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

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## SUMMARY

During cooking the pH-values rose approximately 0.3 units in the core of the products, while remaining unchanged in the surface layer. Meat raw-material of high pH-values did not cause quality deterioration of the products more rapidly than meat raw-material of lower pH-values. This cannot be due to pH-values approaching each other because the original pH-differences of different pH-groups did not change during cooking. Only the products of the group of pH-value <5.5 were evaluated as spoiled by several panelists after 6 weeks of storing at 6°C the obvious reason being the higher counts of lactic acid bacteria in this group compared to the other groups.

Inoculated heat resistant streptococci and pseudomonads survived after cooking in only a 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 remained below 4 log cfu/g. - It was concluded that the pH-value of meat raw-material does not have a significant impact on the rate of quality deterioration.

## Introduction

The meat products made from coarsely ground meat are heated to internal temperatures of 68-72°C. Despite that the quality sometimes deteriorates quite rapidly, and that holds true not only for the surface layer but also for the core. The bacterial flora as well as spoilage of this kind 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 these did not affect the rate of deterioration. The products were spoiled in the surface layer by lactic acid bacteria which obviously had contaminated the surface of the products. Addition of glucose to the product has not been found to affect spoilage (Petäjä 1994). Because it would be benefical to make the products in question from the high-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. Meat raw-materials with the pH-values <5.5, 5.5-5.0 >6.0 and <5.5 + >6.0 (1:1) were used.

## Material and methods

Manufacture of the products: Each experimental batch contained 4 kg pork, 20 g (0.5 %) glucose and 0.4 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 being $10^7$/g meat) was added as nutrient broth (Merck 5443) culture (0.2 l) and streptococcus inoculum as (the aim being $10^7$/g meat) APT-broth (Merck 10454) culture (0.2 l). The meat raw-material was coarsely ground with a 0-collar. Then the additives, water and bacterial cultures were added to the meat and the mixture was tumbled for 3 h at 6°C with pauses of 15 min/h. After the the first hour the tumbler was vacumized and the mixture was kept in vacuum for 0.5 h. After tumbling for 3.5 h the meat batch was stuffed into 90 mm fiber casings (Visko Light, OY Visko AB, Hanko, Finland). At least one chub was made for each storage 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 chilled for 50 min in a cold shower and then transferred to 6°C. During cooking and chilling the rise and fall of the temperature in the core, in the surface layer and in the cooking

chamber were registered with a data logger (Grant, Grant Instruments Ltd. Cambridge, England). The mean temperature profile is presented in figure 1. After being in the cooler for 24 h the products were packed in vacuum packages and stored at 6°C. Vacuum packages of slices were also made from each product group and these were also 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 the streptococcus strain survived after a 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 separately. The product was peeled and the surface layer sample of 0-2 mm in thikness was aseptically taken. The core sample was taken from the centre of the product after breaking the product in two parts so that the sampling area remained untouched. The following determinations were conducted: Total plate count of aerobically 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 (Statgraphics) in relation to pH-value of meat raw-material and time of storage.

Chemical studies: The amount of glucose and glycogen was 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.

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

Sensory evaluation: The keepability of the products was followed by two laboratory workers, who tasted the products after two, three, four and five weeks of storage. After six weeks of storing at 6°C the products were evaluated by a panel consisting of seven persons familiar with the sensory evaluation of meat products. The panelists tasted and smelled the product and evaluated the product as spoiled, possibly spoiled or not spoiled. The total number of "spoiled" and "possibly spoiled" evaluations in relation to the total number of evaluations was tested by using the paired test table to determine the 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; 4. mixture of groups 1 and 3 (1:1). Experimental series were conducted 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 the 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 both times only in one product group. Pseudomonads also survived in two experimental series, yet altogether in five product groups. However, both inoculated bacterial strains 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 were noticed also in the previous production scale studies of Petäjä and Puolanne (1993). However, according to the results of Petäjä (1991, 1992) the inoculated streptococci and pseudomonads survived in laboratory scale experiments. This disagreement will be monitored in the next phase of the study.

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 but were only occasionally 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 to below 1.0 log cfu/g during cooking. The counts rose only in the surface layer of the products during storage time of 6 weeks. The mean count of staphylococci + micrococci ranged from 3.5 to 4.3 log cfu/g before cooking. After cooking these bacteria seldom exceeded the count of 2 log cfu/g in the products. Before cooking Brochothrix thermosphacta randomly exceeded 2.0 log cfu/g whereas after cooking not once.

Bacterial growth in the vacuum package: Growth of streptococci inoculated on the surface of the 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 2). Between product slices inoculated with streptococci bacterial growth was first found 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 the added glucose content (5 mg/g). During 6 weeks of storing glucose contents further 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 on the same level after 6 weeks of storing at 6°C. The pH-values of the centre of the products were approximately 0.3 units higher after cooking than before cooking, the differences also being significant. The original pH-differences of different pH-groups did not change during cooking. During 6 weeks of storing at 6°C the pH-values did not change.

Sensory evaluation: The experimental products were not found to be spoiled after 2, 4 or 5 weeks of storing at 6°C when evaluated by two laboratory workers. On the other hand, 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 statistically proved to be "not spoiled" (Table 3). The products of the group of pH-value <5.5 were found a little sour by many panelists, the obvious reason for this being high count of lactic acid bacteria in the surface layer of the 6 week old products.

## Conclusion

The use of high-pH meat as raw material for meat products made from coarsely ground pork did not lead to more rapid spoilage of these products than using meat of lower pH-value. This cannot be due to pH-values approaching each other because the original pH-differences of different pH-groups did not change during cooking. After storing the total bacterial and lactic acid bacterial counts were, as a matter of fact, higher in the surface layer of the low-pH-products than in the other product groups causing sourish taste.

## References

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Figure 1. Temperature profile of cooking and chilling of experimental products.

Table 1. Total count of aerobically growing bacteria (log colony forming units/g = cfu/g; plate count agar) in cooked meat products made from coarsely ground meat before and after cooking (0) and during storing for 6 weeks at 6°C.

Table 2. The appearance of bacterial growth (number of samples) in vacuum packages of whole products (P) and between slices packed in vacuum (S). The packages were stored at 6°C.

Table 3. The number of "not-spoiled" evaluations on experimental products in different experimental series after storing for 6 weeks at 6°C ("not-spoiled evaluations/total number of evaluations).