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Active coating and modified-atmosphere packaging to extend the shelf life of Fior di Latte cheese

A. Conte,*† D. Gammariello,* S. Di Giulio,† M. Attanasio,* and M. A. Del Nobile*†[1]
*Istituto per la Ricerca e le Applicazioni Biotecnologiche per la Sicurezza e la Valorizzazione dei Prodotti Tipici e di Qualità, Università degli Studi di Foggia, Via Napoli, 25–71100 Foggia, Italy
†Dipartimento di Scienze degli Alimenti, Università degli Studi di Foggia, Via Napoli, 25–71100 Foggia, Italy

ABSTRACT

In this work the combination of active coating and modified-atmosphere packaging (MAP) was used to prolong the shelf life of Fior di Latte cheese. The active coating was based on sodium alginate (8% wt/vol) containing lysozyme (0.25 mg/mL) and EDTA, disodium salt (Na_2-EDTA, 50 m*M*). The MAP was made up of 30% CO_2, 5% O_2, and 65% N_2. The speed of quality loss for the Fior di Latte cheese, stored at 10°C, was assessed by monitoring pH and weight loss, as well as microbiological and sensorial changes. Results showed that the combination of active coating and MAP improved Fior di Latte cheese preservation, increasing the shelf life to more than 3 d. In addition, the substitution of brine with coating could allow us to gain a double advantage: both preserving the product quality and reducing the cost of its distribution, due to the lower weight of the package.
Key words: Fior di Latte cheese, active coating, modified-atmosphere packaging, shelf life

INTRODUCTION

Fior di Latte cheese is a widely known fresh dairy product, consisting mainly of casein, fat, and water. Because fresh cheeses have high moisture content (from 55% to 60%) and high fat content (>45%; Salvadori del Prato, 2001), they are very susceptible to microbial spoilage, especially under temperature abuse. Storage of fresh cheeses under aerobic conditions results in rapid spoilage.

The potential of modified-atmosphere packaging (**MAP**) and active packaging to extend the shelf life of different dairy products has been demonstrated (Floros et al., 2000; Pantaleao et al., 2007; Papaioannou et al., 2007). These authors stated that the success of a cheese packaging is dependent on several important parameters, such as the type of cheese, the use of starter cultures during production, microbial contamination, and storage conditions. The gases normally used for MAP include CO_2, O_2, and N_2. The most important gas from a microbiological point of view is CO_2, used alone or in mixtures with N_2, O_2, or both, which inhibit the growth of many microorganisms, including spoilage bacteria (Daniels et al., 1985). To the best of our knowledge, very few papers have reported on Mozzarella cheese packaged in MAP. Eliot et al. (1998) reported that shredded Mozzarella cheese packaged in MAP containing levels of 75% CO_2 was well protected from undesirable organisms and gas formation. Alves et al. (1996) also found that microbial growth in sliced Mozzarella cheese packaged in MAP and stored at 7°C was delayed with high concentrations of CO_2.

Several natural substances are suitable to develop an active packaging. Conte el al. (2007) successfully tested the effectiveness of a lemon extract release system on Mozzarella cheese. In addition, Sinigaglia et al. (2008) demonstrated that it is possible to prolong the shelf life of Mozzarella cheese by dissolving lysozyme and Na_2-EDTA in the packaging brine. Lysozyme is a lytic enzyme found in many natural systems, used in cheese manufacture to prevent the growth of lactate-fermenting and gas-forming *Clostridia* spp. (Crapisi et al., 1993). The antimicrobial spectrum of lysozyme could be enhanced when it is used with other substances, such as EDTA (Branen and Davidson, 2004; Sinigaglia et al., 2008), disodium pyrophosphate, pentasodium tripolyphosphate (Boland et al., 2003), caffeic acid, and cinnamic acid (Masschalck and Michiels, 2003).

Another important factor that limits Fior di Latte cheese distribution beyond the market borders is the weight of the package. For this reason, recently, attention has been focused on more attractive preservation methods. Laurienzo et al. (2006) showed that the use of a gel packaging, based on natural polysaccharides, could be a strategic solution to both reduce the packaging weight and increase the shelf life of Mozzarella cheese.

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[1]Corresponding author: ma.delnobile@unifg.it

A natural coating could represent an interesting alternative to the product brine. The coatings are widely utilized to extend the shelf life of minimally processed fruit and vegetables (Devlieghere et al., 2004; Olivas et al., 2007; Rojas-Grau et al., 2007). However, not much information is available on edible coating applied to cheese. Kampf and Nussinovitch (2000) showed that bio-based polymeric layers, prepared using κ-carrageenan, alginate, and gellan gum, could reduce weight loss and improve textural and sensorial properties of semi-hard cheese.

