

## THE BACTERIAL FLORA AND KEEPABILITY OF FINNISH FRANKFURTERS

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## SUMMARY

The season had no effect on the keepability of frankfurters. Only the flavour points of 4 week old sausages stored at 7-8°C in summer were significantly lower than the points of 4 week old sausages stored at 4°C in summer and at 4°C or 7-8°C in winter. The frankfurters stored for 4 weeks at 7-8°C in summer or in winter were no longer suitable for sale. Season or storing temperature did not affect the bacterial counts determined.

Storing time caused more of an effect than the season or storing temperature on the keepability and on the counts of bacteria. The flavour points of 4 weeks old sausages stored at 7-8°C in summer and in winter were significantly lower than the flavour of respective 1 week old sausages. Usually the bacterial counts of 4 weeks old sausages were significantly higher than the bacterial counts of one week old sausages. The frankfurters contained about 1/10 thermotolerant bacteria in their total bacterial count.

It was shown that in particular special attention should be paid to the keeping temperature of frankfurters in summer.

## INTRODUCTION

The amount of informations regarding the total number of bacteria in cooked sausages varies from under  $10^2$  cfu/g (Whiting et al. 1984) to over  $10^6$  cfu/g (Dowdell and Board 1968). The bacterial number of Palumbo's (1974) experimental sausages  $9 \times 10^2$  cfu/g after manufacturing and  $9 \times 10^4$  cfu/g after storing 3 weeks can be regarded as typical in cooked sausages.

According to many scientific workers lactobacilli are the biggest bacterial group in cooked sausage. According to Reuter (1969) the number of lactobacilli can rise during 2 weeks over  $10^7$ /g at 4-6°C. Mantel and Beck proved that it is changing on the level of  $10^5$ - $10^6$  cfu/g, while Daelman and Hoof (1977) have indicated that the number of lactobacilli can rise to over  $10^6$  cfu/g during 3 weeks at 10°C but disappearing entirely at a 4°C. Microbacterium thermosphactum is, according to Dowell and Board (1968), being according to the most important bacterial group in English cooked sausage. Pohja et al. (1964) investigated the number of bacteria and bacterial flora in Finnish commercial cooked sausages. In this research, when storing sausages at 5°C, the total number of bacteria was  $4,8 \times 10^4$  cfu/g after storing 1 day,  $3,2 \times 10^5$  cfu/g after storing 7 days and  $1,4 \times 10^7$  cfu/g after storing 14 days. At their respective ages, the counts of anaerobic bacteria were  $1,7 \times 10^4$  cfu/g,  $3,7 \times 10^5$  cfu/g and  $6,2 \times 10^6$  cfu/g. The sausages investigated contained clostridia (some  $10^4$  cfu/g) and Bacillus cereus (about  $10^4$  cfu/g) but coliforms and salmonellas not at all. The sausages contained but no Clostridium perfringens at all. In the keepability project I of National Board of Trade and Consumer Interests, Department of Consumer Affairs (Anon 1983) the mean of the total bacterial of "lenkki" type sausage was  $3 \times 10^5$  cfu/g after manufacture and  $1,5 \times 10^7$  cfu/g on the last selling day. The counts of Bacillus cereus, Staphylococcus aureus, faecal streptococci, Clostridium perfringens and coliforms were < 100 cfu/g (One sample of 15 was indicated unsuitable for human food). In the keepability project II of NBTCI (Anon 1985), the sausages were stored at 8°C until

the last selling day before bacteriological examination. The counts of psychophilic bacteria and lactobacilli were 4,1 cfu/g and 3,6 cfu/g. 15,3 % of the sausages were evaluated as decreased in their condition for selling, and 19,8 % were found unsuitable for human food.

