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Research paper

Effect of castration and age at slaughter on sensory perception of lamb meat

Vasiliki Gkarane[a], Paul Allen[b], Rufielyn S. Gravador[a], Michael G. Diskin[c], Noel A. Claffey[c], Alan G. Fahey[a], Nigel P. Brunton[a], Linda J. Farmer[d], Aidan P. Moloney[e], Frank J. Monahan[a,*]

[a] University College Dublin, School of Agriculture and Food Science, Dublin 4, Ireland
[b] Teagasc, Food Research Centre, Ashtown, Dublin 15, Ireland
[c] Teagasc, Animal & Grassland Research and Innovation Centre, Athenry, Co. Galway, Ireland
[d] Agri-Food and Biosciences Institute, Newforge Lane, Belfast, BT9 5PX, United Kingdom
[e] Teagasc, Animal & Grassland Research and Innovation Centre, Grange, Co. Meath, Ireland

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ABSTRACT

This study assessed the effect of castration and slaughter age (196–385 days old) on sensory quality of lamb meat from two sheep breeds (Scottish Blackface, SB; Texel x Scottish Blackface, TxSB). Results obtained using a trained sensory panel showed small but statistically significant differences due to castration, with rams having higher scores for *Intensity of Lamb Aroma*, *Animal Smell/Farm Smell*, *Woolly Aroma*, *Rancid Aroma*, *Manure/Faecal Aroma*, *Sweaty Aroma* and *Off-flavours*. SB lamb had higher scores for *Intensity of Lamb Aroma*, *Lamb Flavour*, *Lamb Aftertaste*, *Tenderness* and *Juiciness*. Age effects on sensory attributes were not linear and significant age × gender interactions were observed. The number of samples considered "extreme" in undesirable flavour attributes was higher among rams and T × SB animals. The impact of the sensory differences on consumer acceptability of lamb remains to be established.

1. Introduction

Consumer liking of cooked lamb is not universal (Young et al., 2003) and some studies have shown a lower preference for lamb compared to other meats (Crouse et al., 1983; Duckett and Kuber, 2001; Wong et al., 1975). One of the reasons for lower preference/consumption of lamb is its distinctive flavour (Hornstein and Crowe, 1963; Sink and Caporaso, 1977), sometimes associated with a waxy texture (Young et al., 1994). The sensory quality of lamb meat has been explored by many researchers (Hoffman et al., 2003; Priolo et al., 2002; Resconi et al., 2009; Rousset-Akrim et al., 1997) and is believed to be affected by factors such as gender (Purchas et al., 1979; Young et al., 2003), diet (Watkins et al., 2013), age at slaughter (Pethick et al., 2005) and breed (Hoffman et al., 2003; Notter et al., 1991). However, the nature and the extent of the influence of these factors, and their interactions, on lamb palatability are often unclear. Sanudo et al. (2007) highlighted the difficulty in defining the lamb characteristics, or types of lamb products, that would be acceptable to consumers in European countries. They attributed this difficulty to the variability in sheep production systems across Europe due to different husbandry conditions (local environmental conditions and agricultural methods). This high variability in production methods, and the need to understand how they relate to meat quality, emphasises the requirement for controlled studies, which through the elimination of confounding comparisions, identify the real influence of production factors on lamb flavour (Hopkins and Mortimer, 2014; Purchas, 2007).

Leaving lambs uncastrated results in improved animal performance and production efficiency which has economic benefits for producers (Dransfield et al., 1990; Purchas et al., 1979) while meeting increasing consumer demand for leaner meat, since ram carcasses are leaner (Dransfield et al., 1990; Field, 1971; Seideman et al., 1982). Age at slaughter also influences production efficiency and ultimate meat quality and, while the quality of meat from younger and older lambs differs, unravelling the age effects on quality characteristics is not simple because animal age is almost invariably confounded with other factors (Purchas, 2007). Thus, for example, lambs fed on cereal concentrate-based diets have higher average daily gains than those on pasture and, therefore, animals slaughtered at a fixed age differ in weight while those slaughtered at a fixed weight differ in age (Priolo et al., 2002). Breed type can also affect meat quality, leading to differences in the amount and deposition of fat, in combination with parameters like live weight, age and degree of maturity (Guerrero et al.,

