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LACTOSE CONTENT IN POWDERED MILK AND/OR MILK COMPOUND LACTOSE-FREE

TEOR DE LACTOSE EM LEITE EM PÓ E/OU COMPOSTO LÁCTEO TIPO ZERO LACTOSE

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ABSTRACT

Lactose is a disaccharide formed by glucose and galactose. Individuals with deficiency or absence of the enzyme responsible for the digestion of the lactose, "lactase", are diagnosed as "lactose intolerant". The marketplace provides, to this public, carb-free dairy products, regulated by the Ordinance number 135, from February 08, 2017, of the Brazilian Health Regulatory Agency, relative to special purpose products. Legally, lactose-free dairy products may contain the maximum of 0.1 g of the referred nutrient per 100 g or 100 ml of the final product while low lactose products may contain between 0.1 g and 1 g per 100 g or 100 ml of ready-to-eat food. Thus, lactose-free dairy products must meet the requirements for the permitted lactose content. The objective of this study was to evaluate the lactose content in powdered milk and/or lactose-free milk compounds. It was an experimental study performed at Faculdade Nossa Senhora de Fátima Science Laboratory, in the city of Caxias do Sul. The determination of lactose content occurred by means of methodology described by the Adolfo Lutz Institute and the data was analyzed descriptively. All the analyzed samples presented lactose content over 0.1 g per 100 g or 100 ml of the final product. All samples analyzed are in disagreement with current legislation for zero lactose type products, complying only the classification of low lactose type products.

Keywords: Lactase. Lactose. Special purpose food.

RESUMO

A lactose é um dissacarídeo formado por glicose e galactose. Indivíduos com deficiência ou ausência da enzima responsável pela digestão da lactose, a lactase, são diagnosticados como intolerantes à lactose. O mercado disponibiliza, para esse público, produtos lácteos isentos do carboidrato, regulamentados pela Resolução número 135, de 08 de fevereiro de 2017, da Agência Nacional de Vigilância Sanitária, referente a produtos para fins especiais. Legalmente, produtos isentos de lactose podem conter no máximo 0,1 g por 100 g ou 100 ml do alimento pronto para o consumo, enquanto que produtos com baixo teor de lactose podem conter entre 0,1 g e 1 g por 100 g ou 100 ml do alimento pronto para o consumo. Dessa forma, os produtos lácteos tipo zero lactose devem cumprir as exigências referentes ao teor de lactose permitido. O objetivo deste trabalho foi avaliar o teor de lactose em leite em pó e/ou composto lácteo tipo zero lactose. Tratou-se de um estudo experimental realizado no Laboratório de Ciências da Faculdade Fátima, na cidade de Caxias do Sul. A determinação do teor de lactose se deu através de metodologia descrita pelo Instituto Adolfo Lutz e os dados foram analisados de forma descritiva. Todas as amostras analisadas apresentaram teor de lactose superior a 0,1 g por 100 g ou 100 ml do produto final. Todas as amostras analisadas encontram-se em desacordo com a legislação vigente para produtos tipo zero lactose, atendendo somente à classificação de produtos tipo baixo teor de lactose.

Palavras-chave: Alimentos para fins especiais. Lactase. Lactose.

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INTRODUCTION

Special purpose foods, according to national legislation, are those specially formulated or processed, in which changes are introduced in the nutrient content, suitable for use in diets, to meet the needs of people in specific metabolic and physiological conditions (BRASIL, 1998). Repealing this regulation, Resolution of the Collegiate Board of Directors (RDC) No. 135, of February 8, 2017, included the category "food for lactose-restricted diets" subdivided into "lactose-free" and "low lactose content" (BRAZIL, 2017a).

Lactose is a disaccharide, in other words, a carbohydrate composed of two sugar molecules, one of glucose and one of galactose. Foods with restriction of this disaccharide must be specially formulated to meet the needs of people with lactose intolerance and/or inborn errors of carbohydrate metabolism (CICHOKE, 1999). Currently, lactose-free products may contain a maximum of 0.1 g per 100 g or 100 ml of ready-to-eat food, while products with a low lactose content may contain between 0.1 g and 1 g per 100 g or 100 ml of ready-to-eat food (BRAZIL, 2017a).

