Potential quality control tools for the optimal quality of pork and other meats

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Starting point

Pork research traditionally focused on water-holding capacity

> $pH_{24\ h}$ has traditionally been used as an indicator of pork quality with higher values giving superior quality

Research has resulted in

- Pigs free of the Halothane gene
- Group-wise transport, lairage and stunning (welfare reasons)
- CO_2 stunning
- Chilling tunnels (-20°C, 3 m/s)

My observations are that:

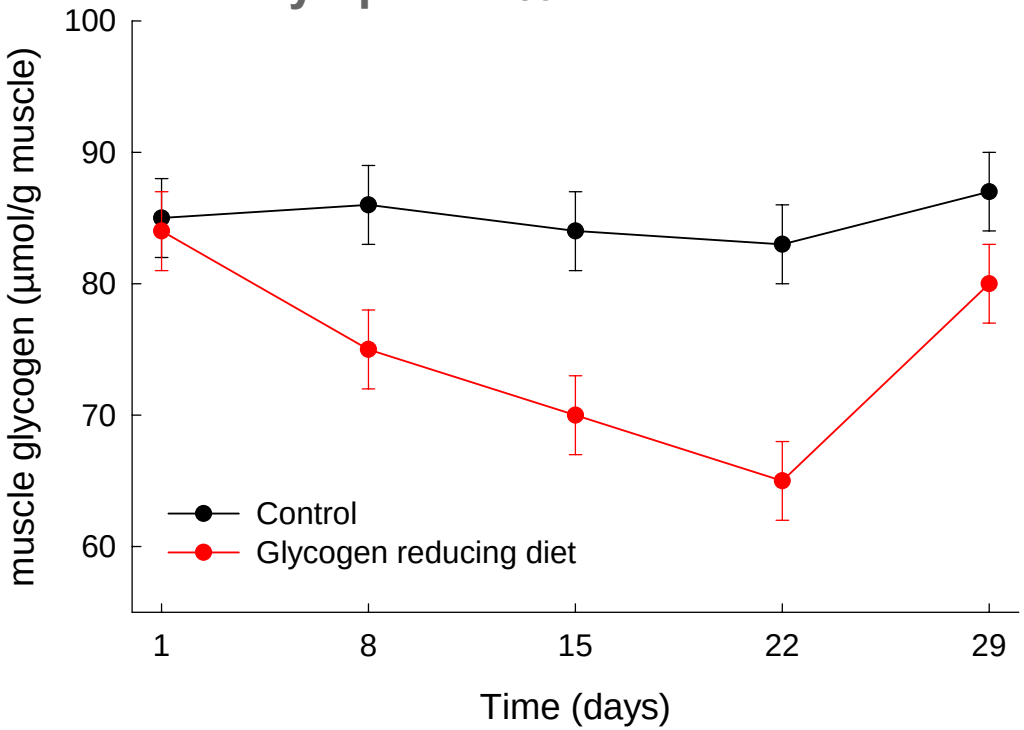
$pH_{24\ h}$ is not a good indicator of pork quality in the modern pig

Reducing muscle glycogen through feeding

AIM: Reduce muscle glycogen through feeding to increase $pH_{24\ h}$ and thereby reduce drip.

Diet were low in digestible starch, but high in fat & protein.

Glycogen was reduced by up to 25% after 3 weeks



Rosenvold, 2002

Reducing muscle glycogen through feeding

RESULTS

- Despite 25% reduction in muscle glycogen levels $pH_{24\ h}$ was not affected in test animals
- BUT drip was decreased by ~1 percentage point
- This was due to higher $pH_{45\ min}$ and lower $T_{45\ min}$

Drip loss (%)	Trial 1	Trial 2
Control	5.3	5.6
Glycogen reducing diet	3.9	4.2

CONCLUSION

- Muscle glycogen can be reduced through feeding
- The reduction decreased drip
- $pH_{24\ h}$ was not a good indicator of this reduction
- Early *post mortem* conditions (pH/temperature) were

Rosenvold, 2002

Further evidence of the importance of early *post mortem* conditions

AIM: obtain large variation in water holding capacity to investigate the underlying mechanisms

37 pigs were either

a) handled very gently or

b) exercised on a treadmill to simulate pre-slaughter stress (increase muscle temperatures)

Drip loss: a variation of 2-13% was obtained

- $pH_{24\ h}$ explained for 2% of this variation
- **$T_{1\ min}$ & $pH_{2\ h}$ explained for 89% the variation**

Schäfer *et al.*, 2002

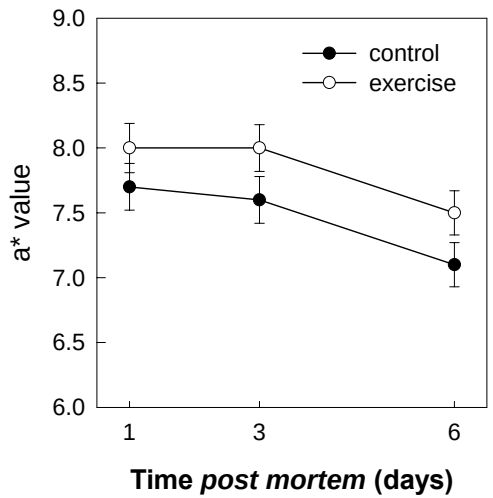
Colour

A number of studies have subsequently shown that temperature & pH early *post mortem* affect the colour and colour stability of pork. Example from Lindahl et al. 2006:

pH & temperature measured 0 to 2 h *post mortem* explained ~40% of variation in lightness (L*), redness (a*) and yellowness (b*)

