ECONOMIC PERFORMANCE AND SENSORY ANALYSIS OF PROBIOTIC “MINAS FRESCAL” CHEESE PRODUCED USING BOVINE AND CAPRINE MILK

Marion Pereira da Costa¹, Hugo Leandro Azevedo da Silva¹, Celso Fasura Balthazar¹, Robson Maia Franco², Marco Antonio Sloboda Cortez²

¹ Mestrandos, Faculdade Veterinária da Universidade Federal Fluminense, Rio de Janeiro, Brasil
² Departamento de Tecnologia de Alimentos. Faculdade de Veterinária, Universidade Federal Fluminense, Rio de Janeiro, Brasil

*Autor para correspondência: marionpdc@hotmail.com

ABSTRACT

The "Minas Frescal" cheese is the most produced and consumed cheese in Brazil, which can be added probiotic cultures and prebiotic ingredients. The objective of this work was to determine the industrial yield and sensory evaluation of cheese from cow and goat milk added with probiotic (Lactobacillus acidophilus LA-5®). The bovine cheese had pH 6.53, 47.6% fat in dry matter, 63.2% moisture and 39° D titratable acidity, while the caprine cheese had pH 6.5, 58.4% fat in dry matter, 58.5% moisture and 35° D titratable acidity. All bacteriological analyzes were in accordance with that established in Brazilian legislation. Both elaborations obtained high yield, 4.0 liters cow milk had been used for the production of one kilogram of cheese, and 4.5 liters of goat milk for the same amount of cheese. Regarding the acceptance test, bovine and goat cheeses obtained respectively hedonic term "like moderately" and "dislike very much". For the attitude test, the bovine cheese received hedonic term "eat often", while the goat "rarely eat". The cheese made from goat milk was not well accepted by consumers, due to intrinsic characteristics of goat milk, requiring the addition of spices or other ingredients to improve the acceptance of this dairy product.

KEYWORDS: Acceptance and Attitude test, Bovine cheese, Caprine cheese, Probiotic, Yield.
6,5, 58,4% de gordura no extrato seco, 58,5% de umidade e 35°D de acidez titulável. Todas as análises bacteriológicas estavam de acordo com o estabelecido na legislação brasileira. Ambas as elaborações obtiveram alto rendimento econômico, sendo utilizados 4,0 litros de leite bovino para a produção de um quilograma de queijo, e 4,5 litros de leite caprino também para um quilograma de queijo. Em relação ao teste de aceitação, os queijos bovino e caprino obtiveram, respectivamente, termo hedônico "gostei moderadamente" e "desgostei muito". Quanto ao teste de atitude, o queijo bovino obteve termo hedônico "comeria frequentemente", enquanto o caprino "raramente comeria". O queijo produzido com leite de cabra não obteve uma boa aceitação perante os provadores, devido às características intrínsecas do leite caprino, sendo necessário o acréscimo de condimentos e/ou outros ingredientes para melhorar a aceitação deste produto.

**PALAVRAS-CHAVE:** Probiótico, Queijo de cabra, Queijo de vaca, Rendimento, Teste de aceitação e atitude.

**INTRODUCTION**

Milk is described as a colloidal suspension, containing emulsified fat globules, proteins, lactose, minerals, vitamins and enzymes. Hence, milk is considered one of the most completed foods, and it has great importance in human nutrition (HAUG et al., 2007). Among domestics species, bovine milk is the most produced and manufactured (FAO, 2012) and it is composed by approximately 87% water, 3.5 to 4% fat, 5% lactose, slightly acidic pH in range of 6.6 - 6.8, vitamins (A, B, D, E) and minerals (PARK et al., 2007). However, milk from other ruminants species, especially goat, sheep and buffalo, is also produced and used in the manufacture of dairy products, as cheeses and fermented milk (PANDYA & GHODKE, 2007).

