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COMPARATIVE BEEF PRODUCTION FROM BULLS, STEERS AND HEIFERS UNDER INTENSIVE FEEDING CONDITIONS

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OPSOMMING: VERGELYKENDE VLEISPRODUKSIE VAN BULLE, OSSE EN VERSE ONDER INTENSIEWE VOEDINGSTOESTANDE

'n Vergelykende studie van vleisproduksie is met behulp van bulle, osse en verse uitgevoer. Groeitempo, finale karkasmassa, doeltreffendheid van voerverbruik en verskeie karkasmate is as basis van vergelyking geïmplementeer. Van geboorte tot op 12 maande ouderdom het hulle 10% vinniger gegroei as osse en 23% vinniger as verse; osse het 12% vinniger gegroei as verse. Op 12 maande ouderdom het die massa van bulle dié van osse met 10% oorskry en dié van verse met 21%. Die massa van osse was 11% groter as die van verse. Bulle, osse en verse het onderskeidelik 5,14; 5,49 en 5,39 kg droëmateriaal per kg massatoename benodig. Die resultate in terme van TVV per kg massatoename, in dieselfde volgorde, was 3,96; 4,26 en 4,24 kg. Weens duidelike verskille met betrekking tot die doeltreffendheid van vleisproduksie behoort die produksie van bulvleis in die toekoms aansienlik toe te neem.

SUMMARY:

Certain facets of comparative beef production from bulls, steers and heifers were investigated. Growth rate, final carcass mass, efficiency of feed utilization and several carcass measurements served as parameters for the purpose of comparison. From birth to twelve months of age, bulls gained 10% faster than steers, and 23% faster than heifers; steers gained 12% faster than heifers. At an age of 12 months the mass of bulls exceeded that of steers by 10% and that of heifers by 21%. Steers were 11% heavier than heifers. Bulls, steers and heifers required 5,14; 5,49 and 5,39 kg dry matter per kilogram live mass gain, respectively. The results for TDN per kilogram gain in the same order were 3,96; 4,26 and 4,15 kg. Due to these notable differences in respect of efficiency of meat production, the production of meat from intact males should be increased considerably in future.

Hitherto the meat from entire males, when it did appear on the market, was derived mostly from mature, discarded breeding animals. Consequently such meat was generally of inferior quality and low commercial value. Due to a slow but certain swing away from fat to lean beef, the demand for beef from entire males should increase substantially in future. Also, the high gain in mass and superior efficiency of feed utilization compared to the performance of castrates adds to the popularity among meat producers of meat production from bulls.

The eastern part of the Highveld Region favours the production of specific feed crops and consequently also a specific feeding regime. The area in question also has a dairy cattle component which constitutes some 70% of the total cattle population. In such a situation a need for information on the utilization of different locally grown feeds by bulls, steers and heifers derived from dairy herds, is selfevident. Since the practice of mating beef bulls to dairy cows is widely adopted in "beef from the dairy herd" programmes, a large proportion of heifers are actually used for beef production. Hence it was deemed necessary to compare also the efficiency of beef production from heifers with that of steers and entire males.

Several investigations dealing with the effect of castration on growth rate have indicated a retarding effect (Klosterman, Kunkle, Gerlaugh & Cahill, 1964a; Prescott & Lamming, 1964; Harte & Curran, 1967 and Hale & Oliver, 1972b). However, in South Africa Joubert & Dreyer (1965) and in Rhodesia Hale & Oliver (1972a, b) demonstrated that a superior growth rate of bulls over steers applies only when the plane of nutrition is adequate.

The present investigation was conducted to study the growth pattern and feed conversion rates of bulls, steers and heifers derived from dairy cattle within a feeding regime commonly found in the eastern part of the Highveld Region.

Procedure

Animals

Friesland cows and heifers were inseminated with semen from a Charolais bull during December and January and then calves were born the following September and October. The live mass of calves was measured immediately after birth; they were allowed to suckle their dams for three days prior to being removed and placed on the experimental ration.

Treatment

Calves were divided into two groups according to sex i.e. 16 bull and 15 heifer calves. Male calves were alotted to two comparable groups of eight animals each according to birth mass and conformation. The groups were designated as follows: Group 1 – Bulls; Group 2 – "Steers"; Group 3 – Heifers. At six months of age all animals in one of the male groups were castrated using the closed method of castration.

