INFLUENCE OF ULTIMATE pH AND BREED ON THE SLICING LOSSES OF HIGH-QUALITY COOKED HAMS TO BE SOLD PRE-PACKED

CHEVILLON P.*, BOULARD J.*, LE JOSSEC Ph.*, KÉRISIT R.*, SALAÜN Y.*, ALVISET G.** VIDAL E.***

* Institut Technique du Porc, Le Rheu, France ** Salaisons Fleury-Michon, Pouzauges, France *** Salaisons Elquin, Quintin, France.

S-VIB.02

SUMMARY

A study was conducted to evaluate the effect of both ultimate pH and breed on the slicing losses of high-quality cooked hams (without polyphosphate), intended for pre-packing. The breed comparison involved 3 types of terminal sires : Large White x Pietrain, Pietrain, and a synthetic crossbred boar containing Hampshire ; all sires were mated to Large White x Landrace sows. Meat quality was described by four classes of ultimate pH of the Semi-membranous : pH24 < 5,5 ; 5,5 < pH24 < 5,75 ; 5,75 < pH24 < 6,0 ; pH24 > 6,0.

960 cooked hams were processed, in two different plants, according to high quality ("Label Rouge") standards. At slicing, abnormal slices were sorted in 3 categories of observed defects : separation of the muscles in the slice, slice with hole, presence of areas with crumbly structure .

Technological yield was found to be highly related to the ultimate pH and to the total slicing losses. Meat color assessed either by reflectance or by means of the Japanese scale explained, to a lesser extent, the variations in the technological yield and slicing losses.

Breed differences showed a clear superiority of Large White x Pietrain or Pietrain terminal boars, for the technological yield and at slicing. This superiority is due to the lower results obtained on hams of pigs from synthetic crossbred sires with a low ultimate pH value (pH24 < 5.5), i.e. nearly one half of the pigs produced by this type of boar : these hams showed a low technological yield (86.2 % vs. 91.6 up to 101.5 % in the other categories) as well as high slicing losses (55.1 % vs. 11.1 % up to 25.3 % in the other categories). This is likely to be due to the RN- gene causing the so-called "acid" meat phenomenon. Thus, low pH meat (pH24 < 5,5), and especially "acid" meat is not suitable for making high quality cooked hams for pre-slicing and pre-packing.

1. Introduction

In order to satisfy meat processors requirements, many studies have been carried out on pigmeat quality, and more particularly on the cooking losses of hams : so were defined the notion of technological quality and its best criteria of estimation on fresh meat, i.e. the pH measurement 24 hours post mortem on the Semi-membranous muscle. But there were few studies about the more specific problems linked to the slicing of high-quality cooked hams intended to be vacuum-packed or pre-packed under modified atmosphere. At the supermarket, high-quality cooked hams are leader products of the delicatessen department and their level of sale has increased by 36 % in 1992 compared with a fall of 13 % for the normal-quality hams.

Because of meat processors observations and queries, a study was conducted to evaluate the influence of both pH and breed on the cooking yield and slicing losses of high-quality hams (without polyphosphates).

2. Material and methods

2.1. Sorting of hams

The breed comparison involved 3 types of terminal sires : Large White x Pietrain, Pietrain, and a synthetic crossbred boar containing Hampshire ; all sires were mated to Large White x Landrace sows.

Hams were chosen and sorted out in 2 slaughterhouses and over 13 days of slaughter for the first one, and 10 days for the second one (respectively from March 3rd to July 2nd 1992 and from November 3rd 1992 to April 7th 1993). Four classes of meat quality were determined according to the ultimate pH of the Semi-membranous muscle : pH24 < 5.5 ; 5.5 < pH24 < 5.75 ; 5.75 < pH24 < 6.0 ; pH24 > 6.0.

For each of the 3 breeds, batches of 30 to 40 hams were selected in each of the 4 classes of meat quality.

