Some observations on the bacterial growth in sliced, vacuumpacked ham in relation to pH of the product.

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Introduction

The general effect of pH on the growth of bacteria is well-known. However, within the pH variations which normally occur in meat products, and especially those added phosphate, very little information is available regaring any effect on the growth of bacteria as related to pH.

It has been shown that some phosphates in themselves have antimicrobial properties. Kelch and Bühlmann (1958) studied the effect of two commercial polyphosphates on the growth of S.aureus, Str.faecalis, B.subtilis, and Cl. bifermentans, and reported an inhibitory effect caused by the polyphosphates when these were incorporated in media in concentrations ranging from .5 to 1%. Elliott et al (1964) found extended shelf life of broilers, if they were immersed overnight at 1°C in 3 to 8% solutions of polyphosphates before storage. Similarly, Kitchell (1971) found considerably lower bacterial numbers on matured bacon sides pumped with polyphosphates than if polyphosphates were not added to the pickle. However, he failed to show any extended shelf life when he stored vacuumpacked bacon or whole bacon sides, where polyphosphates had been added during production.

Mead and Adams (1979) also found an antimicrobial effect, when chicken carcasses were treated with polyphosphates. They found a change in growth rate and composition of the flora of chilled chickens when they stored the carcasses at 1° and 10°C. Especially the lag phase of the growth cycle was prolonged.They used "Puron", a commercial preparation, and it seemed mainly to affect the growth of gram positive bacteria, whereas cold tolerant coliforms appeared to be more resistant against the polyphosphate treatment.

In a survey by Hargreaves et al (1972) it is pointed out that there seems to be a lack of systematic results which shows the antimicrobial spectrum and overall effect of the various phosphates and polyphosphates. With reference to the above quoted authors it is unquestionable that at least some of the polyphosphates possess antimicrobial properties, but although phosphates and polyphosphates are widely used as food additives for other reasons it seems indicated that the future use to a greater extent should consider their influence on the bacterial behaviour.

Experimental

When using phosphates for the production of cooked hams it is worth remembering that the more the pH in the raw material deviates from "normal", the greater the pH change will be in the final product. The following example shows this (Zeuthen, 1969)

3 groups of raw hams were selected based on differences in pH. The hams were manufactured as cooked hams, and during production all 3 groups were added about .4% tripolyphosphate. pH measurements of selected muscle groups in the raw materials and the final, sliced product showed the following results:

Measured muscle group as raw material	Group A		Group B		Group C	
	Average	s.d.	Average	s.d.	Average	s.d.
M.gluteus	5.5	.10	5.7	.17	6.2	.32
M.adductor,gracilis, and semitendinosus	5.6	.13	5.9	.16	6.5	.21
M.biceps femoris	5.5	.09	5.7	.13	6.4	.28
M.semitendinosus	5.5	.08	5.8	.14	6.4	.29
Sliced ham manufactured from above raw materials	6.0	.03	6.1	.03	6.4	.04

Table 1. pH measurements of raw materials and corresponding final products.

It is worth noting that not only did the addition of polyphosphate increase the pH in raw materials of low or normal pH, as expected, but the variations in results also decreased in all cases.

In the investigation regarding the bacteriological work reported here,two lots, each comprising of 12 hams were used. The hams were selected according to the ultimate pH of the raw materials, aiming at about pH 5.5-5.7 in the one lot, called I, and at about pH 6.3-6.5 in the other lot, called II.

Two separate batches of canned, pasteurized hams were manufactured from the raw materials. After trimming and boning the hams were multineedle pumped with a pickle containing sodium tripolyphosphate, massaged, canned,and cooked to a center temperature of about 70°C. After chilling the hams were sliced and vacuumpacked. During slicing every 10 slice was removed for chemical analyses for content of sodium chloride, moisture, nitrite, protein,and phosphate. The vacuumpackages were stored at 5°C, but were moved to room temperature for a quarter of an hour every working day, and transfered from one basket to another to simulate handling. Twice a week 2 packages from each lot were examined bacteriologically for total counts on Plate Count Agar added 5% blood serum and 4% sodium chloride. In connection with this,pH measurements of the hams were also made.

Results and discussion

Table 2 shows the results of the chemical analyses. It will be seen that with regard to the salt/water ratio the difference between the two lots is negligible although, as expected, the moisture content of the hams with high pH was higher than in the other lot. Also, the initial content of sodium nitrite was higher in the lot with high pH, although the same amounts of nitrite had been added to both lots during curing.

