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Influence of on-farm production practices on sensory and technological quality characteristics of pork loin

D.A. Omana [a], E. Goddard [b], G.S. Plastow [a], J. Janz [c], L. Ma [b], S. Anders [b], S.S. Moore [a,d], H.L. Bruce [a,*]

[a] Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta T6G 2P5, Canada
[b] Department of Resource Economics and Environmental Sociology, University of Alberta, Edmonton, Alberta T6G 2P5, Canada
[c] Leduc Food Processing Centre, Alberta Agriculture and Rural Development, Leduc, Alberta T9E 7C5, Canada
[d] Centre for Animal Science, Queensland Alliance for Agriculture and Food Innovation, University of Queensland, St. Lucia 4072, Queensland, Australia

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Quality of pork from pigs raised either traditionally (outdoor access or bedded settings with no sub-therapeutic antibiotics or growth promotants in feed) or conventionally (commercial indoor) was evaluated. Pork loins (m. *longissimus thoracis et lumborum*, LTL) from four hundred pigs from either traditional or conventional production systems (n = 200) fed commercially formulated diets ad libitum were harvested at slaughter. Intramuscular crude fat content and lean color (L^* and b^*) values were significantly decreased in conventional pork loins. LTL from conventionally-raised pig carcasses showed increased ($P < 0.05$) mean pH, moisture content and reduced cooking loss and shear force values and had increased tenderness and juiciness scores compared to those from traditionally-raised pig carcasses. Results indicated that pork from conventionally raised pigs was superior to that from traditionally raised pigs in terms of tenderness and juiciness, suggesting that consumers may value pork from traditionally raised pigs on the basis of factors other than eating quality and appearance.

1. Introduction

Production conditions vary between farms and differences between farm practices increasingly will be in response to market factors driven by consumer choices (Dransfield et al., 2005). Although incorporated in response to market signals, changes to the rearing protocols of pigs may affect pork quality. Alterations of pig rearing conditions by providing sawdust or wood shavings as bedding and free outdoor access can considerably improve pig growth performance and the subsequent eating quality of the pork from these pigs compared to the conventional housing system consisting of slatted floors (Lebret et al., 2006), although the responses of pigs to these alterations may also depend on pig genotype (Brandt, Werner, Baulain, Brade, & Weissmann, 2010). Outdoor rearing of pigs may also reduce animal stress, which may decrease the occurrence of pale, soft and exudative (PSE) or dark, firm and dry (DFD) pork, as Barton-Gade (2008) showed that pigs with outdoor access were less aggressive and had decreased serum creatine kinase activity after mixing at loading compared to pigs housed indoors. With outdoor rearing, pigs have more opportunity to move about and forage for food than those reared exclusively indoors. Also, increased exercise is important for animal welfare, as restricted movement can negatively affect the muscle tone and bone strength of animals (Edwards, 2003), although additional energy may be used by the unrestricted pigs for heat production to maintain body temperature and fuel movement (Edwards, 2005; Lebret, 2008). In fact, increased physical exercise may lead to increased muscle glycogen stores, which may decrease muscle ultimate pH post mortem and reduce technological yield during ham production (Bee, Geux, & Herzog, 2004).

Although the majority of studies have reported that juiciness and tenderness of pork meat do not differ based on rearing system (outdoor versus indoor), a reduction in the juiciness of pork from outdoor reared pigs has been reported (Enfält, Lundstrom, Hansson, Lundeheim, & Nystrom, 1997). Also, Beattie, O'Connell, and Moss (2000) reported that pigs reared in extensive conditions produced pork with reduced drip loss compared to that of pigs reared on slatted floors with minimum space allowances. Enfält et al. (1997) showed that outdoor rearing of pigs produced pork with lower ultimate pH, higher drip loss and higher shear force values than that from pigs housed in an indoor system, but Van der Wal et al. (1993) reported that pork quality was unaffected by rearing environment. Change in pH has an effect on myofibrillar proteins and will in turn affect other functional properties (Offer & Knight, 1988).

Sensory attributes like odor, flavor, juiciness, and tenderness, as well as technological qualities such as water holding capacity and shear force are associated with the eating quality of meat (Bonneau

* Corresponding author at: Carcass and Meat Science, Department of Agricultural, Food and Nutritional Science, 410 Agriculture/Forestry Building, University of Alberta, Edmonton, Alberta T6G 2P5, Canada. Tel.: +1 780 492 9871, +1 780 257 4705 (cell); fax: +1 780 492 4265.
E-mail address: Heather.Bruce@ales.ualberta.ca (H.L. Bruce).

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& Lebret, 2010); however, the perception of pork quality by a consumer may be influenced by credence attributes such as information regarding origin or production method (Ngapo et al., 2003). Rearing pigs with access to outdoor areas does not appear to affect pork meat quality as perceived by European pork meat consumers unless information regarding the pig production system is provided (Dransfield et al., 2005). Pork meat consumers in many European countries (Britain, France, Denmark and Sweden) preferred meat from an 'outdoor' system of production over 'indoor' (Dransfield et al., 2005). It was also noted that informing consumers about pig rearing practices like indoor space with free outdoor access positively influenced the perception of pork quality (Liljenstolpe, 2008). As a result, there may be a gap between the actual and perceived differences in quality (Edwards, 2005; Lebret, 2008).

