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The effect of supplementary light on certain productive parameters of young beef bulls fed intensively

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Abstract

The aim of this study was to evaluate the effect of supplementary light on the performance of bulls in a feedlot. Feed intake (FI), average daily gain (ADG), back fat thickness (BFT), eye muscle area (EMA), P8 (fat layer on the rump), feed conversion ratio (FCR) and body development were measure in bulls exposed to different levels of light supplementation. Thirty young Bonsmara bulls from the same farm were randomly divided into three homogeneous groups of 10 animals each and subjected to one of three different levels of light treatment (16h, 24h and normal photoperiod). The additional light provided an average light intensity of 124 lux measured at eye level. The animals were housed in open pens and fed for 84 days *ad libitum* on a diet containing 11 MJ ME/kg DM and 14 g CP/kg. Ultrasound scanning was done using a PIE Medical Falco 100 scanner to measure subcutaneous fat depth between the 12th and 13th rib (BFT), *longissimus dorsi* (EMA) and P8 on days 1, 22, 51, 62 and 84 of the trial. Body measurements (body weight, body length and heart girth) were taken on the same days. The FI, ADG and FCR were calculated at the end of the trial. The results of this study demonstrated that light supplementation (24h light) significantly reduced FI and improved ADG and FCR, with no significant effect on the body measurements or subcutaneous fat accumulation (BFT and EMA). It was concluded that an extended photoperiod (EP = 24h) reduces FI but improves ADG and FCR of young beef bulls fed under intensive conditions.

Keywords: Light supplementation, photoperiod, beef bulls, intensive feeding
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Introduction

More than 70% of all beef consumed in South Africa is from cattle intensively finished in a feedlot. The intensive feeding and fattening of livestock are highly specialized practices which require high levels of management to ensure success. Feedlots need to improve feed intake, feed conversion ratio (FCR) and average daily gain (ADG) to be cost effective. After all, excluding the cost of the animal, feed is the highest production cost in most intensive production systems (Bosman, 1996; Parnell, 1996).

The ideal way to reduce the production costs would be to use feed more effectively and achieve the same or even higher growth rates. According to Arthur *et al*. (1996) it is possible to lower the cost of production and increase profitability by improving FCR in weaners. Satisfactory progress was made over the past decades with regard to feeding technology, feedlot outlay and the identification of animals that perform better under feedlot conditions. A factor that may have a potential impact on the animals' performance under feedlot conditions is light manipulation.

Photoperiod management has received interest lately as a cost effective method to increase production in lactating cows. Dahl *et al*. (2000) reported that extended photoperiod (EP) of 16-18 hours of light and 6-8 hours of darkness increases daily milk production per cow by 2 L. According to Peters *et al*. (1981) dry matter intake increased by 6.1% for cows receiving EP, and this could account for increased milk yields. Although photoperiod management is used by many dairy producers to increase profit, very little research has been conducted in beef cattle, especially under South African conditions. A few studies have been conducted on the effect of supplemented light on beef heifers and significant improvements were found in terms of growth rate and carcass composition (Small *et al*., 2003; Kennedy *et al*., 2004).

The questions that arise are: (i) whether light manipulation will affect the feedlot performance of beef cattle and (ii) whether light manipulation has any effect on certain body measurements related to carcass characteristics. The objectives of this study were thus to evaluate the effect of different photoperiods on the ADG, back fat thickness (BFT) eye muscle area (EMA) and feed conversion ratio (FCR) of beef bulls as well as to determine whether light manipulation has any effect on certain body measurements dimensions of the animals.

Materials and methods

Thirty Bonsmara bulls from the same farm, with an average age of (203 ± 14 days) and weight of 257 ± 15.1 kg were used in this study. The bulls were randomly divided into three homogeneous groups of 10 animals each. The trial commenced in July during winter. The animals were adapted for 28 days after which performance data were recorded from all groups during an 84 day trial period. The animals were fed *ad libitum* on a diet containing 11 MJ ME/kg DM and 14 g CP/kg. Animals had free access to fresh water (standard procedure for phase C intensive growth performance testing in South Africa).

