Physicochemical and Sensorial Properties of Sepet Cheeses Packaged under Different Modified Atmospheric Conditions

ABSTRACT

The aim of the present study was to investigate the physical, chemical, and sensory properties of traditional sepet cheese samples which were packaged under different modified atmosphere conditions (MAP). All properties of the Sepet cheese samples were analyzed at the 1st, 45th, 90th and the 180th day of the storage period at +4°C. In packaging of the cheese samples, three different modified atmosphere packaging conditions were applied. The cheese samples were packaged into polystyrene packages containing 100% nitrogen, 80% nitrogen + 20% carbon dioxide or 100% carbon dioxide. According to the results obtained from statistical analyses, a significant difference was obtained by Modified Atmosphere Packaging (MAP) of Sepet cheese samples in terms of dry matter %, fat-in-dry matter %, salt-in-dry matter %. Examining the sensory properties including mass and texture, appearance, flavor and odor statistically, it was determined that there was a significant difference between the packaged Sepet cheese samples containing 100% CO2 during storage period. In general, it could be said that Sepet cheeses that were only packaged under different modified conditions containing 100 % nitrogen or 80% nitrogen + 20% carbon dioxide provided a better protection in terms of physicochemical and sensorial properties.

INTRODUCTION

Cheese is an important traditional food in Turkish cuisine. Many cheese types which are produced only in restricted geographical areas are consumed locally in large quantities in Turkey (Turkoglu et al. 2003; Hayaloglu et al. 2007; Kamber 2008). It is estimated that 40–50 cheese types are known as regional in Turkey, but only three of them have national and economic value: Turkish White (Beyaz peynir in Turkish), Kaşar and Tulum cheeses (Hayaloglu et al. 2002, Kamber 2005; Çakmakçı et al. 2008; Karagözü et al. 2016). While some of the traditional cheese are produced in dairy industry, most...
of them are produced only house conditions. Therefore, necessary quality standards couldn’t be achieved (Cetinkaya 2005). In Turkey, the regional cheese types including mihalic, otlu, cerkez, kazikli, safak, kapanisti, otlu, sepet, yoruk and cimi are produced using traditional methods (Karagözlu et al. 2009).

Sepet cheese is a type of traditional semi-hard cheese in the Mediterranean Region of Turkey. Some of the cheese have been forgotten and these kinds of products are produced in houses and sold only at local markets (Karakaş et al. 2006). Also, sepet Cheese is produced in towns at the Aegean Region which is close to the sea, especially in towns including Ayvalık, Dikili, Burhaniye, Foça, Çesme, Urla, Karaburun, Ödemiş and Söke (Unsal 1997). In particular, Ayvalık, Karaburun and Çesme are renowned for its production. In Ayvalık, the cheese is known as “Kelle Cheese”. The cheese was taught to the local people by immigrants in the region. In general, Sepet cheese is made using goat, sheep and cow’s milk, however local people used goat milk in the production of Sepet cheese. The milk from woolly goats, which are still widely raised by shepherds and small herd owners in the area, is used in the production of the cheese. In Ödemiş and Söke, a blend of cow’s and ewe’s milk is used for the production of Sepet cheese (Kamber 2008). In Ayvalık and Polonezköy, cow milk is usually used in the production of Sepet cheese. According to producers, 1 kg Sepet cheese can be produced from 9-10 L cow’s milk or 6-7 L goat’s milk or 4.5 L ewe’s milk (Büke 1981, Kinik et al. 1999).

Technological advances in processing and packaging of dairy foods have influenced consumers. The consumer demands include convenient dairy products with enhanced nutrition and specific product functionalities (Henning et al. 2006; Singh et al. 2011). Food safety regulatory authorities have recommended the food industries to reduce the chemical and microbial overload in foods. These stringent regulations along with consumer preferences for natural and healthy products which are free of preservatives with extended shelf life have led the food industry to develop new packaging concepts. One of these concepts, MAP in combination with refrigeration has proven successful to increase the shelf life of milk and milk products (Rodriguez-Aguilera et al. 2011a, b).

The aim of this study was to investigate the physical, chemical, and sensory properties of Sepet cheese during manufacture and ripening, and to consider future studies on certain specific topics. Accordingly, sepet cheese was compared with other brined cheeses.

