The quality of dry-cured-smoked ham from different pig cross-breeds and RN-genotypes

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Background

Introducing Hampshire into the Swedish two-way crossbred pig (Landrace x Yorkshire) in the late 70s increased the meat quality, not only was the stress-related PSE-frequency lowered but pure-bred Hampshire was also found to produce more tender and juicier meat (Fjelkner-Modig & Persson, 1986). The Hampshire breed has also been found to be associated with the dominant RN-gene (Naveau, 1986) characterised by a high glycogen content and a low ultimate pH. These meat properties will, in the case of cooked ham, cause lower yields (Monin *et al.*, 1987). But in French dry-cured ham, the process time was shortened and a higher intensity of dry ham and cured meat aroma was obtained (Buscailhon *et al.*, 1994 and 1995). However, in Sweden cured ham, both smoked and cured, is more common than only dry-cured. So far no study has been undertaken, in which the influence of different pig cross-breeds on the quality of dry-cured -smoked ham has been compared.

Objectives

The purpose of this investigation was to study the effects of using hams from pigs of different cross-breeds on the quality of dry-cured-smoked ham.

Methods

The material in this study consisted of crossbred pigs of Swedish Landrace (L) and Yorkshire (Y) sows and pure-bred boars of Swedish Hampshire (H), Yorkshire or Duroc (D) or crossbred boars of Hampshire and Yorkshire (HY). All pigs were reared on the same farm. The LYH-pigs were typed as RN^- carriers and non-carriers (based on the glycogen content). Ten pigs from each cross or genotype: LYH (RN^-), LYH (rn^+rn^+), LYY, LYD and LYHY were selected for the processing of dry-cured-smoked hams. This type of ham consists of the muscles *M. Biceps femoris, M. Quadrceps Femoris, M. Semitendinosus* (ST) and *M.Gluteus Medius* (GM). The pH was measured in BF before processing (2 days post-mortem) and after processing using a Knick Portamess 652 and xerolyte-electrode. The processing was done in a commercial plant and all hams were frozen on the third day after slaughter in order to collect all the material before starting the ham production. The thawed hams were dry-cured with a mixture of salt and starter culture (BIOBAK, Wiberg) for 4 weeks at 2-4 °C. The hams were kept at 4-6 °C for 14 days and then smoked at 25 °C. The drying process was carried out at 18 °C and a relative humidity of 85 % for approximately 14 days or until the hams had lost 30 % of their weight. Lightness (L*), redness (a*) and yellowness (b*) were measured in the QF muscle of the processed ham using a Hunterlab Color Quest-instrument (CIELAB (1976) colour scale; illuminate D65; 10° standard observer; 25 mm measuring aperture). The average from four measurements across the surface of a slice of QF was used. The pure protein content and the non-protein nitrogen (NPN) were analysed according to Barnstein -Stutzer, in a 1 cm thick slice cut across the ham. Processed hams were kept vacuum packed at -1.5 C for a maximum of 2 weeks before sensory analysis. The hams were cut into 5 mm thick slices. Three slices from each ham were randomly served to the assessors. The panel, consisting of 15 members, judged the following parameters on a scale from 1 to 9 (1=no or very little; 9=very much): consistency, chewing-time, chewing residual, initial juiciness, ultimate juiciness, salinity, smoked flavour, taste intensity, acidity, off-flavour and overall impression. The results were statistically evaluated with SYSTAT (Wilkinson, Leland version 7.0) using Tukeys t-test and the Unscrambler (version 6.11) using PCA (Principal Component Analysis).

