Growth of *Listeria monocytogenes* in the Whey Cheeses Myzithra, Anthotyros, and Manouri during Storage at 5, 12, and 22°C

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(MS# 95-304: Received 29 November 1995/Accepted 22 March 1996)

ABSTRACT

The fresh whey cheeses Myzithra, Anthotyros, and Manouri were inoculated with *Listeria monocytogenes* Scott A or California to contain ca. 5.0 × 10^2 CFU/g of cheese and incubated at 5, 12, and 22°C. The initial pH of the finished whey cheeses Myzithra, Anthotyros, and Manouri were 6.50, 6.41, and 6.30 respectively. Fat in dry matter was 16.3% in Myzithra, 65.9% in Anthotyros, and 71.7% in Manouri cheese; the moisture contents of the cheeses were 68.4, 66.9, and 52.2% respectively. The pH of the cheeses dropped gradually to between 5.30 to 4.97 during storage. Duplicate samples of whey cheeses were tested for numbers of *L. monocytogenes* and pH. *Listeria* counts were obtained by surface-plating on lithium chlorite-phenylethanol-moxalactam agar (LPM). Selected *Listeria* colonies were confirmed biochemically. The growth of *L. monocytogenes* in the whey cheeses was very rapid. Generation times of *L. monocytogenes* at 5°C ranged between 16.16 and 20.16 h and were significantly longer than those observed at 12°C, which ranged between 5.07 and 5.81 h. Generation times at 22°C ranged between 1.68 and 2.70 h. The generation time of *L. monocytogenes* Scott A at 5°C in Anthotyros cheese (20.16 h) was significantly longer than those of the same strain at 5°C in Myzithra cheese (16.16 h) and Manouri cheese (17.81 h). Also, the generation time of *L. monocytogenes* California at 22°C in Myzithra cheese (2.70 h) was significantly shorter than the generation time of strain Scott A (1.93 h). Maximum populations of *L. monocytogenes* were reached after 24 to 30 days at 5°C, after 5 to 12 days at 12°C, and after only 56 to 72 h at 22°C and ranged from 6.92 to 8.81 log CFU/g. Maximum populations were significantly lower in Myzithra cheese at 5 and 12°C than maximum populations in Anthotyros and Manouri cheese at the same temperatures independent of the inoculated strain.

Key words: Whey cheeses, *Listeria* growth; *L. monocytogenes*

*Listeria monocytogenes* causes listeriosis, a disease of both humans and animals. In animals listeric infections often result in encephalitis, abortion, and mastitis (40). In humans the illness can range from a mild flu-like sickness (some-times leading to a carrier state) to severe manifestations. The severe forms of human listeriosis present as meningoencephalitis followed by septic infections and occasionally isolated organ involvement. Groups at highest risk are pregnant women, neonates, adults with underlying disease (cancer, AIDS, diabetes, chronic hepatic disorder, transplant recipients), the elderly (>65 years old) and other immunocompromised individuals. Death is rare in healthy adults but can occur at a rate as high as 30% in persons at highest risk (12, 28, 30, 32, 38, 41). The pathogen can be transmitted to humans from infected animals (11, 23) or through consumption of listeria-contaminated foods. Dairy products are the most often incriminated in cases of human listeriosis (1, 2, 8, 14, 20, 21, 39).

Early in the 1960s milk and milk products were suspected as possible vehicles for food-borne human listeriosis in European countries (16, 29, 40), but little information on the presence and behavior of *L. monocytogenes* in milk and milk products was available in the literature at that time. Since 1981, several food-associated outbreaks and sporadic cases of human listeriosis (1, 2, 8, 14, 22, 32, 39) prompted researchers to determine the incidence and behavior of *L. monocytogenes* in milk and dairy products and other foods. *L. monocytogenes* has been detected in 2 to 6% of raw milk samples from a number of countries including the USA, Canada, Greece, Italy, and Switzerland (6, 7, 10, 13, 18, 19, 38) and in 2 to 10% of a wide variety of cheese samples. Soft cheeses are often contaminated (4, 5, 10, 19, 21, 27). In Greece *Listeria* spp. have been found in 3.75% of raw ewes’ milk samples, in 6% of raw goat’s milk samples, in 6% of mixtures of raw ewe’s and goat’s milk samples, in 16.2% of soft Myzithra cheese samples, in 20.8% of Anthotyros cheese samples, in 5.8% of Manouri cheese samples, in 2% of Feta cheese samples and finally in 20% of environmental samples from 8 cheese-processing plants. The high prevalence in the products correlated well with the high prevalence in the dairy plant environment (10). The Council of the European Communities Directive 92/46 E.E.C., which has already been ratified by the Greek government, concerning the health rules for the production.

