ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 10, Issue, 01, pp. 33303-33308, January, 2020

RESEARCH ARTICLE OPEN ACCESS

GOAT'S MILK CHEESE WITH ADDED AMBURANA CEARENSIS AC SMITH: MARKET PROFILE, SENSORY ACCEPTANCE AND REFRIGERATED STORAGE EFFECT

[1*]Thamirys Lorranne Santos Lima, [1]Rerisson do Nascimento Alves, [2]Thayse Cavalcante da Rocha, [3]Mônica Tejo Cavalcanti and [3]Mônica Correia Gonçalves

[1]Postgraduate in Agro-Food Technology, Federal University of Paraiba, Center for sciences Humans, Socials and Agrarian, Bananeiras, Paraiba, 58220-000, Brazil
[2]Postgraduate Program in Food Science and Technology, Federal University of Paraiba, Campus I, Av. Castelo Branco s/n, João Pessoa, 58051-900, Brazil
[3]Center for Agro-Food Science and Technology, AcademicFood Technology Unit, Federal Universityof Campina Grande, Jario Vieira Feitosa Street, n. 1770, Bairro dos Pereiros, Pombal, Paraíba, 58840-000, Brazil

ARTICLE INFO

Article History:
Received 17th October, 2019
Received in revised form
06th November, 2019
Accepted 17th December, 2019
Published online 31st January, 2020

Key Words:

Shelf life, Composition,
Melting, Free oil.

***Corresponding author:**
Thamirys Lorranne Santos Lima

ABSTRACT

The present study aimed to evaluate the effect of storage time (7, 24, 41 and 58 days) on changes in physical-chemical, microbiological and functional characteristics and to sensorially evaluate the cumaru concentration added to the cheeses which were most accepted by consumers through sensorial testing. Significant differences were observed for most of the evaluated physical-chemical parameters, and via the microbiological analyzes it was evidenced that the cheeses were in accordance with the current legislation. The refrigerated storage time significantly affected the contents of acidity, pH, soluble calcium, proteolysis and functional properties. The sensorial evaluation results did not show significant differences between the produced cheeses, although it was observed that there was good general acceptance since the two formulations of "Coalho" cheese were accepted by the evaluators, independently of the added cumaru concentration, as well as presenting a satisfactory result in the purchase intention test.

Citation: ***Thamirys Lorranne Santos Lima, Rerisson do Nascimento Alves, Thayse Cavalcante da Rocha, Mônica Tejo Cavalcanti and Mônica Correia Gonçalves.*** **2020.** "Goat's milk cheese with added amburana cearensis ac smith: market profile, sensory acceptance and refrigerated storage effect", *International Journal of Development Research*, 10, (01), 33303-33308.

INTRODUCTION

Goat's milk is a highly nutritious food because it has unique properties that distinguish it from cow's milk, such as better digestibility and hypoallergenicity (Ma *et al.,* 2017). In addition to containing medium chain fatty acids, fat globules in goat's milk are relatively small in comparison to cow's milk fat, making it easier for the body to benefit from the food. It also plays an important role in the human diet, as it is consumed by special groups of people such as children, older adults, and people who are allergic to cow's milk (Mahdi*et al.,* 2018). Coalho cheese is a product characterized as semi-hard, white in color, presenting a typical texture, and having a salty and slightly acidic flavor. Its functional potential has been reported associated with the presence of bioactive peptides (Moraes *et al.,* 2018).

Coalho goat cheese consumption has been increasing due to the increase in demand for dairy products from goats, and studies show that this cheese already has good acceptance among consumers due to the simple technology applied in its manufacture, its low allergenic potential and high digestibility, as well as its excellent nutritional value. These findings have been reported and clarified by several authors (Garcia *et al.,* 2012; Oliveira *et al.,* 2012; Silva *et al.,* 2012; Queiroga *et al.,* 2013; Sousa *et al.,* 2014; Bezerra *et al.,* 2017). A good option in producing Coalho cheese is adding condiments and/or spices. In the specific case of Coalho goat cheese, its characteristic odor and taste can be altered or masked through this procedure, which in a way would allow a greater product acceptance. However, the added condiments must possess excellent microbiological quality so that they do not influence the unique quality characteristics of the cheese (Hayaloglu and Farkye, 2011). Coalho goat cheese condimented with

Amburana cearensis AC Smith, a vegetable popularly known as cumaru, is one of the products that has been elaborated through artisanal procedures by small producers in the Cariri eastern region of Paraíba, and is a source of income generation (Souza *et al.,* 2011). *Amburana cearensis* A.C. Smith, more specifically its shell in the form of flour, is added to goat cheese in order to confer differentiated sensorial characteristics in color, taste and aroma, with a pleasant odor being conferred by coumarin (Canuto and Silveira, 2006; Canuto and Bezerra, 2010). There are a series of biochemical, microbiological and sensorial changes during the storage process of Coalho cheese which directly contribute to developing the flavor, aroma and texture of the cheese. In this context, the objective of this study was to determine the market profile and to evaluate the sensory acceptance and the effect of refrigerated storage under the physicochemical, microbiological and functional properties of Goat milk cheeses produced with the addition of cumaru in the concentrations of 0.38 and 0.50% (w/w) for 7, 24, 41 and 58 days of refrigerated storage.

