The role of animal origin and technological factors for the occurrence of destructured zones in cooked ham

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Abstract— **The aim of this study was to evaluate the importance of animal origin, slaughter and chilling process as well as processing and slicing technology for the occurrence of destructured areas in cooked hams.**

Two times 100 to 130 Large White or Pietrain crossbred pigs were slaughtered in two commercial abattoirs according to the routine procedures including CO_2 stunning. The animals were alternately shackled at the left or right hind leg. The left and right carcass sides of all four batches were then separately shipped to two different processing plants where cured cooked hams were produced according to the respective routine procedure.

The frequency and extent of destructured (PSE-like) zones was recorded in the raw *m. semimembranosus*; pH and temperature were measured at 45 min, 3 and 24 h p.m. in a subsample of about 30 % of all carcasses. During the slicing of the cooked hams the occurrence of moderate and severe destructured areas and the weight of slices sorted out due to this defect were recorded.

Animal origin, slaughter and processing all contributed significantly to the defect of destructured zones. Analysis of variance revealed that in this investigation, meat processing contributed the biggest part (>80%) to the problem of destructured zones in cooked hams. It is however, not yet clear, which the critical steps in the processing technology are.

Keywords— **cooked ham, destructured areas, PSE-like zones.**

I. INTRODUCTION

So called destructured zones in cooked ham still are a problem in the meat processing industry and cause appreciable losses [1]. Previous studies revealed that PSE-like zones in the *m. semimembranosus* may be a cause of or at least contribute to the defect of destructured zones in cooked ham [2] and thus could be avoided by preventing the formation of PSE-like meat in the centre of the hind leg [2, 3]. Beside the pragmatic but not always applicable approach to remove the inside of the leg in order to accelerate chilling of the inner part of the leg at an early post mortem stage, animal origin, slaughter process, and processing may contribute to the formation of PSE-like meat and further to the expression of destructured zones in cooked ham. Aim of this study was to investigate the extent to which those factors may be responsible for this defect.

II. MATERIALS AND METHODS,

Large White (sireline) x (Landrace x Large white, F1) (LWx) and Piétrain x F1 (Pix) pigs were used as model for animals of different genetic origins with a different susceptibility to produce PSE-meat. The animals were slaughtered at two abattoirs with different systems to bring the animals into the CO_2-stunning chamber and with different chilling regimens. The carcass sides were then shipped to two cooked ham processing plants in a way that these plants were provided with meat from exactly the same animals. This design was chosen to be able to experimentally separate and then compare the influences of animal origin, slaughter process and cooked ham production.

In abattoir A1 the animals are driven one by one, often using an electric prod, into the small cages for two animals, one behind the other, of the CO_2-chamber. After stunning the carcasses go through a 12 min scalding and after further processing the carcasses are transferred directly to a storage chiller with a temperature of 2 °C. In abattoir A2 the animals are driven in groups of four to five animals more gently into the CO_2 cages and the carcasses go through a 7 min scalding and later through a blast chiller for 115 min at -5 to -15 °C with high air velocity. In the first run of the experiment 100 LWx and 130 Pix were slaughtered in abattoir A1; in the second run 100 LWx and 120 Pix were processed in abattoir A2. It was taken care that the animals were alternately shackled

at the left or right leg in order to randomize a potential effect of shackling, as always the left carcass sides were shipped to the one processor P1 and the right sides to the other (P2). Cooked hams were produced from the major muscles of the hind leg (i.e. inside, outside, knuckle, and rump) applying the routine procedures of the respective processors.

In about every third carcass pH was measured at 45 min, 3 and 24 h p.m. in the deep part of *m. semimembranosus* (SM) in the left carcass side (pH-Meter 1140, pH-probe LoT406-M6-DXK-S7/25, Mettler Toledo, Spreitenbach, Schweiz). During cutting and preparing of the meat, the insides (SM, and related muscles) in which pH had been measured were judged for occurrence and degree of PSE-like zones as described elsewhere [2].

During slicing of the cooked hams, the degree of destructured areas was judged in the visible slices on top of each portion, considering the whole portion as affected, and expressed as g/kg medium or severely destructured areas for every block of ham separately.

The statistical analyses were done using the NCSS 2007 package (NCSS, LLC, Kaysville, Utah) applying GLM analysis of variance with origin of the animals, abattoir, and shackling as fixed effects for the traits recorded at the individual animals and the raw meat. For the analyses in cooked ham, origin of the animals, abattoir, and processor were used as fixed effects.

III. RESULTS AND DISCUSSION

Carcass weight and lean meat content of the animals of both origins were in the common range of commercial finishing pigs in Switzerland. LWx showed slightly higher lean meat content than Pix, which is most probably due to low backfat, while the Pix nevertheless were more heavily muscled as also observed in a former study [2].

