IS IT POSSIBLE TO ALTER ULTIMATE pH BY DIFFERENT TREATMENTS OF PIGS PRIOR TO SLAUGHTER ?

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SUMMARY

The purpose of this study is to investigate how much the pH_u-level can be raised by different treatments of pigs prior to slaughter. The three treatments investigated are:

Group 1: No fast and slaughter immediately after unloading at the abattoir

Group 2a: Fast for a minimum of twelve hours at the farm. Upon arrival at the abattoir the pigs are showered for 30 minutes and kept in lairage two hours before slaughter.

Group 2b: As Group 2a, but kept in lairage overnight at the abattoir.

Each group consisted of approx. 600 pigs delivered from nine farms.

The pH_u-levels of Biceps Femoris (BF), Semimembranosus (SM), Longissimus Dorsi (LD), and Semispinalis Capitis (SC) vary significantly among the pigs treated differently. Pigs not subjected to fast at the farm and slaughtered immediately upon arrival (Group 1) show a lower pH_u in BF, SM, LD and SC than pigs subjected to fast and upon arrival at the abattoir showered and kept in lairage for two hours before slaughter (Group 2a). The increase in pH_u obtained by showering and keeping the pigs in lairage for two hours is 0.03-0.04 for BF, SM and LD, and 0.10 for SC.

Furthermore, staying overnight (Group 2b) causes a further increase in the pH_u-level of the BF and SM (0.04-0.05) and SC (0.12). The overnight stay does not change the pH_u-level of the LD. Besides increasing the pH_u-level, the DFD-frequency also increases when the lairage time is increased to two hours. The DFD of BF increases from 0 to 2%, of SM from 1 to 2%, of LD from 0 to 1% and of SC from 1 to 7%. The overnight stay increased the DFD-frequency by approx. 2% for SC. The PSE-frequency was not affected by the treatment and it falls below 1% in this study.

Treatment did not affect the lean percentage nor the skatole level in male pigs. Pigs lairaged overnight had a slightly lower slaughter weight. Significant differences were observed between farms according to treatment.

Introduction

The ultimate-pH of the meat depends on the glycogen- and energy levels of the muscles plus how far the process of transforming glycogen to lactic acid has progressed before it stops due to either too low pH, lack of glycogen, affected by the enzyme capacity or low temperature, Swan (1993). Small glycogen stores will result in the pH-level not being able to drop to a low level. This may result in DFD-meat. PSE evolves when there is a quick pH-drop in the meat simultaneously with a high temperature shortly after sticking (Bendall & Wismer-Pedersen, 1962, cf. Lawrie, 1979).

The pH-drop is thus primarily dependent on the size of the glycogen stores which in live pigs on the day of slaughter may be influenced by:

1. fasting
2. lairage in collecting pen vs ordinary pen at the farm
3. Transportation (time/means)
4. Lairage at the abattoir (time/means)
5. Handling (at delivery, onloading and driving)

Draining of the glycogen stores may be caused by rough handling of the animals (exhaustion) but like for items 1-5 above ethical aspects have to be considered.

The purpose of this excercise is to find out whether ultimate pH can be increased using various treatments.

Materials and Methods

Pigs were delivered from 9 producers, each supplying approx. 75 pigs/week. The 75 pigs were evenly distributed to the 3 experimental groups.

Table 1 shows details of the treatments of the slaughter pigs before sticking.

Pigs of Group 1 were lairaged at the producer's in pens with access to feed until delivery. Loading of the pigs was effected as usual. Pigs were slaughtered upon delivery to the abattoir.

Pigs of Group 2 were subjected to fasting commencing the night before delivery and was of a duration of 12 hours at a minimum. Group 2 pigs were subjected to careful handling when loaded. Unloading at the abattoir was as smooth as possible and pigs were showered in cold water for approx. 30 minutes. Pigs lairaged for the night at the abattoir were fed in the afternoon.

On the day after slaughter pH_u was measured in BF, SM, LD and SC and MQM values measured in BF, SM and LD (Barton-Gade & Olsen, 1984, Borggaard et al. 1989). Based on MQM values water holding capacity was calculated in LD and BF as an indication of PSE in these muscles. The pH_u-level forms basis for an evaluation of possible DFD-meat. Meat quality was measured 16-20 hours after slaughter. Groups slaughtered Friday were measured Monday morning (approx. 70 hours after slaughter). The meat percentage of the experimental pigs was noted and for entires the skatole content of back fat.