There has been discussion in Finland regarding the best selling time for the meat products. The selling time has usually been at least 3 weeks, and in summer perhaps less. According to statute, meat products should be kept in the shop at < 8°C. The keepability of meat products 3 weeks at 8°C is not certain. Because to date, there have not been many investigations into the existence of bacterial flora in Finnish cooked sausage, it was considered useful to examine the subject. In this study we examine one type of sausage, the frankfurters, to acquire more information on the presence of the bacterial flora in Finnish cooked sausage and on the keepability of the Finnish cooked sausage, in an attempt to determine more distinctly the correct selling times of cooked sausage.

## MATERIAL

The samples of frankfurters sausages made by 5 manufactures were provided in two groups: one direct from manufacturers and the other from the shops. The samples received directly from manufacturers were only few days old but the samples from the shops were about 3 weeks old, and they were given a selling time of one week. This analysis consisting of 10 samples was provided during two seasons: winter and summer. Each sample was divided into two parts: one kept at 4°C and the other at 7-8°C. The samples obtained directly from manufactures were examined about 1, 2, 3 and 4 weeks after processing and the samples from the shops examined one week before the last selling day and about on the last selling day.

## Organoleptic evaluation

The panel carrying out the organoleptic evaluation consisted of five persons, all familiar with organoleptic evaluation of cooked sausage. The flavour was evaluated. The sausages provided from manufacturers were evaluated 1, 2, 3 and 4 weeks after processing, and the sausages from shop one week before the last selling day and about on the last selling day. A scoring system and a descriptive method was used side by side as the panel's evaluation method.

## Microbiological examinations

The following examinations were made:

1. The total count of bacteria and the number of thermotolerant bacteria on plate count agar (Difco, 0479). Method plating method. Incubation for 4 days at 30°C. The plated dishes for thermotolerants were kept 2 h at 60°C before incubation. All the colonies were recorded.
2. The total number of bacteria and the number of thermotolerant bacteria on blood agar (Orion, Espoo). Method spreader method. Incubation for 2 days at 37°C. The plated dishes for thermotolerants were kept 2 h at 60°C before incubation. All the colonies were recorded.
3. The number of lactic acid bacteria and the number of thermotolerant lactic acid bacteria on Rogosa agar (Merck 5463). Method plating method. Incubation 4 days at 30°C. The plated dishes for thermotolerants were kept 2 h at 60°C before incubation. All the colonies were recorded.
4. The total number of anaerobic bacteria on SPS-agar (Merck, 10235). Method plating method with covering layer. Incubation for 2 days at 37°C in an anaerobic jar (Gas-Pack jar. manufactured by BBL Microbiology systems Cockeysville Md, US). All the colonies were recorded.

5. The number of staphylococci and micrococci and the number of thermotolerant staphylococci and micrococci on Baird-Parker agar (Merck 5406, manufacturer of tellurite egg yolk emulsion: Difco 0779-72). Method spreader method. Incubation for 2 days at 37°C. The plated dishes for thermotolerant staphylococci and micrococci were kept for 2 h at 60°C before incubation. All the black colonies were recorded. The colonies were examined by microscope.
6. The number of faecal streptococci and the number of thermotolerant faecal streptococci on Slanetz-Bartley's agar (Orion Oy, Espoo). Method spreader method. Incubation for 2 days at 37°C. The plated dishes for thermotolerant streptococci were kept for 2 h at 60°C before incubation. Red and pale red colonies were recorded.
7. The number of coliforms on VRB-agar (Difco 0012-01-5). Spreader method. Incubation 1 day at 37°C. Deep red colonies 1-2 mm in diameter were recorded.

#### The pH-value

The pH-value of the samples received from the manufacturer was measured 0, 1, 2, 3 and 4 weeks after processing. The pH of the sausages from shops were measured 3 and 4 weeks after processing. pH values were measured with Knick Portames 651-pH-meter (manufacturer: Elektronische Allengeräte, Berlin, FRG).

#### Statistical methods

The results of all determinations have been tested with variance analysis and Tukey's test in relation to season, keeping temperature and keeping time (factory and shop samples together).

