Effects of sodium lactate addition on lactic acid bacteria and especially ropy slime formers in vacuum-packed grill sausages

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SUMMARY

Lactic acid bacteria cause the spoilage of vacuum-packed cooked meat products. Among lactic acid bacteria certain ropy types have drawn special attention because of their unpleasent appearance. In this work we report the effect of sodium lactate addition on ropy slime formers and the bacterial spoilage in general in vacuum-packed grill sausages.

In order to monitor the effects of sodium lactate addition grill sausages were manufactured in commercial scale meat plant. The reference sausages were produced according to the normal grill sausage recipe and the 'treated' sausages contained 1,5% sodium lactate. Half of both lots were inoculated with pooled ropy inoculum containing 25 ropy strains. The other half harvested its inoculum naturally because of the post-cookery surface contamination of the sausages in the meat plant. The packages were stored 21 days at +6±0,5°C. They were checked visually for ropiness and their bacterial counts were determined (APT-agar, Merck, incubated 20°C 3 days).

1,5% sodium lactate addition did not affect the bacterial counts in case of naturally harboured inoculum, but it had a statistically significant and practically detectable effect on ropy slime formers. The percentage of ropy strains among the total bacterial flora was clearly diminished.

INTRODUCTION

Lactic acid bacteria dominate the bacterial flora and finally cause the microbiological spoilage of vacuum-packed sausages (Mol et al 1971, Egan 1983, Korkeala et al 1985). Additionally the ropy slime formation has caused infrequent, but annoying spoilage problems in Finnish meat industry over a period of 5-6 years. The most striking feature of the spoiled sausages is their unpleasant appearance. This ropiness is caused by post-cookery surface contaminants, which continue to grow on the sausage surfaces and in the liquid released from sausage materials under vacuum.

Korkeala et al. (1989) have already shown that the ropiness is caused by lactic acid bacteria belonging to the genera Leuconostoc and Lactobacillus. This finding is confirmed by the isolates collected during 1988-91 in our laboratory.

At the moment the major concern is how to inhibit these ropy bacteria. Here we report the effects of 1,5% sodium lactate added into Finnish grill sausages.

MATERIALS AND METHODS

The grill sausages were produced in a commercial scale meat plant. The reference sausages (100 packages) were made according to the routinely used grill sausage recipe. The 'treated' sausages (100 packages) differed from references only by their sodium lactate contents, which was 1,5 % of wet weight.

Half of both sausage batches were moved to storage conditions without delay. They harvested the normal lactic acid bacteria of the meat plant. The other half was inoculated with ropy lactic acid bacteria in our laboratory.

The test strains were 25 ropy lactic acid bacteria strains, which were isolated from ropy sausages of the meat plant during the year 1991. These isolates were cultured in APT-broth (Merck) 25°C for 24 hours and pooled together and diluted to buffered peptone water (Merck), which was used to inoculate the sausages. The final ropy inoculum was on average 20 cfu per package.

The sausage packages were stored at +6,0±0,5°C. The maximum storage time was 21 days. The bacterial counts were determined (APT-agar, Merck, 20°C 72 h) from the free liquid phase of three packages pooled together. Always two parallel sets of pooled samples were examined. The packages were checked visually for ropiness.

In order to determine the percentage of ropy slime formers among the bacterial population random isolates, 40 per each sample were collected, purified and sub-cultured in APT-broth 25°C 24 h and inoculated to vacuum-packed freshly sliced, emulsion type cooked sausage. After 10 days incubation at +6,0±0,5°C the packages were opened and checked visually for ropiness.

RESULTS AND DISCUSSION

1,5% sodium lactate did not affect the bacterial counts of the sausages in case of natural inoculum (figure 1 and table 1.). In the second set of sausages, inoculated with ropy slime forming bacteria, the growth of 'total bacteria' was slowed down (figure 2.) and the difference caused by sodium lactate addition was statistically significant (table 2.).

The visual ropiness data of the inoculated sausage packages are summarized in table 3. None of the uninoculated packages became ropy during the experiment. The percentage of ropy slime forming bacteria in the population was significantly influenced by the addition of sodium lactate (figure 3 and table 4).

1,5% addition of sodium lactate slowed down the growth of ropy slime forming lactic acid bacteria. When the contamination level was low, 20 ropy cfu per package, which was the case in our experiment, the first signs of ropiness were detected after 14 days in sausages without sodium lactate. The sodium lactate containing sausages were classified weakly ropy on th 21st day, i.e. 7 days later.

The slime producers first appeared among the isolated strains after 14 days in the normal sausages. In lactate sausages the proportion of ropy strains was still too small to be observed among 40 isolates after 21 days. This result indicates that visual ropiness can be caused by less than 2,5%, less than 1 out of 40, bacterial strains beeing ropy.