The objective of this research is to study a new packaging system to preserve the quality of Fior di Latte cheese and reduce the costs for its distribution. The strategy investigated is based on a combination of an active coating to MAP conditions. To this aim, the microbiological, physicochemical, and sensory changes of packaged Fior di Latte cheese were monitored over an 8-d period at 10°C.

MATERIALS AND METHODS

Coating Procedure and Packaging

Samples of Fior di Latte cheese (50 g) were purchased from the dairy plant Posta la Via (Foggia, Italy). Fior di Latte cheese was dipped into sodium alginate solution (Sigma-Aldrich, Gallarate, Italy) prepared by dissolving sodium alginic acid (8% wt/vol), 0.25 mg/mL of lysozyme, and 50 m*M* of Na_2-EDTA in distilled water. The coated samples were immersed into a 5% (wt/vol) $CaCl_2$ solution for 1 min, to physically crosslink the polymeric matrix. Sodium alginic acid and calcium chloride were provided by Sigma-Aldrich. All samples were dried at room temperature for 2 min. Each coated sample was packaged in commercially available bags with thickness of 95 μm, provided by Valco (Bergamo, Italy). These were made by laminating a nylon layer and a polyolefin layer, and have an oxygen transmission rate of 50 mL/m^2 per day at 1 atm, measured at 23°C and 75% relative humidity. During packaging, ordinary and modified-atmosphere conditions (30% CO_2, 5% O_2, and 65% N_2) were used. As controls, samples of Fior di Latte cheese without coating were also packaged in bags under MAP and in trays with traditional brine. The brine consisted of 2% NaCl solution. All samples were stored at 10°C for 8 d.

Determinations of pH, weight loss, headspace gas composition, microbial count, and sensory evaluation were carried out before packaging and after 1, 2, 3, 4, 7, and 8 d of storage on different cheese samples. Figure 1 shows a flowchart to better describe the way the investigated samples were produced.

pH Determination

The pH values on each sample were determined by direct reading with a pH meter (Crison, Barcelona, Spain). Each value was an average of measurements recorded on samples from 2 different batches.

Weight Loss

The percentage weight loss was determined according to the following expression:

$$\%\mathrm{WL}(t) = \frac{W_0 - W(t)}{W_0} \times 100 \qquad [1]$$

where %WL(t) is the percentage weight loss at time t, W_0 is the initial sample weight, $W(t)$ is sample weight at time t. A technical balance (Gibertini Europe, Milan, Italy) with an accuracy of ±0.1 g recorded weight periodically. The results are the average of 2 weights taken from 2 different samples.

Gas Composition of Headspace

Before opening the cheese bags, headspace gas composition was determined using a Checkmate 9900 gas analyzer (PBI Dansensor, Ringsted, Denmark). The volume taken from the package headspace for gas analysis was about 10 cm^3. To avoid modifications in the headspace gas composition caused by gas sampling, each package was used only for a single determination of the headspace gas composition. Two samples were used for each test.

Microbiological Analyses

Twenty grams of Fior di Latte cheese was diluted in 180 mL of Ringer's solution in a Stomacher bag and blended with a Stomacher Lab Blender model 4153–50 (PBI International, Milan, Italy). Serial dilutions of homogenates were plated on the appropriate media in Petri dishes. The media and conditions used were plate count agar (Oxoid, Basingstoke, UK), incubated at 30°C for 48 h for total microbial count; de Man, Rogosa, and Sharpe agar (Oxoid), supplemented with cycloheximide (100 mg/L, Sigma), incubated under anaerobiosis (Anaerogen Gas Pack, Oxoid) at 37°C for 48 h for lactic acid bacilli; M17 agar (Oxoid), incubated at 37°C for 48 h for lactococci; yeast peptone dextrose agar (Oxoid), supplemented with chloramphenicol (0.1 g/L, Oxoid) incubated at 30°C for 48h for yeasts and molds; violet red bile agar (Oxoid) incubated at 37°C

