PROCESSING OF HIGH pH MEAT FROM YOUNG BULLS

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SUMMARY: Handling of livestock will influence meat quality resulting in DFD meat. As this meat of inferior quality is not accepted by consumers due to dark colour, different meat flavour, and reduced keepability it is normally used in minced products causing hereby considerable monetary loss for the slaughter plants.

In the present investigation 8 main cuts have been selected from 59 young bulls classified as DFD. The survey showned that sorting of cuts may be recommended in order to achieve the best utilization of the whole carcass.

A small scale experiment was performed to find an industrial utilization of whole cuts of DFD LD muscles. By using a process with injected brine a fully acceptable cooked product was achieved. When testing of products made of DFD meat, moderate DFD meat and normal meat in a sensory evaluation, the panelists found no difference in flavour, tenderness, juiciness and overall impression during a 9 week period.

The panelists preferred the colour arizing from DFD meat products as the red and dark colour was found more acceptable than the paler colour from normal meat.

The quality of products was OK during the test period but may be ruined shortly after due to increasing bacterial growth. Adjustment of heating process and salt content may prolong the shelf life.

Application of this process in practice in Denmark will imply the collection of frozen DFD meat to obtain sufficient material for processing, as the incidence of DFD carcasses is low.

INTRODUCTION: Meat quality related to Dark Cutting Beef (DFD) has been investigated for many years. Handling of livestock will influence meat quality where especially young bulls and veal are exposed to stress during handling, transport and lairage before slaughter. Problems related to DFD meat are well-known all over the world, and precautions are being taken to minimize risk of stressing animals.

Whole cuts of DFD meat are not accepted by consumers due to the dark colour and deviating meat flavour. In addition, the shelf life of vacuum-packed products is very limited. In general, therefore, meat is utilized as minced products or whole cuts are sold to be consumed as braised or cooked products.

In Denmark the production of young bulls amounts approx. 100,000 tons per year. Animals are slaughtered at 11 months of age with live weight of approx. 450 kg. A small and decreasing amount is DFD; the quantity seems less than 4% (Buchter, 1985). However there will for some reasons exist a small number of young bulls which are susceptible to high pH.

In the present investigation ultimate pH measurements were carried out on 8 main cuts from 59 bulls with pH higher than 6.2 in LD muscles. The aim of this project was to find the best industrial utilization of DFD meat from young bulls.

MATERIALS AND METHODS: The investigation of pH was carried out at 3 slaughterhouses all using low voltage stimulation during slaughtering. Measurement of pH with Knick Portamess 751 pH-meter with an Ingold meat electrode (type LOT 406-M4) was performed 18-24 hours after slaughter. Muscles with pH_{24} > 5.8 but < 6.2 were classified as being moderately DFD and muscles with pH_{24} > 6.2 as DFD.

59 bulls with ultimate pH > 6.2 in Longissimus dorsi were selected, and measurement of pH was carried out on 8 main cuts: M. Semimembranosus (SM), M. Semitendinosus (ST), M. Biceps Femoris (BF), M. Gluteus Medius (GM), M. Rhombosideus (RB), M. Triceps Femoris (TF), M. Psoas Major (PM) and M. Quadriceps Femoris (QF).

In the small scale experiment LD muscles were selected for a marinating process taking 2 DFD muscles, 4 muscles with moderate DFD and 4 muscles with normal pH. After deboning the muscles were vacuum packed and frozen in order to simulate realistic handling under industrial conditions.

Processing was carried out in the following order:

The marinade was supplemented with dextrose in order to compensate for the loss of glycogen in the DFD meat. Composition as follows:

81.7% Water
8.3% Salt
3.3% Dextrose
6.7% Seasoning extracts
100.0%

Seasoning extracts containing approx.

60% Hydrolysed vegetable protein (HVP)
20% Maltodextrin
10% Vegetable extracts
10% Spice extracts, mostly white pepper.

