Full Length Research Paper

Microbiological and chemical quality of Çökelek cheese, Lor cheese and Torba (strained) yoghurt

Ayşe Deniz ÇARDAK

Department of Dairy Science and Technology, Agricultural Faculty of Adnan Menderes University, Aydın, Turkey. E-mail: adenizcardak@yahoo.de. Tel: +90 256 772 70 24 (1301). Fax: +90 256 772 72 33.

Accepted 27 November, 2012

To assess the level of contamination of milk products such as, Çökelek cheese (n = 25), Lor cheese (n = 25) and Torba (strained) yoghurt (n = 25) samples were examined for microbiological and chemical quality. In Çökelek cheese samples, 96, 56, 56, 56, 24, 8, 8, 4, 4 and 44% of yeast and mould, total coliform, fecal coliform, Escherichia coli, Bacillus cereus, Clostridium perfringens, E. coli O157, Listeria monocytogenes, Salmonella and Staphylococcus aureus, respectively, were found as contaminants. In Lor cheese samples, 92, 68, 68, 68, 12, 12, 12, 4, 4 and 56%, respectively, of these contaminants were observed, and in Torba yoghurt samples, the percentage was 84, 60, 60, 60, 44, 8, 12, 4, 4 and 32%, respectively. The mean weight of dry matter (DM), fat, protein, ash, salt and titratable acidity of lactic acid (LA) were found to be 60.83 ± 10.18, 15.43 ± 4.61, 25.95 ± 7.10, 4.04 ± 0.67, 2.90 ± 0.61 and 0.49 ± 0.18 g/100 g, respectively, and the mean pH was 3.83 ± 0.70 in Çökelek cheese and 34.59 ± 4.11, 4.78 ± 1.00, 14.98 ± 2.82, 2.86 ± 0.35, 1.69 ± 0.30 and 0.57 ± 0.13 g/100 g, respectively, in Lor cheese and the same pH was 4.85 ± 0.66. The mean values of DM, fat, protein, ash and LA content in Torba yoghurt were 22.15 ± 4.39, 8.20 ± 3.34, 9.93 ± 1.66, 0.96 ± 0.36 and 1.59 ± 0.33 g/100 g, respectively and the pH was 3.75 ± 0.33. These data show poor standardisation and safety of these products.

Key words: Çökelek cheese, Lor cheese, Torba yoghurt, quality.

INTRODUCTION

Consumption of milk and other dairy products is associated with numerous health benefits, providing essential dietary sources of calcium, phosphorous, magnesium and protein. Yoghurt and cheese are the most consumed dairy products in Turkey. According to recent data, total milk, yoghurt and cheese production in Turkey is about 15 million, 1 million and 518 thousand tons/year, respectively. The main cheese varieties are White pickled, Kasar, Tulum, Çökelek and Lor. Çökelek and Lor cheeses are often manufactured in family businesses following traditional methods and are the most consumed cheeses in rural parts of Turkey (Kamber, 2008). Çökelek cheese bears a close resemblance in appearance with Lor cheese and is often confused with it. In some regions, Lor cheese is referred to as Çökelek cheese. However, these cheeses differ significantly from each other. Çökelek cheese is made spontaneously or following the addition of organic acid. As a result, both whey protein and casein are found in this cheese. Çökelek cheese is referred to as Eksimik in Thrace; Kes in Mediterranean and Akcakatik, Kesmik or Urda in several regions of Anatolia (Dervisoglu et al., 2009). The methods of Çökelek cheese production are not standardized, thus it is impossible to find products with the similar quality in the market.

