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GROWTH AND PERFORMANCE OF GROWING-FINISHING LAMBS EXPOSED TO LONG OR SHORT PHOTOPERIODS¹

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Summary

The effects of photoperiod (8 hr light:16 hr dark [8L:16D] or 16L:8D) on performance of growing-finishing lambs were evaluated in an experiment with 24 rams and 24 wethers. All lambs were caged in groups of two in a controlled environment and fed a pelleted diet *ad libitum* for the duration of the study (10 to 22 weeks of age). Performance and carcass data showed that both photoperiod and sex of lamb affected growth rate ($P<.01$) and feed efficiency ($P<.05$) but that only sex of lamb affected carcass quality ($P<.05$) and yield ($P<.10$). A sex by photoperiod interaction was not observed for any of the traits measured. Average daily gain (grams/per day) and feed efficiency (feed/gain) for lambs in the four treatment groups tested were: rams (16L:8D), 410 and 4.3; rams (8L:16D), 340 and 4.5; wethers (16L:8D), 345 and 4.6, and wethers (8L:16D), 300 and 4.8, respectively. Carcass weight, like slaughter weight, was affected by photoperiod ($P<.01$) and sex of lamb ($P<.05$); both rams and wethers exposed to long photoperiods had the heaviest carcasses. Ram carcasses were leaner, had better yield grades and were heavier than wether carcasses, yet both ram and wether carcasses graded Choice. Testosterone concentrations in serum were undetectable ($<.2$ ng/ml) at 22 weeks of

age in wethers but were elevated ($P<.01$) in ram lambs exposed to short (3.4 ± 1.4 ng/ml) or long ($.8 \pm .2$ ng/ml) photoperiods. Prolactin concentrations, on the other hand, were not influenced by sex of lamb but were influenced ($P<.01$) by photoperiod; i.e., prolactin concentrations were high in rams (190 ± 34 ng/ml) and wethers (178 ± 28 ng/ml) exposed to long photoperiods and low in rams (43 ± 9 ng/ml) and wethers (27 ± 11 ng/ml) exposed to short photoperiods. These results suggest that testosterone and prolactin may independently affect growth and performance of growing-finishing lambs.

(Key Words: Lambs, Photoperiod, Growth, Testosterone, Prolactin.)

Introduction

Sheep, like many other species, are sensitive to changes in their photoperiod environment. In fact, photoperiod (daylength) appears to be the primary environmental cue that regulates seasonal breeding activity in sheep (Ortavant, 1977). Artificial photoperiods have been used successfully to manipulate gonadotropin secretion (Pelletier and Ortavant, 1975; Lincoln, 1976; Sanford *et al.*, 1978; Schanbacher and Ford, 1979), spermatogenesis (Schanbacher and Ford, 1979) and fertility of rams (Schanbacher, 1979). On the other hand, limited information is available on the effects of artificial photoperiods on growth and performance of young market lambs. Forbes *et al.* (1975) reported that lambs maintained in controlled environments and exposed to long daylengths (16 hr light:8 hr dark [16L:8D]) gained weight faster than lambs exposed to short daylengths (8L:16D); however, feed efficiency was not affected. In contrast, Hackett and Hillers (1979) were unable to show a beneficial effect of artificial night lighting (long daylengths) on growth and performance of feeder lambs maintained in an open environment. Because

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the results of the latter study may have been confounded with environmental factors other than photoperiod, exposure of growing-finishing lambs to long photoperiods may yet prove to be beneficial.

The present study was conducted to determine the effects of long and short photoperiods on performance of intact and castrate growing-finishing lambs.

Materials and Methods

Treatments. Forty-eight Suffolk ram lambs were weaned at approximately 8 weeks of age and assigned to four treatment groups. Twenty-four lambs were left intact (groups 1 and 2) and 24 were castrated (groups 3 and 4). Intact and castrate lambs were subsequently caged in pairs and housed in controlled environments. Temperature was maintained near 18 C and relative humidity fluctuated between 25 and 35%. Two environmental rooms allowed lambs in groups 1 and 3 to be exposed to long photoperiods (16L:8D) and lambs in groups 2 and 4 to be exposed to short photoperiods (8L:16D). Photo intensity at eye level was provided at between 800 and 900 lux with fluorescent lights.

