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The influence of dietary energy concentrations on scrotal, testicular and semen characteristics of young Dorper rams

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Abstract

A study with the aim to evaluate the effects of different dietary energy concentration (8.23, 9.77 and 11.32 MJ ME/kg DM) on scrotal, testicular and semen characteristics of young Dorper rams was conducted during the breeding season. Thirty-six 11-12 month old Dorper rams were randomly allocated to three groups of 12 rams each and fed at different energy concentrations for 127 days. Semen was collected fortnightly from every ram to evaluate semen characteristics. At the end of the trial period, six rams from each group were slaughtered and the carcass, scrotal and testicular characteristics evaluated. Results indicate that although higher energy concentrations accelerate testicular development and resulted in scrotal fat deposition, these induced changes had no significant effect on semen quality and quantity.

Keywords: Feeding, scrotum, testis measurements, seminal
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Introduction

It is a common practice in South Africa to feed high-energy diets to rams in Phase C performance testing trails and in preparation for sales. It is generally accepted that conditioned (fat) rams often realise better prices when auctioned (Fourie *et al*., 2003). Little is known of the effect of such diets on subsequent ram fertility. Some farmers and animal scientists are against the fattening of breeding bulls and rams, since it is believed that this reduces fertility (Brown, 1994). It is thus important to evaluate the effect of different dietary energy concentrations on ram fertility, in order to evaluate the routine feeding practices used by sheep farmers in South Africa. In recent studies, Coulter *et al. (*1997) and Labuschagné *et al.* (2002) demonstrated the detrimental effect of high energy diets on the fertility of young bulls. Both semen quantity and quality of bulls fed high-energy (11 MJ ME/kg DM) diets were of inferior standard when compared to bulls fed medium (9.8 MJ ME/kg DM) energy concentrations. This phenomenon is ascribed to impaired testicular thermoregulation, resulting from fat accumulation in the neck of the scrotum. Similar findings were reported by Fourie *et al*. (2003) in young Dorper rams.

In a study on sperm production, in which two concentrations of dietary energy and/or protein were fed to mature Merino rams, Braden *et al.* (1974) found dietary energy concentration to significantly affect daily sperm production and testes weight. However, protein concentration had no effect on these parameters. It was concluded that the concentration of energy in a diet affects sperm production in rams.

The aim of this study was to determine the effects of different dietary energy concentrations on the scrotal, testicular and semen characteristics of young Dorper rams.

Materials and Methods

Thirty-six 11 to 12 month old Dorper rams with a mean (± s.e.) body weight of 42.4 ± 0.52 kg were used in the study. Prior to the experiment, the rams were reared on the veld. The rams were trained for semen collection with an artificial vagina and were randomly allocated to three groups of 12 rams each. The observation period was 127 days and took place from the end of summer to the onset of winter (during autumn, the natural sheep breeding season).

All rams were housed in individual metabolic cages in a well-ventilated building. Each group received a different energy diet, balanced on crude and degradable protein, Ca and P on an equivalent basis. The NRC (1985) feeding standards for growing rams were used to formulate the medium energy diet. The energy content of this diet was increased to exceed the energy requirements for growing rams to represent a conditioning diet before sale and decreased to represent a forage diet. The low energy diet contained on a dry matter basis 8.23 MJ ME/kg, the medium energy diet 9.77 MJ ME/kg and the high-energy diet 11.32 MJ ME/kg. All three diets contained approximately 136 g crude protein/kg, 85 g degradable protein/kg, 6.5 g

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Ca/kg and 2.3 g P/kg P on a dry matter basis. The rams in each group received the experimental diets *ad libitum*.

Semen was collected fortnightly from every ram, early in the morning (7:30 – 9:30 am) with the aid of an artificial vagina (water, 54 ºC) and an ewe placed in a neck clamp. The volume of the ejaculates collected was recorded directly from a calibrated test tube, before being placed in a water bath at 32 ºC. The semen was diluted with a pre-warmed (32 ºC) TL-Hepes solution (990µL TL-Hepes and 10µL semen), and evaluated within two minutes for forward progression and overall motility on a scale of 0 (no movement) to 5 (very fast forward movement) by counting 100 individual sperm (Loskutoff & Crichton, 2001). A thin eosin/nigrosin (60 µL eosin/nigrosin and 6 µL semen) semen smear was made from each sample on a pre-warmed (35 ºC) glass slide. One hundred individual sperm cells were evaluated microscopically for morphology (1000x magnification). The concentration of the semen sample was determined using standard procedures with the aid of a Newbawer haemocytometer (Loskutoff & Crichton, 2001).

At the end of the trial, six rams were randomly selected from each group and were slaughtered at a commercial abattoir. Live-weight as well as scrotal and testicular characteristics were evaluated. The empty stomach body weight and scrotal circumference (measured with a measuring tape around the testis) of each ram were determined prior to slaughtering. The scrota were excised from the carcasses, severing them at their base as close to the body as possible. The scrota were stored for 24 h (4 ºC), weighed and dissected into the scrotal skin, testis, fat and epididymis. The weight of each component was recorded. The total volume of the testicles was estimated using the volume of water displaced after submerging both testes in a volumetric measuring cylinder.

