

ORIGINAL ARTICLE

# Making a fresh cheese using the colostrum surplus of dairy farms: an alternative aiming to minimize the waste of this raw material

*Fabricação de queijo fresco a partir do excedente de colostro das fazendas leiteiras: uma alternativa com o objetivo de minimizar o desperdício dessa matéria-prima*

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## Abstract

This study aimed to make and characterize a fresh cheese using the surplus of bovine colostrum from dairy farms. The bovine colostrum was characterized in terms of fat (4.00%), protein (16.30%), moisture (79.68%), ash (0.95%), minerals, pH (6.32), titratable acidity (0.27 g/100 mL), immunoglobulin G (>50 g/L), lactose (1.60%), color, and the presence of pathogenic bacteria. The fresh cheese made with colostrum was characterized in the same terms as the bovine colostrum (fat (7.00%), protein (22.95%), moisture (67.98%), ash (1.85%), minerals, pH (6.15), titratable acidity (0.04 g/100 mL), immunoglobulin G (30.95 g/L), lactose (not detectable), color, and the presence of pathogenic bacteria), with the addition of the texture and sensory analysis. The colostrum cheese had high moisture content (67.98%) and low-fat content (7.00%). The protein content was also high (22.95%), whose major percentage was composed by immunoglobulins. An important finding in this work was associated with the possible absence of lactose in the colostrum cheese, thus opening opportunities for future research regarding the development of dairy products for lactose intolerant consumers. In addition, the high concentration of immunoglobulin G might give this product an immune boost feature. The sensorial analysis showed that the recipe of the fresh cheese requires improvement to achieve higher acceptance from the public, especially regarding texture.

**Keywords:** Lactose intolerance; Colostrum cheese; Bovine colostrum; Immunoglobulin; Immune boost; Food engineering.

## Resumo

Este trabalho teve como objetivo a elaboração e caracterização de um queijo fresco a partir do excedente de colostro bovino de fazendas leiteiras. O colostro foi caracterizado quanto aos teores de gordura (4,00%), proteínas



(16,30%), umidade (79,68%), cinzas (0,95%), minerais, pH (6,32), acidez titulável (0,27 g/100 mL), imunoglobulina G (>50 g/L), lactose (1,60%), cor e presença de bactérias patogênicas. O queijo fresco elaborado com colostro foi submetido às mesmas caracterizações do colostro: gordura (7,00%), proteínas (22,95%), umidade (67,98%), cinzas (1,85%), minerais, pH (6,15), acidez titulável (0,04 g/100 mL), imunoglobulina G (30,95 g/L), lactose (não detectável), cor e presença de bactérias patogênicas, além da avaliação dos parâmetros de textura e da análise sensorial. O queijo fresco elaborado com colostro apresentou alto teor de umidade (67,98%) e baixo teor de gordura (7,00%). A porcentagem de proteína foi elevada (22,95%), sendo grande parte composta por imunoglobulinas. O teor de lactose do queijo fresco elaborado com colostro foi muito baixo para ser quantificado, indicando a possibilidade de desenvolvimento de novos produtos lácteos a partir de colostro para consumidores intolerantes à lactose. Além disso, o queijo apresentou elevada concentração de imunoglobulina G, que pode conferir a esse produto a propriedade de reforço imunológico. A análise sensorial mostrou que o processo de elaboração do queijo fresco com colostro deve ser aprimorado para aumentar a aceitação dos consumidores, principalmente no que se refere à textura.

**Palavras-chave:** Intolerância à lactose; Queijo de colostro; Colostro bovino; Imunoglobulina; Reforço imunológico; Engenharia de Alimentos.

## Highlights

- The making of a colostrum-based cheese using only colostrum showed promising results
- The fresh colostrum-based cheese presented a good acceptance from the public
- The fresh colostrum-based cheese developed has potential for insertion in the market

## 1 Introduction

Colostrum is the fluid secreted by females of all mammals immediately after parturition, not only being the most complete aliment for the new-born (McGrath et al., 2016), but also transmitting passive immunity (Saalfeld et al., 2012). Bovine Colostrum (BC) is a mixture of lacteal secretions and constituents of blood serum, mainly immunoglobulins (Ig), which accumulate in the mammary gland during the dry period (Godden et al., 2019). In comparison to milk, colostrum generally contains less lactose and has a higher content of other components such as fat, protein, ash, vitamins, hormones, and immunoglobulins. After three days, the lactose content increases, whereas the percentage of the other components declines gradually (McGrath et al., 2016; Uruakpa et al., 2002).

