

The colour of the adductor muscle as a predictor of pork quality in the loin

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Abstract

The relation between measurements of colour made in the *m. adductor* (AD) at 45 min or 20 h post mortem and the quality, assessed subjectively in terms of colour and waterholding capacity, of the *m. longissimus* (LD) in the loin was examined. The study used data from 100 pig carcasses exhibiting a wide range of meat quality from extreme PSE (pale, soft and exudative) to extreme DFD (dark, firm and dry). The subjective assessments were confirmed by objective measures of paleness (reflectance) and waterholding capacity (drip loss in storage) in the LD. Lightness (L^*) measured at 20 h post mortem in the AD was the best potential predictor of loin muscle quality, explaining 59% of the variation in subjective and objective quality measures. Comparable measurements at 45 min post mortem explained between 21% and 44% of the variation. The equation that described the relation between AD Lightness (L^*) and subjectively assessed LD quality was derived. This could be used to transpose the AD L^* values from a population of slaughtered pigs into nominal subjective scores for the LD, allowing the frequency of the five subjective quality groups (extremely DFD, slightly DFD, normal, slightly PSE, and extremely PSE) in the population of carcasses to be defined.

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1. Introduction

Whether pork has normal characteristics or is PSE (pale, soft and exudative) is one of the most important determinants of its eating quality. It also has implications for consumer acceptability of the raw meat (Topel et al., 1976; Wachholz, Kauffman, Henderson, & Lockner, 1978) and its technological and processing properties (Kauffman, Wachholz, Henderson, & Lochner, 1978). The Pork Chain Quality Audit, carried out in the USA and reported by Cannon et al. (1996), identified inadequate muscle colour and water holding capacity as ranking second, after excessive fat, as the primary Industry concern about pork quality. Because of this there is considerable concern over the

current apparent high prevalence of the problem (Warriss, 2000, chap. 7), although precise and reliable estimates of this for most countries are difficult to find.

One reason for this is that the term PSE is a subjective description rather than an objective definition. Different individuals' perceptions of what is PSE therefore to some degree vary. This has led to proxy measurements, such as muscle pH or paleness (Kauffman et al., 1993), often being used as indicators of meat with potential PSE characteristics, especially when there is a need to sample large numbers of carcasses. However, the relationships between pH, and colour and water holding capacity (WHC), are complex and non-linear, probably because the effects on colour and WHC relate to denaturation of different protein components of the muscle (Murray, 1995, chap. 4). The pH value measured soon after the death of the animal (≤ 45 min) is therefore not a completely reliable indicator of meat quality and measurements of pH tend to give

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higher estimates of the prevalence of PSE carcasses than subjectively assessed colour and WHC. Recent studies have therefore concentrated on looking for techniques that predict WHC specifically, rather than the occurrence of PSE, using techniques such as near infrared spectroscopy (Forrest et al., 2000), electrical conductivity (Lee et al., 2000) or Fourier transform infrared spectroscopy (Pedersen & Engelsen, 2001).

Another problem is that it is difficult to examine the appearance of the commercially important muscles in the intact, freshly dressed pork carcass. In particular, the *m. longissimus dorsi* (LD), which is one of the commercially most valuable muscles, and one that is especially prone to exhibiting PSE characteristics, is not visible. Various electronic probes have therefore been developed, based on differences in the optical or electrical properties of PSE meat (see, Swatland, 1995). Examples of their commercial use have been given by Oliver, Gispert, Tibau, and Diestre (1991), Chizzolini, Novelli, Badiani, Rosa, and Delbono (1993) Whitman, Forrest, Morgan, and Okos (1996). However, it has been found (Chizzolini et al., 1993; Swatland, 1985), that both pH electrodes and other electronic probes suffer from disadvantages when they are used routinely in the relatively harsh environments and conditions found in slaughter and processing plants.

