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THE EFFECT OF INTRAMUSCULAR IMPLANTATION OF TESTOSTERONE ON GROWTH AND CARCASS CHARACTERISTICS OF ZEBU STEERS

D.H. Hale and J. Oliver

Department of Agriculture, University of Rhodesia, Salisbury

OPSOMMING: DIE INVLOED VAN INTRASPIERSE TESTOSTEROONINPLANTERING OP DIE GROEI EN KARKASEIENSKAPPE VAN ZEBU-OSSE

Sestien diere is gebruik om die invloed van intraspierse inplantering van 200 mg testosteroon, aan osse wat in groepe op twee voedingspeile gevoer is, te bepaal. Gedurende die eerste 56 dae na die eerste toediening was die liggaamsmassatoename 0,88 en 0,78 kg per dag op die hoër en 0,35 en 0,47 kg per dag op die laer voedingspeil vir die proef- en kontrolegroepe diere onderskeidelik. Diere het 'n volgende toediening van 200 mg testosteroon, 196 dae na die eerste inplantering ontvang. Na hierdie tweede toediening totdat die diere 77 dae later (op 'n ouderdom van 29 tot 31 maande) geslag is, is toenames in liggaamsmassa van die proef- en kontrolegroepe van 1,14 en 1,02 kg per dag op die hoër voedingspeil en 0,78 en 0,88 kg per dag op die laer voedingspeil onderskeidelik behaal. Op die hoër voedingspeil het hormoontoediening tot 'n groter doeltreffendheid van voerverbruik en 'n hoër groeisnelheid gelei en het ook die produksie van swaarder karkasse met groter oogspiermate en dunner rugvet tot gevolg gehad. Op die laer voedingspeil het hormoontoediening 'n afname in rugvetdikte veroorsaak. Hierdie resultate benadruk die belangrikheid van 'n voldoende voedingspeil as voorvereiste vir 'n groeireaksie van osse op androgeentoediening.

SUMMARY

Sixteen animals were used to examine intramuscular implantation of 200 mg testosterone to steers which were fed in pens on one of two planes of nutrition. During the fifty-six days after first implantation bodymass gains were 0,88 and 0,78 kg/d on the higher plane of nutrition, and 0,35 and 0,47 kg/d on the lower plane for implanted and control steers, respectively. Animals were re-implanted with 200 mg testosterone 196 days after the first implantation. After the second implantation until slaughter 77 days later (when animals were 29–31 months old) implanted and control animals respectively showed gains in bodymass of 1,14 and 1,02 kg/d on the higher plane and 0,78 and 0,88 kg/d on the lower plane of nutrition. On the higher plane of nutrition implantation led to greater efficiency of feed conversion and growth rates and resulted in heavier carcasses with greater eye-muscle measurements but thinner back fat. On the lower plane, implantation led to a decrease in thickness of back fat. These results emphasize the importance of an adequate plane of nutrition for a growth response by steers to androgens.

Previous studies have shown that bulls grow more rapidly than steers only if plane of nutrition is adequate (Hale & Oliver, 1972a, b).

Production of testicular androgens decreased when rams were fed on a low plane of nutrition (Setchell, Waites & Lindner, 1965). It is possible that, on a low plane of nutrition, production of testicular androgens may be inadequate to allow bulls to grow more rapidly than steers. However, response of secondary sexual organs to stimulation by androgens is influenced by plane of nutrition (Mann & Parsons, 1947). Plane of nutrition could affect similarly response of somatic tissues to stimulation by testicular androgens in bovines.

Either of these factors could account for the lack of difference in growth rate of bulls and steers noted when animals grazed veld. In the present study a known amount of exogenous androgen was implanted into steers fed on two planes of nutrition to examine these alternatives.

Procedure

Animals

Sixteen Angoni steers were available from a previous trial which investigated the effect of different rations on the increase in bodymass of calves weaned at twelve weeks of age. Animals had originated from the Central Veterinary Research Station, Mazabuka, Zambia. All animals were castrated on 16 August, 1965.

At the start of the present trial on 21 September 1966, mass of the animals varied between 181,6 kg and 256,5 kg and ages of the animals between 19 and 20 months.

Experimental

The experimental design was factorial (2 x 2 with four replicates). There were two nutritional treatments (High Plane and Low Plane) and two androgen treatments (Implanted and Control).

