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Microbiological and physical chemical evaluation of traditional cream cheese brands with different market value

Avaliação microbiológica e físico-química de marcas de requeijão cremoso tradicional com diferente valor de mercado

Evaluación microbiológica y físico-química de marcas tradicionales de cuajada cremosa con diferente valor de mercado

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Abstract

The objective of this study was to evaluate the physical-chemical and microbiological characteristics of four brands of traditional cream cheeses with different market value. Three batches of the four commercial brands of cream chesses were acquired, totaling 12 samples. The differences in pH, titratable acidity, starch, fat in dry extract, moisture, ash, lipids, protein, and carbohydrates were measured by physico-chemical analyzes, while the of thermotolerant coliforms and *Staphylococcus aureus* spp. counts were performed by microbiological analyzes. Regarding the four evaluated brands, < 3 Most Probable Number of thermotolerant coliforms and an absence of colonies characteristic of *Staphylococcus aureus* were found. There was no significant difference between the brands studied at 5% of significance for the fat in dry extract, moisture, ash and lipids. All the analyzed cream cheese samples differed significantly ($p < 0.05$) for the starch content. The analyzed samples showed satisfactory hygienic-sanitary quality. The physical-chemical evaluation results presented standardization in the cream cheese preparation, regardless of the amount charged, however, there was a lack of information on the use of starch on all labels.

Keywords: Dairy products; Standardization; Quality; Characteristics.

Resumo

O objetivo do presente estudo foi avaliar as características físico-químicas e microbiológicas de quatro marcas de requeijão cremoso tradicional com diferente valor de mercado. Foram adquiridas três lotes das quatro marcas comerciais de requeijão, totalizando 12 amostras. Realizou-se as análises físico-químicas de: pH, acidez titulável, amido, gordura no extrato seco, umidade, cinzas, lipídeos, proteína e carboidrato por diferença; e microbiológicas com a contagem de coliformes termotolerantes e de *Staphylococcus aureus* spp. Para as quatro marcas verificou-se < 3 Número Mais Provável de coliformes termotolerantes e ausência de colônias características de *Staphylococcus aureus*. Na determinação de gordura no extrato seco, umidade, cinzas e lipídeos não houve diferença significativa entre as marcas estudadas a 5% de significância. Para o teor de amido, todas as amostras de requeijão analisadas diferiram significativamente entre si ($p < 0,05$). As amostras analisadas apresentaram qualidade higiênico-sanitária satisfatória. Os resultados da avaliação físico-química evidenciaram uma padronização na elaboração dos requeijões independentemente do valor cobrado, contudo, houve a falta de informação da utilização do amido em todos os rótulos.

Palavras-chave: Derivados lácteos; Padronização; Qualidade; Características.

Resumen

El objetivo del presente estudio fue evaluar las características físico-químicas y microbiológicas de cuatro marcas de cuajada cremosa tradicional con diferente valor de mercado. Se compraron tres lotes de las cuatro marcas comerciales de cuajada, totalizando 12 muestras. Los análisis físico-químicos de: pH, acidez titulable, almidón, grasa en el extracto seco, humedad, cenizas, lípidos, proteínas y carbohidratos se realizaron por diferencia; y microbiológico con el recuento de coliformes termotolerantes y *Staphylococcus aureus* spp. Para las cuatro marcas, se encontró < 3 Número Más Probable de coliformes termotolerantes y ausencia de colonias características de *Staphylococcus aureus*. En la determinación de grasa en el extracto seco, humedad, cenizas y lípidos, no hubo diferencia significativa entre las marcas estudiadas al 5% de significancia. Para el contenido de almidón, todas las muestras de cuajada analizadas difirieron significativamente ($p < 0.05$). Las muestras analizadas presentaron una calidad higiénico-sanitaria satisfactoria. Los resultados de la evaluación físico-química mostraron una estandarización en la elaboración del queso, independientemente del monto cobrado, sin embargo, faltaba información sobre el uso de almidón en todas las etiquetas.

Palabras clave: Productos lácteos; Estandarización; Calidad; Caracteristicas.

