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Carcass and meat quality traits of four different pig crosses

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ABSTRACT

The study compared properties of Finnish Landrace × Yorkshire crossbred sows mated with Finnish Landrace (FL), Norwegian Landrace (NL), Norwegian Duroc × Norwegian Landrace (NDL), or Swedish Hampshire (SH) boars. The focus was to study the cross-sectional area of loin, cross-sectional area and number of muscle fibres, loin colour and pH value as well as the ratio of water to protein in the loin.

The four studied crosses were quite similar having only small differences in carcass and meat quality. The carcass lean content was the lowest in NDL. The loins of FL and NL were longer than the loins of NDL and of SH. The cross-sectional area of loin was the largest in SH. The loin of FL was lighter in colour and the loin of SH was redder than the loins of the other crosses studied. The protein content was lower and the ratio of water to protein higher in loin of SH than in the other crosses.

1. Introduction

Meat quality is an important factor affecting how pork can be utilised. When choosing the best animal breeding strategy, it is important to recognise that meat quality traits of pigmeat depend on the breed.

The traditional pig breeds in Finland are Landrace and Yorkshire. The origins of Finnish Landrace pigs are Sweden and Norway whilst Finnish Yorkshire pigs originate from England, Denmark and Sweden. Both breeds have about 100-years breeding history in Finland. Nowadays, Landrace and Yorkshire pigs give equally lean carcasses and the technological quality of meat in both breeds is quite similar.

The Norwegian Landrace breed originates from Danish Landrace, but contains also traces of Large White (Epstein & Bichard, 1984). Therefore, its body conformation type and productivity are close to those of the Danish Landrace. The Norwegian Landrace pigs have a long and narrow body similar to all Landrace pigs. Pigs of this breed have a thin subcutaneous fat layer, large hams and high muscularity in the carcass.

Besides traditional white breeds, coloured Hampshire and Duroc breeds have been imported to Finland to improve the meat eating quality of Finnish breeds. The carcass fat content and backfat thickness are high in Duroc pigs (Martel, Minvielle, & Poste, 1988; Edwards, Wood, Moncrieff, & Porter, 1992; Alonso, Del Mar Campo, Espanol, Roncalés, & Beltrán, 2009). Duroc pigs are stress-resistant and have strong legs and bones (Barton-Gade, 1988). Duroc is usually used as a sire breed similar to the Hampshire breed. Crossbreeding is extensively used in pig production to increase the total efficiency of pig production (e.g. Bennet, Tess, Dickerson, & Johnson, 1983).

Both imported breeds, especially Duroc, have a higher intramuscular fat content than white breeds (Fjelkner-Modig & Tornberg, 1986; Barton-Gade, 1988; Ruusunen, 1994; Warriss, Brown, Adams, & Lowe, 1990). The high intramuscular fat content of Hampshire and Duroc pigs is also seen in their crosses (Fischer, Reichel, Lindner, Wicke, & Branscheid, 2000; Mörlein et al., 2007; Meinert, Christiansen, Kristensen, Bjergegaard, & Aaslyng, 2008), although Ruusunen (1994) and Lundström, Enfält, Tornberg, and Agerhem (1998) did not find differences when comparing the intramuscular fat content of loin of crosses between Hampshire boars and Landrace–Yorkshire sows.

The rate and extent of the post mortem pH fall and the ultimate pH can affect the colour of meat. A rapid pH decrease post mortem increases the lightness on the meat surface. Hampshire breed and its crosses usually have a lower ultimate pH than many other breeds but the colour of its meat is dark and red (Ruusunen, 1994). However, Barton-Gade (1988) found the highest ultimate pH of *M. longissimus dorsi* was in Duroc followed by Hampshire, Large White and Landrace.

Skeletal muscles are composed of fibres having different morphological, contractile and metabolic characteristics. The number of muscle fibres is fixed at birth (Wigmore & Stickland, 1983). Muscle size can also increase by satellite cell proliferation which is

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considered unimportant. Therefore, muscle growth and ultimate muscle mass are largely determined by the initial number of muscle fibres, the growth of the cross-sectional area and the length of individual muscle fibres. If the number of fibres in a muscle is low compared to the high number of muscle fibres, the thickness of muscle fibres must increase more in order to attain the same muscle mass at slaughter.

In pigs, it is widely reported that increasing the cross-sectional area of muscle fibre would be detrimental to meat quality, particularly affecting water holding capacity and tenderness (e.g. Rehfeldt, Fiedler, Dietl, & Ender, 2000). However, the large cross-sectional area is often not the only reason for detrimental meat quality. The reason can be, for example, high Ca^{++} release resulting in fast pH fall post mortem or also high muscle glycogen content (Bendall & Wismer-Pedersen, 1962; Huff-Lonergan & Lonergan, 2005).

Feeding has an effect on the amount of fat in the carcass. Lefaucheur et al. (2011) have found that low RFI (residual feed intake: defined as the difference between the observed feed intake and that expected based on requirements for maintenance and production) results in a high lean meat content, low intramuscular fat content but a low water binding capacity, low pH value and a light colour. According to Ruusunen, Partanen, Pösö, and Puolanne (2007) pigs with a low-protein supply showed a lower carcass lean meat content but higher carcass fat content than pigs with a high-protein supply.

The aim of the study was to compare carcass and meat quality traits of pigs produced by mating Finnish Landrace–Yorkshire sows with Finnish Landrace (FL), Norwegian Landrace (NL), Norwegian Duroc × Norwegian Landrace (NDL) or Swedish Hampshire (SH) boars.