MATERIAL and METHODS

Cheese Manufacture

Production of cheese was carried out in a local manufacturer. Raw goat’s milk provided from Saanen goats were used for production. Raw goat milk was filtered through a 5-6 layered thin muslin, heated up to 58-60° C and immediately cooled to renneting temperature. Renneting was carried out by adding 14 mL of renet diluted with water to 100 L of milk. Time determined for the coagulation was 2 hours. At the end of coagulation period, milk was checked for coagulation. Determining the coagulation, curd was cut into small pieces using a perforated ladle. Then the curd’s temperature was increased to 36-38 ºC by pouring hot water on for easier and faster draining. Meanwhile, curd was subsided and separated from whey. The curd at the bottom of container, was collected manually, a ball shape was given and stuffed in optionally 1, 3 or 5 kg capacity baskets made of reed stems called “kova” or “guva” and top surface of the curd was flattened. The cheese in the basket was left to draining, spontaneously without placing any weight on the basket. In the meantime, curd took the basket’s shape during draining. Cheese have been turned upside down in order to make the top surface take the basket’s shape. Cheese had been taken out of the basket 15 minutes after the whey started to drain. Top and bottom surfaces were salted with thin salt and relocated in the basket for further percolation. Approximately 18 hour later, when the curd became a single firm hoop, it was taken out of the basket and put on a wooden surface in a shady place. Cheeses were rubbed with salt every other day in a total of 15 days.

Materials

Goat milk was used in the production of these Sepet cheeses. Rennet, industrial enzyme (Mayasan, 1/16.000 MCU/ml) was used as the coagulant agent in the production. In the packaging of cheese samples, three different modified atmosphere conditions were applied. The cheeses were packaged with polystyrene material under different modified atmospheric conditions. The Sepet cheese (approximately 200 g) were packaged in expanded polystyrene (EPS) (0.2mm thickness, oxygen transmission rate 2.600-7.700 cm³/m²/day bar, CO₂ transmission rate 10.000-26.000 cm³/m²/day bar at 25°C) trays placed in gas-barrier bags under three different atmosphere conditions (100% nitrogen, 80% nitrogen + 20 % carbon dioxide or 100% carbon dioxide). The cheeses were ripened for 6 months at +4°C and were analyzed at the 1st, 45th, 90th and the 180th day of the storage period. K, N, NC and C codes were given to the Control, 100% N₂, 80% N₂ + 20% CO₂, 100% CO₂, cheese samples, respectively. Samples were stored under refrigeration conditions for physicochemical and sensory analysis. Before the analyses, the samples were taken from the cold storage and the edge of the cheese.
blocks were removed and samples obtained from each cheese were homogenized in a blender.

**Physicochemical Analyses**

The total solids (TS) content of the cheese samples was measured by gravimetric method (AOAC 2006); titratable acidity was determined titrimetrically as lactic acid % (Kosikowski 1982). Salt was measured according to the titration method using AgNO₃ (Bradley et al. 1993) and the fat values were determined by the Gerber method using Van–Gulik butyrometer (Ardo and Polychroniadou 1999). The pH values of cheese samples were measured using a pH meter combined with an electrode (Hanna pH 211 Microprocessor, Portugal). Total nitrogen (TN) values of cheese were determined by Kjeldahl method (Barbano et al., 1990), using approximately 1 g of cheese. The water–soluble fraction (WSN) was prepared essentially as described by Ardo and Polychroniadou (1999), using 20 g of cheese with 100 mL H₂O. The mixture was homogenized for 5 min using an Ultraturrax (Heidolph Cient Crusher M, Germany). Water-soluble N content of the cheese extract was determined by the Kjeldahl method, using 10 mL of cheese extracts (Katsiari et al., 2001). Additionally, protease peptone nitrogen (PPN) content was calculated by the derivation of NPN content from WSN content (Gripon et al. 1975) and the ripening index was estimated using the formula of WSN / TN x 100 (Venema et al. 1987). The acid degree value is determined according to Renner (1993). Ripening index was calculated as percentage of pH 4.6 soluble nitrogen fraction and total nitrogen ratio (Metin 2006).

**Sensory Analysis**

Sensory analysis of the cheese samples during the ripening period was carried out by seven individuals who were selected from university staff based on their availability, interest, a demonstrated liking for cheese and experience in sensory evaluation of Sepet cheese. Panelists assessed the cheese samples according to scheme by the (IDF 1987) guide for the sensory evaluation of cheese. Samples of Sepet cheese were placed in white plates coded with four-digit random numbers.

