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Quality of goat milk yogurt produced after intramammary application of a natural product recommended for mastitis therapy

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ABSTRACT: This study aimed to analyze physicochemical characteristics of goat milk and qualitative and sensory aspects of natural goat milk yogurt after intramammary infusion of an ointment containing Jatobá extract. The ointment, containing 5% of the extract, was infused into mammary glands of six female Saanen goats. The experiments were conducted in three experimental moments and involved physicochemical analysis of milk and natural yogurt production. The mean values of solids-not-fat, protein, and lactose content in the milk samples did not differ significantly. Moreover, the physicochemical aspects of the yogurt samples showed similar results between the two treatments. The mean scores of sensory evaluations except taste did not differ significantly between the two treatments. Therefore, the physicochemical characteristics of goat milk and yogurt, the yield, and the qualitative evaluation of the final product were not affected by the Jatobá ointment.

Key words: dairy goat; dairy product; mammary gland; natural extract

Qualidade do iogurte produzido após aplicação intramamária de produto natural preconizado para terapia da mastite

RESUMO: Objetivou-se observar as características físico-químicas do leite de cabra, além dos aspectos qualitativos e sensoriais em iogurte natural produzido com leite de cabras após infusão intramamária de pomada contendo extrato de jatobá. A pomada contendo extrato a 5%, foi elaborada para uso intramamário e aplicada em seis fêmeas caprinas da raça Saanen. O experimento foi conduzido em três momentos experimentais, sendo realizada análise físico-química do leite e produção de iogurte natural. Para o iogurte foram realizados testes físico-químicos, avaliação qualitativa e sensorial. As médias de sólidos não gordurosos, proteínas e lactose não apresentaram diferenças estatísticas. As médias das notas da avaliação sensorial não apresentaram diferença estatística entre os dois tratamentos, exceto para o parâmetro sabor, tendo também se destacado entre os parâmetros avaliados. As características físico-químicas do leite e do iogurte de leite cabra, bem como o rendimento e avaliação qualitativa do produto final não sofreram interferência pelo uso da pomada a base de jatobá.

Palavras-chave: caprinocultura leiteira; derivados lácteos; glândula mamária; extrato natural

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Introduction

Goat milk production is a growing practice in Brazil. Considering its hypoallergenic properties, goat milk consumption is generally associated with early childhood and particularly used for infants with milk protein allergy problems (Delgado Junior, 2020). Fermented milk contains other food substances obtained by milk clotting and pH reduction, or it is a reconstituted product containing other milk components obtained by lactic acid fermentation through culturing of specific microorganisms. Yogurt and milk are fermented by the protosymbiotic cultures of *Streptococcus salivarius* subsp. thermophilus and *Lactobacillus delbrueckii* subsp. bulgaricus, which complement other lactic acid bacteria and their activity and contribute to determining the characteristics of the final product (Brasil, 2007).

In this scenario, the functional food market has grown rapidly as consumers increasingly seek healthy and diversified products, and there has been an ever-increasing interest in the food industry providing new food products with high acceptance, better nutritional values, and health-promoting benefits. From this perspective, yogurt has been consumed as a safe and nutritious dairy product (Aryana & Olson, 2017), and several studies have evaluated the impact of adding natural products to its composition (Buehler et al., 2018; Tumbarski et al., 2018; Feng et al., 2019; Costa et al., 2020).

Several *in vitro* and *in vivo* studies are based on natural products before the production of fermented milk, in farms and production animals, including experimental therapy protocols with natural extracts aiming at mastitis control, a prominent mammary gland disease in dairy animals (Peixoto et al., 2015; Mordmuang et al., 2019; Pașca et al., 2020; Sousa et al., 2020). Since several studies have used natural products in dairy animals, and some of these are infused into mammary glands, the impact of this practice on characteristics of milk and dairy products should be assessed. Therefore, this study aimed to evaluate the effect of intramammary infusion of an ointment containing ethanolic extract of *Hymenaea martiana* Hayne on the physicochemical and sensory characteristics of goat milk and yogurt.

Materials and Methods

The ethanolic extract of *H. martiana* Hayne or "Jatobá" was prepared using leaves collected in the municipality of Petrolina, PE. A dried plant specimen (4653) was deposited at the herbarium of the Nucleus of Ecology and Environmental Monitoring (NEMA) of the Federal University of Vale do São Francisco (UNIVASF).

