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Effect of Chitosan on the Rheological and Sensorial Characteristics of Apulia Spreadable Cheese

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ABSTRACT

The effect of chitosan on the rheological and sensorial properties of Apulia spreadable cheese during storage time was evaluated. The investigated spreadable cheese samples were stored at 4°C. Storage modulus (G′), loss modulus (G″), tanδ, and the overall sensorial quality of the spreadable cheese were monitored for 24 d. Moreover, moisture content, pH, color, and lactic acid bacteria during storage time were evaluated. Results indicate that statistically significant differences in G′, G″, and tanδ values and in the sensorial scores exist between the control sample and the spreadable cheese samples with chitosan. In particular, chitosan improved the rheological and sensorial properties of the spreadable cheese, particularly its softness. Moreover, its addition influenced the physicochemical properties of the investigated spreadable cheese during storage time, without affecting the dairy microflora.
Key words: spreadable cheese, chitosan, rheological property, sensorial characteristic

INTRODUCTION

Obtained from raw or pasteurized milk, spreadable cheeses are characterized by a soft, creamy paste, an elastic texture, and rapid ripening due to the high percentage of water. They are white and homogeneous in color, with a delicate smell. Spreadable cheeses are widely used, especially in Europe, where their mild taste, velvety texture, and versatility (Lante et al., 2006) are prized. During the manufacture of spreadable cheese, some water is added to produce a smooth and stable emulsion (Berger et al., 1993). Water helps to dissolve the calcium chelating salts by hydrating the proteins and dispersing the components. Water is also required to achieve certain product attributes such as softness or meltability in processed cheese slices (Lee et al., 2004). All soft cheeses have a moisture content from 40 to 60%. A drawback of cheese with a high moisture content is its susceptibility to spoilage. Moisture variation can also affect the rheological properties, shelf life (Lee et al., 2004), and sensorial characteristics.

In the literature, several studies focus on the rheological properties of natural and processed cheeses (Zalazar et al., 2002; Piska and Štětina, 2004; San Martín-González et al., 2007; Dimitreli and Thomareis, 2008). Others have been carried out on the relationship between the rheological and sensorial properties of cheese (Sipahioglu et al., 1999; Romeih et al., 2002; Koca and Metin, 2004; Konuklar et al., 2004). To improve the textural and sensorial properties of low-fat cheese, various substances have been used in cheesemaking, including cereals, whey and milk proteins, various carbohydrates such as ß-glucan, and modified starches (Drake et al., 1996; McMahon et al., 1996; Ma et al., 1997). Moreover, Dickinson (1998) carried out studies on the stability and rheological implications of the interaction of several polysaccharides, in particular carrageenans and pectins with milk components.

Chitosan is a modified, natural polysaccharide made up of copolymers of glucosamine and N-acetylglucosamine, and it derives from alkaline deacetylation of chitin obtained from the exoskeletons of crustaceans and arthropods (Li et al., 1997). The addition of chitosan to whole or skimmed milk produces destabilization, resulting in the formation of chitosan-casein-fat coagula. These aggregates are hydrolyzed by digestive proteases. However, the presence of chitosan inhibited the hydrolysis of triglycerides through the action of pancreatic lipase. The consequence of this phenomenon is that almost half of triglycerides remain associated with the aggregates in a nonabsorbable form (Ausar et al., 2001a,b, 2002). In addition, chitosan has attracted considerable attention because of its notable biological activities (Sekiguchi et al., 1994), such as antimicrobial (Altieri et al., 2005), antitumoral (Tokoro et al., 1988), and hypocholesterolemic functions (Sugano et al., 1992; No et al., 2007).

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Evaluating the potential use of chitosan in the manufacture of dairy products, the possibility of the addition of chitosan in Apulia spreadable cheese was investigated. The aim of this work was to study the effect of chitosan on the rheological and sensorial characteristics, as well as on the moisture content, pH, color, and lactic acid bacteria evaluation of the Apulia spreadable cheese during the storage period.

