PE7.43 Subcutaneous fat colour - an indication of beef eating quality? 405.00

Lorinda Frylinck (1) LORINDA@ARC.AGRIC.ZA, Phillip Strydom(1), Hanlie Snyman (1),
(1)Agricultural Research Council - Animal Production Institute

Abstract—The effect of age and feeding regime on carcass (subcutaneous fat colour, cold carcass mass, fatness class and intra muscular fat %) and eating (tenderness, aroma, juiciness, flavour) quality were tested on three typical South African cross-breeds, Brahman-crosses (Br-X), Simmental-crosses (Si-X) and Nguni-crosses (Ng-X). The age groups consisted of A-age (zero permanent incisors) AB-age (one-two incisors) and B-age (three - six permanent incisors) of beef breed crosses. Feedlot animals were raised until required age-classes (A- and AB-age). The pasture animals were introduced to pasture after weaning until required age-classes (A-, AB- and B-age). The animals were slaughtered according to normal South African slaughter procedures and the carcasses were electrically stimulated. As expected the subcutaneous fat colour analyses revealed the highest light reflection (L*), the lowest redness (a*) and the highest yellowness (b*) for the B-age pasture carcasses, but this group was on average more tender than both the A-age test groups and the AB-age pasture test group, with only the AB-age feedlot test group more tender (Warner Bratler shear force and sensory panel analyses). This study shows that judging eating quality on the grounds of visual subcutaneous fat colour is not reliable and that animals with three - six permanent incisors do not necessarily produce tougher meat. In fact some breeds such as the Southern African indigenous Nguni perform very well in these production systems.

L. Frylinck is with the Agricultural Research Council – Animal Production Institute, Private Bag X2, Irene, 0062, South Africa (corresponding author phone: +27 72 959 9722; fax: +27 12 665 1551; e-mail: lorinda@ arc.agric.za). P.E. Strydom is with the Agricultural Research Council – Animal Production Institute, Private Bag X2, Irene, 0062, South Africa (e-mail: pstrydom@arc.agric.za). J.D. Snyman is with the Agricultural Research Council – Animal Production Institute, Private Bag X2, Irene, 0062, South Africa (e-mail: hanlie@arc.agric.za).

Index Terms—age, feed regime, beef cross-breeds, fat colour, eating quality

I. INTRODUCTION

The influence of subcutaneous fat on the visual and eating quality of meat becomes important in carcasses from older animals. The fat of carcasses of pasture-fed animals tend to be more yellow than that of grain-fed animals [1], and is often mistaken for being an indication for being a carcass of an older animal and therefore tougher meat. The carcasses with more yellowish fat will thus achieve lower prices on the market than those with white fat, irrespective of the actual age of the original animal [2]. It will be beneficial to the South African farmers in particular if fat colour could be studied, consumers and wholesalers/abattoirs could be educated accordingly with regard to the association of fat colour with eating quality. The aim of this study is to evaluate the eating quality (tenderness and other sensory attributes such as juiciness and aroma) differences in relation to subcutaneous fat colour and marbling of A-age (feedlot and pasture) animals, AB-age (feedlot and pasture) animals, and B-age (pasture) animals under the determined ideal slaughter conditions for South African crossbred beef breeds.

II. MATERIALS AND METHODS

Each age-feed group consisted of 10 animals of each cross breed (Brahman-X, Simmental-X, Nguni-X). Feedlot animals were raised until required age-classes (A-age (zero permanent incisors) and AB-age (one-two incisors)). These test groups will be revered to as AF and ABF. The pasture animals were introduced to pasture after weaning until required age-classes (A-, AB- and B-age (three - six permanent incisor)). These three test groups will be referred to as AP, ABP, and BP. The animals were slaughtered according to normal South African slaughter procedures and the carcasses were electrically stimulated for 15 sec (400 V peak, 5 ms pulses at 15 pulses per sec). Carcasses were chilled directly after dressing at room temperature before loading at 0 – 4 °C. Ultimate pH of the M. longissimus (LL) was measured between the 11th and 12th rib and cold carcass mass and back thickness was measured at 24 h post mortem. Sampling of the M. longissimus (LL) for measurement of WBSF and sensory analyses took place 24 hours post mortem. LL of both sides was sampled. The position of sampling for each test was consistent. Samples destined for