### RESULTS AND DISCUSSION

#### Flavour

The season and the keeping temperature affected only the flavour of 4 weeks old factory sausages. The summer sausages stored at 7-8°C had significantly lower flavour values than summer and winter sausages stored at 4°C (Table 1). The keeping time of the sausages had no significant effect on the flavour of samples stored at 4°C. When storing at 7-8°C the flavour of 4 weeks old winter and summer sausages from the manufacturer was significantly worse than that of 1 week old. The shop sausages were kept well. 3 and 4 week old shop sausages were better than 4 week old sausages from manufacturers. Both winter and summer sausages stored 4 weeks and 3 and 4 weeks at 7-8°C had the mean flavour values below 4 points which was kept as a limit for selling.

#### Total number of aerobic bacteria.

The only significant difference as a result of season and keeping temperature was the difference between the number of aerobic bacteria between the winter shop sausages stored at 4°C and summer shop sausages stored at 7-8°C, the bacterial count of the latter being the highest (Table 2). The keeping time had no significant effect on the total count of aerobic bacteria of the winter sausages. In the summer at 7-8°C and at 4°C, keeping time consistently raised the total number of bacteria, those with the greatest number being the 4 week old sausages. 3 and 4 week old factory sausages kept at 7-8°C had also higher total counts of aerobic bacteria than 3 week old shop sausages. The mean of the numbers of bacteria in frankfurters ranged between 3,2 and 4,8 log units/g with the exception of the mean of all 4 week old sausages from manufacturers, the mean of 3 week old factory sausages (stored at 7-8°C) and the mean of 4 week old summer shop sausages (stored at 7-8°C), which had risen to between log 5 and 6. In the keepability projects of National Board of Trade and Consumer Interests, Department of Consumer Affairs (NBTCI) (Anon 1983 and 1985) the number of bacteria of "lenkki" type sausage were lower than those from this investigation in both post-processing 3 x 10<sup>5</sup>

cfu/g and post-selling time (about 10<sup>5</sup> cfu/g). bacterial number of this research and the research of NBTCI were, also distinctly lower than the determined in 1960's.

The number of 2 h at 60°C surviving bacteria (thermotolerant bacteria) on plate count agar.

After a keeping time of 2 weeks the number of thermotolerant bacteria of summer sausages kept at 8°C were significantly higher than the respective values of other sausage groups (table 3). 4 week winter sausages from factories stored at 7-8°C contained significantly more thermotolerant bacteria than the sausages stored at 4°C. When storing at 8°C the keeping time consistently raised the number of thermotolerants, those with the greatest number being the 4 week old sausages. When stored at there were no significant differences between numbers of thermotolerant bacteria of sausages groups of different age. The mean of the numbers of thermotolerant bacteria was rising from the level of 3 units/g to a range between 4 and 5 log units/g. The highest values were found in the sausages stored 7-8°C.

The total number of aerobic bacteria and the number of 2 h at 60°C surviving bacteria on blood agar. The season or keeping temperature had no significant effect on both the total number of bacteria and the number of thermotolerant bacteria determined on blood agar (table 4). Also the mean of the mentioned bacterial counts of both factory and shop sausage groups of different ages did not differ from each other. The mean of total bacterial counts of different sausage groups ranged between 3,2 log units/g and 4,9 log units/g. The respective range of the mean of thermotolerant bacteria was 2,9-4,1.

#### The number of lactic acid bacteria

After the storing of two weeks the number of lactic acid bacteria in the winter sausages stored at 7-8°C was significantly higher than in summer sausages stored at 4°C (table 5). The number of lactic acid bacteria of summer factory sausages stored 3 weeks at 7-8°C was significantly higher than those stored at 4°C. The number of lactic acid bacteria in the summer sausages stored at 7-8°C were found to be significantly higher than in that of the winter sausages stored at 7-8°C.