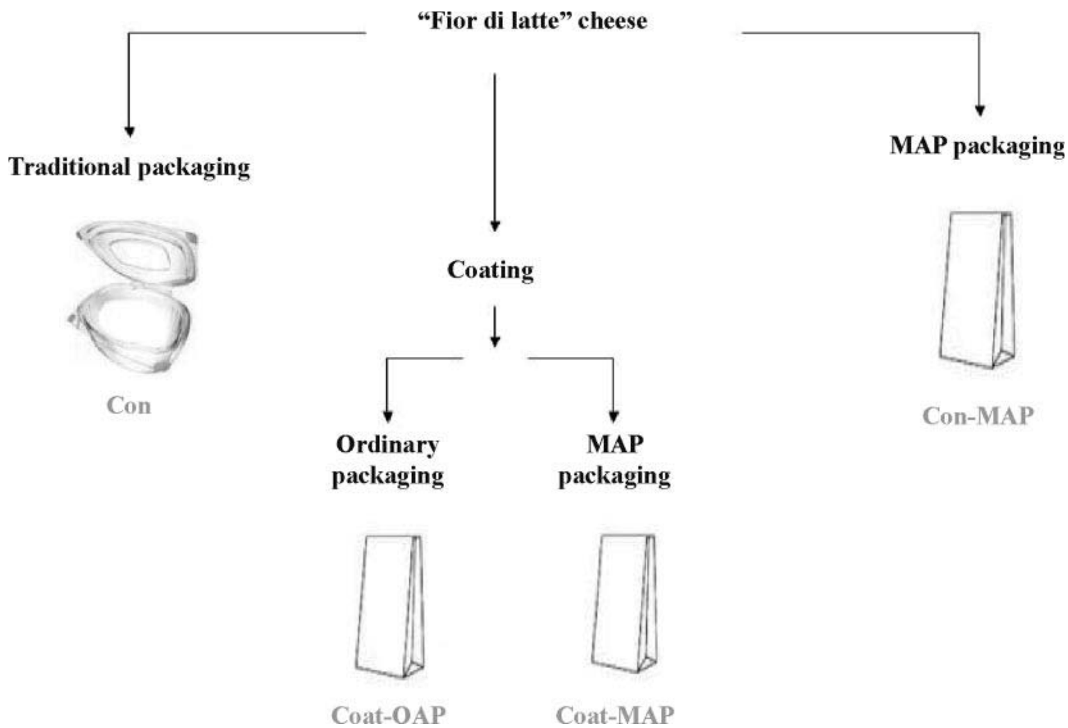

Figure 1. Flowchart describing how the investigated samples were produced. Con = control in traditional packaging; Con-MAP = control in modified-atmosphere packaging (MAP); Coat-MAP = coating in MAP; Coat-OAP = coating in ordinary packaging.

for 24 h for total coliforms; *Pseudomonas* agar base (Oxoid), with added SR103 E selective supplement (Oxoid) and incubated at 25°C for 48 h for *Pseudomonas* spp.

Sensorial Analysis

A panel of 6 trained participants evaluated the sensory attributes of external appearance, consistency, color, flavor, and overall acceptability. They were asked to describe differences between samples by using a scale from 0 to 7 (Corradini and Innocente, 2002), where 4 indicated the attribute threshold for acceptability. Before evaluation, each coated cheese was removed from the coating and immersed in water at room temperature for 10 min, so that the panelists could assess the sensory attributes and compare them with the control.

Statistical Analysis

The values of weight loss and pH of all investigated samples were compared by one-way ANOVA. A Duncan's multiple range test, with the option of homogeneous groups ($P < 0.05$), was used to determine significance among differences. Statistica 7.1 for Windows (StatSoft Inc., Tulsa, OK) was used for this purpose.

RESULTS AND DISCUSSION

The Fior di Latte cheese quality during storage was evaluated by monitoring the main physicochemical parameters, microbial load and sensory properties. The populations of the main spoilage bacteria, together with the sensorial acceptability level, determined the shelf life of the dairy product packaged using the different systems, as described in the following.

Physicochemical Characterization

The percentage weight losses of all samples are reported in Table 1. During the storage period, the weight fell substantially for all cheese samples, except an all-time high after 1 d storage for the control sample, Fior di Latte in traditional brine (**Con**), probably caused by the direction of the osmotic flow. The most liquid was lost by the uncoated samples packaged without brine in a bag under MAP (**Con-MAP**), due to the lack of brine. The difference between the Con-MAP and the other samples is more significant after the first day of storage. Conversely, the percentage weight loss of coated cheese was fairly similar to that of the Con, suggesting that coating can work as a barrier to reduce weight loss. This finding agrees with the literature deal-

Table 1. Percentage weight loss (mean ± SD) of Fior di Latte samples packaged in different systems during the storage period

