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Manufacturing characteristics and shelf life of Quesillo, an Argentinean traditional cheese

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Abstract

Quesillo is a pasta filata cheese variety typical of the Argentine Northwest. Some features of this cheese are reviewed: gross composition, manufacturing technology and shelf life microbiological composition. Gross composition showed: pH 5.1, fat 21.21%, protein 29.02%, total solids 51.50%. The manufacturing methods compared were (1) traditional, with raw milk and native flora growth (TM), (2) experimental 1, with pasteurized milk, lactic starters and conventional, plastic bag packaging (EM1); (3) experimental 2, with pasteurized milk, lactic starters and vacuum packaging (EM2). EM1 and EM2 showed that total processing time is shortened by 8 h with regard to TM. Microbiological quality was better in EM1 than TM, but it was the best in EM2, thus obtaining a longer shelf life product.

Keywords: Quesillo; Argentine artisanal cheese; Shelf life; Cheese type pasta filata

1. Introduction

Quesillo is an artisanal cheese of the Argentine Northwest. It is made on small farms with traditional recipes and sold as a typical regional food. The earnings are an important resource for the farmers.

Quesillo belongs to the category of stretched curd or "pasta filata" cheeses. It is eaten fresh with other foods and desserts. Although it is one of the most popular regional cheeses, its technology and manufacturing have been scarcely studied by food specialists (Cisint, Oliszewski, Vercellone, & Núñez de Kairúz, 2002a, 2002b; IRAM Argentine Standard, 2001; Oliszewski, Cisint, Vercellone, & Núñez de Kairúz, 2002; Patiño, Faisal, Méndez, & Juri Chagra, 2001).

This cheese is customarily made by farmers on a small scale in their farmhouse using raw milk and traditional techniques, which include acidification by the indigenous lactic acid bacteria present in milk. It is common for farmers not to use pasteurized milk and lactic starters. Thus, Quesillo cannot be sold in the normal market and it remains confined to local consumption at small selling centers.

The cheese is characterized by its oval shape (20–30 cm long and 0.5–1 cm high). The mass is flexible and elastic. Weight can be variable (100–200 g). Texture is compact and firm. Color can be white or yellowish-white, according to the percentage of goat or cow milk in it. Taste is lactic and smooth. It lacks rind or eyes (IRAM Argentine Standard, 2001).

A great variety of world cheeses are made from raw milk with a better final flavor than those made from pasteurized milk, due to a higher degree of lipolysis and proteolysis during maturation (Albenzio et al., 2001; Olarte, Sanz, González-Fandos, & Torre, 2000; Rehman et al., 2000). Quesillo, however, is eaten fresh and, therefore does not have a period of maturation where the flavor is developed.

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The purpose of this paper was to study microbiological and some physicochemical properties of Quesillo, and to compare Quesillo shelf life when prepared according to three treatments: (1) traditional, with raw milk, (2) experimental, with pasteurized milk, lactic starters and common plastic bags packaging, and (3) experimental, with pasteurized milk, lactic starters and vacuum packaging.

2. Materials and methods

2.1. Milk treatment and cheese-making conditions

Two artisanal farms of Tucumán (Argentina) were selected. Two manufacturing in each farm were made, with three treatments for each manufacturing: the traditional one (TM), an experimental one with milk pasteurization, starter addition and traditional packaging (EM1), and an experimental technique with milk pasteurization, starter addition and vacuum packaging (EM2).

In each manufacturing process sixty liters of raw cow milk were equally divided in three batches to be used with each method. For the TM treatment, milk was kept overnight (12 h) at 25 °C, while for EM1 and EM2, milk was cooled to 4 °C (12 h) before pasteurization and addition of lactic starters (Fig. 1).

