The Lactose Dilemma: Holistic Solutions for Modern Living

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Abstract

Gut sensitivity is a secondary aspect in lactose intolerance (LI), a common gastrointestinal illness primarily caused by lactose malabsorption from a lack of the lactase enzyme. Even though babies normally generate enough lactase to digest breast milk, as they get older, their production tends to decrease, which can result in symptoms like bloating, gas, and diarrhea when they consume lactose. The frequency of LI is influenced by genetic and ethnic characteristics; Asian, Hispanic, and Native American groups have greater rates. Irritable bowel syndrome, visceral hypersensitivity, and small intestinal bacterial overgrowth are among the conditions that might exacerbate symptoms. Reducing lactose consumption, taking lactase supplements, and selecting plant-based or lactose-free substitutes are some management techniques. By altering the gut microbiota, prebiotics and probiotics—particularly those that include *Lactobacillus* and *Bifidobacterium* species—may also aid in symptom relief. Real-time detection, enzyme delivery systems, and lactose-free food innovations are just a few of the exciting, non-invasive solutions provided by emerging nanotechnology-based diagnostic and therapeutic instruments. By combining nutritional science, microbiology, and nanomedicine, current research focuses on sustainable, individualized methods to enhance quality of life.

Keywords: Lactose dilemma, Gut microbiota, Lactase, Diary-products, Lactase enzyme

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Introduction

Lactose intolerance is a condition that occurs when the body does not produce enough lactase, the enzyme that breaks down lactose, the sugar found in milk. The digestive tract experiences discomfort after consuming dairy products due to this condition. Unlike a food allergy, lactose intolerance is a digestive issue rather than an immune response. Although many people have trouble digesting lactose, not everyone has symptoms. Symptomatic individuals are considered lactose intolerant (Catanzaro et al., 2021).

Symptoms of lactose malabsorption are the hallmark of the clinical disorder known as lactose delimma or intolerance. This may be the result of either decreased or absent lactase activity or decreased or absent lactase production. A number of factors influence the subjective severity of the symptoms. Approximately 57% of people globally currently have confirmed cases of lactose intolerance. The global distribution of cases is highly unequal, and the actual prevalence is thought to be higher than 65%. In America, it is roughly 50%, in Asia, 70%, and in Africa, nearly 100%. To explain these discrepancies, a number of theories have been proposed. Dairy products were a major part of the diet in Northern Europe, which supports one of these explanations. This aided in the natural selection of lactose-digesting subjects. Moreover, migrations over time have resulted in the coexistence of groups composed of lactose-intolerant and non-intolerant persons within the same territory (Tariq et al., 2024).

Symptoms related to lactose malabsorption may indicate lactose intolerance, a clinical disorder of the alimentary tract. One of the primary sources of carbohydrates and energy is lactose, a disaccharide that is mostly present in milk and similar products. Lactase-phlorizin hydrolase (LPH), another name for brush border endogenous β-galactosidase, hydrolyzes it into its constituent galactose monosaccharides, and glucose monosaccharides. The microvillar membrane of the small intestine's epithelial cells breaks down the monosaccharides that are created. Galactose contributes to the synthesis of glycolipids and glycoproteins, while glucose acts as a store of energy. Lactose malabsorption can occur when a person is unable to properly digest and absorb lactose. This is known as lactose intolerance, associated with a number of symptoms, including diarrhea, gas, cramps, borborygmi, and distension and discomfort in the abdomen (Catanzaro et al., 2021).

65–74% of people worldwide suffer from lactose intolerance (LI), which causes many to limit or avoid lactose. Although most people can tolerate up to 12g per intake or 18g daily, reported intolerance depends on the degree of symptoms. Individual variations in lactase levels, intestinal transit, water absorption, gut microbiota, and visceral sensitivity are the causes of symptom variability. While consuming too much lactose can result in pain, consuming too little can have no effect. Although they are linked, lactose malabsorption and LI are different; while not all people with malabsorption exhibit symptoms, all people with LI do. While symptoms appear in the large intestine, malabsorption takes place in the small intestine (Tariq et al., 2024).

