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Processing of meat and co-products

Relationship between raw material quality and production yield of cooked hams manufactured without the use of phosphates

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Background
There is an increasing interest in being able to predict production yield and product quality based on the raw material quality, e.g. whe producing cooked, cured products without using phosphates (G. Alviset et al, 1995).

Aim
The aim was to investigate the possibility of predicting production yield based on knowledge of quality and origin of the raw material.

Material
In the experiment were used hind legs from 111 Danish HDLY-crosses and 124 Danish DDLY-crosses killed during the period Janua to April 1996 (on average 22 per week).
At the abattoir pH (Knick Portatest 655 with Ingold glass electrode) was measured min. 22 and max. 25 hours post mortem in the semimembranosus muscle (SM). At the same time level of reflection was measured in the biceps femoris muscles (BF) with the MQM equipment (Borggaard et al., 1989). Samples for protein analysis (Kjeldahl) and intramuscular fat contents (IMF) (Soxtec) were taken from SM of one leg and from the longissimus dorsi muscles samples were taken for determination of drip loss (Rasmussen and Andersson, 1996) and glycolytic potential (Monin and Sellier, 1985).
The other pork legs were sent to DMRI's pilot plant for individual processing to cooked, cured ham. During this processing the following process yields were calculated:

% curing yield = ((weight after tumbling - uncured weight)/uncured weight)*100
% cooking loss = ((weight after tumbling - weight after cooking)/weight after tumbling)*100

Results
The variation in process yield between hams will depend on 1) raw material (e.g. protein content, pH), 2) process (e.g. process routines brine) and 3) individual variation in processing (e.g. cut of fascia, the positions in multi-needle injector, the placing in cooking unit). I this experiment attempts have been made to minimise the latter two by employing the same personnel and use the same process routine in all experimental weeks.
The proportion of the process yield variation that relates to the raw material has been analysed. Cooking loss has been used as an example (Table 1) where the standard deviation for this material is approx. 2%. Table 1 shows the prediction error of various models expressed as RMSE.

Table 1 - Description of variation of cooking loss in different models

Model No.	Percentage cooking loss	RMSE %-units
1	pH	1.6
2	$\alpha+\beta_1$reflection.$+\beta_2$pH	1.5
3	$\alpha+\beta_1$glycolytic potential$+\beta_2$protein$+\beta_3$pH	1.4
4	$\alpha+\beta_1$glycolytic potential$+\beta_2$protein$+\beta_3$reflection$+\beta_4$drip loss$+\beta_5$meat%$+\beta_6$sex$+\beta_7$pH$+\beta_8$IMF	1.4

Model 1 reflects the sorting normally used at reception of raw materials. The reliability of sorting is not that precise and part of the raw materials may be sorted incorrectly. Cooking loss will therefore be higher in the group accepted as suitable than with a more precise sorting. In Model 2 sorting according to pH and reflection (PSE) is carried out simultaneously whereas Model 3 also includes glycolytic potential and protein content, when pH does not contribute significantly in model 3. Model 4 attempts to include all information available on carcass and raw material quality. The variation in cooking loss is, however, best described by glycolytic potential and protein content. Both Le Roy et al. (1994) and K Lundström et al. (1995) find that Hampshire crosses are less suitable for production of cured, cooked products without phosphate added because of the RN^--gene. It has therefore been attempted to identify carriers of the RN^--gene in the material based on the analysis af the glycolytic potential. Figure 1 shows the distribution of glycolytic potential of the two crosses mentioned above. The distribution for the Hampshire crosses has two peaks indicating that the group has two sub-populations. The limit of 180 suggested by K. Lundström et al. (1995) does not seem to give a clear division of the Hampshire crosses. At the same time several examples of Duroc crosses with a glycolytic potential above 180 were found without other indications that this cross should be a carrier of the RN^--gene.
Barton-Gade, 1990 showed that the protein content in muscles of pigs from the Hampshire breed was lower than in muscles from other Danish breeds. Therefore an analysis was made of the correlation between glycolytic potential and protein content. The investigation proved that the correlation between protein content and glycolytic potential of the two crosses were different (r=-0.75 (HDLY) and r = 0.11 (DDLY)). Connected values for protein content and glycolytic potential were then plotted in a diagram, see Figure 2. Identification of points for each cross revealed that the Hamsphire crosses were clearly divided into two groups by the line "protein=20+0.007*gly-p so that points below the line are animals presumed to carry the RN^--gene. Table 2 shows the effect of the RN^--gene on the analysed process yields.

