INFLUENCE OF ACTIVE PACKAGING ON THE SHELF LIFE OF SOFT CHEESE *KLEO*

Sandra Muizniece-Brasava*, Lija Dukalska, Irisa Murniece, Svetlana Sarvi, Ilona Dabina-Bicka, Emils Kozlinskis

Latvia University of Agriculture, Faculty of Food Technology, Liela street 2, Jelgava, LV-3001, Latvia
**e-mail: sandra.muizniece@llu.lv*

Abstract

The research was carried out at the Faculty of Food Technology of the Latvia University of Agriculture (LLU). Soft cheese *Kleo* produced in Latvia was used for experiments. At present the cheese *Kleo* has been found on the market place in vacuum packaging (VP) and its shelf life is not more than 15 days. For shelf life extension an active packaging in combination with modified atmosphere (MAP) was investigated. Following packaging materials were used: OPP, PE/PA, PE/OPA and Multibarrier 60. An iron based oxygen scavenger sachets of 50 cc obtained from Packaging Solutions OÜ was used. Cheese samples of 100±10 g were packaged in polymer pouches (110 x 120 mm). Modified atmospheres consisting of carbon dioxide CO_2 (E 290) 30% and nitrogen N_2 (E 941) 70% was used, while VP was selected as the control packaging. Pouches were hermetically sealed by *MULTIVAC C300* vacuum chamber machine, stored in a Commercial *Freezer/Cooler „Elcold"* at the temperature of +4.0±0.5 °C up to 32 days' and analysed before packaging and in the 0, 5th, 11th, 15th, 18th, 22nd, 25th, 29th and 32nd day of storage. Physical and chemical properties: headspace gas composition, pH, acidity, moisture content, and microbial conditions were evaluated. By use of both usual MAP conditions as well as with oxygen scavenger commitment in the pouch the shelf life was extended, good outside appearance and lactic acid aroma was observed.

Key words: soft cheese, modified atmosphere, oxygen scavengers, shelf life.

Introduction

Soft fresh cheeses are those cheeses that are unripe. White cheese is usually made from raw milk without of starter culture (Abdalla et al., 1997), souring the milk, either with lemon juice or vinegar. Creamy curds were formed then strained to produce a simple cheese. These cheeses have high moisture content, are usually mild and have a very soft texture. These cheeses are typically the most perishable. Cheeses in the fresh category include Italian Style Mascarpone, and Ricotta, Chevre, Feta, Cream cheese, Quark and Cottage cheese.

Optimal packaging solutions could prevent or minimize quality changes, resulting in increased shelf life as well as quality maintenance. Different types of cheeses have to be packed in different packaging concepts (Mortensen, Bertelsen et al., 2005). Most fresh cheeses are packed in air atmosphere due to the short shelf life required. Some experiments proved that chemical composition and sensory characteristics, colour and body of white cheese made from pasteurized cow milk during the storage period 45 days in vacuum packaging did not significantly change (Osman**,** Abdalla et al., 2009). Find out that packaging and cold storage of Sudanese white cheese in metal containers is better than in plastic containers as low total bacterial, coli forms, *E.coli* and yeast counts were obtained in cheese packed in metal containers (Ahmed, Alhassan, 2010).

An established fact is that primary spoilage organisms in cheeses are moulds and MAP could be used to prevent mould growth. Gases with low residual oxygen and high CO_2 levels may be used to ensure microbial stability (Mortensen, Bertelsen et al., 2005). Sometimes cream cheeses are pasteurized prior packaging (Gonzales-Fandor, Sanz et al., 2000).

The potential use of Modified atmosphere packaging (MAP) and active packaging for extending the shelf life of dairy products, including cheese, has been demonstrated (Floros, Nielsen, and Farkas, 2000). Limited work has been conducted to date on the use of different gas composition MAP for shelf life extension of soft, creamed-style, and whey cheeses (Pintado et al., 2001; Papaioannou, Chouliara et al., 2007; Dermiki, Ntzimani et al., 2008).