Lactose is present in milk as well as its by-products. Milk is the product of complete and uninterrupted milking, under hygienic conditions, of healthy, well-fed and rested cows. By mixing milk and either dairy or non-dairy foodstuffs and substances, permitted in specific regulations, the dairy compound is obtained. While powdered milk is the product of the dissection of previously prepared milk (BRASIL, 2002a; BRASIL, 2018).

For the lactose present in these products to be digested, it is necessary the presence of the lactase enzyme. In the absence of this enzyme, lactose passes intact to the colon, where it is fermented by colonies of bacteria, being transformed into gases and organic acids, resulting in abdominal bloating, cramps, nausea and diarrhea, characteristic symptoms of lactose intolerance (ESCOTT-STUMP, 2008).

The increase in the number of lactose-intolerant individuals has driven the food industry to develop several zero-lactose type products, which present greater added value. Foods for this specific purpose must, therefore, meet certain requirements regarding the amount of lactose permitted. Hence, the objective of this work was to evaluate the lactose content in powdered milk and/or zero lactose dairy compound.

MATERIAL AND METHODS

It was an experimental study in which the lactose content of five national brands of dairy compound and powdered milk was analyzed. The analyzis were carried out at the Science Laboratory of Faculdade Fátima, in Caxias do Sul. The protocol for analyzing lactose-reducing carbohydrates recommended by Instituto Adolfo Lutz (IAL) was used (IAL, 2008).

Powder samples were prepared in the laboratory, according to the manufacturer's instructions on the package, using distilled water for dilution. 10 ml of the liquid were transferred to a 100 ml volumetric flask and 50 ml of water was added, 2 ml of zinc sulfate 30%, and 2 ml of potassium ferrocyanide 15% were added, allowing it to settle for 5 minutes and the volume was completed with water. The resulting filtrate was transferred to a 25 ml burette and, added dropwise, to a 300 ml flat-bottomed flask containing 10 ml of each Fehling solution, added 40 ml of water, heated to boiling and under titration, until reaching a blue to colorless coloration. Analyzis were performed in duplicate. The letter “A” was used, followed by a sequential ordinal number (1 to 5), in order to guarantee the anonymity of the brands analyzed.

In order to investigate the conformity of products with current legislation, Ordinance 540/1997; Regulations 51/2002, 28/2007 and 53/2018; RDC's 360/2003, 259/2002, 135/2017 and 136/2017; and the decree of law number 986/1969 were used.

The results were presented descriptively, through the means and standard deviation obtained in the analyses. In addition to the lactose content, it was analyzed the presence of non-dairy ingredients and/or food additives.

RESULTS AND DISCUSSION

According to Normative Instruction 53/2018, powdered milk is a product obtained by dehydrating whole cow's milk, skimmed or partially skimmed and suitable for human consumption, through technologically adequate processes (BRASIL, 1996). In turn, dairy compound is the powdered product resulting from the mixture of milk and dairy and/or non-dairy food products or substances, with or without addition of dairy and/or non-dairy food products or substances permitted in the specific regulation suitable for food human (BRASIL, 2007).

In the present study, five brands of dairy compound and powdered milk were used. Nutritional information, weight and validity were analyzed on the sample labels, as shown in Table 1.

Table 1 - Characteristics and nutritional composition of five brands of dairy compound and "zero lactose" powdered milk

Sample	Weight (g)	Type	Expiration date	Portion	EV (kcal)	CHO (g)	PTN (g)	TF (g)
A1	400	Powder milk	07/20/17	26 g	128	10[1]	6,8	6,8
A2	300	Powder milk	02/02/17	26 g	129	9,6[2]	6,7	7,1
A3	800	Powder milk	11/11/16	26 g	127	10[3]	6,4	6,8
A4	380	Dairy compound	05/01/17	25 g	122	15[4]	4,7	4,9
A5	350	Dairy compound	05/01/17	25 g	89	15[5]	6,6	0

Notes: EV: energetic value; CHO: carbohydrates; PTN: proteins; TF: total fat. [1]glucose (5 g) + galactose (5 g); [2]glucose (4,8 g) + galactose (4,8 g); [3]glucose (4,6 g) + galactose (4,4 g); [4]glucose (4,4 g) + galactose (4,3 g); [5]glucose (5,6 g) + galactose (5,5 g).
Source: the authors.