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and marketing of raw milk, heat-treated milk, and milk-based products, provides that *L. monocytogenes* must be kept out of these products; otherwise the products must be withdrawn from the market. Previous work indicated that modest growth of *L. monocytogenes* occurred primarily in Cheddar, Feta, and Blue cheese during the first stage of production. Growth ceased when the pH of the cheeses dropped to below 5.0 and numbers of the pathogens decreased markedly during ripening and storage of the cheeses (25, 26, 34). Substantial growth occurred in Brick and Camembert cheese during the ripening process when the pH of cheeses was >5.75 (35, 37). Also a significant correlation of *Listeria* growth, pH values (>5.5), and absence of starter cultures during cheese manufacture has been observed in market cheeses (9). The whey cheeses Myzithra, Anthotyros, and Manouri are made without starter culture; they may contain up to 70% moisture and exhibit pH values between 6.0 to 6.5. Anari whey cheese (the Greek-Cypriot name for Myzithra whey cheese) was incriminated in cases of listeriosis in women in February 1988 in England (2, 21). Thus the purpose of this research was to determine the rate of growth of *L. monocytogenes* in the fresh whey cheeses Myzithra, Anthotyros, and Manouri. Whey cheeses are traditionally produced in Greece from whey recovered during Feta cheese production, a cheese-making procedure in which ewe’s and goat’s milk is used.

**MATERIALS AND METHODS**

*Cultures of L. monocytogenes*

*L. monocytogenes* Scott A and California were used in this study. Stock cultures were maintained at 4°C on tryptose agar (TA) (Difco Laboratories, Detroit, MI) slants and were transferred monthly. *Listeria* cultures used to inoculate fresh whey cheeses were prepared as previously described (24, 34, 43). Working *Listeria* cultures were decimally diluted in sterile 2% citrate solution and a calculated volume of the third decimal dilution was added to 200 g of fresh Myzithra, Anthotyros, or Manouri cheese so that the number of *L. monocytogenes* in the inoculated cheese was ca. 5.0 × 10^5 CFU/g.

*Manufacture of whey cheeses: Myzithra, Anthotyros, and Manouri*

Whey cheeses Myzithra, Anthotyros, and Manouri used in the experiments were made in a commercial milk production facility in central Macedonia, Greece. Whey cheeses are prepared by heating whey, resulting in the denaturation and coagulation of the protein. Myzithra cheese was prepared by heating 1,000 liters of whey in a steam-jacketed cheese vat to 92°C. The curd emerged on the surface when the temperature raised to 82°C. The curd was cooked at 82°C to 92°C for 20 min for the complete denaturation of whey proteins. Finally, the cheese was drained without pressing for 3 to 5 h and stored at 5°C (15).

To prepare Anthotyros whey cheese the above procedure was modified to include the addition of 60 kg of cream (63% fat content) to 1,000 liters of whey when the temperature of the whey was 68°C to 70°C. Also 10 kg of NaCl was added when the temperature of the whey was 73°C to 75°C. To prepare Manouri cheese, 80 kg of cream (63% fat content) was added to 1,000 liters of whey when the temperature of the whey was 68°C to 70°C and 15 kg of NaCl was added when the temperature of the whey was 73°C to 75°C.

*Inoculation and storage of whey cheeses*

Cheese from three different batches was used for three trials for each of the whey cheeses resulting in nine trials (three products and three incubation temperatures) for all the experiments. Cheeses for the first trial were prepared and stored at 5°C for 38 days; for the second trial, at 12°C for 16 days; and for the third trial at 22°C for 7 days. For each of the nine trials two separate experiments were done using cheese of the same batch; one for *L. monocytogenes* California and one for Scott A. The results in Table 1 show that cheeses made on three different days were almost identical in their composition.

