VISUAL STRUCTURAL OBSERVATIONS' CORRELATION WITH BEEF TENDERNESS

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Abstract – This paper describes the visual l observations that a trained panel made on the breed, post-slaughter treatment and ageing differences in beef surface texture, fiber separation, structure integrity and marbling. *M. longissimus lumborum* from 50 steers consisting of *Bos indicus* (Brahman), Sanga type (Nguni), British *Bos taurus* (Angus), European *Bos taurus* (Charolais) and the composite (Bonsmara), 10 animals per breed, n=50. Two post-slaughter treatments were applied: ES (short high voltage electrical stimulation (20 sec, 400 V peak, 5ms pulses at 15 pulses/s) followed by chilling within 1 h at 4 °C) and NS (step-wise chilling (six hours at 10 °C followed by chilling at 4 °C)). Steaks were aged for 3 and 9 days *post mortem* on stryrofoam trays overwrapped with PVC at 6 °C in a display cabinet and for 14 and 20 days *post mortem* in vacuum bags at 1-4 °C in a cold room. Differences in the visual attributes (P<0.05), fiber separation, structure integrity and marbling were observed between breeds, post-slaughter treatments and ageing.

Key Words – Meat visual structural attributes, trained visual panel, shear force.

I. INTRODUCTION

Visual attributes such as meat colour and visible fat influence the purchase-decision by consumers [1, 2], but is not an indication of attributes such as tenderness and juiciness [3]. However, less emphasis is placed on structural or morphological judgement to predict meat tenderness. According to Otremba et al [4] a highly trained descriptive texture profile sensory panel may be able to detect subtle differences among treatments.

The purpose of this study was to evaluate the results of a trained visual sensory panel to see if they find visual differences in fresh steaks from five different beef breeds as a result of two different post-slaughter procedures, ageing and normal display packaging and vacuum packaging.

II. MATERIALS AND METHODS

The five genotypes studied were Brahman (Br), Nguni (Ng), Angus (A), Charolais (C) and the composite Bonsmara (Bo). Ten steers per genotype were purchased (n=50). The animals were fed on a feedlot diet for a period of between 90-110 days. All animals were slaughtered, processed and sampled at the abattoir of the Agricultural Research Council, Irene, Gauteng, South Africa. The carcasses were halved and the right sides were electrically stimulated for 20sec (400 V peak, 5ms pulses at 15 pulses/sec) and chilled in the cold rooms (± 4°C) within 60 min after killing (**ES treatment)**. The left sides were placed in a room with a controlled temperature of 10°C for 6 hours, where after they were placed in the cold rooms at ± 4°C (**NS treatment)**. The *M. longissimus lumborum* (LL) of both carcass sides were sampled between the third last rib and last lumbar vertebra on the day after slaughter. The steaks were aged for 3 and 9 days on stryofoam trays overwrapped with PVC at 6 °C in a display cabinet and for 14 and 20 d in vacuum bags at 1-4 °C in a cold room.

Visual analysis - was evaluated by a 10 member trained sensory panel at the ARC-Irene meat science laboratory for each ageing period according to procedures developed internally. The steaks were allowed to bloom for 1 hour prior to visual observations. The steaks were evaluated for marbling (M; 1=practical devoid of marbling; 8=abundant), surface texture (ST; 1=very smooth, can hardly distinguish fibre bundles; 6=very course, rough), fiber separation (FS; 1=no separation, fibres fit tightly together; 6=fibre structure is falling apart), structure integrity (SI; 1=stiff/hard; 4=very soft). For the purpose of this paper the averages of the ratings of 10 panelists were calculated. Tenderness was measured mechanically by means of Warner Bratzler shear force [5].

