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APPLICATION OF ACTIVE PACKAGING TO IMPROVE THE SHELF LIFE OF FRESH WHITE CHEESES

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Key words: fresh white cheeses, shelf life, active packages, oxygen absorbers

A study was undertaken to examine the effect of oxygen absorbers (by Atco) used in the packaging of white cheeses on their shelf life. White cheeses packed in bags made of PA/PE laminate with and without oxygen absorbents were stored at a temperature of 5±0.5°C for a period of 7, 14 and 21 days. In the time spans mentioned, the white cheeses were determined for: the number of yeast, mould, and coli group bacteria, and for titratable acidity. Oxygen content of white cheese package atmosphere was assayed as well. The application of oxygen absorbers resulted in inhibited growth of yeast and moulds, and after two weeks also the growth of coli group bacteria. The presence of oxygen absorbers was observed not to affect any increase in the titratable acidity of stored white cheeses. The oxygen absorbers were proved effective in the modification of package atmosphere, *i.e.* they decreased oxygen concentration in the package atmosphere below 0.5%.

INTRODUCTION

Active packaging constitutes the latest generation of food packaging. Unlike tradition packaging, the active materials react with the inner atmosphere of a package or with the product packed, which results in extended shelf life of the food product with its safety, nutritive values and appropriate sensory traits preserved. Of multiple active packaging systems, oxygen absorbers applied in the form of sachets, labels, seals or polymers incorporated directly into the structure of packaging material are the most popular. The absorbers bind oxygen through the oxidation of: iron compounds, ascorbic acid, photosensitive dyes, and unsaturated fatty acids or through enzymatic oxidation, *e.g.* the use of alcohol oxidase [Vermeiren *et al.*, 1999]. The absorbers that utilize iron compounds are the simples and the cheapest, thus the most extensively used ones. Oxygen absorbers can be applied alone or in a combination with packaging under modified atmosphere. Investigations into the application of vacuum packaging and modified atmosphere packaging for extending the shelf life of fresh white cheeses have been carried out at the Chair of Dairy Science and Quality Management for years. This study was aimed at identifying possibilities of applying oxygen absorbers for the elongation of the shelf life of fresh white cheeses.

MATERIAL AND METHODS

The experiment was carried out on sliced curd cheeses originating from one dairy plant selected at random. White cheese samples (*ca.* 50 g each) were fixed in bags made of PE/PA laminate (recommended by the Cryovac company for white cheese packaging) with a total capacity of *ca.* 350 cm^3. Sachets with oxygen absorbers (ATCO FT 210) were inserted to a part of samples. White cheeses packed without oxygen absorbers served as control samples. All bags were sealed on a chamber packaging machine Multivac A-300/16 MC under subatmospheric pressure of 500 mbar. This method of packaging was aimed at reducing the content of air in a package and at facilitating the activity of absorbers. The white cheeses were stored at a temperature of 5°C±0.5°C for 21 days.

After 7, 14 and 21 days of storage, the white cheeses were determined for: (i) the number of *coli* group bacteria – with the plate method on VRBD medium with the following composition: agar with methyl violet, neutral red, yellow and dextrose (Merck); (ii) the number of yeast and mould – with the plate method on YGC medium with the following composition: agar with a yeast extract, glucose and chloramphenicol (Merck); (iii) titratable acidity (°SH) [Budsławski, 1973]; and (iv) the content of air in a package (%) by means of PBI Densensor CheckMate 9900.

Analogous assays were carried out on the samples of fresh white cheese (prior to packaging). The experiment was conducted in 4 replications.

RESULTS AND DISCUSSION

The *coli* group bacteria are indicators of the hygienic quality of white cheeses. Most often, the microbiological spoilage of white cheeses during their storage is caused by yeast and moulds. Therefore, in this study we monitored the

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growth of those groups of microorganisms in stored white cheeses packed with oxygen absorbers.

The white cheeses examined were characterised by a low contamination with *coli* group bacilli, which pointed to good hygienic standards at the production of those cheeses as well as to their quality. The number of those bacteria in fresh control samples was less than 10 cfu/g and practically did not change until the end of the storage period of those products, *i.e.* up to day 21. Similarly low population numbers of the coli group bacteria were observed in the white cheese samples packed with oxygen absorbers, yet after 21 days of storage no coli group bacilli were identified in the samples (Figure 1).

