Artigo Técnico

EFEITO DA ADIÇÃO DE LEITE BOVINO AO LEITE DE BÚFALA NAS DIFERENTES CARACTERÍSTICAS DO QUEIJO ARTESANAL DO MARAJÓ, TIPO CREME

Effect of bovine milk addition to buffalo's milk on different characteristics of artisanal Marajó "cream cheese" type

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RESUMO

O objetivo do estudo foi comparar os efeitos da substituição parcial do leite bubalino por leite de vaca, nas características físico-químicas, de textura, cor e nos parâmetros sensoriais do queijo artesanal do Marajó tipo Creme, tradicionalmente elaborado com leite de búfala. Quatro queijos foram elaborados com as seguintes formulações: C100 (100% leite de búfala); C80 (80% leite de búfala + 20% leite de vaca); C70 (70% leite de búfala + 30% leite de vaca) e C60 (60% leite de búfala + 40% leite de vaca). Três repetições foram realizadas. Os resultados analíticos da composição (umidade, proteína, gordura, minerais e acidez); dos parâmetros de textura (dureza, elasticidade, coesividade, mastigabilidade) e dos atributos de cor (L*, a*, b*, C*, ho) foram significativamente diferentes entre as formulações. Por outro lado, a presença do leite de vaca não ocasionou alterações nos atributos sensoriais. Com base nos resultados desse estudo, concluiu-se que a adição de até 40% de leite bovino na elaboração do queijo tipo Creme não afeta a sua aceitação pelo consumidor, permitindo um abastecimento do mercado em períodos de entressafra, quando a produção do leite bubalino diminui.

Palavras-chave: requeijão Marajoara; queijos artesanais; composição centesimal; textura; cor; análise sensorial.

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ABSTRACT

The purpose of the present study was to compare the effects of a partial substitution of buffalo's milk by cow's milk, on physico-chemical characteristics, texture, color and sensorial parameters of an artisanal Cream cheese from Marajó, which is traditionally elaborated from buffalo's milk. Four cheeses prototypes were made from four formulations: C100 (100% buffalo milk); C80 (80% buffalo milk + 20% cow milk); C70 (70% buffalo milk + 30% cow milk) and C60 (60% buffalo milk + 40% cow milk). Three replicates were performed. The analytical results for the cheese composition (moisture, protein, fat, minerals and acidity), for textural parameters (hardness, springiness, cohesiveness, chewiness) and for color attributes (L*, a*, b*, C*and ho) were significantly different between prototypes. On the other hand, the presence of cow's milk did not cause alterations on common sensory attributes. Based on the results from this study, it was concluded that adding up to 40% of bovine milk to buffalo's milk in the elaboration of Marajó "Cream cheese" type does not affect its acceptance by the consumer, allowing a market supply during the "dry" period when production of buffalo milk decreases.

Keywords: cottage cheese Marajoara; artisan cheese; proximate composition; texture; color; sensorial analysis.

1 INTRODUCTION

In several countries, artisanal cheeses are an income source for small rural producers and represent the local culture. In Marajó, the largest river-sea island in the world, located in the Northern region of Brazil, artisanal cheeses are popular and much appreciated. Besides, they represent a way to use the milk production of buffalos bred in small and medium rural properties in the Island.

Today, Marajó Island has the largest buffalo herd of the country, with about 263,000 animals, corresponding to 22% of the total national buffalo herd (IBGE, 2010). Traditionally called "Marajó cheese" ("queijo do Marajó" in Portuguese), they can be of two types: "Cream cheese", the most produced one, and "Butter cheese". With a soft texture, compact, closed and pleasant aroma, a yellow-greenish surface and white inside, the "Cream cheese" is slightly acid and salted (LOURENÇO, 1999).