Time (day)	Con[1]	Con-MAP	Coat-MAP	Coat-OAP
1	$-5.9 \pm 1.1^{A,b}$	$4.1 \pm 0.6^{B,a}$	$4.1 \pm 0.7^{B,a}$	$4.1 \pm 1.0^{B,a}$
2	$3.9 \pm 1.0^{A,a}$	$4.8 \pm 0.05^{A,a}$	$3.1 \pm 0.07^{A,ab}$	$3.4 \pm 0.08^{A,a}$
3	$2.7 \pm 0.6^{A,a}$	$4.0 \pm 1.0^{A,a}$	$4.5 \pm 1.4^{A,a}$	$3.0 \pm 0.3^{A,ab}$
4	$2.5 \pm 1.5^{B,a}$	$5.2 \pm 0.0^{A,a}$	$2.3 \pm 0.1^{B,b}$	$1.7 \pm 0.7^{B,bc}$
7	$2.3 \pm 0.5^{B,a}$	$6.7 \pm 0.9^{A,b}$	$2.3 \pm 0.3^{B,b}$	$1.3 \pm 1.1^{B,c}$
8	$2.7 \pm 0.5^{B,a}$	$5.5 \pm 0.5^{A,a}$	$3.3 \pm 0.4^{B,ab}$	$3.0 \pm 0.2^{B,ab}$

[A,B]Data within a row with different uppercase letters are significantly different ($P < 0.05$).

[a–c]Data within a column with different lowercase letters are significantly different ($P < 0.05$).

[1]Con = control in traditional packaging; Con-MAP = control in modified-atmosphere packaging; Coat-MAP = coating in modified-atmosphere packaging; Coat-OAP = coating in ordinary packaging.

ing with coating of sodium alginate applied to minimally processed food (Olivas et al., 2007; Rojas-Grau et al., 2007).

With regard to the pH data (Table 2), similar trends were recorded over an 8-d period, even though few statistically significant differences were found. In all cases, the highest pH values were noted on the second day of storage. The data agree with that reported in the literature for Mozzarella cheese (Salvadori del Prato, 2001).

Figure 2 shows the change in the O_2 and CO_2 in the headspace of cheese bags, sealed under ordinary and MAP conditions. The gas composition was selected without reaching anaerobic conditions and considering that high carbon dioxide concentrations could provoke bad aftertaste immediately after opening the package (Lichter et al., 2005). Figure 2 shows that, for the coated sample in ordinary packaging, O_2 and CO_2 are steady throughout the experimental observation period, accounting for around 20% and 2%, respectively. The figure also highlights that similar gas values were recorded between Coat-MAP and Con-MAP. In particular, for both of them, O_2 remained fairly constant in the region of 5%, whereas the CO_2 slipped from 29 to 25%. This result demonstrates that no influence of coating seems to be exerted on the headspace surrounding the product.

Microbiological Quality

Figure 3 shows the time course during storage of *Pseudomonas* spp. viable cell concentration for all Fior di Latte cheese samples. Bishop and White (1986) stated that a *Pseudomonas* spp. microbial load equal to 10^6 cfu/g of cheese represents the contamination level at which the alterations of the product start to appear. As can be seen in the figure, only the Con overlaps this threshold value, the other samples remained below this microbial limit during the entire observation period. For this reason, the microbial acceptability limit of all samples except the control, was considered longer than the storage period. To quantitatively determine the microbial acceptability limit of the control packaging system, the Gompertz equation as re-parameterized by Corbo et al. (2006), was fitted to the experimental data of the Con sample:

$$\begin{aligned}\log(N(t)) &= \log(N_{\max}) \\ &- A\cdot\exp\left(-\exp\left\{\left[(\mu_{\max}\cdot 2.71)\cdot\frac{\lambda-\mathrm{MAL}}{A}\right]+1\right\}\right) \\ &+ A\cdot\exp\left(-\exp\left\{\left[(\mu_{\max}\cdot 2.71)\cdot\frac{\lambda-t}{A}\right]+1\right\}\right)\end{aligned} \quad [2]$$

Table 2. pH data (mean ± SD) of Fior di Latte samples packaged in different systems during the storage period