The samples were kept at ambient temperature (18±2°C) for 1 hour and then presented to the panelists in a random order for testing. Water was provided for mouth-washing between samples. The parameters investigated in sensory evaluation were color (0-7), body and texture (0-7), odor (0-7), salt (0-7), adverse taste (0-7) and overall appearance (0-9).

**Statistical Analysis**

Analyses were performed in three repetitions. Data were analyzed using the general linear model procedure of the SPSS software (version 20; SPSS Institute Inc., Chicago, IL). Analysis of variance for each set of data was conducted and the Duncan’s multiple range tests was used to compare the means when the difference was significant (p<0.05). In addition, confidence interval for the statistical analyses were 95% (p<0.05).

**RESULTS and DISCUSSION**

**Chemical Composition and Acidity**

The chemical compositions of the Sepet cheeses are given in Table 1. Dry matter values of the cheeses produced in our study varied between 51.75 % and 59.12 %. These results depend substantially on the composition of milk. They also depend on the conditions during the cheese process (Ucuncu 2004; Karakas 2006). The highest dry matter in all samples were in N and NC Sepet cheese samples. The changes in the dry matter was statistically significant only in NC sample (p<0.05). At this point, it could be said that this impact was related with the atmospheric packaging conditions. Kinik et al. (1999) found the dry matter of the Sepet cheeses as 53.1 % in their study. Erçan (2009), found that the dry matter of their Sepet cheeses produced from goat’s milk changed between 44.56 % and 63.39 %. The results of these studies were similar with our results. Results showed that packaging in two atmospheric conditions containing 100 % nitrogen and 80 % nitrogen + 20 % CO₂ have significant effects on the preservation of dry matter during storage period. Fat content in dry matter of Sepet cheeses varied between 44.4 % and 32.68 %. Kinik et al. (1999) found the fat in dry matter as 53.1 %. Karakas et al. (2006) found the fat content in dry matter of Sepet cheese 45.10%. Comparing the cheeses packaged under different atmospheric conditions to the control sample, it was seen that packaging conditions containing 80% nitrogen + 20% carbon dioxide and 100% carbon dioxide had no significant effect on the preservation of fat in dry matter during storage period. In our study, salt content in dry matter of Sepet cheese samples were high according to Anonymous, 2006a, Anonymous 2006b, and Anonymous 2007 cheese standards. The amount of 14% salt in the dry matter determined in the first days of storage dropped to 11% levels in the further days due to different packaging conditions. Compared to the first day of storage, only sample C was considerably able to preserve the salt content in dry matter until the 90th day. However, salt content in all samples dropped on the 180th day. Lactic acid content of Sepet cheeses changed between 1.04% and 2.14%. Lactic acid values reached their highest point in sample K and N on the 180th day of the storage. Compared to the control sample, lactic acid contents of samples NC and C were effected by different packaging conditions. Kinik et al. (1999) and Karakas et al. (2006), found the lactic acid contents of their cheeses 1.42 % and 0.72 %, respectively. Erçan (2009), reported that lactic acid content of Sepet cheeses varied between 0.6 % and 2.85 % and had an average of 1.66 %. These results...
were similar to the results determined in our study. Kırkın (2009) sliced fresh and ripened white cheese blocks in 2x2x2 cm³ dimensions and packaged under five different atmospheric conditions (0% O₂+0% CO₂, 10% O₂+0% CO₂, 0% O₂+75% CO₂, 10% O₂+75% CO₂ and aerobic). Oxidation, titratable acidity, pH values and sensory evaluations were not different between the package types.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Days</th>
<th>K</th>
<th>N</th>
<th>NC</th>
<th>C</th>
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<td>Titratable acidity %</td>
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<td>4.97 ± 1.27</td>
<td>3.70 ± 1.59</td>
<td>5.67 ± 1.44</td>
<td>4.21 ± 1.66</td>
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</table>

a–d Means ± SD within a column with different superscripts are statistically different (P< 0.05).
X–Z Means ± SD within a row with different superscripts are statistically different (P< 0.05).
1 Presented values are the means of two replicate trials. K refer to the cheeses ripened under normal conditions; N, NC and C refer to the cheeses ripened under 100% nitrogen, 80% nitrogen + 20% carbon dioxide and 100% carbon dioxide conditions, respectively.
2 Titratable acidity values are expressed as grams of lactic acid/100 grams of cheese.