Before the introduction of buffalo in the Island, at the end of XIX century, the production of the "Marajó" cheese was exclusively from bovine milk. However, with the continuous growth of the buffalo herd, due to the presence of natural pastures and floodplains, the production of buffalo milk increased, and it started to be mixed with bovine milk for cheese production (FIGUEIRAS; QUADROS, 2002; SILVA; OLIVEIRA, 2003). Thus, since this time, the artisanalal cheeses of Marajó started to be produced almost exclusively with buffalo milk.

In the Island, the production of buffalo milk is not regular throughout the year, because there is a marked grazing period (June to November) due to larger availability of pastures, and an intermediate dry period (December to May), time of parturition and small offer of native pastures. To meet the demand of cheese production during the intermediate dry period, there is a need to complement with bovine milk, also produced in the island. The mixture of those milks may bring alterations in the blend physico-chemical characteristics, in sensorial parameters, and in texture and color of the cheese made thereof, caused by the added bovine milk composition that has a lower amount of fat, lactose, protein, ashes, calcium and A and C vitamins, and higher concentration of β-carotene, absent in buffalo milk (AHMAD et al., 2008; ABD EL-SALAM; EL-SHIBINY, 2011; MEDHAMMAR, 2012).

In cheeses, generally, texture is one of the most important sensorial characteristics, because it allows the consumer to identify specific varieties and their qualities, even before evaluating the flavor. The texture characteristics of cheeses are influenced by several factors, one of the most important is the raw-material composition (DE JONG, 1976; LAWRENCE, et al., 1987; FOX, et al., 2000). Alterations caused by the protein, salt, and water concentration, the pH value and fat content, in this order, affect texture and cheese color, and consequently may have an effect in its acceptance (CHEN et al., 1979). Besides acting as a differential in characterization of different types of cheese, the color is also part of descriptors for the maturation stage of the cheese.

Therefore, it is important the knowledge of adequate percentages of bovine milk that may be added to buffalo milk so that there are no undesirable alterations in the characteristics of the cheese, what may cause damage in its acceptability and commercialization. In the specialized literature there are no scientific studies that evaluate these alterations. Thus, the purpose of the present study was to determine the physicochemical characteristics, including texture and color, and the sensorial attributes of artisanal "Cream cheese" from Marajó, elaborated from blends of buffalo and cow's milk.

2 MATERIAL AND METHODS

Formulations of "cream cheese"

In this study, four formulations of the "Cream cheese" were elaborated with buffalo and cow's milk, all processed in a cheese factory located in the municipality of Soure, in the Marajó island. The milk (buffalo, cow) came from the same rural property. The four formulations are designed by: C100 (100% buffalo milk); C80 (80% buffalo milk + 20% cow milk); C70 (70% buffalo milk + 30% cow milk) and C60 (60% buffalo milk + 40% cow milk). Threereplicateswere performed. The cheeses were elaborated according to workflow diagram depicted in Figure 1.

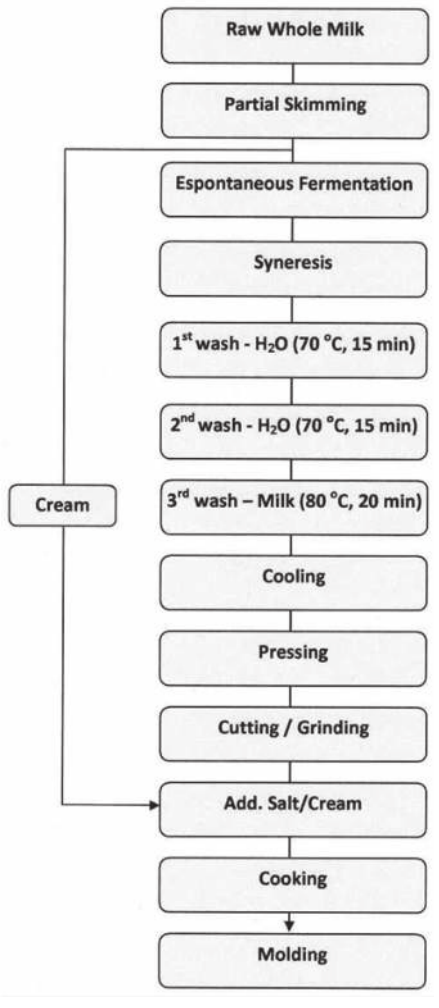

Figure 1 – Workflow diagram for the production of artisanal Marajó "cream cheese" type. Marajó Island (PA), 2012