Goat milk has been a satisfactory substitute for children and adults in allergy events caused by some fractions of cow's milk protein, which is αs1-casein the most important protein fraction to cause allergy. The concentration and types of goat milk casein fractions have different organization and amount that in cow's milk, as well, caprine milk has higher concentrations of β-casein, αs2-casein and a small amount of αs1-casein. (EL-AGAMY, 2007). Nevertheless, goat milk is considered hypoallergenic and it is commonly consumed by individuals who are allergic to cow's milk (ALBENZIO et al., 2012). This milk has a distinctive taste, which is related of the higher concentration of capric, caprylic and capric acids (MAYER & FIECHTER, 2012; PARK et al., 2007). Dairy products are the ideal vehicles for storing and transporting probiotic bacteria to the human gastrointestinal tract, as they provide an environment conducive to growth and increased viability of those micro-organisms (SANDERS & MARCO, 2010).

Probiotics are live microorganisms, which when consumed in adequate amounts, confer a health benefit on the host (SANDERS, 2009). A number of health benefits are attributed to probiotics consumption include improvement of intestinal health by the regulation of microbiota, and stimulation and development of the immune system, synthesizing and enhancing the bioavailability of nutrients, reducing lactose intolerance symptoms, and reducing the risk of certain other diseases (OELSCHLAEGER, 2010). It has been proposed a daily therapeutic dose of 8-9 log CFUg⁻¹. Such high concentration has been suggested to offset possible losses of probiotic bacteria during the passage through stomach and intestine (TAMIME, 2008). Although, *Lactobacillus acidophilus* La-5 survived below 5 log CFUg⁻¹ at artificial gastrointestinal juice, when administrated between 8-9 log CFUg⁻¹ in
Several beneficial effects have been attributed to *L. acidophilus* La-5, as prophylactic activity against children rotavirus diarrhea infection (WEICHERT et al., 2012), relief of clinical symptoms of atopic dermatitis in children, and intestinal microbiota modulation (SAVARD et al., 2011).

COSTA et al., (2013) in their review, concluded that dairy products represent the most important segment of functional foods. This factor is related to three characteristics: (1) milk matrix technological properties, such as allowing the functional viability of ingredients added to the product; (2) the high dairy products practicality; (3) and the relationship that consumers make dairy products with the aspect of healthiness. In addition, the cheese production is the best activity in dairy industry and "Minas Frescal" cheese is the most popular in Brazil (EMBRAPA, 2010). This fact is due mainly to high manufacturing yield and ease processing, which allows a rapid investment return. Moreover, available prices make it present in the diet of the population (NEVES-SOUZA & SILVA, 2005). The “Minas Frescal” is a semi-fat cheese, which has high moisture and must be consumed fresh (BRAZIL, 1996). Therefore, the objective of this work was to determine the industrial yield and sensory evaluation of the cheeses made with bovine and caprine milk.

**MATERIALS AND METHODS**

The determination of the physical chemistry (total acidity, pH, specific gravity at 15°C; freezing point and fat) and bacteriological analyzes (coliforms, *E. coli*, *Staphylococcus* positive coagulase and *Salmonella* spp.) of the raw and pasteurized milk was performed in order to evaluate the quality of milk used in cheeses production (APHA, 2001).

For the manufacture of cheeses, there were used twenty liters of milk (of each species - bovine and caprine), in duplicate. The milk was pasteurized by heating for 30 minutes using the temperature range of 62-65°C, followed by immediate cooling to 32°C. Pasteurization was carried out under constant stirring, in an enclosed, temperature controlled. The manufacturing procedures was followed by FURTADO & NETO (1987) technique, using as ingredients, calcium chloride, commercial milk culture - *Lactobacillus acidophilus* LA-5®, (Chr Hansen, Valinhos, Brazil) and coagulant liquid, all quantities given by the manufacturers.

Before coagulation, 4x10^9 CFU/mL of lyophilized of a probiotic culture of *Lactobacillus acidophilus* LA-5® was add. The mass was cut into grains (2 cm) and left to stand for three minutes. Then, there was a slow and discontinuous agitation for 20 minutes and further molding. The cheeses were turned over every hour, during four hours, followed by one hour and twenty minutes in 20% salt brine immersion. Salting were packaged and kept refrigerated at 4°C ±2 until the day of analysis.

