Meat Science 80 (2008) 1055–1060

Contents lists available at ScienceDirect

Meat Science

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

Sensory and preference testing of selected beef muscles infused with a phosphate and lactate blend

L.C. Hoffman *, M. Muller, A. Vermaak

Stellenbosch University, Private Bag XI, Matieland 7602, South Africa

ARTICLE INFO

Article history:
Received 2 January 2008
Received in revised form 17 April 2008
Accepted 24 April 2008

Keywords:
Meat quality
Enhanced beef
Descriptive sensory analysis
Preference testing

ABSTRACT

Consumers expect beef products to be juicy and tender. In the present investigation four beef muscles, i.e. *Biceps femoris* (BF), *Longissimus lumborum* (LL), *Rectus femoris* (RF) and *Semitendinosus* (ST), were infused with a blend consisting of sodium and potassium salts, di- and triphosphates and lactates. The muscles were stored at 4 °C for 24 h, followed by storage at −18 °C until the descriptive sensory analysis could be performed on all four muscles. BF and LL were also subjected to consumer sensory analysis to determine the overall degree of liking. The infused and non-infused samples did not differ significantly with regard to aroma and flavour. The infused samples were significantly more juicy and tender than the untreated samples. Although the infused samples were rated significantly higher in salty taste than the untreated samples, both treatments illustrated a relatively low mean value for saltiness. Both the infused LL and BF samples illustrated a high degree of liking. Therefore, the infusion of beef muscles with a blend containing phosphates and lactates could be applied successfully to enhance the sensory attributes of beef.

1. Introduction

For consumers, beef tenderness is the most important meat palatability characteristic (Dransfield, 2003; Huffman et al., 1996; Jeremiah, 1982) and the prevalence of inconsistent tenderness is a major problem facing the beef industry today (Belew, Brooks, McKenna, & Savell, 2003; Morgan et al., 1991). The meat industry needs to address this problem by striving to meet consumer demands and at the same time it has to keep abreast of consumer trends. Consumer acceptability and perception of quality are the key determinants of the success of a meat product (Grunert, 2006).

It is clear that variation in beef muscle does exist, especially with regard to the sensory attributes of beef such as tenderness and juiciness (McKeith, De Vol, Miles, Bechtel, & Carr, 1985). In order to reduce this variation and to diminish its negative impact, several interventions and treatments have been suggested and applied in the meat industry. One such treatment is the infusion of the meat with a salt mixture. The use of calcium enhancement has been researched extensively and, despite increased tenderness, the negative effects pertaining to the detrimental colour (Wheeler, Koohmaraie, & Shackelford, 1996) and flavour effects (Wheeler, Koohmaraie, Lansdell, Siragusa, & Miller, 1993; Wheeler, Koohmaraie, & Shackelford, 1997) still need to be resolved satisfactorily. Similarly, using salt (NaCl) in the enhancement solutions led to better sensory scores, but also resulted in colour deterioration, especially after an ageing period under vacuum (Stetzer, Tucker, McKeith, & Brewer, 2007). However, Knock et al. (2006) noted that beef rib steaks enhanced with a solution containing potassium lactate, on its own or in combination with sodium acetate, were darker but more colour stable. Another intervention is the marinating of meat in acidic solutions to soften and flavour meat (Berge et al., 2001; Offer & Knight, 1988). The injection/infusion of fresh, whole muscles with a solution of water and ingredients such as salt, phosphates, antioxidants and flavourings to tenderise, add juiciness and enhance shelf-life qualities is also a popular technique (Lawrence, Dikeman, Hunt, Kastner, & Johnson, 2003, 2004).

Vermaak (2006) described how various beef muscles were infused with a phosphate and lactate blend to achieve a meat product of enhanced physical and chemical characteristics, and also a reduction in the variation of specific characteristics such as instrumental tenderness. It is assumed that the latter technique will also result in a positive effect on the sensory profile of the product as results from previous studies indicate that enhancement of beef with phosphate and salt containing solutions resulted in increased juiciness and tenderness (Hoffman, 2006; Stetzer et al., 2007; Vote et al., 2000).

Therefore, the first aim of this study was to determine the effect of a basting consisting of sodium and potassium salts, various phosphates and lactates on the sensory attributes of beef muscles as determined by descriptive sensory analysis. The second aim was to determine the preference for and acceptability of the basting using consumer sensory analysis.

* Corresponding author. Tel.: +27 21 8084747; fax: +27 21 8084750.
E-mail address: lch@sun.ac.za (L.C. Hoffman).

0309-1740/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.meatsci.2008.04.025

2. Materials and methods

2.1. Animals and sampling

Beef carcasses representing South African beef breeds (Brahman × Simmentaler cross; $n = 3$, average mass = 300.73 kg and Charolais × Hereford cross; $n = 3$, average mass = 297.87 kg) finished off in a feedlot, were sourced from a commercial abattoir in Paarl, Western Cape, South Africa. These animals had all received a corn based finisher diet. At the abattoir, the animals were slaughtered, dressed and thereafter processed according to standard South African techniques and conditions. No electrical stimulation was applied to the carcasses. The animals were selected to represent slaughter steers from a typical commercial scenario, representative of the South African market.

The carcasses were classified as A2 according to the South African classification system (Government Notice No. R. 1748, 1992). An A2 animal is a young animal of the A age group (no permanent incisors) with a fat code of 2, representing a lean fat cover (1–3 mm thick subcutaneous fat depth measured between the 10th and 11th rib, 50 mm from the midline of the cold unquartered carcass). The whole, intact carcasses were chilled at *ca.* 2 °C for 24 h in a cooling chamber before being weighed and quartered at the abattoir. Twenty-four hours *post-mortem* (pm) the beef quarters were transported in a mobile cooling unit (set at 4 °C) to the Meat Science Laboratory at Stellenbosch University, South Africa where the carcasses were stored in the cooling facility at 4 °C. On the same day the left and right side *Biceps femoris* (BF, silverside), *Longissimus lumborum* (LL, striploin), *Rectus femoris* (RF), and *Semitendinosus* (ST, eye of the silverside) muscles were removed from the carcasses. The muscles were trimmed of all visible subcutaneous fat and superficial collagen, weighed, labelled, vacuum packed and stored in a cooler at *ca.* 4 °C until further processing.