Results and discussion

The pH measured 2 days post mortem was lower in BF from LYH (RN^-) (pH=5.38) compared with the other crosses (pH 5.48 - 5.59) (Table 1). The difference was significant when comparing LYH (RN^-) with LYH (rn^+rn^+), LYY or LYD ($p<0.050$). After processing, the pH varied between 5.47 and 5.62 in all crosses and the difference in pH between the crossbreeds or genotypes was smaller and not significant. The hams from LYH (RN^-) had a lower content of pure protein and a higher content of NPN, compared with the rest of the crosses. The difference in NPN was significant when comparing LYH (RN^-) and LYD or LYHY ($p=0.012$ and $p=0.026$). Of the measured colour parameters, lightness (L*) and yellowness (b*) varied between the crossbreeds or genotypes whereas the redness (a*) did not (Table 2). The hams from LYH (RN^-) pigs were significantly lighter compared to LYH (rn^+rn^+), LYY and LYD ($p=0.025$; $p=0.032$ and $p=0.005$) and significantly more yellow than the hams from LYH (rn^+rn^+), LYY and LYD-pigs ($p=0.005$; $p=0.001$ and $p=0.006$). The correlation between the colour parameters and meat-quality parameters was evaluated using multivariate analysis using PCA. The variation was explained by 2 principal components (PC) to 45 %. From Figure 1, it can be seen that lightness correlated positively with glycogen (i.e. genotype) and NPN. The b*-value correlated negatively with pH and positively with glycogen. In Table 1, the weight loss during the salting and smoking process is shown. As can be seen, the weight loss during the salting and smoking process was higher for the hams from LYH (RN^-) compared with the other groups ($p\leq0.050$). The total weight loss during processing (i.e. including the drying stage) did not differ significantly between the crossbreeds or genotypes. But if the weight loss due to freezing and thawing was included, the weight loss was higher for carriers of the RN^--gene, compared with non-carriers (Table 1). Results from the sensory test evaluated using PCA are shown in Figure 2. The variation was explained by 2 PCs to 45 %. Consistency and juiciness (initial and ultimate) were positively correlated to each other and had a positive influence on the overall impression. Chewing time and chewing-residual correlated negatively to the overall impression. The parameters salinity, off -flavour and acidity were positively correlated to each other and negatively correlated to the overall impression. As can be seen from Figure 2, hams from LYH (both carriers and non-carriers of the RN-allele) were found on the right side of the plot in the direction of good overall impression, consistency and juiciness (initial and ultimate) and in the opposite direction of salinity, off-flavour and acidity. Hams from LYD were predominantly found on the opposite side. The hams from LYY and LYHY were not characterised by any specific sensory parameter. The two parameters: smoked flavour and off-flavour were the only sensory traits significantly influenced by cross-breed or genotypes (Table 2). Smoked flavour was significantly lower in LYH (rn^+rn^+) compared with LYD ($p=0.010$) and off-flavour was

significantly lower in LYH (RN^-) and LYH rn^+rn^+ compared to LYD ($p=0.012$). It is interesting to note that both genotypes of LYH had lower off-flavour and smoked flavour compared with the other crosses. Considering the overall impression, both genotypes of LYH received the highest scores followed by LYHY and the lowest scores were obtained by LYD and LYY. The results indicate that the Hampshire-breed (both genotypes) has a positive influence on the eating quality of dry-cured and smoked ham.

Conclusions

The hams from LYH (RN^-) had a higher NPN content, were lighter, more yellow and had a higher weight loss during the salting and smoking process, compared with LYH (non-carriers of the RN^--gene), LYY, LYD and LYHY. The eating quality of dry-cured and smoked ham was, according to the overall impression, better in the two genotypes of LYH, compared with the other crosses. Both genotypes of LYH also had a lower off-flavour and smoked flavour compared with the other crosses.

References

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Table 1. Differences in meat quality traits in dry cured-smoked ham from different crossbreeds or RN-genotype (mean ± standard errors, n=10).

	LYH				LYY		LYD		LYHY	
	RN^-		rn^+rn^+							
pH_{BF} (2 d pm)	5.38^a	±0.03	5.55^b	±0.10	5.51^b	±0.06	5.59^b	±0.13	$5.48^{a.b}$	±0.12
pH_{BF} (processed)	5.47	±0.17	5.62	±0.13	5.55	±0.12	5.52	±0.10	5.52	±0.17
Pure protein (%)	22.18	±1.40	23.65	±1.57	22.63	±0.79	22.38	±0.99	22.22	±0.87
NPN (%)	0.73^a	±0.12	$0.68^{a.b}$	±0.06	$0.63^{a.b}$	±0.08	0.61^b	±0.06	0.62^b	±0.06
Weight loss (salt/smoking) (%)	9.8^a	±1.6	7.1^b	±2.8	6.7^b	±1.4	6.9^b	±1.7	$7.4^{a.b}$	±1.8
Weight loss (total) (%)	30.1^a	±1.4	27.3^b	±3.1	$27.9^{a.b}$	±1.9	$27.9^{a.b}$	±1.1	27.5^b	±1.2

Means within a row with different superscripts are significantly different: $p \leq 0.050$.