In contrast, Lor cheese is produced by precipitating whey left over from the manufacture of other dairy products, such as cheese or butter from yoghurt. Since the milk has been previously processed to make another product, Lor cheese has a low fat content while being rich in whey protein and casein. The Turkish word Lor came into existence from the Persian word “lür” and all over the world there are cheeses made from whey by similar methods; that is Karish from Egypt; Monouri, Myzothra and Anthotylos from Greece; Ricotta, Brocci and Mejette.
from Italy; Ziger from Germany; Primost, Mysost and Gjetost from Scandinavia and Hudleziger from Switzerland (Kamber, 2008). Torba (strained) yoghurt is a concentrated fermented product, which has been made from cow, goat or sheep milk in regions of Anatolia for centuries. Traditionally, yoghurt is strained in a special cloth bag for 10 to 14 h to remove the whey, and is then packed and stored at 4°C. Additionally, salt can be added to Torba yoghurt in order to enhance the shelf life of the product. Several types of concentrated yoghurt including Tulum yoghurt, winter yoghurt and peskıten have also been produced traditionally. This product is also known as Labneh (22 to 26% total solids) in various Middle Eastern countries (Kabak and Dobson, 2011). Kirdar and Gün (2001) report moisture, protein, fat, lactose and mineral contents of Torba yoghurt. However, Nergiz and Seckin (1998) show that important nutrients are lost during the straining of yoghurt, including 51.8% thiamin, 60.5% riboflavin, 7.3% protein, 0.8% fat, 71.1% lactose, 65.6% calcium, 70.2% sodium, 50.2% phosphorus and 68.2% potassium.

Milk and milk products are a nutrient-rich medium for a variety of microorganisms, particularly bacterial pathogens. Pathogens responsible for food-borne outbreaks associated with the consumption of milk include Listeria monocytogenes, Salmonella, Campylobacter, S. aureus, B. cereus and C. botulinum (Chye et al., 2004). An overview of the annual reports on food-borne diseases from seven countries (recorded in France and in other countries since 1980) indicated that milk and milk products were implicated in 1 to 5% of total bacterial outbreaks (milk 39.1%, cheese 53.1%, other milk products 7.8%; De Buyser et al., 2001). The types of microorganisms in milk and milk products may increase through contamination or via growth of the microorganisms already present. Methods of production, handling and manufacture should be designed to prevent both. The most significant sources of contamination are milk-contact surfaces and hands of dairy workers (Robinson and Tamime, 2002).

Çökele cheese, Lor cheese and Torba yoghurt that are made at home under primitive conditions in rural areas and sold in local bazaars are the most consumed dairy products in Turkey. In recent years, these products have been processed in small- and large-scale plants, and have been sold in different retail markets at exorbitant prices. As a result, consumers prefer local bazaars for these products. In addition, there is no official quality standard for Çökele cheese and Torba yoghurt, whereas, the microbiological and physicochemical criteria for quality of Lor cheese have been officially specified. On these grounds, the aim of this study was to evaluate the microbiological and physicochemical contents of Çökele cheese, Lor cheese and Torba yoghurt samples from local bazaars in Aydın and to assess their potential effects on public health.

**MATERIALS AND METHODS**

**Samples**

Çökele cheese (n = 25), Lor cheese (n = 25) and Torba yoghurt (n = 25) samples (300 g each) were randomly collected between November 2011 and February 2012 from different local bazaars and retail markets of Aydın city centre. The samples were transported in sterile plastic bags to the laboratory under aseptic and refrigerated conditions. Microbiological and chemical analyses were performed within 2 to 3 h of purchase.

**Microbiological analyses**

Initially, 25 g of sample (Çökele cheese, Lor cheese or Torba yoghurt) was weighed in a sterile filtered stomacher bag and homogenized with 225 ml sterile Buffered Peptone Water (BPW; Merck, 107228). Subsequent serial decimal dilutions of the samples were prepared in Ringer’s solution (Merck, 115525). Total aerobic mesophilic bacteria (TAMB) counts, including yeast and mould, were assessed using appropriate dilutions plated on Plate Count Skim Milk Agar (PCA; Merck, 115338) and Yeast Extract Glucose Chloramphenicol Agar (YGC; Merck, 116000), respectively, using the pour plate method. The PCA and YGC plates were incubated at 35°C for 48 h and at 25°C for 5 days, respectively. After incubation, 25 to 250 and 15 to 150 colonies were counted on PCA and YGC plates, respectively.

