EFFECT OF AGE ON CARCASS AND CUT COMPOSITION OF SOUTH AFRICAN BEEF CARCASSES

Hettie C. Schonfeldt[1] & Phillip E. Strydom[2]

[1] University of Pretoria, Department of Animal and Wildlife Sciences, Pretoria, 0002, South Africa
[2]Agricultural Research Council, Private Box X2, Irene, 0062, South Africa

Abstract - The physical composition (proportion of subcutaneous fat, meat and bone) of 15 primal cuts from beef animals (n=122) of three different age groups and representing the full variation in fatness, was assessed. Furthermore, proximate analyses (% total moisture, fat, nitrogen and ash) were performed, from which total fat and muscle content for each cut were calculated. In general the meat content decreased and bone content increased with increased age of the animal. A large variation in compositional and chemical characteristics for the various cuts for the three age groups was observed.

Key Words: bone, meat, fat, muscle, nitrogen

I. INTRODUCTION

The value of a beef carcass is principally based on the amount of saleable meat estimated to be in the carcass. Saleable meat is, however, a function of the proportion of lean meat in the carcass [1]. Consumer demand in most developed countries is primarily for lean beef [2, 3] with a continuously increased aversion to fat [4]. In order to comply with the consumers' preferences for leanness, the average fat content of the target class beef carcasses in South Africa (SA) has changed considerably from 32% in 1949 to 18% in 1981 to 13% in 1992 [5], and continue to do so.

The decrease in fat content observed is also price driven as consumers are prepared to pay more for leaner products. This has a direct implication for the industry to produce carcasses with maximum lean edible tissue, i.e. maximum muscle with minimum bone and fat [6].

In SA, producer price is not only influenced by fat content, but also by the age of the animal in an inverse relationship. In general, feedlot animals are marketed before any permanent incisors have erupted and will, in terms of the SA carcass classification system [7], be classed as A-age carcasses. Under conditions of natural or planted pastures animals are normally market-ready by the time their first pair of permanent incisors have erupted (AB-age carcasses). The B-age group represents carcasses with 3 to 6 permanent incisors, and C-age carcasses have 7 or more permanent incisors consisting mainly of culled animals.

As the anatomical composition of an animal changes as it grows and develops, and has a direct influence on the value of the beef carcass based on the amount of saleable meat, age by dentition was the variable incorporated in this study. The data were statistically analysed with carcass fat as a covariant to adjust for differences in carcass fat classes within age groups.

II. MATERIALS AND METHODS

Source of materials

The beef carcasses (*n* = 122) used were representative of the commercial market and had a mass range of between 190 kg and 240 kg. Three age groups were included in the study, and included age A (no permanent incisors), age AB (2 permanent incisors) and age C (8 tooth). The carcasses were obtained on the commercial market by qualified classifiers. All carcasses were electrically stimulated (500 V) within 10 minutes of stunning, dressed, halved, chilled overnight (0°C to 5°C) and transported to the ARC-ANPI in a refrigerated truck.

Carcass composition

Carcasses were divided into 15 primal cuts. Each cut was weighed and dissected into subcutaneous fat, meat (muscle plus inter- and intramuscular fat) and bone, in order to determine the physical composition of each cut. The mass of the various tissues was used to calculate carcass composition.

Chemical analysis

The fat and meat from each of the cuts were cubed, mixed and minced (5 mm and 2 mm mesh plates). Proximate analyses according to AOAC-methods [8] were performed to determine total moisture, fat, protein and ash in the tissue of each cut.

Calculation of meat, fat and bone content

Carcass composition was calculated using dissection results (bone, meat and subcutaneous fat), as well as chemical composition (moisture, protein, fat and ash) of each cut. The mass of the muscle in each cut was determined by adding the calculated mass of moisture, protein and ash together. The mass of ether extractable "lipid" was regarded as fat. In this way chemically determined "muscle" and "fat" were estimated and together with the dissected bone comprised total cut content [9].

