Evaluation of the efficacy of Lactic acid and Buffered Lactic acid on naturally contaminated pork carcasses during the slaughtering process.

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Abstract

The aim of this study was to evaluate the efficacy of Lactic acid (LA) and Buffered Lactic Acid (BLA) as a single treatment onto pork carcasses at the end of the slaughter line. According to literature, a bacterial reduction up to 3 Log can be achieved, but the highest reductions are generally observed with artificial contamination.

This on-site study measured the bacterial and commercial efficacy of spraying carcasses at the end of slaughter, just before chilling, at different concentrations (1 and 2% of LA, and 2% BLA) and temperatures (10 and 40°C). Bacterial contamination and sensory properties were evaluated on treated and untreated carcasses prior and following treatments, after 24h and 48h of storage. Aerobic colony counts and *Enterobacteriaceae* were enumerated on pooled samples from sites of the outside and the inside of each carcass. The overall bacterial reduction ranged from 0.1 to 0.8 Log, according to treatments, flora, and sampled area. Higher temperature or concentration did not clearly improve efficacy of LA, but reduced colour acceptability. BLA improved visual acceptance of treated carcasses but had a lower bacterial efficacy.

In our normal processing conditions, Lactic acid efficacy appeared to be limited for naturally contaminated carcasses.

Introduction

Lactic acid decontamination of pork carcasses has been studied for many years. According to literature, a bacterial reduction up to 3 Log can be achieved, but the highest reductions are generally observed with high concentration, temperature, exposure time and/or artificial contamination (Prasai et al, 1992; Van Netten et al, 1994, 1995; Jensen et al, 2002; Fabrizio et al, 2004). The highest bacterial reductions are generally negatively balanced by unacceptable deterioration of the organoleptic qualities and thus commercial acceptability of the carcasses.

The aim of this study was to evaluate the efficacy of Lactic acid (LA) and Buffered Lactic acid (BLA) as a single treatment onto pork carcasses at the end of the slaughter line, at different concentrations and temperatures. This on-site study measured the bacterial and commercial efficacy of spraying carcasses after 24h and 48h of storage.

Materials and methods

At the end of slaughter line in one French pigs slaughterhouse, an automatic on line system sprayed LA and BLA at different concentrations and temperatures on carcasses. A rinsing cabin with pump and hot water inlet, just before chilling, sprayed water for non-treated carcasses and LA or BLA for treated carcasses.

Preliminary experiments were conducted to validate concentrations and temperatures of treatments. LA concentration was limited to 1 and 2% in order to avoid irreversible colour changes of the carcasses. As BLA is generally considered to improve colour acceptability of treated carcasses, it was also tested at 2%. Hot water was investigated to evaluate a reported synergistic effect of temperature, warm water at 40°C was thus chosen to avoid thermal inactivation and significant heating of carcasses before chilling, and compared to water at 10°C.

For each treatment, i.e. the combination of different concentrations (1 and 2% of LA, and 2% BLA) and temperatures (10 and 40°C), 15 carcasses were tested in 3 periods.

Sensory properties and bacterial contamination were evaluated on treated and untreated (control) carcasses prior and following treatments, after 24h and 48h of storage.

Pork rind, fat and lean tissues were inspected by skilled person, and commercial acceptance of each carcass was scored (satisfactory, acceptable, unsatisfactory).

Sampling for bacteriological examination was carried out by destructive method : 5 cm² tissue samples were excised from 5 sites for the outside and 3 sites for the inside of each carcass. Aerobic colony counts (ACC) and *Enterobacteriaceae* (ENT) were enumerated on pooled samples from sites of the outside (Rind)

and the inside (Meat) of each carcass. For enumeration of Aerobic colony counts, diluted stomachates were plated on PCA during 48h at 30°C (NF V08-51) for AAC and on VRBG during 24h at 30°C (NF V08-54) for ENT.

Means of bacterial reductions (log_{10} CFU/cm²) from each treatment were calculated at 24h an 48h post treatment from initial contamination ; the evolution of untreated carcasses was also taken into account. Statistical analysis were conducted using the GLM procedure of 8.02 SAS software version (SAS Institute, USA).