To determine the numbers of coliform bacteria, fecal coliform and E. coli, a three-tube Most Probable Number (MPN) technique was employed. Total coliform was determined using Lauril Sulphate Tryptose Broth (LST; Merck, 110266) followed by confirmation with gas-positive tubes using Brilliant Green Broth (BGB; Merck, 105454). In this procedure LST and BGB tubes were incubated at 37°C for 24 to 48 h and 30°C for 24 to 48 h, respectively. Fecal coliform was determined using EC Broth (Merck, 110765) incubated at 44.5°C for 24 to 48 h. After evaluation, gas positive tubes were transferred to Tryptone Water (TW; Merck, 110859) and incubated at 44.5°C for another 24 h; finally, the indole test was used to determine the presence of E. coli.

To prepare Polymyxin-pyruvate-egg yolk-mannitol-bromothymol blue agar (PENBAMA) Baicillus Cereus Selective Agar Base (Oxoid, CM0617) was mixed with 50 000 IU of polymyxin (Oxoid, SR0099) per litre of egg yolk emulsion (Oxoid, SR0047). Subsequently, PENBAMA was used to determine β. cereus counts by incubating at 30°C for 24 to 48 h (Holbrook and Anderson, 1980). Tryptose-sulphite-cycloserine (TSC) Agar (Merck, 111972) containing egg yolk emulsion (Merck, 103784), cycloserine (0.4 g/L) and kanamycin (0.012 g/L) was used to determine C. perfringens counts by incubating in anaerobic conditions at 37°C for 18 to 24 h (Anonymous, 2004).

To detect E. coli O157, 225 ml of modified Tryptone Soy Broth containing novobiocin (mTSB-n; Merck, 109205) was added to 25 g of sample. Enrichment cultures were incubated at 42°C for 6 h and then for 12 to 18 h. Enriched cultures were washed and re-suspended and then streaked with Cefixime Tellurite (CT; Merck, 109202) supplemented Sorbitol MacConkey (SMAC) Agar (Merck, 109207). These CT-SMAC plates were then incubated at 37°C for 24 h. Clear and colorless colonies that had morphological characteristics of E. coli were picked from the plates and were colony-purified by streaking onto Tryptone Soy Agar (TSA; Merck, 105458). Isolated colonies from TSA plates were serologically screened for the presence of O157 (Anonymous, 2003). To detect L. monocytogenes, 225 ml Listeria Enrichment Broth (LEB; Merck, 110549) without selective supplement was added to 25 g of sample and was incubated at 30°C for 4 h. Subsequently, Listeria Selective Enrichment Supplement (Merck, 111781) was added and the mixture was incubated for another 44 h at 30°C. At 24 and 48 h, the
test culture was streaked onto both Oxford Listeria Selective Agar (Merck, 107004) and PALCAM Listeria Selective Agar (Merck, 111755), respectively, and was incubated for 24 to 48 h at 35°C. After incubation, five typical colonies from these media were transferred to Tryptic Soy Agar (Merck, 105458) with Yeast Extract (Merck, 103753), incubated at 30°C for 24 to 48 h and the purified isolates were identified (Anonymous, 1997).

To isolate Salmonella, a stomacher bag containing 25 g of sample in Buffered Peptone Water was incubated at 37°C for 24 h. After pre-enrichment, 0.1 ml of the inoculate was incubated on 10 ml of Rappaport–Vassiliadis Soy Broth (Merck, 107700) and Muller–Kaufmann Tetrathionate Novobiocine enrichment Broth (MKTTn; Merck, 105878) at 42°C for 24 h and at 37°C for 24 h, respectively. After selective-enrichment RVS and MKTTn cultures were streaked onto Xylose Lysine Deoxycholate (XLD) Agar (Merck, 105287) and Brilliant Green Phenol Red Lactose Agar (Merck, 107236), and were incubated at 37°C for 24 h. Typical colonies were identified (Anonymous, 2005).

Baird–Parker Agar (BPA; Merck, 105406) supplemented with egg yolk–tellurite emulsion (Merck, 103785) was used to detect S. aureus by incubating inoculated plates at 37°C for 24 to 48 h. Representative colonies with a typical black appearance and surrounded by a clear zone were picked and subjected to a coagulase test (Bactident; Merck, 113306; Anonymous, 2001).

