International Journal of Innovation in Agriculture Sciences and Rural Development
Vol.3, NO.1 , P: 3 - 20
Received : 8 January 2021
Accepted : 22 March 2021

Applications of B-galactosidase enzyme in food industry

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Abstract

B-galactoseidases are obtained from microorganisms such as fungi, bacteria and yeasts, animal cells, plants and from recombinant sources. β-Galactosidase is an important industrial enzyme in the hydrolysis of milk lactose and whey. Lactose enzymatic hydrolysis allows to prevent health and environmental problems caused by this saccharide. In addition, this enzyme catalyzes the formation of galactolygosaccharides, which are prebiotic additives for so-called healthy foods. β-Galactosidase is one of the enzymes that has been used in large-scale processes of the food industry in both free and sedation forms. In order to increase stability, reuse and use in processes continuously, these enzymes have been sedented by absorption, coovarian bonding, micro encapsulation, trapping and transverse connection. Beta-galactoseidase can be penetrated directly into the whey stream, resulting in the production of sweet syrup, which can be used as an additive in ice creams, desserts, etc. This enzyme can be used to reduce crystallization in dairy products, such as ice cream and condance milk, which is caused by high concentrations of lactose. By hydrolysis of lactose and decreasing its concentration, it can help to improve tissue and digestion more easily. In addition, the addition of additional sweeteners decreases, resulting in a lower amount of calories in the final product. The beta-galactoseidase enzyme reduces the fermentation time (when lactose is hydrolyzed into glucose and galactose), thereby lowering the time to reach the desired pH in products such as yogurt and cheese.

Keywords: β-galactosidase, Galactolygosaccharide, Encapsulation, Hydrolysis

Introduction

The beta-galactosidase enzyme, commonly known as β-D-galactoside or lactase, is responsible for the hydrolysis of milk lactose. The average amount of lactose in cow's milk is about 4.4-8.6%, while the amount of this sugar in human milk is higher and reaches about 7% of the dry matter. This enzyme has wide applications in food processing industries. Excessive lactose in the gut typically leads to dehydration and decreased calcium absorption due to low acidity, which causes diarrhea, flatulence and cramps.

Lactose uptake requires the activity of beta-galactoseidase enzyme, an enzyme that exists in the small intestine and acts by decomposing the bond that links monosacid. Deficiency of this enzyme in the gut leads to lactose intolerance, and sufferers are unable to consume milk and dairy products.

Enzyme Specifications

Enzymes are protein compounds that as vital catalysts may cause favorable or undesirable physical and chemical changes in foods. The beta-galactosidase enzyme (also called beta-galactosidase β-galactohydrolase or β-D-galactohydrolase) is from the glycosylated hydrolase family that is able to hydrolyze the residue Galactosil in its various molecular classes (polymers, oligosaccharides and secondary metabolites, etc.) including alpha-digallactoses bonds, alpha-L-arabinozoides) and release them into hemicostal. Beta-galactosids are enzymes that break substrates with galactose-like parts such as lactose, glycolipides, radiation glycolycans, oligosaccharides and polysaccharides. Beta-galactoseidase, as an enzyme, produces lactose, galactose and glucose by fissile disaccharide, which eventually enter glycolysis.

The molecular weight of this enzyme is approximately 76 kD and for activity, it requires metal ions magnesium, manganese and potassium. This enzyme is obtained from animals, plants and microorganisms and its microbial types are produced more than animal and plant sources and are widely used in industry and technology.

As we said, in addition to galactose-powered substrates such as lactose, most known beta-galactoseases require bivalent metal ions such as magnesium and sodium. This has been confirmed by the discovery of the binding locations of these metals in their structure.

Structure and how it functions

The bacterial enzyme beta-galactosidase is a tetrametric enzyme (of four similar polypeptide chains or sub-units, called A-B-C-D), and each of its monomers has 1023 amino acids, which means a molecular weight of more than 100 kDa for each and more than 400 kDa for the complexed protein.