The data were evaluated using an analysis of variance as follows:
pH_u = Handling+Producer+Week* (Handl.*producer)+random variance. Week* (Handl.*producer) states the interaction caused by a third element plus all subordinate interactions caused by the element 'week'. This element is included as a variance component. The variances within each group are checked against the biological variance, which is the variance caused by a random variance and the element created by the interactions of which 'Week' is included.

As the initial analysis revealed big variances from week to week with respect to pH_u and waterholding capacity, a model of analysis has been chosen in which the difference in handling is checked against the variance caused by week-variance and random variance.

Pigs supplied by Producer No. 3 reacted differently from pigs supplied from other producers. Therefore pigs from Producer No. 3 were subjected to specific analysis. Pigs supplied by the other producers have been regarded as one since their reaction to the treatments are alike.

Results and Discussion

Slaughter data from all producers have been analysed as one. However, in analysis of meat percentage only producers of gilts and entire males have been included as the group of producers would otherwise not be comparable.

The meat percentage and the skatole level are not affected by the various treatments. The average meat percentage and the skatole level (male pigs) were 59.8 and 0.05 ppm, respectively. The slaughter weight, however, varies according to treatment, group 2b - pigs lairaged overnight - having the lowest slaughter weight. It is presumed that the variance of slaughter weight is not due to the treatment but that varying live weight on delivery is the cause of the difference, see Table 2.

Meat Quality

Measurements of the variance of pH_u between the treatments varies significantly in relation to the biological variation which means that the treatments affect the pH_u-level considerably. The pH_u-level is increasing from treatment 1 to treatments 2a and 2b (See Table 3a).

There is a significant difference in pH_u-level of the BF, SM, LD and SC in the pigs according to the treatment they have been exposed to. Pigs that have not fasted and are slaughtered upon delivery to the abattoir (Group 1) have a lower pH_u i BF, SM, LD and SC than pigs that have fasted and are showered on arrival to the abattoir and lairaged for 2 hours before slaughter (Group 2a). The rise in pH_u gained by showering and lairage for 2 hours is 0,03-0,04 for BF and SM and 0.10 for LD and SC. Lairage overnight further increases the pH_u in

BF, SM and LD. The rise in pH_u is 0.04-0,05 in BF and SM and 0.12 in SC. Lairage overnight does not affect the pH_u in LD.

The fact that the pH_u-level is lowest when pigs are slaughtered directly without fast and highest when lairaged overnight may be explained by the pigs during lairage and showering utilise some of their energy and thus have less glycogen for producing lactic acid and thereby decreasing the pH-drop in the muscle. With lairage overnight pigs also utilise energy of their muscles, e.g. for fighting etc. so that we find a higher pH_u-level in the pigs of Group 2b.

Pigs supplied by Producer No. 3 showed the highest pH_u-level in group 2a (fasted and lairaged for 2 hours - see Table 3b). Group 2b that has been lairaged overnight holds a lower pH_u-level than Group 2a. This could be because the pigs subjected to fast have been moved to a separate deep straw unit the night before delivery. The pigs have here mingled with pigs from other pens which has created some activity. This may cause the pigs to use more energy resulting in a higher pH_u-level. The reason why these pigs have a lower pH_u-level after lairage overnight could be that the pigs have rested sufficiently so that they are able to rebuild the glycogen stores in their muscles. The pH_u-level in pigs from Group 1 corresponds to the level of the other pigs.

Water Holding Capacity, DFD and PSE

In BF the water holding capacity increases according to the lairage period, while in LD there is a slight drop when lairaged overnight. There is no difference between Group 1 and Group 2a (see Table 4). In pigs from Producer No. 3 the water holding capacity in BF and LD is highest when lairaged for 2 hours. The water holding capacity level corresponds to that of the other slaughter pigs. The differences in water holding capacities are small and in practice of no importance. The frequency of PSE is not affected by the treatment and is below 1% in this experiment.

The DFD frequency is rising with the increasing lairage period which is expected since some of the pigs are exhausted from longer periods of lairage with a.o. fights. With a rise in the pH_u-level there is a simultaneous rise in the DFD frequency when increasing the lairage period from 0 - 2 hours. In BF the rise in DFD is 0-2%, in SM 1-2%, in LD 0-2% and in SC 1-7%. Lairage overnight resulted in a rise in the DFD-frequency of 0-2% in LD.

