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CARCASS AND MEAT QUALITY OF AFRICANDER AND JERSEY CROSSBRED STEERS

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OPSOMMING: KARKAS- EN VLEISKWALITEIT VAN AFRIKANER- EN JERSEYKRUISRASOSSE

Afrikanerkoeie is geïnsemineer met Limousino- en Normandebulle se saad en Jerseykoeie met genoemde tipe bulle sowel as Charolaise-bulle se saad. Die gekastreerde manlike nageslag is in 'n vetmestingsproef vergelyk ten opsigte van groei, karkas- en vleiskwaliteit. Lewende massas van ongeveer 460 kg is bereik op ouderdomme van om en by 16 maande. Al vyf kruistipes se groei- en kwaliteitseienskappe was besonder eenders. Ekonomiese faktore soos uitslagpersentasie, karkaskonformasie, algemene vetheid en hoeveelheid afvalvet in die karkas was egter meer gunstig vir die osse afkomstig van vleiarasmoers. Vleiskwaliteitsfaktore soos sagtheid, kookverlies, kollageenkwaliteit en spierkleur was nie statisties verskillend tussen die verskillende tipes osse nie. Die Jersey vergelyk dus redelik gunstig met die Afrikaner in 'n kruisteelprogram vir vleisproduksiedoeleindes.

SUMMARY

Africander cows were inseminated with the semen of Limousine and Normande bulls and Jersey cows with that of bulls of the above two breeds as well as with Charolaise semen. The male castrate progeny were compared in a fattening experiment. Criteria studied were growth, carcass and meat quality. Live masses of approximately 460 kg were attained at about 16 months. The carcass and meat quality of all groups were very similar. Certain economic factors such as dressing percentage, carcass conformation, general fatness and amount of waste fat in the carcass were however better in Africander crossbred steers. The meat quality parameters: tenderness, cooking loss, collagen quality and muscle colour were not significantly different between the five types of steers. The Jersey compares favourably with the Africander in a crossbreeding programme for beef production purposes.

In attempts to increase the quantity of meat produced per animal in South Africa, crossbreeding local beef cattle with the rapidly gaining leaner type beef bulls is common practice. Consumers all over the world are at present showing an ever increasing preference for leaner younger beef than was the case two or three decades ago. Certain European breeds of cattle yield exceptionally lean beef, have a high muscle to bone ratio and have a high growth rate (Carroll, 1971; Meat Control Board, 1970; Dumont & Boccard, 1967; Boccard, 1973). The Africander breed of cattle is well adapted to the environmental conditions in South Africa, and is numerically the most important breed in the country (Naudé, 1965). It is widely used and has proved suitable for crossbreeding with more rapidly growing and leaner beef breed bulls. This applies especially to areas with more favourable nutritional conditions or for intensive pen feeding of slaughter stock. The Jersey is numerically the second most important dairy breed in South Africa. Because of its poor growth performance it is not suitable as a pure breed in any beef production enterprise. The relatively high mild yield efficiently produced by the Jersey cow (Naudé, 1966), renders it a suitable dam for rearing a large sized crossbred calf. The successful production of high quality beef from crossbred Jersey cattle has been well established in numerous countries of the world (Naudé, 1968, 1972; Wellington, 1971).

In a crossbreeding experiment (Department of Agricultural Technical Services, 1971) at the Vaalhartz Experiment Station Jersey cows are being compared with Africander cows under extensive grazing conditions for mothering and reproductive ability. The steer progeny of these two dam breeds were used to evaluate different breeds of sire with regard to carcass and meat quality characteristics.

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Procedure

Animals

Africander and Jersey cows were inseminated with Limousine and Normande semen. Some Jersey cows were also inseminated with Charolaise semen. Calves suckled their dams under veld grazing conditions until 7 to 9 months of age when they were weaned and male calves castrated. After 4 to 5 months of pen feeding at Vaalhartz 5 steers of each of the Jersey and 6 of the Africander crossbred types were transferred to Irene where they were group fed *ad libitum* on a diet containing 12% crude protein and 20% roughage. This feeding period commenced at an average age of 12,6 months. Steers were slaughtered at a live mass of approximately 460 kg.