Solvent extraction of the leaves was performed to obtain the crude ethanolic extract (CEE). Subsequently, the ointment was prepared according to a 200 g q.s. formulation containing 5% Jatobá extract, propylene glycol, and Tween.

Six female Saanen goats aged 2-5 years and between their first and third lactations were used in the experiment. All animals were obtained from a private property in the municipality of Juazeiro, BA. The experimental groups were defined, and the mammary half was established as the experimental unit. The control group (G1), formed by the right mammary halves, received saline solution (0.9% NaCl) and the treatment group (G2), formed by the left mammary halves of the animals, received an intramammary ointment infusion (5 mL). The following experimental models were established: M0, beginning of therapy; M1, day 10 (first milk collection); M2, day 30 (second milk collection); M3, day 60 (third milk collection). Animals were milked once a day for two consecutive days, and the milk samples were stored in a freezing chamber (−15 °C) for yogurt production later. The milk samples from both groups were subjected to physicochemical analyses using AKSO® Master Classic milk analyzer equipped with an ultrasonic sensor.

The treatment and control groups were physiochemically analyzed according to the guidelines of the Adolfo Lutz Institute (IAL, 2008), wherein the following were determined: protein content (using the classical Kjeldahl method) (4th Ed. 036/IV), fat content (by direct Soxhlet extraction) (4th Ed. 032/IV), acidity in lactic acid (4th Ed. 016/IV), and residues (by incineration; ash) (4th Ed. 018/IV). Yogurt yield was determined by measuring its initial and final volume. In addition, the products were qualitatively analyzed for clotting time, consistency, and whey leakage. Furthermore, sensory acceptance tests were performed using the 9-point hedonic scale in 60 untrained tasters of both sexes according to the guidelines of the Adolfo Lutz Institute (IAL, 2008). Figure 1 depicts the yogurt production stages adapted from Silva et al. (2017).

The variables associated with the physicochemical analyses of goat milk and yogurt sensory analysis for both samples were tested for normality using the Shapiro-Wilk test. The values related to fat, lactose, protein, total solids, and milk production were analyzed by comparing them with each other and with those of the experimental group. The mean was considered a measure of central tendency.

For the variables that did not show data normality, the non-parametric Friedman test was applied to compare the values within each group, while the Mann-Whitney test was applied to compare the values between the groups. The independent

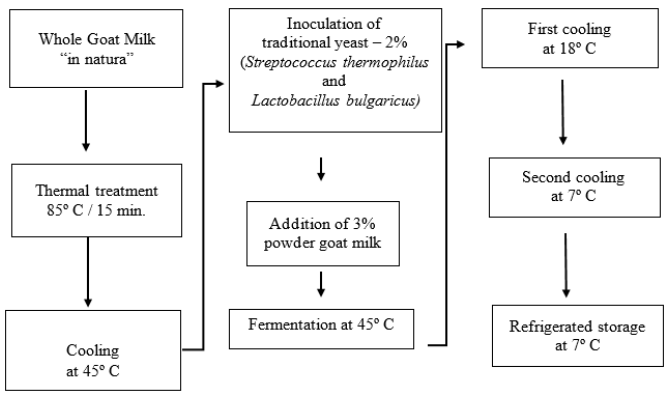

Figure 1. Flowchart of the yogurt production process at the IFSertãoPE Agroindustry, Campus Petrolina Zona Rural.

samples T-test was used for the normally distributed variables, while repeated-measure analysis was used for intra-group comparison. The sensory parameters were subjected to principal component analysis using the statistical software R.

The procedures performed in this study were approved by the Research Ethics Committee (Protocol nº 2.790.716) and the Ethics in the use of Animals (Protocol nº 027/2016) of the Sertão Federal Institute of Education, Science and Technology.

Results and Discussion

Table 1 shows the results of the physicochemical analysis of milk used for yogurt production. In the paired analysis within the control group, all parameters except density and freezing point did not differ over the experimental duration. Moreover, in the experimental group, no differences were observed in the evaluated milk parameters.