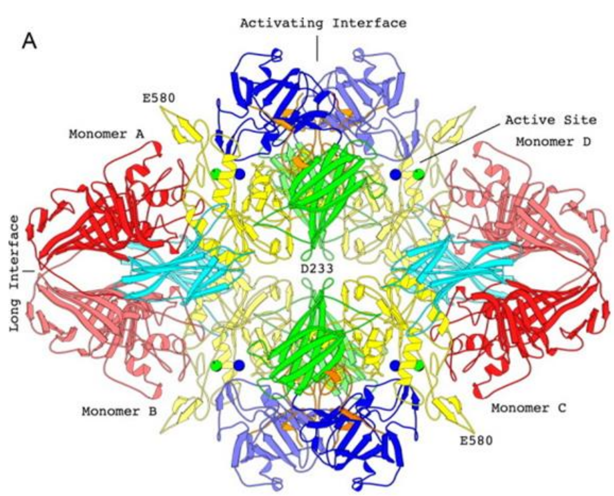

Figure 1: Structure of the bacterial enzyme beta-galactosidase

Its active location has the ability to bind to glucose-D and galactose-D, two lactose-forming monosacaride. It's especially special for galactose, but it's not very specific for glucose, so the enzyme can affect other galactoseides.

Beta-galactoseidase is an enzyme that has hydrolytic activity as well as transgallactosilation. It hydrolyzes β glycosydic bonding (1→4) in β-D-galactosides, causing β-D-galactose degradation.

Hydrolytic and transgallactosylation activity depends largely on the origin of the enzyme and the concentration and acceptor of galactose, beta-galactoseidase from microorganisms Aspergillus niger and Bacillus circulans have high transgallactoctosilation activity, while the activity of high hydrolytic Kluyeromyces but less transgalactoctosilation.

Galactose is a monosaccharide that, if combined with another monosaccharide called glucose and during a compression reaction, constitutes a disaccharide called lactose. Hydrolysis and lactose degradation lead to the re-formation of galactose and glucose, which is done in our bodies due to the presence of enzymes called beta-galactoseidase and beta-galactoseidase.

Lactose is a disaccharide consisting of one glucose unit and one galactose unit. During digestion, this sugar is broken down into two simple superglycemia by intestinal beta-galactoseidase enzyme and then absorbed through the mucosal wall of the intestine. In the absence or decrease of the activity of this enzyme, lactose in dairy products enters the colon intact and is fermented under the influence of intestinal microorganisms. The fermentation activity of these microorganisms on lactose will be the production of lactic acid, short-chain fatty acids and H2' CO2 and CH4 gases, which ultimately leads to unpleasant clinical complications and symptoms for the consumer.

In the process of beta-galactoseidase, the beta-glycoside bond is formed in lactose, hydrolyzed to galactose and glucose, two of which can be absorbed by the intestinal wall and into the bloodstream.

Enzymatic methods are the most common methods for reducing lactose. In this way, the milk of beta-galactoseidase enzyme or beta-galactoseidase extracted from different sources (usually from fungi, yeast or bacteria) is added and the above enzyme performs hydrolysis or lactose molecule breaking.

As can be seen, the result of lactose enzymatic hydrolysis is the formation of glucose and galactose monosaccharides and limited oligosaccharide. With the formation of glucose and galactose monosaccharides and due to their relative sweetness (0,6) compared to the relative sweetness of lactose disaccharide (0,27), low lactose milk has a mild and pleasant sweet taste. Of course, it should be noted that this sweet does not mean an increase in sugar percentage and has no effect on the calorie content of the product. Apart from the better taste of these milks, due to the positive effects of glucose and galactose on the health of these milks, they have better nutritional properties. Glucose is the most important carbohydrate in the human body and all metabolic activities of the body are assisted by it. In addition, glucose stimulates insulin secretion and also has a positive effect on lowering bad blood cholesterol. Galactose is a sugar that is found in the structure of neurons in the body, it is absorbed like fast glucose, but it does not stimulate insulin secretion and thus maintains blood sugar for longer periods of time.

Beta-galactoseidase enzyme sources

The beta-galactoseidase enzyme catalyzes lactose hydrolysis and belongs to the hydrolase family. Beta-galactosidase can be obtained from numerous biological systems including plants, animals and microorganisms. The production of beta-galactoseidase from microorganisms such as bacteria, fungi and yeasts is preferred due to its higher yield and relatively low cost of enzyme production.

The beta-galactosidase enzyme is found in bacteria, fungi, yeasts, animals and plants. This enzyme is produced in humans by small intestinal wall cells.

Microbial sources mainly produce more beta-galactoseidase enzymes and, consequently, lead to lower costs. Lactobacillus and Bifidobacterium are the most important bacterial species producing beta-galacthoidase. Using lactobacillus strains with the ability to produce beta-galactoseidase enzyme (such as Lactobacillus delbrueckii), as a probiotic starter, in the production of dairy products, lactose intolerance can be helped.