Time (day)	Con[1]	Con-MAP	Coat-MAP	Coat-OAP
0	$5.0 \pm 0.0^{A,d}$	$5.0 \pm 0.0^{A,d}$	$5.0 \pm 0.0^{A,c}$	$5.0 \pm 0.0^{A,b}$
1	$5.4 \pm 0.0^{B,ab}$	$5.3 \pm 0.0^{A,c}$	$5.3 \pm 0.0^{A,d}$	$5.4 \pm 0.0^{C,f}$
2	$5.4 \pm 0.1^{B,b}$	$5.3 \pm 0.0^{A,c}$	$5.3 \pm 0.0^{C,a}$	$5.4 \pm 0.0^{A,be}$
3	$5.4 \pm 0.0^{A,ab}$	$5.2 \pm 0.0^{B,b}$	$5.2 \pm 0.0^{B,a}$	$5.3 \pm 0.0^{B,c}$
4	$5.3 \pm 0.0^{A,a}$	$5.3 \pm 0.0^{A,b}$	$5.3 \pm 0.0^{A,a}$	$5.3 \pm 0.0^{A,d}$
7	$5.2 \pm 0.0^{A,c}$	$5.2 \pm 0.0^{B,a}$	$5.1 \pm 0.0^{C,b}$	$5.2 \pm 0.0^{A,a}$
8	$5.2 \pm 0.0^{A,c}$	$5.2 \pm 0.0^{C,a}$	$5.1 \pm 0.0^{B,b}$	$5.2 \pm 0.0^{A,a}$

[A–C]Data within a row with different uppercase letters are significantly different ($P < 0.05$).

[a–f]Data within a column with different lowercase letters are significantly different ($P < 0.05$).

[1]Con = control in traditional packaging; Con-MAP = control in modified-atmosphere packaging; Coat-MAP = coating in modified-atmosphere packaging; Coat-OAP = coating in ordinary packaging.

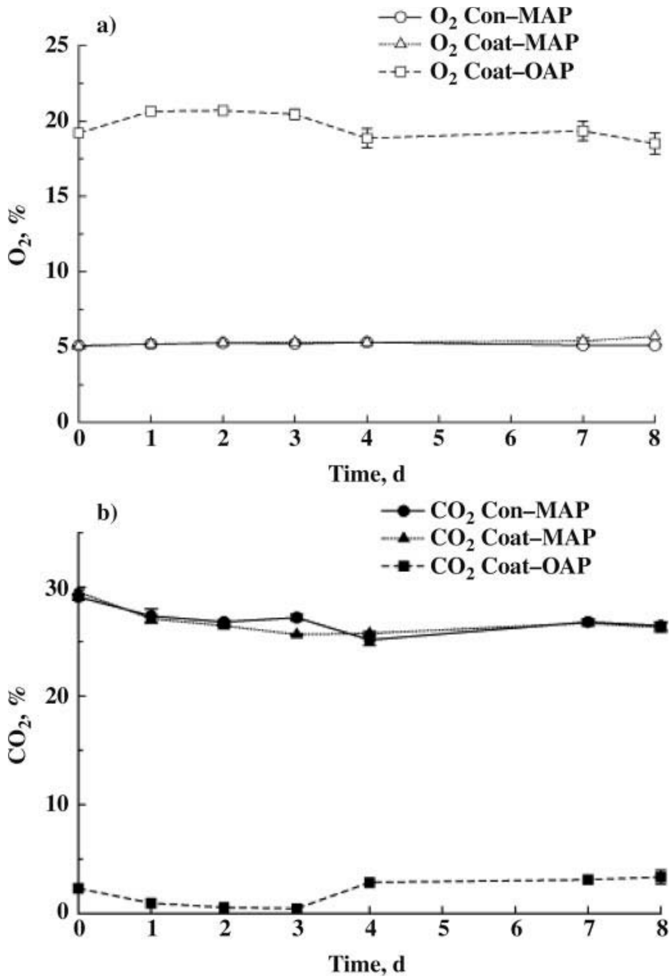

Figure 2. a) Oxygen changes in the hermetically sealed bags of Fior di Latte cheese; b) Carbon dioxide changes in the hermetically sealed bags of Fior di Latte cheese.

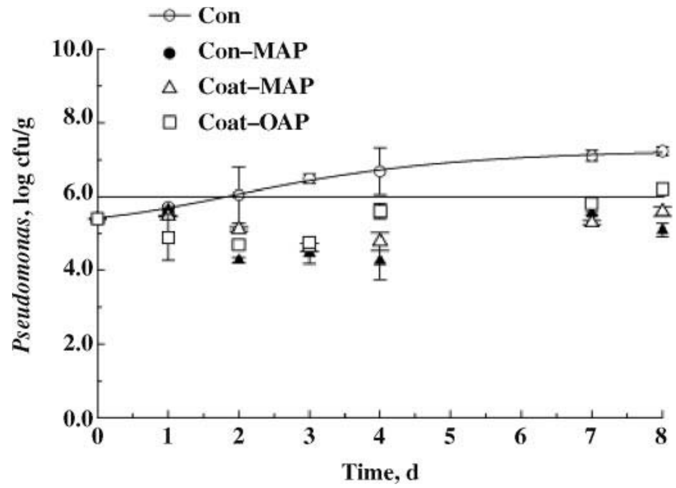

Figure 3. Evolution of *Pseudomonas* spp. count in Fior di Latte cheese during storage at 10°C for 8 d. The curve is the best fit of Eq. (2) to the experimental data of the control.

