THE BACTERIAL FLORA AND KEEPABILITY OF GAS-PACKED MEAT BALLS[1]

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SUMMARY

The total count of aerobic bacteria in one-week-old meat balls was 10^4 cfu/g. When stored at 7-8°C the total count of aerobic bacteria in meat balls rose to over 10^6 cfu/g. Thermoduric bacteria made up 10% of the total bacteria counted. Lactic acid bacteria accounted for 1% of the total count of bacteria.

Season, storage temperature and time had no significant effect on the keepability of the meat balls. However, meat balls stored for 2 weeks at 7-8°C in summer had mean flavour values below the permissible value limit for selling, while the flavour values in the meat ball groups fell below this limit after 4 weeks storage.

The season and storage temperature had no affect the bacterial counts determined apart from the case of lactic acid bacteria, whose numbers were significantly higher in summer than in winter meat ball samples. Storing time had a greater effect on the bacterial counts than did the season and storing temperature. The total counts of aerobic and anaerobic bacteria in 3-week-old meat balls stored at 7-8°C in summer were significantly higher than the respective counts of bacteria after one weeks' storage.

It was concluded that gas-packed meat balls do not keep for more than 4 weeks at 4°C and 2 weeks at 7-8°C in summer.

INTRODUCTION

There is little information of the bacterial counts of processed ready-to-eat products made of minced meat. According our experience the total bacterial count of cooked minced meat patties just after processing was 10^4 cfu/g rising during the next two weeks to over 10^6 cfu/g. The quality defects appear when the bacterial count of ready-to-eat products reaches 10^7 - 10^8/g. As a rule mould colonies are the reason for the spoilage of processed minced meat products. According to our unpublished results the bacterial counts of meat balls bought from shops are in the region of 10^3 - 10^5/g. As processed minced meat products are an important meat product group in Finland and meat balls are the most commonly eaten an investigation was done to obtain more reliable information of bacterial count of the flora in meat balls.

MATERIAL AND METHODS

Samples of meat balls made by 5 manufactures were provided in two ways: one direct from manufacturers and the other from the shops. The samples received directly from manufacturers were only a 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 winter and summer. Each sample was divided into two portions: one kept at 4°C and the other at 7-8°C. The samples obtained directly from the manufacturers 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 on the last selling day.

Organoleptic Evaluation

A panel which consisted of five members carrying out the organoleptic evaluation. All the panel members were familiar with organoleptic evaluation of cooked sausage. The flavour were evaluated. The meat balls provided by manufacturers were evaluated 1, 2, 3 and 4 weeks after processing, and the meat balls from shop one week before

Table 1. The flavour (mean of 5 panelists evaluation of 5 meat balls) of meat balls.

Time in weeks from manufacturing	Winter 4°C x	Winter 4°C sd	Winter 7-8°C x	Winter 7-8°C sd	Summer 4°C x	Summer 4°C sd	Summer 7-8 °C x	Summer 7-8 °C sd
Factory samples [1]								
1 week [2]	5.09	0.52	5.09^{ab}	0.52	4.96	0.54	4.96	0.54
2 weeks	4.96	0.48	4.98^{ab}	0.59	4.58	0.34	3.84	2.00
3 weeks	4.04	2.11	4.48^{ab}	0.70	4.04	2.16	2.22	2.00
4 weeks	3.84	2.03	3.36^{a}	1.8	3.60	1.92	3.16	1.76
Shop samples								
3 weeks	5.20	0.43	5.20^{b}	0.43	4.64	0.55	4.64	0.55
4 weeks	4.50	0.70	4.76^{ab}	0.15	4.42	0.86	3.54	2.01

[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 thecapital letter are significantly different ($p<0.05$). If there are no capital 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 meat balls.