Nutritional labeling, according to RDC 360/2003, must inform the consumer about the nutritional properties of a food in terms of energy value, nutrients and complementary nutritional information (BRASIL, 2003). One hundread percent of the brands analyzed were in accordance with the Technical Regulation on Nutritional Labeling of Packaged Foods.

All mandatory information such as the sale name of the product, list of ingredients, liquid content, identification of origin, batch identification, expiration date and instructions on the preparation and use of the food are present in all samples, in accordance with the Technical Regulation for Labeling of Packaged Foods (BRASIL, 2002b).

Two samples of dairy compost (A4, A5) indicated the presence of allergen (soybean derivative) and addition of non-dairy ingredients, which in sample A4 were vitamins (C, A and D) minerals (ferric pyrophosphate and zinc sulfate), soy lecithin emulsifier and potassium hydroxide acidity regulator. While in sample A5, there were calcium carbonate mineral, vitamins (A and D), soy lecithin emulsifier and carrageenan thickener. With regard to dairy compounds, the addition of non-dairy ingredients is permitted as long as the final product has at least 51% (mass/mass) of dairy ingredients (BRASIL, 2007).

Regarding to the presence of allergens in both samples (A4 and A5), the soy derivative indicated as an allergen on the label is the soy lecithin emulsifier, permitted by legislation for use as a technology support. Although the University of Nebraska Food Allergy Research and Resources Program (TAYLOR; BAUMERT, 2013) claim that soy lecithin does not contain enough residues of soy protein to provoke allergic reactions in most allergic consumers, the Brazilian Society of Pediatrics and the Brazilian Association of Allergy and Immunopathology (SOLÉ *et al*., 2008) ensure that soy lecithin is part of the protein composition of soy and, therefore, is an ingredient that represents a risk for food allergy.

All samples indicated the presence of lactase enzyme in the final product, which is described as an ingredient. RDC 259/2002 considers an ingredient every substance, including food additives, which is used in the manufacture or preparation of food, and which is present in the final product in

its original or modified form (BRASIL, 2002b). On the other hand, according to ordinance 540/1997, manufacturing technology adjuvant material is any substance that is not consumed as an ingredient per se and is intentionally used in the preparation of raw materials, foods or their ingredients, to obtain a technological purpose during the treatment or manufacturing, having to be eliminated from the food or inactivated, admitting in the final product the presence of substance traces or its derivatives (BRASIL, 1997). In this context, the authors of this work questioned the presentation of lactase as a food ingredient and not as a adjuvant technology in the analyzed samples.

The label of all analyzed samples contained in their ingredient list the lactase enzyme. The presence of enzymes as an optional adjuvant technology or elaboration is provided by Normative Instruction 28 (BRASIL, 2007), which concerns the technical regulation for establishing the identity and quality of dairy compound, but not explicitly by Normative Instruction 53 (BRAZIL, 2018) regarding the technical regulation for establishing the identity and quality of powdered milk. According to the latter, it is admitted the use of adjuvant technology authorized by specific legislation in the elaboration of powdered milk. In the specific case of zero lactose milk powder, the lactase enzyme is permitted, since the objective is to enzymatically hydrolyze lactose.

The enzymatic hydrolysis of lactose can be done by adding the enzyme lactase in raw milk after the sterilization process (UHT – 141 º C / 5 seconds) and subsequent aseptic packaging, in which the lactose hydrolysis will occur. Still, it can be made in raw milk that undergoes pasteurization (161.6 º F / 15 seconds), in which, after cooling, lactase is added. In this case, hydrolysis takes place inside storage tanks and, as soon as this process ends, sterilization and aseptic filling are carried out (LONGO, 2006). The enzyme, in the latter case, is inactivated during the thermal process.

