation occurs (i.e. when food comes into contact with oxygen) the enzymes cause the destruction of certain nutrients e.g. vitamin c, thiamine and carotene.

- Browning

Enzymes again cause browning in certain foods the moment they are exposed to air. When you cut or bruise food such as apple or yam, the exposed surface will discolour and turn brownish due to the activity of enzymes.

- Ripening

Enzymes are involved in the process that causes ripening in certain foods such as fruits and vegetables. Unripe bananas for example contain starch which is gradually converted to sugars, until the banana becomes very sweet, and its skin colour changes from green to yellow. Eventually, the skin colour changes to dark brown and it is no longer fit to be consumed.

The activity of enzymes in food makes it easier for the micro-organisms responsible for food spoilage to enter the food.

Enzymes that cause food spoilage

Enzymes	Food	Spoilage action
Ascorbic acid oxidase	Vegetables	Destruction of vitamin C
Lipase	Milk, oils	Hydrolytic rancidity
Lipoxygenase	Vegetables	Destruction of vitamin A
Pectic enzymes	Fruits	Destruction of pectic substances (Softening)
Peroxidases	Fruits	Browning
Polyphenoloxidase	Fruits, vegetables	Browning, off flavour, vitamin loss
Proteases	Eggs crab, lobster Flour	Reduction of shelf life Overtenderization Reduction in gluten network formation
Thiaminase	Meats, fish	Destruction of thiamine

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Controlling Enzymatic spoilage

- Inactivated by heating: cooking, canning.
- Cold temperature slow action: cool storage.
- Enzymes in vegetables work at low temperatures so they must be balanced before freezing
- Acid inactivates enzymes: lemon juice used to stop browning
- Sulphur dioxide stops enzymatic spoilage

Preventive measure for Food Deterioration

Food is valuable**.** Preserving food can help to avoid wasting of food. Food preservation involves preventing the food from being spoilt. Preservation of food is the process by which food is stored by special methods. Cooked or uncooked food can be preserved in different ways to be used later. Some methods of preservation are:

1. Freezing

Food kept in a refrigerator remains fresh for some days. Germs do not grow easily in cool places. We preserve food items, like milk fruit, vegetables and cooked food by keeping them in a refrigerator.

2. Boiling

By this method, we can preserve food for a short period of time. Germs in milk are killed by pasteurization. It is done by boiling milk for sometimes and then cooling it quickly.

3. Salting

We can add salt to preserve pickles and fish.

4. Sweetening

Excess sugar in food also acts as a preservative. We store food for a long time in the form of jams, jellies, and murabbas by adding sugar.

5. Dehydration

In this method, the food items are dried in sun to stop the growth of bacteria in them. Certain foods, like raw mangoes, fishes, potato chips and papads are preserved by this method.

6. Canning

In this method, air is removed from food and put in airtight cans so that germs do not grow on them. Food items like vegetables, seafood, dairy products etc. Are preserved through this method.

Applications of Enzymes in the Food Industry

Enzyme is a kind of catalytically active protein. Its catalytic efficiency is higher than inorganic catalysts. Except the general characteristics of the chemical catalyst, enzyme has the following advantages: high catalytic efficiency; high specificity; mild work condition.

Enzyme engineering is a new technology that combines enzymology theory with chemical technology. It is able to eliminate the inherent shortcomings of many chemical processes in a variety of industries, and also a driving force for the development of traditional chemical industry.

In the past, the enzyme used in food processing was mostly derived from animal offal and plant extracts. Most of the enzymes used are now from microbial fermentation. In general, the purity

of the enzyme used in food processing does not need to be particularly high, mostly partially purified enzyme. Unless in the special applications, such as proteolytic enzymes used in low-calorie beer, the higher the purity, the better the effect. Most enzymes applied in the food processing are glucoamylase and then followed by protease, lipase, esterase, oxidoreductase and isomerase.

Flour product

Enzyme, from organism and made with modern biotechnology, is a pure natural biological products and green food additives. It plays a significant role in a variety of special flour production and transformation. For instance, it can improve the baking quality, nutritional quality, texture, storage resistance and other functions of flour products. The major enzymes used for flour modification are listed in Table 1 below:

Enzyme Name	Function
α-amylase	Make bread volume increased, loose texture; speed up the dough fermentation; improve the bread tissue structure, increase the softness of the internal organization; produce a good and stable bread color; improve the furnace into the swelling; anti-aging, improve bread elasticity and taste; extend the fresh storage period of bread.
Glucose oxidase	Improve the silty properties of the flour, prolong the stabilization time, reduce the softening degree, improve the tensile and gelatinization characteristics of the flour, increase the tensile resistance, enhance the elasticity, increase the mechanical impact resistance and the maximum viscosity, and reduce the damage value; improve the furnace into the swelling; increasing the bread size; improve the noodles bite taste; improve the surface condition of the noodles.
Protease	Weakening the gluten to soften the dough to improve the viscoelasticity, extensibility and fluidity of the dough, shortening the mixing time of the dough, improving the mechanical properties and baking quality, making the product easy to shape and improving the taste.
Lipase	Delaying the aging of starch; increasing the stability of dough fermentation, increasing the volume of bread and improving the bread quality and preservation ability; reducing the spots on the dough,

	increasing the bite force, making the noodles not sticking in the boiled water, not easy to break, bright; increase the tensile resistance and elongation of flour.

