THE EFFECT OF pH-VALUE OF MEAT ON THE KEEPABILITY OF COOKED MEAT PRODUCTS MADE FROM COARSELY GROUND PORK

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Introduction

The meat products made of coarsely ground meat are heated to internal temperatures of 68-72°C. In spite of that they sometimes spoil quite quickly so that not only the surface layer but also the core is spoiled. The bacterial flora and spoilage of these kinds of products have been studied by PETÄJÄ (1991) and PETÄJÄ and PUOLANNE (1993) but the reason for core spoilage was not found. The core contained heat resistant streptococci or heat resistant pseudomonads or both but they did not affect the spoilage The products were spoiled in the surface layer by lactic acid bacteria which had contaminated the surface of the products. Addition of glucose to the product has not found to affect spoilage (PETÄJÄ 1994). Because it would be benefical to make the products in question from the hihg-pH-meat having a good water holding capacity the effect of pH-value on the bacterial count and flora and keepability of the products was investigated. The meats with the pH-values <5.5, 5.5-5.0 and >6.0 were used.

Material and methods

Manufacture of the products: One experimental batch contained 4 kg pork, 20 g (0.5 %) glucose and O.4 l water. The following additives were used: NaCl (2 %), $NaNO_2$ (0.012 %), phosphates (0.15 % P_2O_5) and Na-ascorbate (0.12 %). The pseudomonas inoculum (the aim 10^7/g meat) was added as nutrient broth (Merck 5443) culture (0.2 l) and streptococcus inoculum as (the aim 10^7/g meat) APT-broth (Merck 10454) culture (0.2 l). The meat raw-material was coarsely ground with 0-collar. Thereafter the additives, water and bacterial cultures were added to meat and the mixture was tumbled for 3 h at 6°C with pauses of 15 min/h. After the the first hour the mixture was kept in vacuum for 0.5 h. After the tumbling of 3.5 h the meat batch was stuffed into 90 mm fiber casing (Visko Light, OY Visko AB, Hanko, Finland). Different products were made for each keeping period. The stuffed products were kept for 18 h at 6°C before cooking. The cooking program was as follows: Smoking for 1 h (50-70°C) + cooking for 100 min (76°C, humidity 100%).
After cooking the products were cooled for 50 min in cold shower and moved to 6°C. The rising and decreasing of the temperature in the core, in the surface layer and in the cooking chamber were registered with data logger (Grant, Grant Instruments Ltd. Cambridge, England) during cooking and cooling. The mean temperature profile is presented in figure 1. The products to be stored were packed in vacuum packages and stored at 6°C. Vacuum packages of slices were also made in each product group and also they were stored at 6°C.
Inoculated bacteria: Pseudomonas strain (7b2) and streptococcus strain (7b1) inoculated into the products were isolated on the APT-agar (Merck 10453) from the core of cooked meat products made of coarsely ground pork. Both strains were noticeably heat resistant. Pseudomonas survived after heating for 15 min at 72°C in coarsely ground cured pork (PETÄJÄ 1991, PETÄJÄ and PUOLANNE 1993). When heated in coarsely ground cured pork streptococcus strain survived after heating corresponding to the heat treatment used for cooked sausages (PETÄJÄ 1992).

Microbiological experiments: Each experimental series was studied microbiologically after tumbling and keeping 18 h at 6°C, after cooking and cooling and after 2, 4 and 6 weeks of storing. The determination was carried out on the surface layer and the core of the product differently. The product was peeled and the surface layer sample was aseptically taken 1-2 mm in thickness. The core sample was taken from the centre of the product after breaking the the product in two parts so that nothing touched the sampling area. The following determinations were made: Total plate count of anaerobically growing bacteria (Plate count agar, Merck 5463, 3 d at 30°C; APT-agar, Merck 10453, 3 d at 30°C); anaerobically growing bacteria (SPS-agar, Merck 10235, 2 d at 37°C in anaerobic jar); lactic acid bacteria (Rogosa-agar, Merck 5413, 4 d at 30°C); staphylococci and micrococci Baird-Parker-agar, Labm 85 and X085, 2 d at 37°C); pseudomonads (GSP-agar, Merck 10230, 3 d at 25°C) Brochothrix thermosphacta (STAA-agar, Gardner 1966, 2 d at 22°C). The results were tested with variance analysis (Stat Graphics-program) in relation to pH-value of meat raw-material and keeping time.