The immunoglobulins presented in BC are Immunoglobulin G (IgG), Immunoglobulin M (IgM) and Immunoglobulin A (IgA), with IgG making up to 80% of the total. As stated by Aydogdu & Guzelbektes (2018), Ig absorption through the placenta did not occur in cattle, therefore colostrum ingestion by the new-born is necessary for exposure to the antibodies that are essential for healthy growth. There is a period of 24 hours where the calf can absorb the necessary amount of IgG, after that, the absorption is less efficient and the risk of contracting diseases and infections is higher (Morin et al., 2001). That explains why the first colostrum has the better composition. The level of IgG hallmarks the quality of the colostrum, as this material is considered of high-quality when its IgG levels are greater than 50 g/L (Godden et al., 2019). In addition, as presented by Godden et al. (2019), there are several factors that can affect its quality, such as cow's breed, age of dam, nutrition during periparturient period, season of calving, dry period length, among others.

A healthy cow produces more colostrum than the calf really needs (~43.5 kg of colostrum over the 3 days) (Foley & Otterby, 1978). The amount of colostrum given to the new-born at the first feeding is equivalent to only 10-12% of its body weight (3 - 4 L for a Holstein calf, for example). After its 3<sup>rd</sup> day of life, the calf consumed ~11 kg of colostrum, which is from 14 to 35% of the total volume produced by the cow. This

means that there is a ~32.5 kg of colostrum surpluses (Foley & Otterby, 1978). This surplus of colostrum had no use in Brazil for 65 years, due to prohibition by law (Brasil, 1952). This material is often improperly discarded, which causes many environmental problems. One example is eutrophication, i.e., the increase in available nutrients in water bodies causes the number of bacteria and algae to grow exponentially. This growth consumes oxygen in the water, suffocating the rivers, and leading to a gradual disappearance of fish and other elements from water biodiversity (Shete & Shinkar, 2013). Only in 2017, the use of raw colostrum was regulated (Brasil, 2017). The National Sanitary Surveillance Agency also decreed that colostrum can be used as a substitute for milk in any recipe, as long as the pasteurization technique is followed correctly (Empresa de Assistência Técnica e Extensão Rural do Rio Grande do Sul, 2017).

In general, BC is seen as a good source of IgG for the development of both pharmaceutical and food derivatives for human's consumption (Ceniti et al., 2019; Gaspar-Pintilieșcu et al., 2020), as it favors human health by improvements in the immune system (Silva et al., 2019). Most of the BC-based products available in the market are supplement powders or pills, containing somewhere between 20-25% of IgG (for further information, see Deep Blue Health, 2021 and Colostrum MIP, 2021). Recent studies have shown that the Immune Defence Proteins (IDP) from BC may be related to protective effects against respiratory diseases such as the ones caused by SARS-CoV-2 infection (Covid-19) (Galdino et al., 2021).

Even though the colostrum is reported to contain several benefits, due to the previous prohibition of this material in Brazil, people are prejudiced against using this material in human food. Nonetheless, the development of new products based on colostrum could be advantageous for the environment, the economy, and the consumers.

Cheeses are a valuable source of high-quality proteins, lipids, vitamins, and minerals; and its global consumption is expected to increase by ~13.8% between 2019 and 2029 (Feeney et al., 2021). Considering the large consumption of cheese worldwide, the development of new formulations of this product with innovative raw materials will enable industries to reach different consumer profiles. Once understood the protection effects of IgG, the potential, and the importance of using BC to develop new products, the aim of this study was related to the development of a fresh cheese using BC and to the evaluation of the physical-chemical, microbiological, technological, and sensory properties of these cheeses.

## 2 Material and methods

### 2.1 Material

The samples of BC used for all the experiments were provided by a farm located in Rio Grande do Sul state, in Brazil. All the samples used were associated with the surplus of colostrum after one day of parturition of multiparous Holstein cows. The rennet used for cheesemaking was the Ha-la® 1:3000/75 International Milk Clotting Unit (IMCU) chymosin-based, produced in São Paulo state, in Brazil. The calcium chloride used was produced by Launer Chemical Ind. and Trade (Rio Grande do Sul state, in Brazil). For the evaluation of lactose percentage, an *Aspergillus oryzae* beta-galactosidase (Lactomax F30®) produced by Prozyn (São Paulo state, Brazil) was used. All other reagents used were of analytical grade.