1. Introduction

One of the most appreciated dairy products in Brazil is cheese, a food of ancient origin which is present on the tables of most Brazilians. The Brazilian state with the highest cheese production is Minas Gerais, being historically known for cheese manufacturing, and today represents about 25% of the national production. However, despite the great presence of cheese in Brazilian homes, per capita consumption is still low compared to other countries (Lourenço et al., 2017). According to the Brazilian Association of Cheese Industries (in Portuguese *Associação Brasileira das Indústrias de Queijo* – [ABIQ], 2019) , per capita consumption currently only averages 5.5 kg of cheese per year, despite Brazil occupying the fifth position in the world as a cheese producer (ABIQ, 2019).

Various types of cheese are produced and consumed in Brazil. Among them, cream cheese has been gaining great acceptance by consumers, belonging to the class of processed cheeses, and is widely consumed by people of different classes and wide age group. Cream cheese originated from butter as a homemade dairy derivative. It was a by-product made with skimmed milk which would be discarded in the process of making the cream to make the

butter (Trintim et al., 2017). The production of culinary cream cheese in Brazil in 2013 was 182 thousand tons, corresponding to 20.4%, and 77,868 thousand tons of cream cheese equivalent to 8.7% (Zacarchencho, Van Dender & Rego, 2017).

The Technical Regulation for Fixing Identity and Quality of Cottage Cheese No. 359, of September 4, 1997, defines it as: a product obtained by melting the cream cheese dough, cooked or not, drained and washed, obtained by acidic and/or enzymatic coagulation of milk optionally added with sour cream and/or butter and/or anhydrous milk fat or butter oil. The cream cheese can be classified according to the raw material and ingredients used, called Curd, Creamy Curd or Butter Curd. Traditional cream cheese (*Requeijão*) contains reconstituted milk or milk, cream and/or butter and/or anhydrous milk fat or butter oil in its composition (Brasil, 1997).

Resolution RDC no. 12 of January 2, 2001, which establishes the microbiological standards for food, regulates that an analysis of thermotolerant coliforms must be carried out for cream cheese with an allowed limit of up to 10 MPN/g, and positive coagulase *Staphylococcus* counts of up to 10^3 CFU/g (Brasil, 2001).

Through the parameters established by the current legislation and the increase in the production and consumption of cream cheese, the objective of the present study was to evaluate the physical-chemical and microbiological characteristics of four brands of traditional cream cheese with different market values marketed in the city of Limoeiro do Norte-CE.

2. Materials and Methods

The laboratory and quantitative study were carried out at the Bromatology and Microbiology Laboratories of the Federal Institute of Education, Science and Technology of the State of Ceará, *Campus* Limoeiro do Norte, during the months of August to October 2019. Following the methodology of Pereira, Shitsuka, Parreira and Shitsuka (2018) the study data were statistically arranged, allowing a better understanding of the results obtained.

We acquired four traditional brands of curd cheese sold in retail supermarkets in the city, two well-known and more expensive brands (A and B) with twice the commercial value in relation to two little-known brands in the region (C and D).

Three lots were selected for each brand, totaling 12 samples, filled in plastic containers with lids, and then stored in a refrigerated environment. A thermal box with ice

was used in transporting the material to maintain the temperature until the laboratory for analysis.

2.1 Microbiological Analysis

Microbiological analyzes were performed according to the methodologies described by the American Public Health Association (APHA, 2001) and by Silva et al. (2017a). The results were compared with those recommended by RDC No. 12 of the National Health Surveillance Agency – (in Portuguese *Agência Nacional de Vigilância Sanitária – ANVISA*) (Brasil, 2001), which establishes the thermotolerant coliforms and positive coagulase *Staphylococcus* counts for this type of product.

The multiple tube technique was performed using three series of three tubes to determine the Most Probable Number (MPN) of thermotolerant coliforms. First, 1 mL of each sample was inoculated into tubes from serial dilutions containing 10 mL of lactated broth (Acumedia, USA), followed by incubation at 35-37 °C for 48 h.

Counting for determining the amounts of *Staphylococcus* spp. was performed on plates containing Baird-Parker agar (Acumedia, USA) enriched with egg yolk and added with potassium tellurite. Next, 0.1 mL of each dilution was transferred to sterile plates, spreading the inoculum using the Spread-Plate technique. The plates were incubated inverted at 35-37 °C for 48 h.