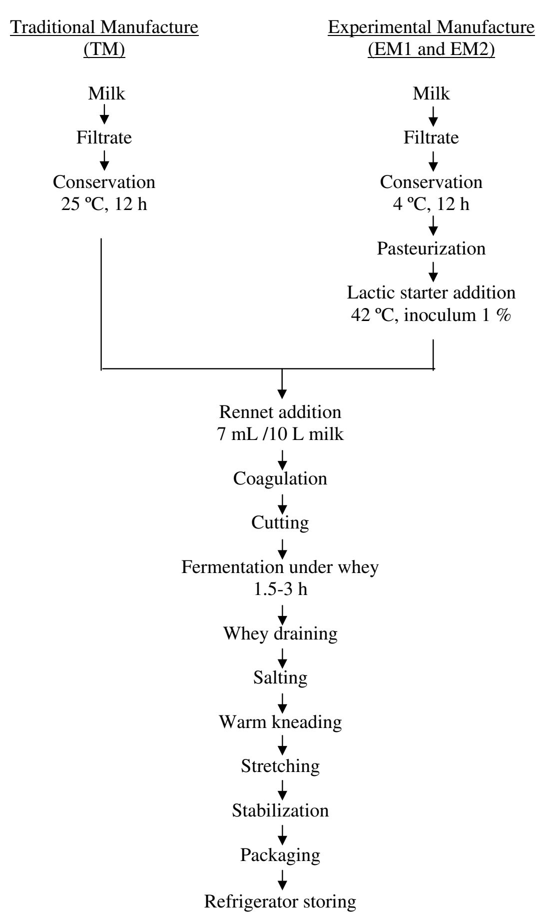

Fig. 1. Protocol for the production of Quesillo cheese.

2.2. Protocol for the production of Quesillo cheese

2.2.1. Cheese starter

The strains chosen as starter culture were *Lactobacillus delbruekii* subsp. *bulgaricus* CRL 423 and *Streptococcus thermophillus* CRL 728 (CRL: Centro de Referencia para Lactobacilos culture collection, Tucumán, Argentina). Each strain was grown for 12 h in MRS broth (Sigma, St. Louis, MO, US) and then inoculated into sterilized (110 °C, 20 min) reconstituted (10% w/v), skim milk powder. Several 10-fold culture successive dilutions were prepared and incubated overnight at 25 °C. The first dilution (in decreasing order) in which milk did not clot was used as a starter.

2.2.2. Traditional manufacture (TM)

The milk for traditional manufacture (TM) was filtered and incubated at room temperature (25 °C) for 12 h until acidity reached 25 °D (pH 6.1) taking into account that farmers traditionally manufacture their products by incubating milk for 10–13 h until acidity reaches 21–28 °D (pH 6.0–6.2). Then, the milk was heated to 37 °C before adding 7 ml of liquid cow rennet (Bugge, Argentina) per 10 l of milk. In 30–40 min, the curd was ready to be cut. The mass was sunk to the bottom of the vat for 140–180 min until reaching the ideal elasticity point. This was checked by heating an aliquot (20 g) in water at 70–75 °C until the proteins melted to reach the stretching and elasticity characteristic of the product. The mass was ready to be kneaded at pH 5.2. Then, the whey was removed and 200 g portions were kneaded in a container with 100–200 ml of water at 70–75 °C for 20–30 s and stretched until giving them their final elongated form, and were to rest for 10 min. Lastly, they were packed in common plastic bags and stored at 4 °C.

2.2.3. Experimental manufactures

In experimental manufactures 1 and 2 (EM1 and EM2), the remaining batches of milk were filtered and kept at 4 °C overnight. Then, the milk was pasteurized at 65 °C for 30 min before addition of thermophilic lactic starter at 42 °C. When milk pH of EM1 and EM2 milk was equal to that of TM milk, manufacture continued without changing the other parameters, except for the use of vacuum packaging in EM2 batch. The manufacturing procedure is described in Fig. 1.

2.3. Analyses

2.3.1. Physical and chemical analyses

Changes in pH (pHmetro Metrohm, model 962, USA) and titratable acidity (Casado Cimiano, 1991) of milk, whey and curd were monitored during cheese making. Dry matter content was determined according to the IDF Standard (International Dairy Federation, 1982). Total protein was determined by micro-Kjeldahl (rapid digestor unit model Labconco 60300-01, and rapid distillation unit model Labconco 65000, Missouri, USA) (International Dairy Federation, 1964, 1993) and fat content was established according to IDF Standard (International Dairy Federation, 1997a). All determinations were carried out by triplicate.