Beta-galactocydases are found in microorganisms (bacteria, fungi, yeasts), plants especially in almonds, peaches, apricots, apples and animal organs. Major industrial enzymes are generally obtained from Aspergillus sp and Kluyveromyces sp.

Beta-galactosidase produced from Kluyveromyces lactis yeast requires ions such as Mn+2 or Na+, while Kluyveromyces fragilis requires Mn+2 and Mg+2 or K+.

Beta-galactocydases from microorganisms

Over time, beta-galactoseidases from the following microorganisms have also been studied and studied:

Table 1: Beta-galactosidase enzyme sources

Studied species	Researcher
Aspergillus oryzae	Guerrero Duarte et al. (2017)
Streptococcus thermophilus	Geiger et al. (2017)
Kluyveromyces lactis	Santibáñez et al. (2016)
Lactobacilus helveticus	Watson and others, (2016)
Planococcus sp	Mahdian and others, (2016)
coli.E	Doan et al. (2017)
Bacillus circulans	Duarte et al. (2017)
Rahnella sp	Fan et al (2015)
Caldicellulosiruptor saccharolyticus	Shen et al. (2016)
Teratosphaeria acidotherma	Yamanda et al. (2017)

Mushrooms

Fungal galactocydases are heat-resistant enzymes. In fungi, two main strategies for lactose catabolism have been realized:

(1) Extracellular hydrolysis and subsequent absorption of resulting monomers and (2) adsorption of disaccharides

These fungal enzymes are used for hydrolysis of acidic cheeses and altherfyration processes. In the stranded fungus Aspergillus spp, beta-galactoseidase is produced outside the cell. Fungi have beta-galactosidase enzymes that are more sensitive to galactose inhibition than enzymes belonging to other organisms. Lactose metabolism is divided into cells and cytosolics by these enzymes, because these organisms can hydrolyze extracellularly using beta-lactose and import products into cells or can take disaccharide directly and process internally.

Bacteria

Beta-galactoseidases from bacterial sources have been widely used for lactose hydrolysis due to its ease of fermentation, high enzyme activity and good stability. Lactic acid bacteria (LAB), which make up a diverse group of lactococcus, streptococcus and lactobacilli, have become the focus of scientific studies for three specific reasons. They are usually safe (GRAS), so the enzyme derived from them may be used without extensive purification, and also some strains have prebiotic activities such as improving lactose digestion.

Bacteria have large Galacto hydrolytic enzymes compared to other galactocydases. In these organisms, the same enzyme catalyzes three types of enzyme reactions:

• Hydrolyzes lactose into monosacarids: galactose and glucose.

• Lactose-to-allolactose transgallactosylation catalyzes disaccharide sugar, which is used to regulate the expression of E.Coli-owned operon genes.

• Hydrolyzes allolactose in a similar way to lactose.

Yeasts

Kluyveromyces lactis yeast is an important commercial source of beta galactoseidase because its natural habitat is the dairy environment.

The production of beta-galactosidase by yeast can be of interest because this enzyme is used by the food industry to produce low lactose milk (a prominent industrial product consumed by a large number of people with lactose intolerance).

This enzyme has been used to produce lactose-free milk products due to its massive hydrolytic activity. Based on the results of this study, whey is a suitable environment for the production of beta-galactosidase enzyme by Cloveromyce Marxianus yeast in the presence of yeast extract and magnesium sulfate and manganese supplements. Temperatures of C□30 were determined as the best temperature for enzyme production in both strains, and the addition of mineral supplements and yeast extract has a positive effect on the production of beta-galactosease enzyme.

Beta-galactocydases from plants

Beta-galactocydases are widely distributed in plant tissues.

Plants contain β-galactocydase enzymes in leaves and seeds. These perform important functions in galactolipide catabolism, which is characteristic of algae and plants.

Beta-galactosidase is involved in plant growth process, fruit reach, this is the only known enzyme capable of hydrolysis of galactosyl residue from galacocided polysaccharides of cell walls.

It has been shown that these enzymes play a role in a number of biological processes including plant growth, fruit reach and lactose hydrolysis. These enzymes (herbal beta-galactoseidases) also play a role in the development and reach of fruit. Beta-galactoseidase chickpeas, radish, mish, oats, carrots, rice shoots, lupin and melon apple beans, Japanese pears (Pyrus pyrifolia) and avocados are separated and bitter.

Plant galactocydases differ significantly from bacterial galactocydases. Bacterial enzymes are generally quadrilateral or monomeric and much greater than plant enzymes (which are generally dimmer and are much smaller.