In order to optimize product and packaging compatibility, materials with improved barrier properties should be used. Optimization may include new areas such as active packaging

concepts, and nanocomposite technology (Mortensen, Bertelsen et al., 2005). A study conducted by the Department of Food Science at Cornell University concluded that *FreshPax*™ is effective in extending the shelf-life of oxygen-sensitive foods, and its use decreases mould and mould spoilage of commercial cheese (*FreshPax™ Oxygen Absorbing Packets).* Different antimicrobial packaging systems were used as active agents to increase the shelf life of Mozzarella cheeses (Conte, Scrocco C, et al., 2007).
The objective of this work was to study two different modified atmosphere packaging (MAP) solution effect on the shelf life of soft fresh cheese *Kleo* – the use of both usual MAP conditions as well as with oxygen scavenger commitment in the pouches made of different polymer materials and compare them with the commercial vacuum packaging (VP) of the cheese.

Materials and method

Cheese Kleo characteristics

Experiments were carried out at the Department of Food Technology, Latvia University of Agriculture in 2011. The objects of the research: cheese *Kleo* – a regional white soft fresh cheese manufactured in local cheese making factory from pasteurized (+78–+82 °C) and normalized cow milk – for experiments was bought on the local supermarket in Latvia. The albumin from the milk have been set down by addition of acid cheese whey, after than filled in self compressing vat for moulding during 16 to 18 hours. The pressed unripe cheese peaces have a cylindrical shape with rounded off side edges, before packaging they are rubbed with salt (NaCl), salt content – from 0.3 to 0.8%. The consistency of cheese is mild, and has a homogenous slightly grainy texture, with irregular breaks, the surface slightly wet, the colour from white to slightly yellowy. The moisture content of cheese should be not more than 64%, fat content – 35±2%.

Packaging and storage of samples

Cheese *Kleo* in currently is sold on the market place in a polymer PA/PE pouch vacuum packaging (VP) weight of 0.3–0.8 kg in each and its shelf-life is not more than 15 days at the temperature 0 to +6 °C. Four different polymer films were used: PA/PE, PE/OPA, Multibarrier 60 and OPP. The structure of performed experiments is shown in Fig.1.