MATERIAL AND METHODS

Obtaining raw materials: The milk used to make the cheeses was obtained from a goat herd from rural producers in the municipality of Santo André-PB. The intercropping of the cumaru stem, also collected in the rural area of the abovementioned municipality, were submitted to natural drying, and then crushed using a Simple Centrifugal Mill (Vieira MCS 280) until the formation of a fine and homogeneous flour.

Coalho goat cheese processing: Cheeses with different concentrations of cumaru were elaborated following the technique adopted by the small producers according to the study carried out by Lima *et al.,* (2017). The milk was pasteurized at 65 °C for 30 min, cooled to 35 °C, added with 1.0% mesophilic lactic fermentation consisting of *Lactococcus lactis* ssp. cremoris and *Lactococcus lactis* ssp. lactis (R-704, Chr. Hansen, Valinhos, SP, Brazil), calcium chloride (0.001% v/v), and 0.001% v/v liquid coagulant (HA- LA, Chr. Hansen, Valinhos, SP, Brazil) to coagulate the milk in 35 minutes. The curd was cut after coagulation, followed by desorption. The whey from the desorption was heated to 75 °C and added to the mass to pre-cook until the mass reached a temperature of 40 °C, where it remained standing for 5 minutes. Total desorption and cumaru flour were then added to the batter at two concentrations: 0.38 and 0.50% (w/w) followed by salting (0.01% (w/v)).) The cheeses were formed and subjected to pressing where they remained for 24 hours, then packed in a vacuum and stored under refrigeration at 10 °C (± 1 °C).

Physico-chemical and colorimetric analyzes of cheeses: The effect of refrigerated storage on days 7, 24, 41 and 58 was observed by titratable acidity analyzes (AOAC, 2006a), potentiometric pH (Digimed DM20, Digicron Analítica Ltd, Santo Amaro, SP, Brazil), soluble calcium (CS), according to the methodology described by Gangidi and Metzger (2006); Total Nitrogen (TN) (AOAC, 2006b), proteolysis through proteolysis indexes in extent ((Soluble Nitrogen (SN) at pH 4.6)/% NT*100), and depth proteolysis index (SN in 12%TCA)/% NT*100), following the procedures described by Andreatta *et al.,* (2007). The colorimetric determination was performed in a Minolta colorimeter according to the procedure proposed by Andrade *et al.,* (2007) in the CIELAB colorimetric space, defined by L, a* and b*; where the L coordinate corresponds to the brightness, while a* and b* refer to the green (-)/red (+) and blue (-)/yellow (+) chromaticity coordinates, respectively. The measurements were performed in triplicate with the previously calibrated apparatus using the internal part of the Coalho cheeses immediately after their removal from the packaging.

Microbiological analyzes: The microbiological quality of cheeses was evaluated by counting *Staphylococcus* coagulase positive and the *Salmonella* spp. coliforms at 35 °C and 45 °C, following the procedures described by the American Public Health Association (APHA, 2001). Microbiological analyzes were performed at 7 and 58 days of refrigerated storage.

Analyzes of functional properties (melting and free oil): The melting capacity test was performed according to the method described by Schreiber and Barbano (1991) and the release of oil was determined by the modified Gerber method, according to Kindstedt and Fox (1991). Analyzes of functional properties were performed on storage days 7, 24, 41 and 58.

Market Profile and Sensory Analysis: We confirm that any aspect of the work covered in this manuscript that has involved either experimental human has been conducted with the ethical approval of the Ethics and Research Committee of the Federal University of Campina Grande under the number 53423315.7.0000.5182. An online questionnaire (Google docs) was elaborated in relation to the market profile, with questions related to the habits and frequency of consumption of seasoned goat's cheese. The questionnaire was available online for 15 days, from which 155 responses were obtained. The assumptions described by Oliveira *et al.,* (2016) were followed for the sensorial evaluation,. A Free and Informed Consent Form (ICF), questionnaire on consumption and the evaluation form were delivered to the participants at the evaluation time. The analysis was performed through the acceptance test for the attributes of appearance, color, aroma, texture, flavor and overall acceptance using a mixed nine-point hedonic scale anchored at the extremes as 1 = I greatly disliked it, and 9 = I liked it very much. For the intention to purchase, a 5-point structured scale was anchored to 1 = I would certainly buy it, and 5 = I certainly would not buy it (Faria and Yotsuyanagi, 2002). The test was performed by a team of 80 untrained tasters of Coalho goat cheese.