With a meat injector (FGM model 26/52) 15% brine was injected (brine pressure 1.9 kg/cm^2) and the meat was cured in a 200 l Scanio tumbler for 8 hours. The programme was set at 6 revolutions per minute, tumbling 20 minutes and resting 40 minutes.

Stuffing into BT1 (175x750) bags from Cryovac.

Cooking in steam cabinet with the following programme:

35°C for 210 minutes
68°C until the product reached 65°C at the centre (230 minutes).

After rapid cooling the products were stored at +2°C.

Measurements were carried out in the following order:

- pH measurement of muscles as thawed, cured and cooked products.
- Bacteriological measurement of muscles as thawed, cured and cooked products. Total bacterial count on PCA with 1% NaCl, Lacto bacillus on MRS, Brochotrix Thermophacta on STA A, Leuconostoc on NA + saccharose.

- Measurement of the colour of cooked products using Datacolor Dataflash 2000 equipment.

- Sensory evaluation by nine taste panelists. Samples were evaluated as cold slices after 1, 3, 5, 7, 8 and 9 weeks strage for colour, flavour, tenderness, juiciness, and overall impression. A 10 point scale was used, where 10 is best.

RESULTS AND DISCUSSION: The ultimate pH value of the different muscles is presented in Table 1. All data come from DFD carcasses with pH > 6.2 measured in the muscle.

Although the muscles have high ultimate pH, apparently many cuts may be selected so that the best use of the whole carcass can be achieved. Therefore the data have been split up (Table 2) in order to illustrate the percentage of the cuts within the groups being DFD, moderate DFD and normal. When the pH in muscles is above 6.6 only few of the cuts will be useful (fig. 1 and 2), and in this situation you will find larger variation within each muscle.

SM and ST are shown in Figure 1 and 2 as examples. Based on these figures and tables it may be recommended to measure pH in the different muscles and thereby regain some value of the otherwise inferior meat. These results and procedure correspond to findings by Augustini 1979, Poulanne 1981, Dezeure-Wallays 1988, and Fostier 1988.

Marinated products show the following results: pH changes during the processing and storage. According to Figure 3 the pH will end up at values about 6.3 after 8-9 weeks for storage. We do not see any direct explanations for this trend.

The taste panel found the products very acceptable. No significant differences were found between products made of DFD meat, moderately DFD meat or normal meat. Products made of all 3 types of raw materials were evaluated as very acceptable for flavour, tenderness, juiciness and overall impression. These scores maintained the same level during the experimental period. The colour of the slices was found to be fully acceptable though with a slight preference for products made of DFD meat.
The products were not rejected due to off flavour after a 9 week period, but bacteriological findings indicated that the shelf life would be finished shortly after the 9 week period.

Findings of 10^5-10^8 of total bacteria-count indicated that the product quality decreased. Lactobacillus did not grow out nor did Brochotrix thermosphactum and Leuconostoc.

Cooking loss (Figure 4) was found to be approx. 9% in packages with normal meat. In packages with DFD we found - as expected - less cooking loss (approx. 3%). These findings confirm other results (Poulanne 1981, Katsaras 1990), where steaks made of DFD show significant less loss during heating process. Apparently there is small increase in cooking loss after 5 weeks of storage, but this seems to be of less importance, as products remained at the same level after 8-9 weeks of storage.

Lightness indicates low values for dark meat colour and higher values for light meat colour.

In raw meat samples of young bulls values of lightness is around 40 measured on meat with normal pH.

When cooking the meat the colour will change and lightness increases. In the experiment the values of lightness were around 53 for normal meat products and the product was found pale. Lightness values of DFD meat products were found around 44 as shown in Figure 5 and the products were obviously more dark and red, when evaluated visually.

The hue value shows the relationship between red and yellow colour in the meat. A low hue indicates that the colour has high content of red and low content of yellow. According to Figure 6 the results are significantly lower for DFD meat which confirms the visual evaluation, where DFD meat samples were found to be more reddish.

