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Effect of active coating on microbiological and sensory properties of fresh mozzarella cheese

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ABSTRACT

The effectiveness of active coating on microbiological and decay of sensory quality in mozzarella cheese was investigated. The work was divided into two subsequent experimental steps: the first one was aimed at selecting the optimal active compound among different substances, such as potassium sorbate (PS), sodium benzoate (SB), calcium lactate (CL) and calcium ascorbate (CA). In the second trial, three different concentrations (1%, 2%, 3%, w/v) of the best selected compound (PS) were tested. All active compounds were dispersed in a sodium alginic acid solution before coating the cheese. Fresh mozzarella without coating was also used as the control. During storage at a temperature of 8 ± 1 °C, microbiological and sensory quality was monitored. Results obtained from the first step showed that CL and CA did not improve mozzarella cheese quality; whereas, the PS and SB showed good results. In the second trial, the coating with PS (3%) showed a certain inhibition on microbial proliferation and samples remained acceptable for 8 days with respect to the control that was refused after about 4 days.

1. Introduction

Mozzarella cheese is a mild, soft white cheese. It is a typical Mediterranean pasta filata product, cut and manufactured in various shapes, with high moisture content (50–60%). It is usually stored into a cold liquid, consisting of tap water or dilute solution of salts (NaCl and/or $CaCl_2$) (called conditioning brine) and whey. Some authors (Cabrini & Neviani, 1983; Mauro, Delia, & Laganà, 2005) have reported that tap water can be a vehicle for undesirable psychrotrophic bacteria. Due to its high moisture content, fresh mozzarella cheese is particularly perishable and has a short shelf life (5–7 days). Although it receives a heat treatment during curd stretching, post-processing contamination by micro-organisms may occur, causing cheese spoilage and health risk to consumers (Spano et al., 2003). The principal spoilage microorganisms of mozzarella are *Pseudomonas* spp. and coliforms, that can provoke proteolysis, discolorations, pigmentation and development of off-flavours (Cantoni & Bersani, 2010; Cantoni, Iacumin, & Comi, 2003; Cantoni, Stella, Cozzi, Iacumin, & Comi, 2003; Cantoni, Soncini, Milesi, Cocolin, & Iacumin, 2006).

Several attempts have been made to control spoilage microflora. Generally, modified atmosphere efficiently inhibited staphylococci, moulds and yeasts, but psychrotrophs were inhibited less or not at all (Eliot, Vuillemard, & Emond, 1998). Recently, other studies have focused on the effectiveness of lysozyme combined with Na-EDTA (Sinigaglia, Bevilacqua, Corbo, Pati, & Del Nobile, 2008), natural vegetable antimicrobial substances (Conte, Scrocco, Sinigaglia, &

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Del Nobile, 2007) and chitosan (Altieri, Scrocco, Sinigaglia, & Del Nobile, 2005) that are well-known agents against gram-positive bacteria, coliforms and pseudomonads. One of the potential approaches is the use of active coatings that cover cheese surface with bio-materials containing antimicrobial compounds (Conte, Gammariello, Di Giulio, Attanasio, & Del Nobile, 2009). Among the substances with antimicrobial and antioxidant properties, potassium sorbate, sodium benzoate, calcium lactate and calcium ascorbate are used to prevent deterioration of food products. In the food industry, sodium benzoate and potassium sorbate are often used as preservatives. Sodium benzoate is used as an antifungal agent to conserve margarine, fresh juices and sweets. European Commission thresholds for benzoic acid and sodium benzoate are 0.015–0.5%, respectively (EC, 1995). Potassium sorbate is used to preserve cheese, cakes and syrups also at very low concentration accounting for 0.2% (Sofos & Busta, 1981). Moreover, sorbic acid and its potassium salts are generally recognized as safe (GRAS) compounds to inhibit growth of yeasts, moulds, and some bacteria, without compromising product taste and odour (Karabulut, Lurie, & Droby, 2001; Thomas, 2000). Calcium ascorbate and calcium lactate are approved for use as food additives in the EU, USA, Australia and New Zealand.