Statistical Analysis

Principle Component Analysis (PCA) [10] was performed on all the different variants for each of the 15 cuts. It showed that fatness of the carcass was one of the most important factors identified in this multivariate data. For that reason it was used as a covariant during ANOVA analyses [11] at 15.45%.

III. RESULTS AND DISCUSSION

Effect of age on carcass and cut characteristics

According to the physical dissection results, the subcutaneous fat content of cuts increased significantly with age in four of the 15 cuts. The loin ($p \leq 0.05$), wing rib ($p \leq 0.001$), rump ($p \leq 0.001$) and fore shin ($p \leq 0.05$) of age A and age AB had significantly less subcutaneous fat compared to the C-age group (Table 1).

Table 1. Least square mean values of physically determined subcutaneous fat (%) for cuts from three age groups

Cut	p-Value	Age A	Age AB	Age C
Prime rib	0.9517	6.25	6.25	6.35
Loin	0.0187	8.16^{a}	8.50^{a}	9.51^{b}
Wing rib	0.0002	9.03^{a}	8.72^{a}	11.0^{b}
Rump	0.0008	6.97^{a}	6.65^{a}	8.74^{b}
Topside	0.5631	8.30	7.99	7.77
Fillet	0.3402	0.20	0.01	0.01
Silverside	0.0991	6.06	6.11	7.12
Thick flank	0.1590	6.18	5.49	6.37
Chuck	0.9202	1.33	1.28	1.28
Brisket	0.2676	5.36	4.84	5.61
Neck	0.6420	3.41	3.71	3.26
Shoulder	0.8153	4.27	4.29	4.49
Thin flank	0.2822	21.1	20.6	19.3
Fore shin	0.0281	0.86^{a}	0.58^{a}	1.03^{b}
Hind shin	0.1066	2.11	1.40	1.98
Carcass	0.4384	6.54	6.32	6.66

[abc] Means in a row with different superscripts differ significantly ($p \leq 0.05$)
*Carcass calculated

The physically determined meat content decreased significantly with age in seven of the 15 cuts, as well as in the total carcass (Table 2). The prime rib, loin, wing rib, rump, brisket and shoulder of age A and age AB had significantly more meat than the C-age group ($p \leq 0.01$). The neck from age A had significantly ($p \leq 0.001$) more meat compared to the AB-age group which, in turn, had significantly ($p \leq 0.001$) more meat than the neck in the C-age group.

Table 2. Least square mean values of physically determined meat (%) for cuts from three age groups

Cut	p-Value	Age A	Age AB	Age C
Prime rib	0.0012	76.9^{a}	76.2^{a}	74.5^{b}
Loin	0.0001	73.7^{a}	72.5^{a}	70.1^{b}
Wing rib	0.0001	72.4^{a}	73.1^{a}	69.0^{b}
Rump	0.0002	75.3^{a}	75.8^{a}	73.3^{b}
Topside	0.2964	84.6	84.9	84.0
Fillet	0.3402	99.7	100	100
Silverside	0.1156	93.9	93.9	92.9
Thick lank	0.2689	90.9	91.5	90.7
Chuck	0.9383	83.3	83.5	83.3
Brisket	0.0008	76.3^{a}	76.3^{a}	74.2^{b}
Neck	0.0001	82.4^{a}	80.6^{b}	78.4^{c}
Shoulder	0.0066	87.5^{a}	87.2^{a}	86.2^{b}
Thin flank	0.5379	75.8	73.9	75.5
Fore shin	0.0501	44.8	46.3	45.4
Hind shin	0.8368	34.6	35.2	35.1
Carcass*	0.0001	80.3^{a}	80.1^{a}	78.8^{b}

[abc] Means in a row with different superscripts differ significantly ($p \leq 0.05$)
*Carcass calculated

The bone content increased significantly with age in eight of the 15 cuts, as well as in the calculated carcass meat content (Table 3). The neck and thin flank from age A had significantly ($p \leq 0.001$) less bone compared to the AB-age group which, in turn, had significantly ($p \leq 0.001$) less bone than cuts obtained from the C-age group. The prime rib, loin, wing rib, topside and brisket of A- and AB-age groups had significantly ($p \leq 0.01$) less bone than those from the C-age group.

