Evaluation of Lactose in Milk and Dairy Products

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Abstract

Milk is an emulsion containing fat, protein, carbohydrate, vitamins, minerals and water. Lactose is the main carbohydrate presented in milk and dairy products. This sugar is composed by one unit of glucose and one of galactose. Metabolism of lactose depends on enzyme lactase which hydrolyzes this sugar. In some cases, lactase may be absent or an insufficient quantity in human body. Deficiency in lactase production causes numerous symptoms such as diarrhea; abdominal pain and bloating that characterize lactose intolerance. The aim of this work was to evaluate concentration of lactose in milk and dairy products to determine the effect of the processing and to calculate the quantity of each product which can be consumed without symptoms in lactose intolerant. Results obtained show lactose concentration of 4.42% w/v in Milk; 3.5% w/w in Minas cheese; 9.9%w/v in condensed milk and 4.76%w/v in yogurt. Portion innocous ranged from 60 to 170 mL depending on each product.

Keywords: Milk, dairy products, lactose

Introduction

Milk is an emulsion produced by mammary glands which has white color, mild taste and flavor. It contains water, protein, fat, carbohydrate, minerals and vitamins. Milk is produced by goats and cows, is the most consumed for human people [1,2]. Lactose is practically the unique sugar presented in milk and its concentration ranges from 4.0 to 5.0% v/v [3,4]. Lactose is hydrolyzed producing glucose and galactose by lactase action in the intestine. It is a reductor sugar and can be determined by tritimetric method using Felhing licor (solution of cupric ions in alkaline medium) [5].

Concentration of lactose can change a lot in dairy products. Yogurt production is done by fermentation of lactose that produces acid lactic and the concentration of lactose decreases compared to initial ingredients. During Minas cheese process, lactose is eliminated in serum depending on pressing improved, so the concentration in the final product is lower too. On the other hand, in condensed milk, the concentration of lactose increases due to water evaporation. [6, 7, 8].

Milk and dairy products are extensively consumed by humans, however many people have lactose intolerance. This is a syndrome caused by absence or partial reduction of lactase in intestine. Lactose intolerance can be classified as primary, when there is an intrinsic defect on lactase, or secondary when an

injury occurs in intestinal mucosa. The syndrome usually develops in people after age of 5 years old; however it can appear at any age [9].

Reduction or absence of lactase prevents lactose hydrolysis, which cannot be absorbed through intestinal wall. Thus, lactose accumulates in the intestine where it is fermented in lactic acid and gases. Diarrhea, abdominal pain and bloating are the most common symptoms [10]. The treatment of the disease consists in removal of dairy products from the diet. However, reduction or removal of milk and dairy products may affect the absorption of calcium, causing different health problems [11]. Depending on the degree of lactase deficiency, a small amount of lactose can be included on the diet without causing noticeable symptoms [12]. Normally, an amount of 6g of lactose is considered the limit which does not cause symptoms in people with lactose intolerance [13].

Material and methods

Milk, yogurt, condensed milk and Minas cheese were evaluated to determine concentration of lactose. Tritimetric method using Felhing licor (solution containing cupric ions in alkaline medium) was applied to measured lactose in these products. A solution of each product was made using 50 mL (or 50 g) dissolved in 2 mL of acetic acid (2.0% v/v) and distilled water. The mixture was heated for 5 minutes at 80^{o}C, after this, the samples were transferred to volumetric flasks of 200 mL and volume was completed with distilled water. After filtration the solutions obtained were used to react with 20 mL of standard Felhing licor [14].