In Table 4 is shown the frequency of DFD in the four muscles. The frequencies have been calculated for each group comprising all pigs, except the pigs from Producer No. 3 which have been calculated separately. The frequency of DFD is somewhat higher in pigs from Producer No. 3 than in pigs from the other producers, which may be explained by the higher level of activity with pigs lairaged overnight in deep straw units.

The frequency of PSE in BF and LD is in this experiment below 1% for all groups except, however, Group 2b where the PSE frequency in LD is 2.8%. There is no immediate explanation for this.

Discussion

Warriss et al (1990) find that pH_u falls from 5.68 to 5.61 in SM if lairage period increases from 2 to 21 hours (with feeding). The same tendency was seen in AD (Adductor) but there was no effect on LD. The effect on pH_u was larger had the pigs been transported for a longer time (1 or 4 hours). Long transports result in lower energy levels in the muscles. The fall in pH level in pigs lairaged for 21 hours is caused by resting and feeding. If the pigs are rested and fed after treatment they are able to build up the glycogen stores in their muscles and thereby reach a lower pH_u. A longer lairage period also reduced plasma lactate.

Eikelenboom et al (1989) find in two experiments that the pH_u-level is affected by longer fast periods. If the fasting period increases from 0 to 24 hours (two different trials) the pH_u in SM goes up with 0.13-0.23 units and the pH_u in LD goes up with 0.11-0.22. In these experiments there was no effect when pigs fasted for 16 hours. Danish work with male pigs showed no effect on pH_u in pigs fasting for 16 hours vs. no fasting. In this experiment male pigs were fasted at the farms and in the lairage together with gilts and were not mixed with unfamiliar pigs (Maribo 1992).

Weeding et al. (1993) made a trial testing of the effect of showering during lairage. Their work showed no effect on pH_u.There were two different showering periods (60 + 15 min or 6*5 minutes) and the total lairage period was 2-3 hours. The experiment was carried out during the summer. If an effect of showering should be seen the weather should be cold or the shower period should be longer. This would lead to a regular cooling of the body followed by use of muscle energy to maintain the body temperature.

Augustin and Fischer (1981) find in a field experiment that pigs lairaged for more than one hour showed higher pH_u in SM than pigs lairaged for up to 1 hour. They did not find any other effect caused by

lairage overnight. A higher pH_u led to a higher incidence of DFD-meat. Slaughter weight and grading had no effect on the pH_u level.

Early Danish experiments with male pigs showed that lairage overnight compared to a 1 hour lairage period resulted in differences in pH_u of 0.11-0.17 for LD and 0.09-0.31 for SC. These figures are much higher than the results of this experiment. The explanation may be that male pigs from different farms lairaged together fight more resulting in exhaustion, DFD and skin damage (Maribo 1991).

The total rise of pH_u in this experiment by combining factors expected to affect pH_u was smaller than anticipated. The explanation could be: 1. the pigs lairaged are of mixed sexes,
2. the pigs are showered on arrival at the abattoir which calms them down and reduce the fighting, 3. the experiment was carried out at a small abattoir where the handling of the pigs was more gentle than at other abattoirs.

Conclusion

There is a significant difference in pH_u-levels of BF, SM, LD and SC in pigs exposed to different treatments. Pigs from Group 1 had the lowest pH_u-level, pigs from Group 2b the highest pH_u-level where results from Group 2a was in between.

The rise in pH_u-level seen between Group 1 and Group 2a is 0.03-0.04 pH-units in BF, SM and LD. In SC the difference was 0.10 pH units. Lairage overnight further increases the pH_u-level by 0.04-0.05 pH-units in BF and SM whereas the pH_u-level in LD was unaffected. In SC the rise was 0.12 pH-units after lairage overnight. It was furthermore found that an increase of lairage period resulted in a rise in DFD-frequency. The DFD frequency in BF, SM ad SC was the same in pigs from both Group 2a and 2b. In Group 1 the DFD frequency was 1-1% in all 4 muscles. In Group 2a and 2b the DFD frequency was approx. 2% in BF, SM and LD. DFD frequency in SC was 7% in Group 2a and 9% in Group 2b. Lairage overnight results in an increase of the DFD-frequency by approx. 2%-units in SC. The PSE frequency is not affected by the treatment and is below 1% in the experiment.

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