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Research Note

Foreleg Angle in Pig Carcasses as a Potential Indicator of Degree of Rigor Development and Meat Quality

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ABSTRACT

The current study was conducted to assess the foreleg angle (FLA) in pig carcasses as a potential indicator of the degree of rigor development and correlate it with certain pork quality attributes. Sixteen cross-bred female Large White Yorkshire pigs (6-8 months, 90-100 kg) were humanely slaughtered and the FLA at 45 min post-slaughter for each carcass (held at about 35 °C) was determined by pictorial measurement. Meat samples were analysed for pH at 45 min post-slaughter (pHi), instrumental colour, drip loss, ultimate pH (pHu) and difference between pHi and pHu (ΔpH). FLA was significantly correlated ($p<0.01$) with pHi, ΔpH and chilling loss, while there was no significant correlation between pHu and L, a and b values. When observations were grouped based on the FLA (Group I: FLA>120° and Group II: FLA<120°), the mean FLA for Group I (11 Pigs) was 128.8° and that for Group II (5 Pigs) was 103°, with significantly different ($p<0.05$) pHi values of 6.17 and 5.82 respectively. The ΔpH values for the two groups were 0.4 and 0.13 respectively, which were significantly different, indicating greater degree of rigor development in the latter group. The chilling losses of the two groups were 5.82 and 7.70 per cent respectively which differed significantly. There was no significant difference in the L, a and b values between the two groups. The results of the study indicate that FLA of less than 120° is a potential indicator of rapid rigor development in pork carcasses, which is an indirect measure of the pre-slaughter stress and pork quality.

Keywords : *Pig, Fore leg angle, Pre-slaughter stress, Pork quality*

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Pigs are considered to be one of the most stress-susceptible food animals. Various methods of handling and restraint, and environmental factors during marketing, transportation, holding in the lairage and in the immediate pre-slaughter period undesirably affect pork quality. These effects generally manifested as pale, soft, exudative (PSE) or dark, firm, dry (DFD) pork (Gregory, 1998), though the latter condition is more common in beef. There is a genetic pre-disposition to the stress susceptibility, with breeds like Hampshire, Landrace, Pietrain and Poland China being more susceptible (Gracey *et al*. 1999). These pork quality problems affect shelf life, eating quality, processing properties and yield of the product, besides being less visually appealing to retail customers (Faustman, 1994).

Assessment of the pre-slaughter stress and predicting lean meat quality has traditionally involved biochemical parameters (lactate, creatine kinase, cortisol) evaluation, subjective colour assessment or pH measurements, which are either time consuming and expensive, or less feasible in commercial slaughter facilities (Warris *et al*. 2003). Early post-mortem detection of potentially abnormal muscle quality is important because it allows the processor to subject the carcasses to different post-mortem treatments and helps to identify those herds which may be more stress susceptible (Eikelenboom *et al*. 1974). This pilot study was conducted to correlate the degree of early post-mortem rigor development with certain pork quality attributes, which were indicative of pre-slaughter stress experienced by the animal.

Sixteen cross-bred female Large White Yorkshire pigs (6-8 months, 90-100 kg) were humanely slaughtered following scientific slaughter techniques at the Department of Livestock Products Technology and Meat Technology Unit, College of Veterinary and Animal Science, Mannuthy, Kerala. The group included those pigs which were slaughtered immediately after a short distance transport (one km) as well as those which were rested for about 16 hours in the lairage, but this was not considered as a treatment in the experiment. The animals were electrically stunned using low-voltage (100V), bled, scalded (at 64 °C, 6 min) and dehaired. These primarily processed carcasses were suspended from the overhead gravity rail by one of the hind legs using shackle and left lateral view photographs of the suspended carcasses were taken at 45 min post-sticking (Canon Power shot SX 140). The photographs were developed on photo glossy paper (A4 - 130 GSM) and foreleg angle (FLA) of each carcass was measured by slightly