Experimental design and statistical analysis of the results: The results were submitted to descriptive statistics, observing means and standard deviation of three replicates. The experiment was set up in a 2 x 4 factorial scheme in a completely randomized design. The effect of the cumaru flour concentration (2 levels of variation: 0.38 and 0.50%), storage time (4 levels of variation: 7, 24, 41 and 58 days), as well as the effect of the interaction of these factors on the physical-chemical characteristics and functional properties were evaluated by Analysis of Variance (ANOVA) and the Tukey test for comparison of means at a significance level of 5%. The microbiological results were expressed in mean values and the values obtained in the market profile were expressed in percentage values through Microsoft Excel 2010, while the data obtained in the sensorial analysis were evaluated by Analysis of Variance (ANOVA) and Tukey test for comparison of means at a significance level of 5% probability. Statistical analyzes were calculated using STATISTICA 7.0 software (StatSoft Inc, Tulsa, OK, USA).

RESULTS AND DISCUSSION

Effect of cumaru flour concentration and refrigerated storage time on the Coalho goat cheese characteristics: The storage time significantly affected the acidity ($p = 0.000$), pH ($p < 0.0001$), proteolysis in extent ($p < 0.0001$), depth proteolysis ($p < 0.0001$), soluble calcium ($p < 0.0001$), color parameter L ($p < 0.0001$), melting ($p < 0.0001$) and free oil ($p < 0.0001$). The addition of cumaru flour affected the acidity ($p = 0.013$) and soluble calcium ($p = 0.000$). The interaction between the addition of different cumaru concentrations and storage time did not affect any of the studied variables. Figure 1 depicts the effect of storage time on pH (1A) and titleable acidity (1B). It is observed that there was an increase in acidity over time, accompanied by a corresponding reduction in pH for the two cumaru concentrations (0.38 and 0.50%). The changes in pH and acidity during the cheese storage time were mainly due to the action of the yeast used in the processing, which produced lactic acid from degrading the residual lactose. The highest pH decrease occurred during the first seven days of storage, with 0.81 and 0.69 pH units for the cheese with 0.38 and 0.50% of cumaru, respectively. In relation to acidity, the cheeses presented the highest value at 58 days of storage.

The indices known as "extension" and "depth" measure the proteolysis intensity in cheeses. The extent of proteolysis refers to the fraction of soluble nitrogen compounds accumulated during the protein degradation process and which have high molecular weight (large peptides), mainly characterized by the action of rennet, which is responsible for a large part of this fraction; and proteolysis depth refers to low molecular weight nitrogenous substances. This fraction contains all the free amino acids, mainly characterized by the action of proteinases and peptidases of the lactic ferment which act on the larger peptides formed by the action of rennet and/or plasmin (Buzato, 2011). The storage time effect on the proteolysis index in extension (2A) and depth (2B) indicated classical behavior of the rennet cheeses during maturation, which is an increase in the two nitrogen fraction indexes. This behavior occurred for the two cheeses and was already expected due to the hydrolysis of the protein matrix, the storage time and the proteases present in the cheeses. However, the variation with time was very small and not significant from the practical point of view, since they do not alter the characteristics of the cheese, especially those related to the mass softening and cracking when chewing, while the low rates of proteolysis result in few changes in texture and functionality over storage time, as it is highly desirable for such cheese which must have firm texture and low melting.

