VASCULAR INFUSION OF PIGS WITH WATER: EFFECTS ON CARCASS SHRINKAGE, MEAT TEMPERATURE AND QUALITY

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SUMMARY

A group of 20 stress susceptible pigs of market weight (90-100 kg) were stunned by electricity (head to back stunner at 400v and 60 Hz) for 2-3s. A total of 6 pigs were randomly chosen as controls and bled by severing the carotid arteries. The remaining 14 pigs were bled by the right jugular vein and infused with pre-chilled water through the left carotid artery until the carcass had increased 10% over its original weight. All carcasses were scalded, polished, eviscerated and washed following commercial procedures. Weights of all organs and the warm and cold carcass weights were recorded. Meat temperature and pH were measured at 45 min, 3h and 24h post-slaughter. The longissimus thoracis and semimembranosus were assessed subjectively for colour and structure along with a series of objective quality measurements. Infused carcasses had higher carcass (by 39g kg^{-1}) and offal yields than control carcasses. However, infused carcasses had similar muscle temperature (except at 45 min post-slaughter) and meat quality to that of control carcasses. Moisture content of the longissimus thoracis was increased in the infused compared to the control carcasses. It was concluded that infusion of pre-chilled water had important effects on carcass shrinkage but did not alter the pH related aspects of meat quality. Since all pigs produced poor quality meat (high incidence of PSE pork) further work would be of interest in pigs of a normal genotype for stress susceptibility.

INTRODUCTION

Pig carcasses shrink in weight mainly during the chilling process and losses amount to 1-3%. In North America, the amount of carcass shrinkage that occurs commercially is generally controlled by spraying the carcass during the chilling process with a fine mist of water (e.g. spray chilling). Carcasses that have been spray chilled often show a weight loss less than 1% (Jones et al. 1993). Another approach to the control of carcass shrinkage is blast chilling (James et al. 1983) which also reduces carcass weight losses during chilling to less than 1%. In addition blast and spray chilling can be combined.

Vascular infusion following a modified bleeding procedure has the potential to reduce carcass shrinkage during chilling and could also be used to modify post-mortem metabolism. Therefore the present experiment was conducted to determine the effects of water infusion on carcass shrinkage losses, meat temperature and muscle quality.

MATERIAL and METHODS

A group of stress susceptible pigs (nn genotype) weighing between 90-100 kg were used in this study. The pigs were randomly allocated into two groups. Group 1 was a control group of 6 pigs that were slaughtered and processed following current commercial procedures. Pigs were stunned for 2-3 s with a head to back stunner (400v and 60Hz), bled via the carotid arteries, scalded, polished, eviscerated, trimmed and washed prior to chilling at 1°C. Group 1 was a treatment group of 14 pigs. These pigs were stunned in the same way as the control group but bled by the right jugular vein. While bleeding, the jowl area was carefully opened to expose the carotid arteries and the left carotid artery was catheterized with a stainless steel needle. Pre-chilled water at 2°C was infused into the left carotid artery until the carcass had increased 10% over its original weight. The needle was then removed and the carcasses processed in the same way as the control group.

Weights of the organs and of the warm carcasses were recorded along with pH and muscle temperature at 45 min, 3h and 24h post-slaughter. Muscle temperature and pH were measured at the 10th rib for the longissimus thoracis (LT) and in the semimembranosus (SM). The day after slaughter, the loins and hams were removed from all carcasses and both the longissimus thoracis and semimembranosus were examined for subjective colour and structure on a 5 point scale (1 = extremely pale with soft dough like structure and 5 = extremely dark with firm structure). In addition, both muscles were measured for colour (Minolta Chroma Meter using the L*, a*, b* colour scale), drip loss (loss in weight while held in plastic bag for 48h), protein solubility, Instron peak shear and proximate composition (water and lipid).

Statistical analysis was conducted using a least squares analysis of variance with treatment (infusion vs control) and error included in the model.