2.2 Physicochemical Analysis

The analysis of the parameters corresponding to the composition of macronutrients and physicochemicals recommended by the Ministry of Agriculture, Livestock and Supply – (in Portuguese *Ministério da Agricultura, Pecuária e Abastecimento – MAPA*) (Brasil, 1997) were carried out according to the official methodology of the Adolfo Lutz Institute – (in Portuguese *Instituto Adolfo Lutz* – [IAL], 2008) and the Association of Official Analytical Chemists (AOAC, 2005). The determination of pH, titratable acidity, starch content, moisture (M), total ash (TA), total protein (TP), total lipids (TL), fat in dry extract (FDE), and carbohydrates (TC) were performed by comparing the differences.

The pH was determined using a digital pH meter (Kasvi, Brazil), previously calibrated in buffer solutions pH 7, pH 4 and pH 10 (method 017 / IV; IAL, 2008).

Total titratable acidity was determined by titration with 0.1 N NaOH using a 1% phenolphthalein solution as an indicator and expressed in mL of 0.1 N NaOH per 100 grams of sample. The data obtained were expressed in g 100 g^{-1} of lactic acid using 0.09 as a correction factor for lactic acid (method 942.15; AOAC, 2005).

Starch was determined by the Lane and Eynon method (1934) from 5 g of the sample in a beaker (500 mL) plus 250 mL of distilled water and 10 mL of hydrochloric acid PA, and then placed on a heating plate with a reflux system for two hours. After the reflux time, the sample was cooled and neutralized with the addition of 40% NaOH solution with the aid of the digital pH meter (Kasvi, Brazil). Then the contents were transferred to a volumetric flask (250 mL) and completed with distilled water. A conical flask (250 mL) containing 10 mL of Fehling A solution, 10 mL of Fehling B solution and 40 mL of distilled water was heated to boil, then and 2 drops of methylene blue were added and immediately titrated with the previously prepared sample solution until the color turned to brick red.

Next, approximately 3 g of the sample was dried in an oven (Heraeus Instruments, USA) at 105 °C until constant weight was obtained (method 934.06; AOAC, 2005).

The fixed mineral residue was determined by eliminating organic matter, with approximately 2 g of the sample weighed in porcelain crucibles previously tared and coded, incinerated and put into a muffle furnace (Heraeus Instruments, USA) at 550 ºC/6 hours. After this period, the crucibles were weighed at hourly intervals, repeating this procedure until constant weight (method 940.26; AOAC, 2005).

The samples were analyzed for protein content according to the micro Kjeldahl method, which consists of determining total nitrogen. After digestion, the sample was distilled in a Nitrogen distiller (Marqlabor, Brazil) and the distillate received a 4% boric acid solution with indicator, which was then titrated with a standardized 0.1 N hydrochloric acid solution. The conversion factor used for the conversion of total nitrogen to protein was 6.38 (adapted from the 920.152 method; AOAC, 2005).

The fat content was determined using the methodology of Bligh and Dyer (1959) for wet and liquid samples. The quantification of fat in the dry extract was calculated using Equation 1.

$$\text{Equation 1: } FDE = \frac{Fat\ content}{FDE}\ x\ 100$$

FDE: Fat in Dry Extract

The determination of total carbohydrate was calculated by the difference using Equation 2.

$$\text{Equation 2: } TC = 100 - (M + TA + TP + TL)$$

TC: Total Carbohydrates

M:Moisture

TA: Total Ash

TP: Total Protein

TL: Total Lipids

2.3 Statistical Analysis

The results obtained were subjected to statistical analysis of variance (ANOVA) and the Tukey test was performed for the comparison of means at a significance level of 5% ($p > 0.05$) using the Statistica 10 program (Statsoft, 2011).

3. Results and Discussion

The thermotolerant coliform count showed lower values than allowed by RDC No. 12 of 2001 (Brasil, 2001) for this type of product in the four analyzed brands (Table 1). The analysis was interrupted in the presumptive test, as there was no growth in the Lactated Broth tubes.

Table 1. Results of microbiological analysis of four traditional cream cheese brands with different market values.

Brands	**Thermotolerant coliforms (MPN/g)**	***Staphylococcus aureus* (CFU/g)**
A	< 3	Absence
B	< 3	Absence
C	< 3	Absence

D	< 3	Absence
Legislation*	10^1	10^3

*Brasil (2001). Source: Authors (2020).