### Chemical analyses

The following characteristics were determined in duplicate: titratable acidity and pH were measured using AOAC standards (Association of Official Analytical Chemists, 1980 a; b); dry matter by IDF standards 4A and 21B (International Dairy Federation, 1982; 1987); fat by IDF standards 5B and 1D (International Dairy Federation, 1986; 1996); protein by IDF standard 20B (International Dairy Federation, 1993); ash by IDF standard 27 (International Dairy Federation, 1964) and salt according to Case et al. (1985). Fat content and salt in dry matter were calculated. All chemicals used for these analyses were obtained from Merck or Sigma Aldrich and were of analytical grade.

### Statistical analyses

Statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) statistical software for Windows (SPSS Inc., 2005). Pearson correlation coefficient analysis was used to examine correlations between the chemical and microbiological properties of Çökelek cheese, Lor cheese and Torba yoghurt. The bivariate correlation procedure was used to compute Pearson correlation coefficients and their corresponding significance.

### RESULTS AND DISCUSSION

The results of microbiological quality analyses of Çökelek cheese, Lor cheese and Torba yoghurt are shown in Table 1. The TAMB count of Çökelek cheese varied between $3.1 \times 10^4$ and $7.8 \times 10^6$ cfu/g and this was similar to that reported by Kavaz et al. (2012; 5.96 log cfu/g), but lower than those reported by Kurt and Caglar (1988; 0.84 $\times 10^6$ and 8.60 $\times 10^5$), Caglar et al. (1997; 0.27 $\times 10^6$ and 2.80 $\times 10^5$), Tarakci et al. (2003; 8.9 $\times 10^5$ and 2.7 $\times 10^5$ cfu/g), Ates-Öksützepe et al. (2007; 2.0 $\times 10^5$ and 2.36 $\times 10^6$ cfu/g), Öngenar and Kirbag (2009; 8.65 $\times 10^5$ and 10.49 $\times 10^5$) and Kirdar (2012; 6.00 and 9.50 log cfu/g), and higher than that reported by Cakir et al. (2009; 2.78 and 5.92 log cfu/g). The TAMB count of Lor cheese was lower than that reported by Kavaz et al. (2012; 5.79 log cfu/g). Kirdar and Gün (2001) reported that the TAMB count of winter and summer Torba yoghurt was in the range $2 \times 10^3$ and $1.74 \times 10^5$ to $1.3 \times 10^5$ and $4.9 \times 10^4$ cfu/g, respectively. These values are lower than those obtained in the present study.

<table>
<thead>
<tr>
<th>Contaminants</th>
<th>Çökelek cheese</th>
<th>Lor cheese</th>
<th>Torba yoghurt</th>
</tr>
</thead>
<tbody>
<tr>
<td>TAMB $^a$</td>
<td>$3.1 \times 10^4$</td>
<td>$7.8 \times 10^6$</td>
<td>$2.9 \times 10^3$</td>
</tr>
<tr>
<td>Yeast and mould $^b$</td>
<td>$3.7 \times 10^2$</td>
<td>$6.7 \times 10^4$</td>
<td>$2.2 \times 10^2$</td>
</tr>
<tr>
<td>Total coliform $^b$</td>
<td>$&lt;3$</td>
<td>$&gt;1100$</td>
<td>$&lt;3$</td>
</tr>
<tr>
<td>Fecal coliform $^b$</td>
<td>$&lt;3$</td>
<td>$&gt;1100$</td>
<td>$&lt;3$</td>
</tr>
<tr>
<td>E. coli $^b$</td>
<td>$&lt;3$</td>
<td>$&gt;1100$</td>
<td>$&lt;3$</td>
</tr>
<tr>
<td>B. cereus $^a$</td>
<td>$2.5 \times 10^2$</td>
<td>$3.2 \times 10^4$</td>
<td>$3.1 \times 10^2$</td>
</tr>
<tr>
<td>C. perfringens $^a$</td>
<td>$1.5 \times 10^1$</td>
<td>$3.3 \times 10^2$</td>
<td>$5.1 \times 10^2$</td>
</tr>
<tr>
<td>E. coli O157 $^c$</td>
<td>+</td>
<td>2</td>
<td>+</td>
</tr>
<tr>
<td>L. monocytogenes $^c$</td>
<td>+</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td>Salmonella spp. $^c$</td>
<td>+</td>
<td>1</td>
<td>+</td>
</tr>
<tr>
<td>S. aureus $^a$</td>
<td>$3.1 \times 10^2$</td>
<td>$3.9 \times 10^4$</td>
<td>$5.0 \times 10^2$</td>
</tr>
</tbody>
</table>