Data collection was begun after 2 weeks' acclimation, when lambs were 10 weeks old and weighed approximately 24 kilograms. A pelleted diet consisting of 60% ground, shelled corn, 20% alfalfa hay, 15% soybean meal and 5% supplement and analyzed to contain 89.7% dry matter, 17.1% crude protein and 78.6% total digestible nutrients was fed *ad libitum*. Feed consumption was tabulated daily and fresh water was provided. At biweekly intervals,

single blood samples were collected by jugular venipuncture, and testicle diameters and body weights were measured and recorded. Twelve weeks after the trial began, lambs averaged 54 kg and were slaughtered.

In addition to hot carcass weight, carcass cooler data, including backfat thickness and percentage of kidney and pelvic fat, were recorded; from these, quality and yield grades were determined.

Hormone Assays. Testosterone concentrations in serum were determined in a single assay by radioimmunoassay (Schanbacher, 1976). Prolactin concentrations were determined in serum samples collected at 22 weeks of age by a double antibody radioimmunoassay procedure described previously (Schanbacher and Ford, 1979; Schanbacher, 1980).

Statistical Analyses. Performance and carcass data were analyzed by the program for least-squares analysis of data with unequal subclass numbers (Harvey, 1975); the model used included the main effects of sex and photoperiod. Initial weight and carcass weight were included as linear covariates; however, regression on carcass weight was statistically nonsignificant and therefore was deleted from the final analyses. Student's *t*-test and split-plot analysis of variance were used to evaluate statistically differences in testicular diameters and serum hormone concentrations.

Results

Table 1 shows the summary of analyses of variance for performance and carcass traits of growing-finishing lambs. Sex of the lamb significantly affected performance and carcass

TABLE 1. SUMMARY OF ANALYSES OF VARIANCE FOR PERFORMANCE AND CARCASS TRAITS OF GROWING-FINISHING LAMBS (F VALUES)

Source of variation	df	Avg daily gain	Final weight	Carcass weight	Backfat thickness	Kidney pelvic fat	Quality grade	Yield grade	df	Feed efficiency
Sex	1	13.53**	13.91**	5.39*	3.22	4.97*	6.06*	3.22	1	9.46**
Photoperiod	1	17.00**	16.00**	22.26**	1.89	.24	.20	1.89	1	3.04
Sex X photoperiod	1	.68	.66	.62	.08	.13	.005	.08	1	.16
Regression on initial weight	1	5.03*	1.74	6.84*	6.97*	.30	10.78**	6.97*	1	7.30*
Remainder	42								19	

* $P < .05$.

** $P < .01$.

merit, whereas photoperiod significantly affected lamb performance but had no effect on carcass data. No interaction between the main effects was found ($P > .10$). As indicated in table 1, weight at 10 weeks of age had a significant influence on all performance and carcass traits except final weight and percentage of kidney and pelvic fat. The analyses were limited to 47 lambs (one ram was excluded because of a fractured leg).

Data presented in table 2 show that rams grew more rapidly and efficiently than wethers and that long photoperiods promoted more rapid gains than short photoperiods and improved feed efficiency. In spite of improved feed efficiency, however, the rapid gains of lambs exposed to long photoperiods increased ($P < .01$) feed consumption; i.e., rams (16L:8D), 297 kg/pen; rams (8L:16D), 262 kg/pen; wethers (16L:8D), 274 kg/pen; wethers (8L:16D), 243 kg/pen. The positive effects of sex and photoperiod treatment on lamb performance were evident in carcass weight. Ram carcasses were heavier than wether carcasses, and carcasses of lambs exposed to long photoperiods were heavier than carcasses of lambs exposed to short photoperiods.