The majority of research on the relationship between different rearing systems and the perception of pork meat quality has been performed in European countries; however, Goddard et al. (2012) recently examined the effect of the credence attributes of housing system, no sub-therapeutic antibiotics or hormones and no in-feed animal products on the consistency of Canadian consumer pork sensory and purchase decisions. Incorporation of outdoor housing into pork production facilities in Canada may affect pork quality because of the low temperatures associated with the Canadian winter (October to April) and have implications for consumer perception and demand of these products. The present study aimed to evaluate the influence of an outdoor access farm versus a conventional production farm on carcass and the technological and sensory characteristics of pork in a North American industrial perspective.

2. Materials and methods

2.1. Animals

Animals used in the present study included 400 pigs of Large White × Landrace commercial crosses with up to 25% Duroc and less than 10% Hampshire influence. Sexes were mixed and not differentiated as is common in commercial production. Pigs (200 each) were reared in either a traditional (T; $n = 200$) or conventional (C; $n = 200$) single farm production system and finished for slaughter during the months of November and December (Northern Hemisphere autumn). Single farm production systems were used to minimize variation due to farm geography and management for the purposes of another study (Goddard et al., 2012). A family farm production system with access to the outdoors and an indoor bedded setting and no sub-therapeutic antibiotics or growth promotants in the feed was termed a "traditional system" while the "conventional system" was a single farm commercial indoor production system with controlled environment conditions. Pigs raised on the traditional farm received a 40:40:20 mixed diet of wheat screenings, barley and field peas, respectively, with a 2% vitamin and mineral pre-mix. Pigs raised on the conventional farm received a 70:20:10 mixed diet of wheat, barley and fava beans, respectively, also with a commercial vitamin and mineral pre-mix. Feeding in both systems was ad libitum and intake and growth rates were not recorded as the pigs were raised in commercial settings that had not incorporated these practices. Pigs from the traditional farm operation were slaughtered at approximately 7 months of age when they reached a target live weight of between 126 and 135 kg. Pigs from the conventional farm were slaughtered at a target weight of approximately 115 kg at about 5.5 months of age. Pigs from both farms were slaughtered at the same federally-inspected abattoir in five different groups over a one month period with 40 pigs from each farm in each slaughter group. Following slaughter, both pork loins were harvested from each pig carcass, vacuum packaged and stored frozen at −20 °C until analysis.

2.2. Methods

2.2.1. Carcass quality characteristics

Carcass weight and lean yield were recorded in the slaughter plant. Lean yield was derived from the depth of the loin muscle and subcutaneous fat as described by Marcoux, Pomar, Faucitano, and Brodeur (2007) using a Destron probe (Model PG-100, Anitech Identification System Inc., Markham, ON).

2.2.2. Pork loin management

Sensory analysis was performed on one randomly chosen frozen pork loin from each animal while meat quality analyses were conducted on the remaining frozen pork loin. For meat quality analysis, samples from each housing system were equally represented at each analysis and all analyses were completed within three months of the respective slaughter date. Frozen pork loins were thawed for 72 h at between 2 and 4 °C immediately prior to analysis.

2.2.3. pH measurement

Measurement of muscle ultimate pH was performed on the thawed pork loin using a portable pH meter (Fisher Scientific Company, Toronto, Ontario) equipped with a glass electrode (Hanna HI 98121, Hanna Instruments, Quebec, Canada) calibrated using commercial pH 4 and 7 standards (Fisher Scientific, Toronto, Ontario) at room temperature. Measurements were taken by inserting the pH probe into a slice made by a scalpel within the center of the loin (approximately 4 cm in depth) in three different locations 2.5 cm from the sirloin end of the loin eye muscle (LTL).

2.2.4. Color

Following pH measurement, an approximately 2.5 cm thick chop was removed from the sirloin end of each LTL for color assessment using the color system values specified by the Commission Internationale de L'eclairage (CIE). In this system, L^* represents lightness, a^* represents redness and b^* represents yellowness of the loin muscle. After wrapping with oxygen-permeable plastic (Fisher Scientific, Mississauga, Ontario), the chops were placed in a refrigerator (4 °C) for 1 h. CIE color measurements were taken at the cut surface using a Konica Minolta Chromameter CR-400 (Konica Minolta Sensing Inc., Japan) and the average of three readings was used. The chroma-meter was calibrated against a white tile wrapped in oxygen-permeable plastic provided by the manufacturer.

2.2.5. Moisture and fat content

A second chop approximately 2.5 cm thick was removed from the sirloin end of the LTL muscle for moisture and fat content estimation. Each chop was trimmed of epimysium, weighed, cubed, frozen at −20 °C and then lyophilized for four days. Moisture content was calculated as the difference in sample weight before and after lyophilization. The dried sample was then powdered in a blender with dry ice and used to estimate crude fat content using AOAC (2007) method 960.39. Approximately 2 g of sample was extracted with petroleum ether for 2.5 h using a Goldfisch apparatus, a length of time deemed adequate based upon preliminary extractions (data not shown). Extracted fat was collected in a pre-weighed glass beaker, dried, weighed, and crude fat was calculated as the difference in beaker weight before and after sample extraction. Crude fat as a percentage of sample wet weight was calculated by using moisture content values for each respective sample.

2.2.6. Drip loss

A third chop of similar thickness to those above was removed from the sirloin end of the pork loin, trimmed of fat and connective tissue to approximately 90 g (±10 g) and used to determine drip loss. The trimmed chop was suspended on a hook placed in a cold room (2–4 °C) and the chop was surrounded by an inflated plastic bag