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Characterization of a processed cheese spread produced from fresh cheese (quesito antioqueño)

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Caracterización de un queso procesado untable elaborado a partir de queso fresco (quesito antioqueño)

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Key words:
Processed cheese
Fresh cheese
Emulsifying salts

ABSTRACT

Processed products are made from mixes of fresh and ripened cheeses; the use of cheeses with a short shelf-life in the development of processed cheeses is an alternative for the dairy industry. A processed cheese spread was made using only a soft and fatty fresh cheese that had been stored for 25 days. The primary materials were the fresh cheese, water, and emulsifying salts (sodium citrate (E-331) and sodium phosphate (E-450)), using a STEPHAN® Universal Machine (UMSK 24E) with indirect vapor injection and equipped with rasping and cutting blades. The resulting cheese (A) was compared with a commercial cheese (B) for compositional, physicochemical, and sensorial characteristics. The cheeses were similar except for the fat in dry matter (FDM), with values of 54.50% and 47.21%, respectively. Sensorially, there were significant differences (P<0.05) for firmness, viscosity, and flavor; however, the instrumental viscosity did not present significant differences (P>0.05). Cheese A provided, in mg per 100 g of product, 935.823 for phenylalanine, 1003.070 for isoleucine, 2041.420 for leucine, 475.337 for methionine, 119.300 for tryptophan, and 758.347 for valine. Producing processed cheeses with only fresh cheese is possible, resulting in a product that is similar to others that are currently on the market with typical characteristics that are accepted by consumers.

Palabras claves:
Queso fundido
Queso fresco
Sal fundente

RESUMEN

Los productos procesados o fundidos son elaborados a partir de mezclas de quesos frescos y madurados, el aprovechamiento de quesos de vida útil corta en la elaboración de este tipo de productos es una alternativa viable para la industria láctea. Un queso fundido tipo untable fue elaborado a partir de un queso fresco, blando, graso, con 25 días de almacenamiento; las materias primas fueron el queso fresco, agua y sal fundente (citrato de sodio (E-331) y fosfato de sodio (E-450)), usando una maquina universal STEPHAN® (UMSK 24E), con inyección indirecta de vapor y equipada con cuchillas cortadoras y raspadoras. El quesoobtenido, solo a partir del queso fresco (A) fue comparado con uno comercial (B) encaracterísticascomposicionales, fisicoquímicas y sensoriales. Los quesos A y B, fueron similares, excepto en el contenido de materia grasa en extracto seco (FDM) con valores de 54,50 y 47,21%, respectivamente. Sensorialmente existieron diferencias significativas (P<0,05) en la dureza, viscosidad y sabor, pero no fue así en la viscosidad instrumental (P>0,05). El queso (A) aporta, en mg por 100 g de producto, 935,823 de fenilalanina, 1003,070 de isoleucina, 2041,420 de leucina, 475,337 de metionina, 119,300 de triptofano y 758,347 de valina. Elaborar quesos fundidos, partiendo únicamente de un queso fresco, es viable generando un producto similar a algunos encontrados comercialmente, con características típicas y aceptado por el consumidor.

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The shelf-life of a natural cheese is limited by the action of bacteria and enzymatic reactions, which are favored by, among other things, the composition, the sanitary conditions during production and storage, which can last from a few weeks for fresh cheeses to several years for hard cheeses, and the need to transform deteriorated cheeses (sensorial and physically) into stable and commercial products. Processed cheeses were initially developed by recovering products with a short shelf-life, such as Camembert, Brie and Limburger in Germany, and the technique was perfected in Switzerland with the use of sodium citrate (Tamime, 2011).

Processed cheeses are produced by shredding or cutting natural cheeses with different degrees of ripening and mixing them with emulsifying agents under heated conditions, in a partial vacuum or at ambient pressure, until a homogenous mass is obtained (Hladká *et al.,* 2014). Per local legislation, other ingredients can be added, such as powdered milk, stabilizers, preservatives, water, meat, fruit, and spices, among others (Guinee*,* 2004).

In order to obtain a suitable balance between flavor and texture in processed cheeses, cheeses are selected for use depending on their type, flavor, composition (moisture content, fat, protein, calcium), ripening (degree of proteolysis), consistency, and pH. A good processed cheese must be smooth, homogenous, uniform in color and free of holes formed by fermentation; furthermore, the quantity of emulsifying salt used also plays an important role in the functionality and aspects of the final product and can compose up to 5% of the total mixture (Guinee*,* 2004; Tamime, 2011).

