INCREASING JUICINESS AND TENDERNESS IN BEEF FROM MATURE COWS

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Background

Tenderness in beef may be defined as the state of being easily comminuted or masticated. Differences in tenderness occur between carcasses, between muscles within a cut, and occasionally between parts of the same muscle. It is also known that beef from older, cull animals is tougher and tends to be dry upon first bite with a mealiness residue than that from young animals. These phenomena results in the meat from these animals being perceived as being of inferior quality and thus of less financial value to the meat trade. The trade is frequently searching for means of improving these quality traits so as to improve its financial value. Various methods have been used to try and nullify this effect of age on meat tenderness and include, natural aging, the use of natural and artificial enzymes, electrical stimulation, methodology of carcass suspension, the tendercut, blade tenderisation, injecting of various artificial and natural metabolites and or tenderisers, and lately, explosion. A facet that has enjoyed considerable attention as a means of increasing the tenderness of beef is the use of salt, particularly calcium chloride. Although successful in decreasing the toughness of meat, $CaCl_2$ does have a number of negative attributes, particularly as pertaining to colour and a noted decrease in beef-like flavour. The use of alternative salts (sodium) and various phosphates seem to have slightly decreased some of these negative attributes and enhanced sensory panel characteristics.

Objectives

In the present investigation, a commercially available basting consisting of Na and K salts, various phosphates and lactates was injected into the left *M. longissimus dorsi* of old mature cull cows. The muscle from the right side of the carcass was used as the control to see what the effect of this enhancer would be on various chemical and physical attributes. A trained analytical sensory panel also evaluated the beef to determine if a significant difference between the two treatments could be detected.

Methods

Dead cull animals (Simmentaler breed) were sourced from a commercial abattoir. No electrical stimulation had been applied. The carcases were all classified as C3 according to the South African classification system (Government Notice No. R 1748, 26 June 1992). A C3 animal is a mature animal with a medium fat cover (3.1-5.0 mm thick subcutaneous fat depth measured at the 9th rib, 50 mm in from the midline). Twenty-four hours after slaughter (refrigerated at 4ºC), both the left and right *M. longissimus dorsi* were removed, vacuum packed and transported to the processing plant where they were stored in a cooler for six days at 2 °C. Thereafter, the samples were removed, trimmed of all visible fat and superficial collagen, and treated. The muscle from the right hand side of the carcass were not treated and used as control (vacuum packed) whilst that from the left hand side was injected and then vacuum packed. Samples were injected with a salt mixture containing sodium and potassium di- and triphosphates, lactate and chloride (Freddy Hirsch # 802539; PO Box 2554, Cape Town, 8000) at a pressure of 2.4 bar at 30 strokes per minute on a Rühle Curing Centre ±R56 (Rühl GmbH, D·79865, Grafenhausen, Germany) to give a calculated pumped gain of 15% with a retention of 12%. The Freddy Hirsch basting mixture gave a calculated chemical composition of 75.75% water, 5.21% Na^+, 2.53% K^+, 3.45% P_2O_5 and 12.40% lactate. The samples were stored once more in the cooler for a further seven days prior to analysis. Care was taken throughout the investigation to ensure that the handling procedures were similar for the left and right muscles from the same carcass. After removal from the cooler and from the packaging, the samples were divided into two portions, the first for physical analysis and the second for sensory analysis. The later samples were vacuum packed once again, frozen at –12 °C until tested for sensory attributes by a trained taste panel.

The following physical parameters were determined: colour (CIELab) of the raw muscles as well as of the exudates in the vacuum bags, drip and cooking loss and Warner Bratzler shear force values (N/1.27 cm diameter) of the cooked muscles according to standard laboratory techniques (Honikel, 1998).

For sensory evaluation, the meat samples were defrosted at a temperature of 2-4ºC over 48 h for each sensory evaluation session. Meat samples was cut to uniform size and placed on foil covered metal racks. Each metal rack was placed in a coded oven bag and a probe inserted into the centre of the meat. Samples were roasted at 160ºC in two Defy 835 ovens to an internal temperature of 65ºC. The meat was allowed to rest for 5 minutes, in which time an endpoint temperature of 72ºC were reached. Cubed samples (1.5 x 1.5 cm) were taken from the middle of each sample and individually wrapped in aluminium foil. The samples were placed in preheated, coded glass ramekins in a preheated oven of 100ºC and evaluated within 10 minutes. An analytical sensory evaluation panel consisting of seven members was used to evaluate the meat using the standard questionnaire of the American Meat Science Association (AMSA, 1995). This is a numerical, eight point scale from low in intensity (1) to extremely high in intensity (8).

The experimental design consisted of a randomised complete block design with two treatments (2 salt treatments x 1 muscle) replicated in 10 blocks (carcasses). For the physical data, differences between the control and treated samples were tested for by means of paired ttests (SAS, 1990). For the sensory analysis, the data was subjected to ranks before analysis of variance was performed. Tunkey's LSD were calculated at a 5% significance level to compare treatment means (SAS, 1990).