By contrast with most large muscles, the surface of the *m. adductor* (AD) in the pelvic region is inevitably exposed in at least one side when the carcass is split by cutting down through the backbone. We have therefore examined the potential usefulness of objective measures of colour made on the cut surface of the AD to predict the subjectively assessed quality of the LD in intact pig carcasses. Colour can be objectively and reliably measured using portable tristimulus colour analysers (Warriss, 1995). As well as the value of these measures to predict PSE carcasses, for completeness we also looked at their value to identify carcasses in which the LD showed DFD (dark, firm and dry) characteristics. The use of measurements of electrical capacitance, resistivity and paleness (CIE percent Y) in the AD to predict LD quality, have been described previously by Swatland (1982), although based on a relatively small sample of eight pigs.

2. Materials and methods

Measurements were made in 100 carcasses (mean weight 69.9 ± 4.6 (sd) kg) from female pigs of predominantly white breeding killed using normal commercial practices in the University abattoir at Langford. Measurements made on these carcasses have been reported previously (Brown, 1992; Lopez-Bote, Warriss, & Brown, 1989; Warriss, Brown, Lopez-Bote, Bevis, & Adams, 1989). At 45 min post mortem a sample of LD was removed and frozen in liquid nitrogen pending later measurement of the pH (pH₄₅) using a glass electrode after homogenisation in 5 mM sodium iodoacetate, 150 mM KCl, pH 7.0. The colour of the freshly exposed surface of the AD was deter-

mined by making triplicate readings using the CIELAB $L^*a^*b^*$ colour space (Warriss, 1995) with a Chromameter Reflectance II instrument (Minolta (UK) Limited, Milton Keynes) after being allowed to “bloom” for about 15 min. Blooming allows the reaction of reduced purple myoglobin and haemoglobin at the muscle surface with oxygen to convert them into the bright red oxygenated forms. Brewer, Zhu, Bidner, Meisinger, and McKeith (2001) showed that the rate of blooming was constant over a wide range of pig muscles and moreover did not affect L^* value. Small changes in a^* and b^* chromaticity coordinates were complete within 10 min after exposure of the fresh muscle surface to the air.

At about 20 h post mortem a thin slice of the surface of the same AD was removed to expose a fresh cut surface and, after allowing the meat to “bloom” for 15 min, a further three colour readings were made on the fresh meat surface. A slice of the LD about 2.5 cm thick, just posterior to the head of the last rib, was removed and used for subjective assessment of colour-structure. This was done by a panel of seven judges, experienced in the assessment of meat quality, working independently and using a five-point scale (1 = extremely DFD, 2 = slightly DFD, 3 = normal, 4 = slightly PSE, 5 = extremely PSE). This scale has been characterised and validated by relating it to objective quality measures (Warriss & Brown, 1993). The subjective assessment score for each sample was the mean of the values given by the seven judges. A 10 cm length of LD posterior to the subjectively assessed slice was also removed and used for determination of ultimate pH (pHu), drip loss (Warriss, 1982), reflectance using an EEL Reflectometer (MacDougall, Cuthbertson, & Smith, 1969) and CIELAB colour, as described above for the AD. We measured reflectance using the EEL Reflectometer because values above 50 have been used to define PSE meat (MacDougall et al., 1969). Moreover, the UK Meat and Livestock Commission (MLC) blueprint standards for high quality pork specify that the colour of the LD should be consistent with EEL values between 30 and 55.

For analysis the carcasses were divided into three groups (PSE, normal and DFD) based on the quality characteristics of the LD. For the purpose of this work, meat was classified as PSE if six out of the seven judges assessed it as slightly or extremely PSE (scores of 4 or 5). Similarly it was classed as DFD if it was assessed as slightly or extremely DFD (scores of 1 or 2) by six out of the seven judges. Linear correlation coefficients were calculated between selected measurements made in the LD and those made in the AD.

3. Results

Sixteen carcasses were classed as having PSE loins, 61 normal loins and 23 DFD loins. The characteristics of the loins in the three classes have been reported previously (Lopez-Bote et al., 1989) but, for clarity, the most important are shown in Table 1. These confirmed the subjective

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