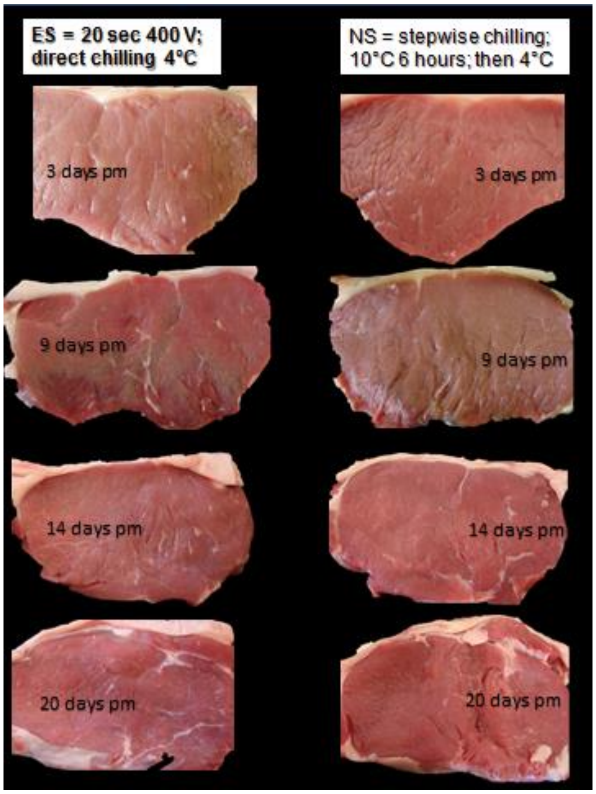

Figure 1. Examples of steaks evaluated for effect of post-slaughter treatment (ES and NS) and ageing on the visual evaluation of meat attributes by a trained sensory panel of 12 members.

The data were subjected to analysis of variance for a split plot design [6] with the six beef breeds (Angus, Bonsmara, Brahman, Charolais and Nguni) as whole plots and the four ageing periods (3, 9, 14 and 20 d *post mortem*) and treatments (ES and NS) as sub-plots. Means for the interactions between sub-plot and whole-plot were separated using Fisher's protected t-test least significant difference (LSD) at the 5% level of probability [7]
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III. RESULTS AND DISCUSSION

A correlation matrix using all values showing correlation coefficients of shear force and visual evaluated surface texture, fibre separation, structure integrity and marbling rating of LL are represented in Table 1. Fibre separation (FS), surface integrity (SI) and marbling (M) showed intermediate ((-0.391) to fairly strong (-0.6) negative relationships with WBSF meaning that samples with less marbling, hard surfaces, and less separation of fibres will tend to be tougher. Surface texture (ST) ratings did not show a good correlation with shear force. It could be as a result of less understanding of the panel what to look for, and a follow-up study might present better results.

Table 1. Correlation matrix showing correlation coefficients of shear force (SF) and visual evaluated surface texture (ST), fibre separation (FS) and structure integrity (SI) and marbling (M) rating of *M. longissimus lumborum* (LL).

	SF	ST	FS	SI	M
SF	1	0.012	**-0.422**	**-0.621**	**-0.391**
ST	0.012	1	**0.617**	0.164	0.148
FS	**-0.422**	**0.617**	1	**0.620**	0.194
SI	**-0.621**	0.164	**0.620**	1	0.245
M	**-0.391**	0.148	0.194	0.245	1

Table 2. The effects of beef breeds on shear force (SF) and visual evaluated surface texture (ST), fibre separation (FS) and structure integrity (SI) and marbling (M) rating of *M. longissimus lumborum* (LL).

	Cattle breeds						
	A	**Bo**	**Br**	**C**	**Ng**	**SEM[1]**	**P-Value**
SF	4.85	4.35	5.47	4.61	4.40	0.289	0.056
ST[2]	2.54^{c}	2.34^{ab}	2.16^{a}	2.66^{c}	2.45^{bc}	0.067	<0.001
FS[2]	3.09^{bc}	2.95^{ab}	2.78^{a}	3.09^{bc}	3.15^{c}	0.063	0.001
SI[2]	2.99^{a}	3.00^{a}	2.85^{a}	2.94^{a}	3.15^{b}	0.053	0.006
M[2]	2.15^{c}	1.82^{b}	1.44^{a}	1.75^{b}	1.91^{bc}	0.097	<0.001

[1] Standard error of means
[2] Average of panel ratings as define under methods
[a,b,c,d] Means within a row with different superscripts differ significantly ($P<0.05$)

Surface texture, fibre separation, structural integrity and marbling ratings were all affected by breed ($P<0.05$), although breed only had a minor effect on shear force ($P = 0.056$) (Table 2). Trying to distinguish between breeds on the ground of these ratings in terms of tenderness might be difficult, but here they follow the pattern of higher shear force and lower visual ratings. Table 3 shows that the two post-slaughter treatments; ES and NS had an effect ($P<0.05$) on shear force (ES were more tender than NS). Unexpectedly higher ratings were given for NS steaks for FS, SI and M, compared to lower ratings for ES steaks.