Emulsifying salts are used to obtain a homogenous and stable product and can be satisfactorily included at 2 to 3% of the initial cheese mixture (Weiserová *et al.,* 2011). Commonly, sodium phosphate, polyphosphates, citrates and combinations of these are used (Guinee*,* 2004). The principal role is to remove calcium, which connects casein to its hydrolyzed fractions in natural cheeses, and replace it with sodium ions. This process changes the calcium paracaseinate, which is insoluble, to sodium paracaseinate, which is soluble and an excellent emulsifier (Guinee*,* 2004; Cunha and Viotto, 2009; Hladká *et al.,* 2014).

Proteolysis is inversely related to the quantity of intact casein, while pH affects the quantity of calcium associated with the casein (Guinee*,* 2004). In immature cheeses, the casein molecules are whole; therefore, their emulsifying capacity remains intact, generating cheese spreads with long and soft textures. Casein, which is hydrolyzed during maturation, loses these properties, meaning the structure of the cheese spread will be short and spreadable (Piska and Stetina, 2004).

Quesito Antioqueño is a fresh cheese, it does not have any added bacteria, and has a shelf-life of 21 days, resulting in problems for the dairy industry due to the high level of returns which reach 5% (Sepulveda, 2007), these returns represent losses for the cheese industry. If these returns can be used to obtain another products, this will be a solution for cheese makers. The objective of this research was to characterize the processed cheese spread produced from Quesito Antioqueño with *Bifidobacterium bifidum* with 25 days of storage, using a comparison with a commercial product in terms of physicochemical, compositional and sensorial variables.

MATERIALS AND METHODS

Characterization of fresh cheese (Quesito Antioqueño)

The products were produced following the current sanitation requirements of Colombian legislative Resolution 2310 of 1986, and under the procedures developed by Sepulveda (2007) with the addition of *Bifidobacterium bifidum.* The fresh cheese was characterized before being used in the production of the cheese spread. The analyses were carried out in triplicate. The sample was prepared following method AOAC 955.30 (1997), with which strips of cheese were homogenized in a food processor.

The protein was determined with the Kjeldahl method, AOAC 991.20 (1997); for the ash, the cheese was incinerated at 550 ± 1 °C (AOAC 935.42, 1997); the fat content was determined with the Babcock volumetric method, as modified by AOAC 989.04 (1997); for moisture, the cheese was dried with forced air at 130 ± 1 °C for 1.25 h (AOAC 948.12, 1997). The water activity was determined with a hygrometer at a dew point of 25 °C ± 1 °C, series 3TE, Decagon Devices INC (Cortes *et al.,* 2007; López-Tenorio *et al.,* 2012); the pH was determined with a potentiometer, (Peláez *et al.,* 2003);

and the titratable acidity was recorded through titration with 0.1 N NaOH and phenolphthalein as an indicator at 2% (AOAC 947.05, 1997).

Production of the cheese spread

A STEPHAN® Universal Machine, UMSK 24E, was used to produce the processed cheese using a natural fresh cheese with *Bififobacterium bifidum* after 25 d of storage. The emulsifying salt contained 65% sodium phosphate and 35% sodium citrate.

The natural cheese was placed in the STEPHAN® machine without cutting or shredding it and was homogenized with cutting blades at 1200 rpm, indirect heating was used, up to 45 °C, then the 2.2% emulsifying salt was added and the heating was continued until 75 °C ± 2 °C and held for 10 min at 900 rpm. Afterwards, the product was cooled to 60 °C and placed in polypropylene containers. The entire process lasted 22 min. The resulting product was stored at 2 ± 2 ºC for 24 h in refrigeration before conducting the sampling for the determination of the physicochemical, sensorial and compositional variables. Using the same conditions, 4 replicates were carried out.

Compositional and physicochemical characterization of the cheese spread

The analyses were carried out in the resulting cheese (A) and the commercial cheese (B)with the same techniques that were used for the fresh cheese for the sample preparation, and the contents of protein, ash, fat and moisture; for the viscosity determination, the cheeses were put in a programmable Brookfield DV-III Ultra viscosimeter at 25 °C (Brookfield Engineering, 2008) with a velocity range of 0 to 50 rpm; the sodium (Na), potassium (K) and calcium (Ca) contents were determined with atomic absorption spectrophotometry (AOAC 985.35, 1997); the water activity was recorded with a hygrometer at a dew point of 25 °C ± 1 °C, 3TE series, Decagon Devices INC (Cortes *et al.,* 2007; López-Tenorio *et al.,* 2012); the pH was determined with a potentiometer (Peláez *et al.,* 2003) and the titratable acidity was done following the AOAC 947.05 method (1997), using 0.1 N NaOH and phenolphthalein as an indicator.