β-galactosidase is isolated from almond extract (Amygdalus communis) using ammonium sulfate deposition. Almond galactoseidase with approximately 89% activity over 2 months storage is maintained at 4°C. Lactose hydrolysis is carried out in milk and whey in a mixed compound with this enzyme. Using this enzyme, it was observed that lactose hydrolysis increases continuously with increasing time. The results showed that this enzyme can hydrolyz 94% lactose in soluble buffer and whey, while 90% of milk lactose is hydrolyzed in it.

In Animals

In the human intestine, the main function of this enzyme is related to the absorption of oral lactose because it is located on the plasma membrane side of the intestinal cells. In addition, it has been shown that lysosomic isoforms of this enzyme contribute to the degradation of many glycolipids, mucopolysaccharides and galactose-glycoproteins and provide different targets in different cellular pathways.

Methods of Using Enzymes

Beta-galactoseidase can be used in two ways: e.g. free enzymes in solution or as an sedation enzyme.

Using free enzymes is technically easier, but useless and at the same time more expensive, because the soluble enzyme is not reusable. This is the main obstacle to its use in industrial processes.

Ultrafiltration-based membrane technology on membranes that are not permeable to beta-galactoseidase is a favorite method due to the possibility of reuse of the enzyme

Immobilization techniques are technically more needed to use the enzyme, but they provide reuse of the enzyme and the possibility of use in continuous processes and ensure greater stability of the enzyme.

This can increase the usefulness of the enzyme, as well as increase its stability when stored. Immobilization to/from the appropriate environment can stabilize the enzyme to changes in temperature and pH. The sederen enzyme can be used several times, which reduces the cost of recovery and purification of the enzyme.

Instead of separating the enzyme, the cells in which the enzyme is located can be icy. With this type of immobilization, costs are lower because there is no need for isolation, and yet some enzymes are more stable when immobile in their natural environment.

Enzyme Fixation

Although these enzymes are widely used in food and dairy industries, stability is one of their problems. To fix them, these enzymes can be stabilized by different strategies with different methods, including various techniques known for beta-galactoseidase immobilization, such as trapping, encapsulation, absorption, coovarian connection (transverse bonding) with the possibility of combining techniques.

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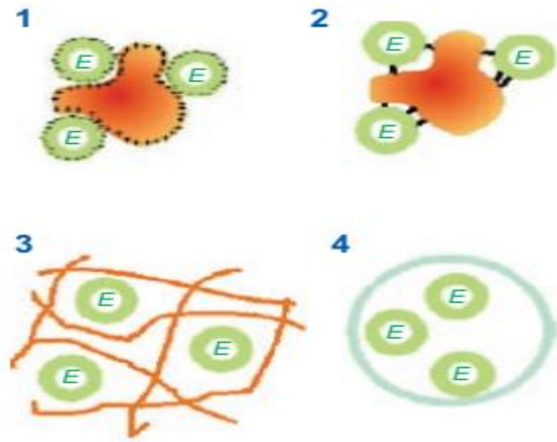

Figure 2: Enzyme stabilization methods

Beta-galactoseidase stabilization methods

Beta-galactocydases have been proven in several ways in a variety of ways, including trapping, cross-binding, adsorption, co-capacity relationship with a combination of these methods. Since each method has its own advantages and problems, choosing the appropriate fixation method depends on the enzyme (different properties of different types of beta-galactoseases such as molecular weight, protein chain length and the condition of this active location), mold, reaction conditions, reactant, etc. we will briefly describe these methods:

1- Covalent composition (co-valent communication) This method is the most widely used method for fixing beta-galactosease. In this method, co-capacity enzymes are connected through groups active in these enzymes, which are not essential for catalytic activity. This method has the following advantages compared to other methods. These enzymes do not leak from the carrier and do not separate, since this bio-catalyst is located on the carrier surface, it can easily interact with this subset. On the other hand, the main defects of this method are high costs and low production efficiency due to exposure of bio-catalyst against toxic identifiers with harsh reactive conditions.

