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Interference of natural extract from Jatobá (*Hymenaea martiana* Hayne) with the physico-chemical characteristics and yield of goat milk and cheese

[*Interferência do extrato natural de jatobá* (*Hymenaea martiana* Hayne*) sobre as características físico-químicas e o rendimento do leite e queijo coalho de cabra*]

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ABSTRACT

Several studies have assessed the therapeutic potential of natural products against mastitis, but only a few have evaluated the impacts of this alternative therapy on the main properties of milk and dairy products. In this study, we observed how the treatment of mastitis with ethanolic extract of Jatobá (*Hymenaea martiana* Hayne) influenced the physicochemical and sensory characteristics of coalho cheese. An ointment containing the ethanolic extract was prepared for intramammary use in six dairy goats. The experiment was conducted in three experimental moments. Milking was performed, manually, and both milk and cheese were subjected to physicochemical and sensory tests. No difference was observed ($p>0.05$) in the physicochemical aspects of milk between the studied groups. The solids-non-fat showed a statistical difference between experimental moments M1 and M2. The protein means varied from 3.33 to 3.62, and there was a statistical difference between the two moments, while the lactose means varied from 4.79 to 5.38%. The physicochemical aspects of cheese remained similar with both treatments. Except for appearance, the sensory characteristics showed no statistical difference. In conclusion, the use of Jatobá extract ointment did not influence the physicochemical and sensory characteristics of goat milk or cheese.

Keywords: mastitis, phytotherapy, dairy goat farming, technology, coalho cheese

RESUMO

A mastite representa uma das principais enfermidades nos rebanhos de caprinos leiteiros, com implicações na produção de leite e na qualidade final dos derivados. Objetivou-se observar a influência do tratamento da mastite com o extrato etanólico da Hymenaea martiana *Hayne sobre as características físico-químicas e sensoriais do queijo tipo coalho. Uma pomada contendo extrato foi elaborada para uso intramamário em seis fêmeas caprinas especializadas na produção de leite. As metades esquerdas dos tetos das cabras receberam essa infusão, enquanto a metade direita era controle. O experimento foi conduzido em três momentos experimentais. Realizou-se ordenha manual e análise físico-química do leite. Para o queijo, foram realizados testes físico-químicos e teste sensorial. Quantos aos aspectos físico-químicos do leite, é possível afirmar que não houve diferença (P>0,05) entre os grupos. Houve diferença estatística para sólidos não gordurosos nos momentos experimentais M1 e M2. As médias de proteína variaram entre 3,33 e 3,62, e houve diferença estatística em dois momentos. As médias de lactose variaram entre 4,79% e 5,38%. Os aspectos físico-químicos do queijo mantiveram resultados similares entre os dois tratamentos. Os parâmetros sensoriais para o queijo coalho de cabra não tiveram diferença estatística entre os tratamentos, contudo a aparência se destacou em relação aos demais parâmetros sensoriais. O uso da pomada elaborada com extrato de jatobá não interferiu sobre as características físico-químicas do leite de cabra e sobre as características físico-químicas e sensoriais do queijo tipo coalho de cabra.*
Palavras-chave: mastite, fitoterapia, caprinocultura leiteira, tecnologia, queijo coalho

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INTRODUCTION

Goat milk production has increased in Brazil and shows a consumption profile associated with early childhood, especially for infants, due to milk protein allergy problems (Delgado Junior, 2020). In this context, coalho cheese is a traditional Brazilian dairy product mainly produced by small goat farmers, showing social and economic importance for the region. Despite being considered a local product, coalho cheese is consumed in several Brazilian states and its identity and quality standards are established by the Ministry of Agriculture of Brazil. It is characterized as a medium to high moisture cheese that should be consumed in up to 10 days after production (Brasil, 2001).

Although the dairy industry has expanded significantly, ensuring the quality of these products is essential for the conformity of therapeutic practices aimed at controlling mastitis with the grace periods established by commercial drug manufacturers. The presence of milk residues can interfere with technological processes in the dairy industry and pose serious threats to public health. From this perspective, studies have been conducted to investigate the potential of natural products to treat mastitis (Peixoto *et al*., 2015; Mordmuang *et al*., 2019), also requiring an assessment of the interference caused by these alternatives on the characteristics of milk and dairy products.

Therefore, this study aimed to evaluate the physicochemical aspects of goat milk and coalho cheese quality on the production technology, yield, qualitative aspects, and sensory characteristics after intramammary infusion with an ointment based on the therapeutic ethanolic extract of Jatobá (*H. martiana* Hayne).