Carcasses

The digestive tracts were weighed full and empty in order to obtain the empty body mass of each animal. The hide, omental fat and warm carcass masses were also determined. After chilling the following masses were recorded: cold carcass, left and right side, kidney and channel fat of the right side and right fore and hind quarter (cut between 10th and 11th ribs). The length of side and leg were measured as well as the thickness of the subcutaneous fat on the cut surface of the *M. longissimus thoracis*. The prime rib cut (8th to 10th rib) was taken from the right fore quarter for deboning and proximate analysis (Naudé, 1971) in order to determine the muscle : fat : bone ratio in the carcass.

Meat

The left prime rib cut was taken for quality testing on the *M. longissimus thoracis*. A portion of the *M. pertoralis produndus* was also dissected from the left side for similar

tests. Steaks with a thickness of 2,5 cm were cut from the above muscles which were ripened for 8 days at 4°C. Each steak was placed in a plastic bag, partially immersed in a water bath at 70°C for one hour. The internal temperature of the meat was 65°C. Shear force values were determined with the Warner Bratzler apparatus. The cooking loss was determined by weighing the raw and cooked meat. The extraneous fat and the aponeurosis of the remaining protion of each muscle was removed and the trimmed muscle minced thoroughly in a special meat cutter. Solubility of collagen was determined by a method similar to that of Hill (1966). Muscle samples were heated for four hours at 90°C in a 1% saline solution. Hydroxyproline in solluble collagen was consequently expressed as a percentage of total hydroxyproline to determine the degree of solubility. The remaining portions of the minced samples were freeze dried, total nitrogen determined by the micro Kjeldahl method and hydroxyproline content by the method of Bergman and Loxley (1963) adapted for spectrophotometric determination with the auto analyzer. Collagen content is expressed as the ratio of N in hydroxyproline to total N in muscle (Boccard, 1968). The pigment content of the muscles was determined by the method of Hornsey (1965) on fresh muscle prior to freeze drying.

Discussion of results

Body and carcass data

All animals commenced the feeding trial at an average of 12,6 months and were slaughtered at approximately 460 kg live mass yielding carcasses weighing about 270 kg (Table 1). Normande x Africander steers gained significantly faster in live mass than Limousine x Africander and Limousine x Jersey steers. Feeding periods of the different breed groups varied between 2,6 and 4,3 months. Even though the Jersey crossbreds had to gain 40 kg more in live mass than the Africander crossbreds, it was achieved at similar growth rates. In view of the low growth rate of purebred Jerseys (Naudé, 1972) a certain degree of hybrid vigour may be implicated in the growth of Jersey crossbreds. All types of steers graded satisfactorily and no significant differences were established between breed groups. At a carcass mass of approximately 460 kg and an age of about 16 months, such as with the animals in this experiment, very high quality beef is generally obtained (Harrington, 1969).

Carcass yield data

The dressing percentage of Africander crossbred steers was significantly higher than that of Jersey crossbred steers. Contributing factors are given in Table 2. Africander crossbred steers had significantly lighter digestive tract masses than the Jersey crosses (7% as compared to 9,5%). The animals with the heavier digestive tracts also had the largest gutfill. A certain portion of the difference in digestive tract mass between the two dam breed groups can be attributed to the greater amount of omental fat found in the Jersey type steers. They also contained significantly more fat in the carcass. Fatter carcasses within type of animal generally have higher dressing percentages (Callow, 1944). Dairy type animals do however tend to distribute their fat in the body differently to beef type animals (Anonymous, 1967; Naudé, 1973). The fatter Jersey crossbreds deposited more fat in the non carcass parts. In contrast to the greater amount of waste fat in the Jersey type animal their hides were relatively lighter than those of the Africander type steers (7,1 cf. 7,8%) which had a favourable effect on dressing percentage. The nett result was that Africander type animals had higher dressing percentages than Jersey type steers even though the latter were the fattest. Naudé (1972) found that purebred Jerseys had significantly lower dressing percentages than Jersey x beef crossbred steers and Venter & Luitingh (1967) found similar results when pure- and crossbred Africander steers were compared. The fatter dairy crossbred carcasses (Table 3) also had a higher percentage of kidney and channel fat (Ramsey, Cole, Terrell & Temple, 1965; Anonymous, 1967) which, even though being part of the saleable carcass, is regarded by the butcher as waste.