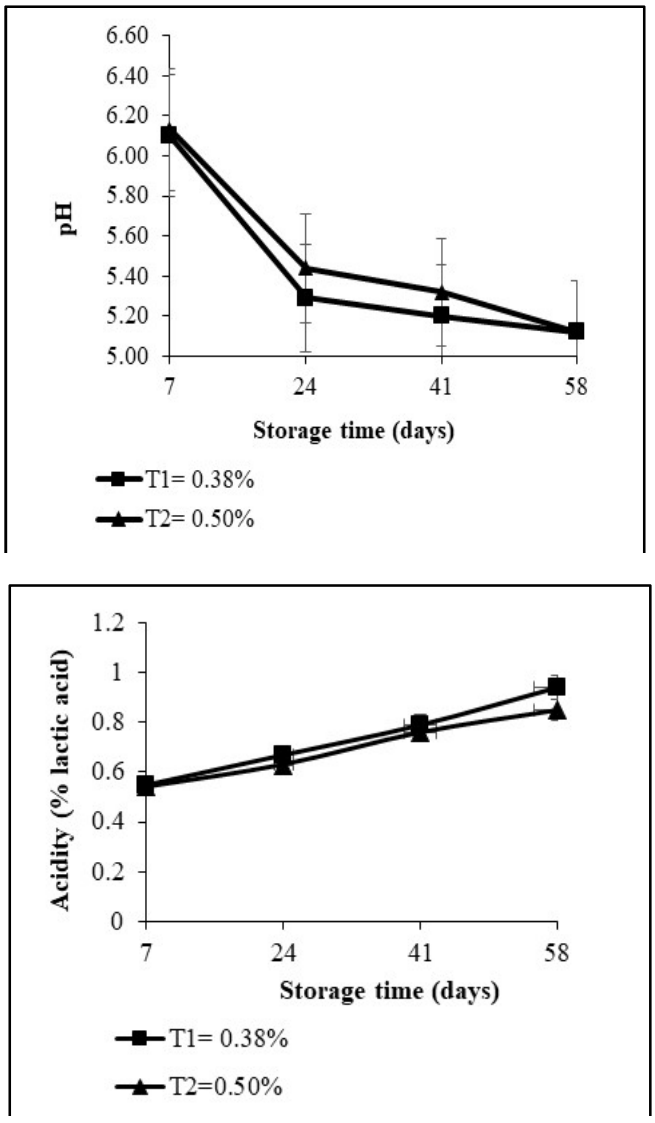

Figure 1. Effect of storage time on pH (1A) andtitleable acidity (1B) of Coalho cheeses with added cumaru flour

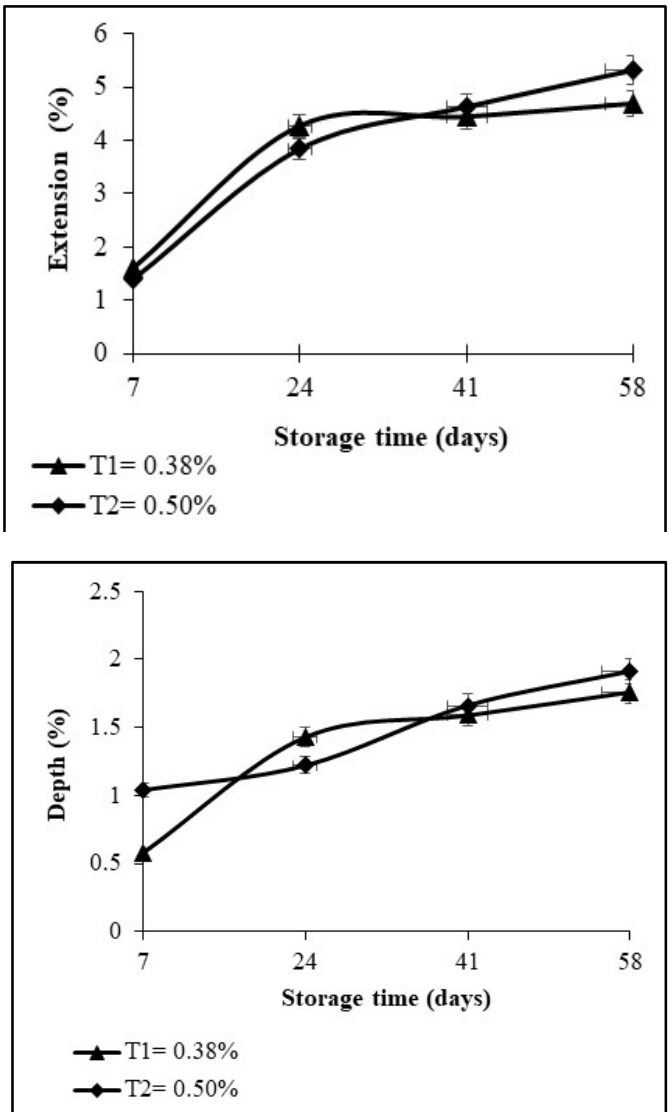

Figure 2. Effect of storage time on extension (2A) and depth (2B) proteolysis of Coalho cheeses with addedcumaru flour

According to Silva (2012), the portions of calcium, phosphorus and proteins provide useful information for understanding the manufacturing variables (such as acidification rate and pH), structure and texture of cheeses. An increase in the soluble calcium content for the two samples was verified in Figure 3, mainly at 41 and 58 days of refrigerated storage, where cheese with 0.38% of cumaru presented 0.18 ± 0.02 mg/100g, and cheese with 0.50% had 0.20 ± 0.02 mg/100g of soluble calcium at 58 days of storage. This fact can be justified by the changes that occurred in the acidity, pH and proteolysis, which may have promoted the calcium solubilization with a consecutive increase in soluble calcium in the last days of storage.