WBSF and sensory analyses were vacuum packaged and aged at 2°C ± 2 ºC for 1 d, 7d- and 14 d post mortem and WBSF was measured as described by Strydom and Frylinck [3]. A sensory study by means of a trained sensory panel consisting of 10 members (Sensory Analytical Laboratory, Meat Industry Centre, ARC – API) assessed tenderness, first bite, amount of residue (connective tissue), flavour, juiciness and sustainable juiciness on a 8 point scale of A-age (feedlot and pasture) animals, AB-age (feedlot and pasture) animals, and B-age (pasture) animals. A score of 8 described the sample as extremely intense in aroma and flavour, extremely juicy, extremely tender with no connective tissue residue, while a score of 1 describe it as extremely bland in aroma and flavour intensity, extremely dry, extremely tough with extremely abundant connective tissue residue [4]. Subcutaneous-fat colour, back-fat thickness and marbling were measured at 24 h post mortem. Colour parameters, CIE L*, a* and b* values were determined on freshly cut back fat exposed surfaces with a Minolta chromameter Minolta CR200 (Minolta,Japan) as recommended by CIE [5]. The chromameter was calibrated against a white calibration tile that was wrapped in the same polythene cling film used for the fat samples. Three random measurements were done. L* represents the surface lightness/darkness, a*, the redness and b*, the yellowness. Thus the b* value is considered the ideal objective measurement of the yellowness of a fat surface [6]. Additionally, hue angle was calculated as: tan-1(b*:/a*), the saturation index calculated or also known as Chroma (C*): (a*2+b*2)1/2, and the redness index (RI) as: a*/b* [7]. The data were subjected to multiple analysis of variance. Means for the main effects and their co-variants were separated using Fisher's protected t-test least significant difference (LSD) at the 5% level [8].

III. RESULTS AND DISCUSSION

Carcass characteristics The carcass characteristics were summarized in Table 1. The average carcass size of the AP and ABP test groups were much smaller than those of the AF and ABF test groups with the B-age animals reared on the pastures being the largest. This could indicate to the fact that the animals needed time to adapt to the pasture circumstances. Ultimate pH measured on the carcasses showed low pHu in the AF group (pH 4.47), with the other groups having a higher pHu on average (pH = 5.6 plus). The fatness classes of the feedlot animals are significantly higher than that of the pasture animals, with the Br-X and Ng-X performing better under pasture circumstances than the Si-X. The back-fat thickness correlates with the rest of the carcass characteristics stated above, with the AF and ABF groups measuring the thickest back fat, followed by the BP and then the AP and ABP groups. The highest % intra muscular fat (IMF) was measured in the feedlot groups, AF and ABF, followed by BP. The lowest IMF was in AP and ABP showing that the animals did not perform as well on the pastures compared to the feedlot. Subcutaneous fat colour Fat colour measurements were reported in Table 1. A lower L* was measured in the younger carcasses (AF, AP), but also ABF. The older pasture animals hat higher L*. The younger carcasses, AF, AP and ABF had a higher a*, which became increasingly lower in ABP and BP. The breed effect was significant – Si-X and Ng-X seem to have redder fat colour up to an older age. The yellow green (b*) tends to be higher in pasture carcasses than in feedlot carcasses with ABF higher than AF and BP. The calculated SI became higher with age but lower in feedlot carcasses with no breed effect and RI was high in AF, AP, ABF, but lower in ABP and very low in BP. These results are consistent with those reported by Kerth et al. [9] and others. Aroma, juiciness and flavour Meat from the AF and ABF groups had the highest aroma followed by BP with AP and ABP the lowest. This corresponds with the % IMF back fat profiles. A significant breed effect showed that the Si-X and Ng-X tended to be more aromatic. The ABF and BP groups had the highest juiciness. The AF and ABF groups seemed to be significantly more flavoursome followed by the BP and then AP and ABP. The Ng-X seemed to be significantly more flavoursome. Meat tenderness The lowest WBSF were measured in ABF followed by AF and then BP with AP and ABP the highest. This corresponds with all the tenderness related sensory attributes first bite, tenderness and residue, evaluated by the trained panel (Table 2). A significant breed effect was detected for all the tenderness measurements with the Si-X cross breed producing the most tender meat overall as expected for a Bos taurus breed, but not doing well under pasture conditions. The Ng-X as part of the ABF and BP groups produced ekwivalently tender meat.