2- Trapping: This method is based on determining the location of an enzyme in the network membrane. The main limitation of this technique for fixing the anesthesis is the possible leakage during repeated application due to small molecular size compared to cells. Another disadvantage of this method are emission restrictions. The trapping method is classified into five important types: network, microcapsules, liposomes, converse membranes. In order to fix beta-galactoseidase, leites method (network) is the most commonly used. The enzyme is trapped in the framework of various natural or synthetic polymers. Al-Jinet, a polysaccharide or natural occurrence that constitutes gel with ionotropic criticism, is the most common method. Among the synthetic polymers used to trap beta-galactoseidase, polyvinyl alcohol gel has been very attractive. Preparation of enzyme microcapsols desperately requires appropriate controlled conditions. In the opposite type of mesil, beta-galactoseidase is trapped in inverted mesils, which are formed by combining a surface with an organic solution, for example, inverted iso-flax copper l and in this type of membrane this enzyme is separated from the reaction solution with a supertreatment membrane, a finely refined membrane or a hollow fiber.

3- Physical adsorption: Adsorption of physical materials is the easiest and oldest method of fixing enzymes on carriers. Fixation with this method is based on physical reactions between bio-catalyst and carrier such as hydrogen binding, alluvilation reactions, van der Waals force and their compounds. Despite its simplicity, this method is very limited by the enzyme's tendency to remove the absorbed materials resulting from support and sensitivity to environmental conditions such as temperature and ionic concentrations.

4- Transverse connection: This method uses a combination of two or more applications that acts as a use for the transverse intermolecular connection of bio-catalyzer. In the case of beta-galactoseidase fixation, transverse connectivity is often used in combination with other fixation methods mainly with absorption and trapping.

Application

Source selection depends on the final application of beta-galactoseidase enzyme e.g. beta-galactoseidase from yeasts with optimal acidity of 7-6.5 commonly used for lactose hydrolysis found in whey. In the case of acidic whey hydrolysis, fungal beta-galactoseidase is suitable for optimal acidity of 3-5. Therefore, the selection of beta-galactoseidase depends on the final application of the enzyme or industry in question.

Galactozidase is produced from yeasts, which are more suitable for milk hydrolysis and fresh whey. The fungal beta-galactoseidase enzyme hirolizes about 75% of whey.

In industrial activities, the two main categories of beta-galactoseidase are of particular importance, including:

• Cold-active
• Heat-stable (Thermostable)

Beta-galactoseidases are mainly used to improve the technological and sensory properties of foods by increasing the soluability of sugars, forming galactolygosaccharides, reducing lactose content (for dairy foods designed [for IJ of lactose intolerants), and converting whey into several high-value added products.

These enzymes have two main applications.

Lactose removal from milk products for lactose intolerance in people and the production of galactosiled products.

With internal stability against temperature and other β, β galactoseases obtained from thermophilic microorganisms can be useful as soluble or form stabilized in food industry, these enzymes are useful at the same time for thermal modification and low hydrolysis of lactose. Thermophilic beta-galactocydase enzymes are used in industrial processing of dairy products along with heat treatment for sterile product and are a very useful alternative to mesophilic enzymes. Reduction of microbial contamination due to enzymatic treatment of these substances at high temperatures is one of the known advantages of these enzymes in food industry. β of cold activated galactoseidase, which hydrolyzes lactose into its main components, is one of the most important enzymes in the food industry. From cold-loving yeasts, which grow on lactose at low temperatures under acidic conditions as the only source of carbon, active and cold beta-galactosease is extracted.

In the food industry related to dairy products, the beta-galactoseidase enzyme is used to catalyze the lactose hydrolysis found in dairy products, which is responsible for many of the defects associated with storing these products. Hydrolysis of this sugar seeks to prevent particle deposition, crystallization of frozen dairy desserts and the existence of sand textures in most commercial derivatives of milk. . By hydrolysis of lactose with beta-galactoseidase, problems related to whey disposal, lactose crystallization in frozen concentrated devices and milk consumption by lactose intolerant individuals can be eliminated.

Lactose Hydrolysis Valve

Since mammals are unable to absorb disaccharides in their intestines, the beta-galactoseidase enzyme hydrolyzes lactose into simpler and absorbable monomers. With aging, the amount of this enzyme decreased, to the extent that it is no longer sufficient for lactose hydolisis. Large amounts of lactose in the intestines typically lead to a lot of water absorption, which causes dehydration, reduced calcium absorption and diarrhea. It may also be metabolized by narrow gut bacteria and cause bloating and stomach pain by producing gas. About 70% of adults in the world are suffering from this problem and are unable to consume milk and dairy products. Lactose intolerance or digestion and lactose uptake occurs in the small intestine due to deficiency or lack of beta-galactoseidase enzyme. Yogurt and other conventional microbial cultures and prebiotic bacteria in fermented and non-fermented milk products improve lactose digestion and reduce symptoms of intolerance in people with bad lactose digestion. These beneficial effects are related to the microbial beta-galacthoidase enzyme present in fermented milk products, which delays the passage time of the intestine, has positive effects on intestinal function and intestinal microbiota and reduces susceptibility to symptoms of the disease. Therefore, by adding lactobacilli containing beta-galactoseidase enzyme as prebiotics to milk and cheese and other dairy products, lactose digestion can be used to help lactose-tolerant individuals. Bacteria such as Bulgaricus and Streptococcus thermophilus (e.g., common bacteria in yogurt) are the strongest manufacturers of beta-galactoseidase. In addition to increasing the amount of lactose hydrolysis, these conditions prevent the growth of other undesirable microorganisms.