Table 1: Enzymes for flour modified

In addition to enzymes in Table 1, other enzymes such as phytase, hemicellulase and glutamine aminotransferase are used in the flour industry to improve the quality of wheat flour and specialty flour. In the practical application, it should be based on the characteristics of different special flour and enzymes to ensure the rational use of enzymes and the proper amount of enzymes. Besides, the rational use of a variety of enzymes (complex enzyme), can not only reduce the total amount of enzyme, but achieve a synergistic effect.

Dairy processing

The main enzymes used in dairy processing are catalase and lactase. Catalase has high enzyme activity in bovine colostrum, mainly used for the removal of excess hydrogen peroxide in dairy products thereby to kill pathogens by using H_2O_2. Lactase can reduce the content of lactose to produce low lactose milk, low lactose hydrolyzed milk can improve the milk flavor, sweetness and nutritional value. In fermented milk, the use of lactase can accelerate the reaction and improve the fermentation efficiency to make fermented milk unique frankincense flavor and relatively extend shelf life of the product. Lactase used in condensed milk not only allows lactose to avoid lactose crystallization during concentration, but also make the product tasty, increase the sweetness, reduce the amount of sucrose, thereby inhibiting bacteria. The application of lactase in ice cream can not only increase the sweetness to reduce the amount of sucrose, but also solve the sediment due to the crystallization of deep frozen lactose, reduce the freezing point and improve the anti-thawing property. The use of lactase in milk powder can improve the flavor of milk powder, its rich caramel and caramel color after hydrolysis can produce chocolate milk.

Meat products processing

Enzyme used in the meat industry is mainly used to improve product quality (color, smell, taste, etc.) and increase the added value of by-products.

Beef products, treated with papain Ca ++ intensifier, have reddish brown color, crispy taste and good flavor, which completely overcomes traditional shortcomings including the tough taste, tenderness, gray color and low yield. The use of a certain amount of bromelain combined with phosphates, calcium chloride, etc. to tender mutton can improve the taste greatly. Lamb sausage produced with raw materials, which are treated with this method, has tender meat, good elasticity, unique flavor. It also makes up for the absence of lamb sausage in ham sausage. Transglutaminase can catalyze the formation of lysine covalent bonds between molecules of proteins or within molecules to form effective protein gels that impart specific hardness and elasticity to meat products.

In the deep processing of meat products, the use of protein complex enzymes can produce protein hydrolyzate. For instance, under the process conditions of pH value of 6.5-6.8, 55℃ and six-hour reaction, utilizing papain and bacillus subtilis neutral protease to hydrolyze snake meat, after proper purification, it can produce substances with rich nutrients and bioactive characteristics, and easy-to-degested nutrition solution. Bacillus subtilis neutral protease and pepsin hydrolize Maoshi pearl meat. Most of the protein in the hydrolyzate are converted to amino acids, which makes it delicious, lighter color and easy to be absorbed. These enzymes can be applied to the production of seafood seasonings, health drinks, etc.

Common by-products of meat processing are bone, bone crackers, mechanical flesh, fat and oil residue, which can be used as raw materials to obtain new meat extracts after enzymatic treatment. Meat extracts according to their characteristics and functions are divided into two categories: one is the flavor meat extract composed of small peptides and free amino acids; the other is a functional type of meat extract, generally composed of 10 amino acid molecules and with a moderate degree of hydrolysis. Flavor meat extracts have meat extract, bone soup or bone elements, etc. Such products with the natural aroma of raw materials can be made into paste or powder added to meat products, instant noodles seasoning package, sauce or snack foods, in order to enhance food flavor and protein content; what's more, it can be precursor of flavors or meat flavor after further Maillard reaction. Functional meat extract can be treated in high temperature without protein denaturation. Due to the unique adhesive and water holding function, it can be used in sausage, ham and other products to improve the adhesive properties of the meat products, cutting, and reduce the loss of meat products during cooking.