For the cheese making trials, after manual mix, raw and partial skimmed milks in milk skimmer machine, without addition of starter culture,were submitted to spontaneous fermentation and kept at room temperature (30 °C), during 24 hours. Afterwards, went through a manual handling to induce syneresis and removal of the serum was performedand hereafter washed twice with water at room temperature about 30 °C (2 L of water/1kg of curd mass) under heating (70 °C, 15 min), for acidity reduction. A third wash with buffalo milk (2 L of milk/1 kg of curd mass) was performed, also under heating (70 °C, 15 min), to reincorporate flavor and components washed out by the water, that is, some soluble solids. The mass was then stretched over a table to reduce the temperature to 40 °C; after that, it was mechanically pressed in metallic press for removal of excess serum, cut into cubes and crushed to small particles using a manual or an electric cruncher, assuming a milled appearance. Salt (15 g/1 kg of curd mass) and cream (1 L of cream/1 Kg of curd mass) from milk skimming, were added to the crushed mass and submitted to a thermal treatment (80 °C, 20 min). In this stage the curd stretching occurs, which is performed by manual beating. Then, the melted mass was distributed in polypropylene plastic packages (PP) and cooled to room temperature (30 °C). All cheeses were kept under refrigeration (7 °C - 8 °C) until the analyses were carried out. A package of each formulation was used for this purpose.

Instrumental analysis ofthe physico-chemical composition

The cheese fat was determined by the Mojonnier's method (BRAZIL, 2006). The total protein content was estimated by the micro-Kjeldal's method (BRAZIL, 2006), moisture by kiln drying at 105 °C until constant weight (BRAZIL, 2006) and the fixed mineral residue by calcination in muffle furnace (BRAZIL, 2006). The factor used in conversion from nitrogen to total protein was 6.38. The cheese pH was determined by the potentiometric method (Metrohn Pensalab Instrumentação Analítica Ltda., São Paulo, SP, Brazil) and the acidity estimated by the determination of lactic acid % (BRAZIL, 2006). Determination of fat content in dry matter was made indirectly, by calculating the ratio between the fat content and the total solids content of the cheese (PEREIRA et al. (a), 2001). The analyses of physico-chemical composition were evaluated seven days after the elaboration of the formulations. Analyses were carried out in duplicates in Laboratório Nacional Agropecuário - Lanagro/PA/Brazil.

Instrumental Texture Profile Analysis (TPA)

The textural characteristics were evaluated two days after the elaboration of the formulations,

using a device from Stable Micro Systems, model TA.XT Plus (Surrey, England), equipped with cell charge of 25 kg. Cylindrical samples with diameter and height equal to 20 mm were removed from random points in the cheese, in order to get uniform and homogeneous samples, and equilibrated at room temperature (21 °C). The texture profile was obtained by double compression test of the cheese cylinder, at room temperature, using a cylindrical compression probe with 75 mm of diameter (P75). Compression was performed at constant speed of 2.0 mm. s-1 with contact strength equal to 5 g, until the sample height was reduced to 10 mm (that means 50% of the initial height). Data were obtained by software Texture Expert for Windows - version 1.20 (Stable Micro System). The analyses were performed in five replicates in Empresa Brasileira de Pesquisa Agropecuária – Embrapa Amazônia Oriental /PA/Brazil.