In kefir, about 30% of milk lactose is hydrolyzed by the beta-galactoseidase enzyme in its microorganisms and converted to galactose and glucose. Another part of lactose is converted into lactic acid during fermentation.

Medically, they use beta-galactoseidase to produce lactose-free dairy products and for the formulation of pills that people with lactose intolerance use to digest milk and its derivatives (yogurt, cheese, ice cream, butter, creams, etc.). It is used as a biosensor or biomarker for a variety of purposes, from safety measurement and toxicology analysis to gene expression analysis and pathology diagnosis thanks to the chemical immobility of this enzyme on specific support.

There are three types of lactose deficiency; primary, congenital and secondary;

1- Primary beta-galactoseidase deficiency occurs along small intestine vulections in people between the age of 2 and 20 due to decreased beta-galactoseidase synthesis.

2- Type 2, congenital deficiency of beta-galactoseidase caused by genetic abnormalities, in the body of the affected people, this enzyme is very low or does not exist at all.

3- The third type, as a result of low level of this enzyme, is caused by an underlying disease that affects the gastrointestinal tract.

The use of β-galactoseidase, which is generally known as safe, is highly developed for milk lactose hydrolysis in the dairy industry, the main reason for which reaction to the phenomenon of lactose intolerance is actually milk pH suitable for beta-galactosease activity. In addition to the advantage of converting lactose into glucose and lactose in the process of enzymatic hydrolysis, Rouiz-Matut et al. stated that during milk production without lactose, galactose is formed oligosaccharide, which are prebiotic compounds that, as indigestible foods, affect the host by stimulating the growth of bacteria in the clone and leading to improved health.

Beta-galactoseidase is produced by most lactobacilli, which converts lactose sugar, the main sugar of milk, into glucose and galactose. These sugars can be easily absorbed through the intestinal epithelial cells, beta-galactoseidase of the narrow intestinal enzyme has two enzymatic activities:

Beta-galactoseidase activity and hydrolase fluorine activity.

Beta-galactoseidase activity is responsible for lactose hydrolysis and also breaks selobiosis, cellulotriosis, celotosis and partially cellulose. Hydrolustic fluorine activity breaks down beta-glycosides. Most beta-galactosidase activities in the intestines are performed by beta-galactoseidase and its location is at the tip of the intestinal vulection.

Different genus Lactobacillus and Bifidobacterium and a few bacteria that are used as initiator in dairy products are often the producers of beta-galactoseidase by adding bacteria producing this enzyme to milk or consuming dairy products containing this enzyme can help to improve lactose intolerance symptoms. Glucose and galactose levels can regulate beta-galactosease activity by inhibiting catabolite or by eliminating the inducer (Catabolite Repressio).

Industrial applications of beta-galactoseidase include the removal of lactose from dairy products for lactose intolerant individuals and the production of various galactosidate compounds. They are also used to improve the sweetness, flavor and digestion of many dairy products. One of the important applications of beta-galactoseidase enzyme is the hydrolysis of whey lactose and its conversion into products such as sweet sirops applicable in bakery, confectionery and chocolate industries. This enzyme can be used to reduce crystallization in dairy products, such as ice cream and condance milk, which is caused by high concentrations of lactose. By hydrolysis of lactose and decreasing its concentration, it can help to improve tissue and digestion more easily. In addition, the addition of additional sweeteners decreases, resulting in a lower amount of calories in the final product. The beta-galactoseidase enzyme reduces the fermentation time (when lactose is hydrolyzed into glucose and galactose), thereby lowering the time to reach the desired pH in products such as yogurt and cheese.

To produce milk without lactose, lactose hydrolyze the milk with the enzyme external beta-galactoseidase or remove it with the help of membrane technology.