The small intestine plays a critical role in absorbing nutrients by breaking them into smaller molecules that can enter the bloodstream. However, any unabsorbed nutrients, such as lactose, move to the large intestine. In the large intestine, undigested lactose draws in extra water and is fermented by gut bacteria, producing gas. This process can cause symptoms like diarrhea, bloating, and abdominal discomfort (Catanzaro et al., 2021).

Factors Influencing Lactose Intolerance

Several factors influence the development and severity of lactose intolerance. Key among these are:

1. Genetics: A major determinant of lactose intolerance is the genetic predisposition of an individual. Genetic factors are the main determinants of whether lactase activity persists or not in maturity. In communities where dairy consumption has a long history, lactase persistence is more common, whereas in populations without such a history, lactase non-persistence is more prevalent (Swallow, 2003).
2. Age: Many people naturally experience a decrease in lactase activity as they age, which increases their risk of lactose intolerance in later life. Among adults of African, East Asian, and Native American heritage, this is most apparent (Swallow, 2003).
3. Dietary Habits: Societies that generally consume large quantities of milk products tend to have lower rates of lactose intolerance due to natural selection favoring lactase persistence. In contrast, in regions where dairy consumption is less common, lactose intolerance tends to be more widespread (Tishkoff et al., 2007).
4. Health Conditions: Secondary lactose intolerance can result from small intestine damage and decreased lactase production caused by certain gastrointestinal disorders, including Crohn's disease, coeliac disease, and gastrointestinal infections (Misselwitz et al., 2017).
5. Geography and Ethnicity: The prevalence of lactose intolerance varies significantly based on geographic location and ethnic background, as mentioned above. Understanding the cultural, genetic, and dietary factors at play is key to assessing the global burden of lactose intolerance (Itan et al., 2010).

Pathophysiology of Lactose Intolerance

The LPH enzyme, a membrane-bound glycoprotein, is the primary enzyme responsible for the digestion of lactose. Along with enhancer genes like the MCM6 gene, the LCT gene, which is found on the long arm of chromosome 2, is the primary encoder of the LPH enzyme (Misselwitz et al., 2019). Before entering intestinal epithelial cells as a functioning enzyme, LPH pre-mRNA goes through a number of post-translational changes. Disrupted lactase activity leading to lactose intolerance (Misselwitz et al., 2019). It is caused by changes in epigenetic alterations, gut microbiota, transcriptional, translational, and post-translational mechanisms, as well as inheritance patterns (Labrie et al., 2016). LI may be categorized as

(1) Congenital
(2) Primary
(3) Secondary
(4) Developmental lactase insufficiency

Depending on a number of pathogenic variables. According to reports, lactase deficiency is primarily caused by mutations and polymorphisms in the LCT gene.

Congenital Lactose Intolerance

Congenital lactose intolerance or congenital/permanent lactase deficiency is caused by a malfunction or mutation in the lactase synthesis gene, the lactase phlorizin hydrolase (lph) gene located on human chromosome 2q21.3. The condition manifests as severe, uncontrollable diarrhea in newborns who are fed human milk or lactose-containing milk formula. This rare genetic illness, which is probably autosomal recessive, can be deadly due to the potential for electrolyte loss and dehydration. It is currently unknown whether heterozygote carriers of the lph gene show symptoms or even go away on their own because of the potential for a wild-type lactase phlorizin hydrolase monomer to dimerise with a mutated monomer in the endoplasmic reticulum to create an active and transport-competent enzyme (Wanes et al., 2019).

Primary Lactose Intolerance

Full-term babies generate enough lactase at birth to break down lactose, a crucial source of energy, in milk. However, because there is less dependence on dairy as a major energy source during the first year of life, lactase activity naturally decreases. Intestinal lactase levels in those with primary lactose intolerance decrease dramatically from their birth peak to less than 10% of infantile levels in childhood. The most prevalent type of lactose intolerance is known as adult-type hypolactasia, lactase non-persistence (LNP), primary lactase deficiency, or hereditary lactase deficiency. The main variables influencing it are genetic.

Ethnic variations in the age at which lactase expression begins to decline and its geographic distribution reveal an underlying element of genetic origin. While children in Latin America, Asia, or Africa may have gastrointestinal symptoms between the ages of two and three, children in Europe and North America typically do not exhibit them until later in infancy (5 to 6 years of age) or adolescence. Slow, progressive, and irreversible age-related down-regulation of lactase activity is a physiological phenomenon. It can result from dietary modifications or the ageing process itself, and it is genetically predetermined (Mäkelä et al., 2017).

