Effect of carbon dioxide packaging on ropiness observed in meat products

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SUMMARY: Cooked sausages inoculated with ropy slime-producing lactobacilli strains A210 and C1 were packed in gas-impermeable bags of nylon polyethylene laminate and filled with CO_2. Vacuum packaged sausages inoculated with the same strains served as controls. Two levels of inoculation (40 or 7.0 x 10^4 bacteria per sausage) were used. The sausage packages were stored 4 weeks at 8°C before examination.

CO_2 packaging significantly reduced but did not totally prevent slime production. After the lower level of inoculation, CO_2 packaging reduced the lactic acid bacteria population as compared to vacuum packaging, and the pH decrease was lower in CO_2 than in vacuum packages. With the higher level of inoculation, no statistically significant differences were observed between CO_2 and vacuum packaging either in the lactic acid bacteria count or in the pH decrease. CO_2 packaging is thus not a solution to the ropiness problem.

INTRODUCTION: The formation of ropy slime on vacuum-packed cooked meat products has been a common spoilage problem in Finland for some years (KORKEALA et al., 1988). This phenomenon has been shown to be caused by lactic acid bacteria, and the most important strain seems to be a homofermentative Lactobacillus strain.

High concentrations of CO_2 in the gas atmosphere surrounding the meat have been shown to affect the development of the microbial spoilage population. CO_2 prolongs the shelf-life of meat by retarding especially the growth of the Gram negative spoilage population, but it also affects the growth and proportion of lactobacilli (ENFORS et al., 1979; BLICKSTAD and MOLIN, 1983; MOLIN, 1983). The present study was undertaken to investigate the effect of CO_2 on the formation of ropy slime on meat products.

MATERIALS and METHODS: Two ropy slime-producing lactobacilli strains A210 and C1 (KORKEALA et al., 1988) were used in the experiments. Forty cooked sausages were inoculated with strain A210 and 58 sausages with strain C1, and the sausages were packed (Multivac A300, Sepp Heggenmüller KG; Wolfertschwenden, FRG) separately in gas-impermeable bags of nylon polyethylene laminate (Wihuri Oy Wipak, Nastola, Finland). The bags were filled with CO_2. Sixteen and 24 vacuum-packaged sausages inoculated with the same ropy slime-producing strains served as controls. Two levels of inoculation (about 40 or 7.0 x 10^4 bacteria per sausage) were used for each strain. The sausages were stored for 4 weeks at 8°C.

After the storage period, ropy slime production was evaluated visually on the following scale: 0 = no ropy slime, 1 = weak ropy slime production and 2 = abundant ropy slime production. Lactobacilli population were determined on MRS-S agar according to KORKEALA and LINDROTH (1987). For MRS-S agar, MRS agar (Oxoid) was used as the base agar. The pH was measured from the homogenate.

Statistical analyses were carried out by the two-sample t-test using the Statgraphics program.

RESULTS and DISCUSSION: Strain A210 produced more ropy slime than strain C1 (Tables 1 and 2). This is in accordance with earlier findings that strain A210 is the most important strain causing ropy slime in vacuum-packed meat products (KORKEALA et al., 1988).

Table 1. Ropiness in CO_2 packed and vacuum-packed grill sausages inoculated with two ropy slime-producing lactobacilli strains (40 bacteria per sausage) after storage of 4 weeks at 8°C

Strain	CO_2 packaging			Vacuum packaging		
	Ropy slime formation[a]			Ropy slime formation[a]		
	0	1	2	0	1	2
A210	8/20[b]	10/20	2/20	0/8	0/8	8/8
	(40%)	(50%)	(10%)	(0%)	(0%)	(100%)
C1	4/24	20/24	0/24	1/10	1/10	8/10
	(17%)	(83%)	(0%)	(10%)	(10%)	(80%)

[a]0 = none, 1 = weak, 2 = abundant.
[b]Number of ropy packages/number of packages examined. Percentages in parentheses.

Table 2. Ropiness in CO_2 packed and vacuum-packed grill sausages inoculated with two ropy slime-producing lactobacilli strains (7.0×10^4 bacteria per sausage) after storage of 4 weeks at 8°C

Strain	CO_2 packaging			Vacuum packaging		
	Ropy slime formation[a]			Ropy slime formation[a]		
	0	1	2	0	1	2
A210	0/20[b]	10/20	10/20	0/8	1/8	7/8
	(0%)	(50%)	(50%)	(0%)	(13%)	(87%)
C1	5/34	26/34	3/34	4/14	1/14	9/14
	(15%)	(76%)	(9%)	(29%)	(7%)	(64%)

[a]0 = none, 1 = weak, 2 = abundant.
[b]Number of ropy packages/number of packages examined. Percentages in parentheses.

No other visible defects were observed on the sausages after storage than ropiness. CO_2 packaging significantly reduced slime formation compared to vacuum packaging after both inoculation levels used, but the effect was more pronounced after the lower inoculation level. Since the lactobacilli contamination level before packaging has been shown to be very low (MÄKELÄ and KORKEALA, 1987) the contamination caused by ropy slime-producing lactobacilli likewise must be very low. The use of CO_2 packaging therefore increases the shelf-life of cooked meat products contaminated by ropy slime-producing lactobacilli. However, CO_2 packaging does not totally prevent the ropiness problem, and the use of CO_2 packaging is not a real solution to the ropiness problem.

After the lower level of inoculation, CO_2 packaging decreased the lactobacilli population as compared to vacuum packaging (Table 3) ($p < 0.001$ with strain A210, $p = 0.08$ with strain C1). The shorter shelf-life of vacuum packaging compared to CO_2 packaging was also observed by GILL and PENNEY (1988). When the higher inoculation level was used the lactobacilli counts were very high in both package types (Table 4) and no statistically significant differences were observed between CO_2 and vacuum packaging.

Table 3. Mean log lactobacilli count and pH values in CO_2-packed and vacuum-packed grill sausages inoculated with two ropy slime-producing lactobacilli strains (40 lactobacilli bacteria per sausage) after storage of 4 weeks at 8°C

Strain	CO_2 packaging		Vacuum packaging	
	Lactobacilli count	pH	Lactobacilli count	pH
A210	6.20±1.60[a]	6.29±0.27	8.55±0.40	5.92±0.32
C1	6.94±1.36	6.25±0.15	7.76±0.72	6.12±0.17

[a] Mean±standard deviation.

Table 4. Mean log lactobacilli count and pH values in CO_2-packed and vacuum-packed grill sausages inoculated with two ropy slime-producing lactobacilli strains (7.0×10^4 lactobacilli bacteria per sausage) after storage of 4 weeks at 8°C

Strain	CO_2 packaging		Vacuum packaging	
	Lactobacilli count	pH	Lactobacilli count	pH
A210	8.73±0.90[a]	5.25±0.61	9.10±0.32	5.05±0.44
C1	8.14±0.94	5.92±0.29	7.97±1.04	5.92±0.25

[a] Mean±standard deviation.

The pH decrease was lower in CO_2 than in vacuum packages with both strains after the lower inoculation level (Table 3) ($p < 0.001$ with strain A210, $p < 0.05$ with strain C1). After the use of the higher inoculation level the pH decrease was great in both package types and no significant differences were observed between CO_2 and vacuum packaging (Table 4).

CONCLUSIONS: CO_2 packaging significantly reduces but does not totally prevent slime formation in vacuum-packed cooked meat products. The use of CO_2 packaging is thus not a real solution to the problem.

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