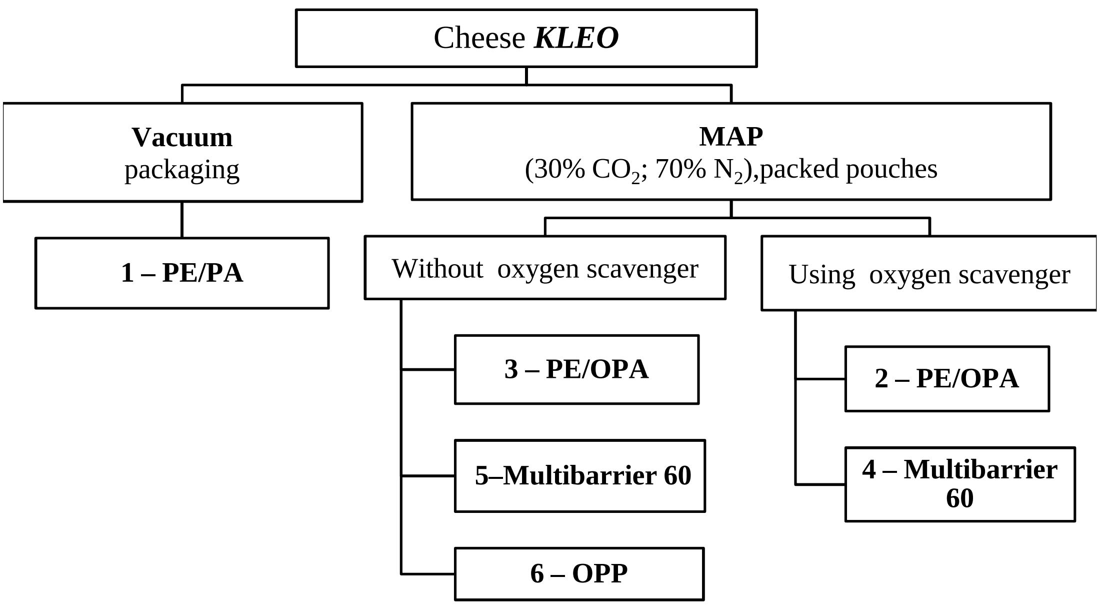

Figure 1. The structure of performed experiments

Packaging materials for experiments were selected with different water vapor transmutation rate and various thicknesses. The manufactured cheese *Kleo* cylindrical peaces were cut into four parts each, packed by 100±10 g in beforehand from roll stocks made polymer pouches size of 110 x 120 mm. For shelf life extension the use of both usual MAP conditions as well as with oxygen scavenger commitment in the pouch was investigated. Modified atmosphere consisting of carbon dioxide CO_2 (E 290) 30% and nitrogen N_2 (E 941) 70% was used, while vacuum packaging (VP) was selected as the control. For reduced oxygen packaging (ROP) creation (O_2–0%) in pouches an iron based oxygen scavenger sachets of 50 cc obtained from Packaging Solutions OÜ were used. The samples were hermetically sealed by MULTIVAC C300 vacuum chamber machine and stored in a Commercial Freezer/Cooler „Elcold" at the temperature of +4.0±0.5 °C, controlled by MINILog Gresinger electronic. At the storage time up to 32 days' physical and chemical properties: headspace gas composition, pH and acidity, moisture content, water activity were evaluated. Content of microorganisms – moulds, yeasts, and lactic acid and *Escherichia coli* bacteria was pointed. At each time of measurement, two identical packages for each packaging material were randomly selected on sampling days (day 0) and after 5th, 11th, 15th, 18th, 22nd, 25th, 29th and 32nd day of storage; six measurement repetitions of each sample were performed.

Physical, chemical, and microbial analysis

Headspace gas composition – expressed as % oxygen (O_2) and % carbon dioxide (CO_2) was measured using a gas analyser OXYBABY® V O_2/CO_2. Mass loss – determined by standard LVS ISO 1442: 1997. Water activity – determined by standard ISO 21807:2004, AquaLab LITE device. pH – determined by JENWAY 3510 pH-meter, standard method LVS ISO 5542:2010. Acidity – to 5 g cheese 30 ml distilled H_2O was added and the grinded mixture titrated by solution of 0.1 n NaOH. An acidity in °T was calculated the ml of NaOH multiplying by 20. Microbial analyses**:** lactic acid bacteria count – determined by standard method, ISO 9332:2003; yeasts – determined by ISO 21257-2:2008; mould appearance was visually observed.

Statistical analysis

The results were processed by mathematical and statistical methods. Statistics on completely randomized design were determined using the General Linear Model (GLM) procedure SPSS, version 16.00.

Results and Discussion

Water vapor permeability of packaging materials is essential for water loss. In our experiments has been established the mass losses from packages during 32 storage days didn't exceed 0.3%. Dosebry and Hardy (2000) noted that a 2.5–5.0% weight loss of cheese due to insufficient barrier properties is normal. They also found that dehydration of fresh cheese should be avoided, because a dehydrated surface is a major quality defect in those products. Moisture loss was the main factor of weight loss from the cheese during the storage time caused by different water vapor barrier properties of packaging materials. Water activity a_w of cheese *Kleo* at the beginning of experiment was 0.98, during the storage time it increased till 0.99.

The gas composition in the headspace changed. Carbon dioxide content decreased in all packages by approximately 10 to 15% during first 5 days of storage due to partial dissolution in the cheese mass. Following the storage CO_2 content as a result of growth of lactic acid bacteria significantly increased (till 58%) in MAP, Multibarrier 60 packages, when in the presence of oxygen scavengers its increase was only till 40% (Fig. 2). The oxygen content (O_2) in Multibarrier packaging increased a little in the packages with oxygen scavengers incorporated, while in the packages made of the same material without scavenger, including vacuum packaging, the O_2 concentration increased in average till 4.5% (Fig. 3). Phenomena showed MAP, OPP packaging increasing the O_2 content in packages till 20%, similar like in air conditions, and all samples after 22 storage days spoiled and turn moldy, therefore further experimentally were not analyzed