### 2.2 Methods

#### 2.2.1 Colostrum sampling and storage conditions

The samples of colostrum were transported under refrigeration (4 °C). For the characterization of the colostrum and making of the cheeses, the samples were pooled and stocked into the refrigerator (4 °C). An aliquot of 100 mL of the Refrigerated Colostrum (RC) was fractioned for the physical-chemical,

microbiological, technological analysis. Another aliquot of 6 L of the RC was used for the manufacturing of the Fresh Colostrum-Based Cheese (FCH).

### 2.2.2 Physical-chemical analysis of refrigerated colostrum

The composition of RC samples was evaluated in triplicate according to the subsequent AOAC International (Association of Official Analytical Chemists, 1990) methods as following: percentage of fat (Gerber method); percentage of protein (Kjeldahl method); moisture (oven drying method at 105 °C); ash (incineration in a muffle furnace at 550 °C); minerals (Flame Atomic Absorption Spectrometry – FAAS); and titratable acidity (Dornic degree (°D)). In addition, pH was measured by digital potentiometer, IgG concentration was verified by a Brix refractometer according to Quigley et al. (2013). For the measurement of lactose content, samples were hydrolyzed using beta-galactosidase. For the hydrolysis, two tubes with 1 mL of colostrum and 6 mL of deionized water were prepared. Into one of these tubes, 500 µL of *A. oryzae* beta-galactosidase (30.5 U/mL) was incorporated. Both tubes were homogenized in a Dubnoff Metabolic Water Bath (Marconi®, MA 093, Brazil) set at 55 °C for 10 minutes (130 rpm). A glucose monoreagent kit (Bioclin®, 0070, Brazil) was used to determine the glucose concentration and the lactose content was determined by stoichiometry (Equation 1).

$$\text{Lactose}(\%) = \frac{\text{Sample Absorbance} \times \text{df}}{\text{Standard Absorbance}} \times 1.33 \quad (1)$$

Where df is the dilution factor of the sample and 1.33 is the conversion factor by stoichiometry from glucose mg/dL to lactose g/L.

### 2.2.3 Microbiological analysis of refrigerated colostrum

Microbiological assays of RC were done according to the Normative Instruction of the Secretariat of Animal and Plant Health and Inspection N° 62, from August 26<sup>th</sup>, 2003 (Brasil, 2003), which contains: count of total and thermotolerant coliforms (Most Probable Number (MPN)); count of *Staphylococcus aureus* (direct plate count method in Baird-Parker (BP) agar, followed by positive coagulase test); count of *Salmonella* sp. (direct plate count method in Salmonella Shigella (SS) agar); and count of *Listeria* spp. (direct plate count method in Palcam listeria agar). For all assays, 25 mL of colostrum were homogenized with 225 mL of sterile peptone water (0.1% (w/v)), followed by serial dilution. Aliquots (100 µL) of these dilutions were then added to the respective agar plates by spread-plate method.