Table 1

Body and carcass data of Africander and Jersey crossbred steers

	Limousine x Africander 1	Normande x Africander 2	Limousine x Jersey 3	Normande x Jersey 4	Charolaise x Jersey 5	F-value	C.V. %
Number of animals	5	5	6	6	6		
6 Initial body mass kg	380,1	383,3	336,9	326,6	341,1		
7 Initial age months	12,8	12,9	12,8	12,8	12,4		
8 Final body mass kg	460,5	470,5	455,1	455,6	458,0		
9 Final age months	15,9	15,5	17,1	17,0	16,4		
10 Average daily gain kg	0,87 ± 0,05	1,15 ± 0,08	0,93 ± 0,03	1,01 ± 0,07	0,98 ± 0,03	P < 0,05	11,5
11 Warm carcass mass kg	278,1	280,7	259,9	255,3	256,4		
12 Carcass grade	Super $^-$	Super $^-$	Super $^-$	Prime	Prime $^+$	NS	

10 2 > 1 (P < 0,01); 2 > 3 (P < 0,05)

Table 2

Carcass yield data of Africander and Jersey crossbred steers

	Limousine x Africander 1	Normande x Africander 2	Limousine x Jersey 3	Normande x Jersey 4	Charolaise x Jersey 5	F-value	C.V. %
6 Warm carcass/Final mass %	60,4 ± 0,63	59,6 ± 0,46	57,1 ± 0,59	56,0 ± 0,87	56,0 ± 0,70	P < 0,01	2,7
7 Warm carcass/Empty body mass %	67,9 ± 0,55	68,4 ± 0,65	65,8 ± 0,57	65,8 ± 1,10	64,8 ± 0,60	P < 0,01	2,5
8 Digestive tract mass/ Empty body mass %	6,83 ± 0,13	7,19 ± 0,36	9,32 ± 0,31	9,58 ± 0,29	9,80 ± 0,28	P < 0,01	7,6
9 Digestive content/ Empty body mass %	7,55 ± 0,09	8,23 ± 0,57	9,20 ± 0,65	11,39 ± 0,48	10,70 ± 0,91	P < 0,01	13,4
10 Hide mass/Empty body mass %	8,13 ± 0,30	7,71 ± 0,26	7,30 ± 0,15	6,60 ± 0,14	7,30 ± 0,14	P < 0,01	6,1
11 Omentum fat/ Empty body mass %	1,20 ± 0,11	1,00 ± 0,15	1,39 ± 0,14	1,43 ± 0,12	1,64 ± 0,10	P < 0,05	22,6

	P < 0,01			P < 0,05	
6	1 > 5,4,3;	2 > 5,4		2 > 3	
7	–			2 > 5,4,3;	1 > 5,4
8	5 > 1,2;	4 > 2,1	3 > 1,2	–	
9	4 > 1,2;	5 > 1		4 > 3;	5 > 2
10	1 > 4;	2 > 4		1 > 5,3	3 > 4
11	5 > 2			–	

Carcass composition and conformation.

The differences in the distribution of fat depots between beef and dairy type crosses which was discussed earlier are furhter substantiated by the data in Table 3. These results were obtained with carcass masses of the two dam breed types being fairly similar. The general fat level of the Jersey type carcasses, estimated by the composition of the prime rib cut, (Hankins & Howe, 1946; Naudé, 1971) was however significantly higher than that of the Africander type steers. However, no statistically significant difference was established between the fat thicknesses of the two types of animals which indicates a difference in distribution pattern.

In addition to the carcass yield, composition and fat cover, the carcass conformation is also an important characteristic to be considered in carcass evaluation (Tayler & Rudman, 1963; Everitt, 1966; Harrington, 1969). The Africander type carcasses were all about 20 kg heavier than the Jersey type carcasses. The latter carcasses were less compact; 2,00 kg/cm for dairy cf. to 2,27 kg/cm for beef type carcasses. Furthermore, even though Jersey type carcasses had shorter legs than those of the Africander types, the hind quarters of the former were still less compact than those of the latter (0,81 cf. 0,88 kg/cm leg length). The greater compactness of the Africander type animals was not only the result of the differences in mass : lenght ratios of the two types of animals but was also due to greater muscle to bone ratio of the beef type steers when judged by the composition of the prime rib cut. Limousine crossbreds of both types had higher muscle to bone ratios than Normande crosses which agrees with the results of Dumont and Boccard (1967) with purebreds. The Limousine cross carcasses of both dam breed groups graded the same but the Normande x Africander cross carcasses graded one grade higher than the same Jersey cross carcasses. Even though dairy type carcasses were fatter their poorer conformation resulted in a slightly lower grading than for beef type carcasses. A striking result regarding the conformation of the carcasses of these five breed type carcasses was the similar ratio between hind and fore quarter (Butterfield, 1963), when the kidney and channel fat is removed and also the very low coefficient of variation of 1%. Another noteworthy statistic is the exceptionally high coefficient of variation in all fat parameters of the carcass.

