

Effects of Transport Duration on the Stress Response and Pork Quality of Pigs

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SUMMARY

The impact of the effects of transportation duration, season, and compartments (within trailers) was examined in relation to the stress physiology of market pigs and pork quality. Results indicate transportation of pigs over longer distances producing more significant results. Seasonal differences also indicate that pigs experience a greater amount of stress in summer months largely due to heat stress during summer transport. While compartmental differences indicate some compartments within the trailer produced a greater amount of stress on market hogs, and a reduction in meat quality.

INTRODUCTION

The transport of market pigs within Canada presents a number of significant challenges, including long transport durations, and extremes of temperature. These conditions can cause significant stress in pigs, which is detrimental to their welfare and may also affect transit losses and meat quality. It is therefore important to understand factors influencing transport conditions of market pigs within Canada and how these affect the welfare of pigs and pork quality.

These findings were part of a larger project on the transport of pigs in Canada. This study examines the effects of transport times of 6, 12 and 18 hours on the stress physiology and subsequent meat quality of pigs transported to slaughter in western Canada, and effects of season (summer and winter) and compartmental variation in the truck.

EXPERIMENTAL PROCEDURES

Animals and transport procedures

Over a period of eight weeks (four weeks per season) three transport trailers were loaded with market pigs (mean live weight 121 kg) and transported from a commercial finishing operation to an abattoir. Each week, prior to leaving for market 16 focal pigs per truck

were weighed, identified with ear tags and given an individual tattoo number. Feed was withdrawn 8-9 hours before transport, but water remained available. To study the effect of durations of transport (6, 12 and 18 h), three trucks were loaded at six hour intervals, with the 18 h truck leaving the farm at 1 pm, the 12 h truck at 7 pm and 6 h truck at 1 am on the day before slaughter. Timing of loading was scheduled such that the three trucks arrived at the abattoir at the same time. The abattoir was located 300 km from the farm, and longer transport times were achieved by travelling by longer routes to the abattoir. Pigs travelled at a density of 0.38 m²/pig (4 ft²), in accordance with Canadian Agri-Food Research Council guidelines. Winter transport took place between January and February (average temperature -13.4°C) and summer transport between July and August (average temperature 25.9°C). In each week, the meat quality of 48 pigs was studied. These focal pigs were distributed 4 per compartment, across four compartments (C) of interest, C1, C4, C5 and C10 (Fig. 1).

“Improvements in truck design and optimization of handling and transport practices will reduce most of the stress experienced by pigs during long transport.”

Pigs were unloaded at the abattoir and rested in lairage for 1.5 hours with water provided, following which they were driven to an electrical stunner and processed. After evisceration carcasses were chilled (1-4 °C) for 24 hours pending cold deboning.

Stress physiology measures

Indicators of physiological stress creatine kinase (CK), cortisol and lactate were measured in 48 pigs per week. Blood was collected at exsanguination. For the measurement of CK and cortisol a minimum of 10mL was collected without anticoagulant. Serum was collected and stored at -80°C until analysis. For lactate, 2 mL of blood was collected in tubes containing anticoagulant. These samples were centrifuged and the plasma was stored at -80°C until analysis.

Meat quality measures

Muscle pH and temperature was measured in the longissimus dorsi (LD) and semimembranosus (SM) muscles at 24 hours postmortem. Light reflectance (color) was measured on SM and LD muscles with a Minolta Chromameter CR 300 (CIE L*, a*, b*) after exposing the muscle surface to 45 min blooming time. Drip loss was assessed on

an adjacent chop according to a modified EZ-DripLoss procedure (Correa et al., 2006). The muscles were classified according to the following quality categories: pale, soft and exudative (PSE), moderate PSE, red, firm and nonexudative (RFN or normal), pale, firm and non-exudative (PFN), red, soft and exudative (RSE), moderate DFD and dark, firm and dry (DFD) as described by Correa et al. (2006).

RESULTS AND DISCUSSION

Stress physiology measures

The mean concentration of CK in pigs was affected by compartment ($P < 0.001$) and the duration of the transport ($P < 0.05$). A significant interaction between the transport duration and the compartment (Fig. 2) indicates significantly higher concentrations of CK occur when pigs are transported for longer durations (12 & 18 h), and when housed in C4 and C10. As a measure of physical stress (Warris et al., 1994), these results demonstrate that the longer journeys are more physically demanding for pigs. The interaction with compartment demonstrates that some compartments can cause more stress (C4 and C10), while in others (e.g. C1) pigs traveled long journeys with no increase in CK.