Instrumental color analysis

After two days of elaboration of formulations, the cheese color parameters were evaluated using a colorimeter Hunter Lab, model Color Quest XE (Reston, EUA), according to definitions proposed by the Commission Internationale de l'Éclairage (CIE, 1986). The value L* represents luminosity and indicates how bright or dark the product is, it refers to the object capacity to reflect or transmit light and varies from zero (totally black) to 100 (totally white), the higher the value of L* is, the brighter the object is. The chromaticity coordinate a* is an indicator of green (-) and red (+), while b* is an indicator of blue (-) and yellow (+). The values a* and b* were used to calculate Hue (ho), tone angle or color, and Chroma (C*) that describes a color intensity (chromaticity of color saturation), using the following formulas: h = tan-1(b*/a*) e C* = (a*2 + b*2)1/2, respectively. The determinations were performed in triplicate, with the calibrated equipment, using 10 samples, 05 from the central part and 05 from the periphery of cheeses from each formulation, at room temperature (23 °C) (PANARI et al., 2003; TOSI et al., 2008; PATHARE et al., 2013). The analyses were performed in Empresa Brasileira de Pesquisa Agropecuária – Embrapa Amazônia Oriental /PA/Brazil.

Sensory Evaluation

The sensorial acceptability and buying intention (REIS; MININ, 2006) for the cheese from the four formulations were evaluated three days after the elaboration by 50 untrained tasters, 30 female and 20 male, (≥18 years old), including researchers, trainees, students, technicians and workers from Embrapa Amazônia Oriental /PA/Brazil, the site where the analyses were performed. The attributesevaluated in the acceptance test were:appearance, color, smell, taste and hardness, the hedonic scale of 9 points was used, with value 1 attributed to the hedonic term "extremely disliked", and value 9 to the term "extremely liked" (CHAVES; SPROSSER, 2001). Blocks of cheese were cut in cubes with 1.5 cm of edge, placed inside paper pans codified with three digits random numbers. The samples were served in an aluminum paper tray, together with water to clean the taste. The tests wereperformed in individual booths at room temperature (21 °C).

Statistical analysis

To compare the effects of different cow milk admixtures to buffalo milk on the physico-chemical composition of cheese, including their texture and color, the averages from the analytical data were submitted to a variance analysis (One Way-ANOVA). When significant differences ($p \leq 0.05$) were observed, a Tukey's test was applied. In the sensorial analysis the scores obtained did not have normal distribution, hence, the averages from the descriptors of each formulation were compared by Kruskal-Wallis' test and. The correlation between texture and physico-chemical parameters was expressed as Pearson's correlation coefficient. When statistical differences happened, a Dunn's test was applied. An adherence chi-square test was used to compare the frequencies of buy intentions. In all analyses was used a significance level of 5% ($p \leq 0.05$). Values of p were obtained with software BioEstat 5.0.

3 RESULTS AND DISCUSSION

Physical-chemical composition

The effects of replacing buffalo's milk by cow's milk in the physico-chemical composition of the formulations for "Cream cheese" types are shown in Table 1.

Cheese pH, fat, fat in dry matter (FDM), protein, ashes and acidity decreased with increasing addition of cow's milk to buffalo's milk in the formulations used for processing, while the moisture content increased. These results are in agreement with those found by Fenelon et al. (2000), Mistry (2001), and Souza et al. (2012), whom also reported in their studies an increase in the amount of cheese moisture as the fat content was reduced. The Marajó "Cream cheese" prototypes had low acidity (Table 1), however higher values than those found by Figueiredo (2011).

As expected, the cheese elaborated with 100% of buffalo milk (C100) had the higher values for protein, fat, fat in dry matter, minerals and acidity, and the lower values for moisture; however, an equal amount of fat matter when compared with formulations C80 and C70 and differing only from C60. The lower moisture in formulation C100 may be explained by the

higher amount of fat present in buffalo milk, while, in the other formulations, the decrease of protein, fat and mineral amounts was due to the lower amount of those components in cow milk that was added in higher proportions (ABD EL-SALAM; EL-SHIBINY, 2011; MEDHAMMAR, 2012).