With these results it was found that the hygienic-sanitary conditions in the production of these cream cheeses do not pose a risk to the health of consumers. A similar result was obtained for the *Staphylococcus aureus* count with no characteristic colonies to proceed in the following steps, and therefore it is shown to be a safe product for consumption and within the requirements of the current Brazilian legislation (Brasil, 2001).

These results are similar to the study carried out by Silva, Costa, Leite, Cunha and Santos (2017b) between well-known and not well-known brands in the market in comparing traditional and light cream cheeses. In a study on the chemical, physical and microbiological properties of Norther or butter cheese and commercially independent of brands and prices, Alexandre, Camatari, Santana and Silva (2020) obtained similar results to those of the present study for the counting of both thermotolerant coliforms and *Staphylococcus aureus*.

The values in determining pH were between 6.42 and 6.78 (Table 2), only showing a significant difference ($p < 0.05$) for the D sample.

Table 2. Physico-chemical characterization of four brands of traditional cream cheese with different market values.

Brands	**Physicochemical Analysis**			
	pH	**Lactic acid (g/100g)**	**Starch (g/100g)**	**Fat dry extract (g/100g)**
A	6.42±0.08b	0.84±0.04ab	3.01±0.31b	39.58±5.54a
B	6.51±0.08b	0.89±0.13a	Tr.	44.87±3.28a
C	6.42±0.08b	0.72±0.08ab	2.33±0.02c	46.19±1.36a
D	6.78±0.02a	0.68±0.04b	4.23±0.22a	38.08±2.82a

Tr.: Traces - Not possible to quantify. Averages followed by the same letter in a column do not differ significantly ($p \geq 0.05$). Source: Authors (2020).

Brazilian legislation does not standardize values for this parameter, however the results were lower than those found by Silva et al. (2017b) who evaluated 6 commercial brands of traditional cream cheese with values between 6.86 to 7.22 in the city of Urutaí/GO. This difference may be due to the type of processing employed by the industry.

In studying the physical-chemical and microbiological aspects of commercial rennet cheese, Sousa et al. (2014) found an average pH of 6.21 for samples from the state of Ceará. The pH parameter is related to the microbiological behavior, as cheeses with a high pH have more favorable conditions for developing deteriorating bacteria. Although the study in question showed pH values above 6.42, none of the samples analyzed showed microbiological contamination; as a result, the hygienic quality and inspection during processing are quite satisfactory and have a direct influence on these parameters.

The slight acidic flavor is characteristic of cream cheese due to the presence of lactic acid which is produced through the fermentation of lactose by lactic acid bacteria. However, lactic acid is normally used to make the adjustment in obtaining the mass (coagulation) belonging to the processing (Zacarchencho et al., 2017).

Regarding acidity, there was a significant difference ($p < 0.05$) for the B and D brands (Table 2), however, there is no minimum standardized value for this parameter. Viana (2009) found 0.12% to 0.61% when evaluating cream cheese sold in the Belo Horizonte market, while Zacarchenco et al. (2017) found 0.39% to 0.42% when evaluating the final mass for cream cheese processing.

All the analyzed cheese samples differed significantly from each other ($p < 0.05$) for the starch content (Table 2), with brand B being the second most expensive and most common in the region, the only one which did not present starch in its composition. Degaspari, Viotto and Karaziack (2019) evaluated ten brands of culinary cheese with added starch and found values between 2.5% to 8.2% of starch in their samples, constituting similar levels to that in this study.

There is no restriction on the incorporation of starch, as long as it is clearly stated on the label informing the consumer of the type of product he is purchasing (Brasil, 1997). When performing the analysis of the labels of the samples of this study, it was found that the products did not contain the presence of starch in their composition, in disagreement with article 31 of the Consumer Protection Code (2017), which guarantees the right to information clear and precise about the products.

The fat in the dry extract showed levels from 38.08 to 46.19 g 100 g^{-1} (Table 2), with no significant difference between the brands ($p \geq 0.05$), and with all samples not in

accordance with the norms established by legislation on the parameters of identity and quality of the cheese, which establishes a minimum of 55 g 100 g^{-1} (Brasil, 1997). Degaspari et al. (2019) obtained levels within those determined by legislation in almost all analyzed samples, presenting from 38.1 to 72.1 g 100 g^{-1} of sample. In performing an analysis of four brands of traditional and light cream cheese, Paiva, Revillion, Dias, Utpott and Hertz (2018) found results ranging from 54.64 to 74.48 g 100 g^{-1}, with only one at odds with current legislation.