The absence of differences over the experimental duration suggests that ointment therapy did not affect the fat parameter. These values were above the current limit for this parameter (2.9%), as established by the law (Brasil, 2000). In addition to representing the major energy component of milk, fat plays a key role in the dairy production technology because the fat fraction of goat milk affects the yield and firmness of dairy products, in addition to their characteristic color, taste, and odor (Waldron et al., 2020).

The protein content of goat milk samples was higher than the limit established by the Normative Instruction No. 37 (Brasil, 2000). As the animals were milked once a day in the present study, it favored the concentration of this milk component. Moreover, these components showed a direct relationship with animal feeding habit, and all animals received a specific diet in accordance with the nutritional demands of the lactation stage. Among all components of goat milk, proteins have attracted scientific interest due to their nutritional importance and significant role in the dairy production technology such as yogurt (Jia et al., 2021).

The lactose content of milk was also higher than the limit established by the Brazilian regulations (4.96-5.22%). According to Rangel et al. (2012), milk obtained from the Saanen breed had high lactose content compared to that obtained from the Moxotó and Anglo-Nubian breeds. High lactose content favors the fermentation process in yogurt production, and consequently, the formation of lactic acid, a valuable constituent for the development of sensory and preservation characteristics during manufacturing of fermented milk (Kljajevic et al., 2017).

When the physicochemical parameters of milk were compared between the two experimental groups (group analysis), salt content was the only variable that showed a significant difference. In experimental moment M3, the percentage of salt was higher in the control group than in the experimental group. However, both groups showed higher values than that established by the Brazilian regulations. Mineral salts in milk are formed by association between cations and anions or binding to proteins. High salt content might be attributed to higher protein content value than that established by the law. Goat milk is usually an excellent source of biodigestible calcium, phosphorus, and magnesium because it contains high soluble contents of these minerals (Garcia et al., 2014).

The density of milk in the control group was significantly different between moments 2 and 3, and the highest value was observed in the control group. The value was higher than that established in the Brazilian regulations (1.0340 kg m^{-3}) (Brasil, 2000). This parameter corresponds to the specific gravity of milk and depends on the concentration of elements and fat content in the solution. Milk composition is one of the

Table 1. Mean and standard deviation of the evaluated physicochemical parameters of goat milk in the experimental groups and moments.

Variables	Experimental groups	Moments		
		M1	M2	M3
Fat	G1	2.50 ^{a} ± 0.40	2.49 ^{a} ± 0.27	2.48 ^{a} ± 0.26
	G2	2.70 ^{a} ± 0.69	2.25 ^{a} ± 0.57	2.18 ^{a} ± 0.37
% SNF	G1	9.38 ^{a} ± 0.52	9.44 ^{a} ± 0.40	9.31 ^{a} ± 0.53
	G2	9.21 ^{a} ± 0.62	8.99 ^{a} ± 0.73	8.70 ^{a} ± 0.79
% Protein	G1	3.49 ^{a} ± 0.19	3.50 ^{a} ± 0.15	3.39 ^{a} ± 0.16
	G2	3.42 ^{a} ± 0.23	3.33 ^{a} ± 0.28	3.30 ^{a} ± 0.41
% Lactose	G1	5.18 ^{a} ± 0.29	5.21 ^{a} ± 0.22	5.05 ^{a} ± 0.23
	G2	5.09 ^{a} ± 0.34	4.96 ^{a} ± 0.41	4.74 ^{a} ± 0.36
% Salts	G1	0.79 ^{a} ± 0.04	0.79 ^{a} ± 0.03	0.77 ^{a} ± 0.03
	G2	0.77 ^{a} ± 0.05	0.76 ^{a} ± 0.06	0.70 ^{a} ± 0.06
Density	G1	1.0343 ^{ab} ± 0.002	1.0346 ^{b} ± 0.001	1.0337 ^{a} ± 0.002
	G2	1.0337 ^{a} ± 0.002	1.0333 ^{a} ± 0.003	1.0327 ^{a} ± 0.004
Freezing point (°C)	G1	0.60 ^{ab} ± 0.04	0.60 ^{b} ± 0.02	0.58 ^{a} ± 0.03
	G2	0.59 ^{a} ± 0.04	0.57 ^{a} ± 0.05	0.56 ^{a} ± 0.05
Electric conductivity	G1	1.35 ^{a} ± 0.19	1.55 ^{a} ± 0.27	1.50 ^{a} ± 0.14
	G2	1.33 ^{a} ± 0.27	1.71 ^{a} ± 0.51	1.58 ^{a} ± 0.28

G1: right mammary half (control); G2: left mammary half (treatment), treated with the extract of *Hymenaea martiana*; M1: day 10 after therapy; M2: day 30 after therapy; M3: day 60 after therapy; SNF: solid-not-fat.
Values followed by the same lowercase letters, in the same line for each parameter, are not significantly different (P > 0.05).

several factors that affect milk density, and the value of this parameter increases by increasing the total solids (Parmar et al., 2020). Therefore, high content of the total solids in the present study might have contributed to increased density of some milk samples.