- High temperature and low pH increased lightness and yellowness (well described for e.g. PSE meat).
- However, the effect on redness was more complex:
  - Pork more red if pH < 6 and T > 38°C
  - Pork less red if pH > 6 and T < 38°C

$pH_{24\ h}$ didn't explain differences in colour



So improvements with respect to water holding capacity (genetics, pre-slaughter handling and slaughter processes) has a negative effect on the red colour of pork

Lindahl *et al*., 2006

Improving tenderness of pork

Background

Introduction of groupwise transport, lairage and CO_2 stunning has decreased the temperature at the time of slaughter (< 40°C)*, which has improved water holding capacity.

The chilling process hadn't been adjusted to the lower carcass temperatures, and there were indications that tenderness could be improved.

BUT chilling conditions could only be changed if they didn't compromise water holding capacity

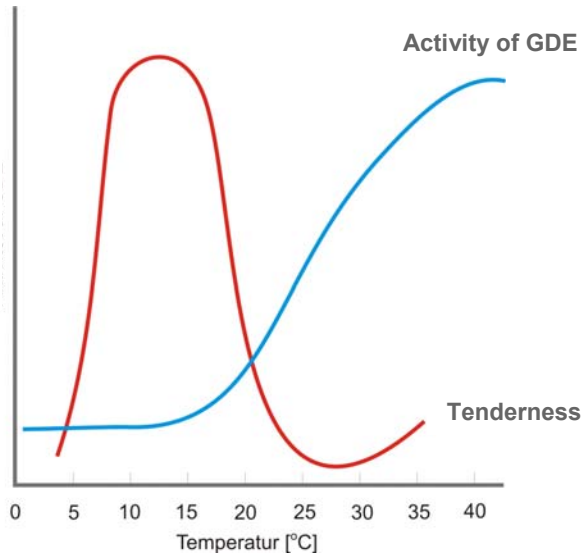
Støier *et al*., 2001

* Could be above 42°C in some cases

Stepwise chilling

Hypothesis: Tenderness can be improved without compromising water holding capacity through stepwise chilling:

- $T_{1\ min}$ is reduced because of improved pre-slaughter handling (Støier *et al.,* 2001)
- *Pre rigor* temperatures between 10 to 20°C results in maximal tenderness (Locker & Hagyard, 1963).
- The activity of glycogen debranching enzyme (GDE) which affects glycogen breakdown *post mortem* - and hence the pH-fall in the carcass - is minimal below 15°C (Kylä-Puhju *et al*., 2005)



Stepwise chilling process:

Tunnel chilling until average carcass temperature 10°C (70 min)