MATERIALS AND METHODS

This study was approved by the Animal Ethics and Experimentation Committee of the Federal Institute of Education, Science, and Technology of Pernambuco (CEUA / IF SERTÃO-PE) under protocol No. 028/2016 and by the Human Research Ethics Committee (CEP) under protocol No. 63929716.0.0000.8052.

The plant material (leaves) for the production of the ethanolic extract of *Hymenaea martiana* Hayne was 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). In the Chemistry Laboratory of IF SERTÃO-PE – *Campus* Petrolina Zona Rural, the leaves were subjected to solvent extraction to obtain the crude ethanolic extract (CEE) according to the methodology described by Sales *et al*. (2015). The ointment was prepared as follows: each 200 g (base) contained 5% of Jatobá extract, 100 drops of propylene glycol, and 45 drops of Tween.

Six Saanen dairy goats with ages from two to five years and between the first and third lactation were used in the study. All animals came from a private property in the municipality of Juazeiro – BA. Animal diet was maintained as in the place of origin, with roughage consisting of elephant grass and corn silage. The concentrate was composed of corn, soybean, cottonseed meal, and mineral supplement. Milk culture was performed to verify the health of the mammary gland, with negative confirmation by tests. After sorting, the left mammary gland of the animals received an intramammary infusion with a single 5 mL dose of Jatobá ointment, with the other half (i.e., the right mammary gland) constituting the control. Saline solution (NaCl 0.9%) was used in the right mammary gland according to the methodology described by Peixoto *et al.* (2015).

The following experimental moments were established: M0 – beginning of therapy; M1 – 5^{th} day (first milk collection); M2 – 15^{th} day (second milk collection); M3 – 45^{th} day (third milk collection). The animals were subjected to manual milking in the moments established (M1; M2; M3) by discarding the first streams of milk and performing the strip cup test separately (treated x control). The milk samples from both groups were subjected to physicochemical analysis. Animals were milked once a day, and the filtered milk volume was stored in a cold chamber (± -15°C). The stored milk was subsequently used for coalho cheese production according to Lima *et al*. (1998). The entire manufacturing technology was developed separately for the milk from the left half (treatment) and from the right half (control), with identical processing conditions.

Milk processing for coalho cheese production took place in the milk handling room of the

Agroindustry Sector of IF Sertão-PE - *Campus* Petrolina Zona Rural.

The physicochemical analysis of the milk samples was performed in the laboratory with an AKSO® Master Classic milk analyzer equipped with an ultrasonic sensor. The evaluated parameters were: fat, degreased dry extract, density, proteins, lactose, added water, temperature, freezing point, total solids, and conductivity.

The physicochemical analysis of the treatment and control cheeses was performed according to the guidelines of the Adolfo Lutz Institute (Zenebon *et al.*, 2008). Cheese yield was calculated based on the volume of milk required to produce 1 kg of cheese, which was approximately 10 liters of milk per 1 kg of cheese. Furthermore, acceptance sensory tests were applied to 60 untrained tasters of both sexes using a structured 9-point hedonic scale (Zenebon *et al.*, 2008).

The variables of the sensory and physicochemical analyses were evaluated for normality by the Shapiro-Wilk test. The values related to fat, lactose, protein, total solids, and milk production were analyzed throughout the experimental moments by comparing them with each other and with the experimental groups and considering the mean as a measure of central tendency. For the variables that did not show data normality, the non-parametric Friedman test was applied to compare the moments within each group, and the Kruskal-Wallis test was used to compare the groups within each experimental moment. For the variables with normal distribution, the T-test was used for independent samples, while repeated-measures analysis was used for intra-group comparison. The sensory parameters were subjected to principal component analysis using the statistical software 'R', according to the methodology described by Pimentel (2009).

RESULTS AND DISCUSSION

There was no difference ($p>0.05$) between treatments in the physicochemical aspects of milk (fat, solids-non-fat, density, protein, lactose, salts, freezing point, and conductivity) within experimental groups G1 and G2 (Table 1). The mean fat values varied from 2.07 to 3.17. According to Coelho (2012), the fat content is important during cheese production as it may be related to the yield. There was no variation between groups and experimental moments in this study, suggesting that the ointment did not interfere with this parameter.

The solids-non-fat means varied from 8.69 to 9.73 (Table 1). It is worth noting that there was a statistical difference between experimental moments M1 and M2. However, this variable did not vary between experimental groups and was above the minimum limits established by law (8.20%) (Brasil, 2000). Milk density is an evaluation parameter used to prevent fraud, although not applicable to the present study. However, for experimental group G2, M1 differed from M2.