Table 3. Least square mean values of physically determined bone (%) for cuts from three age groups

Cut	p-Value	Age A	Age AB	Age C
Prime rib	0.0002	16.9[a]	16.5[a]	19.2[b]
Loin	0.0044	18.1[a]	19.2[a]	20.4[b]
Wing rib	0.0108	18.5[a]	18.2[a]	20.0[b]
Rump	0.5184	17.7	17.5	18.0
Topside	0.0001	7.16[a]	7.16[a]	8.20[b]
Fillet	0.3402	0.07	0.00	0.00
Silverside	0.0944	0.03	0.04	0.00
Thick lank	0.8280	2.95	3.03	2.92
Chuck	0.9560	15.4	15.3	15.4
Brisket	0.0004	18.3[a]	18.9[a]	20.2[b]
Neck	0.0001	14.1[a]	15.9[b]	18.3[c]
Shoulder	0.0001	8.22[a]	8.51a	9.30[b]
Thin flank	0.0001	3.17[a]	3.92[b]	5.18[c]
Fore shin	0.1363	54.3	53.2	53.6
Hind shin	0.8869	63.3	63.4	62.9
Carcass*	0.0001	13.2[a]	13.6[a]	14.5[b]

[abc] Means in a row with different superscripts differ significantly ($p \leq 0.05$)
[*] Calculated

Age of the animal had a significant effect on the chemically determined fat percentage of the various cuts (Table 4). Four of the 15 cuts increased and three decreased in fat content with age. The rump and silverside of the A- and AB-age groups contained significantly ($p \leq 0.01$) less fat compared to those from the C-age group. The prime rib of age A had significantly ($p \leq 0.05$) less fat than the AB- and C-age groups. The wing rib of the A-age group contained significantly ($p \leq 0.001$) less fat than the AB-age group, which in turn contained significantly ($p \leq 0.001$) less fat than the C-age group. The neck of the A- and AB-age groups contained significantly ($p \leq 0.01$) more fat compared to those from the C-age group. The thick and thin flank of age A had significantly ($p \leq 0.05$) more fat than the AB- and C-age groups.

Table 4. Least square mean values of chemically determined fat (%) for cuts from three age groups

Cut	p-Value	Age A	Age AB	Age C
Prime rib	0.0109	18.6[a]	19.9[b]	20.5[b]
Loin	0.4502	16.8	6.50	17.2
Wing rib	0.0004	18.2[a]	19.5[b]	20.9[c]
Rump	0.0001	14.9[a]	15.1[a]	15.7[b]
Topside	0.4030	12.9	12.3	12.4
Fillet	0.1828	8.43	8.67	7.52
Silverside	0.0072	11.5[a]	11.3[a]	12.7[b]
Thick flank	0.0432	10.4[a]	9.30[b]	9.48[b]
Chuck	0.0886	12.6	13.2	13.5
Brisket	0.2285	24.1	23.9	23.4
Neck	0.0001	16.2[a]	15.5[a]	13.5[b]
Shoulder	0.8401	11.8	11.6	11.6
Thin flank	0.0212	32.0[a]	33.1[b]	30.5[b]
Fore shin	0.7751	3.78	3.76	3.65
Hind shin	0.2819	5.52	5.04	5.07

[abc] Means in a row with different superscripts differ significantly ($p \leq 0.05$)

The chemically determined muscle content decreased significantly with age in seven of the 15 cuts (Table 5). The prime rib of the A-age group had significantly ($p \leq 0.01$) more muscle content than the AB-age group that in turn had significantly ($p \leq 0.01$) more muscle content than the C-age group. The loin, wing rib, rump and silverside of A- and AB-age groups contained significantly ($p \leq 0.01$) more muscle content than the C-age group. The muscle content in the thick flank of A-age group was significantly ($p \leq 0.05$) less than the AB- and C-age groups. The muscle content in the neck of the A-age group was significantly ($p \leq 0.05$) more than the C-age group.