Experimental animals were individually fed in pens measuring 1,3 m x 2,5 m for the entire rearing and feeding period of 12 months. All experimental animals received 4,5 l of full milk per day up to an

age of 21 days, after which they were switched to 4,5 l of skim milk per day which they received until 180 days of age. A concentrate ration (CP 13,3% and TDN 67,4%) was provided *ad lib.* from 10 days of age and lucerne hay was provided from 21 days of age. As soon as the calves were readily consuming the concentrate ration and lucerne hay concentrates and hay were fed in a 2:1 ratio.

Composition of concentrate ration:

Maize meal	70%
Wheaten bran	20%
Groundnut oilcake meal	10%
Salt	1%
Bone meal	2%

Experimental technique

Animals were mass measured at 07h00 at two-weekly intervals, after feed and water had been withheld for 14h.

Rations of all experimental animals were mass measured daily and fed individually at a rate of 15% in excess of the previous week's intake, thus ensuring feed being offered *ad lib.*

At 12 months of age final live mass was determined and animals were slaughtered.

Calculation of Dry Matter and TDN

Dry matter: Representative samples of feeds were ovendried at 105°C for 24 h.

TDN: TDN was calculated according to TDN contents previously determined in the regular way in vivo by difference.

Carcass data

Cold carcass mass without kidneys and kidney fat was determined after cooling for 24h at −3°C. Buttock length, carcass length and chest depth were also determined.

The following measurements were taken after a clean cut had been made between the 12th and 13th thoracic vertebra:

Length (A) and depth (B) of *M. longissimus thoracis.*

Area of *M. longissimus thoracis.*

Fat covering of *M. longissimus thoracis* measured at two sites, i.e. at a height of $\frac{1}{4}$ (C) and $\frac{3}{4}$ (D) of the dorsal arch of *M. longissimus thoracis.*

After carcasses had been cooled for 24h at −3°C they were graded by a qualified grader according to generally accepted standards to the nearest one-third of a grade.

Processing of data

The experimental design was a completely randomised design with unequal numbers in the three treatments. The Student Newman-Keuls multiple range test was applied to test for significance (May, 1952).

Abbreviations

CV = Coefficient of variation
SS = Statitstical Significance
NS = Non-significant

Results and Discussion

From the results in Table 1 it is evident that Groups 1 and 2 were significantly ($P < 0,01$) heavier than Group 3 at six months of age. Since Group 2 was castrated at that stage, no difference in mass between Groups 1 and 2 was expected. At 12 months of age the bulls (Group 1) attained a mass which exceeded that of steers by 10% and that of heifers by 21% , these differences being statistically highly significant ($P < 0,01$). The mass of steers at 12 months exceeded that of heifers by 11%, this difference also being statistically highly significant ($P < 0,01$). This result is in agreement with that of Harte & Curran (1967) who established a mass advantage of bulls over steers of some 13,2%.

Table 1

Mass changes of bulls, steers and heifers

Groups		n	Mass					
			Birth mass	Mass at six months	Mass at 12 months	Mass gain birth to 12 months	ADG 6 to 12 months	ADG birth to 12 months
			(kg)	(kg)	(kg)	(kg)	(kg)	(kg)
Bulls	(1)	8	44,4	206,9	429,2	384,8	1,23	1,04
Steers	(2)	8	40,6	210,4	391,6	351,0	1,01	0,97
Heifers	(3)	15	41,7	157,3	354,3	312,6	1,00	0,87
SS			NS	2,1 > 3**	1 > 3,2** 2 > 3**	1 > 3,2** 2 > 3**	1 > 3,2**	1 > 3,2*** 1 > 3*
CV (%)			13,3	8 8,1	4,5	4,9	12,4	4,6

Table 2

Efficiency of feed utilization

Groups	n	Feed utilization				
		Dry matter consumption	DM/kg gain	TDN/kg gain	DM/kg carcass	TDN/kg carcass
		(kg)	(kg)	(kg)	(kg)	(kg)
1	8	1978,6	5,14	3,96	7,68	5,92
2	8	1929,3	5,49	4,26	8,26	6,39
3	15	1686,2	5,39	4,15	8,43	6,49
SS		1,2 > 3**	2 > 1*	2,3 > 1**	3,2 > 1**	3,2 > 1**
CV (%)		6,8	9,7	3,8	4,8	4,7

Harte (cited by Rhodes, 1969) found an even higher (17,5% advantage) of bulls over steers on a very high plane of nutrition. It must be borne in mind, however, that these animals were slaughtered at an age of 17 months as compared with a slaughter age of 12 months in the present investigation. Turton (1969) summarised 27 experiments in which live mass and age at slaughter of bulls and steers could be compared on a scatter diagram. In one experiment bulls and steers were slaughtered at 12 months of age and the mass advantage of bulls over steers was approximately 10%, which corresponds with the figure obtained in the present investigation.