Milk desiccation is normally carried out by the "spray-dryer" process, at temperatures between 302 - 482 ºF (AMIOT, 1991). The β-galactosidase enzyme does not show thermal deactivation at temperatures ranging from 68 to 95º. However, at 113 º C it reaches 55.8% of the initial activity, and at 122 º F and above, the enzyme presents marked thermal inactivation, and after 30 minutes at this temperature, the enzymatic activity is no longer observed (MATIOLI *et al*., 2001).

Concerning the analysis of the lactose content, of the five brands analyzed, 100% had lactose content above 0.1 g.100ml^{-1}, being, therefore, in disagreement with item 4.1.1.4.1 (Lactose-free) of the RDC 135/2017. Although they cannot be called zero lactose, the analyzed samples could be classified as products with low lactose content, since they can contain between 0.1 g and 1 g per 100 g or 100 ml of ready-to-eat food. In this way, keeping or complying with item 4.1.1.4.2. of RDC 135/2017, the average values found in the analysis of lactose content are shown in Table 2.

Table 2 - Lactose content of dairy compound and powdered milk labeled "zero lactose". Caxias do Sul, 2017

Sample	Type	Lactose content (mean ± SD, in g.100 ml^{-1})
A1	Powdered milk	0,322 ± 0,04
A2	Powdered milk	0,324 ± 0,02
A3	Powdered milk	0,340 ± 0,00
A4	Dairy compound	0,352 ± 0,01
A5	Dairy compound	0,437 ± 0,02

Source: the authors.

In Brazil, there is no obligation to present the lactose content in the list of nutrients, except for milk packages that qualify as special purpose foods. The lactose content of cow's milk varies from 4.6 to 5.0, depending on the method of analysis (SILVEIRA *et al*., 2004; ROBERT, 2008). Current Brazilian legislation permits the classification of the product as "lactose-free" ("zero lactose", "0% lactose", "no lactose", "do not contain lactose") and "low lactose content" (or 'low lactose') (BRASIL, 2017a), which can confuse consumers if they do not know the lactose limits established by law.

Few studies in the country have evaluated the lactose content in dairy products. The study by Rosa and Alves (2019) can be mentioned, in which the lactose content in yogurts and fermented milks

was evaluated, and values were found between 2.8 g and 4.0 g in 100 ml and 0.19 g to 0.26 g in 100 ml, respectively. In the study of Borges *et al*., (2010), the lactose content ranged between 2.10 and 4.18 g in liquid yoghurts, 2.16 to 6.40 g in flavored yoghurts and 3.97 to 5.82 g per 100 g in yogurt with pieces of fruit. Canci *et al*. (2018) found a reduction in the lactose content in milks fermented by kefir (2.77 and 3.55 g per 100 g) after 48 hours of fermentation. Studies that analyzed lactose content in products called “zero lactose” presented values above of what is permitted by legislation, corroborating what was found in the present study. Silva *et al*. (2014) found that the lactose content in fluid milk diverged from that indicated on the label "zero lactose", presenting more than 3% lactose.

In general, lactose values in fermented milk yogurts are below the content presented by milks, due to the fermentation process, in which lactose is consumed (ROBERT, 2008). The same happens in cheeses: fresh cheeses have higher lactose contents than matured cheeses, due to the process of using lactose by microorganisms. In a study of Silva *et al*. (2012), rennet, ricotta and Minas frescal cheeses presented an average of 0.25 g, 0.14 g and 0.02 g per 100 g, respectively. Thus, rennet cheese presented a lactose concentration 10.48 times higher than the ricotta cheese, and 1.83 times higher than the Minas frescal cheese (SILVA *et al*., 2012). Dickel *et al*. (2016) found lactose contents ranging from 0.19 g to 0.48 g per 100 g for mozzarella cheeses and from 0.18 g to 0.36 g per 100 g for colonial cheeses. These results show that some cheeses do not need special formulation for special purposes, since some matured cheeses have lactose levels that allow them to be classified as “zero lactose” or “low lactose content” (DICKEL; JUNKES, 2016). Hence, the fact of indicating the lactose content present in the product would reduce the consumer's error of thinking that only cheeses labeled "zero" or "low content" can be consumed by those who have different levels of lactose intolerance.