The mean protein values varied from 3.33 to 3.62, and M1 was significantly different from M2 in both experimental groups (G1 and G2). The milk protein contents were higher than the minimum established by Normative Instruction No. 037 (Brasil, 2000) but lower than those reported by Malheiros Filho *et al*. (2014), who stated that variations in this parameter could be influenced by the milk production capacity of the animal, considering the dilution effect.

Lactose is one of the most stable nutrients among milk constituents. However, there was a statistical difference between M2 and M3 in experimental group G2. The lactation period and milk retention in the mammary gland are among the factors that may have contributed to this statistical difference. Animals were milked manually and, therefore, were susceptible to incomplete milking. Milk retention decreases production and, consequently, modifies the main milk constituents (Coelho, 2012). Normative Instruction No. 037 established the ideal lactose content of goat milk as 4.3% (Brasil, 2000). The lactose means (4.79%–5.38%) were above this value.

A significant difference was observed in the salt contents of group G1 between experimental moments M1 and M2. Moreover, the experimental moment M2 differed from moments M1 and M3 and from group G2. This parameter varies due to several factors. However, in the present study, these variations are suggested to be due to the lactation period and milk retention after successive milking. The reference value established for salts in goat milk is 0.70% (Brasil, 2000).

Table 1. Means of the physicochemical parameters of goat milk in the experimental groups and moments.

Variables/Experimental Moments		Experimental Groups	
		G1	G2
%SNF	M1	9.54 [a]	9.73 [a]
	M2	8.98 [b]	8.69 [b]
	M3	9.14 [ab]	9.12 [a]
Density	M1	1.036 [a]	1.035 [a]
	M2	1.033 [a]	1.032 [b]
	M3	1.033 [a]	1.033 [ab]
% Protein	M1	3.55 [a]	3.62 [a]
	M2	3.33 [b]	3.54 [b]
	M3	3.40 [ab]	3.39 [ab]
% Lactose	M1	5.28 [a]	5.38 [a]
	M2	4.96 [b]	4.79 [b]
	M3	5.05 [ab]	5.04 [a]
% Salts	M1	0.80 [a]	0.82 [a]
	M2	0.76 [b]	0.73 [b]
	M3	0.77 [ab]	0.77 [a]
Freezing Point °C	M1	-0.617 [a]	-0.632 [a]
	M2	-0.586 [b]	-0.586 [b]
	M3	-0.586 [ab]	-0.586 [b]

G1: right mammary gland (control); G2: left mammary gland (treatment) treated with the ethanolic extract of *H. martiana*; M1 - 5th day after therapy; M2 – 15th day after therapy; M3 – 45th day after therapy;
Values followed by the same lowercase letters in the same column for each separate parameter (%SNF, density, protein, lactose, and freezing point) are not statistically different (P > 0.05). There was no statistical difference between groups.

With regard to the cryoscopic index, a significant difference was observed in both groups throughout the experimental moments. Some factors may interfere with this index, such as increased acidity, milk freezing in the expansion tank, increased concentration of solutes, water addition, or characteristics related to the herd (Robim *et al*., 2012).

The mean values of the physicochemical parameters of goat coalho cheese were as follows: proteins: 21.55; fats: 27.00; ash: 3.88; total acidity: 0.57. For the treatment cheese, the contents of proteins, fats, ash, and total acidity were 21.27, 19.50, 3.6, and 0.68, respectively. The physicochemical parameters showed similar results for both types of cheese, except for total fat. The use of standardized milk for cheese production avoids excess fat and minimizes fat and casein losses. Furthermore, milk standardization allows manipulating the final composition of the milk in order to meet the standards of the specific cheese type and increase the yield (Coelho, 2012). Therefore, the absence of standardization interferes with cheese yield and with its final composition.

The yield of both cheeses was within the average, corresponding to 11.4% for the cheese produced with milk from the control mammary glands and 10.5% for the group that received the intramammary infusion with Jatobá extract. Cheese yield is affected by factors such as milk composition, amount and genetic variants of casein, milk quality, somatic cell count (SCC), milk pasteurization, clotting agent, and curd firmness at cutting, among others (Mona and Nawal, 2011).

The means of the sensory parameters of appearance, aroma, texture, flavor, and global impression for the control group were 7.48, 6.77, 6.73, 6.33, and 6.73, respectively. For the treatment cheese, the means were as follows: appearance: 7.53; aroma: 6.98; texture: 6.42; flavor 5.68; and global impression: 6.42. Figure 1 shows that cheese appearance stood out compared to the remaining sensory parameters (CP1). The interaction between appearance and aroma (CP1 and CP2), with a cumulative ratio of 83.11%, was a determining factor for the decisions that resulted in the sensory means.

