# EFFECT OF SEAON, TRANPSPORT LENGTH, DECK LOCATION AND LAIRAGE LENGTH ON BLOOD CORTISOL CONCENTRATION AND PORK QUALITY

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## Introduction

The 2002 Unites States National Pork Benchmarking Audit estimate of economic loss associated with pale, soft, and exudative (PSE) pork has been reported at $0.90 per pork carcass. Given the estimated daily market hog slaughter capacity in the U.S is around 420,000 pigs/ d, the estimated cost of PSE pork to the United States packing industry is approximately $378,000 a day.

There have been numerous studies investigating the effects of various transport and lairage lengths (Hambrecht et al., 2005; Warris et al., 1987, 1998) relative to muscle metabolism and pork quality. In the U.S double-decked "pot bellied" trailers for multiple species are commonly used to transport market hogs. Very little research evaluating the influence of seasonal environment or differences between transport deck location during transport on blood parameters and ultimate meat quality data has been conducted in the U.S. The objectives of this study were to determine the effects of seasonal environment, top and bottom deck transport, transport duration and time in lairage on pork quality and blood serum cortisol concentrations of market hogs.

## Materials and Methods

Mixed commercial crossbred market hogs (PIC, Franklin, KY) were harvested at dates representing traditional seasonal environments in the Midwestern United States: February, 2006 (W), (n = 599), May, 2006 (SP), (n = 660), August, 2006 (SM), (n = 649), and October, 2006 (F), (n = 661). Within season, pigs were randomly assigned to one of 8 treatments in a 2 x 2 x 2 factorial arrangement, with two transport durations; short (3 h) or long (6 h), two deck locations (top or bottom), and two lairage durations; short (3 h) or long (6 h). All pigs originated from the same commercial source and were harvested on two seperate days within each season. Temperature and relative humidity were recorded during transit. Pigs were given ad libitum access to water during lairage. All pigs were subjected to humane electrical stunning procedures. Blood was collected at exsanguination into pre-numbered 15ml vacutainer tubes. Each pig was then tagged with a metal ear tag possessing the number corresponding with the blood tube. Blood samples were cooled, transported to the laboratory, centrifuged, serum was removed, and then stored at -20°C until cortisol analysis assayed in duplicate. Values were reported in ng/ml. At 24 h postmortem, left loins were collected in the plant, cut at the $10^{th}/11^{th}$ rib interface and tagged for meat quality assessment. *Longissimus* muscle (LM) pH was taken (MPI pH-Meter) after a 10 min bloom time. Objective lean color (L*, a*, b*) was evaluated on the cut surface of the loin after a 10 minute blooming period using a Konica-Minolta portable Chroma Meter (Model CR 410) with an illuminant setting of D65/10 calibrated to a white tile. A 2.54 cm diameter core sample was taken from the $10^{th}/11^{th}$ rib interface for determination of drip loss as described by Rasmussen and Stouffer (1996). Initial core samples were weighed, placed into a meat extraction tube and placed in a 4°C cooler for 24 h. After 24 h samples were reweighed. Drip loss (24 h) percentage was calculated by dividing the difference between weights by initial sample weight X 100.

Data were analyzed by the mixed-model procedure (PROC MIXED) of SAS. Tests of multiple comparisons of LSMEANS were adjusted according to the TUKEY-KRAMER method to ensure the overall significance level of $P < 0.05$.

## Results and Discussion

*Serum Cortisol Concentrations at Exsanguination*. Pigs transported to slaughter in the Fall had the highest cortisol levels. Aside from long hauled pigs transported on the bottom deck, Fall pigs transported on the long haul on the top deck had significantly higher serum cortisol concentrations than pigs hauled any other season, regardless of short/long transport or top/bottom deck location. Summer harvested pigs had lower concentrations of cortisol after a short lairage whereas, Winter, Spring, or Fall harvested pigs had elevated cortisol concentrations associated with a short lairage, suggesting a prolonged exposure to heat during lairage in the summer has a more profound influence on cortisol release. During Winter, Spring, or Fall the cooler temperatures and lower humidity do not interact with the stress of transport, therefore the longer lairage facilitates resting and or recovery. Minolta L* value. Short haul and short lairage resulted in pork loins with a higher L* value in Winter and Fall vs. Spring and Summer. Pigs given a long haul and short lairage transported to slaughter Spring, Summer or Fall had similar L* values.

