J. Dairy Sci. 90:1102–1121

Microbiology, Biochemistry, and Volatile Composition of Tulum Cheese Ripened in Goat's Skin or Plastic Bags

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ABSTRACT

Tulum cheeses were manufactured from raw ewe's milk and ripened in goat's skin bags (tulums) or plastic containers to understand the effect of ripening container on the chemical composition, biochemistry, microbiology, and volatile composition of Tulum cheeses during 150 d of ripening. Chemical compositions of the cheeses ripened in tulums were significantly different and the moisture contents decreased rapidly in those cheeses because of the porous structure of the tulum. Higher microbial counts were detected in the cheeses ripened in plastic than in cheeses ripened in tulums. Differences in nitrogenous compounds and total free AA of the cheeses were not significant. Total concentrations of free AA in cheeses increased with age and Glu, Ala, Val, Leu, and Phe were the most abundant AA in the cheeses. Urea-PAGE of pH 4.6-insoluble fractions of the cheeses during ripening showed similar degradation patterns in all cheeses. Peptide profiles by reversed-phase HPLC of pH 4.6- and ethanol-soluble or ethanol-insoluble fractions of the cheeses revealed only minor differences in the concentrations of some peptides among the cheeses; however, age-related changes in peptide concentrations were significantly different among the cheeses. Cheeses were analyzed at 90 d of ripening for volatile compounds by solid-phase microextraction gas chromatography-mass spectrometry. One hundred volatile components were identified, including 11 acids, 16 esters, 12 methyl ketones, 7 aldehydes, 22 alcohols, 7 sulfur compounds, 6 terpenes, and 19 miscellaneous compounds. The main components were short-chain fatty acids, 2-butanone, diacetyl, and primary alcohols. Quantitative differences in several volatile compounds were evident among the cheeses. Cheeses ripened in tulums or plastic had similar aroma patterns, but the concentrations of some components were different.

Key words: Tulum cheese, packaging material, volatile composition, ripening and proteolysis

INTRODUCTION

Cheese ripening is a complex and dynamic biochemical process that includes protein breakdown, fat hydrolysis, and lactose and lactate metabolism (El Soda et al., 1995; McSweeney and Sousa, 2000). Proteolysis is catalyzed by proteolytic enzymes from the coagulant, milk, and bacteria (starter, secondary starter, or nonstarter). The coagulant is mainly responsible for hydrolyzing the CN to large and intermediate-sized peptides (Law et al., 1992; Lane and Fox, 1997). Enzymes originating from starter (i.e., proteinases, peptidases) play major roles in the formation of small peptides and AA, which serve as precursors of flavor compounds in the cheese (Urbach, 1997).

Many cheese varieties that are produced only in restricted geographic areas of the world are consumed locally in large quantities. More than 50 varieties of cheese can be found in Turkey; however, 3 of them (Beyaz, Kasar, and Tulum cheeses) are the most popular. The annual production of Tulum cheese was 10,000 tonnes in 2004 (data from the Turkish Statistical Institute, Ankara, Turkey). Its production has increased greatly, and this trend has continued over recent years in a number of cheese plants.

According to the description by Kurt et al. (1991a), Tulum cheese has a white or cream color, a high fat content, and a crumbly and semihard texture; it is dispersible in the mouth and has a buttery and pungent flavor. The name *tulum* means "goat's or sheep's skin bag" in Turkish, which is the bag used for packaging and ripening. In general, there are 2 kinds of Tulum cheese: One is Izmir Brined Tulum, which is produced in the western region of Turkey, and the second is Erzincan Savak Tulum, which is produced mainly in the eastern region of Turkey. The latter is made in the mountains and plateaus of Erzincan, Erzurum, Tunceli, Bingol, and Elazig and in the East Anatolian regions by the Savak tribe, and was originally ripened in tulums

Received May 17, 2006.
Accepted October 30, 2006.
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in caves for at least 3 mo. When people say "Tulum cheese" in Turkey, they imply Erzincan Savak Tulum cheese. Therefore, the term "Tulum cheese" is used throughout the text to refer to Erzincan Savak Tulum cheese. Goat's skin bags are stronger than sheep's skin bags and tulums are permeable to water and air because of their porous structure. In the past, the tulum was probably used for cheese packaging because of the absence of alternative packaging materials for preserving and ripening the cheese. Nowadays, hardened plastic barrels have been used for ripening the Tulum cheese.