### 2.2.4 Technological analysis of refrigerated colostrum

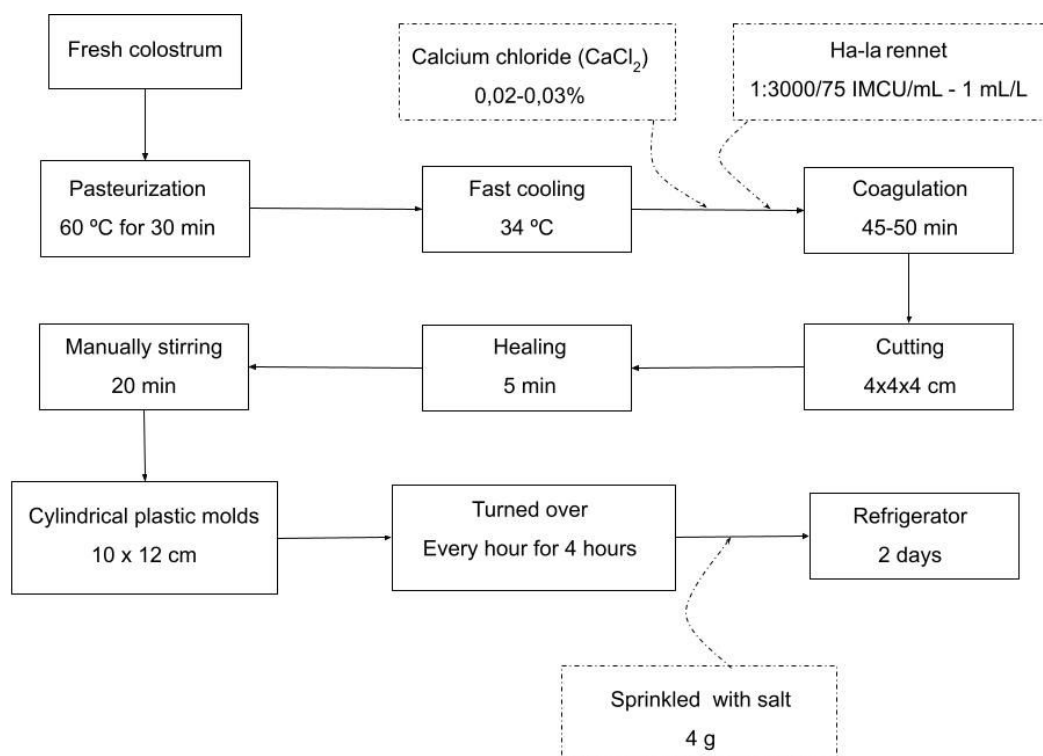
For the technological analysis of RC, a bench-top spectrophotometer (Konica Minolta®, CM-5, Japan) was used to determine the color of the colostrum, according to the International Commission on Illumination colorimetric system (CIE L\*a\*b\*). Briefly, each letter (L\*, a\*, and b\*) represent one axis in a three-dimensional graph. L\* is the y axis and corresponds to the lightness coefficient of the sample, ranging from black (= 0) to white (= 100). The letter a\* is the x axis, whose values range from green (-) to red (+). Finally, b\* is the z axis, whose values range from blue (-) to yellow (+) (Mayta-Hancco et al., 2019).

### 2.2.5 Manufacturing of the fresh colostrum-based cheese

Figure 1 shows the cheesemaking process of the FCH. A total of 2 L of colostrum was used in each batch. The pasteurization process was based on Elizondo-Salazar et al. (2010). The recipe followed was according to the Normative Instruction N° 4, from March 1<sup>st</sup>, 2004 (Brasil, 2004). RC was heated up to 60 °C for 30 minutes and quickly cooled down to 34 °C. At this temperature, calcium chloride (CaCl<sub>2</sub>) was incorporated to the recipe in a concentration of 0.02 to 0.03% of the total volume of colostrum. The mixture

was thoroughly stirred for 1 minute, then the rennet (Ha-la<sup>®</sup> 1:3000/75 IMCU) was added in a proportion of 1 mL/L of colostrum and it was thoroughly homogenized for 15 seconds.

This mixture was kept under 34 °C and rested for approximately 45 minutes, until the clotting was completed. The curd was cut into cubes (4 cm edge), which were allowed to heal for 5 minutes and then manually stirred for about 20 minutes. The curd was then divided into cylindrical plastic cheese molds (10 x 12 cm) and turned over every hour for four hours. Finally, the cheese was sprinkled with 4 g of salt and stored in the refrigerator for 2 days.



**Figure 1.** Cheesemaking process of the fresh cheese made with colostrum.

### 2.2.6 Physical-chemical analysis of the fresh colostrum-based cheese

The composition of FCH samples was evaluated regarding percentage of fat, percentage of protein, moisture, ash, minerals, pH, titratable acidity, IgG concentration and percentage of lactose using the same methods described in Section 2.2.2. For the assays that required liquid samples (percentage of fat, IgG concentration and percentage of lactose), 25 g of cheese were homogenized with 225 mL deionized water in a stomacher (BagMixer<sup>®</sup>, São Paulo, Brazil).

### 2.2.7 Microbiological analysis of the fresh colostrum-based cheese

Microbiological assays of the FCH were done as described in Section 2.2.3. For all assays, 25 g of FCH were homogenized with 225 mL of sterile peptone water (0.1% (w/v)), followed by serial dilution. Aliquots (100 µL) of these dilutions were then added to the respective agar plates by spread-plate method.

