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Changes in springbok (*Antidorcas marsupialis*) *Longissimus thoracis et lumborum* muscle during conditioning as assessed by a trained sensory panel

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ABSTRACT

This study aimed to determine the effect of ageing in vacuum bags at 5.4 ± 0.60 °C on the sensory quality of springbok (*Antidorcas marsupialis*) *Longissimus thoracis et lumborum* (LTL) muscle. Four randomly assigned portions of muscle from six male and six female mature springbok were aged for 1, 3, 8 or 28 days, after which they were blast frozen. Assessment by a trained sensory panel found a significant increase in gamey, metallic, liver-like, sour/aged and off/manure attributes and a decline in beef-like aroma during ageing. Sensory tenderness and sustained juiciness increased and residue decreased significantly; however there was no significant change in the Warner Bratzler shear force of the cooked meat, which was below 24 N for all ageing periods. Significant gender effects were only present for metallic aroma (female > male), residue (male > female) and cooking loss (male > female). It was concluded that springbok LTL should be aged for a maximum of eight days.

1. Introduction

Despite improvements in food security since 1990, it still persists as a global problem, with Africa presenting one of the greatest challenges (FAO, 2013). This challenge is exacerbated by adverse economic and environmental conditions as well as the increasing emphasis placed on sustainability and environmental conservation (Godfray et al., 2010). Apart from intensification and precision farming the adaptation of methods to specific environments may also play a role in meeting these challenges. By using indigenous game species that are better adapted to the conditions present in a particular environment input costs as well as the impact on the environment may be reduced (Du Buisson, 2006; Lindsey, 2011; Mossman & Mossman, 1976). Game ranching also supplies a wider range of sources of income than traditional farming, with ecotourism, trophy and recreational hunting and live sales all increasing profits (Lindsey, 2011).

While the emphasis of the South African game industry is currently on tourism and hunting rather than meat production (Hoffman, 2007; Van Zyl & Ferreira, 2004), there is potential for the production of meat from game species to directly contribute to the red meat supply of the country. However, in order for this market to be developed producers need to be able to supply products of high and consistent quality (Hutchison, Mulley, Wiklund, & Flesch, 2010). This in turn can only occur if standardised handling methods are developed and applied to the carcasses and meat, with ageing being an important part of this process.

The purpose of this study was to assess the changes in the physical and sensory characteristics of springbok (*Antidorcas marsupialis*) *Longissimus thoracis et lumborum* (LTL) that take place during the ageing process in order to determine the ideal ageing period. Although meat is primarily aged in an effort to improve textural attributes, with a focus on increased tenderness, various other alterations of the flavour and aroma profile of the meat can also take place (Warriss, 2010). The descriptive sensory analysis performed thus also considered these attributes in order to determine how the overall sensory quality of the meat changed during ageing. Springbok meat makes up the largest proportion of the game meat produced and exported from South Africa, with 80% of the game carcasses exported in 2005 being springbok carcasses (Hoffman, Muller, Schutte, Calitz, & Crafford, 2005; Hoffman & Wiklund, 2006).

2. Materials and methods

2.1. Harvesting and slaughtering

Eighteen (nine male, nine female) mature springbok were harvested according to the standard operating procedure number SU-A CUM13-00034 in March of 2014. They were obtained from Brakkekuil farm, located near Witsand in the Western Province of South Africa (34°18′ 24.0″ S; 20°49′3.9″ E; altitude of 93 m). Harvesting was done at night using a spotlight to locate and temporarily immobilise the springbok (Hoffman & Laubscher, 2010). They were killed with a single shot to

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the head from a 30–06, .308 or .270 calibre rifle and exsanguinated immediately thereafter by severing the jugular vein and carotid arteries. Observed stress levels were recorded if necessary. Once the required number of animals had been harvested the bled carcasses were transported to a nearby slaughtering facility where they were skinned and eviscerated. All the carcasses were dressed within three hours of death. The dressed carcasses were placed in a cool room (<6 °C) to undergo rigor mortis. Carcasses were hung by both Achilles tendons in order to ensure equal contraction of the muscles in both sides of the carcass during the development of rigor mortis. Ethical clearance for this study was issued by the Stellenbosch University Animal Care and Use Committee (ethical clearance number SU-ACUM13-0034).

2.2. Sampling

Carcasses were transported whole to the meat processing facility at the Department of Animal Sciences at the University of Stellenbosch for further sampling. The LTL muscle was excised from both sides of the carcass from its natural termination at the cervical vertebra to the last lumbar vertebra. Each muscle was cut perpendicularly to its longitudinal axis to produce two portions of approximately equal mass, resulting in four portions per carcass. Each of these portions was randomly assigned to one of four ageing periods (1, 3, 8 or 28 days) and vacuum-packed. The portions were aged in a refrigerator at 5.4 ± 0.60 °C.

On the completion of each ageing period the portions were frozen to a temperature of −30 °C in a blast freezer (Marcold refrigeration co. (PTY) LTD, Cape Town, South Africa). All samples were completely frozen within 1 h. Once frozen the portions were stored at −20 °C for two to seven weeks until analysis.