The data were statistically analysed using GLM procedures of SAS (1995). Repeated measures analysis was performed to determine the effect of different dietary energy concentrations, time (weeks) and their interaction on semen parameters, while a one-way ANOVA was used to analyse the carcass, scrotal and testicular data.

Results and Discussion

No significant interactions between energy concentration and time of measurement were observed for the semen traits measured repeatedly. Only the main effect of treatment was thus tabulated. The body weight, scrotal, testicular and semen characteristics of young Dorper rams are summarised in Table 1

Table 1 The mean (± s.e.) body weights, scrotal, testicular and semen characteristics of young Dorper rams fed different energy concentrations

Parameter	Dietary energy concentration		
	Low	Medium	High
Final body weight (kg)	56.5 ^{a} ± 1.5	65.5 ^{b} ± 1.1	71.0 ^{b} ± 1.4
Total scrotal weight (g)	646 ^{a} ± 50	920 ^{b} ± 54	1062 ^{b} ± 53
Scrotal circumference (cm)	29.5 ^{a} ± 1.1	34.5 ^{b} ± 0.9	35.5 ^{b} ± 0.7
Scrotal skin weight (g)	161 ^{a} ± 14	198 ^{b} ± 6	221 ^{b} ± 12
Scrotal fat (g)	106 ^{a} ± 16	180 ^{a} ± 14	280 ^{b} ± 28
Testes volume (mm^3)	246 ^{a} ± 30	378 ^{b} ± 44	384 ^{b} ± 21
Testes weight (g)	262 ^{a} ± 27	406 ^{b} ± 40	398 ^{b} ± 24
Semen volume (mL)	0.8 ^{a} ± 0.1	1.1 ^{a} ± 0.1	1.2 ^{a} ± 0.1
Overall motility (%)	84 ^{a} ± 2	86 ^{a} ± 2	77 ^{a} ± 3
Forward progression (0-5)	2.8 ^{a} ± 0.1	3.0 ^{a} ± 0.1	2.7 ^{a} ± 0.2
Sperm concentration (x 10^6/mL)	1851 ^{a} ± 121	1678 ^{a} ± 172	1834 ^{a} ± 169
Live sperm (%)	70 ^{a} ± 2	69 ^{a} ± 4	64 ^{a} ± 3
Normal sperm (%)	96 ^{a} ± 2	91 ^{a} ± 4	91 ^{a} ± 4

^{a,b,c} Row means with different superscripts differ significantly ($P < 0.05$)

Low energy (8.23 MJ ME/kg DM); Medium energy (9.77 MJ ME/kg DM); High energy (11.3 2 MJ ME/kg DM)

At the end of the trial, the low energy group recorded a significantly lower ($P < 0.05$) mean body weight and carcass grade than medium energy and high-energy groups, with no significant differences between the latter groups. All the scrotal and testicular parameters considered in this study, namely total

scrotal weight and circumference, testes weight and volume and epididimys weight, recorded in the low energy group were significantly ($P < 0.05$) lower than in both the medium and high-nergy groups. Although the high-energy group recorded higher values than the medium energy group, these differences were not significant. Almost all the fat deposited in the scrotum was located around the *pampiniform plexus*, in accordance with findings reported by Labuschagné *et al. (*2002) and Fourie *et al*. (2003) in Bonsmara bulls and Dorper rams, respectively. The quantity of fat deposited in the scrotum was directly related to the concentration of energy in the diet, although no significant difference was observed between the low and medium energy groups. In general these results indicate significant differences at the end of the trial in terms of scrotal and testicular traits between the nutritional extremes, but not between the extremes and the intermediate dietary energy concentrations.

No significant differences were recorded between the three groups regarding quantitative and qualitative semen characteristics evaluated, namely semen volume, concentration, overall motility, forward progression, as well as % live and normal sperm cells. Some of these results are contrary to the results of Fourie *et al.* (2003), showing that a high-energy diet detrimentally affected sperm concentration and motility in Dorper rams. It would be expected that using a higher energy concentration (11.3 *vs*. 9.5 MJ ME/kg DM) and a longer feeding period (127 *vs*. 49 days) compared to the study of Fourie *et al.* (2003) would induce greater differences in these parameters between groups. Possible reasons contributing to these conflicting results are differences in age (14-15 *vs*. 11-12 months), season (autumn *vs*. winter) and semen collection method (artificial vagina *vs*. electro-ejaculation). According to Matthews *et al.* (2003), semen collected with the aid of an artificial vagina has a higher sperm concentration compared to that collected by electro-ejaculation. With the latter method, the semen sample obtained is often contaminated with urine and contains more seminal fluid.

Results pertaining to volume of ejaculate, as well as the percentages live and normal sperm accorded with the study of Fourie *et al.* (2003), where no significant effect of high dietary energy concentrations on these parameters were found.

Conclusions

Despite the considerable quantity of scrotal fat deposition recorded in young Dorper rams fed on high energy concentration, no significant differences where recorded on the most important semen characteristics. It seems that the amounts of fat deposited in the scrotums of young Dorper rams had no detrimental effect on spermatogenesis. Further research on the effect of high-energy diets on possible impaired fertility of young livestock males is indicated.

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