It appears that curves of both lightness and hue will finish around the same level after 9 weeks.

This observation may confirm that the shelf life of the products will be terminated shortly after a 9 week period.

Chemical analysis of cooked products showed following ranges:

% Water	65-76
% Protein	17-19,5
% Fat	3-15
% Salt	1.1-1.9

CONCLUSIONS: Sorting of young bulls classified as DFD gives the possibility of further sorting of parts of the carcass that are not DFD. Muscles from the hind quarter (ST, GM, SM, BF) are most susceptible to DFD.

Sorting of cuts can be recommended in order to achieve best utilization of the whole carcass.

Cured and cooked meat products made of DFD meat, moderately DFD and normal meat was found to be very acceptable. As for raw meat we found that cooked products made of DFD meat to be more red and dark and the cooking loss was lower. Shelf life of approximately 8 weeks was obtained for the cooked products and no difference was observed between the various raw for materials.

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Table 1 - Overall mean and standard deviation (St.Dev.) for ultimate pH in different muscles - all from DFD carcasses, young bulls (59).

Cut/muscle		pH mean	St.Dev.
Filet	(LD)	6.55	0.20
Eye of round	(ST)	6.24	0.40
Neck	(RB)	6.15	0.30
Sirloin	(GM)	6.03	0.30
Topside	(SM)	5.96	0.30
Silverside	(BF)	5.95	0.30
Chuck	(TF)	5.91	0.25
Tenderloin	(PM)	5.88	0.25
Knuckle	(QF)	5.77	0.35

Table 2 - % of cuts being DFD, moderate DFD or normal - all from DFD carcasses, young bulls. (59)

Cut		DFD pH > 6.2	Moderate DFD 5.8 < pH < 6.2	pH < 5.8
Filet	(LD)	100	-	-
Eye of round	(ST)	45.8	42.4	11.9
Neck	(RB)	37.3	52.5	10.2
Sirloin	(GM)	30.5	40.7	28.8
Topside	(SM)	23.7	35.6	40.7
Chuck	(TF)	22.0	28.8	49.2
Silverside	(BF)	16.9	50.9	32.2
Tenderloin	(PM)	13.3	37.3	49.2
Knuckle	(QF)	6.8	78.0	15.2

Fig. 1. Percentage of Topside Cuts. (SM)