Season affected the concentration of cortisol in pigs with levels being significantly higher during summer than winter (Summer: 36.11ng/mL, Winter: 27.42ng/mL, $P < 0.05$) suggesting that pigs experienced a greater amount of stress in the summer months. This influence of season is most likely due to heat stress during summer transport, and other studies have frequently observed that more death losses occur in summer months (Vecerek et al., 2006).

The concentration of lactate in pigs transported in C10 was significantly lower than in the other three compartments ($P < 0.01$). An interaction between season and compartment showed that in summer there was no difference in lactate concentrations between pigs in different compartments, however in winter pigs had significantly higher lactate concentrations when travelling in C1 and C4 (Fig. 3).

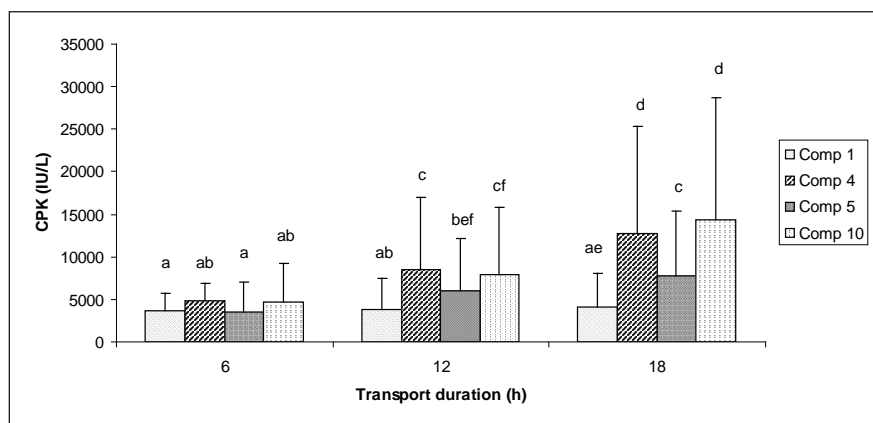


Figure 2. Mean concentration of CK (IU/L) in pigs transported for 6, 12 and 18 hours in different vehicle compartments. Where superscripts differ $P < 0.05$.

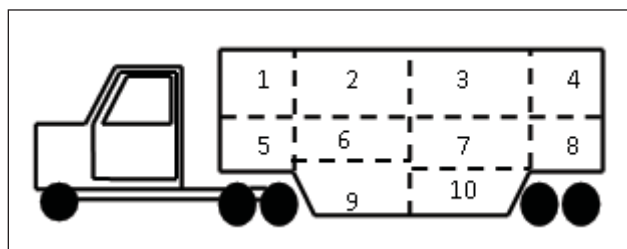


Figure 1. Truck design indicating location of compartments within. Focal pigs transported in C1, C4, C5 and C10

Levels of lactate increase in individuals experiencing physical exertion and stress, leading to increased anaerobic glycolysis for the release of energy (Husain et al., 2003). Lactate thus provides a good measure of acute physical stress (Warris et al., 1994). The elevated lactate levels found in compartments C1 and C4, located on the top deck of the trailer, suggest that pigs travelling on the upper decks experienced greater physical exertion during the winter.

Meat quality

Multiple compartment and trip duration effects on meat quality were found. The longer the duration of travel, the lower the driploss observed in C4 and C10, whereas the rate of driploss did not vary for pigs transported in C1 or C5. Variation due to the interaction of compartment and trip length was greatest in C10, with driploss in SM muscle being higher following 6 hrs of transport compared to 18 hrs.

Within season, pigs traveling in summer in C4 had significantly lower driploss than pigs traveling in other compartments. In winter, pigs traveling in C10 had the lowest driploss, but this was only significantly different from C5. The variation in driploss from LD muscle due to compartment and season interactions differed from that in SM. In LD muscle, there were no significant differences between compartments in summer. Driploss in C10 was significantly greater in summer than in winter, and within winter, driploss from pigs in C1 was higher than in any other compartment.

The pH of LD muscle of pigs traveling in C10 for 18 h was highest compared to any other compartment (Fig.4). When traveling for 6 h the pH level did not differ between any of the compartments, while at 12 h, C4 was significantly higher than C1 and C10.

The colour (L^*) of LD muscle was significantly darker in C4 and C10 than in C1 and C5, with C4 and C10 showing moderate DFD characteristics. The large number of compartment differences found suggest that improvements to truck design would aid in improving both the welfare and meat quality of pigs during long distance transport.