where $N(t)$ is the viable cell concentration at time t, A is related to the difference between the decimal logarithm of maximum bacteria growth attained at the stationary phase and decimal logarithm of the initial value of cell concentration, $\mu_{\max}$ is the maximal specific growth rate, λ is the lag time, $N_{\max}$ is the microbial threshold value, MAL is the microbiological acceptability limit [i.e., the time at which $N(t)$ is equal to $N_{\max}$], and t is the storage time. The value of $N_{\max}$ for was set to 10^6 cfu/g of cheese. The values of $\mathrm{MAL}^{Pseudomonas}$, reported in Table 3, show that the control recorded the worst result, whereas all other samples have a microbial acceptability limit higher than 8 d. The effectiveness of lysozyme on *Pseudomonas* spp. counts from Mozzarella cheese was also demonstrated in the literature (Sinigaglia et al., 2008). The data in table also show that MAP alone can affect the $\mathrm{MAL}^{Pseudomonas}$ value.

Figure 4 shows the total coliforms viable cell concentration plotted as a function of storage time for all fresh dairy samples. As reported in the figure, the Con overlaps the threshold value (10^5 cfu/g), imposed by the DPR 54/97 (European Union, 1997) for coliforms, and maintains this level over the entire observation period. On the contrary, all other samples, after a peak in the cell concentration, fell significantly below the above microbial limit. For this reason, Eq. (2), used to determine the $\mathrm{MAL}^{Pseudomonas}$ value, was fitted exclusively to the experimental data related to coliforms

Table 3. Shelf life (d; mean ± SD) of Fior di Latte samples, assumed as the lowest value among the calculated microbial and sensorial acceptability limits

Sample[1]	$\mathrm{MAL}^{\mathrm{coliforms}}$ (d)[2]	$\mathrm{MAL}^{Pseudomonas}$ (d)	SAL (d)	Shelf life (d)
Con	0 ± 0	2 ± 0	3 ± 0	0 ± 0
Con-MAP	<1	>8	3 ± 1	>1
Coat-MAP	>8	>8	3 ± 1	3 ± 1
Coat-OAP	>8	>8	2 ± 1	2 ± 1

[1]Con = control in traditional packaging; Con-MAP = control in modified-atmosphere packaging; Coat-MAP = coating in modified-atmosphere packaging; Coat-OAP = coating in ordinary packaging.

[2]$\mathrm{MAL}^{\mathrm{coliforms}}$ = microbiological acceptability limit for coliforms; $\mathrm{MAL}^{Pseudomonas}$ = microbiological acceptability limit for *Pseudomonas* spp.; SAL = sensorial acceptability limit.

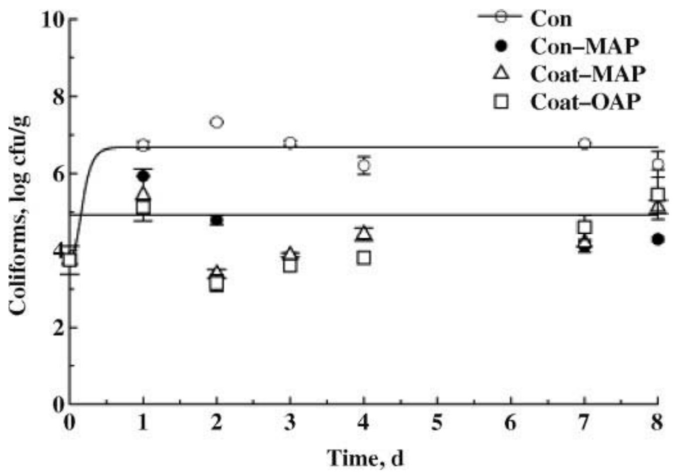

Figure 4. Evolution of total coliforms count in Fior di Latte cheese during storage at 10°C for 8 d. The curve is the best fit of Eq. (2) to the experimental data of the control.