### 2.2.8 Technological analysis of the fresh colostrum-based cheese

For the technological analysis, FCH samples were evaluated regarding color and texture. Color was analyzed using a bench-top spectrophotometer (Konica Minolta<sup>®</sup>, CM-5, Japan), according to the international commission on illumination colorimetric system (CIE L\*a\*b\*) as mentioned in Section 2.2.4. Texture was evaluated with a texture

analyzer (Brookfield®, CT3 10K, USA), which measured the firmness, cohesiveness, adhesiveness, elasticity, and gumminess of the samples. The cheese samples were cut into cubes (20 mm edge) and a 25 mm cylindrical probe was used for the test. The samples of the cheeses were compressed to 50% of their initial height at a speed of 2 mm/s. In each cheese sample, the measurements were repeated twice.

### 2.2.9 Sensory analysis of the fresh colostrum-based cheese

Sensory analysis was performed by 60 consumers (49 women and 11 men, between 20 and 62 years old), including students, professors, and other collaborators, from the University of Vale do Taquari – Univates. Volunteers were provided with a Free and Informed Consent Form (ICF), approved by the University Ethic Committee CAAE: 38884920.0.0000.5310. The evaluation method was the Affective Test (hedonic scale). In this test, the evaluator informed the degree of acceptability of the attributes (appearance, odor, taste, texture, and global acceptance), by rating cheese samples on a scale of nine (9) categories that range from one (1) (dislike it extremely) to nine (9) (like it extremely) (Cais-Sokolinska et al., 2021; Garcia-Gomez et al., 2021). In addition, evaluators also indicated the purchase intention for the product, through another scale of five (5) categories that range from one (1) (definitely would not buy it) to five (5) (definitely would buy it). Lastly, the acceptability index was calculated by dividing the average score given to the product by the higher score given to the product, and then multiply it by 100. For a product to be considered accepted, it must have the acceptability index greater than 70% (Arruda et al., 2016).

## 3 Results and discussion

### 3.1 Physical-chemical analysis of refrigerated colostrum and fresh colostrum-based cheese

The physical-chemical analysis of RC and FCH are presented in Table 1. The results correspond to the mean ± standard deviation of three different samples analyzed in duplicates. The found results for the RC assays were compared to previous published papers. The FCH results were compared to Barbosa (2020), which made fresh cheeses with different percentages of colostrum and milk, once it was not possible to find other papers that aimed the making of fresh cheese using only colostrum.

**Table 1.** Physical-chemical characteristics of the refrigerated colostrum and the fresh colostrum-based cheese.

Parameters	RC	FCH
Total solids (%)	20.32 ± 0.04	32.02 ± 1.16
Moisture (%)	79.68 ± 0.04	67.98 ± 1.16
Fat (%)	4.00 ± 0.20	7.00 ± 1.00
Total proteins (%)	16.30 ± 0.20	22.95 ± 0.74
IgG (g/L)	>50.00 ± 0.00	30.95 ± 0.00
Lactose (%)	1.60 ± 0.00	nd*
Ash (%)	0.95 ± 1.00	1.85 ± 0.10
Sodium (mg/L)	37.10 ± 1.11	104.10 ± 7.42
Potassium (mg/L)	64.10 ± 1.84	57.30 ± 3.11
Calcium (mg/L)	5.40 ± 0.04	10.10 ± 0.37
pH	6.32 ± 0.02	6.15 ± 0.01
Titrateable acidity (g/100 mL)	0.27 ± 0.01	0.04 ± 0.01

\*nd = not detectable, RC = Refrigerated Colostrum, FCH = Fresh Colostrum-Based Cheese. The results correspond to the mean ± standard deviation of three different samples analyzed in duplicate.

*Moisture and total solids.* Godden et al. (2019) reported 76.1 and 23.9% of moisture and total solids in the colostrum, respectively, which is very close to the values obtained in the present study. Regarding moisture content, the Ministry of Agriculture, Livestock and Food Supply's ordinance n° 146 from 07 of March of 1996 (Brasil, 1996) characterizes fresh cheeses according to their moisture levels. A cheese with >55% of moisture is characterized as a “very high moisture cheese”, and as well as the fat, the percentage of moisture affects the texture of the cheese. Colostrum cheese has higher moisture due to its pH. The higher concentration of hydrogen ions leads to a reduction in the repulsive forces and a consequent moister cheese (Barbosa, 2020). Lastly, the moisture of FCH was  $67.98 \pm 1.16\%$  characterizing it as a “very high moisture cheese” and consequently, a very soft cheese.