Secondary Lactose Intolerance

Any pathological condition that damages the small intestine results in fewer formed enterocytes, which lowers lactase expression. Diseases of the small intestine may lead to secondary lactose intolerance (Di & Berni, 2018). Secondary lactose intolerance is more frequent in infancy, but it can happen at any age and is usually transient (reversible after the epithelial lining has been repaired (Harvey et al., 2018). Secondary lactose intolerance can be caused by a number of conditions, including bacterial overgrowth in the small intestine, a short bowel that reduces

the surface area of absorption, food allergies (including cow's milk allergies), chronic diarrhea from giardiasis, cryptosporidiosis, and other parasites that infect the proximal small intestine, coeliac disease, cystic fibrosis, Crohn's disease, Alzheimer's disease, and acute gastroenteritis caused by a Rotavirus or Norovirus infection (Di & Berni, 2018).

Gastroenteritis is the most common cause of secondary lactose intolerance in children. (Heine et al., 2017). It was initially documented by Burke et al. in 1965 and is somewhat prevalent in newborns under two years old, with the largest prevalence occurring during the first year of life. Approximately 16.8% of infants under the age of five in Spain and 11.2% of children under the age of three in Poland were found to have secondary lactose intolerance following rotavirus infection (Szajewska et al., 1997). 3.4% of Spanish children under the age of five were found to have secondary lactose intolerance brought on by the norovirus. (Gonzalez-Galan et al., 2011). However, in Malaysia, whereas this link was not observed, subsequent lactose intolerance was discovered in 4 out of 393 children who were treated for acute gastroenteritis. This suggests there may be an underlying explanation for the association between secondary lactose intolerance and gastroenteritis that is not yet understood.

Causes of Lactose Intolerance

Both lactose malabsorption and gut sensitivity are major causes of lactose intolerance, with the former being the most common. Insufficient lactase production in the small intestine results in this disorder.

Lactase Deficiency

The enzyme is required to convert lactose into sugars that can be absorbed. In infancy, most people produce sufficient lactase to digest breast milk, but its production often decreases with age. When there is insufficient lactase, lactose enters the large intestine and causes symptoms like gas and bloating. While some individuals produce more lactase than others, the majority of the global population experiences lactose malabsorption due to reduced enzyme production. Only certain populations retain high levels of lactase into adulthood (Misselwitz et al., 2019).

Gut Sensitivity

Gut sensitivity plays a secondary role. Many people occasionally consume indigestible components, like dietary fibers and certain sugars, which feed gut bacteria. While minor amounts of these substances are typically well-tolerated, factors like genetics, intestinal health, diet, and the gut microbiome influence how the body processes lactose. Each person's microbiome, the unique mix of bacteria in the colon, determines how efficiently lactose is handled. Ultimately, your symptoms indicate the amount of lactose your body can manage. Pathogenesis, diagnosis, and clinical management (Yang et al., 2013).

Standard Therapeutic Practices

After consuming lactose, the LI individuals find it challenging to recover from the symptoms due to the irreversible activity of weaning lactase. Reducing dairy consumption is a popular approach among those with a clinical diagnosis or those who believe they have LI. However, avoiding dairy products that include elements like potassium, calcium, vitamin D, and vitamin B raises the risk of osteoporosis, bone fractures, and other health problems (Misselwitz et al., 2019).

Limiting lactose consumption may be the cornerstone of LI treatment. This is a successful strategic treatment strategy that helps LI patients with their symptoms by managing their diet. The use of lactase supplements, non-dairy substitutes, lactose-free dairy products, prebiotics, and probiotics may be the most practical management strategies for LI patients (Di et al., 2002). You are more likely to have lactose intolerance and lactose malabsorption if your genetic profile is:

1) Asian
2) Hispanic
3) Native American

You may be more likely to have lactose tolerance and lactase persistence if your genetic profile is:

1) Middle Eastern.
2) Northern European
3) African

Congenital lactase deficiency is an uncommon genetic disorder that causes lactose intolerance from birth in certain people. However, for most people, lactose intolerance develops later in life, typically transitioning from childhood to adulthood. This common form, known as primary lactose intolerance, occurs as the body gradually reduces lactase production. Additionally, over time, lactose intolerance may develop as a result of changes in gastrointestinal sensitivity.