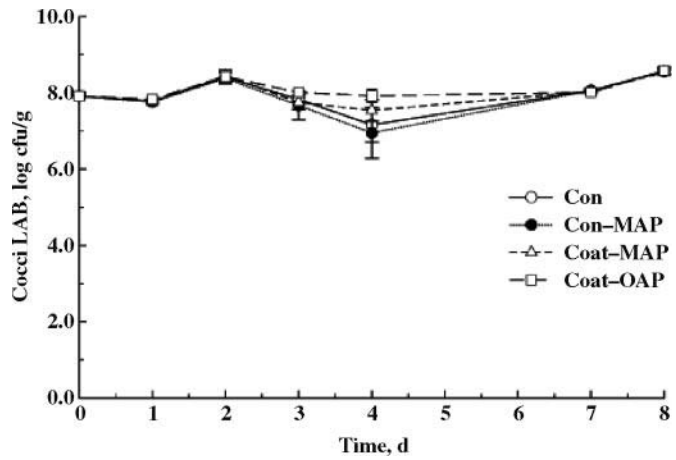

Figure 5. Evolution of cocci lactic acid bacteria count in Fior di Latte cheese during storage at 10°C for 8 d. The lines were drawn to highlight the data trend.

in the Con sample. A different approach was adopted for all other Fior di Latte packaging systems based on the statistical comparison between the threshold value and the microbial concentration reached at the peak point. The 2 types of coated Fior di Latte cheese reach a microbial load that is not statistically different from 10^5 cfu/g of cheese, suggesting that the microbial acceptability limit is higher than 8 d (Table 3). For the Con-MAP sample, the microbial peak at d 1 of storage is higher than the coliforms threshold value, and it is statistically different to 10^5 cfu/g of cheese. Therefore, the microbial acceptability limit is less than 1 d (Table 3), even though an antimicrobial effectiveness seems to be exerted, if compared with the Con. To sum up, the worst results are those recorded for the Fior di Latte in the traditional brine (Con) and without brine under MAP (Con-MAP). In contrast, the active coating exerts good antimicrobial properties against spoilage microorganisms. These are often on the cheese surface (Cantoni et al., 2003; Sinigaglia et al., 2008), therefore, the effectiveness of the active coating is most probably due to the direct contact of the active compounds to the food surface. These results suggest that active coating successfully inhibit the growth of both coliforms and *Pseudomonas* spp. Torres et al. (1985) also demonstrated the antimicrobial effect of an active edible coating on an intermediate-moisture cheese. On the contrary, packaging under MAP without coating does not guarantee the same antimicrobial efficacy as the active coating; whereas, if combined with active coating it further delays the growth of spoilage microorganisms.

No molds were detected on samples during the storage period. With regard to yeasts, similar trends were recorded between the different samples (data not shown). The yeasts' load in all cheese samples started from a low level (10^2 cfu/g of cheese) to arrive at 10^4 to 10^5 cfu/g of cheese at the stationary phase, according to Nunez et al. (1981) and Coppola et al. (1988).

Figures 5 and 6 report the data of cocci and rod lactic acid bacteria, respectively, in all Fior di Latte cheese samples. As shown, the cell load of the flora type is not affected by the packaging system, suggesting that the selected active compound and MAP conditions do not influence the growth of typical dairy microorganisms (Eliot et al., 1998; Sinigaglia et al., 2008).

Sensorial Quality

Figure 7 shows the sensorial quality plotted as a function of storage time for the Fior di Latte samples. To quantitatively determine the efficiency of the packaging system proposed in this work in terms of sensorial quality preservation, the Gompertz equation as re-parameterized by Corbo et al. (2006) was fitted to the sensorial data:

$$\begin{aligned}\mathrm{OSQ}(t) = {} & \mathrm{OSQ}_{\min} \\ & - A^Q \cdot \exp\left(-\exp\left\{\left[\left(\mu^Q_{\max}\cdot 2.71\right)\cdot\frac{\lambda^Q - \mathrm{SAL}}{A^Q}\right]+1\right\}\right) \\ & + A^Q \cdot \exp\left(-\exp\left\{\left[\left(\mu^Q_{\max}\cdot 2.71\right)\cdot\frac{\lambda^Q - t}{A^Q}\right]+1\right\}\right)\end{aligned} \quad [3]$$

where $\mathrm{OSQ}(t)$ is the Fior di Latte overall sensorial quality at time t, A^Q is related to the difference between