Meat quality

In order to compare the quality of the meat from different carcasses, more than one muscle representing a range of quality types should be evaluated. Two such muscles are the *M. Longissimus thoracis* and the *M. pectoralis profundus*. The quality of the meat of the 5 different types of animals was similar for all parameters. These were tenderness, cooking loss, amount and solubility of connective tissue collagen as well as the colour of muscle (Table 4). Three of these characteristics could unfortunately not be determined on the meat of Africander crossbred steers. The tenderness/toughness of meat is determined by many characteristics of the muscle (Boccard, Dumont & Schmitt, 1967; Boccard, 1973a, 1973b). Only a few of the more

Table 3

Carcass composition and conformation of Africander and Jersey crossbred steers

	Limousine x Africander 1	Normande x Africander 2	Limousine x Jersey 3	Normande x Jersey 4	Charolaise x Jersey 5	F-value	C.V. %
6 Cold carcass mass kg	274,4	277,4	255,8	250,8	252,2		
7 Kidney + Channel fat/Side mass* %	2,74 ± 0,35	2,29 ± 0,36	4,17 ± 0,27	3,85 ± 0,35	4,39 ± 0,41	P < 0,01	24,9
8 Carcass Length cm	118,6	121,3	123,8	125,8	125,2		
9 Carcass mass/Carcass length kg/cm	2,28 ± 0,01	2,26 ± 0,05	2,02 ± 0,03	1,96 ± 0,03	1,97 ± 0,03	P < 0,01	3,4
10 Leg length cm	75,8	77,9	74,4	75,6	74,0		
11 Hind quarter mass*/ Leg length kg/cm	0,88 ± 0,01	0,87 ± 0,02	0,81 ± 0,01	0,80 ± 0,01	0,82 ± 0,01	P < 0,01	3,2
12 Hind quarter mass*/ Side mass %	50,9 ± 0,16	50,7 ± 0,41	50,0 ± 0,20	50,3 ± 0,29	50,4 ± 0,27	NS	1,0
13 Bone in prime rib cut %	13,7 ± 0,38	13,9 ± 0,72	13,1 ± 0,31	14,0 ± 0,50	13,4 ± 0,50	NS	8,2
14 Muscle in prime rib cut %	66,8 ± 0,63	63,6 ± 0,82	60,1 ± 1,92	57,6 ± 1,23	61,5 ± 2,00	P < 0,01	5,2
15 Fat in prime rib cut %	19,0 ± 0,87	22,5 ± 1,28	26,4 ± 1,57	27,6 ± 1,57	24,8 ± 1,33	P < 0,01	12,7
16 Mean fat thickness mm	7,8 ± 1,38	7,7 ± 1,45	9,1 ± 0,55	8,3 ± 1,26	7,4 ± 0,83	NS	32,3

	P < 0,01	P < 0,05
7	5 > 2; 3 > 2; 4 > 2	5 > 1; 3 > 1
9	1 > 3,4,5; 2 > 3,4,5	–
11	1 > 3,4,5; 2 > 3,4,5	–
14	1 > 3,4; 2 > 4	1 > 5
15	4 > 1; 3 > 1	4 > 2; 5 > 1

*Less kidney and channel fat.

important intrinsic ones were considered in this study. The effect of post mortem ageing of contractile proteins was controlled by storing the meat for eight days at 4°C (Solov'ev, 1968). As could be expected the higher content of collagen in the *M. pectoralis profundus* resulted in higher shear force values (9 kg cf. 7 kg per 2,5 cm diameter) than in the *M. longissimus thoracis*. A correlation of r = 0,42 (P < 0,01) was found between collagen content and shear force values of these two muscles. A further factor which probably contributed to the toughness of the former muscle was its higher cooking loss. The collagen in the prime rib cut muscle was also slightly more soluble than that in the muscle of the brisket. The last parameter considered was the colour of muscle, measured as haematic iron, which was found to be darker in the *M. pectoralis profundus* than in the *M. longissimus thoracis*.