With regard to the freezing point, a significant difference was observed within the control group between moments 2 and 3. Brazilian regulations established that the freezing point should be −0.531 to −0.565 °C for all goat milk varieties (Brasil, 2000). However, the freezing point values obtained in the present study were below those established by the Normative Instruction No. 37 (Brasil, 2000). The presence of high protein content may justify the low freezing point observed in this study.

Regarding physicochemical analysis of yogurt samples, similar results were obtained for the two experimental groups (Table 2). The protein content values were above the minimum value (2.9%) established by the law (Brasil, 2007). When evaluating the milk protein content, Sumarmono et al. (2015) observed that high protein content values in fermented milk increase their shelf life, which is an advantage for the milk production industry.

According to the guidelines of the Identity and Quality Standards for Fermented Milks (Brasil, 2007), the yogurt samples evaluated in this study met the requirements established by the law for total fat content (3.0-5.9 g $100g^{-1}$) and total acidity in lactic acid (0.6-1.5 g $100g^{-1}$). The content of mineral salts was higher than that obtained by Queiroga et al. (2011) (0.63-0.72%) when evaluating goat milk yogurt. The mineral salts fraction refers to the presence of iron, phosphorus, sodium, and potassium. Although yogurt and milk showed similar nutritional composition, some nutrients such as proteins, riboflavin, vitamins B6 and B12, potassium, zinc, and magnesium are more concentrated in yogurt than in milk, owing to the processing, whose acidity increases the bioavailability of specific nutrients, including calcium (Garcia et al., 2014).

Further, no difference in the yield was observed between the evaluated milk samples, which showed similar values (1 L of milk yielded 1-1.2 L of yogurt). This result demonstrates that treatment with natural product-based ointment did not interfere with milk composition, and consequently, maintained the technological attributes of milk for yogurt production. There is no loss in the yogurt production process, and dairy products offer producers one of the best profit margins.

The yogurt samples were also qualitatively evaluated for their clotting time, consistency/firmness, and whey leakage. Clotting occurred after 5 h, and the lactic acid content was 0.86%, meeting the requirements established by the law (Brasil, 2007). The consistency/firmness of the product determines the moment when fermentation is interrupted. This parameter is related to the presence of soluble solids, thermal treatment, and the fat content (Lima et al., 2011) and is as important as the taste and aroma of the product. A firm and smooth texture indicated that addition of natural compounds in milk resulted in a product with the quality expected by the industry and the consumer.

Dönmez et al. (2017) classified whey leakage or yogurt syneresis as a fault. However, the samples did not show whey leakage; high content values of protein and soluble solids in milk favored the texture of the final product, providing firmness without whey separation and highlighting the importance of these characteristics for the optimal quality of the final product.

The goat milk yogurt samples were subjected to sensory analysis to evaluate their organoleptic quality with regard to appearance, aroma, texture, taste, and overall impression. The scores attributed to all sensory aspects except taste showed no significant difference between the yogurt samples from the experimental groups (Table 3). The tasters attributed similar grades for the "overall impression" of the samples, suggesting the absence of interference by addition of natural compounds during the yogurt production process.

According to Figure 2, appearance and aroma were the most crucial sensory parameters that contributed to the decision of the evaluators, with an accumulated proportion of 71.62%. Queiroga et al. (2011) also obtained high scores of the sensory aspects of goat milk yogurt samples, achieving high sensory acceptance. In addition to great technological potential for its dairy products, goat milk has nutritional and

Table 2. Mean concentrations of the physicochemical parameters of yogurt made with goat milk in the control and experimental groups.