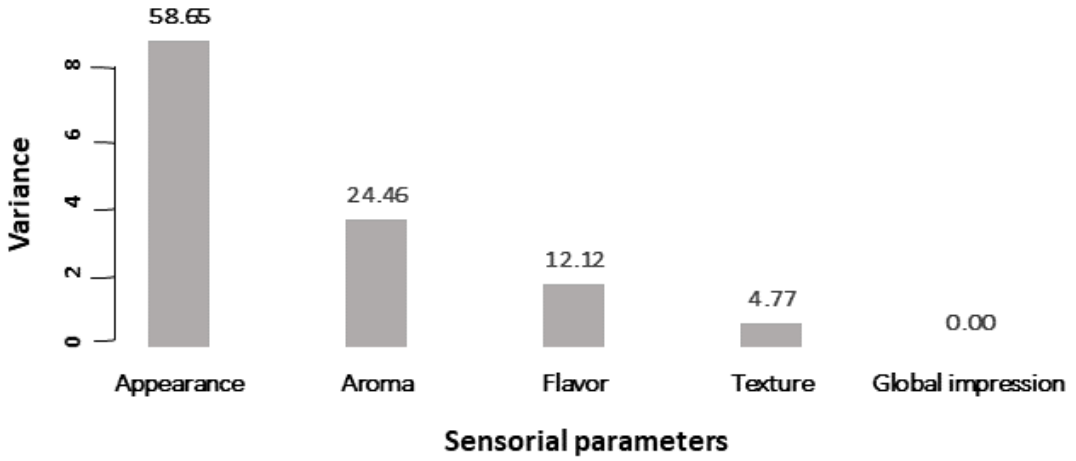

Figure 1. Principal component analysis of the sensory parameters of goat coalho cheese.

The use of goat milk for cheese production has great application potential in the dairy industry, constituting an alternative product for customers allergic to cow milk (Oliveira *et al*., 2016). However, fresh goat milk consumption is traditionally avoided due to its strong flavor, favoring the production of cheese and other dairy products (Souza and Dias, 2017).

Studies have demonstrated the growing acceptability of goat dairy products. Oliveira *et al*. (2016), studying Minas Frescal cheese made from goat milk, stated that 35.8% of tasters confirmed to have already consumed dairy products from animals other than cows; of these, 90% said to have appreciated the experience.

When assessing the effects of the addition of *Lactobacillus acidophilus* LA-05, *Bifidobacterium animalis* subsp. lactis BB-12, and insulin on the quality parameters of creamy goat cheese, Barbosa *et. al*. (2016) verified that the addition of insulin and probiotics, alone or in co-culture, did not affect cheese acceptance.

Another important aspect is the influence of antimicrobials (allopathic or natural) on cheese preparation. Giraldo *et al*. (2017) stated that the cheese manufacturing processes (milk coagulation and curd drainage) could be significantly affected by the presence of these drugs in the mammary gland, highlighting the need to assess the impact of alternative therapeutic protocols to control mastitis on the physicochemical parameters of milk and dairy products. In the present study, the use of a natural ointment did not interfere with the physicochemical parameters of goat milk, the manufacturing techniques of goat coalho cheese, and its sensory parameters, suggesting that its future use with therapeutic purposes will not affect relevant features of milk and dairy products.

Moreira *et al*. (2014), studying the *in vitro* antibacterial activity of the hydroalcoholic extract of pomegranate skin against bacteria isolated from cow milk, concluded that the extract showed inhibitory action against *Staphylococcus* bacteria, especially *S. aureus*, demonstrating a beneficial potential in the control of bovine mastitis and highlighting the treatment of mastitis with alternative therapies.

The use of plant extracts to treat diseases has been encouraged in the dairy industry. Mazorra-Manzano *et al*. (2013), studying the milk-clotting properties of kiwi, melon, and ginger extracts correlated to temperature, concluded that the kiwi extract had the best potential for use as a milk-clotting agent in cheese preparation.

Kurćubić *et al*. (2015), using the extract of *Kitaibelia vitifolia* as an antioxidant agent for Pirotski Kachkaval cheese, concluded that the plant extract intensified the antioxidant activity compared to the control cheese, in addition to not interfering with the sensory perception of the cheese.

CONCLUSIONS

The use of Jatobá extract ointment administered by intramammary infusion did not interfere with the physicochemical parameters of goat coalho cheese and its manufacturing techniques. Furthermore, the sensory characteristics of the product were satisfactorily evaluated by the tasters, highlighting the potential of studies with natural products.

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