Separately from lactose malabsorption, you may be more likely to experience symptoms if you have:

1) Small intestinal bacterial overgrowth
2) Visceral hypersensitivity.
3) Irritable bowel syndrome

These are ailments that typically appear gradually over the course of a lifetime (Misselwitz et al., 2023).

Exogenous lactase, also known as β-galactosidase, is used to pre-digest lactose into glucose and galactose in order to manufacture lactose-free dairy products. This could be especially helpful in treating calcium shortage in adults with hypolactasia or galactose deficiency (galactosemia) in babies. Supplementing lactase with β-galactosidase from various sources is an additional possible pharmacological strategy. These could be taken before eating anything that contains lactose. To meet the nutritional needs of LI persons, a number of non-dairy substitutes could be employed, including plant-based beverages (like soy, almond, and rice milk) and soy items (like tofu, edamame). Using probiotics and prebiotics to alter the gut microbiota may help with lactase digestion.

This can be accomplished via colonic adaption of bacterial species that can aid in the management of LI symptoms, including *Bifidobacterium*, *Limos lactobacillus and Lactobacillus*. *Bifidobacterium* and *Lactobacillus* create lactase, which catalyzes the conversion of lactose into an energy source that produces SCFA, such as butyric acid, in the colonic epithelium. They don't create gases (methane and hydrogen) like the colon's heterofermentative bacteria do. Consequently, it has been shown that consuming lactose on a regular basis promotes the growth of these advantageous bacteria as a prebiotic effect. Riboflavin, Calcium, vitamin B12, vitamin B6, probiotics, and protein are all found in good amounts in yogurt. During their lactose consumption pathway, a number of bacterial strains in it generate β-galactosidase, which probably aids in lactose digestion (Derma et al., 2024).

Cross-disciplinary research has undergone a remarkable revolution in recent years, encompassing technological advancements in several nano-sized materials. It includes the collection, use, and incorporation of diverse physical, chemical, and biological systems into more extensive systems. These can be submicron in size, or single molecules or atoms. Nanotechnology is the result of combining the mechanical, optical, magnetic, and electrical properties of nanostructures. With numerous potential applications in the upcoming generation of functional materials, it is currently a rapidly expanding, multidisciplinary area.

Nanotechnology has improved, and researchers have been able to develop new applications thanks to the development of nanotubes, nanocomposites, nanocrystals, nanotechnology, Nano electronics, and Nano medicines. These nanomaterials are between 1 and 100 nm in size in at least one dimension.

They provide platforms that are non-invasive, easy to use, portable, extremely sensitive, selective, dependable, and reasonably priced, opening up new fields in biomedical research. Through the combination of medical nanotechnology and nutritional sciences, they have contributed to the creation of numerous diagnostic and therapeutic applications as well as management strategies (Ramos et al., 2017).

The pathogenic origin of LI, a gastrointestinal tract lifestyle disorder, is unknown. It features differential therapy and management approaches, as well as diagnostic criteria that are trial-and-error. A lot of research is being done on how to address it using lifestyle modifications and medical therapies. Potential medicines with the necessary solubility and bioavailability have been identified through nanotechnology and microencapsulation. They address several facets of LI by providing attainable sustainability at the designated locations. Nanotechnology has established itself as a therapeutic tool that serves as a pharmacological agent in the production and distribution of lactase enzyme, as a diagnostic tool for LI, and for strategic management through the development of lactose-free products (Tariq et al., 2024).

Common Symptoms of Lactose Intolerance

After consuming lactose-containing meals or beverages, the symptoms of lactose intolerance usually manifest 30 minutes to 2 hours later. These symptoms are primarily digestive in nature and include the following:

1. Bloating

One of the most prevalent and bothersome signs of lactose intolerance is bloating. It happens when intestinal bacteria in the colon ferment undigested lactose, resulting in gas. This extra gas makes the abdomen enlarge, which makes the stomach feel full, constricted, or under pressure. Bloating may be an unpleasant and upsetting experience for a lot of people (White & Lomer, 2017)

2. Diarrhea

Diarrhea occurs when undigested lactose draws water into the colon due to the osmotic effect. The unabsorbed lactose acts as a laxative, leading to loose, watery stools. This can be accompanied by an urgent need to have a bowel movement. Diarrhea is especially common in individuals who consume large amounts of lactose in a single sitting (Wanes et al., 2019).