For the characterization of cheese, representative samples of each production were evaluated on the first day after preparation: bacteriological analyzes (coliforms, *Escherichia coli*, *Staphylococcus* positive coagulase, and detection of *Salmonella* spp.) (APHA, 2001) and chemical physical analyzes (fat in dry matter - FDM, acidity, pH and moisture) (BRAZIL, 2001). The yield of each cheese was calculated as follows: four liters of milk needed for the development of a kilogram of cheese (L/kg). In this case, it was divided the volume of milk by the sum of the mass of the cheeses (ROSSI, 1998).

The sensory evaluation of the two cheeses was performed on the fourth day after manufacture in order to a good salt distribution and correlated with the usual
cheese consumption. The overall acceptance and attitude scale of samples was assessed by a hedonic test. For this purpose, a nine-point hedonic scale (DRAKE, 2007) was used by 40 consumers (21-58 years), which including 29 women and 11 men, randomly recruited. The criterion of inclusion to enroll the study was regular dairy products consumption. There were not accepted allergic or intolerant people to dairy products. The sensory analysis was performed in individual cabins, the samples were presented according to a randomized complete block design (MACFIE et al., 1989). The results of the sensory tests were subjected to one-way analysis of variances (ANOVA) followed by Tukey test. A p-value below 5% (P < 0.05) was regarded as significant.

RESULTS AND DISCUSSION

The average of total acidity, pH, density, cryoscopic index and fat of bovine and goat milk are summarized in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>TOTAL ACIDITY</th>
<th>pH</th>
<th>DENSITY a 15º C (g/mL)</th>
<th>FREEZING POINT (H)</th>
<th>FAT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOVINE</td>
<td>17.5</td>
<td>6.66</td>
<td>1.030</td>
<td>-0.530</td>
<td>4.43</td>
</tr>
<tr>
<td>CAPRINE</td>
<td>17.8</td>
<td>6.63</td>
<td>1.031</td>
<td>-0.576</td>
<td>3.56</td>
</tr>
</tbody>
</table>

Both milk presented acidity result according with some authors, ranging from 14.95°D to 18°D. As well as, the pH values, which corroborate with the literature, are in the range of 6.57 to 6.8 for cow (DAMÁSIO et al., 1987; PARK et al., 2007) and 6.5 to 6.8 for goat (GOMES et al., 2004). The density of bovine milk is similar that one mentioned by PARK et al. (2007) from 1.028 to 1.034 g/mL at 15 °C, and the goat milk greater than the value found by DAMÁSIO et al. (1987), which was 1.028 g/mL. That can be explained by the fact that density is influenced, among other factors, indirectly by stage of lactation (GOMES et al., 2004). According with legislation, value for bovine milk freezing point with 12.5% total solids is -0.530°H (FONSECA & SANTOS, 2000). Thus, the cow milk obtained -0.530°H, being within the expected range. In another hand, the goat milk freezing point was -0.576 °H, less than established by PARK et al. (2007). The percentage of cow's fat milk found (4.43%) may be considered high compared to results described in the literature, which are in the range 3.32 to 4.13% (DAMASIO et al., 1987). While the amount of goat's fat milk (3.56%) was approximately 3% and may reach 5.80% for Saanen goats (GOMES et al., 2004), agreeing with the average found in this study. The values of raw milk and post-pasteurization analyzed are indicated in Table 2.
The pasteurization process was effective due to decrease and/or absence of some bacteria after the heat treatment (Table 2), undetected growth of total coliforms (30/35°C) and Staphylococcus bacteria in cow and goat milk samples (BRAZIL, 2000; BRAZIL, 2001) allowed the preparation of cheese, and conduct of sensory analysis.

The results of moisture, fat, pH and acidity analyzes of cheeses were shown in Table 3.

