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Effects of Limit Feeding a High Concentrate Diet on Feedlot Performance and Carcass Composition of Lambs

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EFFECTS OF LIMIT FEEDING A HIGH CONCENTRATE DIET ON FEEDLOT PERFORMANCE AND CARCASS COMPOSITION OF LAMBS

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Summary

Regulating daily weight gains to a predetermined level can be achieved by restricting intake of a high concentrate diet. Feed efficiency was improved by increasing feed intake at a given live weight. Carcass composition did not appear to be affected when intake was restricted to approximately 80% of ad libitum. However, further reducing intake increased carcass fat and decreased carcass water. Although limit feeding a high concentrate diet is a viable management option for lamb feeders, determining optimum levels of restriction will require further study.

Introduction

Limit feeding high concentrate diets offers several potential benefits to lamb feeders. Limit feeding is one alternative to ad libitum feeding where intake is restricted to an amount which will permit animals to attain some predetermined daily weight gain. This type of feeding system provides a means to reduce day-to-day variations in feed intake, simplifies bunk management, and allows for greater control over feed inventories (Zinn, 1986). Using limit feeding to program a particular rate of gain also allows greater marketing flexibility. Restricting intake has been shown to improve the efficiency at which feed is converted into live weight gain in sheep (Glimp et al., 1989) and cattle (Plegge, 1986). Reduced average daily gains have been shown to reduce the fat content of empty body weight gains (Turgeon et al., 1986). The objectives of this study were to determine the effect of limit feeding a high concentrate diet to achieve three different rates of gain on feedlot performance and body composition of growing lambs.

Experimental Procedures

Sixty-six crossbred lambs (38 wethers and 28 ewes) weighing 31 ± 2.1 kg were used in the study. Nine lambs (5 wethers and 4 ewes) were randomly selected within sex to represent the initial composition of the lambs. The remaining lambs were randomly allotted into nine pens of (3 wethers and 2 ewes) five lambs and three pens of four lambs (2 wethers and 2 ewes). These pens were then randomly allotted one of three treatments (4 pens/treatment--3 - five lamb pens and 1 - four lamb pen). Treatments were represented as a fast (350 g/day), medium (250 g/day) and slow (150 g/day) growth rate achieved by restricting pen intake of a high concentrate diet. Within treatment, pens were assigned a slaughter weight (35, 45, 55 or 65 kg fleece-free live weight). The four sheep pens in each treatment were all assigned to the 65-kg slaughter weight.

Diets (Table 1) were formulated to meet NRC (1985) requirements for an expected rate of gain at a given intake. Intake was roughly 90 (fast), 80 (medium) or 60 (slow) percent of expected ad libitum intake for a pelleted diet (NRC, 1985). The fast and medium groups were maintained at these intakes, while the intake of the slow group was adjusted to maintain the desired rate of gain.

The initial group was slaughtered at the onset of the experiment. The remaining lambs were weighed weekly and pens within treatment were slaughtered when the average fleece-free live weight of the pen reached its preassigned slaughter weight. At slaughter, each lamb was separated into five components: 1) an

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TABLE 1. COMPOSITION OF DIETS

Item	Treatment[a] Slow	Medium	Fast
Ingredient, %			
Alfalfa	15.0	15.0	15.0
Corn	56.8	59.0	61.0
Soybean meal	10.0	10.0	10.0
corn gluten meal	7.5	5.5	3.5
Blood meal	1.0	1.0	1.0
Urea	.2	0	0
Molasses	3.0	3.0	3.0
Megalac	1.0	1.0	1.0
Animal fat	1.5	1.5	1.5
Binder	2.0	2.0	2.0
Calcium carbonate	.45	.45	.45
Dicalcium phosphate	.50	.50	.50
Ammonium chloride	.50	.50	.50
Trace mineralized salt	.50	.50	.50
Lasalocid	.025	.019	.015
Vitamins A, D, E	.095	.007	.006
Composition			
Crude protein, %	20.52	19.67	17.33
NEm[b], Mcal/kg	1.96	1.96	1.96
NEg[b], Mcal/kg	1.32	1.32	1.32

[a] Treatments refer to limit feeding the diets to achieve a desired average daily gain: slow, 150 g; medium, 250 g; and fast, 350 g.
[b] Net energy values were estimated from NRC (1985).