Resolution RDC 136/2017, regulated in Decree-Law No. 986, of October 21, 1969, sanctioned on February 8, 2017, was added to art. 19-A, establishing that food labels containing lactose must indicate the presence of the lactose substance, in accordance with the provisions of the regulation (BRASIL, 1969; BRASIL, 2017b). According to the RDC, the declaration of the presence of lactose is mandatory in foods, including beverages, ingredients, food additives and adjuvant technology, which contain lactose in an amount greater than 0.1 g per 100 g or ml of the food as displayed for sale. In this regard, 100% of the samples were in compliance.

CONCLUSION

All analyzed products (powdered milk and/or dairy compound) presented lactose content greater than 0.1 $g.100ml^{-1}$, in disagreement with the Technical Regulation for the Establishment of Identity and Quality of Food for Special Purposes (RDC no. 135, 2017), and cannot be considered lactose-free. Regarding to Legal Regulations and Ordinances evaluated, the samples were in compliance.

REFERENCES

AMIOT, J. **Ciência y tecnologia de la leche**. Zaragoza: Editorial Acribia S.A., 1991. 547 p.

BORGES, T. *et al.* Quanta lactose há no meu iogurte? **Acta Pediatrica**, v. 41, n. 2, p. 75-78, 2010.

BRASIL. **Ministério da Marinha de Guerra, do Exército e da Aeronáutica Militar. Decreto de lei nº 986, de 21 de outubro de 1969.** Institui normas básicas sobre alimentos. Diário Oficial da República Federativa do Brasil. Brasília, 21 de out. 1969.

BRASIL. Ministério da Saúde Agência Nacional de Vigilância Sanitária. **Instrução Normativa nº 540**, de 27 de outubro de 1997. Adota o regulamento técnico sobre aditivos alimentares. Diário Oficial da República Federativa do Brasil. Brasília, 28 out. 1997.

BRASIL. Secretaria de Vigilância Sanitária, do Ministério da Saúde. **Portaria n° 29**, de 13 de janeiro de 1998. Adota o Regulamento Técnico para Fixação de Identidade e Qualidade de Alimentos para Fins especiais. Diário Oficial da República Federativa do Brasil. Brasília, 30 mar. 1998.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Instrução Normativa n° 51**, de 18 de setembro de 2002. Adota o Regulamento Técnico de Identidade e Qualidade de Leites. Diário Oficial da República Federativa do Brasil. Brasília, 20 set. 2002a.

BRASIL. Ministério da Saúde Agência Nacional de Vigilância Sanitária. **Instrução Normativa nº 259**, de 20 de setembro de 2002. Adota o regulamento técnico sobre rotulagem de alimentos embalados. Diário Oficial da República Federativa do Brasil. Brasília, 23 set. 2002b.

BRASIL. Ministério da Saúde Agência Nacional de Vigilância Sanitária. **Instrução Normativa nº 360**, de 23 de dezembro de 2003. Adota o regulamento técnico sobre rotulagem nutricional de alimentos embalados. Diário Oficial da República Federativa do Brasil. Brasília, 26 dez. 2003.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Instrução Normativa n° 28**, de 12 de junho de 2007. Adota o Regulamento Técnico para Fixação de Identidade e Qualidade de Composto Lácteo. Diário Oficial da República Federativa do Brasil. Brasília, 14 jun. 2007.

BRASIL. Ministério da Saúde Agência Nacional de Vigilância Sanitária. **Instrução Normativa nº 135**, de 8 de fevereiro de 2017. Adota o regulamento técnico sobre alimentos par fins especiais. Diário Oficial da República Federativa do Brasil. Brasília, 9 fev. 2017a.