Classified as DFD, Moderate DFD and Normal

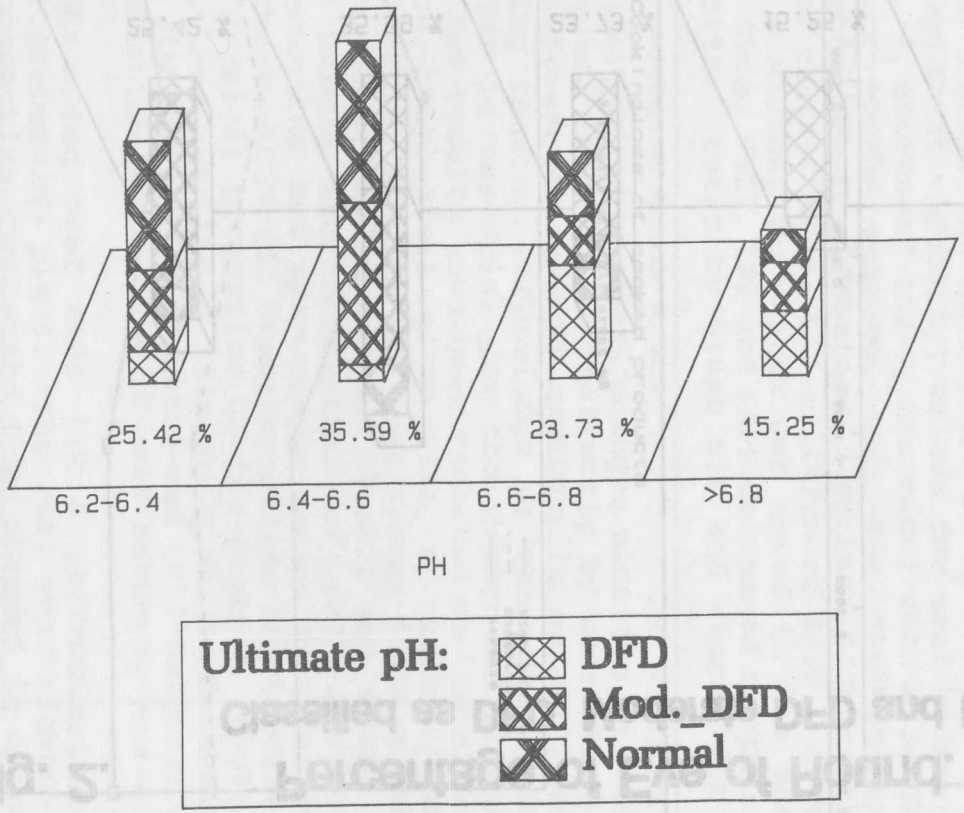

Fig. 2. **Percentage of Eye of Round. (ST)**
Classified as DFD, Moderate DFD and Normal