Texture Profile Analysis (TPA)

The results of the instrumental texture analysis (TPA) are compiled in Table 2. According to the rheological results, the partial substitution of buffalo milk by bovine milk, in concentrations from 20%, 30% and up to 40%, did not alter significantly ($p < 0.05$) the parameters flexibility, adhesiveness and gumminess of Marajó "Cream cheese" type.

The addition of different percentages of bovine milk to buffalo's milk in the trials altered significantly the values for cheese hardness, elasticity, cohesiveness and chewiness (Tabela 2). The values of hardness decreased with the increase in bovine milk concentration, that is, the cheeses became softer however without significant difference, showing that cheeses produced with addition of up to 30% of bovine milk keeps the same hardness than C100. However the formulation C60 differed from the others. The hardness values are lower when compared to those of other cheese types: for example, the hardness values of fresh Cheddar, Gouda and Mozzarella were found to be 47, 77 and 68 N, respectively (TUNICK; VAN HEKKEN, 2002). On the other hand, they are higher than those found for Minas cheese made frombuffalo milkand for fresh cheese (MARCATTI et al., 2009; TUNICK et al., 2012). Rogens et al. (2010) concluded that the lower amount of fat influences the texture properties of Cream cheese and Cheddar, leading to an increase of hardness. In this study, however, the decrease in cheese fat concentration (Table 1), did not increase the hardness, on the other hand, there was a decrease in this parameter, which can be probably explained by the lower amount of protein and higher amount of moisture found in the cheese composition (Table 1). Possibly there was the formation of a smaller protein mass by unit area of fat which has been associated to lower hardness values, since the protein matrix is the structural component that gives more deformation resistance (LOBATO-CALLEROS et al., 1997).

The values obtained for elasticity, or recovery after the first compression, indicate that the increase of cow's milk concentration in the blend increased the elasticity of Marajó "Cream cheese", with all cheese formulations significantly differing among themselves. Cheddar, Gouda and Mozzarella cheeses, in comparison, have elasticity values from 8.5 to 10.0 mm, meaning that formulations of Marajó "Cream cheese" that have values between 4.7 and 6.5 mm do

Table 1 – Effects of the addition of cow's milk to buffalo's milk on the composition of Marajó "Cream cheese" (in g/100g)

Formulation	Physico-chemical parameters						
	pH	Moisture(%)	Protein (%)	Fat (%)	FDM** (%)	Ashes (%)	Acidity***
C100	5.54 ± 0.05^{a}	40.46 ± 0.01^{a}	21.35 ± 0.21^{a}	39.30 ± 1.27^{a}	66.00 ± 2.13^{a}	2.11 ± 0.01^{a}	0.36 ± 0.00^{a}
C80	5.43 ± 0.07^{a}	42.29 ± 0.01^{b}	20.85 ± 0.07^{b}	38.00 ± 0.11^{a}	64.12 ± 0.74^{a}	1.89 ± 0.01^{b}	0.31 ± 0.01^{b}
C70	5.38 ± 0.04^{c}	$42.22 \pm 0.13^{c.b}$	$20.35 \pm 0.07^{c.b}$	37.00 ± 0.42^{a}	63.82 ± 0.01^{a}	$1.59 \pm 0.01^{c.b}$	0.23 ± 0.00^{c}
C60	5.21 ± 0.03^{d}	47.25 ± 0.07^{d}	20.10 ± 0.05^{d}	30.30 ± 0.08^{b}	57.4 ± 0.22^{b}	1.55 ± 0.02^{d}	0.20 ± 0.01^{d}
P value*	0.005	< 0.001	0.003	0.002	0.007	< 0.001	0.001

*Statistical analysis using ANOVA post-hoc Tukey's tests. Each value represents mean ± SD; data represent means of three replicates; **FDM – Fat in dry matter; *** % Lactic acid. Values with different superscript letters within the same column are significantly different ($p < 0.05$). C100 = no addition; C80 = 20% cow's milk added; C70 = 40% cow's milk added; C60 = 40% cow's milk added.