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modifying the method of Davies *et al*.(1978). In the developed photographs, a straight line was drawn connecting the hock joint of the suspended left hind leg and the left angle of the jaw and a second straight line was drawn parallel to the anterior edge of the left foreleg. The upper angle of the point of intersection of the two lines was measured to get the FLA of each carcass (Fig. 1). Muscle samples were collected at 45 min post-sticking from *m. longissimus dorsi* at the region of the 10th rib. The muscle samples were analyzed for pH at 45 min (pHi) and ultimate pH after 24 h of chilling at 4±1°C (pHu) according to the method described by O' Halloran *et al*. (1997). The difference between pHi and pHu (ΔpH) was calculated. Objective colour of muscle samples in terms of Hunter L, a and b values was determined using Mini Scan XE Plus Spectrophotometer (Hunter Lab, Virginia, USA) with diffuse illumination. Chilling loss was determined as per Taylor *et al*. (1990). The data were recorded and analyzed statistically as per Snedeor and Cochran (1994) using SPSS software (Version

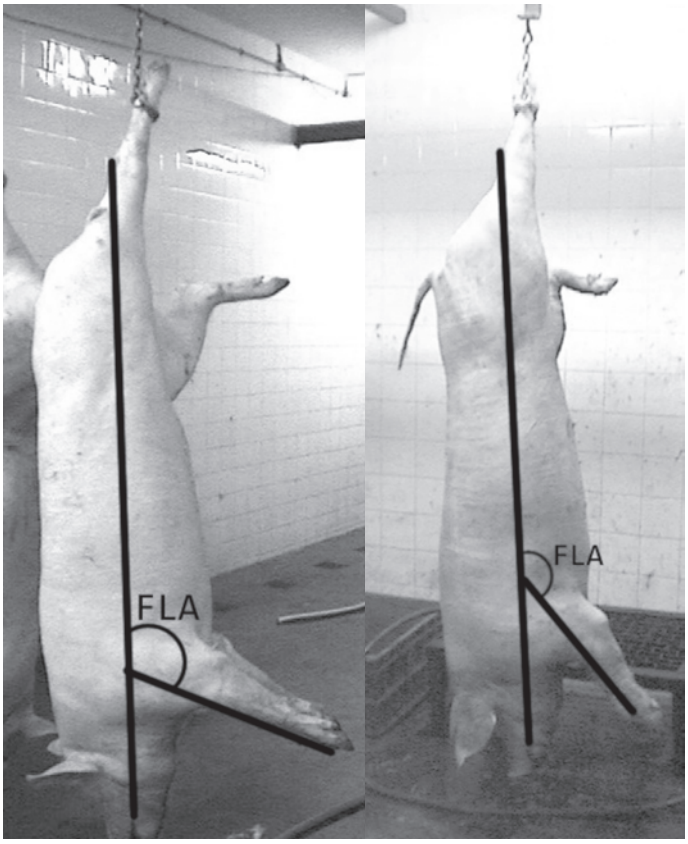

Figure 1: Lateral view photographs of pig carcasses showing FLA at 45 min post-sticking

The FLA was significantly correlated (p<0.01) with pHi, ÄpH and chilling loss which is in agreement with the report of Davies *et al*. (1978). The L values represent the paleness or darkness of the muscle surface, with higher values indicating paler meat. There was no significant correlation between FLA and L value in the present study (Table 1).

Table 1: Correlation between FLA and physico-chemical attributes of pork

Physico-chemical attributes	Correlation coefficient (r)
pHi	0.82**
pHu	0.43
ΔpH	0.67**
Chilling loss (per cent)	-0.69**
L	-0.42
A	0.30
B	-0.17

The observations on the meat quality parameters were grouped into two based on the FLA of the carcass from which the muscle samples were collected. Group I consisted of carcasses having FLA>120° and Group II carcasses had FLA<120°. The mean values of the meat quality attributes for each FLA group are presented in Table 2.

Table 2: Quality attributes of meat from pork carcasses belonging to the two FLA groups

Physico-chemical attributes	Group I (FLA>120°)	Group II (FLA<120°)
FLA (degrees)	128.80±0.04^{a}	103.00±0.09^{b}
pHi	6.17±0.04^{a}	5.82±0.08^{b}
pHu	5.57±0.04^{b}	5.69±0.01^{a}
ΔpH	0.40±0.03	0.13±0.04
Chilling loss (per cent)	5.82±0.52^{b}	7.70±2.32^{a}
L	56.91±5.55	59.02±7.74
A	9.54±2.39	8.80±3.31
B	15.75±0.59	15.94±1.02

Means in the same row bearing different superscripts differ significantly (p<0.01)