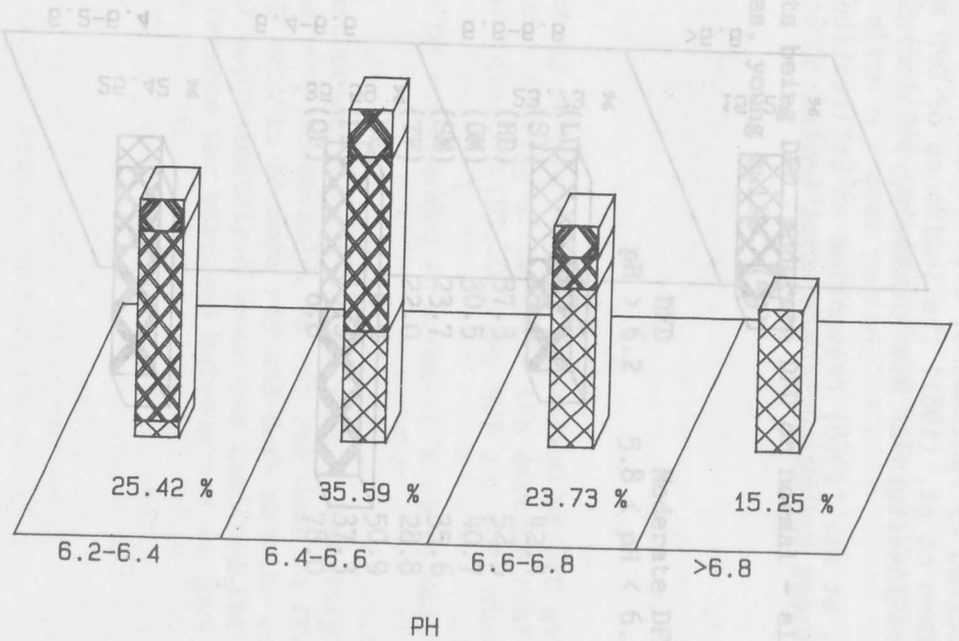

Figure 3. ph during process and storage

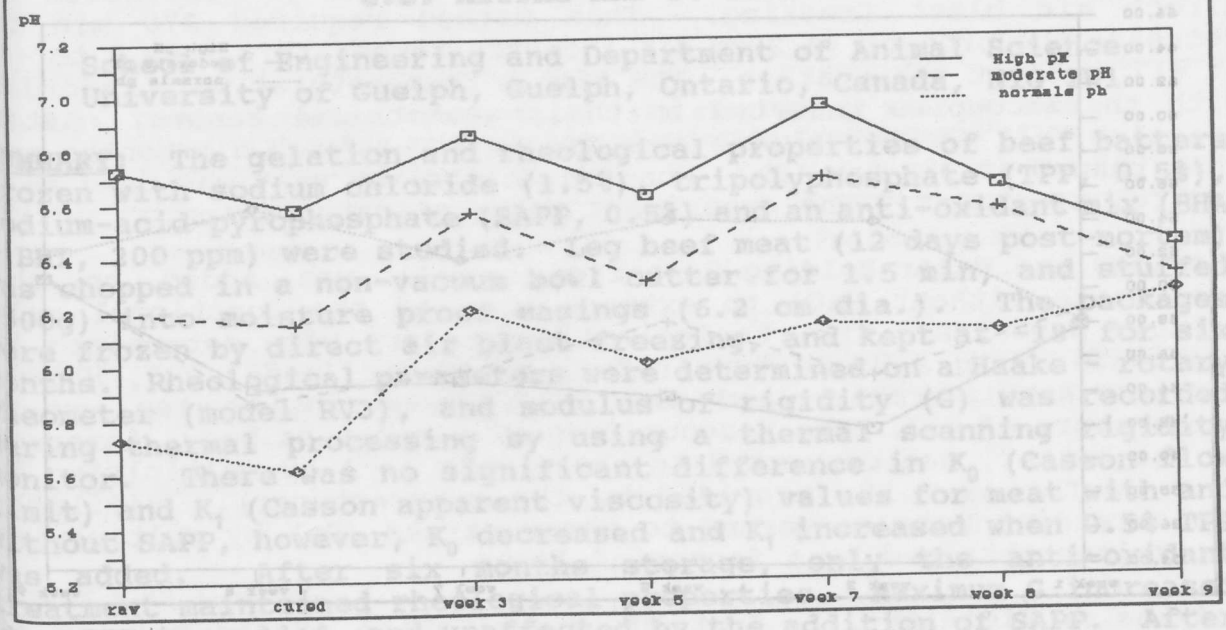

Figure 4. Cookingloss of cooked products