3. Abdominal Pain and Cramping

Abdominal discomfort, including pain and cramping, is a hallmark of lactose intolerance. This occurs because the fermentation of undigested lactose by bacteria in the colon produces acids and gases, leading to an increase in pressure within the digestive system. The result is sharp, bloating-induced pain or cramps, which may come and go, depending on the amount of lactose ingested (Ramos et al., 2017).

4. Flatulence (Excessive Gas)

Excessive gas or flatulence is a direct consequence of the fermentation process. The gut bacteria in the colon break down lactose into hydrogen, methane, and carbon dioxide. These gases accumulate in the intestines, leading to the sensation of excessive or uncontrollable farting. People with lactose intolerance may also experience bloating and abdominal pain as a result of gas production (Di et al., 2021).

5. Nausea

Nausea is a common symptom of lactose intolerance, especially in those who consume high amounts of lactose or whose symptoms are more severe. Other symptoms like diarrhea and cramping in the abdomen, might accompany nausea. Vomiting is less usual, but it can happen in some situations when the nausea is severe enough (White & Lomer, 2017).

6. Indigestion

Indigestion, or dyspepsia, is another symptom that may occur in individuals with lactose intolerance. The discomfort from indigestion may be felt as a general sense of unease or an upset stomach. This can include feelings of fullness, heartburn, or slight discomfort in the upper abdomen, which can be aggravated by consuming dairy products (Misselwitz et al., 2023).

Severity of Symptoms

Individual differences may exist in symptom severity. After taking small amounts of lactose, some people may only feel moderate bloating or discomfort; others, particularly after consuming higher amounts of lactose, may experience more severe reactions, such as cramps, vomiting, and diarrhea. Numerous factors can affect how severe the symptoms are.

1. Amount of Lactose Ingested

Small amounts of lactose are frequently tolerated by people with lactose intolerance, particularly when combined with other meals that slow down its absorption. Nevertheless, more severe symptoms may result from consuming bigger portions of lactose-containing foods (such as milk, cheese, or ice cream) (Alam et al., 2020).

Degree of Lactase Deficiency

The amount of lactase produced by an individual's small intestine directly affects the severity of symptoms. Those with complete lactase deficiency experience more pronounced symptoms, while individuals with partial lactase deficiency may have milder reactions (Di et al., 2021).

2. Dietary Habits and Adaptation

Some individuals with lactose intolerance may experience a reduction in symptoms over time as their gut microbiota adapts. Regularly consuming small amounts of lactose may help build a tolerance to the sugar. However, this is not true for everyone, and some individuals continue to experience discomfort even with minimal lactose intake (Rasmussen et al., 2009).

3. Co-occurring Conditions

Lactose intolerance symptoms can be made worse by illnesses like inflammatory bowel disease (IBD) or irritable bowel syndrome (IBS). In these cases, individuals may experience heightened sensitivity to lactose and more intense digestive discomfort. It is essential to distinguish between LI and other gastrointestinal disorders to prevent misdiagnosis and inappropriate treatment (Lund et al., 2006).

Different Mechanisms and Manifestations between Lactose Intolerance and Cow's Milk Allergy

Food hypersensitivity is the term used by the 2001 nomenclature task group of the European Academy of Allergology and Clinical Immunology (EAACI) to describe adverse food reactions. Depending on whether an immunologic mechanism is involved, they can be classified as

(i) Food allergy
(ii) Non-allergic hypersensitivity.

A more appropriate definition of "food intolerance" would be "non-allergic food hypersensitivity," which includes adverse food reactions that result in recurring symptoms at dosages that are generally tolerated. Despite coming from the same source—cow's milk—lactose intolerance (LI) and cow's milk allergy (CMA) have different causes and symptoms: While CMA is an immunological response to milk proteins, LI is caused by an enzyme imbalance that affects lactose, a carbohydrate. Accurate diagnosis is difficult because of their comparable symptoms, despite different processes. The necessity for comprehensive clinical evaluation and appropriate action is highlighted by the fact that misidentification might result in incorrect dietary restrictions, delayed treatment, nutritional deficits, or misdiagnosis (Derma et al., 2024).