The only significant difference between the number of lactic acid bacteria in the sausages of different ages was between the 1 week old and 4 week old summer sausages stored at 7-8°C (Table 6). The number of lactic acid bacteria was on the level of 2 log units/g, 1 week after manufacturing, rising to the level of 3 and 4 log units/g. The highest mean of lactic acid bacterial counts was in 4 week old summer sausages stored at 7-8°C, 5,4 log units/g. The winter shop sausages contained lactic acid bacteria between 1,5-2 log units/g.

In the keepability project I of NBTCI, the number of lactic acid bacteria were between  $<10 - 7,4 \times 10^5$  cfu/g, but in the keepability project II of NBTCI, the numbers of lactic acid bacteria were on the level of  $10^5$  cfu/g. It can be concluded that the numbers of lactic acid bacteria on subject to wide variation.

The number of 2 h at 60°C surviving lactic acid bacteria (thermotolerant lactic acid bacteria). Only 0-2 samples/sausage group received from 5 manufacturers, containing thermotolerant lactic acid bacteria over 10 cfu/g during the first 3 keeping weeks (Table 7). After 4 weeks of storing, sample/sausage groups contained thermotolerant lactic acid bacteria over 10 cfu/g. Among shop samples thermotolerant lactic acid bacteria over 10 cfu/g appeared only in 4 week old summer sausages at 4°C 3 and at 7-8°C in 1 samples.

The number of anaerobic bacteria (on SPS-agar) in summer sausages stored for 3 weeks at 7-8°C was significantly higher than that of sausages stored 3 weeks at 4°C (table 8). The season and keeping temperature did not cause any other significant differences between sausage groups. Keeping time significantly influenced the number of anaerobic bacteria only in the summer sausage groups stored at 7-8°C. The sausages stored for one week after manufacturing and 3 weeks old shop sausages contained significantly less anaerobes than the 4 weeks old sausages received from the manufacturers. The numbers of anaerobic bacteria ranged between log units of 1,8-3,8 the counts being as a rule usually higher in older sausages. According to Pohja (1964) the numbers of anaerobic bacteria were immediately after processing  $1,7 \times 10^4$  cfu/g, raising to the level of  $10^5$  cfu/g during a 2 week period. These bacterial numbers are higher than those from this investigation.

#### Number of staphylococci and micrococci on Baird-Parker agar

The highest three appearing samples from the manufacturer's winter sausages had over  $10^4$  cfu/g staphylococci and micrococci (table 9). In respective summer sausages only a few accidental sausages contained staphylococci or micrococci over  $10^4$  cfu/g. Among the shop sausages in both winter or summer there were 2-3 sausages/group containing staphylococci or micrococci over  $10^4$  cfu/g. Staphylococci and micrococci surviving after preincubation of 2 h at 60°C appeared only in 3 factory and 6 shop sausages.

#### Number of faecal streptococci on Slanetz-Bartley's Agar

The number of faecal streptococci in winter sausages from manufacturers appeared in most samples over  $10^2$  cfu/g (table 10). There occurred a surprisingly high number of streptococci ( $10^4$ - $10^5$  cfu/g) even in 1 week old sausages. The number of enterococci in summer factory sausages was only occasionally over  $10^2$  cfu/g. In shop samples there were not faecal streptococci over  $10^2$  cfu/g. Faecal streptococci surviving after preincubation of 2 h at 60°C appeared over  $10^2$  cfu/g in 7 factory and 6 shop sausages.

#### Coliforms

The purpose was to assure that post-contamination with a gram-negative bacteria could not happen. No sausages contained coliforms over  $10^2$  cfu/g which was a satisfactory result.

#### pH-value

There appeared significant differences between the pH values of different frankfurter groups but they were not consecutive. The pH values were as a rule decreasing 0,2 - 0,3 units from the level of 6 during keeping period. Mostly the pH values of 4 weeks old sausages were significantly lower than 1 week old samples.