Fruit and vegetable processing and beverage industry

Enzymes used in this area are mainly pectin, cellulase and amylase, and mostly are used alone or in combination. These enzymes are mainly used for peeling fruit, clarifying fruit juice, reducing the viscosity of fruit juice, increasing the rate of fruit juices, enhance stability, what's more, they are also applied in making vegetable juice, extending the shelf life of fruits and vegetables, reducing nutrient loss and so on.

For example, under the condition of pH value of 4.0, 60℃ and four-hour reaction, adding cellulase (600U/100g), pectinase (1000U/100g), alpha-amylase (250U/100g) and papain (10000U/100g) to the clarification lychee juice process, and good clarity, low nutritional loss of high-quality lychee juice can be achieved.

Additionally, enzymes are also widely used in deep processing of tea. Tannase can improve the tea cold-soluble, prevent tea cloudy, and can improve the strength of the strength of tea. And now it is used in black tea, green tea and oolong tea. Cellulase and pectinase can break down the cell wall of tea, making the active ingredients of tea more easily to dissolve, improving the rate of instant tea products and, product clarity and the aroma of tea. Protease can improve tea extract rate and clarity, enhance the taste and improve the separation performance of tea.

Food and Beverage Applications

Enzymes are known to aid food processing in a wide variety of applications, for example manufacturing of cheese, vinegar and wine; leavening of bread; brewing of beer and so on. In

these processes enzymes help to save energy and resources, as well as improve the overall efficiency. In many instances, the use of enzymes has been proved to decrease the volumes and toxicity of byproducts and effluents. **Creative Enzymes** provides a wide range of products including high purity enzymes and custom blends, which can be readily used in food and beverage processes.

Fruit and Vegetable Processing Enzymes

- Increase juicing yields
- Protect original color
- Improve filtration efficiency

Categories:

Pectinases
Pectinases are the most commonly used enzyme in the fruit juice industry because they increase juice yields and accelerate juice clarification.

Cellulases

Tannases

Xylanases

Esterase

Baking Enzymes

Baking enzymes have become an essential part to the industry. By extending shelf-life of breads, improving dough handling, providing anti-staling properties, and increasing manufacturer's control over crumb texture, color, taste, moisture, and volume, these enzymes are revolutionizing the baking industry.

- Dough conditioning
- Larger volume and longer shelf-life
- Improved softness

Categories:

Xylanases

Amylases

Glucose Oxidase

Lipases

Proteases

Cellulases

Glucoamylase

Brewing Enzymes

Brewing enzymes increase starch liquefaction and saccharification, which in turn increase the production of fermentable sugars. The enzymes work to simplify filtration, reduce the presence of viscous polysaccharides like glucans, and increase free amino nitrogen production.

- Reduce viscosity
- Increase fermentable sugars
- Chill-proof & excellent clarification

Categories:
α-Amylases
Glucoamylase
Peptidase

β-Glucanases

Proteases

Xylanase

Decarboxylase

Starch & Sweeteners Enzymes

- Better tastes of healthy choices
- Improved texture

Categories
Glucoamylases
α-Amylases
Carbohydrases

Proteases

- Protein hydrolysis for flavour enhancement in protein digest
- Meat tenderization
- Enhanced digestibility of wheat gluten
- Degradation of the turbidity complex in fruit juice and alcohol
- Curdling of milk by breaking down kappa-caseins in cheese making

Amylase

- Starch liquefaction and sacchcarification
- preparation of maltose and high fructose syrup
- Increase bread softness and volume
- Conversion of dextrin to fermentable sugar for low calorie beer

Cellulase

- Starch liquefaction and sacchcarification
- Preparation of maltose and high fructose syrup
- Conversion of dextrin to fermentable sugar for low calorie beer

Lipase

- Cheese ripening
- Hydrolysis of milk fat, improve aroma in beverages
- Improve quality of edible of oils and fats
- Functional food ingredient to reduce cholesterol level in blood
- In-situ emulsification for dough conditioning

Pectinase

- Facilitate juice extraction, clarification and filtration
- Production of functional oligosaccharide (Pecto-oligosaccahride)
- Improves the yield and quality of essential oils (pepper and cardamom)
- Preparation of modified pectins used as functional food ingredient

Xylanase

- Dough conditioning, elasticity of the gluten network and crumb structure
- Increase bread softness and volume
- Xylo-oligosaccaride synthesis

β- Galactosidase

- Breakdown of lactose for the production of low-lactose/lactose free milk
- Production of galacto-oligosaccharides from lactose

Phytase

- Improve nutritional value of plant-based food
- Release phosphate and other nutrients from phytate and increase the bioavailability of some trace minerals, including copper, manganese, iron and zinc
- Enhance digestibility

Tannase

- Releasing of gallic acid and glucose from tannin
- Removal of tannins from a green tea infusion, preparation of instant tea