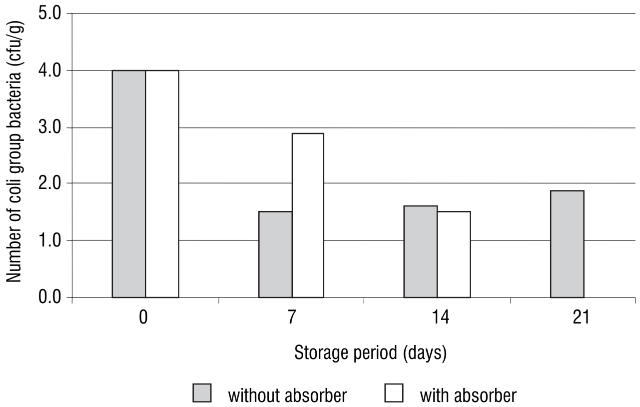

FIGURE 1. The effect of packaging method and storage period of white cheese on the number of *coli* group bacteria.

The number of moulds in the fresh white cheese ranged from 1.2×10^2 to 3.0×10^2 cfu/g, which accounted for 1.9×10^2 cfu/g on average. In the white cheeses packed without oxygen absorbers, after 7, 14 and 21 days of storage the population of moulds increased to respectively 4.9×10^3; 2.5×10^4 and 1.2×10^5 cfu/g, on average. A less dynamic growth of moulds occurred in the samples of white cheeses packed with oxygen absorbers and accounted for: 7.4×10^2, 1.7×10^3 and 1.3×10^4 cfu/g on average, respectively (Figure 2).

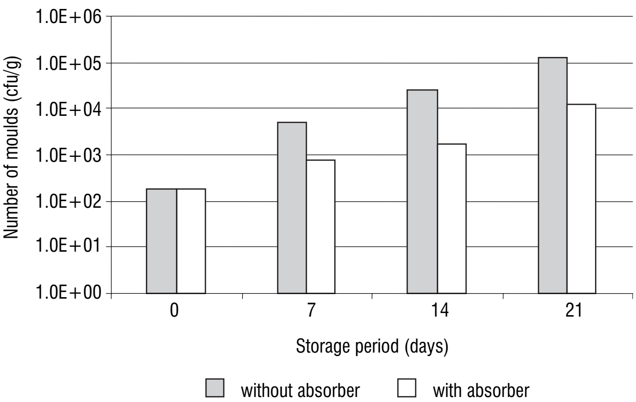

FIGURE 2. The effect of packaging method and storage period of white cheese on the number of moulds.

Similar tendencies of changes were reported while determining the number of yeast. The degree of white cheese samples contamination with those microflora before packaging ranged from 2.8×10^2 to 6.5×10^2 cfu/g, which gave an average of 4.5×10^2 cfu/g. After 7 days of storage, the white cheeses packed without oxygen absorbers were characterised by a rapid growth of the yeast population to 1.4×10^4 cfu/g. After 14 and 21 days of storage, the average number of those bacteria reached 5.0×10^4 and 1.6×10^5 cfu/g, respectively. In the white cheeses packed with oxygen absorbers, the growth of yeast appeared to be less dynamic. In the subsequent time intervals (7, 14 and 21 days), their average number accounted for: 1.4×10^3, 3.5×10^3 and 6.4×10^4 cfu/g (Figure 3).

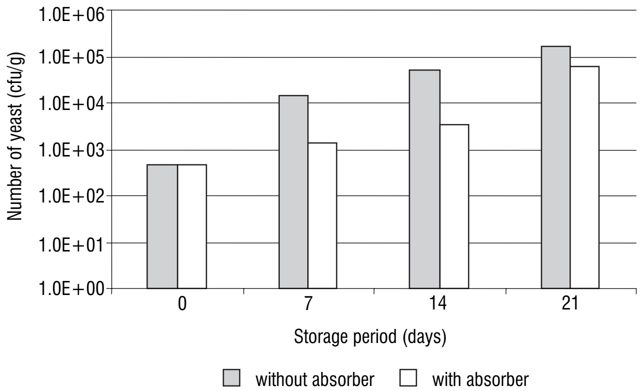

FIGURE 3. The effect of packaging method and storage period of white cheese on the number of yeast.