For each trial, ca. 1.8 kg of fresh cheese was taken from the whey cheese vat just after cooking at 82 to 92°C for 20 min and placed into a steam-sanitized hoop for drainage for ca. 5 h. The hooped cheese was placed in an ice chest, transported to the laboratory within ca. 1 h, and stored at 5°C until draining was complete (5 h total). The temperature of the cheese after draining was 5°C.

Fifty grams of cheese were inoculated with a calculated volume of *Listeria* cultures and mixed thoroughly in a 250-g capacity yoghurt container with a sterile metal spoon. Later, a second 50-g portion of cheese was added into the same yoghurt container and the sum of 100 g of cheese was again mixed thoroughly. The same schedule of inoculation was repeated in another container. Finally both portions were combined into one 200-g sample which was placed into 250-g capacity yoghurt container with a well-fitted plastic cap, preventing loss of moisture. This inoculation procedure ensured adequate distribution of *Listeria* cells in the cheese. To have enough cheese for sampling for each trial, cheese in 6 containers of 200 g each was inoculated with *L. monocytogenes* California (3 containers) and Scott A (3 containers). Inoculated cheese in containers was refrigerated until all 6 containers of 200 g each were prepared and then were stored at 5°C (first trial), 12°C (second trial), and 22°C (third trial). To minimize any contamination, the yoghurt containers used were unsealed just before the inoculation and the cheese was sampled with a sterile metal spoon.

*Sampling schedule and enumeration of L. monocytogenes*

The frequency of sampling to enumerate *L. monocytogenes* depended upon temperature of incubation. After a preliminary experiment, sampling intervals were adjusted to observe the lag, logarithmic, and stationary phases of growth and the maximum populations of *L. monocytogenes* in the whey cheeses. Duplicate samples for enumeration of *L. monocytogenes* and determination of pH were taken at 2-day, 1-day, and 8-h intervals for the cheeses incubated at 5, 12, and 22°C respectively.

Ten-gram cheese samples were used for the initial (1:10) dilution in warm (42 ± 2°C) sterile tryptose broth with 2% sodium citrate in sterile Stomacher bags of ca. 500-mL capacity (44). Samples were blended in a Stomacher 400 for 3 min. Appropriate serial decimal dilutions were made in a warm (42 ± 2°C) sterile solution of 2% sodium citrate, followed by duplicate surface plating of 0.1 ml of appropriate dilutions on lithium chloro-phenylethanol-moxalactam agar (LPM) (17). The agar plates were incubated aerobically for 48 h at 35°C. Colonies typical of those formed by *L. monocytogenes* were counted, and selected colonies were confirmed as *L. monocytogenes* according to the procedure of Ryser and Marth (34), which is based on a positive catalase reaction, tumbling motility, the appearance of blue-green colonies on tryptose agar, and results of biochemical tests found with API 20S test strips (API System, Montalieu Vernieu, France). Ten-gram cheese samples from all nine lots used in the experiments were tested for *L. monocytogenes* before they were inoculated with the
pathogen. Initial (I:10) dilutions made in sterile tryptose broth in sterile stomacher bags were reexamined after 2, 4, 6, and 8 weeks of cold enrichment at 4°C. Cold-enrichment samples were surface plated on LPM agar and the plates were incubated aerobically for 48 h at 35°C (34).

Analysis of cheeses
Duplicate moisture and fat determinations were made for each trial of cheeses used as described in reference (31). Duplicate NaCl determinations were made on g- cheese samples using the Quantab chloride titrator test strip (Miles Laboratory, Inc., Elkhart, IN) method. The pH of the cheeses was determined at the time of testing for L. monocytogenes with a pH meter (type 522, wissenschaftlich-Technische Werk, Stütten, Germany).

Calculation of growth rate and statistical methods
Growth curves were constructed for each combination of Listeria strain and incubation temperature of each cheese. Generation times for L. monocytogenes were calculated using the following formula (33): Generation time = \( \frac{1}{P_2 - \log P_j/0.301} \) \( (T_2 - T_j) \), where \( T_j \) = time of \( P_j \), \( T_2 \) = time of \( P_2 \), \( P_1 = CFU/g \) at \( T_j \), and \( P_2 = CFU/g \) at \( T_2 \).