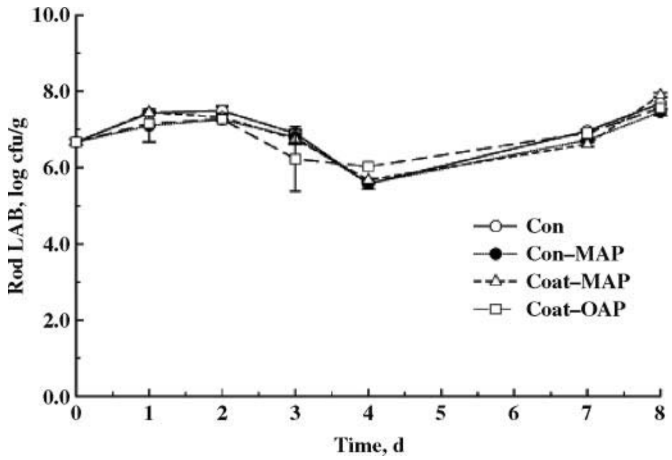

Figure 6. Evolution of rod lactic acid bacteria count in Fior di Latte cheese during storage at 10°C for 8 d. The lines were drawn to highlight the data trend.

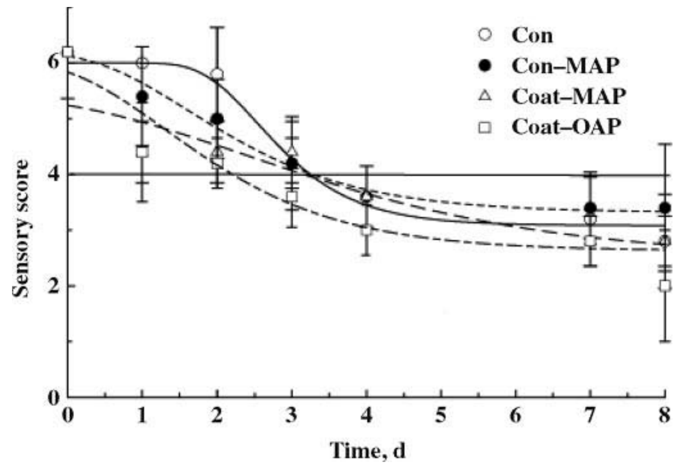

Figure 7. Fior di Latte cheese sensorial quality during storage at 10°C for 8 d. The curves are the best fit of Eq. (3) to the experimental sensorial data.

the Fior di Latte overall sensorial quality attained at the stationary phase and the initial value of Fior di Latte overall sensorial quality, $\mu_{\max}^{Q}$ is the maximal rate at which OSQ(t) decreases, λ^{Q} is the lag time, $OSQ_{\min}$ is the Fior di Latte overall sensorial quality threshold value, SAL is the sensorial acceptability limit [i.e., the time at which OSQ(t) is equal to $OSQ_{\min}$], and t is the storage time. As reported in the Materials and Methods section, the value of $OSQ_{\min}$ is equal to 4. The curves shown in Figure 7 were obtained by fitting Eq. (3) to the experimental data; the values of SAL (sensorial acceptability limit) obtained are listed in Table 3. Similar SAL values were recorded between the different samples. It is worth noting that the sensorial properties of the product do not remain in the acceptable range for longer than a 3-d storage period, probably due to the weight loss that compromises its appearance and consequently the product acceptability.

Shelf Life Evaluation

Wherever the overall quality of a given product depends on several quality subindices, the shelf life of the packed product is, by definition, the time at which one of the product quality subindices reaches its threshold value. In the case under investigation, the shelf life of each tested sample was calculated as the lowest value between the MAL and the SAL values and is reported in Table 3.

As can be seen, a significant shelf life prolongation was recorded for the samples packaged according to the proposed techniques compared with the traditional system. It is worth noting that the microbial quality is responsible for the unacceptability of Fior di Latte packaged in brine. Coating in ordinary packaging and coating under MAP could be advantageously proposed for industrial applications, because of the synergic effects on microbiological and sensorial quality, and also the possibility of reducing costs related to product distribution.

CONCLUSIONS

Lysozyme and Na_2-EDTA incorporated in a bio-based coating were used to prolong the shelf life of Fior di Latte cheese, in combination with MAP packaging. Microbial and sensorial properties, as well as weight loss, pH, and headspace gas composition were monitored for about 8 d to determine the quality loss during storage at 10°C. Results confirm literature data on the antimicrobial properties of lysozyme and Na_2-EDTA on the spoilage microorganisms of dairy products. Moreover, the combination of coating as a carrier of natural antimicrobials with MAP conditions in a sealed packaging system represents a strategic solution to prolong the shelf life of Fior di Latte cheese. This technique has an additional advantage because the coating also guarantees a considerably lower packaging weight. Considering that it is simple and relatively inexpensive, a simple coating could be very beneficial and of commercial importance to the dairy industry.

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