Lactose Free Alternatives

To meet the nutritional calcium and high-quality protein demands of LI people, the global dairy industry has developed lactose-free products by adding exogenous lactase, β-galactosidase, which pre-digests the lactose in milk. Lactose-free dairy products allow people who are lactose intolerant to still enjoy the flavor of dairy without having to cope with the digestive problems that follow lactose consumption (Alam et al., 2020).

Furthermore, lactose hydrolysis has been regarded as a sugar reduction technique since it raises the product's sweetness to the same degree as adding 2% sugar. Lactose-free dairy is also not expected to have any unique nutritional effects on the human body when compared to traditional dairy products. Specifically, lactose or its breakdown products, galactose and glucose, did not affect the glycemic response of diabetic patients. As a result, customers should be encouraged to choose lactose-free dairy products due to their widespread availability, variety, and safety (Zhao et al., 2022).

Milk

Many nations offer lactose-free cow's milk in a variety of formats. Soluble lactase enzymes are used in both of the main processes used today to create this particular milk for intolerant people. The first approach is the batch process, which involves adding neutral lactase to raw milk as part of a pre-hydrolysis step. To avoid creaming, the mixture is typically incubated for almost 24 hours with moderate stirring. Additionally, because the milk is not yet sterile, this procedure is carried out at 4–8 °C to prevent microbial growth. Milk is pasteurized, homogenized, and packed following incubation. Because the enzyme is rendered inactive during the sterilization/pasteurization process, there is no lingering enzyme activity in the finished product (Catanzaro et al., 2021).

Ultra- and nano-filtration or chromatography techniques are used in conjunction with the hydrolysis of the remaining lactose to restore a traditional palatability and reduce the usual doubling of sweetness that follows lactose hydrolysis. The result is high-quality milk that tastes almost exactly like regular milk. The second method sterilizes the milk as part of an aseptic post-hydrolysis procedure using ultra-high temperature (UHT) technology. Just before packaging, a sterile lactase solution is added to the milk. The hydrolysis can be completed before the product is sent to the store because UHT milk is sometimes quarantined for almost three days. The conversion of lactose occurs within the

milk's packaging. Since both temperature and time of incubation are higher in this method, the amount of the enzyme can be much lower when compared to the batch process.

Cheese

Numerous types of lactose-free cheese are available. The solid curds are separated from the liquid whey, which contains the majority of the lactose, and the milk is thickened throughout the cheese-making process. Since the whey is drained off before the cheese is produced, a considerable percentage of lactose is removed. Because the curds used to manufacture soft cheeses have less moisture (whey) than those used to make hard cheeses, soft cheeses have a higher lactose content.

As cheese ages, more moisture is lost. Furthermore, no lactase incubation is required since lactic acid bacteria in hard and matured cheeses absorb all of the lactose during the aging process. The lactose content of hard-matured (long-ripened) cheeses is typically quite low and easily handled by the majority of people with primary LI because the longer a cheese is matured, the less lactose is left in the finished product. One example of a hard-matured cheese is Parmigiano Reggiano PDO, which is naturally made with up to 30% water and 70% nutrient-dense ingredients, namely calcium, phosphorus, and protein (Vetere, 2024).

Yogurt and other Fermented Products

Yogurt is a fermented food that is made from fermented milk and contains living bacteria. For those with lactose intolerance (LI), yoghurt eating is recommended as a viable dietary strategy to meet the daily intake of calcium, and most LI people can eat yoghurt without experiencing the typical symptoms. Some yoghurt culture bacteria, such as *L. delbrueckii* subsp. *bulgaricus* and *S. thermophilus* can produce β-galactosidase, particularly as part of their lactose ingestion route. This enzyme is believed to aid lactose digestion in vivo (Mohamed et al., 2024).