2.2. Sample preparation

On day 3 (48 h pm) all the muscles were transported for 30 min to the Freddy Hirsch Processing Plant in a cooler at *ca.* 4 °C where the left-side muscles were removed from their packaging, demembraned and infused. Muscles from the right side of the carcass were left untreated and stored in a cooler at *ca.* 2 °C to be used as the control. The muscles were infused with a cooled (2 °C) commercially available solution containing sodium and potassium di- and triphosphates, lactate and chloride (Freddy Hirsch Tenderbite; PO Box 2554, Cape Town, 8000) at a pressure of 2.4 bar at 30 strokes per min on a Rühle Curing Centre IR56 (Rühle GmbH, D-79865, Grafenhausen, Germany) to give a calculated pumped gain of 15% with a retention of 12% for all muscles. The commercial basting solution gave a calculated chemical composition of 75.75% water, 5.21% Na^+, 2.53% K^+, 3.45% P_2O_5 and 12.40% lactate. After a resting (equilibration) period of 2 h on a drying rack in a cooler (*ca.* 4 °C) the infused meat samples were dried, vacuum packed (in 300 × 400 cm vacuum bags, 90 μm thick with a permeability of 40 cc/m^2/24 h/bar), labelled and transported back to the Meat Science Laboratory at Stellenbosch University and stored at *ca.* 4 °C.

Twenty-four hours after infusion the samples were removed from the cooler and frozen at −18 °C for approximately 10 months prior to the respective analyses. Throughout the trial an attempt was made to ensure that all activities were similar to a typical commercial scenario as pertaining to the methodologies employed in the industry in regards of removal of the muscles, trimming, and injecting, resting and cold chain maintenance. Care was also taken throughout the investigation to ensure that the handling procedures were similar for the muscles from both sides of the same carcass.

2.3. Descriptive sensory analysis

The treatments included untreated control beef samples (muscles from the right side of the carcass) and beef muscle infused with a phosphate and lactate blend (muscles from the left side of the carcass). The muscles analysed were the *Biceps femoris* (BF), *Longissimus lumborum* (LL), *Rectus femoris* (RF) and the *Semitendinosus* (ST). Therefore per carcass, eight samples of meat (2 treatments × 4 muscles) were used for each sensory analysis session.

The vacuum-packed meat samples were defrosted at a temperature of 2–4 °C for a period of 48 h prior to cooking on their pre-assigned sensory analysis dates. The meat samples were cut to an uniform weight (approximately 500 g) and placed in a coded Jiffy roasting bag on a metal rack covered with aluminium foil. A temperature probe was inserted into the centre of the meat sample. Temperature changes were monitored with thermocouples connected to hand-held digital recorders. Samples were oven-roasted at 160 °C in two conventional electric Defy 835 ovens connected to a computerised electronic temperature control system (Viljoen, Muller, De Swart, Sadie, & Vosloo, 2001) to an internal temperature of 68 °C. After cooking, the meat was removed from the oven and allowed to rest for 5 min, in which time an endpoint temperature of 72 °C was reached. Cubed samples (1.5 × 1.5 × 1.5 cm) were taken from the middle of each sample and wrapped individually in aluminium foil. The samples were placed in preheated glass ramekins, which were marked with random three-digit codes and positioned in a preheated oven of 100 °C. The samples were removed from the oven and analysed within 10 min by the sensory panel (AMSA, 1995).

A panel consisting of eight judges was used to analyse the sensory attributes of the selected muscles. The judges were trained and selected according to the guidelines for the sensory analysis of meat of the American Meat Science Associations (AMSA, 1995) using the generic descriptive analysis technique (Lawless & Heymann, 1998). The judges were trained in two sessions on the attributes to be evaluated, where after they were tested for consistency. The meat was analysed using the standard questionnaire of the American Meat Science Association (AMSA., 1995). This is an eight-point ordinal scale from low in intensity (1) to extremely high in intensity (8). The score sheet was compiled and refined by the panel during the training sessions. One attribute was added to the standard questionnaire, namely salty taste. The descriptive sensory analysis performed on the meat included beef aroma, beef flavour, initial impression of juiciness, sustained juiciness, first bite, residue and salty taste (Table 1). The meat was analysed in five sessions over a period of 5 d, per session each judge analysed eight samples. The serving order of the samples was completely randomised for each session and each judge. The panel used crackers, apple slices and distilled water to cleanse the palate in-between samples (AMSA., 1995). The judges were seated in individual booths in a light-controlled (artificial daylight) and temperature controlled room (21 °C).

2.4. Consumer sensory analysis

Two treatments of beef, i.e. untreated beef muscle (muscle from the right side of carcass) and beef muscle infused with a phosphate and lactate blend (muscles from the left side of carcass), were tested for degree of liking. Four samples of meat (2 treatments × 2 muscles) were used for the consumer sensory analysis. Only two muscles were used due to logistic problems in acquiring sufficient consumers. The muscles analysed were the *Biceps femoris* (BF) and *Longissimus lumborum* (LL). After the vacuum-packed meat samples were defrosted for 48 h at 2–4 °C, a stock mixture was prepared for each muscle according to its weight and treatment so as to ensure that the ingredients were present as a constant percentage of the