Results

It is well known that colour is the first physical quality attribute that influences a consumer's buying decision (Risvik, 1994; Robbins *et al.*, 2003) and one of the major problems experienced with vacuum packed meat is the purple mioglobin colour that develops. However, throughout this investigation (whilst in the vacuum bags), the treated samples maintained their light red colour and did not darken and form mioglobin as was found with the control samples. The exudates within the vacuum bags were also more red/pink (L*=15.11, a*=13.17, b*=6.64, hue=26.76º, chroma=14.75) than the dark red/brown colour found in the control (L*=14.31, a*=5.10, b*=1.03, hue=11.42º, chroma=5.20). The colour of the raw muscle (after a blooming period of 30 mins for the later) differed significantly from that of the control (Table 1). The higher the a* value, the more red (as opposed to green) the sample is, the higher the b* the more yellow (as opposed to blue) the sample is. What was clearly visible with the treatment group was a more vivid and brighter red colour as opposed to the darker and greyer colour of the control. Colour is the first quality attribute that influences a consumer's purchasing intent (Risvik, 1994) whilst toughness is the attribute that will determine whether he will re-purchase the product. In this investigation, the treatment group should thus be more readily purchased compared to the control.

The treated group also had significantly lower shear values indicating that the control muscle was nearly twice as tough. This phenomenon was also confirmed by the sensory panel who found the treated group to be significantly more tender (P≤0.05) than the control (Table 2). The treated samples were rated the highest for tenderness (rank means = 3.693) being classified as very tender. The original means (see Table 2) give an indication of the part of the scale the panel used (6.722 vs 5.301). A value of 6 was given when a sample was perceived as *moderately tender*, and a value of 7 indicated that the sample was perceived as *very tender*.

In this investigation the *M. longissimus* gained 13±3.99 % by weight during the treatment whilst the untreated control lost 4±0.93%. The later was noted as purge collecting in the vacuum bag. Yet the injected muscle did not have a significantly higher drip loss (Table 1), thereby indicating that the salt mixture injected (predominantly water) was bound within the muscle. Even during cooking, there was no extra cooking loss from the treated samples, once more indicating that the water was still bound within the muscle. The panel rated the samples from the left sides of the carcasses significantly higher (P≤0.05) than the samples from the right side (control) of the carcasses for the attribute of initial juiciness. Initial juiciness is an indication of the amount of fluid exuded on the cut surface when pressing the sample between the thumb and forefinger. This attribute is an indication of the juiciness experienced by a consumer during the first few bites/chews of the meat. The scale used for this attribute was also in the moderately juicy category. Similarly, the treated samples (rank means = 3.343) were rated significantly higher (P≤0.05) for sustained juiciness than the controls (rank means = 1.855). This indicates that the treatment resulted in a juicier (significant) product.

The results for residue follow the same pattern as that for tenderness. The samples differ significantly (P≤0.05) when comparing residue. The treated samples were rated the highest for residue with an original mean of 6.735, indicating that traces to practically no residue was left in the mouth after the first twenty to thirty chews. The panel rated the samples not treated significantly higher (P≤0.05) for overall beef flavour than the treated. However, it must be borne in mind that an experienced trained taste panel was used to evaluate the meat and the probability that a consumer will be able to distinguish between the two treatments is very slight. This is a factor that would have to be monitored closely in future as one of the perceptions of beef meat is its flavour. Some slight successes have been reported in improving the flavour of salt infused beef by adding commercial beef flavourings (Morris *et al.*, 1997).

Conclusions

1) For all the attributes tested, the treated samples were superior in their specific attributes; of particular note is the higher juiciness and tenderness of the salt infused samples.

2) The injecting of the salt mixture resulted in a higher yield of the end product; this is of significant value to the commercial processors.

References

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Table 1: Physical attributes of normal and salt infused beef *M. longissimus* derived from old cull cows

Attribute	Control	Injected	P
L*	39.96±2.4	36.68±2.1	0.00005
a*	16.88±1.3	18.76±2.6	0.01
b*	11.11±1.2	10.40±1.1	0.08
Hue	33.21±2.02	29.22±3.33	0.008
Chroma	20.31±1.65	21.59±2.58	0.03
Cooking loss (%)	40.53±2.1	40.28±2.4	0.7
Drip loss (%)	2.08±0.4	2.42±0.6	0.2
Toughness (N/1.27 cm ⌀)	50.40±8.7	36.73±7.1	0.00004

Table 2: Sensory attributes of normal and salt infused beef *M. longissimus* derived from old cull cows

Attribute	Control	Injected	Tunkey's LSD (5%)
Aroma	3.066^{a} (5.892)	2.440^{b} (5.313)	0.3902
Grey colour	3.458^{a} (5.422)	2.765^{b} (4.940)	0.3391
Initial juiciness	2.281^{b} (5.634)	2.848^{a} (6.098)	0.4122
Sustained juiciness	1.855^{b} (5.217)	3.343^{a} (6.325)	0.3349
Tenderness	2.036^{b} (5.301)	3.693^{a} (6.722)	0.3015
Residue	2.115^{b} (5.651)	3.452^{a} (6.735)	0.3473
Flavour	3.235^{a} (5.940)	1.988^{c} (4.843)	0.3299
Salty taste	1.590^{c} (1.229)	3.542^{a} (5.542)	0.1749