Studies on Tulum cheese are limited; however, some research has been focused on this variety in the last decade. These works have concentrated on the chemical and microbiological status of Tulum cheeses sold in Turkish markets. Few studies are available on the effect of different packaging materials on the microbiological and chemical characteristics of Tulum cheese. The microbiological qualities of Tulum cheeses ripened in goat's skin or polyethylene bags were compared by Guven and Konar (1994a). Similarly, Sengul et al. (2001) studied the effect of packaging materials (wooden box, goat's skin, or polyethylene bag) on the microbiology of Tulum cheeses during ripening. The use of different types of milk (cow's, ewe's or goat's milk) in the manufacture of Tulum cheese was compared by Guven et al. (1995), who reported that the type of milk significantly influenced the microbiology of Tulum cheese during 210 d of ripening. Sengul and Cakmakci (1998) used polyethylene bags and wooden materials as alternatives to a tulum, and the authors emphasized that the use of different packaging materials had an effect on the chemical and microbiological qualities of the Tulum cheese; however, they recommended further studies to determine the best packaging material. Although raw milk has continued to be used for Tulum cheese making, Bostan and Ugur (1991) and Sengul et al. (2001) have recommended using pasteurized milk and a starter culture.

The studies mentioned relate to only the composition and microbiological status (hygienic aspects) of Tulum cheese. Some authors (Guven and Konar, 1994a, 1995; Sengul et al., 2001) have pointed out that ripening in tulums or polyethylene bags significantly influences the chemistry and microbiology of Tulum cheese during ripening. According to consumers, the cheese ripened in tulums has a superior quality in comparison with the cheese ripened in plastic barrels. Furthermore, because of increasing interest in traditional cheeses in Turkey and many other countries, new studies are needed to better understand the role of proteolysis and the volatile composition of the cheese, including characterization of the electrophoretic patterns and peptide profiles, and determination of the levels of volatile compounds. To the authors' knowledge, no other researchers have previously attempted to characterize in detail the proteolysis and volatile profile of Tulum cheese.

In this study, urea-PAGE was performed to determine the extent of primary proteolysis in Tulum cheese, and nitrogen fractions, individual AA, and peptides were analyzed to determine secondary proteolysis. Gas chromatography-mass spectrometry was used to quantify flavor compounds to compare Tulum cheese ripened in goat's skin or polyethylene bags during ripening. In addition, the typical properties of the cheese, the manufacturing procedure, the composition, and microbiological counts of Tulum cheese are described.

MATERIALS AND METHODS

Materials

Fresh ewe's milk (200 L) was obtained from 2 different farmhouses on the Baskurtdere plateau, Ilica, Erzurum, Turkey. Homemade rennet, called *sirden* in Turkish, was obtained from the farmers. Tulums (goat's skin bags) with a capacity of 10 kg of cheese were obtained from the farmers. Plastic materials (hardened cylindrical barrels), also with a 10-kg capacity, were obtained from local markets.

Homemade Rennet Manufacture

Rennet was made using the following traditional method. Cleaned young calves' stomachs were air-dried while shaded from the sun, cut into slices, and then placed in whey containing approximately 10% (wt/vol) NaCl. After 1 to 2 wk, the rennet extract (prepared by blending macerated stomach slices in the NaCl solution) was clarified (filtered) using a cotton material, and the filtrate was used as a coagulant.

Cheese Making

Tulum cheese (Erzincan Savak type) was made from raw ewe's milk (200 kg) in Erzurum Province (Baskurtdere plateau, Ilica, Erzurum, Turkey). The milk was acidified by its native microflora. The homemade calf rennet was added at a level of 1.0% (vol/vol), and coagulation took place at 35°C. The coagulum was cut into pieces (approximately 1-cm cubes) and transferred into cotton bags for whey drainage. Drainage was carried out at 20°C for 24 h, and the curd was pressed by piling the cotton bags on top of each other, with regular turning. Stacking of the curd at this temperature allows curd acidity (pH drops below 6.0) to develop and increases the removal of whey. Following this step, the curd was broken into pea-size pieces by hand and salted