From an experimental point of view it should be noted that the coefficient of variation of all five parameters tested was higher in the prime rib cut muscle than in the brisket muscle which renders the latter more suitable for comparative purposes. It does however have a high collagen content and the mode of cooking could have had an influence on the lower coefficient of variation in the pectoralis. Venter & Luitingh (1967) compared pure- and crossbred types of beef cattle and concluded that the more rapidly growing lean beef breeds of Europe were able to improve the quantity and quality of the meat of Africander cattle. Naudé (1968, 1972) reported the superior performance in all traits of the pure- in comparison with crossbred Jersey cattle. In the present experiment it was found that carcass and meat traits of the beef and dairy crossbred groups, were very similar.

Conclusions

In this experiment similarity was found between the carcass and meat quality characteristics of certain beef and dairy crossbred steers. The percentage of high priced cuts in the carcasses, were similar, indicating that objective conformation varies very little between types of steers. Subjective conformation or compactness of carcass, which is economically important in carcass grading, was however significantly different between dairy and beef type carcasses. The latter type carcasses were also leaner, had a better

Table 4

Meat quality of Africander and Jersey crossbred steers

	Limousine x Africander 1	Normande x Africander 2	Limousine x Jersey 3	Normande x Jersey 4	Charolaise x Jersey 5	F-value	C.V. %
M. longissimus thoracis							
6 Warner Bratzler shear force kg/2,5cm	7,57 ± 1,09	7,03 ± 0,68	7,48 ± 0,77	6,26 ± 0,50	6,26 ± 0,59	NS	24,3
7 Cooking loss %	–	–	22,7 ± 0,9	24,3 ± 1,0	22,8 ± 17	NS	12,5
8 (N in Hydroxyproline/ N in Total) x 10^3	2,00 ± 0,1	1,76 ± 0,1	1,82 ± 0,2	1,95 ± 0,3	1,87 ± 0,3	NS	25,0
9 Collagen Solubility %	–	–	33,5 ± 1,8	32,5 ± 3,1	34,0 ± 2,2	NS	17,7
10 Haematic Iron content µg/g	–	–	1 489 ± 72	1 548 ± 89	1 482 ± 93	NS	13,8
M. pectoralis profundus							
11 Warner Bratzler shear force kg/2,5cm	8,34 ± 0,32	10,29 ± 0,50	8,44 ± 0,27	9,07 ± 0,45	9,34 ± 0,41	P < 0,05	10,0
12 Cooking loss %	–	–	27,0 ± 1,0	26,9 ± 1,2	25,7 ± 1,6	NS	9,8
13 (N in Hydroxyproline/ N in Total) x 10^3	5,05 ± 0,3	3,97 ± 0,3	3,60 ± 0,5	4,39 ± 0,4	4,00 ± 0,5	NS	22,7
14 Collagen solubility %	–	–	33,0 ± 3,4	30,7 ± 1,4	29,6 ± 1,13	NS	15,7
15 Haematic Iron content µg/g	–	–	1 830 ± 37	1 917 ± 58	1 857 ± 119	NS	9,4

11; 2 > 1; 2 > 3

muscle to bone ratio, a higher dressing percentage and had less kidney fat. By slaughtering the Jersey type animals earlier, leaner carcasses with less waste fat would probably be obtained. This may result in carcasses with a poorer conformation and hence a lower grading. It was found that dairy and beef type animals of comparable ages yielded meat which was similar in quality and highly acceptable.

Even though certain carcass traits were found to be in favour of beef type steers these did not render the Jersey crossbred steer markedly inferior. The difference in carcass grading was not statistically significant. The Jersey cow could therefore be utilised as a dam in certain beef production systems in South Africa. It produces crossbred calves which gain rapidly in live mass during the fattening period comparing favourably with similar Africander crossbred calves.

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