*Intramuscular Ultimate pH*. A trend was observed (P = 0.09) for pigs transported on the bottom deck of the trailer to possess a higher loin muscle pH as the haul and (or) lairage duration increased. Pigs transported

in the bottom deck on the long haul then given a long lairage had higher pH than pigs within the bottom deck given short transport duration regardless of lairage time. Our research validates other studies that show short transport followed by a longer lairage results in an elevated intramuscular pH. Similarly, pigs given a long haul and long lairage transported on the bottom deck had higher pH than like pigs transported on top deck. Within summer, pigs given long lairage had higher loin pH than the short lairage group, regardless of transport length.

*Drip Loss*. Pigs transported in the Summer had the lowest drip loss of any season. Pigs from Spring harvest transported on the long haul had significantly higher drip loss values than pigs given the same haul length from any other season. Pigs transported on the top deck during Winter had significantly lower drip loss than pigs on the same trailer on the bottom. Conversely, pigs transported on the top deck in the Fall had higher drip loss than corresponding pigs on the bottom deck.

**Table 1.** Seasonal effects of transport deck location, transport length and lairage length on circulating blood cortisol, pH, Color (L*=lightness) and Drip Loss in the longissimus muscle[a].

| | | Deck (D) | | | Transport (T) | | | Lairage (L) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Season (S) | Measurement | Top | Bottom | SE | Long | Short | SE | Long | Short | SE |
| Winter (n=599) | Cortisol (ng/mL) | 82.11 | 83.49 | 2.9 | 85.08 | 80.51 | 3.2 | 78.63 | 86.96 | 3.2 |
| | 24 hour pH | 5.62 | 5.62 | .01 | 5.62 | 5.63 | .01 | 5.63 | 5.71 | .01 |
| | L* value | 53.28 | 53.57 | .16 | 53.09 | 53.76 | .20 | 53.13 | 53.72 | .16 |
| | Drip loss, % | 2.78 | 3.29 | .12 | 2.87 | 3.19 | .12 | 3.08 | 2.98 | .13 |
| Spring (n=660) | Cortisol (ng/mL) | 88.86 | 87.60 | 2.9 | 92.03 | 84.44 | 3.2 | 83.18 | 93.28 | 3.2 |
| | 24 hour pH | 5.70 | 5.71 | .01 | 5.70 | 5.71 | .01 | 5.72 | 5.70 | .01 |
| | L* value | 51.84 | 51.70 | .14 | 52.04 | 51.50 | .14 | 51.74 | 51.79 | .15 |
| | Drip loss, % | 3.27 | 3.09 | .11 | 3.50 | 2.86 | .11 | 3.22 | 3.15 | .11 |
| Summer (n=649) | Cortisol (ng/mL) | 99.65 | 103.33 | 2.6 | 104.53 | 98.45 | 2.6 | 123.02 | 79.95 | 2.6 |
| | 24 hour pH | 5.66 | 5.68 | .01 | 5.69 | 5.66 | .01 | 5.74 | 5.61 | .01 |
| | L* value | 51.84 | 52.31 | .15 | 52.27 | 52.42 | .15 | 52.28 | 52.41 | .15 |
| | Drip loss, % | 1.97 | 1.70 | .11 | 1.85 | 1.82 | .11 | 1.90 | 1.77 | .11 |
| Fall (n=661) | Cortisol (ng/mL) | 120.24 | 113.06 | 3.3 | 124.26 | 109.04 | 3.3 | 103.93 | 129.38 | 3.3 |
| | 24 hour pH | 5.65 | 5.69 | .01 | 5.69 | 5.65 | .01 | 5.64 | 5.61 | .01 |
| | L* value | 53.31 | 52.78 | .18 | 52.72 | 53.37 | .20 | 53.01 | 53.08 | .18 |
| | Drip loss, % | 3.03 | 2.35 | .13 | 2.54 | 2.84 | .13 | 2.54 | 2.84 | .14 |

[a]Data in the table are presented as least squares means

**Conclusions**

The findings of this project have many implications for future research relative to individual animal stressors experienced through the ante-mortem process. Our findings indicate that real-time assessment of physiological responses of individual animals relative to specific ante-mortem stressors such as stockmen interaction, loading, mixing animals, driving, transport and lairage will provide a more sensitive and scientifically valid model to evaluate factors affecting preslaughter stress. Furthermore, it will provide the industry with an objective means for measuring preslaughter stress identifying precise negative factors associated with animal welfare and ultimate meat quality to be corrected. Identification of events for which a specific physiological response can be quantified, and then taking steps to eliminate (or minimize) that event would not only improve the quality of U.S pork products, but globally improve the perception of the meat industry.

**References**

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