Table 2 – Effects of added cow's milk to buffalo's milk on textural characteristics of Marajó "Cream cheese".

Formulation	Textural characteristics						
	Hardness (N)	Fracturability (N)	Adhesiveness	Springiness (mm)	Cohesiveness	Gumminess (N)	Chewiness (N. mm)
C100	33.00 ± 5.20^{a}	26.20 ± 7.30	- 42.78 ± 8.65	4.69 ± 0.24^{a}	0.44 ± 0.03^{a}	14.52 ± 2.08	$68.2\ 4 \pm 10.10^{a}$
C80	29.03 ± 5.03^{a}	26.40 ± 3.85	- 54.85 ± 20.12	5.25 ± 0.24^{b}	0.38 ± 0.05^{a}	11.00 ± 2.03	57.75 ± 18.2^{a}
C70	25.46 ± 4.17^{a}	30.20± 5.12	- 66.11 ± 20.98	5.85 ± 0.13^{c}	0.42 ± 0.01^{a}	10.70 ± 3.00	62.59 ± 19.0^{a}
C60	24.02 ± 3.00^{b}	25.40 ± 3.67	- 46.67 ± 14.94	6.52 ± 0.33^{d}	0.54 ± 0.06^{b}	13.00 ± 2.12	84.76 ± 22.6^{b}
P value*	0.025	0.523	0.176	< 0.001	<0.001	0.579	0.005

* Statistical analysis was using ANOVA post-hoc Tukey's tests. Each value represents mean ± SD; data represent means of three replicates. Values with different superscript letters within the same column are significantly different ($p < 0.05$). C100 = no addition; C80 = 20% cow's milk added; C70 = 40% cow's milk added; C60 = 40% cow's milk added

not recover well from compression (TUNICK; VAN HEKKEN, 2002). The fat globules in cow's milk, which are smaller (GANGULI, 1979) than those in buffalo's milk, may have caused the increase of this parameter. According to Marshall (1990), in cheese, a smaller fat particle size is associated to a more elastic product. When the diameter of fat globules is reduced, they are more uniformly distributed and in larger number in the continuous phase (protein matrix), causing an increase of protein-protein and protein-fat interactions and, consequently, of elasticity (PEREIRA et al. (b), 2001). Therefore, this increase in the internal interactions of the protein matrix probably explains the lower elasticity of traditional cheese when compared to the other cheese types from admixtures with bovine milk.

Finally, for the parameters cohesiveness and chewiness the values increased with the increase in the concentration of added cow's milk. However only formulation C60, with 40% of added bovine milk, differed significantly from the other ones, being characterized as the cheese composition with higher resistance to chewiness. The cohesion was between 0.38 and 0.54, contrasting with 0.21, 0.28 and 0.41 for cheeses like freshCheddar, Gouda and Mozzarella (TUNICK; VAN HEKKEN, 2002). Therefore, artisanal Marajó "Cream cheese" is quite cohesive. The values of 5.73 – 8.43 N mm for chewiness were similar to those reported for cheese of the Feta type, elaborated from buffalo milk (KUMAR et al., 2011).

Correlation between physico-chemical and texture parameters

The correlation coefficients of Pearson between textural parameters and physico-chemical characteristics are presented in Table 3.

The data from Table 3 indicate that hardness and elasticity had a strong positive correlation with the pH value. In its turn, hardness also had strong positive correlation with protein, whereas elasticity showed a strong negative correlation. The meaning and importance of the correlation coefficients may be related to the type of formulation used and, in this experimental model, showed that protein and pH have an important role over the hardness decrease and elasticity increase of the cheese

Color analysis

In Table 4 are presented the results obtained from the instrumental evaluation of color for the four analyzed cheese types.