Amino acid content of the cheese spread

Phenylalanine, isoleucine, leucine, methionine, tryptophan and valine were only determined for the A cheese, following the 994.12 and 982.30 methods of the AOAC (1997).

Sensorial analysis

The methodology of Zhang *et al.* (2011), with a semi-trained panel, was followed, which established points of 0 to 100 for characteristics of color, appearance, firmness, viscosity, flavor, and oral sensation, as detailed in table 1.

Statistical Analysis

The obtained data were analyzed with the SAS® System using analysis of variance (ANOVA) and, in order to determine the differences between the means, a Tukey test.

Table 1. Standard sensorial evaluation of processed cheese.

Points	Color	Appearance	Firmness	Viscosity	Flavor	Oral sensation
100-70	Bright, defined cream color	Homogenous, smooth, and bright	Smooth and easy to spread	Adhesive capacity, easy to spread	Slight salt flavor, cheese flavor	Smooth and delicate, palatable
69-40	subdued cream color	Refined, a little dry or strange	Very smooth or a little hard, not easily spread	Strong cohesiveness, difficult to spread	Strong flavor, predominating salt note	A little hard or liquid, abnormal
39-10	Faint color, slightly veining	Granularity, dry or strange	Hard, difficult to spread	Little adhesion, difficult to spread	Little cheese flavor or flavorless	Oily and sticks to teeth
9-0	Streaked or without uniformity	Fat separation, separation of solid and liquid	Hard, without spread characteristics or liquid without body	Without adhesion or protein aggregation	Strange flavor, chemicals	Particles present, very oily, objectionable

RESULTS AND DISCUSSION

Characterization of the fresh cheese (Cheese from Antioquia)

The results obtained for the product with 25 d of storage are presented in table 2.

Similar results were obtained by Sepúlveda (2007), who evaluated Quesito Antioqueño that was stored for 21 d, obtaining a pH of 5.71 and an acidity of 0.16% for lactic acid, which indicated the development of acidity and the deterioration of the organoleptic qualities of the product; similar to the findings of the present study. From this cheese, the processed cheese spread was produced.

Physicochemical characterization of the processed cheese spread

The results obtained for the A and B cheeses are in table 3. The moisture, pH, total solids and ash did not present significant differences ($P>0.05$).

The protein content presented significant differences between cheese A and cheese B ($P<0.05$). For A, it was 13.81%, similar to that obtained by Dimitreli and Thomareis (2008), who mixed gouda cheese with water, butter, and powdered skim milk and obtained a range of 12% to 15%. This result is higher than that reported by Cunha and Viotto (2009), who obtained between 10.37% and 10.63% for protein. This content is characteristic of fresh cheese, as can be seen in Table 2; furthermore, the primary materials did not aggregate, which added value to this percentage. The higher content in B must have been that it was obtained from mature cheese, which had drier material and protein as compared to the Quesito Antioqueño that was used in the present study. The protein content in the commercial cheese was connected to the primary materials and processing conditions, which were not controlled in this study and which were carried out by the producing company.

Table 2. Physicochemical characteristics of the Quesito Antioqueño.

Characteristic	Quesito Antioqueño
Moisture (%)	59.52
Water activity	0.95
pH	5.84
Fat (%)	19.79
Acidity (%) (lactic acid)	0.13
Ash (%)	3.62
Protein (%)	14.61

The moisture content of cheese A was 57.33% and 59.4% in cheese B, similar to that reported by Pereira *et al.* (2001) and Ruiz (2007) for processed cheese spreads with values of 58.02% and 58.2%, respectively. Cunha and Viotto (2009) reported 62.77% and 63.49% moisture. This characteristic is connected to the initial primary materials and the formulation, which was carried out in compliance with the Code of Federal Regulations (2013), which provides for between 44% and 60% for cheese spreads. This variable is vital for a suitable cheese texture (Pereira *et al.,* 2001) and, furthermore, is directly linked to the pH of the product because, when casein is close to the isoelectric point, it has a lower capacity for retaining water and binding other compounds (Perez and Perez, 2008). The fat content was 23.3% for cheese A and 19.19% for cheese B, presenting significant differences ($P<0.05$), but similar to the fresh cheese (Table 3). Dimitreli and Thomareis (2008) reported similar data: 20% on average for cheese spreads; Cunha and Viotto (2009) obtained 23% with the addition of milk cream to the finished product. The fat content in the processed cheese must have been due to the composition of the natural fresh cheese or to the addition of fat sources. The content of the fat in the dry material (FDM) was 54.5% for cheese A and 47.21% for cheese B; according to Guinee (2004) and Law and Tamime (2010) this percentage should not be lower than 47% for processed pasteurized cheeses. Kapoor and Metzger (2008) postulated that, in cheeses with between 40 and 60% moisture, the fat content must be more than 20%.

