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Effect of feed texture, meal frequency and pre-slaughter fasting on carcass and meat quality, and urinary cortisol in pigs

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Abstract

Carcass and meat quality traits, and urinary cortisol variation was studied in 96 barrows assigned to the following treatments: feed texture (FT; mash *vs*. pellets), meal frequency (MF; 2 *vs*. 5 meals per day) and fasting time (F; 4, 14 and 24 h) according to a $2 \times 2 \times 3$ factorial design. Pigs fed mash, receiving feed five times a day and fasted for 24 h before slaughter had lower carcass dressing yield ($P < 0.001$). A higher ($P < 0.05$) bruise score was found on carcasses from pigs fasted for 14 and 24 h and fed either pelleted or mashed feed five times per day. The pH_u value in the Longissimus muscle increased ($P < 0.05$) with increasing fasting time, whereas in the Adductor muscle it was higher ($P < 0.05$) in pigs fed with pellets in two meals per day and fasted for 24 h. Urinary cortisol tended to be higher in pigs fasted for 14 h compared to those fasted for 4 ($P = 0.10$) and 24 h ($P = 0.06$). The results of this study show a significant influence of pellet feeding on carcass yield in fasted pigs, while the effects of pre-slaughter fasting time on meat quality traits were limited.

Keywords: Fasting; Feeding; Skin bruise; Meat quality; Cortisol; Pigs

1. Introduction

One of the standards included in many codes of practice or legislations requires that pigs should be fasted before slaughter at reasonable intervals and be given water ad libitum (Agriculture & Agri-Food Canada, 1993; SCAHAW, 2002). Among others, the advantage of feed withdrawal prior to slaughter is to increase food safety and improve meat quality (Chevillon, 1994; Eikelenboom, Hoving-Bolink, & Sybesma, 1991). Fasting pigs before slaughter reduces the volume of the stomach content at slaughter, preventing the release and spread of bacterial contamination (e.g. *Salmonella*) through the spillage of gut contents due to inadvertent puncture of the stomach during the carcass dressing process (Berends, Urlings, Snjiders, & van Knapen, 1996; Miller, Carr, Bawcom, Ramsey, & Thompson, 1997). Furthermore, pigs being handled on full stomach are more susceptible to transport sickness (Bradshaw, Hall, & Broom, 1995) and are more difficult to handle (Eikelenboom et al., 1991). These effects may result in a stress response, which can affect ante mortem muscle glycogen reserves with clear consequences on pork meat quality (Foury et al., 2005; Gispert et al., 2000).

A feed withdrawal of 16–24 h before slaughter is recommended in practice (Eikelenboom et al., 1991). However, industry reports and some studies have revealed a high variability in stomach weight at slaughter, even among pigs that were subjected to this fasting interval before slaughter (Guise et al., 1995; Turgeon, 2003). According to Guise

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et al. (1995), smaller feed particle size and pelleting may influence gastric emptying rate in pigs. A number of studies also reported lower whole stomach and content weights in pigs fed ad libitum compared to those subjected to restricted feeding (Magras, Delaunay, & Bénéteau, 2000; Turgeon, 2003). This difference can be explained by the intake of smaller feed portions at each meal in pigs fed ad libitum, which favours food digestion and consequently accelerates stomach emptying (Laplace, Corring, Rérat, & Demarne, 1986). Gregory, McFadyen, and Rayner (1990) also showed that feeding finely-ground feed favoured gastric emptying to the same extent as liquid feeding. The lower feed intake associated with pellet feeding, which is generally more finely ground (Fekete, Castaing, Lavorel, & Leuillet, 1983) might have contributed to this effect. However, the combined effects of mash *vs*. pellet feeding and different fasting intervals on the physiological response to pre-slaughter stress and pork carcass and meat quality variation are not known. This experiment was thus conducted to determine the combined effects of different feeding practices prior to transportation to slaughter and of various feed withdrawal times on stress hormones and carcass and meat quality variation of pigs. Another objective of this study was to determine the relationship between the degree of stomach fill, urinary cortisol, and meat quality traits variation.