BRASIL. Ministério da Saúde Agência Nacional de Vigilância Sanitária**. Instrução Normativa nº 136**, de 8 de fevereiro de 2017. Estabelece os requisitos para declaração da presença de lactose nos rótulos dos alimentos. Diário Oficial da República Federativa do Brasil. Brasília, 9 fev. 2017b.

BRASIL. Ministério da Agricultura, Pecuária e Abastecimento. **Instrução Normativa n° 53**, de 01 de outubro de 2018. Adota o Regulamento Técnico para de Identidade e Qualidade do Leite em Pó. Diário Oficial da República Federativa do Brasil. Brasília, 16 out. 2018.

CANCI, B. T. *et al.* Caracterização físico-química e microbiológica de leite fermentado por kefir. **Revista Científica Virvi Ramos**, v. 6, n. 1, p. 56-63, 2018.

CICHOKE, A. J. The Complete Book of Enzyme Therapy. Penguin, 1999, 492p.

DICKEL, C. *et al.* Determinação do teor de sódio e lactose em queijos mussarela e colonial consumidos na região sudoeste do Paraná. **Revista Instituto Laticínios Cândido Tostes**, v. 71, n. 3, p. 144-152, 2016.

DICKEL, C.; JUNKES, J. K. **Avaliação do teor de lactose e sódio em queijos mussarela e colonial. Curso Superior de Tecnologia em Alimentos, da Universidade Tecnológica Federal do Paraná (UTFPR)**. 2017. 42f. Trabalho de Conclusão de Curso (Tecnologia em Alimentos) - Universidade Tecnológica Federal do Paraná, Francisco Beltrão, 2017.

ESCOTT-STUMP, S. Nutrition and Diagnosis-related Care. Philadelphia: Lippincott Williams & Wilkins, 2008, 948 p.

INSTITUTO ADOLFO LUTZ. **Métodos físico-químicos para análise de alimentos**. Edição IV, 2008.

MATIOLI, G.; MORAES, F. F.; ZANIN, G. M. Hydrolysis of lactose by β-galactosidase from *Kluyveromyces fragilis*: characterization of the enzyme. **Acta Scientiarum**, v. 23, n. 3, p. 655-659, 2001.

LONGO, G. **Influência da adição de lactase na produção de iogurte**. 2006. 89f. Dissertação (Mestrado em Tecnologia de Alimentos) - Universidade Federal do Paraná, Curitiba, 2006.

ROSA, F. S.; ALVES, M. K. Teor de lactose em iogurtes naturais e leites fermentados. **Uniciências**, v. 23, n. 2, p. 66-69, 2019.

ROBERT, N. F. **Dossiê técnico. Fabricação de iogurtes**. Rede de tecnologia do Rio de Janeiro. Serviço Brasileiro de Respostas Técnicas, 2008.

SILVA, M. V. V. *et al.* Determinação do teor de lactose em leite fluído pelo método *lane-eynon*. **Anais Eletrônico. 54º Congresso Brasileiro de Química**. 03 a 07 de novembro. Química e Sociedade: Motores da Sustentabilidade, Natal - Rio Grande do Norte, 2012.

SILVA, M. C. *et al.* Análise quantitativa de lactose e sódio em queijos. **Anais Eletrônico. VI Mostra Interna de Trabalhos de Iniciação Científica**. 23 a 26 de outubro, 2012.

SILVEIRA, T. M. L. *et al.* Comparação entre os métodos de referência e a análise eletrônica na determinação da composição do leite bovino. **Arquivos Brasileiros de Medicina Veterinária e Zootecnia**, v. 56, n. 6, p. 782-787, 2004.

SOLÉ, D.; *et al.* Consenso Brasileiro sobre Alergia Alimentar: 2007. **Revista Brasileira de Alergia e Imunopatolologia** v. 31, n. 2, p. 64-89, 2008.

TAYLOR, S. L.; BAUMERT, J. L. Allergenicity of Soybean Lecithin. Expert Opinion statement. **Food Allergy Research & Resource Program. Institute of Agriculture and Natural Resources**. University of Nebraska, 2013.