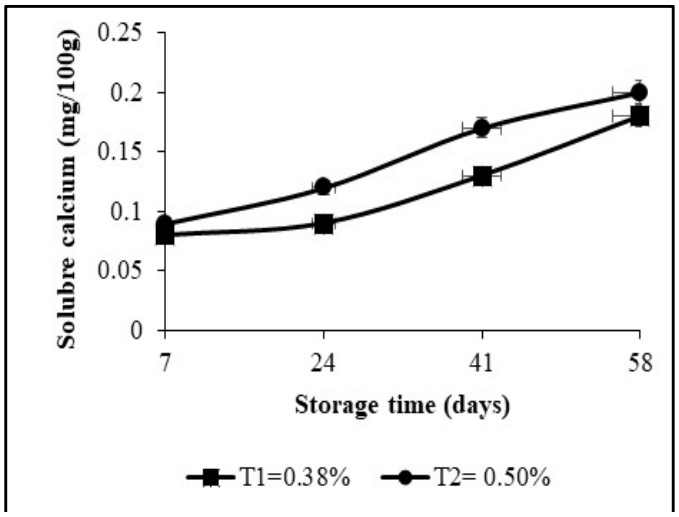

Figure 3. Effect of storage time on soluble calcium content of Coalho cheeses with added cumaru flour

The color determination through colorimetric analysis is one of the main indicators of cheese quality and has a strong influence on the consumer's acceptance of the product (Andrade*et al.,* 2007). However, it should be noted that the goat cheeses with different cumaru concentrations produced in this study presented high luminosity (L*) mainly at 58 days of storage, with a predominance of the yellow color coordinate (b*) on the green color coordinate (a*). The L value represents the brightness (light to dark degree) of the sample varying from 0 (black) to 100 (white), so that the clearer the sample, the greater the L value. The luminosity is directly related to the quantity of light emitted by the sample. In this study, the storage time significantly affected the L value ($p < 0.0001$) for which high values were found for the two cheeses (Figure 4). This indicates that the cheeses produced independently of the added cumaru concentration presented a high luminosity during the refrigerated storage time; however, a decrease in values occurred during the 24 and 41 days for the two cheeses, followed by a relative increase at 58 days, indicating the characteristic of the product to reflect or transmit light. Furthermore, the a* coordinate was not influenced by the refrigerated storage time of the cheeses ($p = 0.249$), which corroborates the very low values and the negative scale, thus indicating the absence of the green color in the elaborated goat cheeses. The b* color parameter, whose colorimetric indication refers to color levels ranging from blue (-) to yellow (+), was not influenced by the cheese storage period ($p = 0.364$). The color change was very small, since the values found for this parameter during the storage days were low but positive up to 58 days, thus revealing a predominance of the yellowish white color, which is characteristic of Coalho cheese, especially near the end of its shelf life. As for the effect of the cumaru flour concentration added to the cheeses, it was observed that the formulation with 0.38% differed significantly and presented higher acidity ($0.74^a \pm 0.15$) when compared to the cheese with 0.50% of the cumaru flour ($0.69^b \pm 0.13$), probably due to the higher moisture content of the cheese which favored lactose degradation in a greater proportion. The soluble calcium content was also significantly affected by the cumaru flour concentration, where the cheese flavored with 0.50% had a higher soluble calcium content ($145^a \pm 0.05$), statistically differing from the cheese with 0.38% cumaru ($120^b \pm 0.04$).

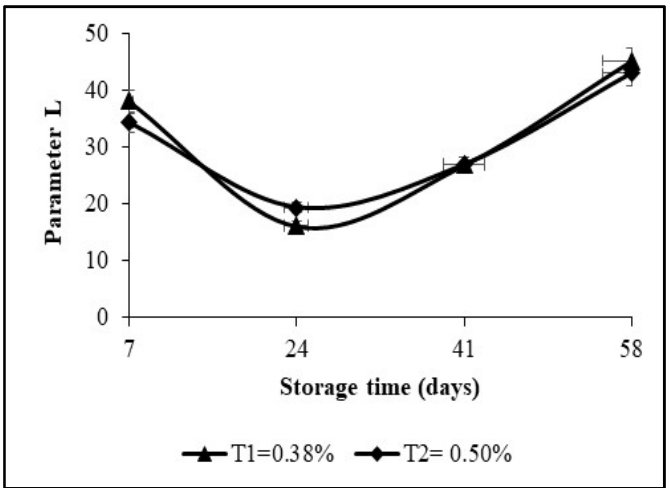

Figure 4. Effect of storage time on L* parameter of Coalho cheeses with added cumaru flour