On 21 September, 1966, animals were allocated at random to four experimental groups, which were penned separately. Mean bodymass of the groups was equalized by subsequent exchange of animals between groups.

From 21 September, 1966, to 23 November, 1966, animals in two groups (High Plane) were offered 6,81 kg/day of a concentrate ration while animals in the other two groups (Low Plane) were offered 3,63 kg/day of the same ration. Veld hay and water were freely available to all animals. On 24 November, 1966, no further veld hay was available for the animals. Amount of concentrate ration available to animals in all groups was increased to 9,08 kg/day and held at this level until 1 March, 1967. From 1 March, 1967, all animals were fed in individual pens until slaughter on 28 June, 1967. Animals in the High Plane of nutrition groups were offered 10,80 kg/day each of concentrate ration and animals in the Low Plane were offered 3,63 kg/day of the same ration. Veld hay was freely available to animals on the Low Plane of nutrition.

On 7 October, 1966, and again on 12 April, 1967, testosterone (200 mg) (Organon) was implanted intramuscularly into animals in one High Plane group and one Low Plane group. The crystalline implant of testosterone was placed in the gluteal muscle by means of a trocar and cannula.

Animals were weighed (± 0,5 kg at 0700) at intervals of two weeks. Feed and water were withdrawn at 1600 on the day prior to weighing.

Ration

The concentrate ration was composed of:

20% cotton seed
5% fish meal
75% corn and cob meal

Approximate chemical composition of the ration was:

19,56% crude protein
78,35% TDN
4,00% Ash

A mineral lick was freely available to all animals.

The trial was conducted at Mount Makulu Research Station, Chilanga, Zambia.

Results

Bodymass gains

During the period immediately after the first implantation of testosterone (28 September, 1966 – 23 November, 1966), the effect of implantation on growth rate interacted with that of plane of nutrition ($P < 0,01$) (Table 1). Whereas implanted steers grew more rapidly than control steers on the high plane of nutrition, control steers grew more rapidly than implanted steers on the low plane of nutrition.

When all animals were fed a pure concentrate ration between 23 November, 1966, and 1 March, 1967, low plane animals grew more rapidly than high plane animals and implanted steers grew more rapidly than control steers. However, these differences were not significant statistically. By 1 March, 1967, bodymass and rate of growth of animals had recovered from the setback caused by withdrawal of hay from the diet.

Implantation of testosterone on 12 April, 1967 affected increase in bodymass considerably (Table 1). On the high plane of nutrition, implanted animals grew more rapidly than control animals but implantation of testoster-

Table 1

The effect of intramuscular implantation of testosterone on bodymass and rate of increase in bodymass of steers which were fed in pens on one of two planes of nutrition. Testosterone (200 mg) was implanted on 7 October, 1966, and again on 12 April, 1967

Plane of nutrition	High		Low		Overall standard error
Treatment	Implant	Control	Implant	Control	
Bodymass (kg)					
Initial 21.9.66	222,9	222,5	222,5	222,5	1,94
Final 28.6.67	388,6	378,2	354,6	355,5	3,56
Rate of increase in bodymass (kg/day)					
28.9.66–23.11.66	0,88	0,78	0,35	0,47	0,03
23.11.66–1.3.67	0,15	0,13	0,38	0,33	0,04
12.4.67–28.6.67	1,14	1,02	0.78	0,80	0,01

one did not affect rate of increase in bodymass of animals on the low plane of nutrition. Thus, there was a slight interaction ($P < 0,1$) between the effects of implantation of androgen and of plane of nutrition.

Consumption of concentrate ration

During the first period of the trial, when hay was available to all animals, on the high plane of nutrition implanted animals consumed slightly less concentrate ration than did control animals (Table 2). Thus, because they grew faster, implanted animals made more efficient use of the concentrate than did control animals on the high plane of nutrition. On the low plane of nutrition, control animals consumed less concentrate ration and converted their concentrate into increase in bodymass with greater efficiency than did implanted animals. Consumption of hay was not measured.

Consumption of concentrates did not differ between androgen treatment groups on the low plane of nutrition, nor did efficiency of utilization of concentrate ration. Thus, the interaction if implantation with plane of nutrition affected efficiency of utilization of concentrate ration ($P < 0,1$).