Table 3. Physicochemical and compositional characteristics of the A and B cheeses.

Characteristics	Cheese A	Cheese B
Protein (%)	13.8[a]	16.3[b]
Moisture (%)	57.3[a]	59.4[a]
pH	5.8[a]	5.7[a]
Fat (%)	23.3[a]	19.1[b]
DM (%)**	42.75[a]	40.63[a]
FDM (%)***	54.50[a]	47.21[b]
Ash (%)	5.64[a]	5.08[a]

* Values within a row with different superscripts differ significantly ($P<0.05$).
** DM=Dry matter
*** FDM= Fat in dry matter

The instrumental viscosity of cheese A and B can be seen in figure 1.

The viscosity of cheese A presented values between 716.39 Pa.s at 3.58 rpm and 559.36 Pa.s at 50 rpm, indicating that, at a higher shear, the product had a lower viscosity. This behavior was similar to that observed in the commercial cheese, but with lower values, as seen in table 4 and figure 1, with 531.08 Pa.s at 3.58 rpm and 419.65 Pa.s at 50 rpm; values similar to those reported by Ruiz (2007) and Monroy (2007) for a cheese spread made from mature cheeses and by Frau *et al.* (2005) for cheese spreads made from fresh cheese.

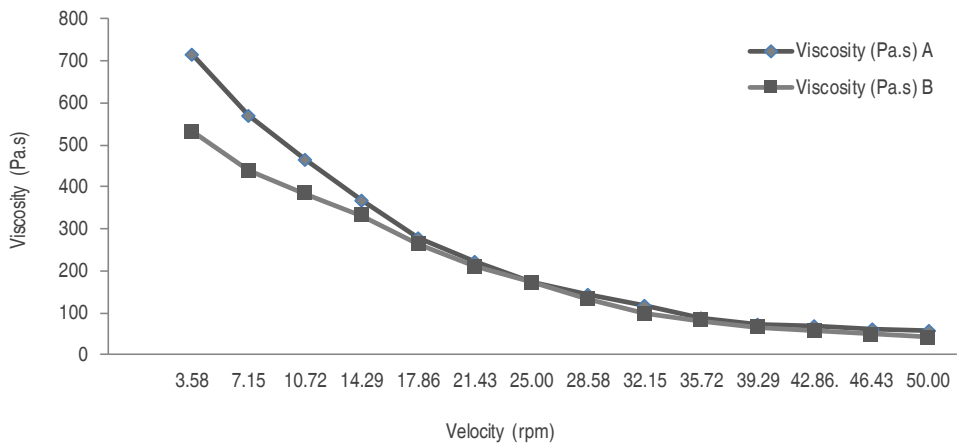

Figure 1. Viscosity of cheese A and B at 25 °C.

There were no significant differences for viscosity in the two cheeses ($P>0.05$), despite the slightly lower values in the commercial cheese. This behavior resulted from the initial materials of each product; for example, the fresh cheese had casein molecules in their original state that resulted in firm structures with a higher viscosity (Piska and Stetina, 2004); on the other hand, cheese B resulted from the mixture of mature cheeses that had developed a broad range of flavors and textures through the breaking down of amino acids, fatty acids, and lactic acid (Sousa, 2001); this mixture produced textures that were smoother, shorter, and more spreadable and with less viscosity due to protein hydrolysis (Guinee, 2004). In this sense, the age (level of proteolysis) appears to produce major effects, as reflected by the use of cheese age as a major selection criterion for blend formulations at the production level. Block processed cheeses with good sliceability and elasticity require young cheeses (70-90% intact casein),

whereas predominantly medium-ripe cheeses (60-75% intact casein) are used for cheese spreads (Fox *et al.,* 2004)

Amino acid content of cheese spread A

The results are shown in table 4. According to the World Health Organization (WHO) (2007), the estimated daily requirements for the following essential amino acids in mg per kilogram of body weight (mg kg^{-1} in body weight per day) are: phenylalanine 25, isoleucine 20, leucine 39, methionine 10, tryptophan 4 and valine 26. In a person weighing 70 kg and taking into account the above values, a cheese portion, according to Resolution 333 of 2011 of the Ministerio de la Protección Social of Colombia, of 30g would provide 16.3% of the required phenylalanine, 21.5% of the required isoleucine, 20.3% of the required methionine, 12.8% of the required tryptophan and 12.5% of the required valine per day.