MATERIALS AND METHODS

Cheese Making

Spreadable cheese samples were manufactured in the cheese-making factory "Posta la via" (Foggia, Italy). Four batches, each containing 10 kg of cow's milk, were prepared and pasteurized at 70°C for 2 min. A commercial starter culture (0.5%, *Streptococcus thermophilus* strain CR57, Chemifer, Livraga, Lodi, Italy) was revitalized using part of the cow's milk for 45 min at 37°C to improve the growth and activity of lactic bacteria. When the pH of the revitalized milk reached approximately 5.50, the latter was divided into 4 parts, of which one was used for the control cheese sample. Low-molecular-weight chitosan (85% deacetylation; Aldrich, Milan, Italy) was added to the remaining 3 parts to obtain the modified starters. Afterwards, they were put into the working milk to obtain final concentrations of 0.012, 0.024, and 0.036% (wt/vol) chitosan. For each batch of working milk, 5% animal liquid rennet (strength 1:10,000) and 1% sodium chloride were directly added. Coagulation was carried out for about 15 min. The obtained curd was cut longitudinally and transversally into small parts about 10 to 15 mm in diameter. At the end of this process, the curd was left for 40 min and then transferred to the mold. In this step, the curd was separated from the whey and put into square molds with holes to allow the draining of the liquid. Finally, the cheese was sweated at 28 to 30°C. After that, the spreadable cheese samples were put into the refrigerator at 4 to 5°C. The samples had a ripening period of 7 d. Moreover, according to the producer, they had a shelf life of about 18 d. The 3 spreadable cheeses with the chitosan, named **C12** (0.012%), **C24** (0.024%), and **C36** (0.036%) respectively, were compared with the chitosan-free cheese sample (control). The tests were carried out at different storage times: during the ripening period (i.e., d 0, 3, and d 7), and during the storage period (i.e., at d 10, 14, 18, 21, and 24).

Chemical and Physicochemical Analyses

The moisture (%) of the spreadable cheese samples was determined by dehydration at 105°C by using a drying oven (9000 series-RS232, Isco, Milan, Italy). The moisture and pH were determined in duplicate for each cheese sample. The colorimetric parameter "hue" was determined by using a colorimeter (CR-310, Minolta, Tokyo, Japan) as the average of the 3 replicates.

Rheological Measurement

Dynamic-mechanical properties of the Apulia spreadable cheese samples were studied using a controlled-strain rotational rheometer (ARES model, TA Instruments, New Castle, DE) equipped with a force rebalance transducer (model 1K-FRTN1, 1–1000g cm, 200 rad/sec, 2–2000 gmf) and parallel plates (superior plate diameter of 25 mm). A steady temperature was ensured with an accuracy of ±0.1°C by means of a controlled fluid bath unit and an external thermostatic bath. To prevent water evaporation, a suitable cover tool sealing the top of the superior plate was used during testing. Storage modulus (**G′**), loss modulus (**G″**), and tanδ were determined in a frequency range of 0.05 to 10 Hz. The strain value was obtained by preliminary strain sweep oscillatory trials to determine the linear viscoelastic region. The strain sweep oscillatory tests were carried out at a frequency of 1 Hz and in a range of shear strain of 0.01 to 300%. All experiments were carried out at 4°C. Three repetitions of the dynamic mechanical experiments were performed for each spreadable cheese sample. To compare the G′, G″, and tanδ values between the investigated spreadable cheese samples an oscillatory frequency of 10 Hz was chosen as a reference (Dimitreli and Thomareis, 2008).

Microbiological Analysis

Ten grams of each spreadable cheese sample was homogenized in 90 mL of saline solution (0.9% NaCl). Afterwards, serial 10-fold dilutions were prepared and counts of lactic acid bacteria enumerated using the pour-plate technique (APHA, 2001). Lactic acid bacilli grew on de Man, Rogosa, and Sharpe (MRS) agar (Oxoid, Milan, Italy) supplemented with cycloheximide (100 mg/L, Sigma-Aldrich, Gallarate, Italy), at 37°C for 48 h under anaerobiosis (Anaerogen Gas Pack, Oxoid); lactococci grew on M17 agar (Oxoid) at 37°C for 48 h.

Sensorial Analysis

Sensory evaluation was carried out according to IDF (1995) standards and Juric et al. (2003). A panel composed of 6 members of the food packaging laboratory was assembled. The panelists were selected based on their interest in the sensory evaluation of cheese and trained by testing commercial spreadable cheese.