* Corresponding author.
E-mail addresses: paul.allen@teagasc.ie (P. Allen), rufielyn.gravador@ucd.ie (R.S. Gravador), michael.diskin@teagasc.ie (M.G. Diskin), noel.claffey@teagasc.ie (N.A. Claffey), alan.fahey@ucd.ie (A.G. Fahey), nigel.brunton@ucd.ie (N.P. Brunton), linda.farmer@afbini.gov.uk (L.J. Farmer), aidan.moloney@teagasc.ie (A.P. Moloney), frank.monahan@ucd.ie (F.J. Monahan).

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2013).

The objective of this study was to investigate the effects of castration (rams vs castrates) and slaughter age (five different slaughter ages) on the sensory quality, particularly the flavour quality, of lamb meat derived from two breed types.

2. Materials and methods

2.1. Animal husbandry, slaughter and sampling

Two hundred lambs (100 Texel × Scottish Blackface (T × SB), 100 Scottish Blackface (SB)) were sourced from Irish farms in March 2014. Within each breed type 50 lambs were castrated within 48 h of birth. Lambs were raised at pasture from birth, weaned at 130 days and selected for slaughter in groups of 40 (10 T × SB rams, 10 T × SB castrates, 10 SB rams, 10 SB castrates) in October 2014, November 2014, January 2015, March 2015 and April 2015, with the heaviest ram and castrate lambs selected for slaughter at each slaughter date. On selection, lambs were housed individually in slatted pens and, following a 12 d adaptation period during which the lambs were gradually introduced to a barley/maize-based concentrate ration and grass silage, they received *ad libitum* a finishing diet consisting of the barley/maize-based concentrate ration (95% dietary dry matter (DM) intake) and grass silage (5% DM intake) for 36 d pre-slaughter. Lambs were maintained in close proximity, but separate from, cyclic females while at pasture and following housing. At the end of the finishing period, lambs were transported to a commercial abattoir (Gillivan's, Moate, Co.Westmeath) for slaughter. The mean ages of the lambs at slaughter in October, November, January, March and April were 196, 242, 293, 344 and 385 days, respectively. A total of 198 animals were presented for slaughter (two SB rams died over the course of the experiment). After slaughter, carcasses were chilled overnight and transported to Teagasc, Food Research Centre, Ashtown, Dublin 15, Ireland for dissection. Mean carcass weights (± standard deviation) for the SB and T × SB animals of 20.8 (± 1.89) and 25.7 (± 2.43) kg, respectively, and for the rams and castrates of 23.2 (± 3.28) and 23.3 (± 3.31) kg, respectively, were recorded. Ultimate pH (pHu) of *M. longissimus thoracis et lumborum* (LTL) was measured 25 h post slaughter at the 13th rib using a SympHony SP70P hand-held pH meter (VWR, Dublin, Ireland). The LTL was excised from each carcass, cut into 2.5 cm thick steaks, vacuum packed, aged for 8 d at 4 °C and frozen at −20 °C until required for analysis. The study was carried out under licence from the Irish Government Department of Health and all procedures used complied with national regulations concerning experimentation on farm animals (HRB, 2011).

2.2. Compositional analysis

Samples of LTL were thawed overnight at 4 °C and homogenized using a Kenwood CH180 Compact Mini Chopper (Kenwood, Hampshire, UK). Moisture and intramuscular fat (IMF) contents were determined using the SMART Trac Rapid Fat Analyzer (CEM Corporation, NC, USA) according to AOAC Methods 985.14 and 985.26 (AOAC, 1990), respectively. Protein concentration was determined using a LECO FP328 (LECO Corp., MI, USA) protein analyzer based on the Dumas method and according to AOAC method 992.15 (AOAC, 1990). Ash was determined following incineration of samples overnight in a furnace at 540 °C. Branched chain fatty acids (BCFAs) were analysed using microwave assisted preparation of FAMEs (Brunton et al., 2015) with separation and quantification by GC-FID (PerkinElmer Clarus 580, PerkinElmer; ZB-5 column, 30 m x 0.25 mm internal diameter, 0.25 μm film thickness). The results were reported in μg/g with the response factor for each FAME set to 1.