The animals slaughtered on Tuesday had their genetical type identified on Monday and checked by phone call to the breeders and to the breeding organizations. No animals from farms using artificial insemination were retained, in order to be sure of the exact genetical origin of every animal.

The day after slaughter, 30 to 40 carcasses of a given breed were marked when matching to one of the required categories of pH24 of the Semi-membranous muscle. Corresponding hams were then collected and carefully identified ; on the same day or the day after, these hams were sent to the processing plant.

2.2. Measurements operated at the processing plant

Hams were processed in two different plants. On Thursday, when receiving a batch of hams and before deboning, the following measurements were taken : - pH measurement on the Semi-membranous, the gluteus profondus and the gluteus superficialis ; - reflectance on the gluteus profondus and the gluteus superficialis ; - color assessed by the means of the Japanese scale (on the gluteus profondus and the gluteus superficialis).

Both plants produced a "Label Rouge" cooked ham, without fat or rind. The hams were trimmed according to "Label Rouge" standards by removing the gluteus profondus and the hind shank : in this case, the yield after trimming (i.e. the ratio of "trimmed ham weight" to "raw ham weight" x 100) is about 55 % compared to the 65 % usually observed. After "tumbling", the hams were cake-moulded into bars of 15 kilos then put in plastic bags, vacuum-packed and finally cooked.

Technological yield was obtained as follows :

$$TY = \frac{WCH}{WAT - \frac{WAT}{WAI}(WAC - WB)} \times 100$$

WCH = cooked ham weight
WAT = weight after trimming
WAI = weight after injection
WAC = weight after tumbling
WB = weight of the bars

$\frac{WAT}{WAI}$ (WAC - WB) is a correction to counterbalance the incidence, on the technological yield, of the non-used raw material when moulding the 15 kg-bars (in field conditions, there are no "losses" at this stage).

In both plants, bars of ham were sliced and vacuum-packed, four slices being automatically laid out in each thermo-shaped pack. The flow of two series of packs on each line was controlled by two operators (one on each side of the line) who checked the quality of slices before closing and weighing the pack. Abnormal slices were put aside in containers and weighed at the end of each experimental run.

In one plant, the various reasons for rejection were studied, allowing a record of the following weights :

- losses directly caused by the slicing process (i.e. the weights of end pieces, first and last cuts) ;
- slices with separation of the muscles in the slice ;
- slices with holes ;
- slices with a pastiness defect, i.e. slices presenting areas with crumbly structure instead of a smooth aspect.

In the other plant, elimination causes were not detailed.

In both cases, total slicing losses were calculated as follows :

$$\text{Slicing losses} = \frac{\text{Weight of all the rejected pieces}}{\text{Weight of the cooked ham bar}} \times 100$$

3. Results

3.1. Meat quality measurements

Variations in technological yield were highly explained by the ultimate pH in the Semi-membranous muscle ($R^2 = 0.66$), and to a lesser extent in the gluteus profundus ($R^2 = 0.66$), but poorly explained by meat color assessed by reflectance or by means of the Japanese scale ($R^2 = 0.18$ to 0.14).

Using an exponential model, variations in slicing losses were highly explained by the technological yield ($R^2 = 0.79$), well explained by the ultimate pH ($R^2 = 0.52$), and poorly explained by the Japanese scale ($R^2 = 0.26$).

3.2. Technological yield and slicing losses according to pH class and sire breed

For the three breeds, as the average pH level increased, technological yield increased (table 1) and slicing losses decreased (table 2).

Hams with pH24 < 5.5 from the synthetic crossbred breed had low technological yields and high levels of slicing loss. Compared to both other breeds for the same pH24 value, these hams had a 6 % lower yield and twice as much slicing loss. Hams from Pietrain had results similar to those from Pietrain x Large White breed.

Hams with pH of 5.5 to 5.75 from Pietrain and from synthetic crossbreds were not very different. On the contrary, hams from the Large White x Pietrain breed had a better technological yield (+ 4.4. %) and a lower level of slicing loss (- 3.5 % compared to the Pietrain and - 6.7 % compared to the synthetic crossbreds).