*Fat.* The composition and structure of the fat in the milk was thoroughly studied (MacGibbon & Taylor, 2006), but very little is known about the fat composition in the colostrum, despite the importance for the calves as a source of energy for muscle development (Kehoe et al., 2007). The concentration of fat in the RC found in this work ( $4 \pm 0.20\%$ ) is supported by the results found by Kehoe et al. (2007) that reported an average of  $6.7 \pm 4.2\%$  of fat in the colostrum. In the cheese, the purpose of the fat (as well as the moisture) is to define the texture (McSweeney et al., 2004). Fresh cheeses contain fats ranging from 18 to 29% (Mayta-Hanco et al., 2019), which is very different from the concentration found in the FCH ( $7.0 \pm 1.0\%$ ). Because the curds of the cheese made with colostrum are more fragile than with milk (Barbosa, 2020), the capacity of the curds holding on the fat is affected, lessening the percentage of fat in this cheese.

*Total proteins.* As well as fat, calves need high amounts of proteins in the colostrum for energy and muscle development (Kehoe et al., 2007). The concentration of protein in the colostrum can vary depending on the season of calving (Morin et al., 2001). RC sample was collected during autumn and presented a concentration of 16.3% of total proteins, corroborating with the results ( $14.9 \pm 3.3\%$ ) found by Kehoe et al. (2007). Sant'Ana et al. (2013) and Machado et al. (2004) reported  $15.35 \pm 1.12\%$  and  $17.06 \pm 2.61\%$ , respectively, of protein in the fresh cheese made with cow milk, being almost 1,5 times lower than the protein concentration found in this work ( $22.95 \pm 0.74\%$ ), making the FCH a cheese with greater source of proteins.

*Immunoglobulin G.* Among all the important nutrients of the colostrum, the IgG concentration has been considered the hallmark for evaluating its quality. High-quality colostrum has its IgG concentration greater than 50 g/L (Godden et al., 2019). Following Quigley et al. (2013) method, the RC achieved the break point of 21% Brix, which is equal to >50% g of IgG/L. Following the same method to evaluate the IgG concentration of the FCH, the break point found was 13% Brix, which is around 30.95 g of IgG/L. Considering this value, the use of colostrum for the making of products for human consumption (such as cheeses) is encouraging.

*Lactose.* In comparison to milk, colostrum generally presents a lower lactose level (Uruakpa et al., 2002). The percentage of lactose found in this paper for RC was 1.6%, which is a low value, yet it is in the range of values found by Kehoe et al. (2007), in which the research group could find the percentage of  $2.5 \pm 0.7\%$ . This suggests that could be used by lactose intolerance person (Bagwe et al., 2015). FCH samples did not have a measurable percentage of lactose, which also suggests that this product could be safe lactose intolerance person.

*Ashes.* In comparison to milk, colostrum presented a higher concentration of ashes (McGrath et al., 2016). The concentration of RC agrees with the results reported by Godden et al. (2019). The concentration of FCH was higher than RC, once  $\text{CaCl}_2$  and NaCl were added to the cheese.

*pH and Titratable acidity.* The pH of the colostrum is lower than the milk, due to the amount of protein in it (Barbosa, 2020). The pH in the RC was  $6.32 \pm 0.02$ , agreeing with McIntyre et al. (1952) and Saalfeld et al. (2012). Even though RC had a lower pH than milk, FCH presented a higher pH in comparison to fresh cheeses made with milk ( $6.15 \pm 0.01$ ). This finding might be explained by the antibiotic proprieties of the colostrum, which hinders the action of lactic acid bacteria (Barbosa, 2020). For the same reason, titratable acidity values were also low.

### 3.2 Microbiological analysis of refrigerated colostrum and fresh colostrum-based cheese

Colostrum has the potential to carry a lot of pathogenic bacteria, such as *Mycobacterium avium*, *Salmonella* spp., *Listeria monocytogenes* and *Escherichia coli* (Saalfeld et al., 2012). According to the resolution RDC N° 12, from January 2<sup>nd</sup>, 2001 (Brasil, 2001), for a product such as fresh cheese to be commercialized, it cannot exceed the flowing limits of colony-forming unit (CFU) for the following bacteria: Total Coliforms ( $5 \times 10^2$  MPN/g); *Salmonella* spp. (absent CFU/25 g); *L. monocytogenes* (absent CFU/25 g); and *Staphylococcus aureus* ( $5 \times 10^2$  CFU/g).