RESULTS and DISCUSSION

Although pigs designated for infusion had lower live weights than control pigs, this difference was not significant (Table 1). Infused carcasses produced higher warm carcass yields (863 vs. 824 g kg^{-1} plant live weight) and greater yields of most of the offal components than control carcasses. Increases in warm carcass weight would amount to about 3.9 kg on a 100 kg pig which represents a very substantial gain in weight. Since similar weight losses were observed between control and infused carcasses during the chilling process (Table 1), the majority of this weight was retained within the carcass. A large weight increase was also observed for the liver which would be expected to increase from 1.6 to 2.5 kg in an infused carcass from a pig weighing 100 kg.

Observations made of the infusion process showed that very soon after the cold water infusion was started, there was a corresponding contraction of the musculature of the carcass. Also the lymph nodes were generally observed to be very wet and water filled during the inspection process for infused carcasses. The organs were noticeably enlarged particularly for the liver, heart and kidneys.

Vascular infusion of cold water only had minor effects on muscle temperature and pH at various times post-mortem (Table 2). For the LT, the initial temperature measurement (45 min) showed that infused carcasses had a muscle temperature about 2°C cooler than control carcasses. There were no differences in LT temperature at 3 or 24h. There were no differences in the pH of the LT at any time interval post-mortem. Indeed final pH was essentially reached by 45 minutes post-slaughter as would be expected using stress susceptible pigs with an extremely rapid post-mortem metabolism. For the SM (Table 2), muscle temperature was again lower for the measurement made at 45 min post-slaughter but the 3 and 24h measurements showed no significant differences between infused and control carcasses. The pH of the SM although higher than that of the LT showed only small changes from 45 min to 24h post-slaughter (Table 2). As found with the LT, the majority of the post-mortem metabolism had been completed by the time the carcasses were subject to the initial measurement for pH (45 min).

The overall measurements for LT muscle quality are shown in Table 3. Both infused and control carcasses produced boneless loins that were rated as extremely pale with an extremely soft, dough like structure. There was some indication that infused carcasses had slightly improved structure scores compared to the control carcasses ($P=0.023$), but the differences were quite minor. Pork colour of the LT as assessed by the Minolta Chroma Meter showed no differences attributable to treatment. Drip loss for pork from the LT tended to be higher for the infused carcasses compared to control carcasses but was not significant ($P>0.05$). Soluble protein was higher for infused carcasses but the values were considerably lower than those found for pork of normal quality. Moisture content of the LT muscle was higher for the infused compared to the control carcasses. There were no differences found for lipid content or shear value.

Muscle quality measurements for the SM showed that the infusion treatment had no significant effect. While quality scores for the SM were somewhat higher (pale rather than extremely pale and soft rather than extremely soft) than the LT, there were no observed differences attributable to treatment (Table 4). There were no treatment differences in objective meat colour (L*,a*,b* values), drip loss, soluble protein, moisture, lipid content or shear value (Table 4).

The results would suggest that the vascular infusion of cold water had little or no effect on the post-mortem metabolism of stress susceptible pigs or that any effects took place prior to the first measurements made at 45 min post-slaughter. Since the rate of metabolism is so rapid in this genotype, the quality of the muscle is largely decided within 45 min of slaughter.

CONCLUSIONS

The vascular infusion of cold water immediately following stunning and bleeding had major effects on the weight of both the warm and cold carcass. Infusing the body with 10% of its original weight with water increased warm carcass weight in a 100 kg pig by 3.9 kg. The weight of most of the organs were increased in a similar manner. Cold water infusion had small effects on muscle temperature, but only significantly reduced muscle temperature at 45 min post-slaughter. Similarly, cold water infusion had minimal effects on muscle quality particularly in the SM. There were some indications in the LT that cold water infusion increased pork drip loss and increased the moisture content of pork. However, the muscle quality from both groups was extremely poor and it may have been difficult to discern any treatment effects that may have occurred if pigs of a normal genotype had been used. The process faces significant regulatory challenges since there is the potential for contaminating the internal tissues of the carcass and the question of adding water to meat would be an important concern for consumers. However, the vascular infusion process does provide a mechanism to control post-mortem metabolism and further work might be appropriate in pigs of normal genotype.

REFERENCES

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