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Table 1. The flavour (mean of 5 panelists evaluation of 5 sausages) of frankfurters

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	4,87 <sup>a</sup>	0,47	4,87 <sup>ab</sup>	0,47	5,06 <sup>a</sup>	0,71	5,06 <sup>a</sup>	0,71
2 weeks	4,44 <sup>a</sup>	0,77	4,38 <sup>ab</sup>	0,77	4,67 <sup>a</sup>	0,14	4,42 <sup>ab</sup>	0,28
3 - " -	4,41 <sup>a</sup>	0,34	4,35 <sup>ab</sup>	0,39	4,70 <sup>a</sup>	0,46	3,86 <sup>ab</sup>	0,93
4 - " -	4,44 <sup>a</sup>	A 0,27	3,40 <sup>ab</sup>	1,12	4,52 <sup>a</sup>	A 0,26	2,90 <sup>b</sup>	B 1,24
Shop samples								
3 weeks	5,21 <sup>a</sup>	1,02	5,21 <sup>a</sup>	1,02	4,81 <sup>a</sup>	0,39	4,81 <sup>a</sup>	0,39
4 - " -	4,66 <sup>a</sup>	0,57	4,40 <sup>ab</sup>	0,62	4,45 <sup>a</sup>	0,39	4,37 <sup>a</sup>	0,27

1. Means within the same column not followed by the same small letter are significantly different (p<0.05).  
 2. Means within the horizontal line not followed by the same big letter are significantly different (p<0.05). If there are no big letters after the means listed, there are no differences among them.

Table 2. The total number of bacteria (mean of log cfu/g) on plate count agar in frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	4,25 <sup>a</sup>	1,38	4,25 <sup>a</sup>	1,38	3,72 <sup>a</sup>	0,55	3,72 <sup>a</sup>	0,55
2 weeks	4,08 <sup>a</sup>	0,67	4,48 <sup>a</sup>	0,87	3,98 <sup>a</sup>	0,35	4,84 <sup>ab</sup>	1,30
3 - " -	4,81 <sup>a</sup>	0,63	5,61 <sup>a</sup>	1,53	4,57 <sup>ab</sup>	1,57	5,90 <sup>b</sup>	1,36
4 - " -	5,39 <sup>a</sup>	0,62	5,27 <sup>a</sup>	0,60	5,53 <sup>a</sup>	1,10	5,82 <sup>b</sup>	1,25
Shop samples								
3 weeks	3,26 <sup>a</sup>	2,10	3,91 <sup>a</sup>	1,34	4,11 <sup>ab</sup>	0,75	4,11 <sup>ac</sup>	0,75
4 - " -	3,46 <sup>a</sup>	A 0,84	4,44 <sup>a</sup>	AB 0,83	4,79 <sup>ab</sup>	AB 1,01	5,54 <sup>b</sup>	B 0,74

Table 3. The number of 2 h at 60°C surviving bacteria (thermotolerant bacteria, mean of log cfu/g) on plate count agar in frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	3,27 <sup>a</sup>	0,80	3,27 <sup>a</sup>	0,80	3,02 <sup>a</sup>	0,78	3,02 <sup>a</sup>	0,78
2 weeks	2,80 <sup>a</sup>	A 0,92	2,96 <sup>a</sup>	A 0,69	3,35 <sup>a</sup>	A 0,57	4,43 <sup>b</sup>	B 0,78
3 - " -	3,17 <sup>a</sup>	1,05	4,21 <sup>ab</sup>	2,26	4,17 <sup>ab</sup>	1,54	4,67 <sup>b</sup>	0,89
4 - " -	3,88 <sup>a</sup>	A 1,11	5,47 <sup>b</sup>	B 0,46	4,60 <sup>a</sup>	AB 1,04	4,90 <sup>b</sup>	AB 1,30
Shop samples								
3 weeks	3,10 <sup>a</sup>	1,26	3,10 <sup>a</sup>	1,26	3,47 <sup>a</sup>	0,99	3,47 <sup>ab</sup>	0,99
4 - " -	2,85 <sup>a</sup>	0,49	3,74 <sup>a</sup>	1,16	3,83 <sup>a</sup>	1,56	4,90 <sup>b</sup>	1,37