Table 3. The effects two post-slaughter treatments; ES and NS on s shear force (SF) and visual evaluated surface texture (ST), fibre separation (FS) and structure integrity (SI) and marbling (M) rating of *M. longissimus lumborum* (LL).

	Post-slaughter treatments;			
	ES	**NS**	**SEM[1]**	**P-Value**
SF	4.10[a]	5.07[b]	0.047	<0.001
ST[2]	2.54	2.58	0.021	0.149
FS[2]	2.36[a]	2.53[b]	0.23	<0.001
SI[2]	1.99[a]	2.21[b]	0.027	<0.001
M[2]	1.74[a]	2.01[b]	0.03	<0.001

[1] Standard error of means
[2] Average of panel ratings as define under methods
[a,b] Means within a row with different superscripts differ significantly ($P<0.05$)

We assume that higher shear force should correspond with lower ratings and less tender meat. One suspect that colour differences between two treatments (results not shown) could influence the judgement of the panel members and more experience and training might help eradicate the discrepancies.

Table 4. Effect of ageing/packageing and treatment on shear force and visual evaluated surface texture, fibre separation and structure integrity of *M. longissimus lumborum* (LL)

	Ageing/packaging					
	3 dpm[3]	**9 dpm**	**14 dpm**	**20 dpm**	**SEM[1]**	**P-Value**
SF	6.61[d]	5.17[c]	4.23[b]	3.53[a]	0.043	P<0.001
ST[2]	2.52[a]	2.52[a]	2.52[a]	2.68[b]	0.033	P<0.001
FS[2]	2.06[a]	2.68[b]	2.20[a]	2.85[c]	0.038	P<0.001
SI[2]	1.75[a]	2.41[b]	1.75[a]	2.48[b]	0.033	P<0.001
M[2]	1.74[a]	2.15[c]	1.65[a]	1.97[b]	0.033	P<0.001

[1] Standard error of means; pm = *post mortem*
[2] Average of panel ratings as define under methods
[3] dpm = days *post mortem*
[a,b,c,d] Means within a row with different superscripts differ significantly ($P<0.05$)

Table 4 shows the effect of ageing/packaging on the shear force and visual evaluated surface texture, fibre separation, structure integrity and marbling rating of LL. Days 3 and 9 were more exposed to oxygen and higher display temperatures (6 °C), compared to days 14 and 20 with no oxygen exposure and constant lower storage temperatures (4 °C). Shear force followed the normal ageing pattern showing that the steaks became more tender with time *post mortem*. Fibre separation, structural integrity and marbling ratings increased with ageing post mortem, but packaging had an influence on the ratings at 9 d *post mortem*. These ratings at 9 d *post mortem* could subjective and influenced by the colour instability of that steaks exposed to oxygen and pathogenic decay. All of these samples were rated higher in FS, SI and M, not following the shear force pattern. The panellists could not notice ageing differences in visual surface texture. Although marbling should stay relatively constant through ageing it does seem to become more noticeable with ageing.

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IV. CONCLUSION

From above results it is not sure if it will be possible to predict tenderness by experienced vision. It should be possible to determine tenderness by judging fibre separation and structure integrity. Marbling is not a reliable means to predict tenderness. If these structural changes being evaluated are related to the calpain system protease degradation, it could explain the contradiction towards NS and ES; because it is suspected that electrical stimulation induced tenderness affects more than one mechanism which could give accumulative tenderness results not necessary visible to the eye. A follow-up study is planned; procedures will be updated to eliminate problems identified during the first try.

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