Nevertheless, the majority of the lactose is still present in the finished product after the initial fermentation of yoghurt, which only slightly reduces the lactose concentration. The living organisms in yogurt that contain intercellular β-galactosidase will probably survive the stomach's acidic environment and reach the small intestine, where bile acids will permeabilize them and release β-galactosidase into the lumen. Any lactose is hydrolyzed by bacterial β-galactosidase, and the intestinal epithelium absorbs the glucose and galactose that are produced. Several comprehensive evaluations have suggested that the ability of these probiotic bacteria to improve lactose digestion and reduce the symptoms of maldigestion may vary. Clinical studies evaluating the effectiveness of yoghurt in enhancing lactose digestion in humans were also examined by the European Food Safety Authority (EFSA) (Derma et al., 2024).

Yoghurt consumption is linked to better lactose digestion, according to the expert panel's conclusion that there is "strong evidence for the biological plausibility of the effect" and sufficient evidence to support a health claim for yoghurts containing at least 108 colony-forming units (CFU) per gram.

But to make cultured sour cream and buttermilk, which have the same amount of lactose as other fermented dairy products, cultures of mesophilic Lactococcus and Leuconostoc species are used. Lactose cannot be digested because these bacteria lack β-galactosidase and metabolize it through a β-galactosidase-independent pathway. As a result, those who are lactose intolerant find it difficult to consume either of these dairy products (Mohamed et al., 2024).

Importance of Lactose-free Labelling

The growing interest in lactose-free diets as the primary treatment for individuals with LI has led to a major increase in the manufacturing and sale of lactose-free goods in recent years. Additionally, consumers' awareness of the health benefits of these products has grown. However, the usage of lactose and other substances derived from milk as additions in non-dairy products has grown in popularity within the food industry. Because of its technological qualities, non-dairy alternatives are actually a widespread addition in many manufactured foods, primarily improving the flavor of prepared foods and texture. As such, LI patients may find it challenging to strictly follow the lactose-free diet. To fully avoid lactose, let the stomach recover, and address any possible nutritional deficiencies and related symptoms (Haug et al., 2005).

The food label is the primary means of providing consumers with nutrition and health information. The European Food Information Council (EUFIC) reports that eating disorders, attitudes, and beliefs are among the general determinants of food product choice, along with economical (such as price and knowledge), biological (such as hunger and palatability), social (such as family), psychological (such as mood) factors and physical (such as accessibility) (Facioni et al., 2020).

Test for Lactose Intolerance

Healthcare professionals can test for lactose intolerance in a number of ways. Common tests include:

1) The amount of hydrogen and methane gases in your exhaled breath is measured by a hydrogen breath test. Bacteria in the colon produce these gases. Elevated levels following lactose consumption suggest that gut bacteria are digesting undigested lactose, which results in the formation of gas that may be detected by the test (Shoemaker & West, 2021)

2) A blood glucose test could be suggested by a medical professional if the results of a breath test are unclear. Blood sugar levels are measured both before and after lactose consumption using this test. If there is no rise in blood sugar, lactose is not being digested correctly.

When detecting lactose intolerance in newborns and young children, the stool acidity test is frequently utilized. Following lactose consumption, a stool sample is taken and examined. The body's ability to properly absorb lactose is indicated by the presence of lactic acid and other by-products in the sample.

Management and treatment for lactose intolerance

Lactose intolerance occurs when the body lacks the necessary lactase to digest lactose. Lactase supplements (tablets or drops) are used to help with digestion (Catanzaro et al., 2021). Lactic acid bacteria-containing probiotics may aid by turning lactose into lactic acid rather than

gas, hence lowering discomfort.

To alleviate discomfort, gradually reintroduce lactose into your diet. Some people can consume up to 12 grams of lactose. Lactose-free and low-lactose dairy products are also available. Lactase synthesis and gut sensitivity to lactose are influenced by genetic factors, and specific gut bacteria aid in the breakdown of lactose into lactic acid.

Conclusion

Lactose intolerance (LI) is a common ailment characterized by a lack of lactase, the enzyme necessary to break down lactose. It affects up to 68% of the population, and symptoms include bloating, diarrhea, and stomach pain. The intensity of symptoms depends on lactase production, gut health, and heredity. Populations with a long history of dairy intake, such as Northern Europeans, have greater lactase persistence rates. Dietary adjustments, such as lactose-free goods and lactase supplements, are commonly used to manage the condition. Research into gut bacteria, genetic factors, and nanotechnology may lead to more effective treatments. Understanding these characteristics is critical for improving LI diagnosis and management.

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