In this study, the effectiveness of active coatings on microbiological and sensory quality of fresh mozzarella cheese was evaluated. This work consisted of two sequential experimental steps. Firstly, the mozzarella cheese with different active coatings (with potassium sorbate, sodium benzoate, calcium lactate and calcium ascorbate) were studied in order to select the best one. Secondly, the effect of concentration of the best active compound on the quality of fresh cheese was assessed.

2. Materials and methods

2.1. Samples preparation

The experimental design was organized in two sequential steps. Mozzarella cheese samples (about 125 g) used in this work were kindly provided by ''Capurso Azienda Casearia SPA'' (Gioia del Colle, Bari, Italy). The coating solution was prepared by dissolving sodium alginic acid (2%, w/v) in distilled sterile water. Different active substances, such as potassium sorbate (0.1%, w/v) (PS), sodium benzoate (0.5%, w/v) (SB), calcium lactate (0.5%, w/v) (CL) and calcium ascorbate (0.5%, w/v) (CA) were added to the alginate solution. After complete dissolution of the active compounds, the coatings were obtained by immersing cheese samples first in the sodium alginic acid solution and then in a calcium chloride solution (5%, w/v) for 1 min. For each treatment, two coated samples were prepared and then packaged in polypropylene trays containing brine. In the second trial, three different concentrations of potassium sorbate (1%, 2%, 3%, w/v) in the coating were tested on mozzarella cheese. These samples were prepared as described above and packaged with the same conditions as described above. In both the experimental trials uncoated mozzarella cheese was used as the control (Cnt). In the second trial coated cheese without any active compound was also prepared. All the investigated cheese samples were stored at 8 ± 1 °C.

The investigated samples were labelled as follow: PS-Coat, SB-Coat, CL-Coat, CA-Coat (sample coated with a solution of sodium alginic acid containing potassium sorbate, sodium benzoate, calcium lactate and calcium ascorbate, respectively); PS-1%, PS-2%, PS-3% (sample coated with a solution of sodium alginic acid containing potassium sorbate at 1%, 2%, 3%, w/v, respectively).

The sodium alginic acid and the calcium chloride, as well as all the active compounds were purchased from Farmalabor (Canosa di Puglia, Italy).

2.2. Microbiological analyses

Twenty grams of mozzarella cheese were diluted in 180 mL of a sterile saline solution (0.9%) and homogenized in a blender (Stomacher, International PBI, Milan, Italy). After, decimal dilutions of cheese homogenates were made in saline solution and plated on selective media for determination of mesophilic lactic acid bacilli, lactococci, total bacterial count, *Enterobacteriaceae* and *Pseudomonas* spp. Specifically, mesophilic lactic acid bacilli were plated with de Man Rogosa and Sharpe (MRS) agar, supplemented with cycloheximide (100 mg/L) (Sigma, Milan, Italy) incubated under anaerobiosis at 37 °C for 48 h; M17 agar, incubated at 37 °C for 48 h for lactococci; plate count agar (PCA), incubated at 30 °C for 48 h for total bacteria count; *Enterobacteriaceae* were enumerated on Violet Red Bile Glucose Agar (VRBGA) and incubated at 37 °C for 24 h and *Pseudomonas* spp. were enumerated on Pseudomonas Agar Base (PAB), added with SR103 selective supplement (Oxoid, Milan, Italy) and incubated at 25 °C for 48 h. All media were purchased from Oxoid (Milan, Italy). All the analyses were performed in duplicate.

At each sampling time the pH was also measured by a pH metre (Crison, Barcelona, Spain). The measurements were done in duplicate on two different samples.

2.3. Sensory analysis

Sensory evaluation was carried out by 7 panellists, members belonging to the food packaging laboratory. The sensory characteristics of mozzarella cheese were evaluated according to the method previously described by Corradini and Innocente (2002). The coded samples were presented with and without coating to the panellists in a random order. The intensity of the attributes (firmness, colour, odour and overall quality) of cheese samples was evaluated by using a 7-point scale. A score equal to 4 indicated the attribute threshold for cheese acceptability (Gammariello, Conte, Di Giulio, Attanasio, & Del Nobile, 2009).

3. Results and discussion

During the first experimental step (S_1), different active coatings were tested to find the most suitable to preserve quality characteristics of cheese during storage. Subsequently, the best active coating (i.e., potassium sorbate loaded alginate) was tested at three different concentrations to select the