The mean FLA for Group I (11 Pigs) was 128.8° and for Group II (5 Pigs), it was 103°, with pHi values of 6.17 and 5.82 respectively, which differed significantly (p<0.01). Davies *et al*. (1978) reported significant difference between 45 min pH values of pork carcasses which were grouped on the basis of FLA viz. less than 120°, 110-120° and more than 120° and they concluded that FLA of less than 110° measured using a

pictorial standard indicated presence of early rigor mortis. A pH value less than 6.0 at 45 min after slaughter is generally used to identify PSE carcasses (Warris 2000). Acute stress immediately prior to slaughter can induce PSE condition even in stress-resistant pigs (Monin 2003). Large White Yorkshire pigs are known to be stress resistant (Gregory 1998). Hence mean pHi value of 5.82 for Group II carcasses potentially indicates the intense pre-slaughter stress experienced by this group of pigs.

The chilling loss values for the FLA groups were 5.82 and 7.70 per cent respectively, both of which were within the range of slightly DFD to normal pork as reported by Warris *et al*. (2003). But the minimum and maximum chilling loss values among individual muscle samples were 1.76 and 13.56 per cent, indicating the possibility of existence of extremely dry or exudative carcasses. Hence while grouping was beneficial in identifying carcasses from stressed animals showing early rigor development, all the carcasses in each group did not show uniform variation in the quality attributes that were analyzed.

There was no significant difference between Hunter L, a and b values between the two groups of carcasses. L value denotes the lightness of the meat surface and Warris *et al*. (2003) reported L values of 42, 52 and 66 for extremely PSE, normal and DFD pork, respectively. Kauffmann *et al*. (1992) suggested that quality variations termed as red, soft, exudative (RSE) and pale, firm, non-exudative (PFN) can develop in pork muscles having varying threshold values for the paleness and chilling losses, and Kusec *et al*. (2005) called normal pork as red, firm and non-exudative (RFN).

The lack of any significant difference in L values between the two FLA groups and relatively lower values for chilling loss that were observed in this study need further investigation. In fact, our preliminary observations have indicated that the core temperature of m. longissimus dorsi of pork carcasses at 45 min post-slaughter can be as high as 40°C (data not reported) which should have resulted in much greater protein denaturation and chilling loss.

More detailed investigations using large samples and incorporating subjective assessment of paleness, wetness and firmness of the exposed muscle surface and measurement of palatability attributes are suggested.

REFERENCES

Davies CE, Townsend WE, Mc Campbell HC (1978) Early rigor detection in pork carcasses by fore leg angle position. J Anim Sci 46: 376-383.

Eikelenboom G, Campion DR, Kauffman RG, Cassens RG (1974) Early post-mortem methods of detecting ultimate muscle pork quality. J Anim Sci 39(2): 303-308.

Faustman C (1994) Postmortem changes in muscle foods In: Kinsman DM, Kolula AW, Breidenstein C (eds). Muscle foods: meat poultry and seafood technology. Chapman and Hall Publishers, New York, pp 63-78

Gracey JF, Collins DS, Huey RJ (1999) Meat hygiene, 10th edn. W.B. Saunders Company, London

Gregory NG (1998) Animal Welfare and Meat Science. CABI Publishing, Wallingford, Oxon, UK, pp 156-215

Kauffmann RG, Cassens RG, Sherer A, Meeker DL (1992) Variation in pork quality. NPPC Publications, DES Monines, USA

Kusec G, Kralic G, Hovart D, Pertricrvic A, Mergeta V (2005) Differentiation of longissimus dorsi muscle regarding variation in water holding capacity and correlated traits. Italian J Anim Sci 4(3): 79-81.

Monin G (2003) Conversion of muscle to meat. In: Devine C, Dikeman M (eds). Encyclopedia of meat science, USA. pp 245-265.

O'Halloran GR, Troy DJ, Buckly DS (1997) The relationship between early post-mortem pH and tenderisation of beef muscles. Meat Sci 45: 239-251.

Snedecor GW, Cochran WG (1994). Statistical methods, 8th edn. Iowa state University Press, Ames, Iowa, USA pp 539

Taylor AA, Down NF, Shaw BG (1990) A comparison of modified atmosphere and vacuum skin packing for the storage of red meat. Int J Food Sci Technol 25: 98-109.

Warris PD (2000). Meat Science: An introductory text. CABI Publishing, Willingford. United Kingdom, pp 65-85.

Warris PD, Brown SN, Kotula TG (2003) Measurement of degree of development of rigor mortis as an indicator of stress in slaughtered pigs. Vet Rec 153: 739-742.