Meat Science 117 (2016) 205–211

Contents lists available at ScienceDirect

Meat Science

journal homepage: www.elsevier.com/locate/meatsci

Effect of genotype and age on some carcass and meat quality traits of beef carcasses subjected to the South African classification system

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ARTICLE INFO

Article history:
Received 21 August 2015
Received in revised form 4 March 2016
Accepted 9 March 2016
Available online 11 March 2016

Keywords:
Carcass classification
Colour
Dentition
Meat pH
Tenderness

ABSTRACT

Genotype and age effects on pH_{24}, L*, a*, b*, tenderness (WBSF), cooking (CL %), and thawing loss (TL %) of beef carcasses subjected to the South African classification system were determined. Carcass traits (bruising, subcutaneous fat (SF), and conformation) were also measured. Meat quality measurements were taken on the *longissimus thoracis et lumborum* (n = 175) of A, AB, B, and C carcasses from Angus, Bonsmara, Fleckvieh, Non-descript, and Simmental genotypes. No bruises were evident in all carcasses. All carcasses scored medium conformation (class 3) while in SF classification, class 2 had the greatest frequency (66.3%). Genotypic effects ($P < 0.05$) were observed for a*, hue angle (HA), pH_{24}, TL%, CL%, and WBSF between steers with six, seven, and eight incisors. Notable differences ($P < 0.05$) were observed for tenderness where Angus and Simmental had least tender meat while Non-descript and Fleckvieh had the tenderest meat within the C-age class. Meat quality varied within animals of the same age-class across genotypes.

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1. Introduction

Carcass classification and grading systems are developed with an attempt to describe the yield and features of carcasses which are useful for trading and pricing purposes (Polkinghorne & Thompson, 2010; Strydom, 2011). In Europe, the carcass classification system has been highlighted as a significant tool for market transparency and regulations (Font-i-Furnols et al., 2016). These systems are established to convey information to all stakeholders in the meat production chain, as well as, to provide a satisfying eating experience to consumers. However, the current South African (SA) classification system segregates carcasses into classes that provide information based on the expected eating quality and yield, but it disregards the quality related characteristics of carcasses. Strydom et al. (2015) further highlighted that the current SA classification system only describes carcasses according to certain measurements or scores and does not rank carcasses according to quality and price. They further stated that the carcass is presented to the wholesaler or retailer listing all the attributes that have been evaluated. Nonetheless, these scores alone do not provide any information on the quality of meat.

Polkinghorne and Thompson (2010) evaluated the classification and grading systems for beef carcasses in seven countries around the world. These countries included the Republic of South Africa, South Korea, United States of America (USA), Japan, Europe, Canada, and Australia; with Australia having two different governing systems which include the Australian meat classification (AUS-MEAT) and Meat Standards Australia (MSA). Among these countries only the Australian (AUS-MEAT), European (EUROP), and SA systems are considered as classification systems. The Meat Standards Australia (MSA) and other four countries (Canada, Japan, South Korea, and USA) use the grading system. According to AHDB Industry consulting (2008) carcass classification is a system that only describes features of a carcass which are useful in the trading industry, while the grading system involves ranking carcasses based on quality in order of merit from the most preferred to the least preferred grades. Generally, the main difference between grading and classification systems is that the classification system does not measure quality attributes. Among the criteria used in the grading and classification systems, only the AUS-MEAT and MSA use pre-slaughter criteria in addition to slaughter floor measurements. All other classification and grading systems rely solely on slaughter floor measurements. Although the slaughter floor measurements vary among these systems, measurements such as; carcass weight, sex, and age are common in all systems but using different methodologies. The EUROP, SA, and AUS-MEAT classification systems only consider slaughter floor measurements, while the grading schemes also use chiller measurements such as marbling score, lean and fat colour, pH, firmness, and texture among others (Polkinghorne & Thompson, 2010).

These meat quality attributes are, however, not included in the EUROP and SA classification systems. Nonetheless, consumers are increasingly demanding meat that is of acceptable colour, aroma, flavour, and tenderness among other attributes and they cannot rank these meat quality attributes for themselves in the retail outlets. Furthermore, previous research confirmed changes in the quality attributes, physical and nutrient composition of SA beef carcasses due to age and degree of fatness (Hall, Schönfeldt, & Pretorius, 2015). The SA classification

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http://dx.doi.org/10.1016/j.meatsci.2016.03.013
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system classifies beef carcasses into four age groups which are determined based on the number of incisors present at slaughter using a dentition method with classes A (0 incisors), AB (1–2 incisors), B (3–6 incisors), and C (>6 incisors). However, the system does not clearly differentiate meat quality from animals within the same class but with different number of incisors, for an example in the AB (1–2 incisors), B (3–6 incisors) and C (>6 incisors) classes. Although differences might be detected within animals of the same class due to differences on the number of incisors present at slaughter.

The system also classifies carcasses based on the amount of subcutaneous fat with classes ranging from 0 (no fat) to 6 (extremely over fat). Age and fat codes have been reported as key determinants of market price, with young animals (A-class) and fat code 2 fetching high prices (Hall et al., 2015). However, it has been argued that although A-class animals are sold for high prices since they are presumed to be most tender and consequently of better quality, this is not always the case as many other factors besides age can affect tenderness (Strydom, 2011), such as breed. Since the implementation of the current classification system, it has not been evaluated to assess cogency with regards to the quality of beef carcass classes from different breeds.

