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CHANGES IN EXPRESSIBLE FLUID LOSSES OF PORCINE MUSCULATURE AT DIFFERENT TIMES POST-RIGOR

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Please refer to Folio 15.

INTRODUCTION

When water holding capacity (WHC) of porcine musculature is assessed by either percent of drip loss (DL) (Honikel *et al.*, 1986) or filter paper fluid (FPF) accumulation (Kauffman *et al.*, 1986) at 24 hours post-mortem (PM), the WHC assessed by either method is low for pale, soft and exudative (PSE) muscle. These measurements at 24 hours PM are reproducible and consistent. However, when pork samples are obtained from retail stores (usually 96+ hours PM), we have noticed that these indirect measurements of WHC varied considerably for both PSE and reddish-pink, soft and exudative (RSE) pork, and the results often resembled those of the more normal reddish-pink, firm and non-exudative (RFN) pork. This observation would suggest that the fluid is going to exude, does so in a time-dependent fashion. The only known difference of these samples and the ones tested for research was time PM. This phenomenon also has been observed by Van Laack (1989), and Swatland *et al.*, (1992) reported that the extra fluid released from PSE pork had already left the myofilament lattice at 24 hours PM and was awaiting release. These observations led us to the hypothesis that the reduced DL and FPF accumulation of both PSE and RSE samples at extended PM times were either because excess fluids had "leaked out" over time, or that the WHC of the muscle had improved.
We suspect the former explanation and thus designed an experiment to test this hypothesis. In the first trial, we simply followed the changes in WHC over time and in the second trial we attempted to account for total water content in the muscle over time.

MATERIALS AND METHODS

Trial 1

Six commercial pork loins representing either PSE or RSE were selected from a pork packing company at 24 hours PM. Each loin was cut at the seventh costae and a 3cm thick section of the *longissimus thoracis et lumborum* (LTL) was dissected and tested indirectly for WHC by FPF uptake (Kauffman *et al.*, 1986) and percent DL (48 hours at 5°C) (Honikel *et al.*, 1986). Surface lightness (L*) was measured in triplicate using a Minolta Chromameter 200b with viewing angle and D65 illuminant, auto-select calibration for the four colour standards and an 8mm optical port. Ultimate pH was measured with a portable Omega-pH50 meter and an Orion spear-tipped glass electrode. The ultimate pH and lightness (L*) values were used to confirm the quality classifications. This procedure was repeated on adjacent sections to include the LTL caudal to the previous section at 48, 72, 96. 120 and 144 hours PM. Mean WHC values at each time period were compared using analysis of variance procedures.

Trail 2

Six commercial pork loins were selected to represent PSE and RSE by subjective appraisals of colour and wetness. The

LTL was sampled and tested in an identical manner to trial 1 except that 36 hours PM was used and 144 hours was eliminated. Also, an adjacent 50g sample at each time period was frozen in liquid nitrogen, powdered in a blender and then analyzed for total water by drying for 24 hours at 105°C. In addition, the sample used to determine percent DL was subsequently frozen in liquid nitrogen after 48 hours suspension and blended and analyzed for total water as described before. Finally, the cranial and caudal portions of the loin that had not been used were blotted dry and weighed at each time interval PM to determine proportional changes ion weight over time (percent shrink). Similar statistical analysis as used in trial 1 was employed.

RESULTS AND DISCUSSION

Trail 1

Table 1 is included to identify the quality characteristics of the six LTL muscle at 24 hours PM. Based on chromameter L*, pH and FPF accumulation, four muscles were classified as PSE and two as RSE. Figure 1 includes the changes in percent DL over time. The FPF tests paralleled the DL changes (not shown), and the values at 96, 120 and 144 hours were significantly ($P0<.01$) lower than the 24 hour samples for both FPF and % DL.

Trail 2

Based on subjective visual appraisal of colour and wetness, all six muscles were classified RSE. Figure 2 graphically depicts the findings already reported in trial 1 where percent DL declined with time PM, but here, percent DL peaked at 48 hours PM. The percent DL of samples removed at 96 and 120 hours PM were significantly different ($P0<.05$) from those of samples removed at earlier times. FPF also declined with time PM as shown in Figure 2. Shrink (percent) of the cranial and caudal loin ends also showed a significant decline ($P0<.05$) with time PM, as shown in Figure 3, except for samples removed at 96 and 120 hours PM ($P>0.05$). As illustrated in Table 2, percentage total water was approximately 0.7% lower for each paired LTL sample exposed to a 48 hours DL (when compared to its adjacent sample that had been tested for water content prior to the DL test), this difference appeared to remain reasonably constant throughout the intervals and the water contents of muscles among all PM time intervals were essentially identical (also shown in Figure 2). Over the entire 96-hour time interval, there was a gradual but significant 1.6% elevation in water content of the drip resulting from the 48-hour suspension.

We concluded that percent DL and FPF accumulation of the LTL decreases over 24 hours to 144 hours PM, but this decrease was not linear as the majority of the fluid was lost in the first 24 to 48 hours PM. Drip is thought to originate from the lateral shrinkage of muscle fibres PM and appears to accumulate in extracellular spaces over 24 to 48 hours PM (Offer and Cousins, 1992). It is possible that the higher percent DL that we noted at 48 hours PM in trial 2 was a consequence of later release of fluid from the myofilament lattice in RSE pork samples, although this was not observed in trial 1. After suspension for 48 hours to measure DL, the samples contained on average about 0.7% less water at each time period, but we failed to detect any changes in total water content of the muscle (prior to suspension) at any of the time periods. This suggests that either the WHC of various anatomical locations of the LTL differs significantly as has been reported by Lundstrom and Malmfors (1985) or that the WHC of the musculature has improved, possibly either through renaturation of the proteins or through expansion in the myofibers with time PM. The observations made in this study suggest that indirect measurements of WHC change over various PM periods, but the musculature did not support the "leaking out" theory. However, our results do not necessarily suggest that `actual' WHC of the musculature changes because this was not measured. Perhaps participants of the ICMST may be able to help us provide a logical explanation for these results!

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Table 1. Description of muscles representing PSE and RSE at 24 hours post-mortem for Trail 1. (Values represent mean ± standard errors).

Muscle class n	Lightness L*	pH	Filter Paper Fluid (mg)
PSE, 4	58.4 ± 1.4	5.34 ± 0.05	164 ± 11
RSE, 2	50.6 ± 1.8	5.42 ± 0.04	106 ± 38

Table 2. Change in total water content of muscles prior to and after 48-hour suspension and of the drip collected over time post-mortem. (Values represent means ± standard errors. N=6).

Start time PM. h	Muscle sample adjacent to pre-suspend muscle % water	Post-suspended muscle % water	Decrease in absolute percent water after suspension	Percent water in drip
24	74.3 ± 0.3	73.6^{bc}±0.3	-0.7	84.7^{a} ±0.3
36	74.6 ± 0.3	74.2^{a} ±0.2	-0.4	84.5^{a} ±0.2
48	75.0 ± 0.1	74.1^{a} ±0.1	-0.9	84.7^{a} ±0.3
72	74.7 ± 0.2	74.3^{a} ±0.3	-0.4	85.1^{ab}±0.3
96	74.6 ± 0.4	74.0^{ab}±0.3	-0.6	85.3^{b} ±0.5
120	74.2 ± 0.4	73.2^{c} ±0.4	-1.0	86.3^{c} ±0.4

^{a,b,c} Means with different superscripts in the same column differ significantly ($P<0.05$).