The acidity of fresh white cheeses ranged from 58°SH to 72°SH, *i.e.* 63°SH on average. In the case of the white cheeses packed without oxygen absorbers, a significant increase in the acidity values was observed after 14 and 21 days of storage. The average acidity of the samples measured in those time intervals reached 68°SH and 73°SH, respectively. The acidity of the white cheeses packed with oxygen absorbers was observed to increase in similar proportions (Figure 4).

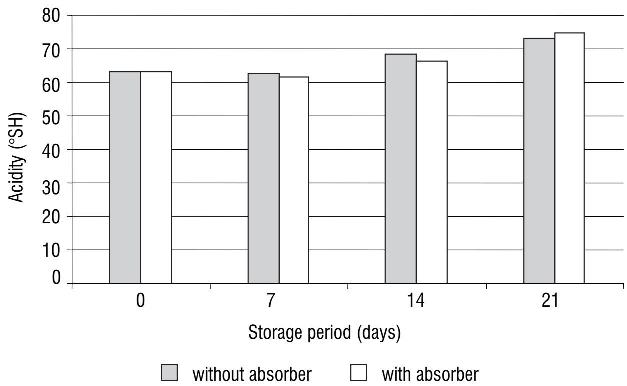

FIGURE 4. The effect of packaging method and storage period of white cheese on its potential acidity (°SH).

The increases in the acidity of both types of samples were alike and typical of stored white cheeses. As expected, the atmosphere's modification by means of oxygen absorbers had no significant effect on the growth of lactic acid bacteria in the white cheeses examined.

Along with storage time proceeding, the atmosphere's composition in white cheese packages was also subject to changes. Initially, the content of oxygen in packages with and without absorbers reached *ca.* 21%. In the packages without oxygen absorbers, after 7 days the content of that gas decreased to 19.4%, and after 14 and 21 days accounted for 17.6% and 13.7% on average, respectively (Figure 5). The reduction in oxygen content of those packages was probably due to the development of aerobic microflora utilizing oxygen, mainly yeast and moulds. In the packages of white cheese containing oxygen absorbers, the concentration of that gas in the first week was subject to a considerable reduction, *i.e.* to 0.55%, and sustained at a similar level up to day 21 of the experiment (Figure 5). According to the producers, *i.e.* the ATCO company, the oxygen absorbers applied in this study should reduce oxygen content of a packaging to a level approximating zero within the first 24 h. Additional assays carried out in this study demonstrated that such a low concentration of oxygen in the packages with absorbers was observed as soon as after 8 h. On termination of the experiment, the sachets with absorbers applied were sent to the ATCO company in France to determine the degree of utilization of their capacity. Analyses demonstrated that after 25-day storage of white cheeses in absorber-containing packages, their capacity still reached 3–5% of the initial capacity. This indicated that over the entire experimental period the absorbers were active, which proved the appropriate selection of their capacity.

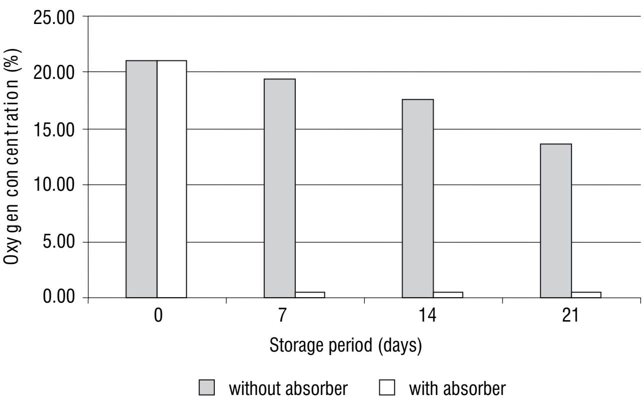

FIGURE 5. The effect of packaging method and storage period of white cheese on oxygen concentration in the package.

The results of microbiological assays demonstrated that the application of oxygen absorbers inhibited the growth of the examined microflora in white cheeses, thus reducing unfavorable changes in their quality. In addition, the increases in acidity seem to indicate that the active packaging did not inhibit the growth of souring microflora in those products.

