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Changes in quality of nonaged *pasta filata* Mexican cheese during refrigerated vacuum storage

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ABSTRACT

Six batches of Oaxaca cheese (a Mexican *pasta filata* cheese) from 3 dairy plants were sampled and vacuum-packaged at 8°C up to 24 d. Counts of principal microbial groups, pH, levels of sugars, organic acids, lipolytic and proteolytic indices, and texture, color, and meltability values of cheeses were studied at d 1, 8, 16 and 24 of storage. A descriptive sensory analysis of selected taste, odor, and texture characteristics was also carried out. The main changes in the cheeses during the storage were decreases in pH, hardness, elasticity, and whiteness, and an increase in meltability. Neither lipolytic nor proteolytic activities were evident during the storage of cheeses. Storage time resulted in a gradual quality loss of unmelted cheeses. This loss of quality might be related to the decrease of hardness and the appearance off-flavors.
Key words: Oaxaca cheese, cheese shelf life, stretched curd, traditional cheese

INTRODUCTION

Changes in the quality characteristics of several well-known styles of *pasta filata* cheese during refrigerated storage; for example, low-moisture mozzarella, Italian mozzarella, (Kindstedt, 1993; Costabel et al., 2007; Kindstedt et al., 2010), have shown that storage time affects texture and melting properties of cheese. Thus, cheese quality appears to improve during the first weeks of storage and then declines due to excessive softness and fluidity when cheeses are melted. Changes in pH, acidity, color, and the structure of *para*-casein fibers during storage have also been described. The above-mentioned effects and changes have been mainly attributed to proteolysis, fermentation of residual carbohydrates, and calcium dissociation and protein solvation processes. Furthermore, it has been found that cheese milk composition and manufacturing conditions (e.g., stretching conditions, salt content) play an important role in the changes in composition and functionality of *pasta filata* cheeses during storage (Yun et al., 1993; Rudan et al., 1999: Kindstedt et al., 2010).

Oaxaca cheese is a nonaged *pasta filata* cheese very popular in Mexico, and which is widely used to prepare dishes in which it is typically melted (Domínguez-López, et al., 2011). This semi-soft cheese is characterized by a visible fibrous texture (resembling chicken breast) and a characteristically mild flavor (Villanueva-Carvajal et al., 2012). Oaxaca cheese has been, and is still, made from raw milk in small-scale dairy plants, although when produced on a medium- and large-scale, it is usually made from pasteurized milk (Domínguez-López et al., 2011). The making process of Oaxaca cheese involves, as key steps, mixed coagulation of milk, acidification of curd to a pH of approximately 5.3, kneading and stretching of the acidified curd in hot water (approximately 80°C), when long thin strips of curd are formed, salting of strips by adding dry salt, and finally cutting of strips into segments that are wound to form ball-shaped 0.25- to 5-kg pieces of cheese (Aguilar-Uscanga et al., 2006; Colín-Cruz et al., 2012). At present, Oaxaca cheese for retail sale is commonly vacuum-packaged to preserve its freshness for longer. Composition and processing of Oaxaca cheese (De Oca-Flores et al., 2009; Morales-Celaya et al., 2012) resemble, to some extent, those of Asadero cheese (Alba et al., 1990), another Mexican *pasta filata* cheese, and low-moisture mozzarella cheese (Kindstedt, 1993).

Although the effects of storage on quality of a variety of *pasta filata* cheeses have been well documented, the changes that occur in Oaxaca cheese during storage have not been studied. Therefore, the present study aimed to evaluate the significance of refrigerated storage on selected quality characteristics (chemical, microbiological, functional, and sensorial) of Oaxaca cheese produced following traditional methods. This research will add knowledge about the effects of refrigerated storage on *pasta filata* family of cheeses.

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MATERIALS AND METHODS

Sampling

Six batches of raw-milk Oaxaca cheese from 3 small plants (Valle de Tucilango de Bravo, Hidalgo, Mexico) were sampled (2 batches per plant being prepared on different days). Samples consisted of 4 vacuum-packaged cheeses per batch, each cheese weighing approximately 1 kg. Samples were taken randomly within the first 24 h after production, and then transported under refrigeration to the laboratory, where samples were stored in a chamber at 8°C (the storage temperature used by local retailers) for up to 24 d. A cheese from each batch was sampled from the chamber at d 1, 8, 16, and 24 of storage for further analysis.