Protein contents of Sepet cheese samples varied between 21.71 % and 28.16 %. Comparing the samples between each other, control sample was found to have higher protein content than those of the other samples. Packaging under different conditions had no significant effect on the preservation of protein content. Kinik et al. (1999) found that the protein content of their Sepet cheeses varied between 18.49 % and 24.22 %. Karakas et al. (2006) have reported that the protein content of Sepet
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Cheese was 29.34%. Erçan (2009) have reported that protein content of Sepet cheeses varied between 24.40% and 33.69% and had an average of 28.99%. Total nitrogen and corresponding decline in protein contents may be associated with casein, hydrolyzed by enzymes, transforming into water soluble low weighted peptides and amino acids and obtaining a passing tendency to bile (Gursoy 2005). The ripening index changed between 4.38 and 7.22. Compared to the control sample, samples N, NC and C had lower ripening indices. N sample had the lowest ripening index. Packaging conditions can be shown as a reason for this decrease. However, sample C had close values of ripening index to that of the control sample. Acid Degree Value (ADV), one of the methods to analyze the degree of lipolysis is described as; the equivalent amount of alkaline needed to neutralize the free fatty acids found in milk fat (Kesenkas, 2005). Free fatty acids content of Sepet cheese samples varied between 2.60% and 6.33%. Previous studies report an increase in free fatty acids contents in different types of cheeses during storage period (Dinkci 1999; Karaman 2007). In a study by Gonzalez-Fandos et al. (2000), Cameros cheese was packaged under 20% CO2+80% N2, 40% CO2+ 60% N2, 50% CO2 + 50% N2, 100% CO2 and vacuum conditions. At the end of the study, it was observed that proteolysis and lipolysis reaction levels were higher in samples packaged under aerobic conditions. Packaging under different atmospheric conditions in Sepet cheese had a significant effect only on sample NC during storage period.

Sensory Profile

Sensory characteristics of cheese have critical importance just as much as their physical, chemical and microbiological qualities. Customers tend to prefer foods with good flavor, aroma and appearance (Akbulut and Kinik 1991; Uysal et al. 2004). Sensory analysis of Sepet cheese samples packaged under different atmospheric conditions was performed to determine color, firmness, structure, appropriate salinity, odor, and distinctive flavor properties (Table 2).

Table 2. Sensory profile values of Sepet cheese samples ripened under different atmosphere packaging conditions

<table>
<thead>
<tr>
<th>Variable</th>
<th>Days</th>
<th>K</th>
<th>N</th>
<th>NC</th>
<th>C</th>
</tr>
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<td>6.12 ± 0.17</td>
<td>6.37 ± 0.17</td>
<td>6.00 ± 0.00</td>
<td>6.20 ± 0.06</td>
</tr>
<tr>
<td>Texture</td>
<td>1</td>
<td>5.81 ± 0.26</td>
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<tr>
<td></td>
<td>45</td>
<td>6.30 ± 0.42</td>
<td>6.35 ± 0.03</td>
<td>5.83 ± 0.24</td>
<td>6.05 ± 0.31</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>5.86 ± 0.41</td>
<td>6.00 ± 0.21</td>
<td>5.57 ± 0.60</td>
<td>5.83 ± 0.24</td>
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<td>5.92 ± 0.24</td>
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<tr>
<td>Odor</td>
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<td>6.34 ± 0.69</td>
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<td>6.30 ± 0.03</td>
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<td>6.08 ± 0.11</td>
<td>6.08 ± 0.11</td>
<td>5.79 ± 0.65</td>
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<tr>
<td>Salt</td>
<td>1</td>
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<td>5.25 ± 0.00</td>
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</tr>
<tr>
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<td>5.95 ± 0.53</td>
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<td>5.16 ± 0.47</td>
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<tr>
<td>Adverse taste</td>
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<td>5.87 ± 0.17</td>
</tr>
<tr>
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<td>6.26 ± 0.56</td>
<td>6.27 ± 0.79</td>
<td>6.20 ± 0.89</td>
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<td>6.54 ± 0.16</td>
<td>6.25 ± 0.57</td>
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<td>5.93 ± 0.31</td>
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<tr>
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<td>6.60 ± 0.00</td>
<td>5.79 ± 0.95</td>
<td>5.75 ± 0.96</td>
<td>5.41 ± 0.12</td>
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<tr>
<td>Overall appearance</td>
<td>45</td>
<td>6.56 ± 0.79</td>
<td>6.56 ± 0.79</td>
<td>6.56 ± 0.79</td>
<td>6.56 ± 0.79</td>
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<tr>
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<td>90</td>
<td>8.25 ± 0.35</td>
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<td>7.54 ± 0.16</td>
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<td>7.50 ± 0.00</td>
<td>7.90 ± 0.14</td>
<td>7.54 ± 0.99</td>
<td>7.25 ± 0.35</td>
</tr>
</tbody>
</table>

* Means ± SD within a column with different superscripts are statistically different (P< 0.05).