Lot no.	% NaCl		% Moisture		salt/water %		ppm $NaNO_2$		% protein		% added P	
	av.	s.d.	av.	s.d.	av.	s.d.	av.	s.d.	av.	s.d.	av.	s.d.
I (low pH)	2.91	.17	71.62	.80	4.07	.20	38	8	21.42	.58	.50	.01
II(high pH)	2.94	.16	74.39	.66	3.96	.21	90	12	19.59	.61	.52	.08

Table 2. Results of the chemical analyses of the two lots of ham used for the storage experiment.

To correct for the natural content of phosphate in meat the total phosphorous content has been corrected as follows: % total phosphorous -(.0106 x %protein) equal to % added phosphorous. (Mikkelsen,1967).

The results of the pH measurements are shown in figure 2. In similar investigations of sliced, processed meats not added phosphates (see e.g. Luke 1978) the pH usually drops during storage, but here the pH remains fairly constant.

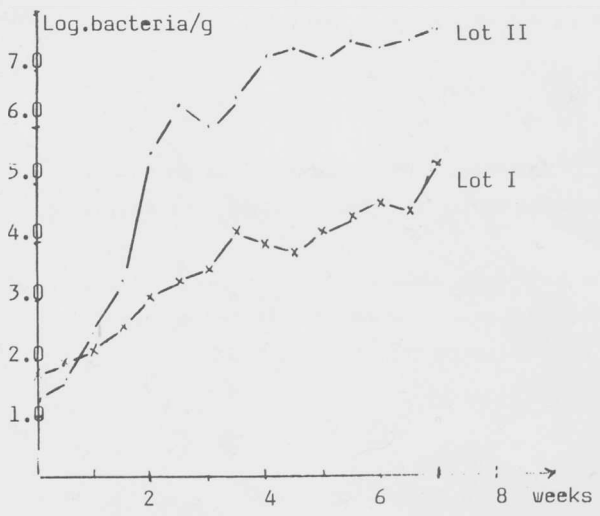

Figure 1. Total numbers of bacteria per gram in sliced ham during storage at 5°C

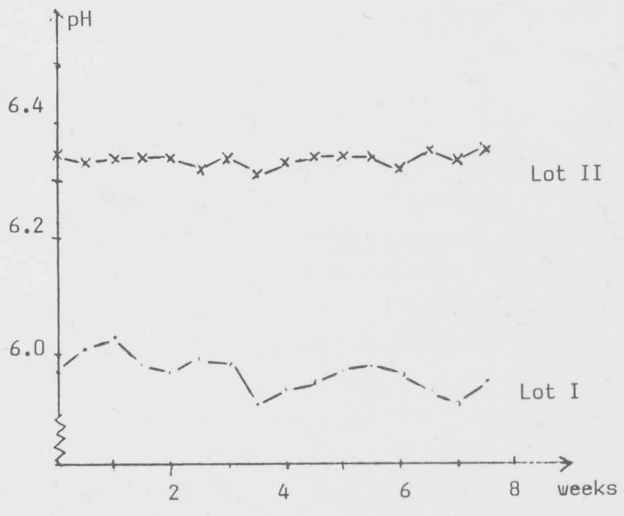

Figure 2. pH during storage.

Figure 1 shows the results of the bacterial examinations. It can be seen that in accordance with that there is a difference in pH between the two lots throughout storage, there is also a difference in bacterial numbers during the storage period, although the initial numbers in the packages initially were essentially the same. The results were not correlated with any formal sensory evaluation, but apart from a slight off-odour which

always is detected immediately upon opening of packages of sliced ham after two to four weeks of storage, no true unacceptability was found during 7-8 weeks' storage.

As earlier mentioned, information in the literature indicates that polyphosphates seem to have some influence on growth, not only on pathogenic bacteria, but also on several species of gram positive spoilage bacteria. However, in the present investigation the same polyphosphates were used, virtually in the same amounts, so pH seems to be the only factor in the two lotsof ham which could be able to influence the growth of the spoilage bacteria. It therefore seems justified to conclude that even with differences in pH as small as found here, there is a difference in bacterial viability during storage of sliced ham. Such differences in pH within the normal variation of pH in meat and meat products are often overlooked, when evaluating the factors which influence the shelf life of sliced meat products.

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