Breed can have significant effects on carcass traits (lean–fat ratio, conformation, and dressing %), meat quality traits (meat colour and cooking loss), and sensory traits (tenderness and juiciness) (Chambaz, Scheeder, Kreuzer, & Dufey, 2003; Muchenje, Dzama, Chimonyo, Raats, & Strydom, 2008). These traits are significant for a satisfying eating experience to consumers and future purchasing decisions. Therefore, there is a need for information on the quality of South African beef carcass classes across different breeds with different number of erupted incisors present at slaughter to address consumer uncertainties. This study sought to investigate carcass and meat quality from SA carcass classes across different beef breeds with different number of erupted incisors present at slaughter.

2. Materials and methods

2.1. Ethical clearance

Consent to carry out the study was approved and issued by the University of Fort Hare Ethical Clearance committee (Reference Number: MUC151SSOJ01).

2.2. Experimental site description

The study was conducted at East London Abattoir in the Eastern Cape Province of South Africa. East London is located at 32.9° S and 27.87° E with a total area of 168, 86 km^2. The abattoir is a high throughput commercial abattoir which slaughters up to 1000 livestock units per day and is furnished with modern technology to improve production. It operates under the laws and regulations of the Meat Safety Act (Act No. 40 of 2000) (SAMIC, 2006) governing the abattoirs in the Republic of South Africa.

2.3. Animal description

Five different beef genotypes (Angus, Bonsmara, Fleckvieh, Non-descript, and Simmental) from different feedlot systems were used in the study. The origin of the studied animals was traced from the cattle identification, registration and movement documents issued by the truck drivers on arrival. Four feedlots were traced as pure breed producing feedlots (Angus, Bonsmara, Fleckvieh and Simmental) with each feedlot producing cattle of the same genotypes; and one feedlot produced crossbreeds (Non-descript) with various genotypes. From each feedlot system thirty five steers of different age categories were selected making a total of 175 steers (35 × 5).

2.4. Data collection

Animals from the same feedlots were selected across multiple visits. The animals were humanely slaughtered at the abattoir. Following the humane slaughter, the carcasses were subjected to the SA classification system under the regulations set for the classification and marking of meat anticipated for sale in the Republic of South Africa (Act No.119 of 1990) (Agricultural Products Standards Act, 1990).

2.4.1. Carcass classification

Five classification categories (age, sex, conformation, bruising, and fatness) were used. The age of the steers was determined using a dentition method described by the South African Meat Industry Company (SAMIC, 2006) depending on the number of erupted incisors present at slaughter with classes A (0 incisors), AB (1–2 incisors), B (3–6 incisors), and C (>6 incisors). Visual appraisal was used to determine the degree of subcutaneous fat (SF) in millimetres (mm) with scores ranging from 0 (No Fat), 1 ($SF < 1$), 2($1 \le SF \le 3$), 3($3 \le SF \le 5$), 4($5 \le SF \le 7$) 5($7 \le SF \le 10$), and 6($10 \le SF$). Bruising (1 slightly damaged–3 excessively damaged) and conformation (1 very flat–5 very round) were also determined and assigned scores by visual appraisal.

2.4.2. Meat sample harvesting and measurements

Meat samples (approximately 2.5 kg) were harvested from the *longissimus thoracis et lumborum* (LTL) after dressing the carcasses. Smaller sub-sections of the LTL muscle (100 mm thick) from the left side of each carcass were sampled from the 10th rib in the direction of the rump for meat quality measurements. Samples were vacuum packaged before they were stored in a cooler box half filled with ice cubes. The samples were stored in a cooler box for approximately 180 min during transportation. After transportation, they were frozen at −20 °C refrigerator temperature until meat colour (lightness; L^*, redness; a^*, and yellowness; b^*), pH, and thawing loss (TL %) analyses were performed 24 h after slaughter. Cooking loss (CL %), and Warner Bratzler Shear Force (WBSF) measurements were done after 7 days of refrigeration. Before meat quality analyses were done, the samples were thawed at 4 °C for 24 h. The 100 mm thick subsections were processed into 30 mm steaks for WBSF measurements and 20 mm steaks for CIE Lab colour measurements by means of a band saw.

2.4.2.1. Meat pH. A portable digital pH metre (Crison pH 25) with a piercing electrode was used to measure pH of the LTL muscle 24 h after slaughter.

2.4.2.2. Meat colour. The Commission International De L'Éclairage (CIE) L^*, a^*, and, b^* values (Commission International De l'Éclairage, 1976) were determined on the LTL muscle. A Minolta colour guide machine (model 45/0 BYK- Gardner GmbH) with a 20 mm diameter, illuminant D65-day light and 10° standard was used to measure the meat colour. The results were taken after 3 readings achieved by rotating the device by 90° on the sample surfaces 3 times. Saturation index (SI) was then calculated as $(a^2 + b^2)^{0.5}$ and the hue angle (HA) was also calculated as $[\tan\text{-}1((b^*/a^*)]$ using a method by Setser (1984).

2.4.2.3. Thawing and cooking loss measurement. The samples were weighed before freezing using a portable weighing scale (LBK 12) and subsequently frozen at −20 °C for 7 days. After 7 days, the frozen samples were reweighed and thawed at 4 °C for 24 h. After thawing the samples were re-weighed and placed in water tight PVC-plastic bags before they were boiled. The samples were boiled using a water bath (Model TRH) which was pre-heated to 72 °C for 45 min to boil water. It was then pre-set to 71 °C before the samples were cooked and the samples were cooked to a final internal temperature of 71 °C (AMSA, 1995). After cooking, meat samples were cooled to room temperature (±20 °C) measured using an analogue thermometer for 5 h. The

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