$^a$cfu/g, cfu, Colony forming unit; $^b$ MPN/g, MNP, Most Probable Number; $^c$ existence in 25 g sample; $^d$ n, number of positive samples.
production, fruity flavours, discoloration and changes in texture. The results of the present study for yeast and mould counts in Çökelek depict lower values than those reported by Kurt and Çağlar (1988; 0.26 × 10^6 and 3.40 × 10^6), Tarakçı et al. (2003; 2.5 × 10^5 and 4.0 × 10^7 cfu/g), Ates-Öksüzoglu et al. (2007; 2.7 × 10^4 and 5.6 × 10^7 cfu/g), Cakır et al. (2009; 1.69 and 6.86 log cfu/g), Önganer and Kirbag (2009; 6.95 × 10^2 and 9.14 × 10^5), Kavaz et al. (2012; 5.62 log cfu/g) and Kirdar (2012; 2 to 9 log cfu/g). Similar to the present results, Kavaz et al. (2012) reported that the yeast and mould count of Lor cheese was 3.85 log cfu/g. Pinto et al. (2001) reported yeast and mould counts of 3.6 × 10^5 cfu/g and 1.1 × 10^6 cfu/g in Requeijão after storage for 6 and 10 days, respectively. These values are higher than those of the present study. Yeast and mould counts in Torba yoghurt were lower than those reported by Gökkce et al. (2001), which were < 10 and 3.6 × 10^5 in winter Torba yoghurt. Çağlar et al. (1997) also reported higher yeast and mould counts (0.13 × 10^5 and 6.25 × 10^5 cfu/g) than observed in this study.

Total coliform, fecal coliform and E. coli counts varied between <3 and >1100 MPN in 14, 17 and 15 samples of Çökelek cheese, Lor cheese and Torba yoghurt, respectively. The total coliform count for Çökelek cheese is partly in agreement with the count obtained by Kurt and Çağlar (1988; 0.18 × 10^4 and 26.6 × 10^6 cfu/g), Ates-Öksüztepe et al. (2007; 2.0 × 10^4 and 9.5 × 10^6 cfu/g), Kirdar (2012; 2.00 and 5.53 log cfu/g), whereas the values in the present study are higher than those reported by Tarakçı et al. (2003; 1 and 5.3 × 10^5) and Kavaz et al. (2012; <1 log cfu/g). In their study, Cakır et al. (2009) did not find any coliform or E. coli in 20 Kes samples, whereas Önganer andKirbag (2009) detected E. coli in ca. 23% of Çökelek cheese samples. Pinto et al. (2001) noted that the number of viable coliforms in Anthothyros was 5.5 × 10^6 cfu/g; a greater number than that obtained in this study. Cossetou et al. (1997) shows that fresh bovine Ricotta had no coliforms or E. coli, and Kavaz et al. (2012) also reported a coliform count of <1 log cfu/g in Lor cheese. The results of this study show higher coliform counts in Torba yoghurt than that reported by Atamer et al. (1988; 10–970 cfu/g), Çağlar et al. (1997; 0 to 85 cfu/g), Gökkce et al. (2001; <10 and 4.4 × 10^5) or Kirdar and Gün (2002; 0 to 1250 cfu/g).

However, Kirdar and Gün (2002) found E. coli in 10% of Torba yoghurt samples. Moreover, E. coli O157 was observed in 2 Çökelek cheese, 3 Lor cheese and 3 Torba yoghurt samples. Chye et al. (2004) reported that coliform bacteria are often used to indicate the presence of microorganisms, as the presence of E. coli implies a risk that other enteric pathogens may be present in the sample. In an extensive study, many serotypes of E. coli were investigated for their pathogenic and enterohemorrhagic properties and were grouped according to their virulence factors. The E. coli O157:H7 serotype, identified as enterohemorrhagic E. coli (EHEC) and categorised as verocytotoxin producing E. coli (VTEC), were first identified as a pathogen causing bloody diarrhoea (Öksüz et al., 2004). Furthermore, Meng et al. (2001) stated that E. coli O157 caused outbreaks of infections associated with dairy products.

