Infrared technologies for identification of market pigs at risk during transport

S. Ereke[1], N. Cook[2], B. Predicala[1], P. Shand[3], and J.A. Brown[1,4]

Jennifer Brown

Samuel Ereke

SUMMARY

Digital infrared thermography (DT) is a non-invasive imaging technique that could be a valuable instrument for producers and packaging plants to identify compromised and diseased animals for isolation and treatment, as well as to implement management practices to reduce the prevalence of pale, soft and exudative (PSE) pork. The decreasing cost of infrared technology makes it a potential for automated real-time data collection. This study evaluated a simple 'consumer grade' digital thermography (DT) camera for measuring stress in market weight pigs; comparing DT values collected on-farm with those collected at an abattoir after transport; and determining if DT values collected at the abattoir are predictive of physiological measures of stress and meat quality characteristics. The results indicate that infrared technology is able to measure temperature changes due to stress in pigs. Temperature measures collected on the farm following weighing and tagging were predictive of pig's response to transport, and measures collected in the abattoir after transport were predictive of physiological measures of stress and meat quality.

INTRODUCTION

According to the Code of Practice for the Care and Handling of Pigs, producers cannot transport unfit pigs. Compromised animals with obvious injury or disease are easy to detect with visual examination. However, sick (febrile) pigs or those affected by stress are more difficult to identify during visual assessment at loading. Digital infrared thermography (DT) is a non- invasive imaging technique that involves recording superficial thermal emission patterns from the pig. Temperature measurements using DT is a promising tool to identify stressed or sick animals in real time with potential benefits for producers and packers.

This project had multiple research objectives. First, two models of DT cameras (research and consumer grade) were used to evaluate whether an inexpensive DT camera (with limited pixel resolution) was as effective for identifying of sick or stressed animals as a more expensive model with higher resolution capabilities.

A second research objective was to identify which area of the pig is more reliable for surface temperature measurement for identifying stressed or morbid pigs. Two body regions were compared, with DT images obtained of the pigs' eyes (ocular region) and body (dorsal region), to determine changes in pigs' temperature over time.

Pork quality can also be affected by stress, with pale soft and exudative (PSE) meat being a significant problem. Because of its association with acute stress, PSE meat is also an indicator of poor welfare, however, there is still no simple, non-invasive, and reliable way to assess acute stress before slaughter. DT may be a useful tool to identify pigs experiencing stress and thus manage and improve pig welfare and pork quality.

EXPERIMENTAL PROCEDURES

Evaluation of research grade and consumer grade digital infrared cameras for assessment of temperature changes in market pigs following handling

A research grade (RG) camera (FLIR A325sc, resolution: 320x240 pixels, FLIR Systems) was compared to a consumer grade (CG) camera (FLIR C3, resolution: 80x60 pixels, FLIR Systems) on 168 finisher pigs near market weight. Eighteen pens of 4-5 pigs were randomly assigned to two treatments, where half of the pens (84 pigs) acted as the Control group (no handling treatment) while the remaining pens received a mild handling stressor consisting of moving groups of two or three pigs down the hallway and back to the home pen (a distance of approx. 100m). Baseline DT images were obtained on the pig's whole body and eye area using both the RG and CG cameras. Three images taken in rapid succession using each camera of both the body and eye region to ensured precise measurement.

Treatment pigs were moved 50 m down a hallway (total distance of 100 meters) in groups of two or three (two groups per pen), then returning to their home pen where ocular and dorsal surface temperature measurements were taken (using both cameras within five minutes of completing the handling stressor). Control pigs remained in their home pen throughout the trial.

1 Prairie Swine Centre Inc, PO Box 21057, 2105 – 8th Street East, Saskatoon, SK S7H 5N9
2 Livestock Systems Section, Alberta Agriculture and Forestry, Lacombe Research Centre, 6000 C & E Trail, Lacombe, AB T4L 1W1
3 Department of Food and Bioproduct Sciences, College of Agriculture and Bioresources, University of Saskatchewan, 51 Campus Drive, Saskatoon, SK S7N 5A8
4 Department of Animal and Poultry Science, University of Saskatchewan, 51 Campus Dr, Saskatoon, SK S7N 5A8

Relationship between thermographic images collected on-farm and following transport

Infrared data collection

DT images of two body areas (ocular and body regions: three images for each per pig) were obtained on all selected pigs in their home pen after selection, weighing and tagging (T1: three days prior to transport) and again on the day before transport (T2) with minimal handling using a CG. The purpose of collecting DT images at two time points was to compare data collected on calm pigs with data collected after a handling stressor, and determine which is better for predicting stress at later time points.

Table 1. Descriptive statistics for infrared ocular and body temperature measures recorded on market pigs at three time points*

Variable	N	Mean Temperature (°C)	Std Dev	Min.	Max.
Ocular T1	120	37.95	2.96	34.10	49.97
Body T1	120	37.29	3.12	33.87	50.13
Ocular T2	120	35.36	1.00	32.43	37.13
Body T2	120	34.69	1.21	30.30	36.83
Ocular T3	120	36.51	1.03	33.93	38.77
Body T3	120	35.90	1.32	32.00	38.70

*Time 1 (T1): After tagging and weighing, three days before transport. Time 2 (T2): In group pens, one day before transport. Time 3 (T3): In lairage pens 10 to 45 min after transport.

