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Effect of 5 years long-term frozen storage on sensory quality of Monterey Jack caprine milk cheese

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ABSTRACT

A study was conducted to evaluate the effect of 5 years long-term extended frozen-storage on sensory quality of Monterey Jack semi-hard goat milk cheeses stored at −20 °C. Three lots of Monterey Jack caprine milk cheeses were manufactured at the university dairy processing plant. Each lot of cheese was placed in 2′ × 4′ × 1.5′ ($W \times L \times H$) plastic pouches, vacuum packaged and immediately frozen at −20 °C for 5 years. A trained sensory panel ($n = 7$, 6 females, 1 male) evaluated the cheeses using a previously published lexicon for cheese flavor adapted for evaluating goat milk cheeses. Flavor and taste intensities were scaled using a 15-point intensity scale using the Spectrum™ descriptive analysis method. Flavor scores of the fresh cheese as the reference standard were compared with those of the 5 years frozen-stored samples. The results of sensory profiling by the trained panel showed that cooked/milk, sweet and milk fat flavors were significantly ($P < 0.05$) reduced after the long-term frozen storage, while no changes occurred in diacetyl, whey, sour, salty, brothy and waxy flavors. A noticeable grainy/pasty texture was detected in the 5 years frozen-stored cheeses. However, flavor characteristics of the goat cheeses were not greatly changed suggesting that long-term frozen storage of goat milk cheese appeared to be feasible and applicable for later consumption and marketing.

1. Introduction

Seasonality of caprine milk production hampers a consistent year-round marketing of the goat milk products to consumers. The seasonal supply of dairy goat products has been one of the major problems for the growth and sustainability of the dairy goat industry (Kosikowski, 1986; Park et al., 2002, 2006; Ribeiro and Ribeiro, 2010).

Although freezing cheeses is not a common industrial practice (Kosikowski and Mistry, 1997), this storage and marketing strategies may be desired for advancement of the dairy goat industry. Some studies have been reported on effects of freezing on quality of different types of cheeses (Ramos et al., 1987; Kasprzak et al., 1994; Califano and Bevilacqua, 1999; Van Hekken et al., 2005; Park et al., 2006). Frozen storage of caprine milk cheeses has been reported feasible for up to 6 months without deterioration of product quality (Van Hekken et al., 2005; Park et al., 2006).

Sensory attributes of cheeses change as they ripen. Sensory characteristics of goat milk cheeses are important indices for consumer acceptability and marketability of the products. Grading and judging can be extensively used by the dairy industry for quality evaluation of all dairy products (Bodyfelt et al., 1988). Carunchia Whetstine et al. (2003) applied a defined descriptive sensory language to document the sensory properties of Chevre-style goat cheeses. Research on predicting the quality of aged cheeses beyond that achieved by cheese graders has been based on

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flavor volatiles, composition, chemical indices and sensory attributes (Gilles and Lawrence, 1973; Roberts and Vickers, 1994; Poveta et al., 2008; Chen et al., 2010). The flavor profiles of cheeses are complex, and affected by a variety of substances such as organic acids, sulfur compounds, alcohols, lactones, methyl ketones and phenolic compounds (Seitz, 1990). High somatic cell counts (SCC) in goat milk did not affect the yield of semisoft goat cheese, while did result in inferior sensory quality of the aged goat cheeses (Chen et al., 2010).

Specific texture attributes have been less frequently related to liking of cheeses such as Cheddar. Cheeses that were harder and more rubbery, crumbly, chewy and grainy were liked less than other cheeses (Lakhani et al., 1991). A very few studies have been reported on freezing and/or short-term frozen effects on the food quality and sensory characteristics of frozen goat milk cheeses. Furthermore, to our knowledge, scientific data on the effect of long-term storage such as 5 years frozen-storage of semi-hard goat milk cheeses has been non-existent. Therefore, the objective of this study was to evaluate the effect of 5 years long-term frozen-storage on sensory qualities of Monterey Jack goat milk cheeses stored at −20 °C in comparison with those of the corresponding original fresh cheeses.