IV. CONCLUSION

Subcutaneous fat colour as a result of the age and feeding regime of the animal does not indicate to less tender meat because certain breeds do very well in a pasture producing situation at an older age (4 to 6 teeth) such as the Nguni-X in this study. Older feedlot animals (AB classification - 2 teeth) can produce more tender meat than their younger (A-class, 0 teeth) counter parts. In fact the B-age pasture carcasses also produced on average more tender meat than both the A-age (feedlot and pasture) and AB-age pasture test groups, with only the AB-age feedlot test group on average more tender. The South African classification system and resultant remuneration system should be revisited and consumers should be educated accordingly.

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Table 1. Effect of age, feeding regime and cattle cross-breed-type on the carcass characteristics, ultimate pH in the *M. longissimus* (LL) and colour attributes in subcutaneous fat at one day post slaughter.

Age groups	AF	AP	ABF	ABP	BP	SEM	P-value
Cold carcass weight (g): Breed/age-feed average							
Br-X	216.8^{ef}	179.4^{bc}	233.1^{f}	201.3^{d}	263.9^{g}	6.85	<0.001
Si-X	234.1^{f}	170.4^{b}	231.8^{f}	175.3^{b}	266.8^{g}		
Ng-X	201.6^{de}	143.7^{a}	175.4^{b}	164.2^{b}	188.3^{cd}		
Ultimate pH (24 hours *post mortem*)							
Age-feed average	5.47^{a}	5.68^{b}	5.64^{b}	5.65^{b}	5.61^{b}	0.017	<0.001
Fatness class: Breed/Age-feed average							
Br-X	$2+^{c}$	1^{b}	2+c	$1+^{b}$	2^{c}	0.18	0.033
Si-X	2^{c}	$1-^{a}$	2+c	$1-^{a}$	1^{b}		
Ng-X	$2+^{c}$	$1-^{a}$	2+c	1^{b}	2^{c}		
P8 fat thickness (mm)							
Age-feed average	7.54^{d}	0.89^{a}	5.70^{c}	1.68^{a}	3.44^{b}	0.298	<0.001
Marbling (% intra muscular fat-NIRS)							
Age-feed average	1.94^{c}	0.84^{a}	2.33^{d}	1.06^{a}	1.58^{b}	0.10	<0.001
Subcutaneous fat colour: CIE Lab							
L* – lightness							
Age-feed average	78.29^{a}	78.41^{a}	78.33^{a}	79.83^{b}	80.33^{b}	0.413	<0.001
a* – red							
V. AGE-FEED EFFECT	0.38^{c}	1.02^{c}	0.83^{c}	-0.83^{b}	-2.40^{a}	0.270	<0.001
Breed/age-feed average							
Br-X	1.01^{c}	0.35^{b}	0.36^{bc}	-1.81^{a}	$-2,15^{a}$	0.468	0.009
Si-X	0.44^{bc}	0.49^{bc}	1.01^{c}	-0.44^{b}	-2.27^{a}		
Ng-X	-0.33^{b}	2.17^{c}	1.12^{c}	-0.24^{b}	-2.77^{a}		
b* - yellow green							
Age-feed average	8.58^{a}	15.38^{c}	12.56^{b}	17.13^{d}	19.18^{e}	0.494	<0.001
Chroma (C) – saturation index							
Age-feed average	8.64^{a}	15.53^{c}	12.65^{b}	17.00^{d}	19.40^{e}	0.488	<0.001
Redness index (RI) *(Hue angle (HA)-no effect)*							
Age-feed effect	0.039^{c}	0.057^{c}	0.067^{c}	-0.045^{b}	-0.128^{a}	0.0187	<0.001
Breed/age-feed average							
Br-X	0.108^{c}	0.027^{bc}	0.026^{bc}	-0.100^{b}	-0.119^{a}	0.0324	0.003
Si-X	0.051^{c}	0.021^{b}	0.089^{c}	-0.030^{b}	-0.113^{a}		
Ng-X	-0.043^{b}	0.124^{c}	0.087^{c}	-0.006^{b}	-0.151^{a}		

[abcd] Means in a row with different superscripts differ significantly ($p<0.05$) with the Fishers' means separation test.

Table 2. Effect of age, feeding regime and cattle cross-breed-type on Warner Bratzler shear force (WBSF) and sensory meat quality attributes measured in *M. longissimus* (LL) at 1d, 7d, and 14d *post mortem*.