Experimental groups	Means concentration			
	Total proteins[1]	Total fats[1]	Mineral salts[2]	Total acidity[1]
Control	3.06	5.30	0.80	0.86
Treatment with natural product	3.75	5.70	0.87	0.88

[1] Values expressed as g $100g^{-1}$.
[2] Values expressed as %.

Table 3. Distribution of the medians for the sensory parameters of goat milk yogurt samples.

Samples	Sensory parameters				
	Appearance	Aroma	Texture	Taste	Overall impression
Sample 1*	8.00 [a]	7.00 [a]	7.00 [a]	7.00 [b]	7.00 [a]
Sample 2**	8.00 [a]	7.00 [a]	7.50 [a]	6.00 [a]	7.00 [a]

*Yogurt 1: produced with milk from the control group;
** Yogurt 2: produced with milk from the group receiving natural product.
Values followed by the same lowercase letters, in the same column for each parameter, are not significantly different (P > 0.05).

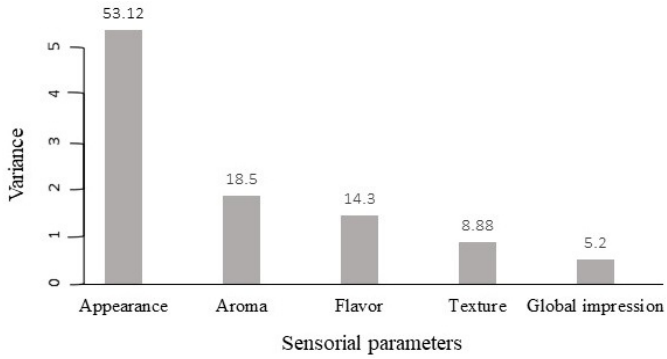

Figure 2. Principal component analysis chart for sensory analysis of goat milk yogurt.

therapeutic properties that could favor product diversification and supply for specific customers (Souza & Dias, 2017).

Conclusion

This study demonstrated that the physicochemical parameters of goat milk and yogurt produced using milk from female goats treated with intramammary ointment infusion showed no changes that could compromise yogurt production. The sensory analysis demonstrated that the tasters attributed similar grades for both products, suggesting high quality of the yogurt evaluated. Further studies should be conducted to quantify the natural compounds contained in milk products, and therefore, facilitate the development of new dairy products with health benefits for consumers.

Compliance with Ethical Standards

Author contributions: Conceptualization: RVSCM, MMC, RMP; Data curation: RVSCM, VOS, TOXM; Formal analysis: RVSCM, FATR; Funding acquisition: MMC; Investigation: RVSCM, VOS, TOXM; Methodology: RVSCM, VOS, TOXM, FATR, MMC; Project administration: RVSCM, VOS, MMC, RMP; Resources: RVSCM, MMC, RMP; Software: RVSCM; Supervision: RVSCM, MMC, RMP; Validation: MMC, RMP; Visualization: RVSCM, TOXM, FATR, MMC, RMP; Writing – original draft: RVSCM, VOS, TOXM, FATR; Writing – review & editing: RVSCM, MMC, RMP.

Conflict of interest: The authors declare that there is no conflict of interest.

Financing source: Own resources of the team that developed the search.

Literature Cited

Aryana, K.J.; Olson, D.W. A 100-year review: Yogurt and Other cultured dairy products. Journal of Dairy Science, v.100, n.12, p.9987-10013, 2017. https://doi.org/10.3168/jds.2017-12981.

Brasil. Instrução Normativa nº 46, de 23 de outubro de 2007. Aprova o regulamento técnico de identidade e qualidade de leites fermentados. Diário Oficial da União, v.144, n.205, seção 1, p.4-7, 2007. https://freitag.com.br/files/uploads/2018/02/portaria_norma_354.pdf. 22 Jun. 2021.

Brasil. Instrução Normativa nº 37, de 31 de outubro de 2000. Regulamento técnico de produção, identidade, qualidade do leite de cabra. Diário Oficial da União, v.138, n.215, seção 1, p.23-25, 2000. https://sidago.agrodefesa.go.gov.br/site/adicionaisproprios/protocolo/arquivos/408781.pdf. 22 Jun. 2021.