After 7 days of storage under refrigeration, the two formulations (0.38 and 0.50%) presented coliform values of $2.0x10^2$ and $2.1x10^3$ (MPN.g-1) at 35 °C, respectively. For coliforms at 45 °C, values $<3x10^1$ (MPN.g-1) were found for the two formulations. The mean values found when verifying the Coagulase positive Staphylococcus counts were <10 $CFU.g^{-1}$. The presence of *Salmonella* spp. was not verified in any of the analyzed cheese formulations. At 58 days of refrigerated storage, the two formulations (0.38 and 0.50%) showed average values for coliforms at 35 °C of $1.1x10^2$ and 1.3x102 ($MPN.g.g^{-1}$), respectively, while the mean values found for coliforms at 45 °C were < 3x10-1 (NMP.g-1), Sthaphylococcus coagulase positive $<10^6$ $CFU.g^{-1}$, and *Salmonella* spp. (absence in 25 g). It was found that the two cheese formulations analyzed presented satisfactory microbiological quality according to current legislation (Brasil, 1996) for medium-moisture cheese, and therefore were fit for human consumption. The melting capacity and the formation of free oil are among the most important functional properties in cheeses, since it is desirable that Coalho cheese intended for use in grids have low melting and small free oil release (Buzato, 2011). The main quality requirement expected by Coalho cheese consumers is that it remains in its original format during its grating time (without draining through the grate), meaning that it has low melting capacity. In Figure 5A it is observed that the melting capacity of the two cheeses remained practically constant over time, however indicating that the melting was little influenced by the refrigerated storage time and that the produced cheeses continued in their original form (with little melting) at 58 days. No major changes in the melting throughout the storage is strongly desirable as the consumer rejects cheeses which show high melting and flow through the grid, as these characteristics

determine the end of their shelf life. The addition of cumaru flour did not significantly affect the melting capacity (p = 0.547), nor did the interaction between the evaluated factors (p = 0.153). The formation of free oil is the tendency of the liquid fat to separate from the cheese when subjected to heating, and its excess release can be considered as a serious defect in the appearance of the melted cheese. It was found that the longer the storage time in this study, the greater the tendency of free oil release for the two produced cheeses (Figure 5B). Although oil formation remained practically stable throughout the storage time, there was greater release at 58 days of refrigerated storage for the two formulations. The small variation in the free oil formation in the two samples with storage time may be related to the low proteolysis (Figure 2) found in Goat cheeses. The addition of cumaru flour did not significantly affect free oil formation (p = 0.111), nor did the interaction between the addition of different coumarin concentrations and storage time (p = 0.987).

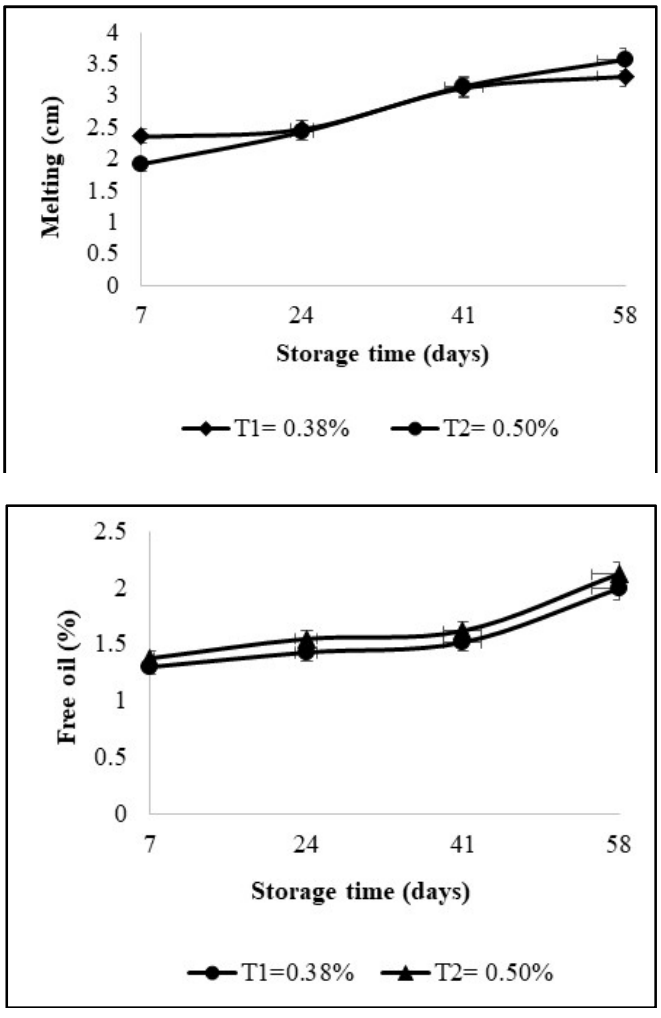

Figure 5. Effect of storage time on melt capacity (5A) and formation of free oil (5B) of Coalho cheeses with added cumaru flour