Microbial Analysis

From each sample, just after sampling, a 10-g aliquot was obtained aseptically by means of radial cuts and homogenized in 90 mL of buffered peptone water (Oxoid Ltd., Basingstoke, UK) according to IDF (1995, 1996) using a Stomacher 400 circulator (Seward Ltd., London, UK) for 2 min. Duplicate serial dilutions were prepared in buffered peptone water, and then 1 mL of each dilution was plated on specific media.

Counts of aerobic mesophilic bacteria were determined on plate count agar (Difco Laboratories, Detroit, MI) incubated at 32°C for 48 h. Lactic acid bacteria (**LAB**) were enumerated on different media according to the bacterial genus to be tested and using the double-layered agar method (Fox et al., 2000): *Lactobacillus* spp. on de Man, Rogosa, Sharpe agar (MRS; Oxoid) adjusted to pH 5.5 with lactic acid; *Lactococcus* spp. on M17 agar (Oxoid); and *Enterococcus* spp. on KF *Streptococcus* agar (Oxoid). The MRS and M17 agar plates were incubated at both 30°C and 45°C for 48 to 72 h to differentiate between mesophilic and thermophilic LAB, respectively; and KF *Streptococcus* agar plates were incubated at 35°C for 48 h. Furthermore, molds and yeasts were determined on potato dextrose agar (Oxoid Ltd.) acidified using 10% tartaric acid to pH 3.5, at 22°C for 7 d; and *Escherichia coli* and coliforms were studied on 3M Petrifilm *Escherichia coli*/coliform plates (3M Microbiology, St. Paul, MN) at 37°C for 24 to 48 h.

Chemical Analysis

A 150-g subsample was taken from each cheese for chemical analysis. Subsamples were homogenized and stored for up to 3 mo at −20°C for further analysis. Cheeses were analyzed for moisture (atmospheric oven method), protein (Kjeldahl method), and ash (dry ash method) in accordance to the procedures described by AOAC International (1999), and fat was analyzed using Van Gulik butyrometers (IDF, 1986). Lactic and acetic acid contents were determined using a chromatographic method (González de Llano et al., 1996). Sugars were analyzed using the same method except that the column temperature was 60°C, detection was performed using a differential refractometer, and the eluent was 5 m*M* H_2SO_4 at a constant flow rate of 0.6 mL/min.

For the analysis of FFA, cheese fat was extracted (Bligh and Dyer, 1959) and FFA were subsequently extracted from the fat and methylated (García-Regueiro et al., 1994). Then, FAME were identified and quantified by gas chromatography (Osorio et al., 2007). Water-soluble nitrogen (**WSN**) was measured by Kjeldahl procedure from an aqueous extract of cheese obtained as follows: 10 g of cheese was homogenized in 80 mL of water, and centrifuged at 750 × *g* at 20°C for 15 min; afterward, the supernatant was filtered and the residue was subjected to the above-mentioned steps. Both supernatants were mixed and used for analysis. Nonprotein nitrogen in 12% TCA was also determined by Kjeldahl procedure from 25 mL of the WSN extract. Moreover, α-amino N (α-NH_2) was determined by the ninhydrin method (Rosen, 1957).

Functional Properties

Flowability tests were carried out in triplicate following the method described by Guinee et al. (2000); results were expressed as the percentage increase in the cheese disc diameter upon heating at 280°C for 4 min. Color was measured on the surface of unmelted cheese samples at room temperature (20°C) using a spectrophotometer (CR-300, Minolta, Osaka, Japan) with the D65 illuminant at 10° observer angle, in SCI mode, and with 11-mm aperture of the instrument for illumination and 8-mm aperture for measurement. Color was also measured in melted cheeses under the same conditions, after a 4-min heating (280°C) followed by a 15-min cooling period. Texture profile analysis was carried out with a texture analyzer (Universal, Stable Micro Systems, Godalming, UK) fitted with a 50-kg load cell. Four cubes of unmelted cheese (2 cm^3) were obtained from each sample and compressed twice, at room temperature, with a 25-mm-diameter cylindrical probe at 1 mm/s to 50% of their original height. The characteristics determined from the force–time curves were hardness, adhesiveness, springiness, and cohesiveness (Van Vliet, 1991).