The RC bacterial counts before pasteurization were positive for *Salmonella* spp. ( $1.07 \times 10^3$  CFU/mL) and total coliforms ( $5.5 \times 10^2$  MPN/g) and negative for thermotolerant coliforms, *Listeria* spp., and *Staphylococcus aureus*. After the pasteurization and the making of the FCH, bacterial counts were only positive for total coliforms ( $3.6 \times 10^2$  MPN/g), showing that the pasteurization method used (Elizondo-Salazar et al., 2010) was efficient and the cheese was proper for consumption, in accordance with the national microbiological standard (Brasil, 2001).

### 3.3 Technological analysis of refrigerated colostrum and fresh colostrum-based cheese

The coordinates for the colors of both RC and FCH were respectively L\* 83.83, a\* -3.77, b\* 24.84 and L\* 86.57, a\* -1.59, b\* 24.23. These coordinates represent an orangish color, which corroborates with Calderón et al. (2007), who reported a higher level of carotenoids in the initial colostrum, giving it a reddish-yellow color that decreased during the first week of lactation. Once the FCH is made with colostrum only, its color was similar to the RC itself.

Table 2 shows the texture characteristics of the FC. The results correspond to the mean  $\pm$  standard deviation of three different samples analyzed in quadruplicate.

**Table 2.** Texture of fresh colostrum-based cheese.

Characteristic	Results
Firmness 1 (g)*	325.5 $\pm$ 8.5
Firmness 2 (g)**	235 $\pm$ 3
Cohesiveness	0.445 $\pm$ 0.020
Adhesiveness (mJ)	0.7 $\pm$ 0.1
Elasticity (mm)	6.43 $\pm$ 0.07
Gumminess (g)	144.5 $\pm$ 3.5

\*Firmness during first compression. \*\*Firmness during second compression. The results correspond to the mean  $\pm$  standard deviation of three different samples analyzed in quadruplicate.

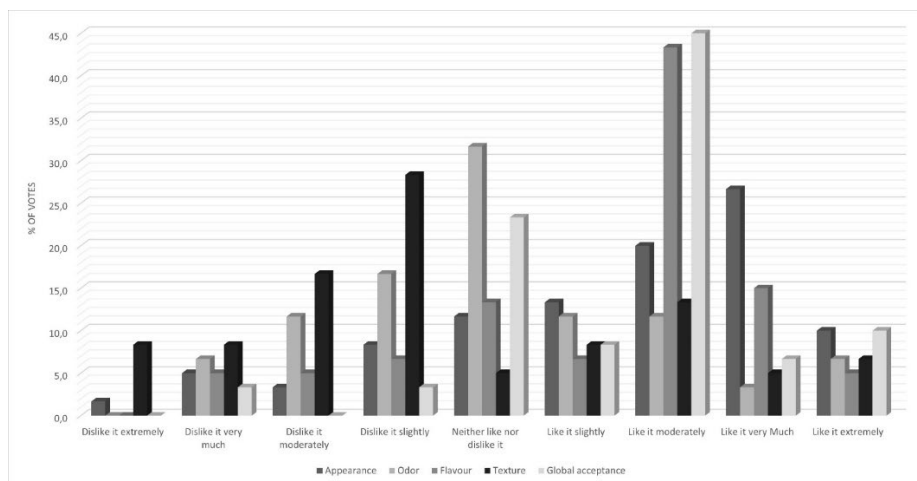
These results were compared to the fresh cheese made with cow milk only, from Sant'Ana et al. (2013), once it was not possible to find another paper that reported fresh cheese made with only colostrum. The authors reported: Gumminess  $7.08 \pm 1.40$  N (722 g); elasticity  $0.83 \pm 0.03$ ; cohesiveness  $0.59 \pm 0.10$ ; and firmness  $11.96 \pm 0.39$  N (1220 g). These results were different from the ones obtained in this study for FCH samples. Thus, it is concluded that the fresh cheese made with colostrum has singular characteristics and, therefore, its comparison with traditional milk cheeses is not adequate.