Table 1 Carcass weight and lean meat content

Abattoir	A1		A2	
animal origin	LWx	Pix	LWx	Pix
n	100	130	100	120
carcass weight	83.6	86.4	87.3	83.9
Lean meat content	57.1	56.5	57.5	57.1

Pix showed a faster pH decline with a mean pH at 3 h p.m. already close to the ultimate pH of LWx, which remained higher than the ultimate pH of Pix (Tab. 2). Comparing the abattoirs, pH decline was faster in A1, while ultimate pH was slightly higher, indicating a more stressful environment than in A2. Shackling only tended to affect pH in the SM with a slightly faster pH decline in the shackled leg, while ultimate pH was not affected at all.

Table 2 pH in the deep part of *m. semimembranosus*

	animal origin			abattoir			shackling		
	LWx	Pix	p	A1	A2	p	N	Y	p
45’	6.46	6.31	0.00	6.34	6.43	0.00	6.42	6.36	0.06
3 h	5.83	5.56	0.00	5.66	5.77	0.01	5.75	5.68	0.12
24 h	5.52	5.46	0.00	5.51	5.47	0.04	5.49	5.49	0.91

As expected from the faster pH drop, Pix showed a higher incidence of severe PSE-like zones in both abattoirs (Fig. 1 upper part). In abattoir A1 about 10 % of the LWx also formed severe PSE-like zones while under the obviously less stressful conditions at A2 no severe PSE was detected in LWx.

When it comes to the cooked hams, the products of processor P2 hardly showed any severe destructorations and overall only a low incidence of destructured areas - fairly independent from the source of the meat in terms of animal origin or abattoir (Fig.1 lower part). In contrast, the cooked hams produced by P1show about 15 % of severely destructured areas even when meat with a low proportion of PSE like zones had been processed. When the meat from Pix, slaughtered under the unfavourable conditions at abattoir A1 was used, more than 25 % of the cooked ham slices expressed the defect of severe destructuration.

Analyses of variance revealed that animal origin and abattoir significantly affected the extent of destructured areas in the cooked hams. However, in this study 55 % of the medium and more than 80 % of the severely destructured areas in the cooked ham may be explained by the different processing technologies.

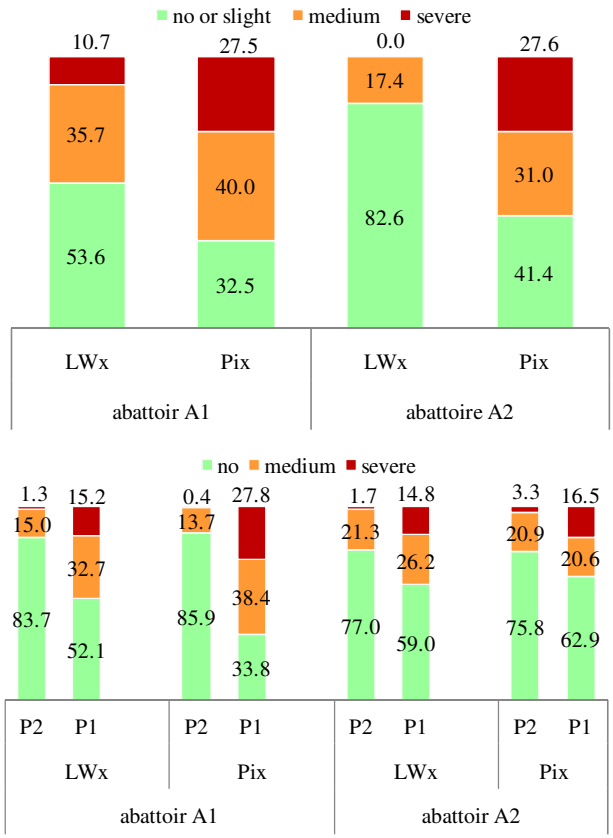

Fig. 1 Degree of PSE-like zones in the *m. semimembranosus* from pigs of different origin slaughtered in two abattoirs (upper part) and the extent of destructured areas in cooked ham slices produced from the meat of these animals

Table 3 Proportion of the variance of medium and severely destructured areas in cooked ham explained by the model and the fixed effects

degree of destructured area	medium	severe
animal origin	0.1	4
abattoir	3	1.3
processing	55	83
model	63	85

IV. CONCLUSIONS

Animal origin and disposition in terms of e.g. breed, stress susceptibility, and carcass conformation as well as slaughter technology including animal welfare relevant issues may influence the incidence of PSE-like meat in the leg and therefore destructured areas in cooked ham. In this study, however, these factors explain only a small part of the problem of the destructured areas in cooked ham. Where this defect causes losses above 2 to 3 %, possibilities to improve the processing technology deserve highest attention.

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