Market profile and sensory analysis

In the market research, it was found that 76% of the 155 participants, would consume seasoned goat's cheese and the majority (84%) considered the product as innovative. However, when questioned about their knowledge of cumaru, 68% said they did not know the condiment and 88% of the respondents reiterated that they would be willing to pay more for a flavored goat cheese which had different flavor, a pleasant appearance and high nutritional value. In the evaluation questionnaire applied at the sensorial analysis, the tasters affirmed that they were frequent consumers of Coalho cheese and that they were not familiar with cumaru. When asked about the consumption of seasoned goat cheese, they stated that they were not regular consumers of the product due to a lack of commercial availability; therefore, they also reiterated that the product was a good commercial option because it was considered an innovative dairy product. The results obtained in the sensory analysis in relation to the sensory attributes (appearance, color, aroma, flavor and texture), global acceptance and purchase intention showed that there were no significant differences between the evaluated parameters, independent of the added cumaru flour concentration. These results are satisfactory, since the sensory attributes of the cheeses were accepted with good means despite the differences in the added coumaru flour concentrations. It is important to note that the mean values obtained from the acceptance test reached concept seven (moderately liked), according to the structured hedonic scale. In the purchase intention test, "acceptance" was assigned to scores 1 and 2, "neutral" when assigned scores of 3, and "rejection" when assigned scores of 4 and 5. Most tasters stated that they would buy the cheeses in question. These results are in line with those obtained in the test with the sensorial attributes. Differences in taste and aroma between cow milk and goat milk are more pronounced in the derivatives, especially after maturation and storage (Sokolinska *et al.,* 2018).

Conclusions

The elaborated cheeses were sensorially well accepted by consumers, independent of the added cumaru concentration. The different concentrations interfered with acidity and soluble calcium and storage time significantly affected most of the evaluated parameters. The results regarding the functional properties and microbiological analyzes are highly desirable for both the industry and the consumer, since it is possible to produce a goat's milk cheese seasoned with cumaru without any relevant changes in its functional properties and maintaining microbiological quality during the storage period.

Acknowledgements

This research was supported by Caprimais, NEDET/Cariri Oriental /CNPq and PEASA/UFCG.

REFERENCES

Andrade, A.A., Rodrigues, M., Nassu, R.T. and Neto, M.A.S. 2007. *Medidas instrumentais de cor e textura em queijo de coalho.*In: Congresso Latino Americano de Analistas de Alimentos, Fortaleza-CE.

Andreatta, E., Fernandes, A.M., Santos, M.V., Lima, C.G., Mussarelli, C., Marques, M.C. and Oliveira, C.A.F. 2007. Effects of milk somatic cell count on physical and chemical characteristics of mozzarella cheese. *Australian Journal of Dairy Technology*62:166.

AOAC, 2006. Associationof Official Analytical Chemists. *Official Methods of Analysis* of AOAC International. 18 ed. Washington.

APHA, 2001. *American Public Health Association*. Compendium of methods for themicrobiological examination of foods.4th ed. Washington,676 p.

Bezerra, T.K.A., Arcanjo, N.M.O, Araújo, A.R.R., Queiroz, A.L.M., Oliveira, M.E.G., Gomes, A.M.P. and Madruga, M. S. 2017. Volatile profile in goat coalho cheese supplemented with probiotic lactic acid bacteria. *LWT-Food Science and Technology*76: 209-215.

Brasil. Instrução Normativa nº 146, de 07 de março de 1996. 1996. *Aprova os Regulamentos Técnicos de Identidade e Qualidade dos Produtos Lácteos*. Diário Oficial da República Federativa do Brasil, Brasília, DF, Seção 1, p. 3977.

Buzato, R.M.P, 2011. *Influência da relação caseína /gordura do leite e da temperatura de cozimento da massa no rendimento de fabricação e nas propriedades físico-químicas, funcionais e sensoriais do queijo de coalho*.Tese (Doutorado em Tecnologia de Alimentos) - Faculdade de Engenharia de Alimentos da Universidade Estadual de Campinas.

Canuto, KM and Silveira, ER. 2006. Constituintes químicos da casca do caule de Amburana cearensis A.C. Smith. *Química Nova*29: 1241-1243.