Chemical studies:Glucose and glycogen were determined by Boehring Manheim UV-method (Boehring Manheim Gmbh, Nr. 207748) and lactic acid by Boehring Manheim UV-method (Boehring Manheim Gmbh, Nr. 193084). All three determinations were carried out on the products after cooking and after 6 weeks of storing at 6°C.

pH-value of the products was measured after tumbling, after cooking and cooling and after 2, 4 and 6 weeks of storing using Knick portames 651 pH-meter (Knick Elektronische Allesgeräte, Berlin, Germany). The measurement was carried out on the surface layer and on the core of the product. The results of chemical studies were tested with variance analysis (Stat Graphics-program) in relation to pH-value of meat raw-material and keeping time.

Sensory evaluation: The keepability of the products was followed by tasting the products after two, three four and five weeks by two laboratory workers. After six weeks of storing at 6°C the products were evaluated by a panel consisting seven persons familiar with the sensory evaluation of meat products. The panelists tasted and smelled the product and evaluated If the product is spoiled, possibly spoiled or not spoiled. The summed number of "spoiled" and "possibly spoiled" evaluations in relation to the total number of evaluations was tested by paired test table to determine spoilage of the product.

Grouping of the experimental products: The experimental products were grouped on the basis of pH-value of meat raw-material as follows: 1. pH <5.5; 2. pH 5.5-5.9; 3. pH >6.0; mixture of the groups 1 and 3 (1:1). Experimental series were made four times.

Results and discussion

Microbiological experiments: The total count of aerobically growing bacteria (Plate count- and APT-agar) of meat raw-material ranged between 4.0 and 6.3 log colony forming units (cfu)/g.

Before cooking the total count of bacteria in experimental products was on the level of 7.0 log cfu/g consisting of inoculated pseudomonads (range 6.0-7.2 log cfu/g) and streptococci (range 5.7-8.0 log cfu/g)(Table 1). Inoculated streptococci survived (>1.0 log cfu/g) after cooking only in two experimental series out of four and then only in one product group. Pseudomonads also survived in two experimental series in five product groups altogether However, both inoculated bacteria disappeared (counts < 1.0 log cfu/g) in the products during the first two weeks of storing. The weak survival and disappearance of inoculated bacteria are in agreement with the earlier results of PETÄJÄ and PUOLANNE (1993). According to the results of PETÄJÄ (1991, 1992) the inoculated streptococci and pseudomonads survived better in laboratory scale experiments than in the production scale experiments in this study and in the study of PETÄJÄ and PUOLANNE (1993).

After cooking the mean total counts of bacteria ranged from 1.3 to 3.0 log cfu/g in the surface layer and from 1.9 to 2.7 in the core of the products (Table 1). During 6 weeks of storing at 6°C the mean counts rose to the level of 6 log cfu/g in the surface layer of the

products of pH-groups <5.5 and 5.5-5.9 while in the other two groups the mean counts only rose to the level of 5 log cfu/g. In the centre of the products the mean total bacterial counts rose only 1 log unit during 6 weeks of storing at 6°C.
The mean counts of anaerobically growing bacteria ranged between 3.0 and 4.0 log cfu/g before cooking and were only accidentally over 1.0 log cfu/g after cooking. The counts of lactic acid bacteria growing on Rogosa-agar were on the level of 2-3 log cfu/g before cooking and decreased during cooking under 1.0 log cfu/g. The counts rose only in the surface layer of the products up to 6 weeks of storing at 6°C. The mean count of staphylococci + micrococci ranged from 3.5 to 4.3 log cfu/g before cooking. After cooking these bacteria apeared only accidentally over 2 log cfu/g in the products. Before cooking Brochothrix thermosphacta appeared in the products over 2.0 log cfu/g occasionally and after cooking not at all.
Bacterial growth in the vacuum package: Growth of streptococci inoculated on the surface of products was observed visually in vacuum packages after 4 weeks of storing at 6°C in one experimental series and after 6 weeks in all four series (Table). Bacterial growth between meat slices inoculated with streptococci was found first after 5 weeks of storing at 6°C in some experimental groups and after 6 weeks of storing in most experimental groups.

Chemical studies: Glucose contents of the products after cooking (range of means 1.9-2.8 mg/g) were lower than added glucose content (5 mg/g). During 6 weeks of storing glucose contents still decreased to almost half. According to analyses the products did not contain glycogen. The mean contents of lactic acid ranged from 15.9 to 30.3 umol/g after cooking and were onthe same level after 6 weeks of storing at 6°C.
After cooking the pH-values of the products were higher than before cooking the differences also being significant in the centre of the products. During 6 weeks of storing at 6°C the pH-values did not change.
Sensory evaluation: The experimental products were not spoiled when evaluated by two laboratory workers after 2, 4 or 5 weeks of storing at 6°C. When they were evaluated after 6 weeks of storing by a panel the product groups of pH 5.5-5.9, >6.0 and the mixture of these two proved statistically "not spoiled" (Table 3). The products of the group of pH-value <5.5 were evaluated a little sour by many panelists. The reason may be high lactic acid bacterial count in the surface layer of the products 6 weeks old.