In respect of differences in mass between bulls and heifers, De Vree (1961) found that at an age of 10 months the mass of bulls exceeded that of heifers by 26% . Turton (1964) in a review of the Charolais and its use in crossbreeding reported a difference of 26% between the live mass of bull and heifer calves at an age of 10 months. In view of the work reported by Aitken, Preston, Macdearmid & Phillip (1963), the possibility exists that the difference of 26% which they obtained could indeed have increased to well over 30% at a slightly older age.

In the United Kingdom, White & Holmes (1963) found a difference of 16,4% between the live mass of steers and that of heifers. This percentage closely resembles the 11% advantage which steers gained over heifers in this investigation, although White & Holmes (1963) only slaughtered their animals at 527 days.

In considering the overall growth rate from birth to twelve months, it is evident that the average daily gain of Group 1 was significantly greater ($P < 0,01$) than that of Groups 2 and 3. Also, Group 2 exhibited a statistically significantly ($P < 0,01$) greater average daily gain than Group 3. The growth rate of bulls in the period of six to 12 months exceeded that of steers and heifers by 23% . Price & Yeates (1969) concluded that the overall growth rate of bulls exceeded that of steers, the advantage increasing from about 1% for mass gains of 0,5 kg per day to 25% for mass gains of 1 kg per day.

Groups 1 and 2 had statistically significant ($P < 0,01$) greater dry matter intakes compared to Group 3. Group 1 required significantly less ($P < 0,05$) dry matter per kilogram gain, compared with Group 2. Quantity of dry matter per kilogram carcass and also TDN per kilogram carcass revealed that both Groups 2 and 3 required significantly ($P < 0,01$) more than Group 1. Several reports in the literature Brännäng (1960), Prescott & Lamming (1964) and Bidart, Koch & Arthaud (1970) have indicated that bulls gain more rapidly and efficiently than steers.

For Friesian bulls and steers slaughtered at an an age of 15 months, Nichols, *et al.* (1964) reported that bulls and steers required 3,81 and 4,11 kg TDN per kg gain respectively, which closely resemble the figures of 3,96 kg and 4,26 kg for bulls and steers respectively, obtained in the present investigation. Harte & Curran (1967) obtained figures of 3,76 and 4,26 kg TDN per kg gain for bulls and steers respectively and are consequently in accordance with the figures presented in this investigation. The difference of 7% between bulls and steers in respect of efficiency of feed utilization corresponds closely with the 8% reported by Nichols *et al.* (1964). However, Harte & Curran (1972) found no significant difference in feed conversion efficiency between bulls and steers. In this investigation bulls also required highly significantly ($P < 0,01$) less DM and TDN to produce a unit of carcass mass in comparison with steers and heifers.

Group 1 had a considerably greater carcass mass at 12 months of age than Groups 2 and 3, these differences of 10% between bulls and steers, 29% between bulls and heifers, and 17% between steers and heifers were all statistically highly significant ($P < 0,01$). Bulls and steers also had a higher dressing percentage (4% and 3%) respectively than heifers. The difference of 21% in final live mass between bulls and heifers increased to a difference of 29% in respect of cold carcass mass. This phenomenon cannot be explained, considering that bulls usually have heavier hides than steers (Klosterman *et al.*, 1954; Aitken *et al.*, 1963; Prescott & Lamming, 1964 and Price, 1971). However, the difference between bulls and heifers in respect of dressing percentage may be due to the fact

Table 3

Carcass characteristics

Groups	Item				
	n	Cold carcass mass	Dressing percentage	Fat covering of *M.l. thoracis* $\frac{C + D}{2}$	Grading out 20
		(kg)	(%)	(mm)	
1	8	257,8	60,02	0,93	12,3
2	8	233,6	59,63	4,49	16,3
3	15	199,6	56,58	6,74	17,5
SS		1 > 3,2** 2 > 3**	1,2 > 3**	3 > 1,2** 2 > 1**	3 > 1,2** 2 > 1**
CV		5,3	2,1	27,3	10,3

Table 4

Surface area M. longissimus thoracis

Groups	n	Item	
		Surface *M. l. thoracis*	Surface *M. l. thoracis* per 100 kg carcass
		(cm^2)	(cm^2)
1	8	80,69	31,29
2	8	69,92	29,93
3	15	61,24	30,55
SS		1 > 2,3** 2 > 3**	NS
CV (%)		10,1	9,6

that kidney and kidney fat were not included in the carcass mass.