The animals were housed in open pens of which approximately one third was under a roof of the shed. Lighting under the roof was supplied by four twin tube (2 x 58W) fluorescent lights, mounted above the feeding troughs and two wide beam floodlights mounted at the middle of the pen opposite each other. One equipped with a 250W high pressure sodium light, was positioned eight metres from the feeding troughs. The other, equipped with a 400W high pressure sodium light positioned at the opposite end of the feeding troughs provided an average light intensity of 124 lux at eye level (Peters *et al*., 1981; Enright *et al*., 1995; Kendall *et al*., 2003). A digital illumination meter (INS DX 200) was used to measure light intensity at evenly spaced locations in both of the pens that received extended photoperiod (EP) with the light meter facing up (vertical) at a height of 1 m above ground level (approximately at eye level of animals; Small *et al*., 2003). The following treatments were applied:

Group 1: The lights were manually switched on at dawn, half an hour before the sunset, so that the animals did not experience natural sunset before the beginning of supplemented light. This group received 24 hours light (24L: 0D).

Group 2: The lights were switched on by means of an automatic timer and the duration was adjusted twice a week as the daylight decreased, in order to expose the bulls to 16 hours light and 8 hours darkness/day.

Group 3: This group served as the control group and only received natural photoperiods (NP) which were between 9 and 10 h/day during the trial period.

The pen of Group 3 was 100 m away from both groups 1 and 2, and was enclosed by a black tarpaulin (250 micron, 4 meters high) to prevent artificial light from reflecting on the pen where this group was housed and having an influence on the natural light conditions.

During the trial period the subcutaneous fat depth was measured with the aid of ultrasound between the 12^{th} and 13^{th} rib (BFT), *longissimus dorsi* (EMA) and P8 (fat layer on the rump) on days 1, 22, 51, 62 and 84 (end of the trial). A trained operator did the ultrasound measurements, using a PIE Medical Falco 100 scanner equipped with a Linear Array probe. Body measurements (body weight, body length and heart girth) were taken on the same days.

Data was statistically analysed using a one way ANOVA in Proc GLM to determine the effect of supplemented light on the different parameters (FI, ADG, FCR and body measurements).

Results and Discussions

The results are presented in Table 1. Body weights (BW) of young beef bulls exposed to NP, 16L: 8D and 24L: 0D averaged at 287.6 ± 22.9, 273.7 ± 29.7 and 280.2 ± 33.2 kg, respectively at the start of the trial (July 05) and increased to 428 ± 23.7, 412.7 ± 40.2 and 434.4 ± 45.3 kg, respectively, at the end of the trial (September 27). The weights of the animals subjected to NP were on average 13.9 and 7.3 kg heavier than those subjected to 16L: 0D and 24L: 0D (at the start of the trial in July). The weights of the NP and 24L: 0D treatments were similar at weeks 7 to 8 with the 16L: 0D group having lower weights. However, from week 9, growth rates of the bulls subjected to 24L: 0D were greater than those of bulls subjected to NP or 16L: 8D. The total weight gained for the 24L:0 D group was 13.8 kg higher than the NP group. These results differ significantly from each other ($P < 0.05$) and are in agreement with those of Peters *et al.* (1981), who reported that EP increases body weight gains (10-15%) of cattle fed under intensive conditions. However, in that study, the 16L: 0D group out-performed the 24L: 0D group.

The ADG of bulls subjected to 24 hours of light (24L: 0D) were 10% (0.17 kg) and 11.5% (0.19 kg) (P < 0.05) greater than the ADG of animals that received NP and 16 hours of light (16L: 8D), respectively (Table 1). However, the ADG of bulls subjected to NP and 16L:0D did not differ significantly from those under NP conditions.

Table 1 The effect of photoperiod on body weight, feed intake, average daily gain and feed conversion ratio (mean ± s.e.) of young beef bulls fed intensively

Parameter	NP (n = 10)	16L: 8D (n = 10)	24L: 0D (n = 10)
Body weight (start) (kg)	287.6[a] ± 22.9	273.7[a] ± 29.7	280.2[a] ± 33.2
Body weight (end) (kg)	428.0[a] ± 23.7	412.7[b] ± 40.2	434.4[a] ± 45.3
Feed intake (kg)	827.2[a] ± 28.2	801.1[a] ± 24.8	795.5[b] ± 25.3
Average daily gain (kg)	1.67[a] ± 0.03	1.65[a] ± 0.05	1.84[b] ± 0.06
Feed conversion ratio (kg/kg feed)	5.91[a] ± 0.22	5.77[a] ± 0.11	5.18[b] ± 0.13