Conclusion

Meat raw-material of high pH-values did not affect spoilage more quickly in cooked meat products made from coarsely ground pork than meat raw-material of lower pH-values. After storing the total bacterial and lactic acid bacterial counts were even higher in the surface layer of the products made from raw-material of low pH-value affecting sourish taste in the products.

References

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Abstract

It was studied the effect of pH-value of meat raw-material on the keepability and bacterial counts of cooked meat products made of coarsely ground pork. Meat raw-materials with pH-values <5.5, 5.5-5.9, >6.0 and <5.5 + >6.0 (1:1) were used. The meat for experimental products was inoculated before cooking with heat resistant pseudomonads and streptococci. The surface of the products and the slices of the sliced products were inoculated with streptococcus strain isolated from the slime in vacuum sausage package.

Meat raw-material of high pH-values did not affect spoilage more quickly than meat raw-material of lower pH-values. Only the products of the group of pH-value <5.5 were evaluated spoiled by several panelists after 6 weeks of storing at 6°C.
Inoculated heat resistant streptococci and pseudomonads survived after cooking only in few experimental groups and disappeared during 2 weeks of storing at 6°C. During 6 weeks of storing at 6°C the mean total bacterial counts rose to the level of 6 log cfu/g in the surface layer of the products of pH-groups <5.5 and 5.5-5.9 while in the other two groups the mean counts only rose to the level of 5 log cfu/g. In the core of the products the mean total bacterial counts left under 4 log cfu/g.

Table 2. Thermal death of the Pseudomonas strain 7b2 in APT-broth (5 test series) and in coarsely ground cured pork (CCP) (4 test series) when heated just after inoculation (B) or after incubation for 24 h at 6°C after inoculation (B). Heating corresponded to the heat treatment used in cooking sausages.

Temperature, °C	Time, min	Cfu/ml in APT-broth A X	A s	B X	B s	Time, min	Cfu/g in CCP A X	A s	B X	B s
22	00	5.4	0.2	6.3	0.3	0	7.1	0.2	7.2	0.1
55	30	5.0	0.1	5.6	0.5	28	4.8	0.2	4.7	0.2
65	39	2.9	0.7	2.1	0.6	35	2.2	1.9	1.3	1.0
72	46	1.3	0.2	0.9	1.0	45	1)1		1)1	
72	51	1.4	1.6	2.4	0.9	50	1)1		1)1	
65	56					56				
55	66					62				
30	82	0.8	1.0	1.8	1.5	83	1)0		1)0	
6°C	1 d	0.3	0.5	1.6	1.8	1 d	1)1		1)0	
6°C	14 d	2)1		2)1		14 d	1)2		1)1	

Cfu = colony forming unit
X = mean
s = standard deviation of mean
1)= number of samples out of four ccontaining containing colony forming units 2 log cfu/g or more
2)= number of samples containing colony forming units

Table 2. Thermal death of the Streptococcus strain 7b1 in APT-broth (5 test series) and in coarsely ground cured pork (CCP) (4 test series) when heated just after inoculation (B) or after incubation for 24 h at 6°C after inoculation (B). Heating corresponded to the heat treatment used in cooking sausages.

Tempera-ture, °C	Time, min	Cfu/ml in APT-broth A X	A s	B X	B s	Time, min	Cfu/g in CCP A X	A s	B X	B s
22	0	6.8	0.2	7.1	0.7	0	7.6	0.4	7.7	0.4
55	30	4.9	1.1	4.4	2.1	28	3,5	0.4	3.5	0.4
65	39	3.2	1.9	3.0	1.8	35	2.5	0.9	2.0	0.8
72	46	2.9	1.9	2.1	1.3	45	2,2	0,2	1.4	0.4
72	51	1.7	1.8	1.4	2.1	50	1.2	0.7	1.0	0.4
65	56					55				
55	66					62				
30	82	1.7	1.7	1.0	1.1	83	1)1		1)0	
6°C	1 d	1.5	1.6	0.2	9.5	1 d	1)2		1)0	
6°C	14 d	2.5	3.3	0.0	0.0	14 d	1)0		1)0	

Cfu = colony forming unit
X = mean
s = standard deviation of mean
1) = number of samples out of four ccontaining containing colony forming units 2 log cfu/g or more
2) = number of samples containing colony forming units