LACTOSE-FREE DAIRY PRODUCTS: A GROWING MARKET AND NUTRITIONAL ADVANTAGES

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ABSTRACT

The increasing prevalence of lactose intolerance among global populations has driven a surge in demand for lactose-free dairy products. This trend is particularly evident in the dairy market, where lactose-free options are now the fastest-growing category due to their health appeal. Lactose-free dairy products offer essential nutrients like calcium, magnesium, and vitamins, crucial for individuals unable to digest lactose due to β-galactosidase deficiency. This paper explores various methods employed in producing lactose-free dairy products, including enzymatic hydrolysis, chromatographic removal, and membrane separation. By employing these technologies, dairy manufacturers can create a wide range of lactose-free products such as milk, yogurt, cheese, and ice cream, catering to lactose-intolerant individuals without compromising taste or nutritional value.

Keywords: dairy products, lactose-free, digestibility, lactase, lactose intolerance

INTRODUCTION

Due to their broad health appeal to consumers, lactose-free dairy products are currently the fastest-growing category in the dairy market. Lactose-free dairy products can provide essential nutrients such as calcium, magnesium, and vitamins to people who are lactose intolerant. Indeed, a significant portion of the world's population suffers from lactose intolerance, associated with a genetically conditioned lack of the enzyme β-galactosidase, which is one of the main reasons for the increase in demand for dairy products among consumers who cannot digest lactose (Li et al., 2023). There are a number of dairy products that do not contain lactose at all or have very little, and generally, such products are well tolerated by people who are lactose intolerant. For example, butter is a product that due to the production technology contains lactose in a concentration less than 0.1% because lactose is a water-soluble component of milk and is separated in the buttermilk process. In addition to butter, most hard, mature cheeses like parmesan contain very little lactose due to the action of lactic acid bacteria during ripening. Unlike hard cheeses, fresh ones can contain enough lactose to cause a reaction among people who are lactose intolerant, depending on the amount consumed. However, most dairy products such as fermented milk, sour cream, whipping cream, sweet cooking cream, and dairy desserts contain a significant amount of lactose (Dekker et al., 2019). For lactose intolerant people, it is not necessary to completely avoid the consumption of such dairy products today because there are technological solutions that hydrolyze lactose to glucose and galactose by adding neutral lactase. The process of producing lactose-free dairy products involves using one of the following methods: i)

enzymatic hydrolysis of lactose using β-galactosidase (lactase); (ii) chromatographic removal of lactose; (iii) fractionation of milk by membrane separation; or (iv) a combination of two or more of these processes. In order to achieve the best sensory properties of lactose-free dairy products, commercial production is based on a combination of several of the mentioned processes (Harju et al., 2012). Today, there are a large number of new lactose-free products launched on the market, such as pasteurized and ultrahigh-temperature (UHT)-treated milk, yogurt, cheese, and ice cream, which have increased considerably in recent years. The aim of this paper is to describe the specifics of the production method of most lactose-free dairy products and to emphasise the importance of consuming such products for people with lactose intolerance.

LACTOSE AND LACTOSE INTOLERANCE

Lactose is a natural sugar found in milk and dairy products. It is an important source of energy for infants and young mammals, including humans, and helps in the development and growth of the body. Lactose molecules consist of two simple sugars, glucose and galactose, which are linked together. However, the digestion of lactose requires lactase, which is produced in the small intestine. Lactase breaks down the lactose into glucose and galactose, allowing it to be absorbed into the bloodstream.

Lactose intolerance occurs when the body does not produce enough lactase, which leads to difficulties in the effective digestion of lactose. This deficiency can be genetic, as certain populations have a higher prevalence of lactose intolerance as they age. In these cases, the reduced lactase activity leads to the lactose entering the large intestine undigested (Suri et al., 2019). In the large intestine, bacteria ferment undigested lactose and produce gases such as hydrogen, methane and carbon dioxide. This fermentation process can cause symptoms such as flatulence, abdominal pain, diarrhea, and nausea, which usually occur within 30 minutes to two hours after consuming lactose-containing foods or drinks (Ko et al., 2018). The severity of symptoms can vary greatly in people with lactose intolerance, ranging from mild discomfort to severe digestive problems. Factors that influence the symptoms include the amount of lactose consumed, the individual tolerance threshold and the presence of other digestive disorders.

Approximately 68% of the world's population is affected by lactose intolerance (Storhaug et al., 2017). To address this widespread problem, the dairy industry has developed lactose-reduced or lactose-free dairy products produced by enzymatic hydrolysis with lactase. By using lactase, dairy manufacturers can produce products that are easier to digest for people with lactose intolerance. These lactose-reduced or lactose-free dairy alternatives are a practical solution for people who want to continue consuming dairy products while managing their lactose intolerance. They offer a wide range of options, including milk, cheese, yoghurt and ice cream, so that people with lactose intolerance can enjoy the nutritional benefits and taste of dairy products without experiencing discomfort.