The product had a significant essential amino acid content for the diet of consumers and was similar to the findings of El-Shazly *et al.* (2010) for a cheese spread, who obtained, in mg per 100 g of product, 1104 for phenylalanine, 725.92 for isoleucine, 1584 for leucine, 445.2 for methionine, and 768.72 for valine.

Table 4. Amino acid content of cheese spread A .

Amino acid	Content (mg 100 g^{-1})
Phenylalanine	935.8
Isoleucine	1003.0
Leucine	2041.4
Methionine	475.3
Tryptophan	119.3
Valine	758.3

Results of the sensorial evaluation

Table 5 shows the results for cheeses A and B. There were no significant differences between cheeses A and B for color, appearance or oral sensation ($P>0.05$). Cheese A had an intense, defined color, a characteristic desired by consumers; the color was creamy white, similar to that of the fresh cheese. Furthermore, the texture was homogenous without the presence of clumps or precipitates, confirming the effective action of the dissolving salts used in this study. There was no enzymatic browning due to the short heating and agitation time. The appearance of cheese A was homogenous, smooth and refined, accepted by the panel members, and similar to cheese B. This characteristic resulted from the appropriate use of emulsifying salts (Sádlíková *et al.,* 2010) because these salts capture the calcium of the caseins and exchange it for sodium, generating paracaseinate, which is an excellent emulsifier, and peptizing, hydrating, filling, solubilizing, and dispersing it (Awad *et al.,* 2001; Weiserova *et al.,* 2011; Hoffmann *et al.,* 2012). The oral sensation was smooth and agreeable in cheese A and cheese B, which is ideal for these types of products (Guinee, 2004; Ruiz, 2007).

The characteristics of firmness, viscosity, and flavor presented significant differences ($P<0.05$) for A and B. The former was firmer and was difficult to spread despite having compositional and physicochemical characteristics that are typical for cheese spreads. On the other hand, B was easy to spread. This phenomenon can be explained by the fact that cheese A was produced using fresh cheese and, in this cheese, the casein was not significantly hydrolyzed, resulting in a harder, firmer product with noticeable stretched characteristics, with a low capacity for being spread and a high emulsifying capacity (Piska and Stetina, 2004); whereas, the evaluated commercial cheese obtained from a mixture of mature cheese had a smooth, spreadable, and short structure (Guinee, 2004; Bunka *et al.,* 2013).

In terms of flavor, A was predominately salty due to the use of emulsifying salts, necessary for the formation of a smooth, homogenous and stable structure (Guinee, 2004); furthermore, there was a low development of flavor because the primary material only included the fresh cheese. On

Table 5. Sensory results obtained for the A and B cheeses.

Characteristic	Cheese A	Cheese B
Color	64.85[a]	69.66[a]
Appearance	72.50[a]	78.03[a]
Firmness	67.75[a]	76.85[b]
Viscosity	61.68[a]	71.96[b]
Flavor	66.92[a]	80.00[b]
Oral Sensation	69.57[a]	71.62[a]
Average value	**67.22**	**74.69**

*Values within a row with different superscripts differ significantly (P<0.05).

the other hand, cheese B had a slightly salty flavor that was agreeable, a characteristic of processed cheeses due to the fact that they are produced for the most part from mature cheeses in which texture and flavor have been developed by breaking down amino acids, fatty acids, and lactic acid (Sousa, 2001; Guinee, 2004).

CONCLUSIONS

The production of processed cheese spreads from fresh cheeses resulted in a product with very good compositional and sensorial qualities, which was suitable under the specifications of the FDA; when compared with a commercial cheese; there were no significant differences (P>0.05) in almost all of the composition, except for the fat content, or for the acceptance and viscosity, as measured with an instrument, resulting in an important and viable alternative for the dairy industry for reducing the amount of returned cheese and for maintaining the traditions of the products, generating a cheese spread from fresh cheese without using combinations. The amino acid content was important in terms of contributing a significant part of the intake of the daily recommended amounts of amino acids; the total protein content was 13.31% and the fat content was 23.31%, resulting in a notable food product in terms of nutrition for different groups of people due to its versatility and ease of consumption.

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