Table 5. Least square mean values of chemically determined muscle (%) for cuts from three age groups

Cut	p-Value	Age A	Age AB	Age C
Prime rib	0.0001	64.8[a]	62.6[b]	60.6[c]
Loin	0.0024	65.0[a]	64.5[a]	62.4[b]
Wing rib	0.0001	63.2[a]	62.5[a]	59.5[b]
Rump	0.0018	67.3[a]	67.6[a]	65.6[b]
Topside	0.0556	79.7	80.7	79.4
Fillet	0.0687	90.0	91.3	92.6
Silverside	0.0031	88.2[a]	88.8[a]	87.1[b]
Thick flank	0.0456	86.5[a]	87.7[b]	87.3[b]
Chuck	0.4555	71.8	72.0	71.3
Brisket	0.1739	57.7	57.3	56.5
Neck	0.0364	69.7[a]	68.7[a.b]	68.1[b]
Shoulder	0.2463	79.6	79.6	79.0
Thin flank	0.3192	64.8	63.5	64.7
Fore shin	0.0786	41.8	43.1	43.0
Hind shin	0.5919	31.1	31.6	32.0

[abc] Means in a row with different superscripts differ significantly ($p \leq 0.05$)

The effect of age on the physically separated carcass tissues can be summarised as an increase in bone content from A- and AB-age groups to C-age group, with a decrease in meat content with age. This is a result of negative muscle growth between AB- and C-ages. The effect of age on the chemical composition of the carcass can be summarised as a significant increase in fat content with age in four of the 15 cuts and a decrease in three of the cuts. The chemically determined muscle content decreased significantly with age in six of the 15 cuts, and increased with age in one cut.

IV. CONCLUSIONS

Age of the animal at an equal carcass fat content affected the physically separated carcass tissues. Bone content increased with age, with a decrease in meat content. The effect of age on the chemical composition of the carcass, at an equal carcass fat content, was decreased chemically determined muscle content.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude and appreciation to the now retired Dr RT Naudé and Prof E Boshoff for their valuable guidance during this project and to Mrs MF Smith for statistical analysis.

REFERENCES

1. Laville, E., Martin, V. & Bastien, O. (1996). Prediction of carcass traits of young Charolais bull carcasses using a morphometric method. Meat Science 44: 93-104.
2. Sanudo, C., Alfonso, M., Sanchez, A., Delfa, R. & Teixeira, A. (2000). Carcass and meat quality in light lambs from different fat classes in the EU carcass classification system. Meat Science 56: 89-94.
3. Resurreccion, A.V.A. (2003). Sensory aspects of consumer choices for meat and meat products. Meat Science 66: 11-20.
4. Wood, J.D., Enser, W., Fisher, A.V., Nute, P.R., Sheard, P.R., Richardson, R.I., Hughes, S.I. & Whittington, F.M. (2008). Fat deposition, fatty acid composition and meat quality: A review. Meat Science 78: 343 – 358.
5. Naudé, R. T. (1972). Die bepaling van spier, vet en been in karkasse en snitte van jong osse. S. Afr. Tydskr. Veek 2: 35-39.
6. Strydom, P. E. (1995). The role of genotype and physiological type of animal in increasing meat yield. J. Zim. Soc. for Anim. Prod 7: 89-95.
7. Government Gazette No. R. 863 (2008). Meat classification regulations. Republic of South Africa.
8. AOAC (1995). Official methods of analysis. 16th ed. Washington. Assoc. Off. Anal. Chem.
9. Carroll, M. A. & Conniffe, D. (1967). Growth and development of mammals, ed. G. A. Lodge & G. E. Lamming, Butterworths, London.
10. GenStat® for Windows® (7th Edition) – Introduction (Editor R.W. Payne), Published 2003 by VSN International, ISBN 1 904375 08 1
11. SAS Institute Inc. (1996). SAS system for Windows, release 6.11. SAS Institute Inc., Cary, NC, USA.