Table 4. The total number of bacteria (mean of log cfu/g) on blood agar in frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	4,22 <sup>a</sup>	1,29	4,22 <sup>a</sup>	1,29	3,33 <sup>a</sup>	0,79	3,33 <sup>a</sup>	0,79
2 weeks	3,19 <sup>a</sup>	0,80	3,66 <sup>a</sup>	0,96	3,59 <sup>a</sup>	0,82	3,35 <sup>a</sup>	0,80
3 - " -	4,07 <sup>a</sup>	0,49	3,89 <sup>a</sup>	0,51	4,48 <sup>a</sup>	1,58	4,50 <sup>a</sup>	1,18
4 - " -	4,07 <sup>a</sup>	1,10	4,85 <sup>a</sup>	1,50	3,99 <sup>a</sup>	1,87	4,08 <sup>a</sup>	0,90
Shop samples								
3 weeks	3,87 <sup>a</sup>	1,44	3,87 <sup>a</sup>	1,44	3,37 <sup>a</sup>	0,84	3,37 <sup>a</sup>	0,84
4 weeks	3,56 <sup>a</sup>	0,47	3,54 <sup>a</sup>	1,24	3,99 <sup>a</sup>	0,58	4,39 <sup>a</sup>	1,06



Table 5. The number of 2 h at 60°C surviving acid bacteria (thermotolerant bacteria) on blood agar in frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	3,64 <sup>a</sup>	1,37	3,64 <sup>a</sup>	1,37	3,01 <sup>a</sup>	0,80	3,01 <sup>a</sup>	0,80
2 weeks	3,05 <sup>a</sup>	0,72	3,13 <sup>a</sup>	0,62	3,14 <sup>a</sup>	0,98	3,91 <sup>a</sup>	1,18
3 - " -	3,72 <sup>a</sup>	0,74	3,47 <sup>a</sup>	0,48	3,55 <sup>a</sup>	1,31	4,04 <sup>a</sup>	1,21
4 - " -	4,05 <sup>a</sup>	1,36	4,33 <sup>a</sup>	1,59	3,20 <sup>a</sup>	1,33	3,60 <sup>a</sup>	1,36
Shop samples								
3 weeks	3,49 <sup>a</sup>	1,25	3,49 <sup>a</sup>	1,25	2,91 <sup>a</sup>	0,93	2,91 <sup>a</sup>	0,93
4 - " -	2,90 <sup>a</sup>	0,30	3,41 <sup>a</sup>	1,19	3,53 <sup>a</sup>	0,9	4,16 <sup>a</sup>	1,13

Table 6. The number of lactic acid bacteria (mean of log cfu/g) on Rogosa-agar in frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	1,91	1,61	1,91	1,61	2,01	1,01	2,01 <sup>a</sup>	1,01
2 weeks	2,24	AB	1,43	3,33	A	0,94	1,70	B
3 - " -	3,12	AB	1,60	3,88	AB	1,53	2,20	A
4 - " -	3,19	1,61	3,50	2,27	2,78	1,98	5,39 <sup>b</sup>	2,86
Shop samples								
3 weeks	1,59	0,82	1,59	0,82	2,84	1,83	2,84 <sup>ab</sup>	1,88
4 - " -	1,84	AB	1,57	1,54	A	1,21	3,60	BC

Table 7. The number of samples containing 2 h at 60°C surviving lactic acid bacteria (thermotolerant lactic acid bacteria) > 10<sup>6</sup> cfu/g on Rogosa-agar in frankfurters.