Canuto, K.M., Silveira, E.R. and Bezerra, A.M.E. 2010. Estudo fitoquímico de especimens cultivados de cumaru (Amburana cearensis A.C. Smith).*Química Nova*33: 662-666.

Faria, E.V. and Yotsuyanagi, K. 2002. *Técnicasde análise sensorial*. Campinas: ITAL/LAFISE.

Gangidi, R.R. and Metzger, L.E. 2006. Ionic Calcium Determination in Skim Milk with Molecular Probes and Front-Face Fluorescence Spectroscopy: Simple Linear Regression. *Journal of Dairy Science,* 89: 4105-413.

Garcia, E.F., Oliveira, M.E.G., Queiroga, R.D.C.R.D.E., Garcia, E.F., Machado, T.A.D. and Souza, E.L. 2012. Development and quality of a Brazilian semi-hard goat cheese (coalho) with added probiotic lactic acid bacteria. *International Journal of Food Sciences and Nutrition*63: 947-956.

Hayaloglu, A.A. and Farkye, N.Y. 2011. Cheese with added Herbs Spices and Condiments. *Encyclopedia of Dairy Sciences*. 783–789.

Kindstedt, P.S. and Fox, P.F. 1991. Modified Gerber test for free oil in melted Mozzarella cheese. *Journal of Food Science* 56: 1115-1116.

Lima, T.L.S., Alves, R.N., Cavalcanti, M.T., Rocha, T.C. and Gonçalves, M.C. 2017. Padronização do processamento de queijo Coalho caprino condimentado com cumaru produzido por agroindústria na Paraíba. *Revista Verde de Agroecologia e DesenvolvimentoSustentável*12: 562-567.

Mahdi, C., Untari, H., Padaga, M.C. and Raharjo, S.J. 2018. The characterization of bioactive peptides of goat milk fermented to activities as anti-hypercholerolemia. *International Food Research Journal*25: 17-23.

Ma, Y.J., Dong, W.B., Fan, C. and Wang, E.D. 2017. Identification of cow milk in goat milk by nonlinear chemical fingerprint technique. *Journal of Food and Drug Analysis*25: 751-758.

Moraes, G.M.D., Santos, K.M.O., Barcelos, S.C., Lopes, A.S. and Egito, A.S. 2018. Potentially probiotic goat cheese produced with autochthonous adjunct culture of Lactobacillus mucosae: Microbiological, physicochemical and sensory attributes. *LWT- Food Science and Technology*94: 57-63.

Oliveira, K.A.M., Jardim, D.M., Chaves, K.S., Oliveira, G.V. and Vidigal, M.C.T.R. 2016. Avaliação físico-química, microbiológica e sensorial de queijo minas frescal de leite de cabra desenvolvido por acidificação direta e fermentação lática. *Revista do Instituto de Laticínios Cândido Tostes*71: 166-178.

Oliveira, M.E.G.D., Garcia, E.F., Queiroga, R.D.C.R.D. and Souza, E.L.D. 2012. Technological, physicochemical and sensory characteristics of a Brazilian semi-hard goat cheese (coalho) with added probiotic lactic acid bacteria. *Scientia Agricola*69: 370-379.

Queiroga, R.C.R.E., Santos, B.M., Gomes, A.M.P., Monteiro, M.J., Teixeira, S.M., Souza, E.L., Pereira. C.J.D and Pintado, M.M.E. 2013. Nutritional, textural and sensory properties of Coalho cheese made of goats', cows' milk and their mixture. *LWT-Food Science and Technology*50: 538-544.

Silva, PHF. 2012. *Cálcio em queijos: aspectos químicos, tecnológicos e nutricionais.* Juiz de Fora: Departamento de Nutrição. Universidade Federal de Juiz de Fora.

Sokolińska, DC, Bierzuńska, P, Kaczyński, ŁK, Baranowska, HM and Tomaszewska-Gras, J. 2018. Stability of texture, meltability and water mobility model of pizza-style cheeses from goat's milk. *Journal of Food Engineering*222: 226-236.

Sousa, A.Z.B., Abrantes, M.R., Sakamoto, S.M., Silva, J.B.A., Lima, P.O., Lima, R.N., Rocha, M.O.C. and Passos, Y.D.B. 2014. Aspectos físico-químicos e microbiológicos do queijo tipo coalho comercializado em estados do nordeste do Brasil. *Arquivos do Instituto Biológico*81: 30-35.

Souza, ELD, Costa, ACV, Garcia, EF, Oliveira, MEG, Souza, WH and Queiroga, RCRE. 2011. Qualidade do queijo de leite de cabra tipo Coalho condimentado com cumaru (Amburana cearensis AC Smith). *Brazilian Journal of Food Technology*14: 220-225.

****