Hold at 10°C for 6 hours

Return to chilling tunnel to reach 4°C

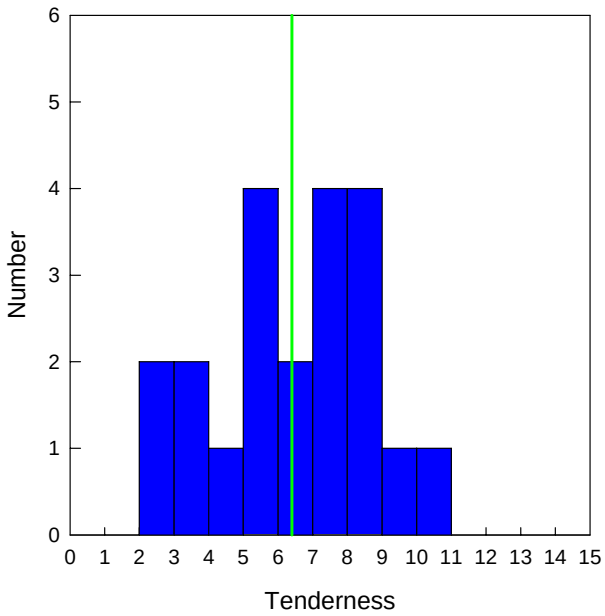
4°C until 24 h *post mortem*

Stepwise chilling

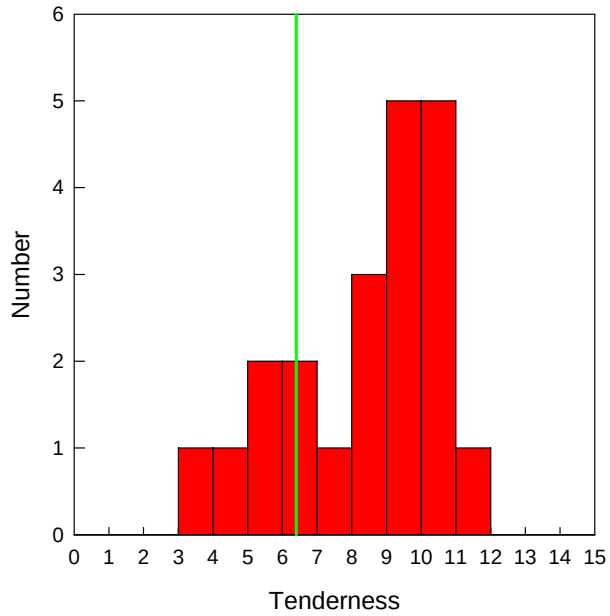
	n	Tenderness*	Drip (%)	$pH_{24\ h}$	L*	a*	b*
Stepwise	21	8.4	1.5	5.51	51.0	5.9	4.6
Control	21	6.4	1.9	5.56	47.6	5.5	3.9
p-value		< 0.0001	0.0023	0.0036	0.001	0.007	0.001

*Tenderness scale: 1-15; 1 is very tough & 15 is very tender

Control



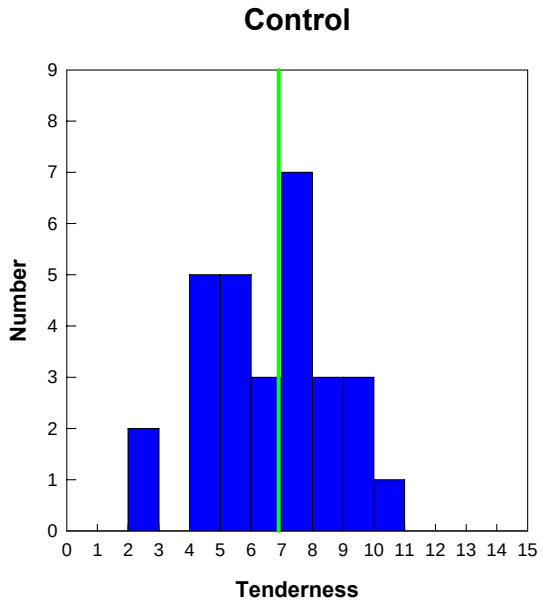
Stepwise

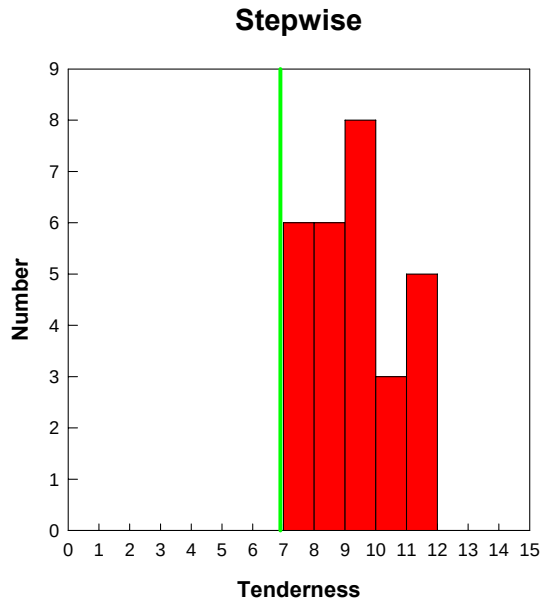


Rosenvold *et al*., 2006

Stepwise chilling

Commercial trial confirmed results with respect to tenderness and drip. Colour was not affected.





Overall conclusion

Tenderness of pork can be improved without compromising water-holding capacity

Colour?

The tenderness consistency was significantly improved!

Process control

There were anecdotal evidence that products from one slaughter plant were superior to other slaughter plants, supposedly due to a difference in slaughter process

Pigs from the same farms were delivered to 2 slaughter plants on the same slaughter day (4 days in total), and temperature was followed during the slaughter process.

Both slaughter plants had – supposedly identical - group-wise lairage and CO_2 stunning

The slaughter plants differed in slaughter and chilling processes

Process control

	N	$T_{1\ min}$ (°C)	$T_{33\ min}$ (°C)	$T_{24\ h}$	$pH_{24\ h}$	Drip (%)
Slaughter plant A	74	38.5	40.7	5.5	5.57	2.7
Slaughter plant B	46	40.1	40.3	5.6	5.57	2.1
p-value		< 0.0001	< 0.0001	0.11	0.73	0.026

Pre-slaughter handling was expected to be identical, but there was 1.6°C difference in carcass temperature!!!

The slaughter process in slaughter plant B prevented the temperature from increasing during the slaughter process

The slaughter process in slaughter plant A resulted in a temperature increase of 2.2°C

This also affects the energy consumption (~3 kJ/kg/°C)

$pH_{24\ h}$ didn't explain differences in drip loss

Control tool to optimise pork quality

Potential tools

- Feeding
- Pre-slaughter handling
- Slaughter process & chilling

→ **TEMPERATURE**

- **HOW IS YOUR TEMPERATURE CONTROL?**