**TABLE 3.** Average of physicochemical analysis of the cheeses

<table>
<thead>
<tr>
<th></th>
<th>ACIDITY (°D)</th>
<th>pH</th>
<th>MOISTURE (%)</th>
<th>FMD (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BOVINE</td>
<td>39</td>
<td>6,53</td>
<td>63,20</td>
<td>47,60</td>
</tr>
<tr>
<td>CAPRINE</td>
<td>35</td>
<td>6,05</td>
<td>58,50</td>
<td>58,40</td>
</tr>
</tbody>
</table>

The both cheese (bovine and caprine) were classified as high moisture according to legislation (BRAZIL, 1996), which may have favored the growth of probiotic strain *L. acidophilus*. Although, the non-probiotic microorganism (*Lactobacillus acidophilus* LA-5®) count realized. It is believed the high acidity in cheeses was due to lactose fermentation, because the addition of lactic culture (MARCATTI et al., 2009). This fact was confirmed by RIBEIRO et al., (2009), who observed the pH reduction when the concentration of probiotic bacteria increased.

Average results of coliforms and *Escherichia coli* in bovine and caprine cheese are presented in Table 4.

**TABLE 4.** Data of coliforms (NMP UFC/g) and *Escherichia coli* (NMP UFC/g) in bovine and caprine cheeses.

<table>
<thead>
<tr>
<th></th>
<th>BOVINE</th>
<th>CAPRINE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliforms</td>
<td>4,3X10²</td>
<td>23</td>
</tr>
<tr>
<td><em>E. coli</em></td>
<td>23</td>
<td>4</td>
</tr>
</tbody>
</table>

Despite the high rate of coliforms found in cow cheese, this result is in accordance with standards of Resolution - RDC nº 12 (BRAZIL, 2001), which declares the maximum concentration allowed of 5x10³ UFCg⁻¹. This fact may be related to recontamination during the various stages of production, since these microorganisms were completely eliminated by pasteurization process. *Staphylococcus* positive coagulase, in both cheeses, were less than 5x10² UFCg⁻¹, which differs from the results found by some authors (MELO et al. 2009; ZOCCHI et al., 2012). All bacteriological analyzes are in accordance with Brazilian Legislation (BRAZIL, 1996).

The yield obtained was 2.966 Kg for cow cheese and 2.630 Kg for goat cheese.
cheese after syneresis. Based on the evaluation of the industrial yield (amount of milk required for drawing) cow milk had the highest yield, requiring 4 L of milk to produce one kilogram of cheese while goat milk required 4.5L for each kilogram of cheese. Positively, both processes of preparation showed high yield being greater than those found by Neves-Souza and Silva (2005). According to BARBOSA et al. (2009) the economic yield of “Minas Frescal” cheese can be significantly changed depending on the time of storage of milk at 4°C.

Regarding the acceptance test, the mean scores obtained for the bovine cheese was 7.236, while for the caprine cheese this value was 2.461, which corresponds the hedonic term "like moderately" and "dislike very much", respectively. For the intention of purchase the bovine cheese was preferred, and the mean scores achieved for this cheese was 8.273, which received "eat frequently" as hedonic term. While the caprine cheese value was 4.331, which meant, "rarely eat" as hedonic term. These results may be related to the fact that consumers are familiar with the bovine “Minas Frescal” cheese, as well as, the pronounced flavor of goat milk presents short chain fatty acids caproic, caprylic and capric (QUEIROGA et al., 2009; SLACANAC et al., 2010), giving this intrinsic flavor to its cheese, that was unpleasant for some consumers.

**CONCLUSION**

The formulations had a high yield, especially cow milk's cheese, representing 10 L of milk for 2.5 Kg of cheese. The bovine cheese had a better acceptance by the consumers, because the intrinsic characteristics of goat milk/cheese presented strong and unpleasant flavor for some consumers. Changes in the manufacture of this cheese can be introduced to improve the sensory acceptance, such as the addition of spices and other ingredients, or even changes in texture.

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