Table 2 – Effect of RN⁻–gene on process yields

	HDLY*	HDLY	DDLY	Significance
% curing yield	11.6	11.4	11.5	ns
% cooking loss	11.0[a]	8.3[b]	8.3[b]	p<0.001

* Presumed carrier of the RN⁻–gene
Characteristics with different letters attached are significantly different

Results are in accordance with the models in Table 1 where the variation of cooking loss to a great extent can be explained by the glycolytic potential and protein contents which are also an expression of the RN⁻–gene.

Discussion and conclusion

Glycolytic potential and protein contents of muscles and thus the occurrence of the RN⁻gene have a great influence on the variation in the cooking loss. The negative effect of the RN⁻–gene will appear during heat treatment, because curing yield will be the same for the total material. As shown in Table 2, the difference in cooking loss is 2.7% between carriers and non–carriers. These results are in agreement with what has already been found by other scientists. K. Lundström et al. (1995) found a difference between carriers and non–carriers with respect to cooking loss of 3.4% in cooked, cured loin.

Results from this experiment show, that in a raw materials of unknown origin the cooking loss may vary 10% between individual hams. If however the raw material is without RN⁻–gene or if the sorting is according to glycolytic potential and protein content the cooking loss will only vary 6–7%. A further sorting of the raw material is possible, e.g. based on pH and reflection value but the range of cooking loss will only change to 5–6% with the new sorting method.

A further reduction in the variation of cooking loss should therefore not be based on variation in the raw material but in other factors that contributes to the variation – e.g. processing method and individual handling.

This contradicts results by Alviset et al. (1995) which showed that independent of sire–line there was a correlation between ultimate pH and process yield. It should, however, be noted that the experiment in question involved boars of the Pietrain breed which are known to be carriers of the Halothane–gene. This gene also influences meat quality and processing quality. The Halothane gene did not have any influence on this experiment due to the low frequency of carriers involved (<5%).

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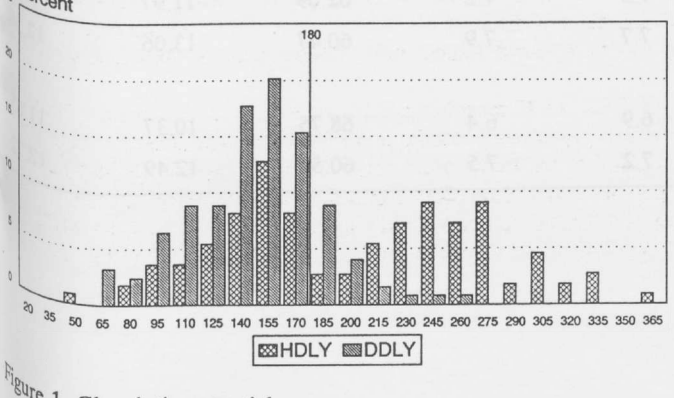

Figure 1. Glycolytic potential

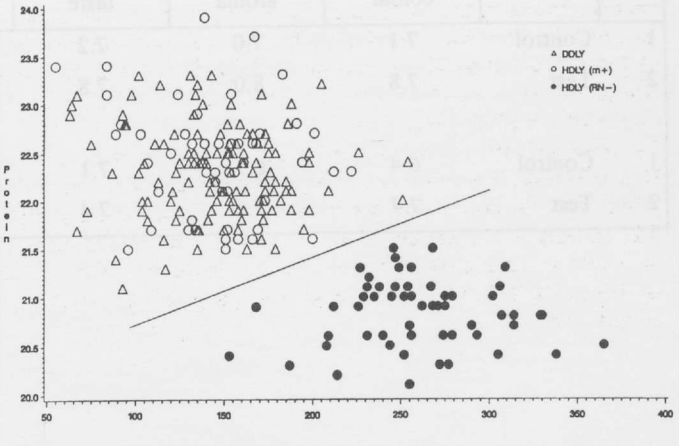

Figure 2. Protein contents and glycolytic potential