Age groups	**AF**	**AP**	**ABF**	**ABP**	**BP**	**SEM**	**P-value**
WBSF							
Age-feed average	5.36^{bc}	6.03^{c}	4.92^{a}	5.69^{bc}	5.02^{bc}	0.157	<0.001
Breed/age-feed average							
Br-X	5.71^{b}	6.25^{b}	5.32^{b}	6.11^{b}	5.14^{ab}	0.272	0.096
Si-X	4.67^{a}	5.38^{b}	4.88^{a}	5.40^{b}	5.07^{ab}		
Ng-X	5.70^{b}	6.46^{b}	4.54^{a}	5.55^{b}	4.85^{a}		
Sensory analyses							
First bite[1]							
Age-feed average	5.67^{c}	4.47^{a}	5.68^{c}	4.68^{ab}	5.04^{b}	0.124	<0.001
Breed/age-feed average							
Br-X	5.32^{c}	4.59^{b}	5.40^{e}	4.61^{b}	4.85^{b}	0.216	0.023
Si-X	6.13^{d}	4.97^{b}	5.68^{cd}	4.66^{b}	5.15^{bc}		
Ng-X	5.57^{c}	3.85^{a}	5.96^{d}	4.77^{b}	5.11^{b}		
Tenderness[2]							
Age-feed average	5.73^{c}	4.66^{a}	5.76^{c}	4.93^{ab}	5.20^{b}	0.112	<0.001
Breed/age-feed average							
Br-X	5.43^{c}	4.80^{b}	5.54^{c}	4.80^{b}	5.08^{bc}	0.194	0.027
Si-X	6.10^{d}	5.11^{bc}	5.73^{c}	5.06^{bc}	5.26^{bc}		
Ng-X	5.66^{cd}	4.07^{a}	6.02^{d}	4.93^{b}	5.28^{bc}		
Residue[3]							
Age-feed average	5.49^{c}	4.54^{a}	5.52^{c}	4.80^{ab}	5.06^{bc}	0.103	<0.001
Breed/age-feed average							
Br-X	5.21^{c}	4.66^{b}	5.38^{c}	4.68^{b}	5.00^{b}	0.178	0.025
Si-X	5.86^{c}	4.98^{b}	5.48^{c}	4.95^{b}	5.08^{bc}		
Ng-X	5.41^{c}	3.98^{a}	5.70^{c}	4.76^{b}	5.09^{bc}		
Aroma[4]							
Age-feed average	5.72^{c}	5.52^{ab}	5.73^{bc}	5.43^{a}	5.60^{b}	0.037	<0.001
Breed/age-feed average							
Br-X	5.79^{c}	5.55^{a}	5.62^{b}	5.42^{a}	5.57^{ab}	0.063	0.026
Si-X	5.64^{b}	5.55^{a}	5.66^{b}	5.43^{a}	5.53^{a}		
Ng-X	5.74^{c}	5.44^{a}	5.92^{c}	5.43^{a}	5.71^{b}		
Initial juiciness[5]							
Age-feed average	5.36^{a}	5.47^{b}	5.49^{b}	5.46^{ab}	5.54^{b}	0.036	0.012
Sustained juiciness[6]							
Age-feed average	5.24^{a}	5.40^{b}	5.50^{bc}	5.46^{bc}	5.57^{c}	0.042	<0.001
Flavour[7]							
Age-feed average	5.62^{c}	5.35^{a}	5.67^{c}	5.35^{a}	5.50^{b}	0.032	<0.001
Breed/age/feed average							
Br-X	5.61^{b}	5.37^{a}	5.54^{b}	5.37^{a}	5.46^{ab}	0.0557	0.019
Si-X	5.60^{b}	5.41^{a}	5.62^{bc}	5.32^{a}	5.45^{ab}		
Ng-X	5.67^{c}	5.28^{a}	5.86^{d}	5.38^{ab}	5.58^{c}		

p.m. = *post mortem;*
[1] First bite (1 = extremely tough; to 8 = extremely tender)
[2] Tenderness (1 = extremely tough; to 8 = extremely tender)
[3] Residue (1 = extremely abundant; to 8 = none)
[4] Aroma (1 = extremely bland; to 8 = extremely intense)
[5] Initial juiciness (1 = extremely dry; 8 = extremely juicy)
[6] Sustained juiciness (1 = extremely dry; 8 = extremely juicy)
[7] Flavour (1 = extremely bland; to 8 = extremely intense)
[abcd] Means in a row with different superscripts differ significantly ($p<0.05$) with the Fishers' means separation test.