In the category of 5.75 to 6.00 pH values, all yields were increased, but hams from Pietrain had a slightly lower yield and a higher level of slicing loss.

Finally, in the high pH24 class, i.e. pH > 6.0, there was still an increase of yields and a decrease of slicing loss. But there were no hams from the synthetic crossbred breed in this category, as there is a low frequency of carcasses with high pH24 value in this population even when the animals wait for a long time at the slaughterhouse (in order to provide carcasses in this class of pH24, animals of each breed had been collected the evening before slaughter).

3.3. Analysis of slicing losses

The main reasons of slicing losses were detailed in only one plant and envolved 591 hams. Total losses varied from 9 % to 58 % according to pH and breed (table 3).

Losses linked to the process itself were approximately constant, between 4 % and 7 % ; the first and last cuts represented on average 2 % and 3 % respectively.

Variations in slicing losses depended therefore on raw material quality. Losses were particularly high for the synthetic

crossbred breed when pH was lower than 5.5, and to a lesser extent when pH was lower than 5.75.

Table 4 details losses related to raw material. For the three defects (i.e. separation of the muscles, holes, pastiness) the synthetic breed with pH < 5.5 had the highest level of losses. In this category of hams, pastiness was the main defect ; this is more likely to be due to the so-called "acid" meat phenomenon frequently observed in this breed rather than to P.S.E. meat related to halothane susceptibility.

4. Discussion

Our study confirmed, once again, that pH value is related to meat color and to technological yield. This relation had been previously shown in many reports (TEFFENE, 1968 ; JACQUET et al., 1984 ; GUÉBLEZ et al., 1990a and 1990b ; GUÉBLEZ, 1993). As for GUÉBLEZ et al. (1990a), our results allow us to conclude that pH24 measurement in the Semi-membranous muscle is still the best predictor for an objective evaluation of technological meat quality and, therefore, of the cooking yield of cooked hams without polyphosphates. In another report, CHEVILLON et al. (1994) implicitly agreed with our conclusion as they concluded colour measurement was unsuitable for checking the technological quality of raw hams at their entry to the processing plant. The difference of yield observed between the average yields of hams with low pH24 (< 5.5) vs. high pH24 (> 6.5) reached 10.6 % ; CARIOU et al. (1998) had found a similar difference of yield (9.85 %) between hams with pH24 < 5.5 vs. pH24 > 5.85.

Our experiment also asserted the influence of genotype on the ultimate pH and technological yield, and more particularly the consequences of the so-called "Hampshire effect" previously reported by MONIN et al. (1984) : the unfavourable RN- gene, responsible for this "Hampshire effect", results in the so- called "acid" meat phenomenon i.e. meats with very low ultimate pH inducing very high cooking losses. BARTON-GADE (1987) in Denmark, and more recently KRIETER and KALM (1991) in Germany had obtained similar results in Hampshire populations : the latter authors recorded a technological yield 6 point lower for hams from Hampshire vs. hams from purebred Pietrain ; hams from purebred Large White had a 5 point higher yield than hams from Pietrain.

In our study, hams from the synthetic crossbred breed got lower results mainly in the category of pH24 < 5.5, but the disadvantage was increased precisely because of their high frequency in this class of pH24, directly due to the RN- gene.

Slicing losses measurements were carried out under industrial conditions. Sorting of defective slices was mainly influenced by two criteria :

- staff ability : operators permanently assigned to these lines improve the regularity of their checkings, which was the case in one plant ; - average quality of products : operators spontaneously tend to counterbalance differences in the quality of the bars of ham by their level of refusals ; i.e. slices from a good-quality bar would be rejected because of a slight defect when other slices, even very damaged, from a poor-quality bar would be accepted.