CONCLUSIONS

Evidence from this study shows that the transportation of pigs over longer durations results in increased physiological stress on pigs and reduced meat quality, as longer durations (12 and 18 h) of transport generally produced more significant results. However, some compartments showing much greater effects than others. In particular, compartments C4 and C10 produced results demonstrating greater stress experienced by the pigs and reduced meat quality, while C1 and C5 produced fewer effects. Based on these results, it appears that much of the stress experienced by pigs during long transports can be ameliorated by improving truck design and optimizing handling and transport practices.

Some practical conclusions can be drawn from this work related to handling and transport of pigs. Pigs are highly susceptible to heat stress in summer, and this can be alleviated by several measures. The critical time for heat stress to occur is just after loading. Therefore, loading in hot weather should be done either very early or very late in the day, and loading documents should be prepared before loading to ensure speedy departure as air flow is needed to cool the pigs. Low stress handling, with minimal prod use, is also necessary to minimize heat stress. Loading density should also be considered, and reductions made in high temperatures and at higher marketing weights. Some truckers will shower pigs before transport, and

this can help to alleviate heat stress. However it should be noted that showering is only effective if transport begins immediately after showering, as air flow is needed to achieve evaporative cooling. Trucks in summer should remain moving for over 1 hour after leaving the farm in order to allow pigs to cool.

Stress and meat quality problems associated with winter transport, while causing fewer death losses, can be argued to be more severe than in summer months. Adequate boarding and bedding must be provided, with consideration given to the prevailing wind direction. Again, loading densities may need to be reduced to allow pigs room to avoid contact with truck siding.

Future work to improve transport conditions should focus on differences between compartments, and how to ameliorate the conditions within problem compartments. For example studies of air flow, vibrations and G-forces, and improvements in trailer boarding patterns and insulation would be useful. Further studies on loading density are also recommended.

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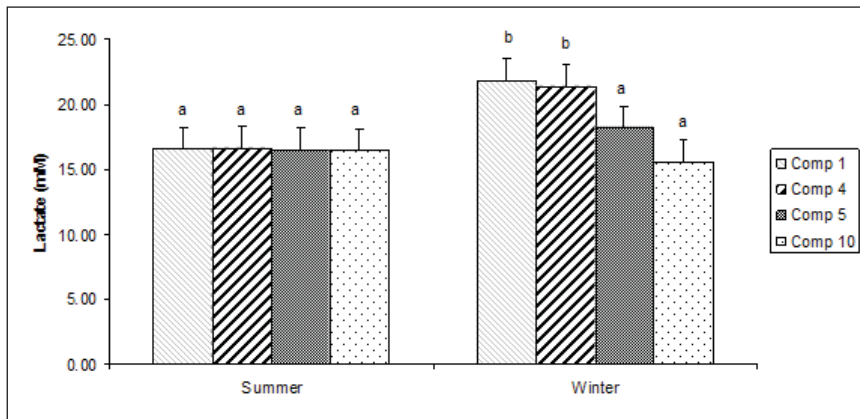


Figure 3. Concentration of lactate (mM) in pigs transported in different seasons and different compartments of a truck. Where superscripts differ ($P < 0.05$).

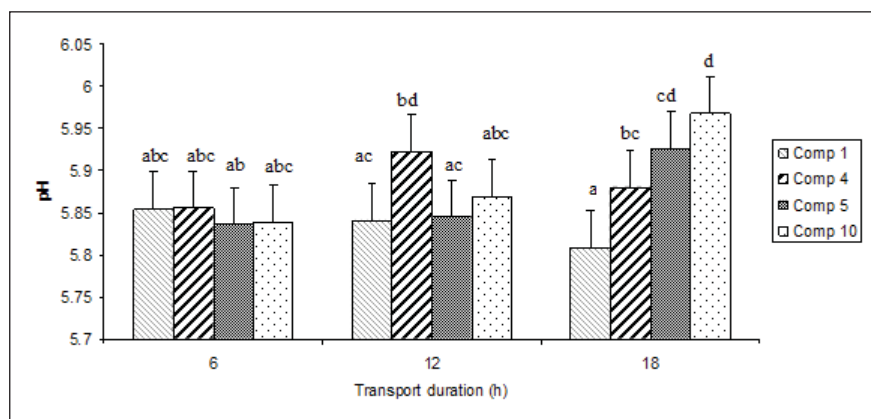


Figure 4. Final pH in longissimus muscle from pigs transported for 6, 12 and 18 h in different compartments within the truck. Where superscripts differ, $P < 0.05$.