Time in weeks from manufacturing	Winter 4°C x	Winter 4°C sd	Winter 7-8°C x	Winter 7-8°C sd	Summer 4°C x	Summer 4°C sd	Summer 7-8 °C x	Summer 7-8 °C sd
Factory samples [1]								
1 week [2]	4.27^{a}	1.28	4.27	1.28	3.38	0.46	3.38^{a}	0.46
2 weeks	4.06^{a}	0.76	4.43	1.24	4.26	1.16	4.98^{ab}	1.50
3 weeks	5.20^{ab}	0.65	6.15	1.70	5.31	1.89	7.23^{b}	0.63
4 weeks	6.38^{b}	0.48	6.22	1.75	5.54	1.71	6.14^{b}	1.56
Shop samples								
3 weeks	5.02^{ab}	0.44	5.02	0.44	4.58	2.13	4.58^{ab}	2.13
4 weeks	5.90^{b}	0.72	5.68	1.01	5.62	1.54	5.38^{ab}	2.03

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

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]	3.01[a]	0.87	3.01[a]	0.87	3.00	0.61	3.00	0.61
2 weeks	2.91	1.10	3.54[a]	2.27	3.77	1.23	3.81	1.59
3 weeks	4.41[ab]	1.19	5.96[b]	1.55	4.86	1.73	5.64	1.93
4 weeks	6.24[b]	0.47	4.75[ab]	1.34	3.95	1.43	5.30	1.73
Shop samples								
3 weeks	4.10[a]	0.80	4.10[ab]	0.80	3.88	1.33	3.88	1.33
4 weeks	4.68[ab]	1.58	3.46[a]	0.78	4.96	1.11	5.02	1.79

Table 4. The number of lactic acid bacteria (mean of log cfu/g) on Rogosa-agar in meat balls.

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]	2.55	1.26	2.55[ab]	1.26	2.01	1.11	2.01	1.11
2 weeks	2.73	1.04	4.06[ab]	1.96	1.80	1.34	2.57	1.33
3 weeks	3.44	1.97	5.50[a]	2.66	3.30	2.41	4.55	1.43
4 weeks	4.86	2.28	4.83[ab]	1.82	4.34	1.40	4.55	1.11
Shop samples								
3 weeks	2.72 A	1.76	2.72[ab] A	1.76	3.62 B	2.25	3.62 B	2.25
4 weeks	1.92	2.06	1.86[b]	0.98	4.40	1.73	3.68	2.69

Table 5. The number of samples containing lactic acid bacteria (thermoduric lactic acid bacteria) that survived for 2 h at 60°C >10^2 cfu/g on Baird Rogosa -agar in meat balls.

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

Table 6. The number of anaerobic bacteria (mean of log cfu/g) on SPS-agar in meat balls.

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]	2.40	1.16	2.40	1.16	1.83[a]	0.61	1.83[a]	0.61
2 weeks	2.69	1.09	3.01	1.33	2.31[ab]	1.34	3.07[ab]	1.55
3 weeks	3.66	1.44	1.00	0.00	3.64[abc]	1.27	4.00[ab]	1.18
4 weeks	3.52	2.67	4.46	1.67	3.85[bc]	1.29	3.61[ab]	1.91
Shop samples								
3 weeks	2.94	0.98	2.94	0.98	2.02[ab]	0.74	2.02[a]	0.74
4 weeks	3.72	1.64	4.34	1.51	5.18[c]	1.59	4.58[b]	2.09

the last selling day and on the last selling day. A scoring system and a descriptive method were both used as the panel's evaluation method.

Microbiological Examination

The following examinations were made:

1. The total count of bacteria and the number of thermoduric bacteria in the plate count-agar (Difco, 0479). Plating method; Incubation for 4 days at 30°C. The plated dishes for thermoduric bacteria were kept for 2 h at 60°C before incubation. All the colonies were recorded.

2. The number of lactic acid bacteria and the number of thermoduric lactic acid bacteria on Rogosa agar (Merck 5463). Plating method. Incubation 4 days at 30°C. The plated dishes for thermoduric lactic acid bacteria were kept for 2 h at 60°C before incubation. All the colonies were recorded.

3. The total number of anaerobic bacteria on SPS-agar (Merck, 10235). 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.

4. The number of staphylococci and micrococci and the number of thermoduric staphylococci and micrococci on Baird-Parker agar (Merck 5406, manufacturer of tellurite egg yolk emulsion: Difco 0779-72). Spreader method. Incubation for 2 days at 37°C. The plated dishes for thermoduric 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.

5. The number of faecal streptococci and the number of thermoduric faecal streptococci on Slanetz-Bartley's agar (Orion Oy, Espoo). Spreader method. Incubation for 2 days at 37°C. The plated dishes for thermoduric streptococci were kept for 2 h at 60°C before incubation. The dark and pale red colonies were recorded.