The application of oxygen absorbers is one of the methods used to modify the atmosphere inside a package, hence the results obtained can be compared with results of studies into vacuum packaging and modified atmosphere packaging. Our previous investigations have demonstrated that the growth of *coli* bacteria, yeast and moulds in white cheeses packed under vacuum and by thermal shrinking of the package around the cheese was inhibited to such a extent that it enabled extending the shelf life of the product to 10–15 days Panfil-Kuncewicz & Kuncewicz, 2000b; Panfil-Kuncewicz *et al.*, 1996, 2001]. Better results were reported while packing white cheeses under CO_2 atmosphere, wherein the number of yeast and moulds in the cheeses did not exceed the obligatory norms up to 21–28 days [Panfil-Kuncewicz & Kuncewicz, 2000a]. Steinka & Przybyłowski [1999] have also demonstrated that the vacuum packaging inhibited the growth of yeast and moulds in white cheeses. In addition, Steinka & Kurlenda [2001] have observed a decrease in the number of the *coli* group bacilli over 14-day storage of vacuum-packed white cheeses. Fedio *et al.* [1994] have reported on changes in the growth intensity of yeast and moulds populations in cottage cheeses as affected by the composition of the surrounding atmosphere. The greatest growth inhibition of those microorganisms was obtained under 100% CO_2 atmosphere.

In their study into the effect of atmosphere inside the package on the microbiological quality of sliced mozarella cheese Alwes *et al.* [1996] reported on the best effects in the case of the product packed under 100% CO_2 atmosphere. The shelf life of the cheese packed under that atmosphere was four times longer than that of the cheese packed under natural atmosphere (in the air). Pintado & Malacta [2000], while investigating vacuum-packed traditional Portuguese cheeses "Requeijao", demonstrated that this type of atmosphere modification inside the package inhibited the growth of both yeast and moulds.

Taking into account the above-mentioned findings, the results obtained in the reported study are not satisfactory. It seems that the modification of a packaging atmosphere by means of oxygen absorbers should be more efficient. The reduction of oxygen concentration to a level approximating zero proceeds, probably, simultaneously with an increase in the concentration of CO_2 produced by bacterial cells, which should considerably inhibit the growth of yeast and moulds. Perhaps, the weak effects of oxygen absorbers on growth inhibition of yeast and moulds have resulted from relatively high numbers of those microorganisms in fresh white cheeses (prior packaging). In addition, some producers of the absorbers inform that their effective activity requires the total number of microorganisms in a product not to exceed 10^5 cfu/g. According to this information, it may be assumed that oxygen absorbers will not be effective in packages of white cheeses in which the total number of microorganism is usually higher due to their production technology (lactic streptococci 10^6–10^7 cfu/g). At this moment, however, it is only a presumption that requires more extended investigations.

CONCLUSIONS

1. The oxygen absorbers (ATCO, France) used in the study were found to effectively modify the atmosphere inside white cheese packages, thus reducing the concentration of oxygen therein to *ca.* 0.5%.

2. The application of oxygen absorbers in white cheese packaging inhibited, but not arrested, the growth of yeast and moulds over the storage period.

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ZASTOSOWANIE PAKOWANIA AKTYWNEGO DO POPRAWY TRWAŁOŚCI SERÓW TWAROGOWYCH

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Badano wpływ pochłaniaczy tlenu (firmy Atco), zastosowanych do pakowania serów twarogowych, na trwałość tych produktów. Sery twarogowe pakowane w woreczki z laminatu PA/PE z dodatkiem i bez dodatku absorberów tlenu przechowywano w temp. 5±0.5°C przez okres 7, 14 i 21 dni. W wymienionych czasookresach oznaczano w twarogach: liczbę drożdży, pleśni, bakterii z grupy coli coraz kwasowość miareczkową. Dokonano również pomiarów zawartości tlenu w atmosferze opakowań twarogów. Zastosowanie pochłaniaczy tlenu spowodowało spowolnienie rozwoju drożdży i pleśni a bakterii z grupy coli po dwóch tygodniach (rys. 1, 2, 3). Nie obserwowano wpływu obecności pochłaniaczy tlenu na przyrosty kwasowości miareczkowej w twarogach przechowywanych (rys. 4). Stwierdzono, że pochłaniacze tlenu skutecznie modyfikowały atmosferę w opakowaniach obniżając w niej zawartość tlenu poniżej 0.5% (rys. 5).