Slaughter and carcass characteristics

Final bodymass was very variable and no effect of treatments on this parameter was apparent (Table 3). Final bodymass of implanted animals exceeded that of control animals by 2,8% on the high plane of nutrition while on the low plane of nutrition the difference was even smaller. However, carcass mass was very much less variable than final bodymass and implantation affected this parameter significantly ($P < 0,05$). Carcass mass of implanted animals

Table 2

Effect of intramuscular implantation of testosterone on consumption of concentrate ration and efficiency of utilization of concentrate ration (kg concentrate ration consumed/kg increase in bodymass) of steers which were fed on one of two planes of nutrition. Testosterone (200 mg) was implanted on 7 October, 1966, and again on 12 April, 1967

Plane of nutrition	High		Low		Overall standard error
Treatment	Implant	Control	Implant	Control	
28.9.66–23.11.66					
Mean daily intake of ration (kg/day)	5,35	5,43	2,56	2,53	
Kg ration consumed/kg gain bodymass	7,22	8,28	8,81	6,35	
12.4.67–28.6.67					
Mean daily intake of ration (kg/day)	9,66	9,52	3,36	3,50	0,04
Kg ration consumed/ kg gain bodymass	8,49	9,32	4,32	4,38	0,28

Between reimplantation of androgens on 12 April, 1967, and slaughter on 28 June, 1967, implanted animals consumed slightly, but not significantly, more feed than did control animals on the high plane of nutrition (Table 2). Implanted animals utilized their feed more efficiently than did control animals ($P < 0,05$).

was 2,7% greater than that of control animals on the high plane of nutrition and 1,3% less than that of control animals on the low plane of nutrition. None of the offal parts was influenced significantly by implantation of testosterone.

Absolute mass of hindquarter of implanted animals did not differ significantly from that of control animals

Table 3

The effects of implantation of testosterone and of plane of nutrition on slaughter and carcass characteristics of zebu steers

Plane of nutrition	High		Low		Overall standard error
Treatment	Implanted	Control	Implanted	Control	
Final live mass, kg	388,8	378,2	354,6	355,6	3,86
Carcass mass, kg	232,9	226,8	206,8	209,5	0,53
Carcass % final live mass	59,8	59,9	58,3	58,9	0,75
Mass left hindquarter kg	56,9	56,8	50,4	51,8	0,45
Left hindquarter % left side	49,6	50,8	48,7	49,4	0,24
Area eye muscle, cm^2	60,5	55,5	51,5	54,7	0,75
Width eye muscle, cm(A)	13,65	11,72	12,81	11,94	0,04
Depth eye muscle, cm (B)	5,57	4,90	5,00	4,95	0,03
Mean depth back fat (mm)	15,5	19,3	7,1	16,0	0,23

however, hindquarters of control animals comprised a greater proportion (%) of mass of side than did those of implanted animals on both planes of nutrition ($P < 0,05$). It must be noted that mass of hindquarters included mass of kidney and perirenal fat.

Area of eye muscle at the 10th rib was greater in implanted animals than in control animals ($P < 0,05$). The two linear measurements of size of eye muscle (width A and depth B) were also greater in implanted animals than in control animals.

Depth of back fat at the 10th rib of implanted animals was considerably less than that of control animals ($P < 0,05$), particularly on the low plane of nutrition. Interaction between the effect of plane of nutrition and that of implantation of androgen on depth of back fat was significant statistically ($P < 0,05$).

Discussion

Testosterone is the principal androgen secreted by the testes of bulls which are more than 5 months of age (Lindner, 1961) and thus levels of this androgen are affected severely by castration. Administration of testosterone to steers provides information about the mechanisms which enable bulls to grow more rapidly than steers under suitable conditions of management.

In the present trial, implantation of testosterone led to increased rates of bodymass gain and efficiency of utilization of concentrate ration by steers which were fed intensively in pens. Results show that these effects of testosterone are modified by plane of nutrition. Thus, implantation of testosterone increased growth rate only when steers were gaining in excess of 0,8 kg/day.