For all four cheese types, parameter a* had negative values, indicating a trend to the green color, while parameter b* had positive values, indicating a trend to a yellow color. For variables L*, a*, b*, C* and ho, significant differences were found between the cheese types. The color variation observed is related with the use of bovine milk as a substitute for buffalo

Table 3 – Linear correlations between physico-chemical and textural parameters [a]

	Texture characteristics						
	Hardness	**Fracturability**	**Adhesiveness**	**Springiness**	**Cohesiveness**	**Gumminess**	**Chewiness**
Moisture	- 0.785^{NS}	- 0.327^{NS}	0.127^{NS}	0.916^{NS}	0.796^{NS}	0.678^{NS}	0.844^{NS}
FDMb	0.841^{NS}	0.293^{NS}	- 0.018^{NS}	- 0.945^{NS}	- 0.729^{NS}	-0.712^{NS}	- 0.820^{NS}
Protein	0.998^{S}	- 0.216^{NS}	- 0.451^{NS}	- 0.976^{S}	- 0.461^{NS}	-0.912^{NS}	- 0.753^{NS}
pH	0.955^{S}	- 0.005^{NS}	- 0.321^{NS}	0.967^{S}	0.480^{NS}	0.782^{NS}	0.698^{NS}

[a] - Results expressed as Pearson's correlation coefficient (r); b - Fat in dry matter; S - Significant ($p < 0.05$); NS - Not significant ($p \geq 0.05$)

Table 4 – Mean composition and Hunter color (L*, a*, b*, C*, h*) values of Marajó "Cream cheese" types

Formulation	**Color parameters**				
	L*	**a***	**b***	**C***	**ho**
C100	86.76 ± 3.11^{a}	-4.18 ± 0.20^{a}	13.67 ± 1.04^{a}	19.53 ± 0.97^{a}	106.25 ± 4.42^{a}
C80	85.37 ± 1.12^{a}	-3.30 ± 0.44^{b}	17.33 ± 1.06^{b}	17.65 ± 0.98^{b}	100.70 ± 1.95^{b}
C70	83.92 ± 3.06^{b}	-2.12 ± 0.10^{c}	22.42 ± 1.75^{c}	22.52 ± 1.74^{c}	95.43 ± 0.59^{c}
C60	82.20 ± 1.87^{b}	-1.50 ± 0.29^{d}	23.95 ± 1.54^{d}	24.00 ± 1.53^{d}	93.61 ± 0.77^{c}
P value**	< 0.0001	< 0.0001	< 0.0001	< 0.0001	< 0.0001

**Statistical analysis was performed using ANOVA post-hoc Tukey's tests. Each value represents mean ± SD; data represent means of three replicates. Values with different superscript letters within the same column are significantly different ($p < 0.05$). C100 = no addition; C80 = 20% cow's milk added; C70 = 40% cow's milk added; C60 = 40% cow's milk added

milk, since differences in the color have a tendency to accentuate with the increase in the proportion of this substitution, which reduced the green color intensity caused by the absence in cow's milk, of a blue-green (biliverdin) pigment, present in buffalo's milk (ABD EL-SALAM; EL-SHIBINY, 2011), and also by the increase in concentration of the pigment β-carotene, present in cow's milk and absent in buffalo's milk. In this way the values of L and a* decreased while the values of b* increased; which means, with the increase in concentration of bovine milk, the cheese became darker, less white and more yellow in color. The values of L* were high, however lower than those reported for fresh cheese (GUO et al., 2011) and rennet cheese (ANDRADE et al., 2007).

The angle or color tone (ho) is the magnitude, in degrees, that characterizes the color quality in food and may be useful to measure the changes in their intensities in different process steps of food elaboration and conservation. In this study, both magnitudes were significantly affected by the addition of cow's milk to buffalo's milk in the making of the different "Cream cheese" types. The cheese made from buffalo's milk with 40% of bovine milk added had the greater C* value, that is, a more intense color (24.00) when compared to the others.