Transport

Weekly batches of selected pigs (20 to 25 pigs/week) were shipped approximately 225km to a commercial packing plant using a commercial livestock trailer. On arrival at the packing plant, the fitness of test animals was assessed visually during unloading and in lairage pens, in addition the time taken to unload the trailer (start and end) as well as any handling problems were recorded. Once pigs entered the lairage pen, DT measurements were repeated on all pigs (T3), as previously described.

Can infrared body temperatures pre-mortem predict meat quality in pigs?

Carcass and meat quality measurements

Carcasses of test animals were identified using individual tattoo numbers and placed on a separate rail in the cooler. Carcasses were split, eviscerated and chilled according to standard commercial practices.

Measurements:

- Muscle pH was evaluated on carcasses in the cooler at 1 and 3 h post mortem at the 10th rib of the longissimus dorsi (LD) muscle using a probe pH meter.
- The pH24 was measured in the loin (LD) muscle at 24 hours post-mortem.
- Meat colour was determined in LD muscle at 24 h post-mortem using a chromameter (Minolta Chromameter, CR 300) according to the reflectance coordinates (CIE L*, a*, b*) after exposing the muscle surface to 15 minutes blooming time at 4°C.
- Three cylindrical muscle cores were taken by a cork borer (25 mm diameter) in each slice and weighed. After weighing, the cores were placed into plastic drip loss containers in sample racks and stored at 4°C. Forty-eight hours after sampling, the samples were removed from their containers, carefully dabbed and weighed.

RESULTS AND DISCUSSION

Evaluation of research grade and consumer grade digital infrared cameras for the assessment of body and ocular temperature changes in market pigs following handling

Effect of camera model and region of interest

Both the research grade (RG) and consumer grade (CG) cameras recorded significantly higher temperatures in the ocular region of pigs after a handling stressor; indicating that both cameras were sensitive enough to identify changes in body temperature due to a mild handling stressor. Temperature of the body region was also significantly higher in treatment pigs following handling, compared to baseline temperatures. However, a significant change in temperature was also found in control animals using the research grade camera, indicating that other factors such as ambient temperature may have affected pigs' body temperature.

Relationship between thermographic images on-farm and after transport

The objective of Experiment 2 was to determine if body temperatures measured on-farm using DT are predictive of body temperatures recorded after transport. Body and ocular DT measures were recorded at two time points on the farm, once (T1) shortly after pigs were stressed by weighing (movement out of the pen and through a weigh scale), ear tagging and slap tattooing, and again two days later (T2) where pigs were disturbed as little as possible. Interestingly, there were significant correlations between T1 measures and DT measures collected after transport, but no significant correlations were found between T2 temperatures and those collected after transport.

Average ocular temperatures were higher than body temperatures at all time points, and overall, the temperature results were highest at T1 and lowest at T2. The T1 measures were recorded immediately after weighing, ear tagging and tattooing the pigs, indicating these handling procedures resulted in higher average temperatures. Temperature measures at T1 also showed a wider range and SD (Table 1). The T2 infrared recordings were collected on pigs in their home pen (with minimal disturbance) on the day before transport, and resulted in lower average temperatures and SD values. Temperatures recorded at T3 fell between T1 and T2 results, suggesting that the stress levels following transport were lower than after on-farm handling (T1).

Can infrared temperatures pre-mortem predict meat quality in pigs?

Numerous significant relationships were identified between DT measures after transport, physiological measures of stress and meat quality characteristics. Of particular note were the relationships between DT temperatures and blood cortisol, b* (meat yellowness), pH and WB shear force (tenderness). Increasing ocular and body temperatures corresponded with higher cortisol levels in blood, lower meat pH at 3 h post-mortem, increased yellow colour and tougher meat. In general, these factors are all associated with PSE pork, although meat lightness (L*) was not affected by pig temperatures in this study.

IMPLICATIONS

Results from this project indicate that an inexpensive 'consumer grade' DT camera is suitable for recording temperature measures in pigs. The consumer grade camera gave similar results to a more expensive research grade camera when used to compare body temperatures between non-stressed pigs and pigs that received a mild handling stressor.

On farms, infrared technology could be used to determine if pigs are stressed during handling or following procedures such as mixing, so that management can be improved, and compromised animals identified. It could also be used to identify sick (febrile) animals in a disease outbreak allowing rapid diagnosis and treatment.

Associations between meat quality and pig temperatures were statistically significant but not strong enough to accurately predict meat quality problems. However, the small sample size and favorable conditions (lack of high ambient temperatures) in this study limited the results, and further investigation is warranted.

ACKNOWLEDGEMENTS

We acknowledge financial support from the Saskatchewan Agriculture Development Fund. The authors would also like to acknowledge the strategic program funding provided by Sask Pork, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund. In addition, we also wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.