Time in weeks from manufacturing	Winter		Summer	
	4°C	7-8°C	4°C	7-8°C
Factory samples				
1 week	0 "	0 "	2 "	2 "
2 weeks	0 "	1 "	2 "	2 "
3 - " -	2 "	1 "	0 "	2 "
4 - " -	3 "	3 "	3 "	3 "
Shop samples				
3 weeks	0 "	0 "	0 "	0 "
4 - " -	0 "	0 "	3 "	1 "

Table 8. The number of anaerobic bacteria (mean of log cfu/g) on SPS-agar in frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	2,77 <sup>a</sup>	1,66	2,77 <sup>a</sup>	1,66	1,89 <sup>a</sup>	0,68	1,89 <sup>a</sup>	0,68
2 weeks	2,50 <sup>a</sup>	0,39	2,94 <sup>a</sup>	1,03	1,82 <sup>a</sup>	1,03	2,41 <sup>ab</sup>	0,29
3 - " -	3,03 <sup>a</sup>	0,90	3,29 <sup>a</sup>	AB	1,68	1,61 <sup>a</sup>	A	0,38
4 - " -	3,39 <sup>a</sup>	0,60	3,69 <sup>a</sup>	1,44	2,61 <sup>a</sup>	1,28	3,82 <sup>a</sup>	1,38
Shop samples								
3 weeks	2,38 <sup>a</sup>	1,89	2,38	1,89	1,89 <sup>a</sup>	1,03	1,89 <sup>a</sup>	1,03
4 - " -	2,06 <sup>a</sup>	0,79	2,34	1,56	2,47 <sup>a</sup>	1,05	3,12 <sup>ab</sup>	1,64

Table 9. The total number of samples containing staphylococci and micrococci >10<sup>6</sup> cfu/g on Baird Parker agar in frankfurters.

Time in weeks from manufacturing	Winter		Summer	
	4°C	7-8°C	4°C	7-8°C
Factory samples				
1 week	3 "	3 "	1 "	1 "
2 weeks	1 "	2 "	1 "	0 "
3 - " -	1 "	1 "	0 "	1 "
4 - " -	2 "	3 "	0 "	2 "
Shop samples				
3 weeks	3 "	3 "	3 "	3 "
4 - " -	2 "	2 "	2 "	2 "

Table 10. The number of samples containing faecal streptococci >10<sup>2</sup> cfu/g on Selenetz-Bartley's agar in frankfurters.

Time in weeks from manufacturing	Winter		Summer	
	4°C	7-8°C	4°C	7-8°C
Factory samples				
1 week	3 "	3 "	0 "	0 "
2 weeks	1 "	2 "	0 "	2 "
3 - " -	3 "	3 "	1 "	1 "
4 - " -	3 "	3 "	0 "	1 "
Shop samples				
3 weeks	0 "	0 "	0 "	0 "
4 - " -	0 "	0 "	0 "	0 "

Table 11. pH of frankfurters.

Time in weeks from manufacturing	Winter				Summer			
	4°C		7-8°C		4°C		7-8°C	
	x	sd	x	sd	x	sd	x	sd
Factory samples 1)								
1 week 2)	6,08 <sup>a</sup>	A	0,12	6,08 <sup>a</sup>	A	0,12	5,93 <sup>ab</sup>	B
2 weeks	5,96 <sup>ab</sup>	0,10	5,95 <sup>ab</sup>	0,12	5,93 <sup>ab</sup>	0,10	5,95 <sup>a</sup>	A
3 - " -	5,90 <sup>ab</sup>	0,19	5,87 <sup>ab</sup>	0,16	6,01 <sup>a</sup>	0,04	5,85 <sup>b</sup>	A
4 - " -	5,86 <sup>ab</sup>	AB	0,20	5,74 <sup>b</sup>	A	0,17	6,03 <sup>a</sup>	B
Shop samples								
3 weeks	5,91 <sup>ab</sup>	0,11	5,91 <sup>ab</sup>	0,11	5,84 <sup>bc</sup>	0,09	5,84 <sup>ab</sup>	B
4 - " -	5,82 <sup>b</sup>	0,19	5,80 <sup>b</sup>	0,22	5,78 <sup>c</sup>	0,09	5,79 <sup>c</sup>	C