2.3.2. Microbiological analyses

The milk used in each treatment was analyzed immediately after extraction. Curd was analyzed before and after heating to evaluate its efficiency as a mass pasteurization method. Milk and cheese samples (10 ml or g) were homogenized in 90 ml sterile 0.1% peptone solution for milk and sterile 2% sodium citrate solution for cheeses. Decimal dilutions of the homogenates were prepared with sterile 0.1% peptone solution. Aliquots were then plated in specified culture media as follows: total mesophilic bacteria count, Plate Count Agar (Sigma, St. Louis, MO, US), incubated for 72 h at 30 °C; mesophilic lactic count, M17 agar (Sigma, St. Louis, MO, US), and MRS agar (St. Louis, MO, US), both incubated for 48 h at 30 °C under anaerobic conditions (CO_2); total coliforms were counted on Violet Red Bile Agar (Difco) (31 °C, 24 h) according to the IDF Standard 73B (1998); faecal coliforms, were determined by the MPN method for a three tubes series in Brilliant Green Lactose Broth (BGBL, Difco) incubated at 44 °C for 48 h (ICMSF, 1978). Coagulase positive staphylococci, salmonella and *Escherichia coli* were analyzed according to the IDF Standards (International Dairy Federation, 1997b, 1995, 1999). Results were expressed as log of colony forming units per milliliters for milk (cfu ml^{-1}) or log cfu g^{-1} for cheese. All determinations were carried out by triplicate.

2.4. Quesillo shelf life

Once manufactured TM and EM1 batches were packed following the traditional farmers' packaging (common plastic bags), while EM2 batches were vacuum packed (Turbovac HFE vacuum systems 320-ST-S, The Netherlands). Then they were kept in refrigerator at 4 °C. Microbiological determinations and pH were performed on TM, EM1 and EM2 Quesillo after 1, 11, 20, 35 and 50 days to assess product shelf life.

2.5. Statistical analyses

Analysis of variance (ANOVA) was performed using Minitab® Release 14 Statistical Software, 2003 Minitab Inc. Tukey's test was performed for means comparison using the same program. Means bearing different superscripts differed significantly ($p < 0.05$).

3. Results and discussion

3.1. Gross composition

Gross composition of Quesillo and raw milk used for cheese making is shown in Table 1.

3.2. pH, titratable acidity, and cheese making time

Quesillo pH changes during manufacture are shown in Fig. 2. As it can be seen, natural milk acidification requires a long time (12 h) in the traditional manufacturing method. This time is shorter in the experimental procedure (only 80 min) due to the presence of the lactic starter. Other cheeses traditionally manufactured with raw milk showed the same reduction in the acidification time when cheeses were made with pasteurized milk and a lactic starter (Olarte et al., 2000). Therefore, the total processing time is shortened by 8 h with regard to the traditional treatment, thus improving microbiological quality by limiting pathogen potential growth.

Table 1
Gross composition of Quesillo cheese and raw milk used for cheese making

	Raw milk	Quesillo
pH	6.47 ± 0.031	5.10 ± 0.180
Titratable acidity	14.7 ± 0.582	ND
% Fat	3.31 ± 0.164	21.21 ± 4.151
% Protein content	3.17 ± 0.039	29.02 ± 2.154
% Solids content	12.15 ± 0.691	51.50 ± 4.710

ND: no determined.

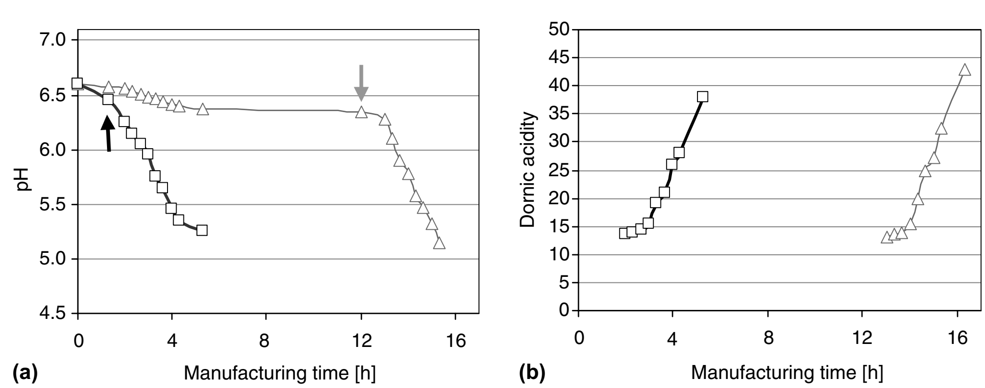

Fig. 2. pH evolution of curd (a) and titratable acidity of whey (b) in traditional manufacturing △ and experimental manufacturing □ during Quesillo cheese making. The time of rennet addition is indicated with an arrow.