Results and discussions

The efficacy of decontamination depended of initial contamination. In fact, the initial level of contamination influences the evaluation of decontamination, the less the level is the less the efficacy of decontamination can be measured. The main effect influencing decontamination was concentration, the other parameters were less or not significant. The temperature at 40°C had no significant effect on treatment and the interaction with concentration was not clear.

The evolution of ACC and ENT was calculated by difference between the contamination prior treatment (J_0) and the contamination at 24h (J_{24}) and 48h (J_{48}). This contamination was assessed using GLM means of 15 carcasses. For evaluating the efficacy of treatment, the evolution of control carcasses was subtracted from treated carcasses evolution. For example, for treatment LA 1% and 10°C, the evolution calculated at 24 h was:

(1) = ACC (J_0-J_{24}) treated carcasses - ACC (J_0-J_{24}) control carcasses

The levels of initial contamination for ACC and ENT were respectively 5,3 and 2,1 log_{10} CFU/cm² for rind, and respectively 3,9 and 1,4 log_{10} CFU/cm² for meat. The tables 1 and 2 present the efficacy of treatments for the two bacteria respectively on rind and on meat.

Table 1. Evolution (log_{10} CFU/cm²) of bacterial contamination on pork rind according to LA treatments

Treatment	ACC				ENT			
	0-24h		0-48h		0-24h		0-48h	
	10°C	40°C	10°C	40°C	10°C	40°C	10°C	40°C
LA 1%	0.54 (1)	0.38	0.26	0.52	0.49	0.87	0.22	0.19
LA 2%	0.28	0.35	0.52	0.48	0.26	0.96	0.44	0.66
BLA 2%	-0.11*	0.03	-0.05*	0.26	0.39	0.26	0.43	0.23

* the negative sign notices growth of bacteria

Usually, the treatments on rind (Table 1) decreased the contamination of ACC and ENT. The efficacy of treatment was better on ENT than on ACC, and the efficacy between 24h and 48h appeared to be equivalent for any concentration, temperature and bacteria. The BLA 2% had not effect on ACC.

The evolution of contamination on meat (Table 2) was contrasted. The temperature decreased the efficacy on ACC for all treatments but not on ENT. BLA 2% had more efficacy on meat than on rind.

The most efficient treatment was a LA 2% at 10°C solution which provided a reduction of 0,8 log_{10} CFU/cm² in average on the rind and on the meat. This reduction was in contrast with literature (2,5 log_{10} CFU/cm² on ACC, Prasaï and *al*, 1992 ; 1,4 log_{10} CFU/cm² on ENT, Van Netten and *al*, 1995). The slaughterhouse had spray chilling process during two hours before storage, the spray water could be diluted LA solution and decreased the efficacy of treatments.

Table 2. Evolution (log_{10} CFU/cm²) of bacterial contamination on pork meat according to LA treatments

Treatment	ACC				ENT			
	0-24h		0-48h		0-24h		0-48h	
	10°C	40°C	10°C	40°C	10°C	40°C	10°C	40°C
LA 1%	1.04	0.08	0.74	0.46	0.46	0.03	0.24	0.31
LA 2%	0.86	0.47	0.68	0.40	-0.01*	0.42	0.23	0.76
BLA 2%	0.58	0.25	0.26	0.69	0.01	0.16	0.17	0.53

* the negative sign notices growth of bacteria

Treatment with LA 2% and 40°C solution produced discoloration of meat and fat. This discoloration was particularly marked on fat, and 25 % of carcasses were unacceptable for sell. This discoloration appeared on collar with darkening of blood and fat. The treatment with BLA 2% and 40°C solution did not cause this discoloration.

In North America, slaughterhouses use decontamination with spray LA system but before treatment the carcass is washing on a specific cabin. This rinse enables spray more concentred BLA solution which improves decontamination efficacy and avoids discoloration.

Conclusions

Higher temperature or concentration did not clearly improve efficacy of LA, but reduced colour acceptability. BLA improved visual acceptance of treated carcasses but had a lower bacterial efficacy.

The temperature (40°C) in this study improved not efficacy of LA treatment. In literature, temperatures were higher than 50°C which could have had a bactericidal effect by heat.

In our normal processing conditions, Lactic acid efficacy appeared to be limited for naturally contaminated carcasses. However, the optimisation of use conditions has to be studied.

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