All data on generation times and maximum populations were analyzed by use of the SPSS statistical program. The effects of strain, kind of cheese and incubation temperature on generation time and maximum population levels were analyzed using multi-way analyses of variances (ANOVA). Fisher’s LSD (least significant difference) test used to determine significant differences between means. For all analyses a level of significance \( \alpha = 0.05 \) was used.

RESULTS AND DISCUSSION
Composition of cheeses
The results for moisture, fat in dry matter (FDM), and salt content of the whey cheeses Myzithra, Anthotyros, and Manouri used in the experiments are summarized in Table 1. All results are means of two measurements. The Greek regulatory standards for whey cheeses provide that Myzithra, Anthotyros, and Manouri cannot contain more than 70% moisture or less than 50% and 65% FDM respectively. Also, Manouri cheese cannot contain more than 60% moisture or less than 70% FDM. No standard exists for the amount of salt, but the addition of salt to whey cheeses is allowed in this regulation (42). The whey is heated in whey cheese vats, capacity 1,000 liters at the most, by using steam, which is either directed to the double wall of the cheese vat or infused directly in the mass of whey. The rate of heating is such as to attain the temperature of 88 to 90°C in 40 to 45 min. This time-temperature condition also has a desirable influence on the yield of cheeses (15). Commercial whey cheeses produced in Greece usually contain about 1 to 2% salt. Manouri and Anthotyros are consumed as table cheeses. Myzithra is used as a table cheese, but mainly for the preparation of certain foods and cheese pies. Low-fat fresh Myzithra cheese also is produced in Greece without addition of salt. Some people used to add sugar or honey to eat this unsalted whey cheese. Salted and dried Myzithra whey cheese is also produced in Greece (15). The whey cheeses used in this study were made in a commercial milk-processing facility in central Macedonia, Greece. The Myzithra cheese was of the unsalted low-fat type usually produced in Greece.

The whey cheeses Myzithra, Anthotyros, and Manouri used in this study complied with the Greek standards for moisture and fat content for all nine trials, except for the FDM in Myzithra cheese, which was distinctly lower because low-fat fresh Myzithra was used in these experiments. This was done purposely because the low-fat fresh product is most commonly produced in Greece. Also the salt content for Anthotyros and Manouri cheeses was that usually found on the market. The average NaCl content for Anthotyros and Manouri cheeses was 1.42% (S.D. ± 0.08) and 2.28% (S.D. ± 0.08) respectively.

The average pH values of the Myzithra, Anthotyros, and Manouri cheeses were 6.50, 6.41, and 6.30 respectively. These pH values dropped gradually to between 5.30 to 4.97 during the entire experiment for seven trials. In two trials of the Manouri cheese (stored at 12°C for 16 days and 22°C for 7 days), the pH values remained relatively constant and above 6.10. For all nine trials, the pH values were not below 5.7 during the growth of L. monocytogenes. Only when Listeria populations reached the stationary phases of growth did pH values decrease below 5.7. These high pH values are favorable for Listeria growth. This has been noted for L. monocytogenes in other cheeses having pH values >5.5 (9, 35, 37).

Growth of L. monocytogenes in the whey cheeses at 5°C
All nine lots of whey cheeses used for all nine trials were free of L. monocytogenes (measured by direct plating and cold enrichment up to 8 weeks (34) before they were inoculated with the pathogen. Growth curves of L. monocytogenes in whey cheeses stored at 5°C are shown in Fig. 1 and Fig. 2 for strains California and Scott A respectively. All results are averages of duplicate samples. A lag phase of ca. 2 days was noted at first, and then the generation times of L. monocytogenes California in the whey cheeses Myzithra, Anthotyros, and Manouri were 16.89, 18.19, and 18.48 h respectively. The generation times of L. monocytogenes Scott A in the same whey cheese products were 16.16, 20.16, and 17.81 h respectively (Table 2). Statistical analysis of all data on generation times at 5°C indicates that the generation