Modified milks are the same milk-based beverages that make changes to their production in milk to carry more complete nutritious compounds, and in some cases, this is done to increase taste, digestion and optimal yield. Modified milks may include vitamin or protein-enriched milks, prebiotic-enriched milks, nutritionally balanced milks, lactose-reduced milks or lactose-free milks and flavored milks in the design of low milk production. Lactose, by hydrolyzing milk lactose by beta-galactoseidase enzyme and converting it into glucose and galactose monosacarids, due to the more sweetness of these two monosacarids compared to lactose, the milk produced is sweeter in terms of The taste is not favored by many consumers, including those who have lactose intolerance. Lactose-free disease is a common disease in the world. The prevalence of the disease in Asia is estimated to be over 50%, and in some Asian countries it reaches 100%. It is associated with symptoms such as flatulence, diarrhea, abdominal pain, abdominal noise, nausea and vomiting following consumption of lactose-containing foods such as milk and dairy products. This challenge can be turned into a new production opportunity by adding flavoring materials and converting it into a product similar to commercial flavored milks, except that the sweetness of this product in order to reduce sucrose and nutritional improvement of the product Choyo Associates stated that due to more sweetness of glucose and galactose from lactose, milk with hydrolyzed lactose is not desirable because of its sweetness and bad taste. In their study, Edicario colleagues compared the sensory characteristics and desirability of lactose-free transpaste milks with different fat percentages with common milk samples. Milk without lactose fara pasteur compared to common milks, dominant sweetness, cooked and processed taste and gypsum tissue had some important technological advantages from lactose hydrolysis to glucose and galactose such as increasing solute from 18% to 55% and increasing sweets to 70%. Therefore, it is possible to produce narcissistic products or products with the lowest added amount of sugar by using milk with hydrolyzed lactose. In other words, using enzymes to produce low lactose milk and then mixing it with different flavors and then drying with spray dryer is a successful method for producing different types of low lactose milk powders. Applying this strategy can be part of a nutrition map that supports healthy living.

It has been reported that lactose pre-water in milk can reduce processing time for the production of yogurt and cheese by 20%. Lactose hydrolysis in milk is aimed at improving the technical and nutritional properties of milk.

Milk with hydrolyzed lactose has many advantages: (1) faster fermentation, (2) more milk sweetness, (3) higher soluability of glucose and galactose compared to lactose, (4) greater stability of milk with hydrolyzed lactose, (5) rapid pH drop in cheese made from milk with hydrolyzed lactose resulting in better sensory properties. Lactose hydrolysis can be an alternative to the use of sucrose or starch syrup by increasing milk sweetness.

Hydrolysis of Whey properties

β-galactoseidase enzyme has also been used to modify whey properties. Lactose in water has little sweetness and solubility, and it is not possible for some humans to digest it due to lack of beta-galactoseidase enzyme in their digestive system.

Beta-galactoseidase and its hydrolytic activity in lactose degradation are effective tools to reduce the negative impact of whey as a major byproduct of cheese production on the environment, while allowing the conversion of whey into widely used products.

Dairy whey is a polluting product with high organic chemistry demand. And after hydrolysis it may be used as cattle food sources and in the food industry to produce new products without lactose content. Whey is a highly contaminated product composed of 0.7% protein, 5% lactose, 93% water and salt. After hydrolysis of lactose by beta-galactosidase, these organic lesions can be used as an inexpensive substrate with easy access to microbial cell culture.

Whey proteins (such as α lactalbumin) have excellent functional properties that can be retrieved and hydrolyzed by ultrafiltration to produce many beneficial pharmaceutical intermediaries. Beta-galactosidase can be penetrated directly into the whey stream, resulting in the production of sweet syrup, which can be used as an additive in ice creams, desserts, etc.

Lactose hydrolysis has many advantages, including:

1. Prevents lactose crystallization in condensed and frozen milk.
2. Accelerate the process of producing cheese yogurt and accelerate the acidization process
3. Improving the radiation
4. Hydrolyzed whey can be used as a sweetener in products such as canned fruit syrup and drinks
5. In ice cream, by breaking lactose into glucose and galactose, it prevents the growth of crystals and the phenomenon of sanding.

Galactovaligo Sakaride Production

Galactovalygosaccharide (GOS) (bio macromolecules are composed of carbohydrates composed of 20 galactose molecules and 1 glucose molecule), a prebiotic derived from the lactose enzymatic reaction and mainly composed of glucose and galactose molecules.