**B. cereus** contamination was also detected in 6 Çökelek cheese, 3 Lor cheese and 11 Torba yoghurt samples within the range of 2.5 × 10^2 – 3.2 × 10^7, 3.1 × 10^2 – 2.7 × 10^6 and 7.0 × 10^5 – 1.3 × 10^6 cfu/g, respectively. Cosentino et al. (1997) stated that ca. 78% of Ricotta samples were contaminated with Bacillus sp. (10–10^3 cfu/g) and B. cereus was the predominant species. Önganer and Kirbag (2009) reported that in Çökelek cheese samples Bacillus sp. counts varied between 6.00 × 10^6 and 9.87 × 10^8 cfu/g.

In the present study **C. perfringens** was found in 2 Çökelek cheese, 3 Lor cheese and 2 Torba yoghurt samples within the ranges 1.5 × 10^5–3.3 × 10^5, 5.1 × 10^5–7.4 × 10^5 and 2.2 × 10^5–4.6 × 10^6 cfu/g, respectively. In a study by Önganer and Kirbag (2009), Clostridium sp. was found at 6.00 × 10^6–9.71 × 10^6 cfu/g. Moreover, L. monocytogenes was detected in one sample each of Çökelek cheese, Lor cheese and Torba yoghurt, whereas *L. innocua* was found in 2 samples of Çökelek and 2 samples of Lor cheese. Papageorgiou et al. (1996) noted that the generation time of *L. monocytogenes* in Greek whey cheese is negatively affected by the ripening temperature, and reported maximum viable counts ranging from ca. 10^6 to 10^8 cfu/g. Filiousis et al. (2009) also reported the presence of *L. monocytogenes* in soft cheese samples from open air food markets in Greece.

**Salmonella** was present in one sample each of Çökelek cheese, Lor cheese and Torba yoghurt, whereas *S. aureus* was detected in 11 samples of Çökelek cheese, 14 of Lor cheese and 8 of Torba yoghurt within a range of 3.1 × 10^2–3.9 × 10^6, 5.0 × 10^2–7.2 × 10^6 and 4.2 × 10^2–9.4 × 10^6 cfu/g, respectively. In their study, Önganer and Kirbag (2009) report counts of Salmonella sp. and *S. aureus* as 6.00 × 10^6–8.46 × 10^6 and 6.00 × 10^10–10.28 × 10^6 cfu/g, respectively. Environmental and personal contamination during production and sale may produce high counts of *S. aureus*. According to the Turkish Food Codex (TFC) Microbiological Criteria Notification, *L. monocytogenes* and *Salmonella* should not be detected in 25 g of cheese sample, whereas coagulase-positive staphylococci counts are tolerated up to 10^5 cfu/g of sample. We detected 4, 4 and 44%, of *L. monocytogenes*, *Salmonella* and *S. aureus*, respectively, in Çökelek cheese and 4, 4 and 44%, respectively, in Lor cheese, which revealed non-conformity with the TFC specifications.