There are few reports in the literature which have examined the effect of androgens on growth rates of farm animals. Nevertheless, an effect of testosterone on growth rate and efficiency of feed conversion has been reported previously by Burris, Bogart & Oliver (1953), who used much higher doses of androgen in heifers and steers, and by England & Taylor (1959), who implanted 450 mg testosterone. Tulloh, Romberg & Seebeck (1964) used 125 mg of testosterone propionate and could detect no effect on growth rates of steers which grew more slowly than those in the present study. Burgess & Lamming (1960) administered 20 mg/day testosterone orally to Friesian bullocks and noted that this treatment led to an increase in rate of gain in bodymass of 21%. Unfortunately, in this present trial, attempts to recover the androgen implants at slaughter were unsuccessful and no information is available about rates of absorption of the androgen. Further, these reports from the literature do not give this information. Consequently, it is difficult to explain differences in results because of the lack of information on the respective effective doses of androgen. It is of interest that in instances in which androgens have been reported to influence rate of growth of steers, growth rates of animals have been almost 1 kg/day (Burris *et al.*, 1953; England & Taylor, 1959) although Burgess & Lamming (1960) who administered testosterone at very high levels, noted an effect of androgen on bodymass gains at somewhat lower growth rates.

Testosterone affected carcass and slaughter characteristics of steers in a manner which was opposite to the effect of castration. Thus, implanted steers had heavier carcasses than controls and area of eye muscle, eye muscle dimensions and mass of forequarter in relation to mass of side were greater in carcasses of implanted steers than those of control steers. Further, back fat was thinner in implanted animals than in controls. These findings indicated that implanted animals produced carcasses which contained more lean meat and less fat than those of control animals. However, differences were small. Similarly, Sambarev & Atraskov (1965) noted that implantation of androgen led to an increase in protein content and a decrease in fat content of carcasses of wethers. Lerche & Sinell (1959) were unable to detect any effect of androgen on carcass value of bulls. Tulloh *et al.* (1964) noted that testosterone propionate increased area of eye muscle carcasses but could detect no effect on thickness of back fat.

Results of the present trial are applicable to the interpretation of the results of Hale & Oliver (1972a), where bulls grew no faster than steers when animals grew slowly on veld. Thus present findings indicate that unless plane of nutrition is sufficiently high, the somatic tissues of bulls will not respond to the anabolic stimulation of any androgens which are produced by the testes. On the other hand, Setchell *et al.* (1965) have shown that production of testosterone by the testes is decreased during undernutrition. It is likely that a combination of these two effects prevents the manifestation of the superior growth potential of bulls relative to that of steers when animals grow slowly.

References

BURGESS, T.D. & LAMMING, G.E., 1960. The effect of diethystilboestrol, hexoestrol and testosterone on the growth rate and carcass quality of fattening beef steers. *Anim. Prod. 2,* 93.

BURRIS, M.J., BOGART, R. & OLIVER, A.W., 1953. Alteration of daily gain, feed efficiency and carcass characteristics in beef cattle with male hormones. *J. Anim. Sci. 12,* 740.

ENGLAND, D.C. & TAYLOR, N.O., 1959. Effect of implanted testosterone on growth rate of weaner steers with and without previous stilboestrol implantation. *J. Anim. Sci. 18,* 1169.

HALE, D.H. & OLIVER, J., 1972a. The effect of castration and vasectomy on male Zebus which grazed veld under two systems of management. *S. Afr. J. Anim. Sci. 2,* 27.

HALE, D.H. & OLIVER, J., 1972b. The effect of castration and plane of nutrition on growth of male Zebus. *S. Afr. J. Anim. Sci. 2,* 33.

LERCHE, N. & SINELL, H.J., 1959. Studies in the carcass value and meat quality of young bulls and steers following hormonal fattening. *Zbl. Vet. Med. 6,* 292.

LINDNER, H.R., 1961. Androgens and related compounds in the spermatic vein blood of domestic animals. *J. Endocr. 23,* 139, 171.

MANN, T. & PARSONS, U., 1947. Effect of testicular hormone on the formation of seminal fructose. *Nature,* Lond. *160,* 294.

SAMBAREV, Ju-N. & ATRASKOV, V.A. (1965). The use of anabolic preparations in the fattening of cattle and sheep. *Izv. timiryazev Sel. Khoz. Akad. 4,* 197.

SETCHELL, B.P., WAITES, G.M.H. & LINDNER, H.R., 1965. Effect of undernutrition on testicular blood flow and metabolism and the output of testosterone in the ram. *J. Reprod. Fert. 9,* 149.

TULLOH, N.M., ROMBERG, B. & SEEBECK, R.M., 1964. The effect of age of castration and testosterone propionate on weight gains and carcass measurements of steers. *Aust. J. exp. Agric. Anim. Husb. 4,* 67.