Buehler, A.J.; Martin, N.H.; Boor, K.J.; Wiedmann, M. Evaluation of biopreservatives in Greek yogurt to inhibit yeast and mold spoilage and development of a yogurt spoilage predictive model. Journal of Dairy Science, v.101, n.12, p.10759-10774, 2018. https://doi.org/ 10.3168/jds.2018-15082.

Costa, C.F.; Fusieger, A.; Andretta, M.; Camargo A. C.; Carvalho, A. F.; Menezes, D. R.; Nero, L. A. Short communication: Potential use of passion fruit (*Passiflora cincinnata*) as a biopreservative in the production of coalho cheese, a traditional Brazilian cheese. Journal of Dairy Science, v. 103, n. 4, p.1-6, 2020. https://doi.org/10.3168/jds.2019-17791.

Delgado Junior, I. J.; Siqueira, K. B.; Ramalho, B. C. F.; Chaves, D. O. Determinante do consumo de leite de cabra e derivados na zona da mata mineira. Cadernos de Ciência e Tecnologia, v.37, n.3, p.1-13, 2020. https://doi.org/10.35977/0104-1096.cct2020.v37.26766.

Dönmez, Ö.; Mogol, B.A.; Gökmen, V. Syneresis and rheological behaviors of set yogurt containing green tea and green coffee powders. Journal of Dairy Science, v.100, n.2, p.901-907, 2017. https://doi.org/10.3168/jds.2016-11262.

Feng, C.; Wang, B.; Zhao, A.; Wei, L.; Shao, Y.; Wang, Y.; Cao, B.; Zhang, F. Quality characteristics and antioxidant activities of goat milk yogurt with added jujube pulp. Food Chemistry, v.277, p.238–245, 2019. https://doi.org/10.1016/j.foodchem.2018.10.104.

García, S.; Rovira, S.; Boutoial, K.; López, M.B. Improvements in goat milk quality: A review. Small Ruminant Research, v.121, n.1, p.51–57, 2014. https://doi.org/10.1016/j.smallrumres.2013.12.034.

Instituto Adolfo Lutz - IAL. Métodos físico-químicos para análise de alimentos. 4.ed. São Paulo: Instituto Adolfo Lutz, 2008. 1020 p.

Jia, W.; Zhang, R.; Zhu, Z.; Shi, L. LC-Q-Orbitrap HRMS-based proteomics reveals potential nutritional function of goat whey fraction. Journal of Functional Foods, v.82, e104502, 2021. https://doi.org/10.1016/j.jff.2021.104502.

Kljajevic, N. V.; Miloradovic, Z. N.; Miocinovic, J. B.; Jovanovic, T. S. Textural and physico-chemical characteristics of white brined goat cheeses made from frozen milk and curd. The use of square I - distance statistics. Mljekarstvo, v.67, n.2, p.130-137, 2017. https://doi.org/10.15567/mljekarstvo.2017.0205.

Lima, S.C.G.; Oliveira, P.D.; Lourenço Júnior, J.B.; Rodrigues, L.S.; Neres, L.S. Efeito da adição de diferentes sólidos na textura, sinérese e característica sensorial de iogurte firme. Revista do Instituto de Laticínios Cândido Tostes, v.66, n.383, p.32-39, 2011. https://www.revistadoilct.com.br/rilct/article/view/187/195. 28 Oct. 2021.

Mordmuang, A.; Brouillette, E.; Voravuthikunchai, S. P.; Malouin, F. Evaluation of a *Rhodomyrtus tomentosa* ethanolic extract for its therapeutic potential on *Staphylococcus aureus* infections using *in vitro* and *in vivo* models of mastitis. Veterinary Research, v. 50, e 49, 2019. https://doi.org/10.1186/s13567-019-0664-9.

Parmar, P.; Lopez-Villalobos, N.; Tobin, J.T.; Murphy, E.; McDonagh, A.; Crowley, S.V.; Kelly, A.L.; Shalloo, L. The effect of compositional changes due to seasonal variation on milk density and the determination of season-based density conversion factors for use in the dairy industry. Foods, v.9, n.8, p.1-12, 2020. https://doi.org/10.3390/foods9081004.

Pașca, C.; Mărghitaș, L.A.; Dezmirean, D.S.; Matei, I.A. Bonta, V.; Pașca, I.; Chirilă, F.; Cîmpean, A.; Iosif Fiț, N. Efficacy of natural formulations in bovine mastitis pathology: alternative solution to antibiotic treatment. Journal of Veterinary Research, v.64, n.4, p.523-529, 2020. http://doi:10.2478/jvetres-2020-0067.