GOS is a prebiotic, indigestible food capable of modifying the gut microflora in favor of health-boosting bacteria (Bifidobacterium sp andLactobacillus sp). Beta-galactocydases are very beneficial for human health due to the formation of galactoligosaccharides (GOS), which are used as a prebiotic nutrient. The ability of beta-galactoseidases to produce a series of galactose-containing oligosaccharides was reported in the early 1950s. Subsequent studies focused on optimizing their production conditions. Recently, interest in the positive effect of oligosaccharides in addition to human health has been reported. 3

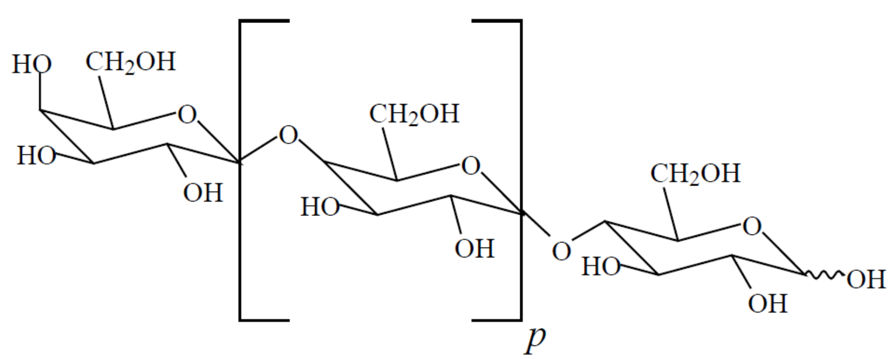

Figure 3 : Structure of galacto-oligosaccharides

GOS is produced simultaneously during lactose hydrolysis due to the activity of β-galactosilation of beta-galactoseidase. Compared to hydrolysis, the need for GOS synthesis is generally different. Reaction conditions should be favorable transgalactulization conditions, i.e. high lactose concentration, increased temperature and low water activity in reaction medium. Therefore, fixed beta-galactoseide must be resistant to high temperatures, low water content and provide high galactocylation transinsor activity.

GOS is usually found in human milk. It has been shown that human milk oligosaccharides increase the number of colon flora bifidobacteria in infants, along with a significant decrease in the number of potential pathogenic bacteria, due to their bifidogenic activity. In the food industry, some food companies have incorporated GOS into their product combinations in an effort to mimic the beneficial function of complex carbohydrates in breast milk. In others, they are used in cereal-based baby foods. However, they are used not only in infant foods, but also in adult-specific foods. Colon oligosaccharides/bifidobacteria provide a wide range of health benefits, including anticancer effects, lowering cholesterol, improving liver function, reducing the risk of colon cancer and improving bowel health and improving blood health. GOS is currently used as low-calorie sweeteners, food and cosmetic additives. They are included in a wide range of foods such as soft drinks, muffins, cereals, gum, candy, ice cream, yogurt, infant formula, etc.

Conclusion

Galactosidase β enzyme can be obtained from a wide range of sources such as microorganisms, plants and animals. β galactosease is used for lactose hydrolysis in milk and whey and converted into monomers of glucose and galactose in the food and dairy industry in two soluble and stabilized forms that have different methods. Enzymatic hydrolysis of lactose prevents health problems caused by this disaccharide. Soluble enzymes can only participate in an unsydy process, but stabilized enzymes can be used in continuous and non-continuous processes.

The results of this study showed that low lactose milk can be produced using enzymatic hydrolysis method to minimize lactose intolerance in consumers. Changes in nutritional patterns in Iranian society in recent years, especially in the context of low per capita consumption of dairy products, have been some of the lack of access to appropriate sanitary and inexpensive products, and another part is related to the occurrence of allergic complications due to lactose intolerance. The result of such a change, which we are clearly witnessing today, is the incidence and increase of complications such as osteoporosis, low resistance to infectious diseases and shortcomings in older ages, etc.

It was also concluded that by using enzymatic hydrolysis by beta-galactoseidase enzyme, undesirable effects and contamination of dairy wastes such as whey can be reduced and whey can be used to produce other valuable products (animal food, culture medium and low calorie sweetener). In the production of ice cream and frozen products based on milk, sand texture of these products can be converted into soft and uniform texture of these products using beta-galactosease enzyme and lactose hydrolysis and help to improve its quality. In this study, it was found that beta-galactosidase enzyme is used in the production of galactovalygosaccharide and modification of intestinal microflora for health-boosting bacteria.

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