Although the carcass traits of backfat thickness, kidney and pelvic fat, quality grade and yield grade were significantly affected by sex, these traits were not influenced by photoperiod exposure. Data presented in table 3 show that wether lambs were fatter than heavier ram lambs. The decrease in subcutaneous and perirenal fat resulted in higher yield grades and lower quality grades for ram lambs than for wether lambs.

Mean testicular diameters at 10 weeks of age were similar for lambs exposed to long photo-

periods ($3.47 \pm .34$ cm) and those exposed to short photoperiods ($3.48 \pm .34$ cm). The testicular growth curve from 10 to 22 weeks of age was sigmoidal; mature testicle size was attained at approximately 18 weeks of age. Testicle diameters at this age differed ($P < .01$) between lambs exposed to long ($5.16 \pm .18$ cm) and short ($5.55 \pm .14$) photoperiods. No further increase was observed.

Testosterone concentrations in serum of ram lambs exposed to long and short photoperiods are shown in figure 1. Testosterone concentrations were undetectable ($< .2$ ng/ml) in wethers throughout the study. Ram lambs had relatively low serum testosterone concentrations at 10 weeks of age. Concentrations increased gradually through 16 weeks of age, then increased dramatically at 18 weeks of age. Concentrations subsequently fell to stable values at 20 and 22 weeks of age. Testosterone concentrations were higher ($P < .05$) for ram lambs exposed to short photoperiods at all time periods after 16 weeks of age.

Prolactin concentrations in serum collected at 22 weeks of age were similar for rams and wethers but differed ($P < .01$) between lambs exposed to long and short photoperiods. Mean concentrations were 190 ± 34 and 178 ± 28 ng/ml for ram and wether lambs exposed to 16 hr of light/day, and 43 ± 9 and 27 ± 11 ng/ml for ram and wether lambs exposed to only 8 hr of light/day.

Discussion

A clear effect of sex and photoperiod on growth and performance of growing-finish-ing lambs was demonstrated in this experiment. The superior growth rate, feed efficiency and

TABLE 2. LEAST-SQUARES MEANS FOR PERFORMANCE TRAITS OF GROWING-FINISHING LAMBS

Treatment ^a	Avg daily gain, g/day	Feed efficiency, kg feed/kg gain	Final weight, kg	Carcass weight, kg
Ram (16L:8D)	410 $\pm$ 14	4.3 $\pm$.1	58.8 $\pm$ 1.2	31.8 $\pm$.6
Ram (8D:16L)	340 $\pm$ 14	4.5 $\pm$.1	53.2 $\pm$ 1.1	28.4 $\pm$.6
Wether (16L:8D)	345 $\pm$ 14	4.6 $\pm$.1	53.4 $\pm$ 1.2	29.8 $\pm$.6
Wether (8L:16D)	300 $\pm$ 14	4.8 $\pm$.1	49.7 $\pm$ 1.1	27.4 $\pm$.6

^a(16L:8D) refers to exposure to long days (16 hr light/24 hr). (8L:16D) refers to exposure to short days (8 hr light/24 hr).

TABLE 3. LEAST-SQUARES MEANS FOR CARCASS TRAITS OF GROWING-FINISHING LAMBS

Treatment ^a	Backfat thickness, cm	Kidney pelvic fat, %	Quality grade ^b	Yield grade ^c
Ram (16L:8D)	.53 ± .08	2.8 ± .3	10.6 ± .3	1.4 ± .2
Ram (8L:16D)	.50 ± .06	2.6 ± .2	10.8 ± .2	1.3 ± .2
Wether (16L:8D)	.68 ± .06	3.2 ± .2	11.2 ± .2	1.8 ± .2
Wether (8L:16D)	.61 ± .07	3.2 ± .3	11.4 ± .2	1.6 ± .2

^a(16L:8D) refers to exposure to long days (16 hr light/24 hr). (8L:16D) refers to exposure to short days (8 hr light/24 hr).