Results of the fat covering of *M. longissimus thorasis* and grading of the carcasses clearly indicate the considerable differences in fat covering between bulls, steers and heifers. Bulls had 79% and 86% less fat respectively over *M. longissimus thoracis* than steers and heifers. Although Harte & Curran (1967) compared fat covering at exactly the same positions on the three-rib-cut, they found that the differences between bulls and steers, although statistically significant, were much smaller than differences obtained in the present study.

Out of a maximum possible grading of 20 points, bulls obtained an average of 12,3 points (Grade 1–) which is considerably lower than the grading points obtained by steers (16,3 = Prime) or by heifers (17,5 = Prime+). Although bulls exhibited excellent muscle development it was mainly due to a lack of fat covering

Table 5

Carcass compaction and fleshiness

Groups	Compaction parameters			
	Mass hind quarter + buttock length	Carcass mass + carcass length	Mass fore quarter + chest depth	Carcass length x area *M. l. thoracis* per 100 kg carcass
	(kg/cm)	(kg/cm)	(kg/cm)	(cm^3/100 kg)
1	0,919	2,144	1,063	3757,0
2	0,884	1,943	0,984	3544,3
3	0,789	1,750	0,790	3494,6
SS	1 > 2,3 ** 2 > 3**	1 > 2,3 ** 2 > 3**	1 > 2,3** 2 > 3**	NS
CV (%)	5,1	4,3	4,7	9,3

which made for their relatively low grading compared with the steers and heifers.

From Table 4 it is evident that the differences in surface area of *M. longissimus thoracis* per 100 kg carcass between Groups 1, 2 and 3, were not statistically significant. The differences between bulls and steers was 1,36 cm^2 in favour of bulls. Harte, Curran & Viall (1965) found differences in favour of bulls of 1,29 and 1,71 cm^2 per 45 kg carcass which closely resemble and agree with the results obtained in this investigation.

The significantly greater compactness of the carcasses of bulls as opposed to those of steers and heifers as indicated by mass over length of both hind and fore quarters can most probably be ascribed to the greater muscle:bone ratio which has been observed in several studies (vide, Bailey, Probert & Bohman, 1966; McDonald & Kay, 1967; Price & Yeates, 1969). However, in respect of the fleshiness index of the carcasses as provided by carcass length x area *M. longissimus thoracis* per 100 kg carcass, no statistical significant differences between bulls, steers and heifers were found. Nevertheless a clear trend indicating the superiority of bulls > steers > heifers in respect of this characteristic was observed and point to a higher meat:bone ratio. In several reports Yeates (1959, 1960 and 1965) has suggested that the length-to-mass relationship may be an objective measure of carcass fleshiness.

Conclusions

Data analysed in this investigation together with a study of the relevant literature indicate that the superior growth rate and efficiency of feed utilization in intact males should be implemented in beef programmes. The consumer's preference should, however, not be ignored but should be gradually steered in the pointed direction. In this respect Venter & Luitingh (1967) concluded that discrimination against the meat of bulls in respect of flavour or palatability was without foundation. It must be stressed that beef production from entire males should be practised by producers who possess the necessary knowledge and skill and are situated in regions where feed for intensive meat production can be produced. Under ranching conditions, Eloff, Reyneke & Skinner (1965) found that growth, body development, carcass grade and composition of oxen were not influenced by castration at one, eight or 15 months of age. The production of meat from entire males on low planes of nutrition cannot be recommended due, partly, to lack of sufficient data on the potential beef production of older bulls out of natural pasture. Reports in the literature on the general management of bulls when run in herds in fact are rather conflicting and require further investigation.

Although bulls and steers in this investigation were superior to heifers in respect of growth rates and efficiency of feed utilization, it must be stressed that heifers produced satisfactory carcasses with the highest grading points according to present grading standards. It follows that in "beef from the dairy herd" production systems, Charolais x Friesland crossbred heifer calves are suitable for the production of beef carcasses of a desired quality.

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