Some chemical characteristics of Çökelek cheese, Lor cheese and Torba yoghurt are presented in Tables 2, 3 and 4, respectively. As seen in Table 2, the pH of Çökelek cheese samples varied between 2.96 and 5.35. Similar deviations were reported by Ates-Öksüztepe et al. (2007; pH 3.57–3.98), Cakır et al. (2009; pH 3.54–4.36),
Dervisoglu et al. (2009; pH 3.43–5.81) and Kavaz et al. (2012; average pH 4.51). The LA content of Çökelek cheese samples in this study were similar to those obtained from the studies of Ates-Öksüztepe et al. (2007; 0.68–1.68), Cakir et al. (2009; 0.08–0.40) and Kirdar (2012; 0.11–0.78), whereas Kurt and Caglar (1988) and Tarakci et al. (2003) stated that the titratable acidity of Çökelek ranged from 54.07 to 123.73 and LA from 0.45 to 2.37%, which was higher than that of this study. The dry matter LA content of Çökelek cheese ranged from 45.64 to 83.55 g/100 g cheese, which is in agreement with data from Cakir et al. (2009; 53.10–81.45 g/100 g), Dervisoglu et al. (2009;44.42–71.92 g/100 g), Kavaz et al. (2012; average 47.85 g/100 g) and Kirdar (2012; 40.56–83.10 g/100 g), but was lower than the data given by Kurt and Caglar (1988; 22.70–40.65 g/100 g), Tarakci et al. (2003; 26.59–48.38 g/100 g) and Ates-Öksüztepe et al. (2007; 17.50–25.05 g/100 g). In the studies by Kurt and Caglar (1988), Tarakci et al. (2003), Ates-Öksüztepe et al. (2007), Cakir et al. (2009) and Dervisoglu et al. (2009), the fat content of Çökelek cheese ranged within 2–5, 2.70–24.00, 0.60–2.00, 4.00–11.50 and 5.00–16.50 g/100 g, respectively.

In contrast, the fat content of Çökelek cheese samples in this study were higher, and were in agreement with data from Kavaz et al. (2012; average of 19.59 g/100 g) and Kirdar (2012; 7.00–39.00 g/100 g). The protein content of Çökelek cheese samples ranged from 19.56 to 42.75 g/100 g and this was similar to that reported by Kurt and Caglar (1988; 16.91–31.16 g/100 g), Tarakci et al. (2003; 11.74–36.04 g/100 g), Ates-Öksüztepe et al. (2007; 10.32–25.92 g/100 g), Cakir et al. (2009; 26.35–39.12 g/100 g) and Kirdar (2012; 13.23–34.78 g/100 g).

In the studies by Kurt and Caglar (1988), Tarakci et al. (2003), Ates-Öksüztepe et al. (2007), Cakir et al. (2009), Dervisoglu et al. (2009) and Kavaz et al. (2012), the ash content of Çökelek cheese was 0.72–1.45, 1.36–3.43,
the present study (Kirdar, 2012) and Caglar et al. (1997; 12.51–26.20 g/100 g). Moreover, our samples contained more ash than that observed by Atamer et al. (1988; 0.60–0.83 g/100 g), but similar to that observed by Caglar et al. (1997; 0.69–1.41 g/100 g).

Pearson’s correlation coefficient analyses show correlations between chemical and the microbiological contents of Çökelek cheese, Lor cheese and Torba yoghurt. In Çökelek cheese there was a significant positive correlation between total coliform, fecal coliform, E. coli and pH (P < 0.01), and titratable acidity (P < 0.05). Moreover, C. perfringens counts negatively correlated with pH, titratable acidity and protein content (P < 0.01) and positively correlated with dry matter, ash, fat and salt content (P < 0.01). A significant negative correlation was also found between S. aureus counts and fat content (P < 0.01). In Lor cheese, significant positive correlations were found between yeast and mould counts and protein content (P < 0.05). B. cereus counts and dry matter (P < 0.01) and ash content (P < 0.05) and C. perfringens counts and salt content. Negative correlations were observed between C. perfringens counts and pH (P < 0.05) and between S. aureus counts and fat content in dry matter (P < 0.05). In Torba yoghurt, C. perfringens counts were positively correlated with pH, titratable acidity, content of dry matter, ash, protein and fat (P < 0.01).

Conclusion

In the present study we measured microbiological and chemical content of Çökelek cheese, Lor cheese and Torba yoghurt samples from the local bazaars of Aydın. These products are often the only dietary source of animal protein for people with low incomes. However, the microbiological quality of these products does not comply with criteria of the TFC. Our chemical analyses also show that there is no standardization of these products because of variations in the type and quality of raw milk, production processes and storage conditions. Inadequate hygiene practices during the processing, storage and sale of these products may compromise consumer health. In order to avoid possible public health risks from these products, hygienic standards of production, modern packaging techniques, and application of control programs such as the Hazard Analysis of Critical Control Points (HACCP) are required to ensure safety of these products.

REFERENCES

Anonymous (1997). TS EN ISO 11290-1: Microbiology of food and animal feeding stuffs—Horizontal method for the detection and