6. The number of coliforms on VRB-agar (Difco 0012-01-5). Spreader method. Incubation for 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 shop meat balls were measured 3 and 4 weeks after processing. pH values were measured with a 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, storage temperature and time stored (factory and shop samples together).

RESULTS AND DISCUSSION

Flavour

The season, storing temperature and storing time had no significant effect on the flavour of the meat balls (Table 1). Four flavour points was elected to be the minimum value for which the balls could still be sold. The meat balls kept for 2 weeks at 7-8°C in summer had mean flavour values below 4 points but in the other meat ball groups the flavour values had fallen below that limit after 4 weeks' storage.

Total Number Of Bacteria

The season and storing temperature did not significantly affect the total bacterial count of meat balls (Table 2). The storage time had no significant effect on the total count of aerobic bacteria of meat balls stored at 7-8°C in winter or at 4°C in summer. The number of bacteria in 4 week old meat balls stored at 4°C in winter were significantly higher than the number of bacteria in meat balls in the first 2 weeks after processing. Also the number of bacteria in 3 week old factory meat balls stored at 7-8°C in summer had risen 3 weeks after processing to a level higher than that in 1 week old meat balls. The mean of the numbers of bacteria in meat balls during the first two weeks of storage ranged between 3.4 and 5.0 log units and in 3 and 4 week old meat balls between 5.0 and 7.2 log units/g.

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

The season and storing temperature did not affect significantly the number of thermoduric bacteria in the meat balls (Table 3). The storage time had no effect on thermoduric bacteria in the summer meat ball groups. The number of thermoduric bacteria was significantly higher in factory winter meat balls both after storing for 4 weeks at 4°C and after storing for 3 weeks at 7-8°C than in 2 week old meat balls.

The mean of numbers of thermoduric bacteria in meat balls during the first two storing weeks ranged between 2.9 and 3.8 log units/g and in 3 and 4 week old meat balls between 3.4 and 6.2 log units.

The number of lactic acid bacteria

The season, storing temperature and storing time did not significantly affect the number of lactic acid bacteria in the meat balls (Table 4). The means of the number of lactic acid bacteria in the meat balls were 10^2 - 5 x 10^2 cfu/g 1 week after processing rising to over 10^4 cfu/g 4 weeks after processing.

The number of lactic acid bacteria surviving after 2 h at 60°C (thermoduric lactic acid bacteria)

One week after processing no meat ball samples contained thermoduric lactic acid bacteria at levels over 10 cfu/g (Table 5). After 4 weeks of storing 2-4 samples/meat ball group contained thermoduric lactic acid bacteria at levels over 10 cfu/g. In shop samples thermoduric lactic acid bacteria at levels over 10 cfu/g appeared in 0-4 samples/meat ball group.

Number of anaerobic bacteria (on SPS-agar)

The season and storing temperature did not significantly affect the number of anaerobic bacteria in meat balls (table 6). The storage time had no significant effect on the count of anaerobic bacteria in meat balls in winter. In summer when the balls were stored at 4 °C the number of anaerobes in 4 week old meat balls (both from shops and factories) was significantly higher than in 1 week old factory meat balls. When stored at 7-8°C the number of anaerobes in 1 week old factory meat balls was significantly lower than in 4 week old shop samples. The number of anaerobic bacteria ranged between 1.8 - 5.2 log units the counts being as a rule higher in older meat balls.

Number of staphylococci and micrococci on Baird-Parker -agar

The number of staphylococci and micrococci was over 10^2 cfu/g in 74 samples of 120 (table 7). The number of staphylococci and micrococci surviving after pre-incubation of 2 h at 60°C was over 10^2 cfu/g only in 21 samples of 120.

Number of faecal streptococci on Slanez-Bartley's agar

The number of faecal streptococci was over 10^2 cfu/g in 40 samples of 120 (table 8). Staphylococci and micrococci surviving after pre-incubation of 2 h at 60°C was over 10^2 cfu/g only in 23 samples of 120.

Coliforms

The purpose was to assure that post-contamination with gram-negative bacteria could not happen. No meat balls contained coliforms over 10 cfu/g.

pH-value

There appeared significant differences between the pH-values of different meat ball groups but they were not consecutive (table 9). The pH-values of meat balls ranged between 5.70 and 6.06.