Peixoto, R. M.; Araújo, R. M. P.; Peixoto, R. M. P.; Bomfim, S. A. G.; Silva, T. M. G.; Silva, T. M. S.; Almeida, J. R. G. S.; Mota, R. A. Costa, M. M. Treatment of goat mastitis experimentally induced by *Staphylococcus aureus* using a formulation containing *Hymenaea martiana* extract. Small Ruminant Research, v.130, p.229–235, 2015. https://doi.org/10.1016/j.smallrumres.2015.07.009.

Queiroga, R. de C. R. do E.; Sousa, Y. R. F. de; Silva, M. G. F. da; Oliveira, M. E. G. de; Sousa, H. M. H.; Oliveira, C. E. V. de. Elaboração de iogurte com leite caprino e geleia de frutas tropicais. Revista do Instituto Adolfo Lutz, v.70, n. 4, p. 489-496, 2011. https://www.bvs-vet.org.br/vetindex/periodicos/revista-do-instituto-adolfo-lutz/70-(2011)-4/elaboracao-de-iogurte-com-leite-caprino-e-geleia-de-frutas-tropicais. 29 Dec. 2020.

Rangel, A.H.N.; Pereira, T.I.C.; Albuquerque Neto, M.C.; Medeiros, H.R.; Araújo, V.M.; Novais, L.P.; Abrantes, M.R.; Lima Júnior, D.M. Produção e qualidade do leite de cabras de torneios leiteiros. Arquivos do Instituto Biológico, v.79, n.2, p.145-151, 2012. https://doi.org/10.1590/S1808-16572012000200001.

Silva, A.G.F.; Bessa, M.M.; Silva, J.R. Elaboração e caracterização físico-química e sensorial de iogurte light prebiótico adoçado com mel. Revista Instituto de Laticínios Cândido Tostes, v.72, n.2, p. 74-84, 2017. https://doi.org/10.14295/2238-6416.v72i2.577.

Sousa, M.M.; Araújo, R.M.A.; Libório R.C.; Costa E.C.; Araújo, B.N.; Lima, M.S.; Gouveia, G.V.; Costa, M.M.; Silva Peixoto, L.J.; Peixoto, R.M. Antimicrobial potential of Jurema preta and umburana, native species of the Caatinga biome, on *Staphylococcus* isolated from small ruminants with mastitis. Semina: Ciências Agrárias, v.41, n.5, suppl. 1, p.2231-2244, 2020. https://doi.org/10.5433/1679-0359.2020v41n5Supl1p2231.

Souza, J. V.; Dias, F. S. Protective, technological, and functional properties of select autochthonous lactic acid bacteria from goat dairy products. Current Opinion in Food Science, v.13, p.1-9, 2017. https://doi.org/10.1016/j.cofs.2017.01.003.

Sumarmono, J.; Sulistyowati, M. Soenarto. Fatty acids profiles of fresh milk, yogurt and concentrated yogurt from peranakan etawah goat milk. Procedia Food Science, v.3, p.216–222, 2015. https://doi.org/10.1016/j.profoo.2015.01.024.

Tumbarski, Y.; Yanakieva, V.; Nikolova, R.; Mineva, G.; Deseva, I.; Mihaylova, D.; Ivanov, I. Antifungal effect of a bacteriocin of *Bacillus methylotrophicus* BM47 and its potential application as a biopreservative in traditional bulgarian yogurt. Journal of Microbiology, Biotechnology and Food Sciences, v.8, n.1, p. 659-662, 2018. https://doi: 10.15414/jmbfs.2018.8.1.659-662.

Waldron, D.S.; Hoffmann, W.; Buchheim, W.; McMahon, D.J.; Douglas Goff, H.; Crowley, S.V.; Moloney, C.; O'Regan, J.; Giuffrida, F.; Celigueta Torres, I.; Siong, P. Role of milk fat in dairy products. In: McSweeney, P.L.H.; Fox, P.F.; O'Mahony, J.A. Advanced Dairy Chemistry, volume 2. Cham: Springer, 2020. p.245-305. https://doi.org/10.1007/978-3-030-48686-0_9.