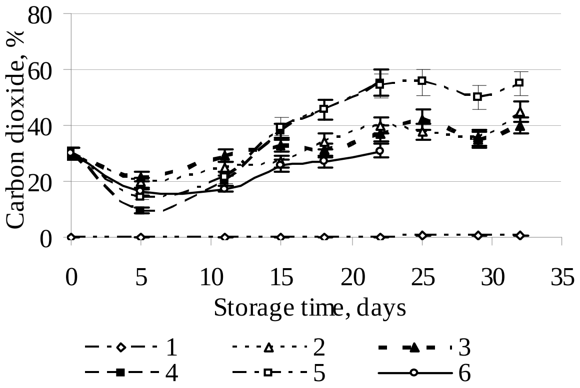

Figure 2. The dynamics of carbon dioxide (CO_2) content in the headspace of package in MAP (30% CO_2+70% N_2)

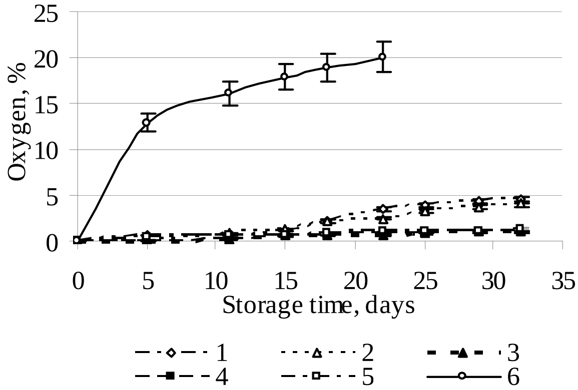

Figure 3. The dynamics of oxygen (O_2) content in the headspace of package in MAP (30% CO_2+70% N_2)

1 –vacuum, PA/PE; 2 – MAP, PE/OPA; 3 – MAP, PE/OPA, oxygen scavenger*;* 4 – MAP, Multibarrier 60, oxygen scavenger; 5 – MAP, Multibarrier 60; 6 – MAP, OPP.

As shown in Fig. 4, initial pH value of cheese *Kleo* was 5.8 decreasing within 32 storage days up to 5.0 of the control sample (VP) and 4.8 in samples packed under MAP in PE/OPA without oxygen scavengers. Using oxygen scavenger's pH values decreased till 4.9 in PE/OPA and till 5.0 in Multibarrier 60 film packaging relating with acidity increase approximately till 130 °T (Fig. 5).

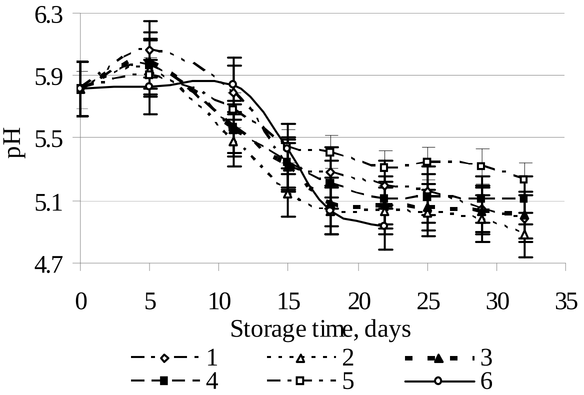

Figure 4. pH dynamic in vacuum and in MAP packed Cheese *Kleo* during the storage time

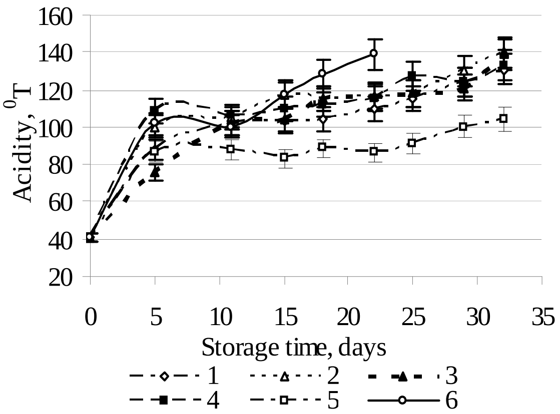

Figure. 5. Acidity dynamics in VP and in MAP packed cheese *Kleo* during the storage time

1 –vacuum, PA/PE; 2 – MAP, PE/OPA; 3 – MAP, PE/OPA, oxygen scavenger*;* 4 – MAP, Multibarrier 60, oxygen scavenger; 5 – MAP, Multibarrier 60; 6 – MAP, OPP.