CONCLUSIONS

Although sodium lactate could not inhibit ropiness totally, it had a clear inhibitive effect. Therefore it is worth further trials. Studies with combinations of stress factors like sodium lactate and gas atmosphere for example are needed. Korkeala et al (1991) have already shown that gas athmosphere inhibits ropiness, but again not completely.

In Debevere's experiment (1989) 1-2% sodium lactate addition prolonged the shelf life to vacuum-packed coarse liver pâté, which was normally spoilt by psychrotrophic lactic acid bacteria. The inhibitive effect of sodium lactate on Leuconostoc mesenteroides, Lactobacillus casei var. rhamnosus and Streptococcus faecalis has been shown by de Wit and Rombouts (1990) too. In their work sodium lactate level was 5% and sodium lactate was shown to lengthen the lag phase and besides diminish the the growth rate and lower the maximum number of bacteria in the stationary phase. In our experiment sodium lactate was not able to reduce the final bacterial counts.

The spoilage of cooked meat products is mostly caused by postcookery recontaminants and under vacuum the spoilers belong dominantly to the lactic acid bacteria, but for example Listeria monocytogenes is found occasionally. In comparison the spoilage caused by lactic acid bacteria, even the ropy types, does not carry any health hazard as far as we know. In order not to select new, less safe spoilage flora by using lactate, further studies are needed to evaluate the bacterial population kinetics 'disturbed' by lactate addition in vacuum-packed cooked meat products.

Figure 1. The logarithmic bacterial counts of the normal and 1,5% Na-lactate containing sausages with a natural inoculum

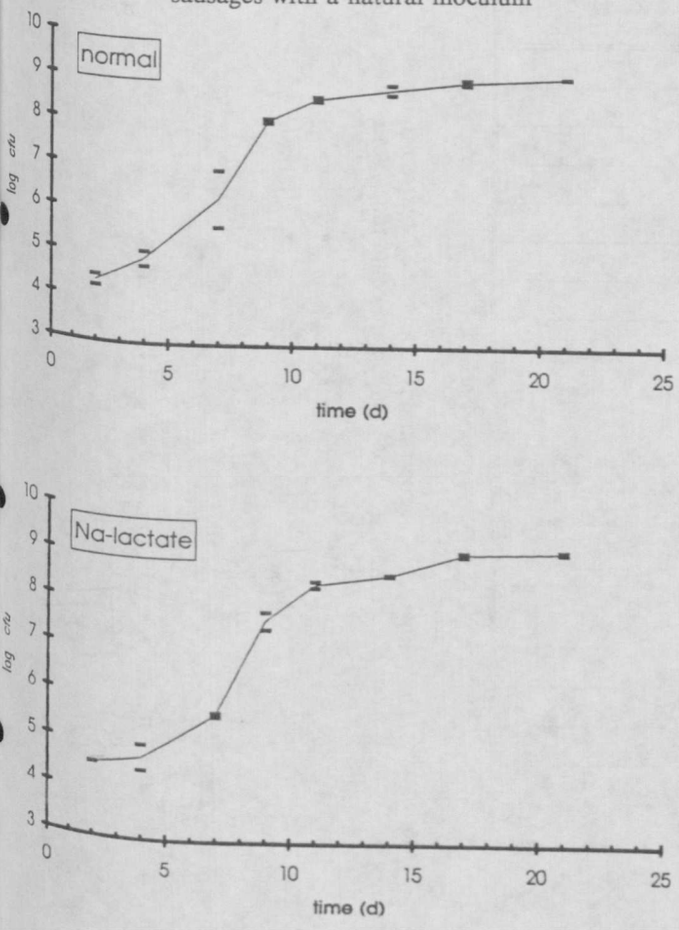

Figure 2. The logarithmic bacterial counts of the normal and 1,5% Na-lactate containing sausages with the ropy inoculum