### 3.4 Sensory analysis of the fresh colostrum-based cheese

Sensory analysis is a very important step to assess the acceptability of a possible new product in the market once no other technology can replace human's sensory preferences. According to the consumers' innovativeness and motivation to eat new foods presented by Delorme et al. (2021), most of the consumers

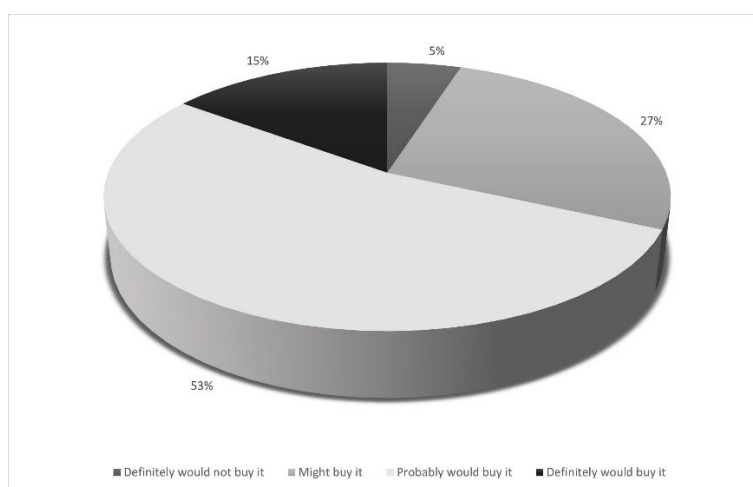


enjoy learning about new foods. In addition, they are interested in trying familiar foods that have been prepared with new ingredients and are curious about the flavours of new foods and ingredients. Therefore, the Figures 2 and 3 show the results of the Affective Test (hedonic test) and the purchase intention of the fresh colostrum-based cheese, respectively.



**Figure 2.** Affective Test (hedonic test) rating fresh colostrum-based cheese samples on a scale of nine (9) categories, ranging from one (1) (dislike it extremely) to nine (9) (like it extremely) (n=60).

Figure 2 shows that the texture did not have a good acceptance from the public, making up to 61.98% of rejection. A few participants of this sensory analysis wrote in the observations that the texture was not what they were expecting of a fresh cheese, once the FCH had more of a creamy consistence. This texture would be explained by the low firmness of the FCH ( $235 \pm 3$  g) in comparison to the cheese made by Sant’Ana et al. (2013) (1220 g). Even though the texture was unexpectedly soft and creamy, Figure 2 shows that the flavour factor had a considerable good acceptance from the public, making up to 70.10% (from like slightly to like extremely). The good flavour of the cheese might be the cause for a “moderately good” global acceptance observed in the sensory analysis. Overall, the acceptability index for the FCH was as following: appearance (70.74%); odor (56.85%); flavour (69.62%); texture (50.74%); and global acceptance (71.66%). It is important to highlight that, according to Arruda et al. (2016), a product must achieve an index of over 70% for it to be considered accepted, and that is the case of the FCH from this study.



**Figure 3.** Purchase intention of the fresh colostrum-based cheese, through a five (5) categories scale, ranging from one (1) (definitely would not buy it) to five (5) (definitely would buy it) (n=60).

Figure 3 shows the purchase intention of the 60 consumers in relation to the FCH, indicating that 68% of the public would buy it. Thus, in terms of global acceptance and purchase intention, the fresh colostrum-based cheese developed has a significant potential for insertion in the consumer market. Some participants commented that they might buy the product with the intention of eating it as a spreadable cheese due to its consistence.

## 4 Final considerations

The making of a cheese using only colostrum showed promising results, such as the absence of lactose and a high concentration of IgG (30.95 g/L). These findings showed the relevance of colostrum utilization by dairy industries in developing new value-added cheese formulations and potentially other lactose free dairy products. None of the tasters from the sensorial analysis board was lactose intolerant, therefore, there is not feedback from consumers with this intolerance, and therefore, more studies are needed to proof the safety of this product for lactose intolerant consumers. Even though the value of IgG in the cheese was high (13% Brix), further studies must be developed to evaluate the structure of these proteins and if they are still playing their immune role in human organism. The cheese presented a good acceptance from the public, but it still needs texture improvements to be similar to a fresh cheese. The use of colostrum should be encouraged, since its utilization enables the development of new value-added products for the dairy industry, the generation of income for farmers, and the reduction of waste in the environment.

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