3.3. Microbiological analyses

The total mesophilic counts in milk kept overnight at 25 °C (TM) were slightly higher ($p < 0.05$) than in refrigerated milk stored overnight (EM1 and EM2) (Table 2). A count of 4.70 log after 12 h at 4 °C in EM1 and EM2 raw milk indicates that it was close to the upper standard limits of acceptance in the milk processing factories. The total coliform counts did not increase in TM milk in spite of being kept at 25 °C for 12 h. This was probably due to the growth of indigenous lactic flora, which acts as a natural inhibitor. Faecal coliforms were not detected in EM1 or EM2 milk but were in TM milk. This shows the importance of storing raw milk at 4 °C before cheese processing. Coagulase positive *Staphylococcus* and *Salmonella* ssp. were absent in all samples.

The curd heating process, a fundamental step to achieve the melting of the curd, and their evaluation as a possible pasteurization method of the mass, showed a decrease of total and faecal coliforms after heating in the traditional manufacture (Table 3). However, even though the curd was stretched in water at 70–75 °C, immersion time (20–30 s) did not seem to be enough to reduce coliform counts to the values accepted by Argentine law (limits for this type of cheese are 3.7 log cfu g^{-1} for total coliforms and 2.7 log cfu g^{-1} for faecal coliforms). Although the mass for EM cheeses before heating comes from pasteurized milk, the presence of total coliforms is probably due to the poor hygienic conditions of cheese manipulation after pasteurization, a very common situation in the manufacturing of this artisanal product. Faecal coliforms were not detected in the experimental lots after heating.

Quesillo shelf life analysis (Table 4) showed differences among batches TM, EM1, and EM2, in the evolution of total and faecal coliforms and acid lactic bacteria. TM surpassed the allowed limits by Argentine law for total coliforms (3.7 log cfu g^{-1}) and faecal coliforms (2.7 log cfu g^{-1}) (Argentinean Alimentary Code, 1996). At day 1 it showed 3.80 ± 0.21 log cfu g^{-1} for total coliforms and surpassed limits largely at day 11 of storage (4.61 ± 0.19 log cfu g^{-1} for total coliforms and 3.95 ± 0.14 log cfu g^{-1} for faecal coliforms). EM1 had the allowed levels by the Argentine law at days 1 and 11 but surpassed the accepted limits at day 20 (4.57 ± 0.24 log cfu g^{-1} for total coliforms and 3.84 ± 0.19 cfu g^{-1} for faecal coliforms). Other raw milk cheeses showed high coliforms counts at the beginning of the ripening (Beuvier et al., 1997; Estepar, Sánchez, Alonso, & Mayo, 1999; Rehman et al., 2000; Zarate, Belda, Pérez, & Cardell, 1997). Coagulase positive staphylococci and Salmonella spp. were not detected in all cheeses, a result different from that of other cheeses manufactured with raw milk, where a high population of *Staphylococcus aureus* was found in the first days of maturation (Olarte et al., 2000). Vacuum packaged Quesillo (EM2) total coliform counts at the beginning of storage were within the levels accepted by Argentine law and they were not detected at the end of storage. In addition, faecal coliforms were not detected in EM2 at any time of storage. On the first day of storage one of the

Table 2
Bacteriological counts (log cfu g^{-1}) of raw milk stored overnight at 4 °C (TM milk) and raw milk stored at 25 °C overnight (EM1 and EM2 milk) for Quesillo manufacturing

	Total mesophilic count	Total coliforms	*Faecal coliforms*
Raw milk of TM procedure	5.23 ± 0.071^a	3.74 ± 0.196^a	2.87 ± 0.128^a
Raw milk of EM1 and EM2 procedure	4.70 ± 0.140^b	3.60 ± 0.212^a	$<0.48^b$

Different superscripts in the same column of the table indicate significant differences between treatments ($p < 0.05$).

Table 3
Bacteriological counts (cfu g^{-1}) of curd before and after heating during cheese making

	CAA	Traditional manufacture		Experimental manufacture	
		Before heating	After heating	Before heating	After heating
Total coliforms	3.7	7.59 ± 0.080^a	3.80 ± 0.214^b	2.46 ± 0.171^c	$<1^d$
Faecal coliforms	2.7	3.69 ± 0.122^a	2.29 ± 0.157^b	$<0.48^c$	$<0.48^c$

CAA: Limit values by Argentinean law. Different characters in superscript in the same row of the table indicate significant differences between treatments ($p < 0.05$).