These variations regarding the quantification of fat in the dry extract are often seen when it comes to dairy products since standardization will depend on the quality of the raw material (milk), as it is directly related to the breeding, age and days of lactation of the cow, as well as the milking form, and can be manually or mechanically (Espindola et al., 2020).

The average values obtained in the proximate composition are shown in Table 3. The moisture content in the four samples ranged from 60.49% to 62.27%, with no significant difference between the studied brands ($p \geq 0.05$), being in accordance with the norms established by RDC No. 359 of a maximum of 65% humidity for cream cheese (Brasil, 1997).

Table 3. Proximate composition of four brands of traditional cream cheese with different market values.

Brands	Centesimal Composition (g/100g)				
	Moisture	**Total Ash**	**Total Protein**	**Total Lipids**	**Total Carbohydrates**
A	60.74±2.20a	2.50±0.07a	8.96±0.11ab	15.54±2.33a	12.26
B	62.27±3.99a	2.83±0.28a	8.80±0.97bc	17.10±2.22a	9.00
C	60.49±0.17a	2.79±0.13a	7.31±0.58c	18.26±0.52a	11.57
D	62.24±1.21a	2.60±0.04a	10.46±0.40a	14.36±0.67a	10.33

Averages followed by the same letter in a column do not differ significantly ($p \geq 0.05$). **Source**: Authors (2020).

In analyzing the physical-chemical profile of artisanal Minas cheese samples, Prata, Silva, Vianna and Naves (2020) obtained averages around 54 to 56 g 100 g^{-1} in moisture content, being slightly lower than the results of the present study. Degaspari et al. (2019) found between 62.4% and 78.5% moisture content, with half of the evaluated samples exceeding the permitted limits for moisture.

Determining the moisture content of dairy products is of fundamental importance for assessing hygienic-sanitary safety and maintaining quality throughout the production chain, as these variations are influenced by the type of derivative produced, processing conditions and characteristics of the raw material.

The total ash content varied from 2.50 to 2.83 g 100 g^{-1} (Table 3), with no significant difference between the analyzed brands ($p \geq 0.05$). Paiva et al. (2018) performed an analysis of total ash and carbohydrates by comparing the difference, obtaining contents between 1.5 and 4.3 g 100 g^{-1}, respectively. Prata et al. (2020) obtained averages of 3 g 100 g^{-1} in artisanal Minas cheese, which is close to the levels in the present study.

In determining total protein, a significant difference was found between the A and C and between the C and D brands ($p < 0.05$). The maximum content found was 10.46 g/100g, which is lower than in the study by Paiva et al. (2018) who found 13.3 g/100g. This difference in protein content between the brands may be related to the difference in the milk used in processing, which can be influenced by the feeding and age of the milking cows, thus causing changes in the milk composition.

The results in the quantification of total lipids ranged from 14.36 to 18.26 g 100 g^{-1} (Table 3), but there was no significant difference between the evaluated brands ($p \geq 0.05$). These levels, as well as protein, depend on the raw material used in the cream cheese-making process. Degaspari et al. (2019) obtained different results from the present study, from 0.82 to 26.9 g 100 g^{-1}. The regulation of identity and quality of cream cheese does not standardize lipid values.

Carbohydrates were quantified by difference, ranging from 9.00 to 12.26 g 100 g^{-1} (Table 3). These results may vary depending on the values obtained for moisture, ash, lipids and proteins, as well as the sample being analyzed.

4. Conclusion

The samples analyzed in this study presented satisfactory hygienic-sanitary quality with respect to the established microbiological parameters. The results of the physical-chemical evaluation showed standardization in the elaboration of the analyzed products, regardless of the amount charged. However, the lack of information on the use of starch on labels violates consumer rights and implies possible fraud in the cream cheese making process.

It is suggested to carry out a larger sample in future studies, obtaining other cream cheese brands, not only those sold in the city. In addition to evaluate a way to communicate

the obtained information to consumers, indicating the care they need to take when purchasing dairy products, especially when reading labels.

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