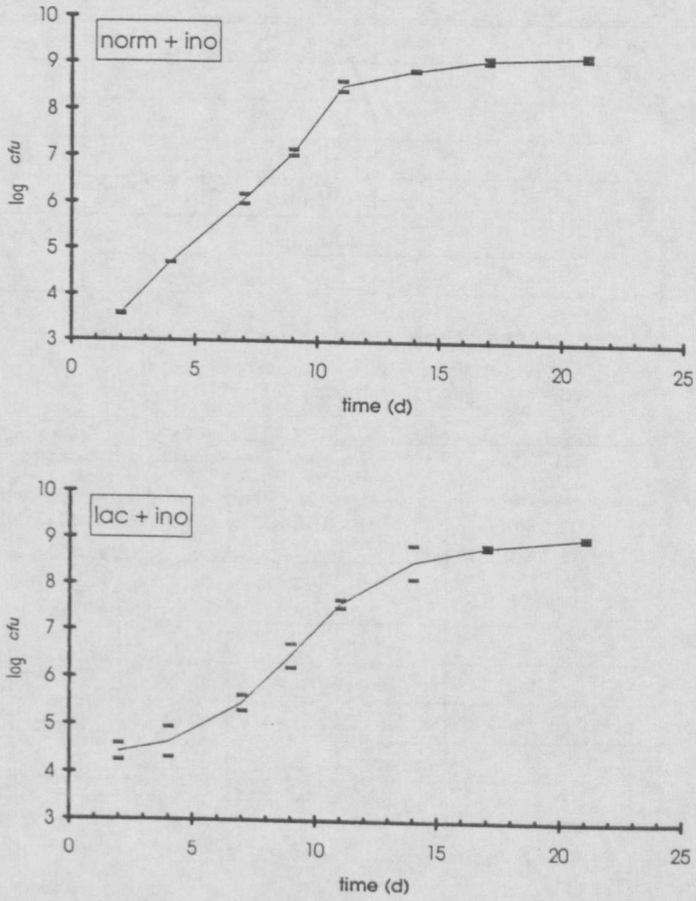

Table 1. Analysis of variance table for the logarithmic bacterial counts of grill sausages with natural inoculum.

SOURCE	DF	SS	MS	F	P
TIME (A)	7	105.53	15.076	201.47	0.0000
LACTATE ADD.(B)	1	1.8453E-01	1.8453E-01	2.47	0.1359
A*B	7	5.5412E-01	7.9160E-02	1.06	0.4322
PARALLELS (C)					
A*B*C	16	1.1973	7.4830E-02		
TOTAL	31	107.47			
GRAND AVERAGE	1	1725.2			

Table 2. Analysis of variance table for the logarithmic bacterial counts of grill sausages with ropy inoculum.

SOURCE	DF	SS	MS	F	P
TIME (A)	7	113.28	16.183	327.57	0.0000
LACTATE ADD.(B)	1	5.7165E-01	5.7165E-01	11.57	0.0036 *
A*B	7	1.9928	2.8469E-01	5.76	0.0018
PARALLELS (C)					
A*B*C	16	7.9046E-01	4.9404E-02		
TOTAL	31	116.64			
GRAND AVERAGE	1	1572.2			

Table 3. Detection of ropy slime in vacuum-packed grill sausages.

STORAGE TIME / DAYS	NORMAL GRILL SAUSAGES	GRILL SAUSAGES WITH 1.5% SODIUM LACTATE
2	0 / 6	0 / 6
4	0 / 6	0 / 6
7	0 / 6	0 / 6
9	0 / 6	0 / 6
11	0 / 6	0 / 6
14	1 / 6 (+)	0 / 6
17	4 / 6 (+)	0 / 6
21	6 / 6 (+++)	4 / 6 (+)

Example: 4 / 6 = ropy slime formation seen in four packages out of six
(+) = weakly ropy (+++) = abundantly ropy

Table 4. The proportions of the confirmed ropy strains among random isolates originating from the cultivated bacterial flora of the normal and 1.5% sodium lactate containing vacuum-packed sausages

STORAGE TIME X	ISOLATES OF LACT. SAUSAGES		ISOLATES OF NORMAL SAUSAGES		
	PROPOR TION	PERCEN TAGE P	PROPOR TION	PERCEN TAGE P	Y ARC SIN √P
9	0 / 40	0	0 / 40	0	0.000
11	0 / 40	0	0 / 40	0	0.000
14	0 / 40	0	2 / 40	5.0	12.9
17	0 / 40	0	3 / 40	7.5	15.9
21	0 / 40	0	7 / 40	17.5	24.7

Y = -20.8 + 2.186 X (r = +0.9758 **)

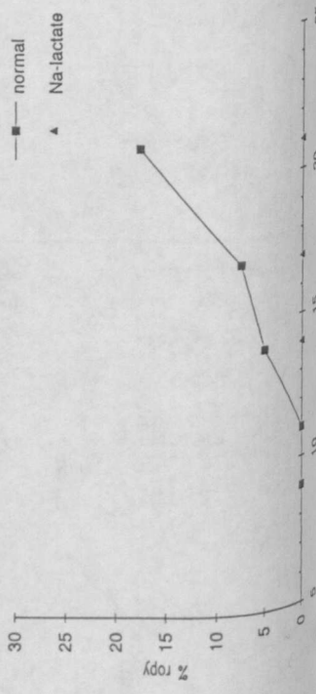

Figure 3. The percentages of ropy strains among the isolates originating from the normal and 1,5% Na-lactate containing sausages

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