2. Materials and methods

2.1. Animals and treatment

A total of 96 Duroc × (Landrace × Large White) crossbred barrows weighing around 63 kg (approximately 16 weeks of age) were randomly divided into four groups (or replicates) of 24 pigs each, and kept in pens of six animals on a commercial swine facility. Over the last six weeks of the finishing period, pens of pigs were either fed pellets or mash (feed texture factor: FT), and were fed either twice or five times per day (meal frequency factor: MF). Animals fed twice a day received their meals at 08h00 and 16h00, whereas the others received five meals every 3 h, starting at 8h00. Pigs were fed a corn-soybean based finisher ration containing 16% CP and 3300 MJ ME/kg. At 110 (±2.79) kg body weight (BW), pigs were shipped in groups of 24 pigs per replicate (six pigs per type combination of feed and number of meals) to the experimental swine unit of Agriculture and Agri-Food Canada (AAFC) in Lennoxville (QC). This transfer was made to ensure better control of the fasting intervals to be applied before slaughter. At the AAFC swine unit, animals within each feeding treatment were kept in small pens in groups of two pigs per pen for a period of five days in order to allow them to recover from transportation stress. The four feeding treatment combinations continued to be applied at the AAFC finishing site until the day of shipment to slaughter. Pigs were weighed two days prior to shipment to the abattoir in order to determine their BW. Prior to shipping, the three pens within each feeding treatment were randomly assigned to one of three fasting treatments (fasting factor: F). Feed was either not withdrawn (0 h) or withdrawn at 10 or 20 h prior to transportation. Animals were transported for 30 min in a single-decked trailer and were given 3.5 h rest at the AAFC experimental abattoir before slaughter. Total fasting time (from last feed to slaughter) was 4, 14 or 24 h, but water was available all the time. At slaughter, pigs were electrically stunned (head-only; 300 V for 4 s) and exsanguinated in a prone position. All animals were slaughtered in the middle of the day (10:30–13:30 h, 11:00–14:00 h and 14:30–16:00 h for the 14 h, 24 h and 4 h fasting time groups, respectively). Animals were cared for according to the recommended code of practice (Agriculture & Agri-Food Canada, 1993) and following the guidelines of the Canadian Council on Animal Care (1993).

2.2. Carcass weight, skin bruises and stomach weight

Following slaughter, carcasses were split, eviscerated and chilled (1 °C and air velocity of 1 m s^{-1}) according to standard commercial practices. Hot carcass weight was recorded and used to calculate the dressing yield. Skin bruises were assessed on the slaughter line with a photographic scale from 0 (none) to 5 (severe) (MLC, 1985).

Stomachs were removed directly from the dressing line during evisceration. They were identified and stored at 4 °C until they were weighed, full and emptied of their content. Content weights are expressed on a wet weight basis. The proportion of empty stomach weight (ESW) and stomach content weight (SCW) over the body weight (ESW/BW and SCW/BW) was also calculated.

2.3. Meat quality measurements

Muscle pH was assessed at 45 min (pH_{45}) and 24 h (pH_u) post-mortem with a pH meter (Oakton Instruments Model pH 100 Series, Nilis, IL) fitted with a spear type electrode (Cole Palmer Instrument Company, Vernon Hills, IL) and an automatic temperature compensation probe by insertion in the *Longissimus* (L) muscle at the 3rd/4th last rib (Canadian grading site) and in the *Adductor* (AD) muscles. At 24 h post mortem the following measurements were conducted in the L muscle in the carcass grading site region: electrical conductivity (EC) by insertion of the Pork Quality Meat probe (PQM-I-INTEK, Gmbh, Aichach, Germany); subjective color score using the Japanese Color Standards (JCS) ranging from 1 = pale to 6 = dark color (Nakai, Saito, Ikeda, Ando, & Komatsu, 1975); light reflectance using a Minolta Chromameter CR 300 (D65 light source with 0° viewing angle geometry) according to the reflectance coordinates (CIE L^*, a^*, b^*) after exposing the muscle surface to 1 h blooming time. Drip loss was assessed on an adjacent chop according to a modified "juice container" procedure (Christensen, 2003). Briefly, three cylindrical muscle cores were taken with a cork borer (25 mm diameter) in each slice and