A linear increase was observed in the color intensity with the increase in concentration of added cow's milk, due to the larger amount of β-carotene pigment carried over. According to the above results, it is possible to observe that with an increase in the concentration of cow's milk added, there was increase in intensity of yellow color and decrease of green color, with alterations in yellow-greenish tone.

Sensorial Analysis

The average scores attributed to each one of the evaluated parameters (overall appearance, color, smell, taste and hardness) are presented in Table 5.

The four cheese types had averages over 6.0 for all sensory attributes, showing good acceptance by the cheese tasters. Although the bovine milk addition may cause a reduction in the parameters color, smell and taste (FUNDORA et al., 2001), all sensory attributes evaluated for the three cheese types made from with different percentages of cow's milk added to buffalo's milk, they did not differ statistically from those found (Table 5) for the traditional cheese (C100). Therefore the partial substitution of buffalo's milk up to 40% with cow's milk caused no significant sensorial alterations.

Figure 2 shows the frequency histogram for the attribute buying intention. Cheese from the formulation C60 had higher value than cheese from the formulation with 100% of buffalo milk (C100). A similar result was found by Sameen et al. (2008). Thus, it may be said that bovine milk has a good potential to improve the sensorial attributes of the traditional Marajó "Cream cheese".

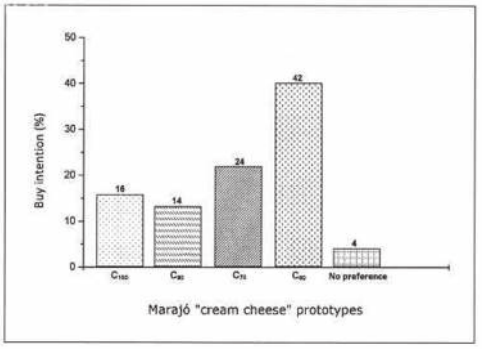

Figure 2 – Frequency histogram of scores for buy intention of artisanal Marajó "cream cheese" prototypes made from buffalo's milk with 0% (C100), 20% (C80), 30% (C70) and 40% (C60) cow's milk added to it. X2 = 40.40; p < 0.0001.

4 CONCLUSIONS

The partial replacement of buffalo's milk by

Table 5 – Mean scores for attributes appearance, color, smell, taste and hardness of Marajó "Cream cheese" types.

Formulation	Attributes[1]				
Appearance	Color	Smell	Taste	Hardness	
C100	7.08 ± 1.64	6.90 ± 1.73	7.20 ± 1.41	7.06 ± 1.67	7.50 ± 1.54
C80	7.54 ± 1.34	7.32 ± 1.39	6.28 ± 1.83	7.12 ± 1.65	7.24 ± 1.78
C70	7.60 ± 1.03	7.54 ± 1.07	6.92 ± 1.43	6.94 ± 1.79	7.12 ± 1.85
C60	7.54 ± 1.28	7.46 ±1.31	6.74 ± 1.47	7.42 ± 1.51	7.54 ± 1.37
P value*	0.482	0.375	0.054	0.570	0.778

**Statistical analysis was performed using ANOVA post-hoc Tukey's tests. Each value represents mean ± SD; data represent means of three replicates. Values with different superscript letters within the same column are significantly different (p < 0.05). C100 = no addition; C80 = 20% cow's milk added; C70 = 40% cow's milk added; C60 = 40% cow's milk added

cow's milk promoted significant changes in the physico-chemical characteristics, in textural parameters and color attributes of artisanal Marajó "Cream cheese". However, the sensory evaluations by non-trained cheese tasters, representing the normal consumer, demonstrated that those differences were not clearly perceptible. Besides, the "Cream cheese" type elaborated from 40% of bovine milk added to buffalo's milk reached the highest ranking for buying intention. For those reasons, it is possible to conclude that the final quality of "Cream cheese" is not strongly affected with the substitution of up to 40% of buffalo's milk by bovine milk. This may be an interesting alternative for producers of this type of cheese, especially during the dry season period, without the risk of losing the product authenticity.

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