The good correlation between cooking yield and slicing losses was clearly evident in our experimentation (-0.89 with the exponential model ; -073 with a linear regression). Low cooking yields resulted in high slicing losses : 35 % of losses were observed in average for a 90.10 % technological yield vs. 11.3 % for a 100.7 % technological yield. For a meat processor, this represents an important economic loss when processing low pH24 hams i.e. with both cooking and slicing losses. For those reasons, economic penalities (such as refusal of goods, eviction of suppliers, financial penalities amounting to 2 or 3 F per kilo) are sometimes duly applied by meat processors who systematically control the quality of raw material at receipt.

Some meat processors have already faced this quality problem by refusing hams in the category of pH24 < 5.7. Truly enough, higher classes of pH24 give better technological and slicing yields as well as more homogeneous and less bicolored slices, but as a consequence the average price of raw hams in these classes should be higher. Actually, a fair price should be based either on the average pH of a delivered batch of hams or on their frequency per pH24 class.

With regard to slices with a pastiness defect, manufacturers usually associated them to PSE meats. Elimination data recorded in our study showed that this phenomenum mainly originated in carcasses with a very low ultimate pH from the synthetic crossbred breed and therefore could be due to the RN- gene : the bad cohesion of the cooked product could be related to the specific ultrastructure of the white muscular fiber discovered by ESTRADE et al. (1992) in pigs carrying this gene and resulting in altered areas (pastiness) in the slice and more torn slices.

5. Conclusion

The problem of slicing losses of hams appears as a detector of meat quality. Meat processors had already observed variations up to twice more slicing losses and some of them have turned down French or foreign suppliers delivering an irregular or poor-quality raw material.

Adding of cooking and slicing losses results in big differences in the sold product. The pH measurement of hams, at delivery, remains the best predictor of their technological quality. Computerized data recording should be carried out at the processing plant, in order :

- to estimate the homogeneity and average quality of a delivery,

- to classify suppliers in the long run,

- to classify hams according to classes of weights and quality so that homogenous batches could be constituted before processing.

Low quality hams remain a problem. But the implementation of certification will induce a generalization of pH measurement at the slaughterhouse, and therefore will contribute to improve meat quality.

Aknowledgements

The authors would like to thank the management and staff of each slaughterhouse and processing plant for their assistance in our study.

References

- BARTON-GADE P., 1987. Livest. Prod. Sci., 16, 187-196.
- CARIOU N., JOANNIC P., DUBOIS M., 1988. Journées Rech. Porcine en France, 20, 177-180.
- CHEVILLON P., LACOSTE A., BOULARD J., 1994. Influence of the cutting method on the color and the ultimate pH of ham muscles. ITP, unpublished data.
- ESTRADE M., BAZIN C., MONIN G., VIGNON X., 1992. Journées Rech. Porcine en France, 24, 71-76.
- GUÉBLEZ R., LE MAITRE C., JACQUET B., ZERT P., 1990a. Journées Rech. Porcine en France, 22, 89-96. - GUÉBLEZ R., LE MAITRE C., VAUDELET J.C., 1990b. Journées Rech. Porcine en France, 22, 83-88. - GUÉBLEZ R., SELLIER P., FERNANDEZ X., RUNAVOT J.P., 1993. Journées Rech. Porcine en France, 25, 5-12. - JACQUET B., SELLIER P., RUNAVOT J.P., BRAULT D., HOUIX Y., PERROCHEAU C., GOGUÉ J., BOULARD J., 1984. Journées Rech. Porcine en France, 16, 49-58.
- KRIETER J. (von), KALM E., 1991. Schweinezucht und schweinemast, 39, 104-106.

-L.S.A. N° 1342, 1993. "Les distributeurs tranchent dans le lard".
-MONIN G., GRUAND J., LABORDE D., SELLIER P., 1984. Porcine en France, 16, 59-64.
-PINOCHET D., HERICHER M.D., KÉRISIT R., 1988. Journées Rech. Porcine en France, 20, 195-200.
-TEFFENE O., 1968. Document interne ITP.