Nowadays, about 80% of the Finnish pig production is based on crossbreeds where Duroc and Hampshire are used as a terminal sire on Landrace–Yorkshire sows.

Meat percentage in purebred Duroc is low compared to many other breeds. That is the reason why it is a normal practice in meat production in Finland to use Duroc–Landrace boars instead of purebred Duroc. That is why it also was done similarly in this study where the purpose was to compare pigs used in Finnish pork production. The focus was on the percentage of the loin in the carcass, the cross-sectional area of loin as well as the cross-sectional area of the muscle fibres, loin colour lightness and redness, pH of the loin and the ratio of water to protein in the loin.

2. Materials and methods

2.1. Animals, sample collection and treatments

A total of 140 crossbred pigs, that were crosses of Finnish Landrace–Yorkshire sows and Finnish Landrace (FL), Norwegian Landrace (NL), Norwegian Duroc × Norwegian Landrace (NDL) or Swedish Hampshire (SH) boars (34 to 36 pigs per crossbreed). The pigs were born and raised at Agrifood Research Finland's experimental farm in Hyvinkää. They were born to a total of 81 litters that were produced by 50 Finnish Landrace × Finnish Yorkshire crossbred sows. The number of litter per sire breed ranged from 20 to 21 and the number of sires per breed from 14 to 17. The pigs were housed in pens of two to thirteen animals during the weaner period, in pens of four animals during the grower and finisher periods and fed using the same multi-phase feeding regime until an average live weight of 115 kg. The piglets had an ad libitum access to a pelleted starter diet (9.5 MJ NE and 9.7 g apparent ileal digestible (AID) lysine per kg) from 14 days of age until 18 days after weaning and thereafter to a pelleted weaner diet (9.3 MJ NE/kg and 9.5 g AID lysine/kg) until they were ca 25 kg body weight and were moved to the fattening unit. There the pigs received a grower diet (8.9 MJ NE/kg and 9.1 g AID lysine/kg) for 5 weeks, early-finisher diet (8.84 MJ NE/kg and 6.7 g AID lysine/kg) for 3 weeks and late finishing diet (8.8 MJ NE/kg and AID lysine 5.7 g/kg) until they reached 115 kg body weight and were slaughtered.

The pigs were stunned by carbon dioxide and slaughtered according to the normal commercial slaughter procedure. Carcass lean meat content was measured from the warm carcass *ca*. 35 min after stunning with a Hennessy Grading probe GP4 (Hennessy Grading Systems, Auckland, New Zealand). The first fat depth measurement (S1) was taken at the last rib, 8 cm from the mid line, and the second fat depth (S2) and loin depth (LD) measurements between the 12th and 13th ribs, 6 cm from the mid line.

The carcasses of two pigs per litter (one barrow and one gilt) were cut three to five days post mortem and the loin (*M. longissimus dorsi*) was dissected and weighed. The cross-sectional area of the loin was measured at 11–12 rib by taking a picture of the loin surface and measuring the area with image analysis software (KS300, Carl Zeiss Vision GmbH, Germany).

2.2. Measurements and analysis

The ultimate pH value of *M. longissimus dorsi* was measured between the 11 and 12 ribs (Knick Portamess pH metre 752 equipped with a Xerolyte electrode; Ingold Xerolyt LoT406-M6, Germany).

Colour ($L^* =$ lightness and $a^* =$ redness) was measured with a Minolta Chromameter CR-400 (Minolta Camera Co. Japan) calibrated with a white plate. The colour was measured on a freshly cut surface of the loin by making three measurements across the surface. The blooming time was 5 min at 12 °C.

Small pieces of *M. longissimus dorsi* (approx. 1 cm × 1 cm × 0.5 cm) were cut following the muscular fibres direction for muscle fibre size analyses. The samples were frozen in liquid nitrogen and stored at −80 °C until analysed. The sections (14 μm) were cut at −26 °C using a Reichert-Jung, 2800 Frigocut-E (Cambridge Instruments GmbH, Germany). The average fibre cross-sectional area was analysed by measuring an area about 1 mm^2 and calculating the number of muscle fibres on that area with an image analyser and computer programme (KS300, Carl Zeiss Vision GmbH, Germany). The average fibre cross-sectional area was calculated by dividing the area by the number of muscle fibres in that area.

The number of muscle fibres per loin area was calculated by dividing the whole loin area by the average muscle fibre cross-sectional area.

Water content was determined by drying the homogenised sample at 104 °C for 16 h. The protein content was analysed using the Dumas method (Vario MAX CN Elementar Analyser systeme GmbH, Germany) and a nitrogen factor of 6.25.

2.3. Statistical analyses

The data was analysed using SAS v9.1 (SAS Institute Inc. Cary, NC). The differences between the crosses were studied by the method of least squares using the General Linear Model (GLM) procedure. Partial correlation coefficient was calculated to study the relationship of the birth weight and cross-sectional area of muscle fibres. The effect of crossbreed was adjusted for.

To study the possibility of identifying pigs from different crosses that resemble each other on the basis of the studied properties, the pigs were classified using discriminate analysis. Each property was studied separately.

3. Result and discussion

In this study, Duroc–Norwegian Landrace crosses (NDL) contained only 25% Duroc as the boars were crosses between Duroc and Norwegian Landrace and the sows were crosses between Finnish Landrace and Finnish Yorkshire. Finnish Landrace (FL) contained 75% Finnish Landrace because the boars were Finnish Landrace and the sows were crosses between Finnish Landrace and Finnish Yorkshire. Norwegian Landrace (NL) and Swedish Hampshire crosses (SH) contained 50% of these pure breeds.