[a,b] Means with different letters within the same row differ significantly at P < 0.05
NP - natural photoperiods; 16L: 8D – 16 hours light;24L:0D - 24 hours of light

The FCR of bulls subjected to 24L: 0D were 14 and 11% (P < 0.05) better than those of the NP and 16L: 0D treatments, respectively (Table 1). The FI of bulls exposed to NP, 16L: 8D and 24L: 0D averaged 827.2 ± 28.2, 801.1 ± 24.8 and 795.5 ± 25.3 g/day respectively, over the 84 days trial period. Thus, the 24L: 0D treatment group had a significantly higher (P < 0.05) ADG from 10 to 11.5% from day 64 of the trial, ingesting 4% less feed (P < 0.05). Peters *et al.* (1978) came to a similar conclusion that supplemented light increased growth rates of dairy cattle from 10 to 15% without requiring additional feed.

Overall the BFT, EMA and P8 were similar for the three treatment groups over the trial period of 84 days. However, during the last 22 days of the trial there was a significant reduction (P < 0.001) in BFT for the 16L: 8D and 24L: 0D treatment groups from 4.22 ± 0.21 to 3.30 ± 0.26 and 4.04 ± 0.31 to 2.94 ± 0.32 mm, respectively. Although these reductions in BFT cannot be explained, these results concur with those of Kennedy *et al.* (2004), who also recorded a reduction in BFT of 15% by day 156 in beef heifers exposed to EP. The studies of Phillips *et al.* (1997) and Small *et al.* (2003) also suggest that the carcass fat of animals exposed to EP decreases. If these results are highly repeatable under feedlot conditions, they indicate that with an extended photoperiod beef cattle can be fed to higher weights without depositing excessive fat. In this way heavier, but leaner and more desirable carcasses can be produced in feedlots with supplemental light.

There were non-significant differences in body length, shoulder height and heart girth between groups. Heart girth (HG) is generally accepted as the most reliable indicator of growth (body weight; Benyi, 1997). The highest correlation of 0.84 (P < 0.0001) was found between HG and body weight (BW). This correlation is even higher than the value of 0.77 (P < 0.0001) between body length (BL) and body weight. Fourie *et al.* (2002) reported a correlation of 0.80 (P < 0.001) between HG and BW and a correlation of 0.76 (P < 0.001) between BL and BW in Dorper rams. Koenen & Groen (1998) also found a very high correlation of 0.74 between HG and BW.

The research of Arthur *et al.* (2001) indicated a negative correlation of -0.74 between FCR and ADG in beef cattle. This is even higher (negatively) than the -0.60 correlation, reported by Bosman (1995) in beef cattle. These results indicate that faster-growing animals tend to have more favourable (lower) feed conversion ratios. A moderate correlation of 0.46 was found between ADG and FI which is in agreement with the value of 0.41 reported by Arthur *et al.* (2001) for the same parameters in beef cattle.

The correlations between the subcutaneous fat measured ultrasonically and FCR, ADG and FI obtained in this study were fairly low (0.38, 0.07 and 0.33, respectively). Exception was the correlation between ADG and EMA, which was relatively high (0.64; P < 0.0001).

Heart girth (HG) which is a good indicator of growth (body weight) (Benyi, 1997) had a high correlation of 0.76 (P < 0.0001) with EMA while the correlation between BW and EMA was even higher

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(0.80; P > 0.0001) than that between HG and EMA (0.76). This indicates that the area (cm²) of the EMA will grow in relation with the growth of HG and BW.

Conclusions

From this study it is evident that EP has a positive effect on ADG and FCR of beef bulls under intensive feeding conditions. Animals can be fed more economically to higher weights and for longer periods because of less fat accumulation. Currently there is no proof that supplemented light has a positive effect on castrated animals. It is therefore recommended that feedlots feed the bulls separately applying supplemental light. Further research needs to be done on this topic, including different breeds of beef cattle using castrated animals as testosterone secretion may have had an influence on lean growth.

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