Table 2. Differences in colour and sensory traits in dry-cured-smoked ham from different crossbreeds or genotypes (mean ±standard errors, n=10).

	LYH				LYY		LYD		LYHY	
	RN^-		rn^+rn^+							
L*	42.8^a	±2.8	39.4^b	±2.8	39.5^b	±2.3	38.7^b	±1.9	$41.5^{a.b}$	±2.5
a*	12.8	±1.3	13.1	±1.2	12.9	±0.7.	12.9	±1.1	13.4	±1.2
b*	10.3^a	±0.8	8.8^b	±0.7	8.5^b	±1.2	8.8^b	±0.8	10.1^a	±0.9
Smoked flavour	$6.29^{a.b}$	±0.34	6.21^a	±0.16	$6.44^{a.b}$	±0.18	6.58^b	±0.27	$6.44^{a.b}$	±0.22
Off-flavour	1.63^a	±0.26	1.63^a	±0.28	$1.91^{a.b}$	±0.27	2.00^b	±0.16	$1.71^{a.b}$	±0.23
Overall impression	5.12	±0.32	5.12	±0.21	4.85	±0.30	4.87	±0.21	5.02	±0.30

Means within a row with different superscripts are significantly different: $p \leq 0.050$.

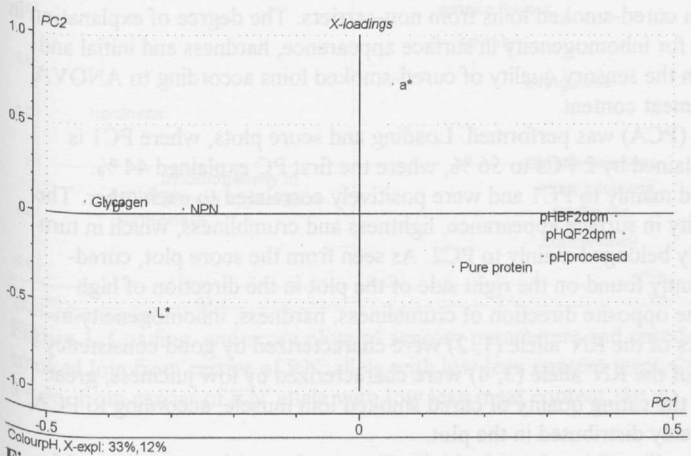

Figure 1. Loading -plot of colour and meat quality parameters in dry cured and smoked ham (R^2=45 % for 2 PC).

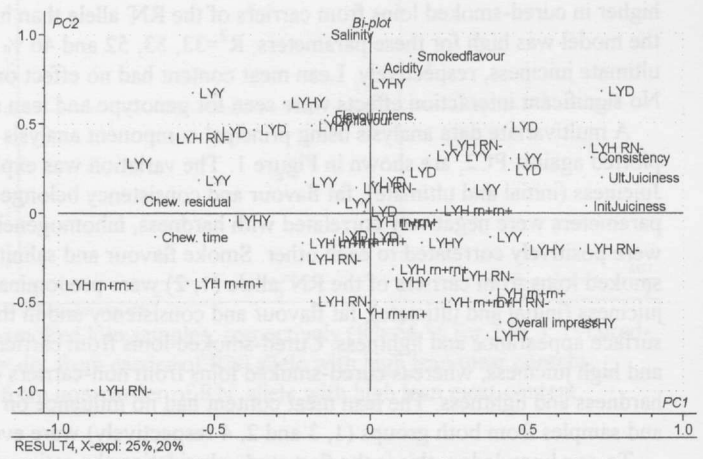

Figure 2. Bi-plot of sensory parameters and dry-cured-smoked ham samples (R^2=45 % for 2 PC).