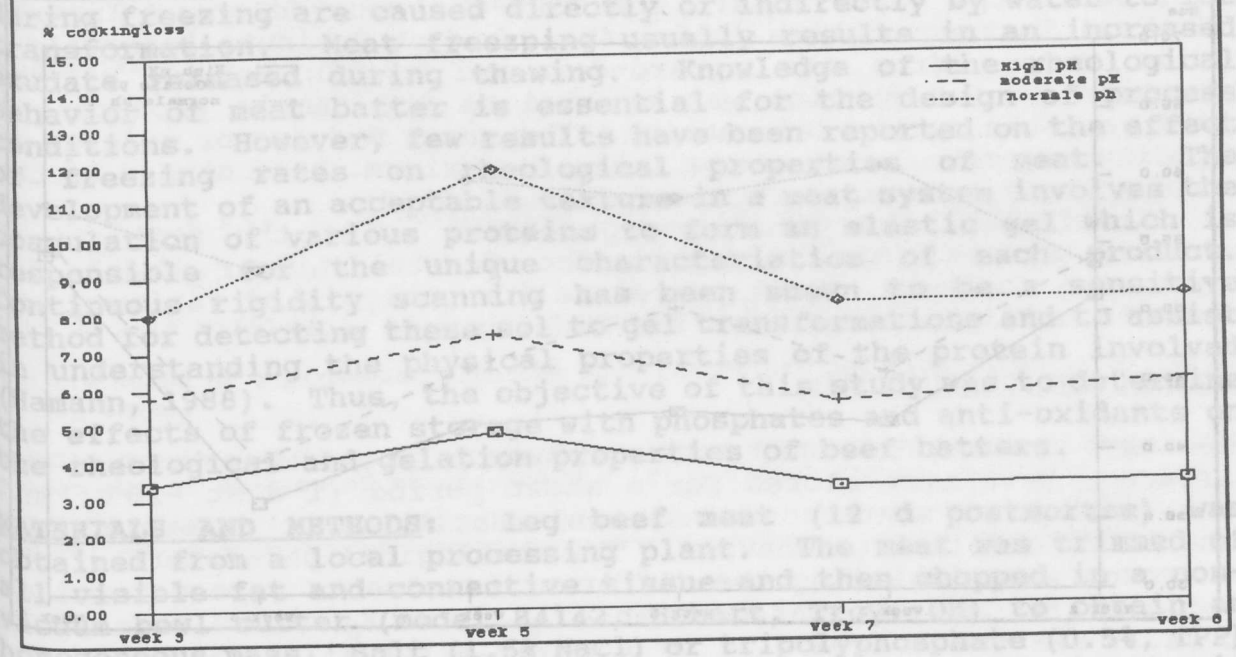

Figure 5. Lightness of cooked products

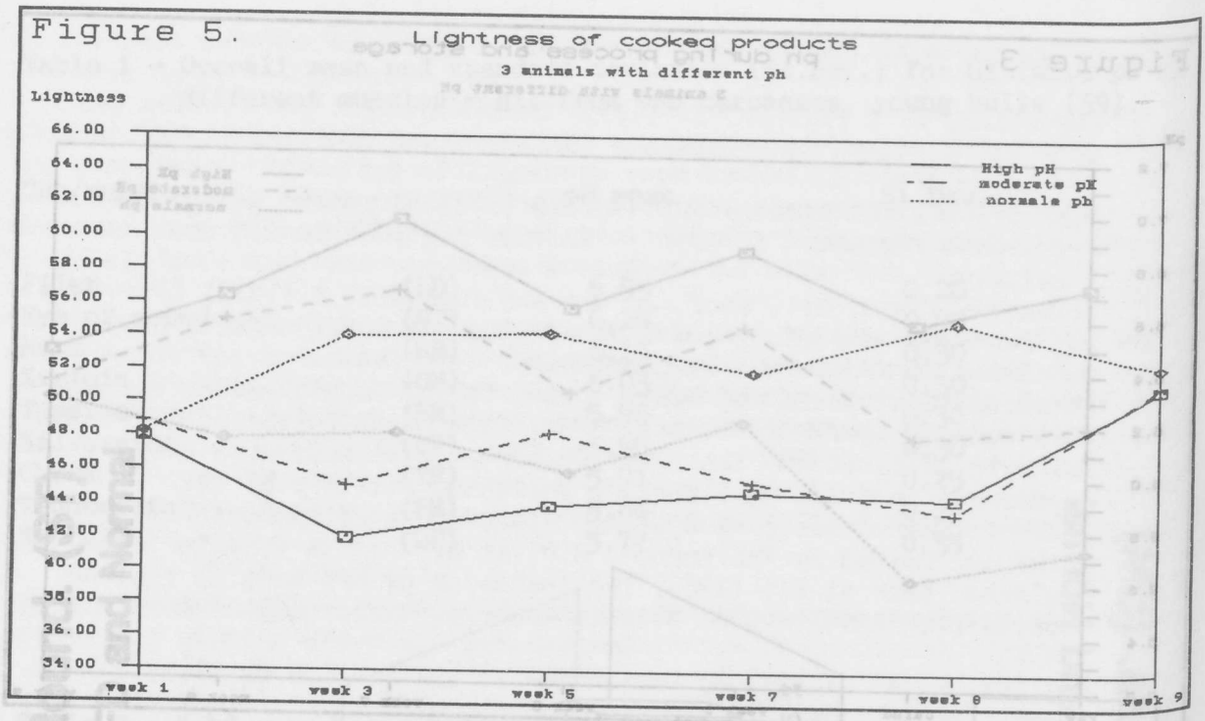

Figure 6. Hue of cooked products