Although lactose intolerance is common in adulthood, many people with lactose intolerance can still enjoy dairy products with the help of various strategies. In lactose-free dairy products, such as lactose-free milk and lactose-free cheese, the lactose is already predigested, making them easier to tolerate. In addition, matured

cheeses such as Cheddar, Parmesan and Swiss cheese have a lower lactose content due to the fermentation process. Another dairy product that is low in lactose is butter. During butter production, most of the water-soluble components of milk, including lactose, are removed, reducing the lactose content in butter to <1% (Dekker et al., 2019). Table 1 lists different types of dairy products and their lactose content, which should be considered before developing a lactose-free product.

Table 1: Lactose content in different types of milk products

Milk products		**Lactose (g/100 ml)**
Skim milk		4.3–5.7
Low fat milk		3.7–5.5
Lactose hydrolysed milk		0.43–0.6
Buttermilk		3.6–5.0
Chocolate flavoured milk		4.1–4.9
Cream		0.1
Whipping cream		2.8–3.0
Ghee (cow milk)		0.0
Yoghurt		4.70–4.76
Whey		5.1
Cheese	Cheddar	0.09–0.5
	Cottage	1.0–3.1
	Mozzarella	0.1–1.59
	Goat cheese	2.2
Butter		0.8–1.0
Ice-cream		3.6–8.4
Kefir		4.0

Source: Suri et al., 2019

LACTOSE-FREE DAIRY PRODUCTS

Lactose-free dairy products that are suitable for people with lactose intolerance are produced industrially using various processes, such as enzymatic lactose hydrolysis, chromatographic lactose removal, milk fractionation by membrane separation or combinations of these processes. Enzymatic hydrolysis with lactase is carried out before or after pasteurization, sometimes using immobilised lactase. Lactose hydrolysis has benefits not only for people with lactose intolerance, but also for consumers who want to reduce sugar consumption, as glucose and galactose are sweeter than lactose (McCain et al., 2018). The sweet flavour of the resulting glucose and galactose can be reduced by chromatography or membrane filtration processes (Harju et al., 2012). Chromatographic methods separate the milk components to obtain lactose-free milk, while membrane filtration separates proteins, fats and lactose. These methods are often combined to achieve the desired flavour and texture.

Due to their lactose content, traditional **fermented milk products** such as yoghurt or kefir are still not a safe food for people with lactose intolerance. The fermentation process of the microorganisms from the milk culture in the production of classic yoghurt only manages to break down 30% of the lactose into lactic acid. For complete hydrolysis of the lactose, lactase can be added before (pre-hydrolysis) or during (co-hydrolysis)

fermentation, which can influence the properties or fermentation products of the yoghurt to a certain extent. The lactic acid bacteria can utilise glucose directly to produce lactic acid, which shortens the fermentation time. At the same time, the lactic acid bacteria produce more exopolysaccharides, which makes the yoghurt more viscous. Rutkowska et al. (2022), for example, produced lactose-free kefir by using commercial lactase for pre-hydrolysis for 24 hours and then adding lactic cultures. The results showed that the product contained 0.1 g lactose/100 g and twice as many ketones, which primarily contributed to the high intensity of the creamy flavour. In addition, the lactose-free kefir tastes sweeter than conventional kefir. Popescu et al. (2022) found the best sensory properties of yoghurt in samples that underwent lactose hydrolysis during fermentation, which they associate with the production of more aromatic compounds.

Lactose-free flavoured milk is produced using the same process as regular milk. The addition of lactase during the production of such milk creates additional sweetness, so that a smaller amount of sugar needs to be added (McCain et al., 2018). Problems with unpleasant taste and dark colouring due to the Maillard reaction occur less frequently than in UHT lactose-free milk.

Ice cream can also be made lactose-free by using milk and lactose-free powder in the ice cream mixture or by adding lactase enzyme after pasteurization and incubation during ripening and before freezing. The increase in monosaccharide content after lactose hydrolysis lowers the freezing point of the mixture, resulting in a softer ice cream at the same temperature. The addition of lactase to the ice cream mixture has an effect on preventing lactose crystallization during freezing and prevents the occurrence of the sensory error "sandiness" (Abbasi et al., 2015).

CONCLUSION

Lactose-free dairy products are gaining popularity, offering great options for those with lactose intolerance to enjoy tasty and nutritious milk-based products. As people learn more about the health advantages and variety of lactose-free choices available, including lower sugar and better texture, the market is set for significant growth. These products not only cater to lactose intolerance but also appeal to a wider audience dissatisfied with traditional dairy. This broader appeal could boost the entire dairy market, leading to more new products in this growing segment. Companies are innovating to meet evolving consumer preferences for dairy alternatives, driving growth in this market.

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