2.3. Sensory analysis

2.3.1. Lamb meat preparation

The LTL muscle from the left side of each carcass was used for sensory analysis which took place at Teagasc Food Research Centre, Ashtown. On the days of sensory tasting, frozen steaks were thawed by immersion in water at room temperature for 45 min. Steaks were grilled, with adhering fat attached, to an internal temperature of 70 °C, using a Tefal OptiGrill clamp grill (Currys, Dublin, Ireland). On reaching 70 °C (monitored using a hand-held digital thermometer (Eurolec, Dublin, Ireland)) the steaks were removed from the grill, wrapped with aluminum foil and allowed to rest for 3 min. Each steak was unwrapped and following removal of the subcutaneous fat, cut into 8 pieces of approximately 2 cm^3. Samples were re-wrapped with foil, assigned a random three-digit code, held in an oven set at 60 °C and served to the panellists within 20 min. Samples from 193 animals were used for sensory analysis (of the initial 200 animals, samples from five (3 T × SB castrates, 1 SB ram, 1 SB castrate) were deemed unsuitable for human consumption in addition to the two lost during the production phase).

2.3.2. Panel training

Staff at Teagasc Food Research Centre, Ashtown, participated as sensory panellists, selected based on their availability, their interest in the project and their sensitivity as assessors following two screening sessions. Panellists participated in 16 training sessions. In the initial training sessions, a range of samples that included the flavours and off-flavours similar to those of interest were used. Samples of lamb meat, some with adhering fat, were presented to panellists who described the sensory attributes they perceived and generated descriptors for flavour, aroma, texture/mouthfeel, taste and aftertaste. In addition, in two sessions, panellists received lamb samples spiked with some of the recognised lamb flavour/aroma compounds (i.e. BCFAs, skatole, indole, p/m-cresol and 3-methylpentanoic acid) to aid in the generation of aroma descriptors. Sessions using physical and chemical reference standards were run so that the panellists would learn to differentiate and identify the sensory descriptors (Table 1). Training in the intensities of odour, flavour and texture (chewiness, tenderness and juiciness) was carried out based on the study of Braghieri et al. (2012) (adjusted for lamb, as opposed to beef). In brief, for low, medium and high odour/flavour intensity, lamb loin boiled for 15 min, microwave cooked (4.5 min at 800W), or grilled to an internal temperature 70 °C (using an electric grill preheated at 240 °C), respectively, was prepared. For low, medium and high chewiness/tenderness intensity, lamb shank cooked to an internal temperature of 70 °C, side loin cooked to an internal temperature of 70 °C and centre loin cooked to an internal temperature of 65 °C, respectively, were prepared. For juiciness of low, medium and high intensity side loin cooked to internal temperatures of 80 °C, 70 °C or 64 °C, respectively, was prepared. Training sessions were informed by AMSA (2015) guidelines.

2.3.3. Quantitative descriptive analysis

Quantitative descriptive analysis (QDA) was performed on one day per week over 16 weeks with two sensory sessions per day (morning and afternoon). In each session, 6 samples were assessed using a balanced and randomized design. Panellists were asked to rate 38 attributes (generated during the training) for each sample, by marking a point on a 100 mm unstructured line scale. The sensory attribute definitions, agreed during the training sessions (Table 1), were available to each panellist during tasting. Panellist evaluations were recorded using *Compusense 5* (v4.4, Compusense Inc., Guelph, Ontario, Canada).

2.4. Statistical analysis

Data were tested for the normality of the residuals for each variable. In the case of non-normal distribution, data were transformed using the