2. Materials and methods

2.1. Preparation of Monterey Jack (MJ) caprine milk cheese

Three batches of MJ goat milk cheeses were made using the bulk tank milk collected from the Fort Valley State University milking herd which consisted of Saanen, Alpine, and Nubian goats. The milk was pasteurized at the University dairy processing plant, and the MJ cheeses were manufactured using a modified procedure of Kosikowski and Mistry (1997). Milk was cooled to 32 °C in a 227 L cheese vat. Lyophilized mesophilic direct vat set starter culture (R704, 50 units, Chr. Hansen, Inc., Milwaukee, WI) and single strength rennet (10.6 mL of rennet per 100 L milk; Chymax; Chr. Hansen, Inc., Milwaukee, WI) were added to the milk and then allowed to coagulate for 30 min. The curd was cut using 1.6 cm wire knives and allowed to heal for 10 min. The temperature was gradually raised to 39 °C over 30 min and the curd was cooked for another 30 min with agitation, assuring for a firmer curd formation. Two-third of the whey was drained, waited for 5 min, and cold water was added to the cheese vat after complete draining the whey to wash the curds. The curd washing was repeated twice, and the final temperature of the curds was 30 °C. Curds were salted at a rate of 2.5% of the original milk weight and placed into 150 mm × 150 mm cylindrical plastic molds and pressed at 40 psi overnight at room temperature in a vertical cheese press (Pneumatic Press, Kusel Equip. Co., Watertown, WI). Cheeses were removed from the molds and vacuum packed in plastic pouches (FreshPak 500 vacuum pouches, Koch Supply, Kansas City, MO) using a vacuum packager (Koch Ultravac 250, Koch Supply, Kansas City, MO). The respective initial pH and moisture content of the fresh MJ cheese were 5.78 ± 0.11 and 41.2 ± 1.4%.

2.2. Experimental design and treatment

The three batches of the vacuum packaged caprine cheeses were divided into two groups. One group was immediately placed in −20 °C freezer, and the other portion was placed in a walk-in-cooler at 4 °C. The three batches of the frozen and refrigerated goat cheeses were shipped on ice packs by overnight carrier to North Carolina State University. Upon receipt, all cheeses were examined for packaging damage and then assigned to treatment designations. Each batch of the cheeses was divided and assigned to one of the two-storage regimen: frozen storage and refrigerated storage. The frozen cheese group were placed at −20 °C and frozen for 0 month (24 h), 3 months, 6 months and 5 years. After each freezing time, the frozen cheeses were removed from the freezer and placed at 4 °C. Once thawed after 24 h, they were sampled for sensory analysis. The fresh MJ cheeses were served as the reference initial standard samples for testing sensory characteristics of the goat cheeses.

2.3. Sensory evaluation

Sensory characteristics of the experimental cheeses were evaluated by a trained sensory panel ($n = 7$, 6 females, 1 male) at North Carolina State University, Raleigh, NC, USA, using a previously published lexicon for cheese flavor adapted for goat cheeses (Drake et al., 2001; Carunchia Whetstine et al., 2003). The specific definition and the references for the sensory characteristic terms used are described in Table 1. University staff and students that were interested, had time available, and liked cheese were also selected as panelists. These panelists had each received 75 h training on aroma and flavor evaluation of cheeses. Flavor and taste intensities were scaled using a 10-point intensity scale with the Spectrum™ descriptive analysis method (Meilgaard et al., 1999; Drake et al., 2001). Cheeses were presented in 2 cm × 2 cm cubes with three digit codes. Panelists had free access to water and unsalted crackers during evaluation. Each cheese was evaluated in duplicate.

2.4. Statistical analysis

The three batches of all experimental caprine cheeses were analyzed individually for the effects of frozen and refrigerated storage on sensory attributes. A mixed model analysis of variance was used with batch and batch × storage period as random effects in the model (SAS, version 8.2, Cary, NC, 2004).

3. Results and discussion

The sensory profile characteristics of the initial fresh and 5 years extended frozen-stored Monterey Jack (MJ) caprine milk cheeses are compared in Table 2 and Fig. 1. These two types of cheeses are basically the same cheeses, but difference lies only on refrigeration and extended frozen storage conditions.

The gross chemical compositions (%) of the fresh MJ cheese were: moisture, 42.1; protein, 27.3; fat, 23.4; carbohydrate, 3.05; ash, 4.05%, respectively. Since the cheeses were vacuum packaged before the frozen-storage experiment, it would be expected that moisture loss during the storage may not be significant, if any. Osman et al. (2009) observed that weight losses of their white cheeses were significantly ($P < 0.001$) lower in refrigerated samples than those stored in room temperature. Therefore, the weight loss of the vacuum packaged MJ cheeses stored frozen at −20 °C in our study would be minimal.

The cooked/milk flavor, milk fat and sweet flavors of the initial fresh MJ cheeses were significantly ($P < 0.05$) reduced after 5 years long-term frozen storage, which would be expected. The decreases in these sensory traits are indicative of decreasing the freshness of the product. In fact, the freshness of the initial cheese was reduced from 9.1 to 5.9 (Table 2), indicating a significant and greater intensity of decrease in freshness of the caprine cheeses after 5 years frozen storage. On the other hand, brothy flavor was significantly ($P < 0.05$) increased from the fresh sample to the 5 years frozen-stored cheese samples, suggesting that increase in brothy flavor may also be an indication of decrease in freshness. This flavor profile is consistent with previous sensory reports of this type of cheese (Carunchia Whetstine et al., 2003). The Monterey Jack goat cheese also displayed high intensities of whey, diacetyl, and brothy flavors and high salty taste, implying the cheese contain relatively low moisture and high salt content.