### Table 1. Moisture, fat in dry matter, and salt content of Myzithra, Anthotyros and Manouri cheeses

<table>
<thead>
<tr>
<th>Cheese</th>
<th>Trial</th>
<th>Moisture, % (Avg. ± SD)</th>
<th>Fat in dry matter, % (Avg. ± SD)</th>
<th>Salt, % (Avg. ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myzithra</td>
<td>1</td>
<td>68.3 ± 0.57</td>
<td>15.7 ± 0.63</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>67.8 ± 0.57</td>
<td>17.0 ± 0.57</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>69.2 ± 0.57</td>
<td>16.2 ± 0.57</td>
<td>0</td>
</tr>
<tr>
<td>Anthotyros</td>
<td>1</td>
<td>67.1 ± 0.57</td>
<td>66.8 ± 0.67</td>
<td>1.37</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>67.8 ± 0.57</td>
<td>65.2 ± 0.67</td>
<td>1.37</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>65.8 ± 0.57</td>
<td>65.7 ± 0.67</td>
<td>1.54</td>
</tr>
<tr>
<td>Manouri</td>
<td>1</td>
<td>50.6 ± 0.57</td>
<td>72.8 ± 0.66</td>
<td>2.23</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>52.6 ± 0.57</td>
<td>71.7 ± 0.66</td>
<td>2.40</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>53.4 ± 0.57</td>
<td>70.8 ± 0.66</td>
<td>2.23</td>
</tr>
</tbody>
</table>
time of *L. monocytogenes* Scott A in Anthotyros cheese (20.16 h) was significantly longer than those of the same strain at 5°C in Myzithra cheese (16.16 h) and Manouri cheese (17.81 h). Maximum populations were reached by the two strains after 24 to 30 days at 5°C and ranged from 7.84 to 8.62 log CFU/g (Table 2). Maximum populations were significantly lower in Myzithra cheese than in Anthotyros and Manouri cheeses independent of the *Listeria* strain used. Results of previous work indicated that *L. monocytogenes* achieved similar maximum populations of $10^7$ to $10^8$ CFU/g or ml in broth, 6% salted whey, and skim milk (24), in unsalted, filter-sterilized whey (36), in Ricotta cheese (9), and in surface samples from fully ripened Camembert cheese (35).

Psychrotropic growth of *L. monocytogenes* also has been reported to occur in unfermented dairy products (3, 24, 33, 36) and market cheeses with pH values >5.5 (9). The results of this work are in agreement with those reports.

Growth of *L. monocytogenes* in the whey cheeses at 12°C

It has been observed that the transportation temperature for cheeses often deviates from 5°C and products may occasionally encounter temperatures up to 10 to 12°C. Also, whey cheeses are usually packed at 12 to 14°C, a temperature that retards multiplication of many bacteria and at the same time is tolerable for the workers.

<table>
<thead>
<tr>
<th>Storage temperature</th>
<th>L. monocytogenes strain</th>
<th>Cheese</th>
<th>Generation time (h) Mean ± SD</th>
<th>Maximum population (log CFU/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5°C</td>
<td>Scott A</td>
<td>Myzithra</td>
<td>16.16 ± 2.48</td>
<td>7.97</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthotyros</td>
<td>20.16 ± 4.90</td>
<td>8.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manouri</td>
<td>17.81 ± 1.75</td>
<td>8.62</td>
</tr>
<tr>
<td></td>
<td>California</td>
<td>Myzithra</td>
<td>16.89 ± 1.33</td>
<td>7.84</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthotyros</td>
<td>18.19 ± 4.24</td>
<td>8.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manouri</td>
<td>18.48 ± 3.88</td>
<td>8.07</td>
</tr>
<tr>
<td>12°C</td>
<td>Scott A</td>
<td>Myzithra</td>
<td>5.65 ± 1.36</td>
<td>7.65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthotyros</td>
<td>5.17 ± 0.86</td>
<td>8.14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manouri</td>
<td>5.68 ± 0.68</td>
<td>8.81</td>
</tr>
<tr>
<td></td>
<td>California</td>
<td>Myzithra</td>
<td>5.35 ± 0.83</td>
<td>7.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthotyros</td>
<td>5.07 ± 0.50</td>
<td>8.69</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manouri</td>
<td>5.81 ± 1.32</td>
<td>8.77</td>
</tr>
<tr>
<td>22°C</td>
<td>Scott A</td>
<td>Myzithra</td>
<td>1.93 ± 0.41</td>
<td>8.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthotyros</td>
<td>1.95 ± 0.49</td>
<td>8.07</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manouri</td>
<td>1.79 ± 0.46</td>
<td>8.59</td>
</tr>
<tr>
<td></td>
<td>California</td>
<td>Myzithra</td>
<td>2.70 ± 0.61</td>
<td>6.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anthotyros</td>
<td>2.55 ± 1.00</td>
<td>7.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manouri</td>
<td>1.68 ± 0.16</td>
<td>8.54</td>
</tr>
</tbody>
</table>
Increasing the storage temperature from 5 to 12°C decreased the lag phase and reduced by ca. 3.3-fold the generation time of *L. monocytogenes* in all three whey cheese products. Fig. 3 and Fig. 4 are the growth curves for *L. monocytogenes* California and Scott A respectively in whey cheeses stored at 12°C. All results are average values of duplicate samples. After a lag phase of 12 to 15 h (data from preliminary experiments not shown in Fig. 3 and Fig. 4), generation times of 5.07 h to 5.81 h were observed (Table 2) for both strains California and Scott A in all three whey cheeses. No significant differences in generation times were observed at 12°C independent of strains or products. These findings on generation times of *L. monocytogenes* in whey cheeses stored at 12°C are consistent with reports of Rosenow and Marth (33), who determined generation times of *L. monocytogenes* between 5.16 h and 6.03 h in whole, skim, and chocolate milk and whipping cream stored at 13°C. Maximum populations reached by the two strains in whey cheeses after 5 to 12 days at 12°C ranged from 7.11 to 8.81 log CFU/g (Table 2) and were significantly lower in Myzithra cheese than in Anthotyros and Manouri cheeses independent of strains. This is more evident in Fig. 3 where the growth curve for *L. monocytogenes* California in Myzithra cheese attained lower levels. This might be due to the lower pH values that were noted in this experiment. The pH of Myzithra cheese in this experiment dropped to 5.7 after only 5 days at 12°C and finally to 4.97 after 16 days at 12°C.