Table 4
Bacteriological counts (log cfu g^{-1}) at 1, 11, 20, 35 and 50 day of storage of Quesillo cheeses elaborated by the traditional manufacture (TM) and experimental procedures (EM1 and EM2)

	TM	EM1	EM2
Total coliforms			
Day 1	3.80 ± 0.210^a	$<1^d$	1.97 ± 0.10^c
Day 11	4.61 ± 0.192^a	3.18 ± 0.041^b	$<1^c$
Day 20	5.75 ± 0.138^a	4.57 ± 0.240^b	$<1^c$
Faecal coliforms			
Day 1	2.29 ± 0.160^a	$<0.48^c$	$<0.48^c$
Day 11	3.95 ± 0.142^a	2.15 ± 0.213^b	$<0.48^c$
Day 20	4.89 ± 0.140^a	3.84 ± 0.189^a	$<0.48^c$
Bacterial counts in MRS			
Day 1	6.72 ± 0.171^a	6.71 ± 0.231^a	8.00 ± 0.064^b
Day 11	7.66 ± 0.259^a	8.17 ± 0.124^a	6.99 ± 0.117^b
Day 20	6.86 ± 0.221^b	8.40 ± 0.141^a	4.99 ± 0.161^c
Day 35	ND	ND	3.96 ± 0.273
Day 50	ND	ND	2.02 ± 0.030
Bacterial counts in M17			
Day 1	7.16 ± 0.171^a	6.84 ± 0.091^a	8.69 ± 0.108^c
Day 11	7.83 ± 0.130	8.25 ± 0.101	7.81 ± 0.133
Day 20	5.86 ± 0.152^c	7.80 ± 0.120^a	5.99 ± 0.121^c
Day 35	ND	ND	5.00 ± 0.070
Day 50	ND	ND	3.00 ± 0.094

Different characters in superscript for the same day of storage in the same group of microorganism indicate significant differences between treatments ($p < 0.05$). ND: not determined.

EM2 cheeses showed positive total coliform counts probably due to manipulating contamination. Even so, the contaminant did not find appropriate conditions to grow in the vacuum packaging. The differences found can be explained by the thermal treatment of the milk and the addition of starter cultures to EMI and EM2, as well as by the type of packaging used in EM2. The product reaches less than 20 days' aptitude with the thermal treatment while vacuum packaging lengthens its shelf life up to 50 days. It is also probable that the differences between EM1 and EM2 are due to the hygiene conditions of the packing bags used in EM1, since the manufacturers use common bags not specifically of alimentary grade. Additionally, vacuum packaging anaerobic conditions do not allow total and faecal coliforms to grow.

Analyses of TM and EM1 Quesillos were carried out until day 20 of storage, because at that time their microbiological composition already made them unsuitable for human consumption according to the Argentinean law. EM2 Quesillo was analyzed until day 50 of storage to find out whether the consumption limit could be extended.

Lactic acid bacteria had a variable behavior during the storage. TM and EM1 cheeses did not show differences at day 1 of storage. The highest lactic acid bacteria growth was observed in both EM1 and EM2 treatments together with a lower coliforms development. Vacuum packed cheeses (EM2) had the highest level at storage day 1 while Quesillo packed in common bags (EM1) did it at 11 storage day, probably due to the anaerobic environmental conditions obtained by vacuum packed procedure in EM2 cheeses. The progressive decrease of lactic acid bacteria as time elapsed may be due to the fact that Quesillo was stored at a temperature (4 °C) that was far from their optimum growth conditions.

4. Conclusions

Quesillo is a pasta filata cheese variety typical of the Argentine Northwest. In the present work we have studied microbiological and some physicochemical properties as well as the shelf life of the cheese manufactured and packaged with different technological procedures.

Pasteurizing milk and stimulating its acidification with a lactic acid starter shortened the manufacturing process several hours. Quesillo made with the traditional method presents high levels of total coliforms immediately after production, possibly due to the use of raw milk, which quickly loses aptitude during incubation at room temperature (25 °C). Hence, the use of pasteurization should be highly recommended to get rid of pathogenic agents as well as lactic starters as protective cultures.

Although EM1 Quesillo shows microbiological aptitude between days 1 and 11 after manufacture, it has a shelf life of less than 20 days according with Argentine law. For this reason manufacturers should stress the importance of extremely careful manufacturing practices to get a longer shelf life product.

The high quality evidenced by vacuum packaged Quesillo would make it advisable for farmers to implement this technique as a strategy to obtain a better, longer lasting product.

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