2.3. Sample preparation

Vacuum-packed meat samples were thawed at 5.4 ± 0.60 °C for approximately 24 h. Once thawed they were removed from the vacuum bags, blotted dry with absorbent paper and placed in individually marked oven bags (Spar® or Glad®). They were subsequently prepared according to the method described by Geldenhuys, Hoffman, and Muller (2014), with the exception that the samples were cooked to an internal temperature of 72 °C and were allowed to rest for 5 min prior to cutting. The wrapped blocks were reheated at 70 °C for 7 min prior to serving and were placed in water-baths set to 70 °C for the duration of the training/testing session in order to maintain them at the correct temperature (AMSA, 1995).

2.4. Descriptive sensory analysis

Descriptive sensory analysis (DSA) of the samples was performed by nine panel members with previous experience in the sensory evaluation of meat.

Prior to the testing phase, portions from six of the 18 harvested springbok were used to train the panel during six training sessions. Training was done according to the guidelines and recommendations of AMSA (1995) and Lawless and Heymann (2010). During the training period seven aroma attributes, six flavour attributes and five textural attributes were decided upon and elucidated (Table 1). Reference samples were used during the training period to help the panel define the attributes (Table 2). During the training period each panel member received three blocks from each springbok portion and reference sample.

Portions from six male and six female springbok that had not undergone any *ante-mortem* stress were selected for the testing period. Each animal was randomly assigned to a testing session and twelve testing sessions were performed (twelve replications). The DSA was performed using the test re-test method, as described in Geldenhuys et al. (2014).

2.5. Physical analyses

2.5.1. pH

Samples for the determination of the pH were taken from each portion after thawing and prior to cooking. These were frozen in liquid nitrogen and stored at −80 °C until the pH could be determined using the sodium-iodoacetate method (Jeacocke, 1977) as described in Geldenhuys, Muller, Frylinck, and Hoffman (2015).

2.5.2. Cumulative purge and freeze/thaw loss

Portions were weighed at sampling (Mettler PC 4400 Delta range, Cape Scientific, South Africa), prior to vacuum-packaging, in order to determine their initial weight. After thawing the vacuum-packed portions at 5.4 ± 0.60 °C for approximately 24 h they were blotted dry using absorbent paper towelling and weighed to determine the weight remaining after purge and thaw moisture losses. This moisture loss was expressed as a percentage of the initial weight of each portion.

2.5.3. Cooking loss

After the removal of the samples for the pH determination the portions were weighed (Mettler PC 4400 Delta range, Cape Scientific, South Africa) to obtain an initial raw weight. After cooking and the five minute rest period the portions were removed from the oven bags, blotted dry using paper towelling and reweighed to determine a

Table 1
Description and scales of assessment for each attribute used during descriptive sensory analysis.

Sensory attribute	Description	Scale
Overall aroma intensity	Intensity of aroma in first few sniffs	0 = extremely bland, 100 = extremely intense
Beef-like aroma	Aroma associated with cooked beef loin	0 = extremely bland, 100 = extremely intense
Gamey aroma	Aroma associated with the meat from wild animal species - combination of liver-like & metallic	0 = extremely bland, 100 = extremely intense
Liver-like aroma	Aroma associated with pan-fried beef liver	0 = extremely bland, 100 = extremely intense
Metallic aroma	Aroma associated with metal/iron/blood	0 = extremely bland, 100 = extremely intense
Sour aroma	Aroma associated with vacuum-packed, aged meat/off milk	0 = extremely bland, 100 = extremely intense
Off/Manure aroma	Aroma associated with farm-yard/contamination/off meat	0 = extremely bland, 100 = extremely intense
Gamey flavour	Flavour associated with the meat from wild animal species	0 = extremely bland, 100 = extremely intense
Beef-like flavour	Flavour associated with cooked beef loin	0 = extremely bland, 100 = extremely intense
Liver-like flavour	Flavour associated with that of pan-fried beef liver	0 = extremely bland, 100 = extremely intense
Metallic flavour	Flavour associated with metal/iron/blood	0 = extremely bland, 100 = extremely intense
Sour flavour	Flavour associated with off milk	0 = extremely bland, 100 = extremely intense
Off/Manure flavour	Flavour associated with farm-yard/contamination/off meat	0 = extremely bland, 100 = extremely intense
Sustained juiciness	Amount of moisture perceived during mastication	0 = dry, 100 = extremely juicy
Tenderness	Impression of tenderness after mastication	0 = tough, 100 = extremely tender
Residue	Residual tissue remaining after mastication (difficult to chew through)	0 = none, 100 = abundant
Mealiness	Extremely fine texture. Disintegration of muscle fibre into very small particles that are retained on the tongue	0 = none, 100 = abundant
Visual assessment of grain	Fineness/coarseness of the fibres present in the meat (look at cross-sectional surface)	0 = extremely fine, 100 = very coarse