**Growth of *L. monocytogenes* in the whey cheeses at 22°C**

Storage at 22°C simulates room temperature. Everyone involved in food microbiology should know how critical time and temperature are to food safety. The question for a soft whey cheese made without starters, having up to 70% moisture and pH between 6.0 and 6.5, is: How long can it remain at room temperature? As expected, *L. monocytogenes* grew most rapidly at 22°C with maximum populations of 6.92 to 8.59 log CFU/g being observed after only 56 to 72 h of storage. Fig. 5 and Fig. 6 present the growth curves of *L. monocytogenes* California and Scott A respectively in whey cheeses stored at 22°C. All results are averages of duplicate samples. The lag phase lasted only 6 to 8 h. Generation times for *L. monocytogenes* California and Scott A in all three whey cheeses ranged between 1.68 and 2.70 h (Table 2). The generation time of strain California in Myzithra cheese (2.70 h) was significantly longer than that of strain Scott A (1.93 h) in the same product. Rosenow and Marth (33) also determined that the generation times of four strains of *L. monocytogenes* in whipping cream, whole, skim, and chocolate milk stored at 21°C ranged between 1.72 and 1.92 h.

Numerous reports concerning the heat resistance and thermal inactivation of *L. monocytogenes* can be found in
FIGURE 5. Growth of $L$. monocytogenes California and changes in pH in the whey cheeses Myzithra, Anthotyros, and Manouri at 22°C.

FIGURE 6. Growth of $L$. monocytogenes Scott A and changes in pH in the whey cheeses Myzithra, Anthotyros, and Manouri at 22°C.

during 1989 were found to be contaminated with $L$. monocytogenes and had to be withdrawn from the market (38). These facts prove that if present in whey cheeses, $L$. monocytogenes can generate enormous problems for both the dairy industry and public health.

The results of this work indicate how easily $Listeria$ can grow in Myzithra (Anari), Anthotyros, and Manouri whey cheeses even at refrigeration temperatures. Pathogens like $L$. monocytogenes must be kept out of susceptible cheeses. To accomplish this goal, the use of adequate hygienic practices is necessary during handling and packing of those products. Also, postpacking pasteurization of whey cheeses is recommended to minimize the risk.

ACKNOWLEDGMENTS

Research supported by the General Secretariat of Research and Technology of the Greek Ministry of Industry and Commerce, the Aristotle University of Thessaloniki, Greece, and the Macedonian Milk Industry MEVGAL S.A. We thank Dr. Chr. Batzios, Assistant Professor of Economics and Statistics, for his helpful assistance with statistical analysis of the data.

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