Results and Discussion

Table 1 – Concentration of lactose in different dairy products

Products	Lactose (% w/v)	Standard deviation (S)	Coefficient of variation (%)	Number of analysis
Milk	4.42	0.06	1.4	10
Yogurt	4.76	0.09	1.9	8
Condensed milk	9.9	0.9	9.1	10
Fresh cheese	3.5*	0.1	2.9	8

* % w/w

Table 1 shows results obtained for concentration of lactose in each product. Lactose was evaluated by tritimetric method using Felhing licor which reacts with reductor sugar. This method is not specific to determine lactose, but in milk and dairy products lactose is practically the unique redactor sugar presents. In tritimetric method coefficient of variation above 1% is expected, however this performance depends on characteristics of samples, conditions of analysis, number of repetition, etc. So, 5% of coefficient of variation is acceptable for the major of analysis [15]. In this work, coefficient of variation was acceptable for all products, except condensed milk. For this dairy product, concentration of lactose was higher and the dilution used was not enough to obtain a great volume during the analysis. The average volume consumed of condensed milk solution was 2.7 mL and just the burette error (0.05 mL) means a variability of 1.9%. For the other products, volume spent was higher and reproducibility was better, above 5%.

Concentration of lactose in milk of (4.42 ± 0.06)% w/v which is very similar to that reported in the literature. In other work, concentration of lactose ranged from 4.28 to 4.61% w/v in different samples of cow milk [16],

however, for other dairy products, results are influenced by the type of process and addition of other ingredients.

In yogurt, lactose is converted in lactic acid during the growth of microorganisms, reducing concentration of this sugar. However, concentration of lactose in this product is not very different compared to fresh milk, because normally milk powder is additioned in formulation to standardize the quantity of solids required in yogurt. Fermentation of sheep and goat milks used 12% w/v of powder milk [17]; in other formulation was added 3% w/v of powder milk in yogurt from cow milk [18]; in other work it was evaluated powder milk in yogurt ranging from 6 to 12% [19]. Therefore, concentration of lactose in yogurt normally ranges from 3.0 to 5.5% [20]. Thus, the result obtained in this work was similar to data reported in the literature and it is according to label that indicates addition of milk powder in formulation.

During condensed milk process occurs evaporation that eliminates water and increases concentration of different compounds including lactose. Lactose concentration in condensed milk depends on the amount of evaporated water and the amount of sucrose added in formulation. So, the result obtained was similar compared to other works [21, 22]. In relation to Minas cheese, it is common a decreasing in lactose concentration, since lactose is removed in serum. However, values of lactose range a lot depending on processing time, type of milk, maturation and other aspects. Concentration of lactose in Minas cheese newly processed ranging from 2.19 to 3.03% w/w [23], but in other work with the same type of cheese produced in Brazil, just 0.55% w/w of lactose was detected in the artisanal cheese [24]. Considering these aspects, results obtained here were according to expectation.

All products evaluated showed concentration of lactose according to processing, raw materials and formulation. From the results obtained it was possible to determine the amount of each dairy product which can be consumed by people with lactose intolerance. The effects of lactose vary from person to person according to lactase levels produced, but the amount of lactose above 6g is indicated to prevent symptoms [13]. The maximum amount that can be consumed of each dairy product evaluated is showed in Table 2.

Table 2 – Estimative of portion of milk and dairy products for lactose intolerance

Product	Lactose (%w/v)	Maximum portion (mL)
Milk	(4,42±0,06)	135
Yogurt	(4,76 ± 0,09)	126
Condensed milk	(9,9 ± 0,9)	60
Minas cheese*	(3,5 ± 0,1)	171

* portion in g

According to table 2, smaller portions of dairy products can be consumed even for lactose intolerant people without clinical symptoms. Minas cheese is the best option due to lower concentration of lactose. However, yogurt can be consumed without significant effects, because microorganisms presented in this product helps to reduce the effects of low lactose absorption, allowing consuming larger portions of this dairy product [13].

Conclusion

Concentrations of lactose obtained in this work were similar to the data reported in the literature and also on the type of processing and ingredients used. The knowledge about concentration of lactose in dairy products is important to determine the amount of these products that can be consumed by lactose intolerant people without health risks. It is important analyzing concentration of lactose because it varies greatly in

different dairy products and in different formulations of the same dairy product. In addition, it is not common to find clear information about lactose content on labels of dairy products and in the literature.

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