The least decrease in pH values showed sample packed in Multibarrier 60 film without oxygen scavenger in conformity with acidity increase from 40 till 100 °T. The higher decrease of cheese pH value was observed in cheese packed in MAP, OPP – already after 22 storage days it was 4.8 corresponding to higher value of acidity 140 °T, therefore all samples in this packaging grow misty, wherewith this packaging material doesn't ensure the cheese quality during storage. This is expressed and may be related to the higher lactic acid bacteria (LAB) counts to those (Figure 6) different packaging methods. During the growth of LAB, lactic acid produced with a consequent drop in pH.

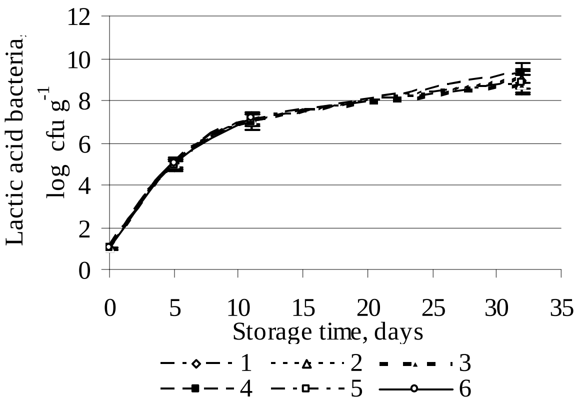

Figure 6. The dynamics of lactic acid bacteria in cheese *Kleo* during storage in MAP 70% CO_2 + 30% N_2

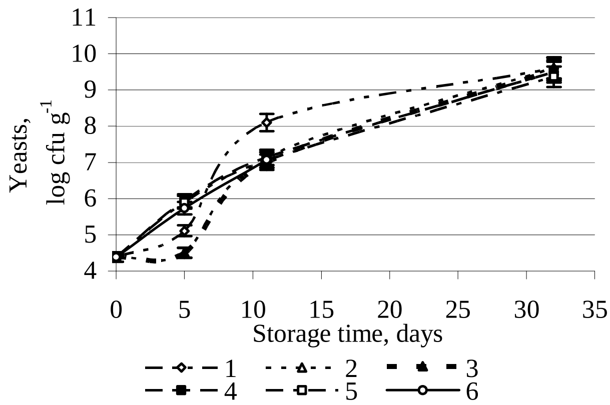

Figure 7. The dynamics of yeasts in cheese *Kleo* during storage in MAP 70% CO_2 + 30% N_2

1 –vacuum, PA/PE; 2 – MAP, PE/OPA; 3 – MAP, PE/OPA, oxygen scavenger*;* 4 – MAP, Multibarrier 60, oxygen scavenger; 5 – MAP, Multibarrier 60; 6 – MAP, OPP.

Regarding LAB (Fig. 6) all samples showed similar growth rate. All samples after 10 storage days presented the value 7 log cfu g^{-1}, after 32 days of storage – in average 9 log cfu g^{-1}. Similar results were fond by Dermiki, Ntzimani et al. (2008) in experiments with MAP packed whey cheese. Lactic acid bacteria may spoil soft cheeses in modified atmosphere, because the bacteria are facultative anaerobic, which implies that they cannot be controlled by modified atmosphere packaging (Westall, Filtenborg 1998). Not any mould growth in all packaged samples, excepting MAP, OPP was observed. In cheese packed in high moisture barrier property OPP film the samples get spoiled and moulded after 22 days. The yeast grows in all packaging conditions was equal (Fig. 7) – after 32 storage days in average 9 log cfu g^{-1} were observed. The incorporation of oxygen scavenger into packages didn't give the desiderate result for quality maintenance and subsequent shelf life extension of soft cheese *Kleo*. It was recognized the shelf life of cheese *Kleo* could be acceptable till 32 days.

Conclusions

1. No significant effect of oxygen scavengers' application for shelf life extension of soft cheese *Kleo* was observed.
2. An elevated content of CO_2 (till 55%) produced by lactic acid bacteria growth positively affected the cheese quality parameters in MAP, Multibarrier 60 film packaging without oxygen scavenger sachets incorporated in pouches.
3. The addition experiments should be carried out to determine the effect of active packaging on cheese *Kleo* shelf life.

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