1 Presented values are the means of two replicate trials. K refer to the cheeses ripened under normal condition; N, NC and C refer to the cheeses ripened under 100% nitrogen, 80% nitrogen + 20% carbondioxide and 100% carbondioxide conditions, respectively.
The changes in color, body, texture, odor, adverse
taste and overall appearance during the storage
period were found statistically not different (p>0.05).
At the same time, changes in values between storage
days were found statistically not significant (p>0.05)
However, the changes in the salt taste during storage
period were only significant statistically in C sample.
The changes in the appropriate salinity validation
performed by panelists during storage period were
statistically significant (p<0.05). Sepet cheese samples
received higher scores in terms of firmness, structure,
appropriate salinity compared to those of the control
sample, however received lower scores in odor and
distinctive flavor properties. Papaioannou et al. (2007),
in their study on Greek whey cheese Anthotyros,
packaged the samples under 30% CO2+ 70% N2, 70%
CO2 and vacuum conditions. Both MAP
applications increased the shelf-life of the cheese,
compared to the vacuum application. It was also
stated that the sensory properties of MAP samples
were preserved. Erkan and Aksu (2006), in their study
on the effects of MAP applications on the shelf-life and
cheese quality of the sliced fresh kashar cheese, found
that the best aroma and taste results were obtained in
samples packaged under 50% N2 - 50% CO2 conditions.
Sensory analysis revealed that the samples packaged
under aerobic conditions could not be consumed
after 90 days while the samples packaged under 100%
CO2 and vacuum conditions could not be consumed
after 120 days and the cheese samples packaged under
25% N2 -75% CO2 conditions could not be consumed
after 150 days. Gonzalez et al. (2000),
obtained the best results in the samples packaged
under 40-50% CO2 conditions. The researchers
determined a sourish taste formation in cheese
samples packaged under 50% N2 - 50% CO2 and vacuum
conditions. Both MAP applications increased the shelf-life of the cheese,
compared to the vacuum application. It was also
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obtained the best results in the samples packaged
under 40-50% CO2 conditions. The researchers
determined a sourish taste formation in cheese
samples packaged under 100% CO2 conditions. In the
study performed by Kırgın (2009), none of the cheese
packaged under modified atmosphere conditions was
found to be different from the control in terms of
sensory properties. Excluding the control sample,
sample N was the most favored cheese by the
panelists. Generally speaking, Sepet cheese samples
packaged under different atmospheric conditions
were favored more than the control sample, creating a
preserved sensory profile impression.

CONCLUSIONS
In this study, some physical, chemical and sensory
properties of Sepet cheese packaged under modified
atmosphere conditions were investigated during their
storage period. Accordingly, the cheese samples were
compared with the control Sepet cheese. Comparing
the Sepet cheese samples to the control sample, no
significant differences were seen between samples in
terms of physical, chemical and sensory properties of
sepet cheese, except for pH values. In addition, the
results of physical, chemical and sensory analyses of
sepet cheese was in compliance with the standards.
The values were found to be close and similar.

For the local community, Sepet cheese, with its
high nutritional values, is an important source of food
for the families' protein needs, Total dry matter, fat
and protein contents were relatively higher,
compared to other types of cheese. There is no
standard method for the production of Sepet cheese.
Standard and industrial production technologies of
traditional cheeses must be necessarily conserved.
Local cheeses should be manufactured in high
 capacities using modern technologies. There is vital
importance in choosing the appropriate packaging
material for the preservation of the characteristics and
immediate packaging following their production.
In the further studies, Sepet cheese and other traditional
cheeses must be scientifically researched and the
methods should be established for production to
obtain standard products complying with the food
safety regulations for public.

ACKNOWLEDGEMENTS
This research was supported by Ege University
Scientific Research Fund (Project Number: 2009-ZRF-
051) and was presented as a poster communiqué in
11th Food Congress held in Hatay-Turkey between
10th-12th October 2012 and included in the congress
book as an abstract text.

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