^bQuality grade: 10 = low Choice, 11 = average Choice and 12 = high Choice.

^cYield: 1 = high cutability; 5 = low cutability.

carcass yields observed for intact ram lambs (compared with those for castrate lambs) are in accord with data published previously (Schanbacher and Ford, 1976; Schanbacher *et al.*, 1980). The beneficial effects of producing market lambs under stimulatory long daylengths, however, is equally impressive. Not only do lambs grow more rapidly and reach

market weights sooner when exposed to long photoperiods, but feed conversion is also more efficient. Increased feed consumption by lambs exposed to long photoperiods appears necessary for accelerated rates of gain, but the physiological reason for the increased feed consumption is not known. Long photoperiods may increase rates of gain indirectly by stimulating appetite and feed consumption. On the other hand, increased consumption may be requisite to the increased nutritional requirements of the rapidly growing animal. The first explanation seems more likely, because lambs are known to gain most rapidly when feed consumption is maximized.

Increased carcass weight without sacrifice of quality or yield is a distinct advantage of producing market lambs with the aid of artificial lighting. Hackett and Hillers (1979) were unable to show either a beneficial or a detrimental effect of supplemental lighting on lamb performance. However, in a study designed similarly to the present study, Forbes *et al.* (1975, 1979b) found that lambs exposed to 16 hr light/day gained weight more rapidly than lambs exposed to only 8 hr light/day. Furthermore, the observation by Forbes *et al.* (1975) that photoperiod affected carcass weight but not carcass fat is in agreement with the results obtained in the present study. Feed efficiency, on the other hand, was not affected by photoperiod in one study by Forbes *et al.* (1975) but was significantly affected in their subsequent study (Forbes *et al.*, 1979b) and in the present study. The absence of a stimulatory effect of supplemental lighting on lamb performance in the study by Hackett and Hillers (1979) may be attributable to some

Figure 1. Serum testosterone concentrations in ram lambs exposed to long (16L:8D) photoperiods (○) or short (8L:16D) photoperiods (●) as a function of age. Values represent mean ± SEM for 12 animals.

unmonitored environmental factor(s) that interacted negatively with photoperiod.

To assure that photoperiodic effects were perceived by the animals in the study by Forbes *et al.* (1975, 1979a) and in the present study, serum prolactin was monitored. As shown by Pelletier (1973) for rams and by Leining *et al.* (1979) for bulls, prolactin secretion depends largely on the photoperiod environment; i.e., light is stimulatory. Thus, animals exposed to relatively long photoperiods increased their serum prolactin concentrations presumably by increasing prolactin secretion. The positive relationship between serum prolactin and growth rate in this study provides support for the suggestion that prolactin may stimulate growth in the ruminant (McAtee and Trenkle, 1971; Forbes *et al.*, 1979a). However, the report that growth rate in young ram lambs treated with the prolactin inhibitor, CB 154, was not affected (Ravault *et al.*, 1977) causes one to question the proposed anabolic role of prolactin in ruminants.

Other hormones (Davis *et al.*, 1977; McGuffey *et al.*, 1977) with growth-promoting activity may be responsible for the improved performance of lambs exposed to long photoperiods; however, growth hormone, insulin and thyroxine do not appear to be affected by photoperiod (Peters and Tucker, 1978; Forbes *et al.*, 1979a), and the gonadotropins, LH and FSH, as well as testosterone, are affected inversely by photoperiod; i.e., these hormones are decreased after exposure to long photoperiods (Schanbacher and Ford, 1979). Testosterone, which is considered to be the testicular hormone responsible for improved performance of intact lambs (Schanbacher *et al.*, 1980), is decreased during exposure to long photoperiods. Furthermore, the significant difference in performance between wethers exposed to long and short photoperiods indicates that photoperiodic effects on growth are mediated by mechanisms independent of the testes.

In conclusion, long photoperiods appear to improve performance of the growing-finishing lamb without affecting carcass merit. The mechanism(s) by which this effect is mediated is yet to be determined.

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