8 rib rack, 2) a fore and hind saddle, 3) pelt (fleece-free head, hide and feet), 4) blood and 5) viscera (digestive-free remainder). Weights of each component were recorded and the sum of the components represented empty body weight (EBW). Hot carcass weight (HCW) was defined as the sum of the weight of the saddles plus the rack weight. In the initial slaughter group, the pelt was not removed from the carcass except for a small section to allow for the removal of the rack. Thus, a regression equation relating HCW to the sum of HCW and pelt weight was developed to estimate the HCW for the initial slaughter group:

$$HCW = 2.3993 + 1.1377 * (HCW+pelt)$$
(n=57, R2=.9939 and RMSE=.642)

Racks were removed from the carcass after hanging in the cooler for 48 hours and separated into soft tissue and residue. The saddles and the soft tissue of the racks were analyzed for DM, ether extract and ash (AOAC, 1980). Lean was defined as the remaining percentage after accounting for water, ether extract and ash. Carcass composition was obtained by summing the composition of the saddles and the racks. Carcass composition of the initial slaughter group was estimated from regression equations relating cold carcass composition to rack composition. Data for developing these regressions were obtained from the other lambs in the study.

Feedlot performance was analyzed as a completely random design, with pen used as the experimental unit. Since the period between 55 and 65 kg was not replicated within treatment, the data for this period were not included in this analysis. Weights of various body components and carcass composition were expressed as deviations from the average value of the initial slaughter group. These adjusted variables were then analyzed as a completely random design, with pen as the experimental unit, using a zero intercept model to ensure that all treatments started from a common point (initial average value). The model for body components included treatment and EBW as main effects. EBW was treated as a continuous variable and only the linear and quadratic effects were considered. Carcass composition was analyzed in a similar model where HCW was used in place of EBW. The animals in the 65-kg slaughter weight pen on the slow treatment were killed at the same time as the animals in the 55-kg pen. However, since weight was used as a continuous variable, data for this pen were included in the analysis.

Results and Discussion

Average daily intake within each treatment (fast, medium and slow growth rates) across weight periods (30-35, 35-45 and 45-55 kg) is presented in Figure 1. Lambs in the medium and slow group quickly adjusted into meal eaters, consuming their daily allotment of feed in a short period of time, while the fast group required the entire day. Personal observation suggests that the fast group was just below ad libitum intake on this particular diet. Average daily gain (ADG) was significantly affected by both treatment ($P<.01$) and period ($P<.02$) (Figures 2 and 3). The medium and slow group responded well to the limit feeding and ADG (241 and 152 g/day, respectively) was not different from the desired ADG. The fast group, while outgaining the other groups, did not perform as expected (291 g/day). The reason for this is not known but may relate to an increased maintenance energy requirement that has been shown to accompany increased rates of gain (Ferrell et al., 1986). The period effect on ADG is most likely a time on feed factor, where overall performance was slightly depressed early in the trial until the lambs became accustomed to the environment of the feedlot, feeding situation, and weighing procedures. Feed efficiency (kg gain/kg intake) was also significantly affected by both treatment ($P<.01$) and period ($P<.01$) (Figures 2 and 3). Since gain is supported by intake available after accounting for a maintenance requirement, it is not surprising that the faster growing lambs (increased intake) are more efficient. If the maintenance requirement of the lambs in the fast group was increased above that suggested by NRC (1985), it was not increased enough to detrimentally affect feed efficiency. Body weight typically has a strong influence in overall feed efficiency. This was primarily due to a shift in the composition of empty body gain from lean tissue to fat as body weight increases. Due to the energy content of lean and fat tissue, it takes more feed to deposit a kilogram of fat than it does to deposit the same amount of lean tissue. There were no interactions between treatment and period on either ADG nor feed efficiency.

The cold carcass composition of the initial slaughter group was estimated from rack composition (Table 2). Carcass water was estimated from rack DM. Carcass lean and ash were estimated from rack lean and ash expressed on a DM basis. Carcass ether extract (fat) was estimated using rack ether extract expressed on a fresh basis. When rack composition is expressed on a fresh basis, these regressions are quite similar to those presented by Hankins (1946). One major difference is that the intercept in the equation predicting carcass fat from rack fat is statistically different from the equation presented in Table 2. However, the slope is not different between the two equations. One other difference is that carcass composition as expressed here is whole carcass composition and not just the composition of the edible meat in the carcass. Given these differences, it would appear that rack composition can be used to predict carcass composition in lambs.

FIG 1. DAILY INTAKE OF LIMIT FED LAMBS
BY WEIGHT PERIODS

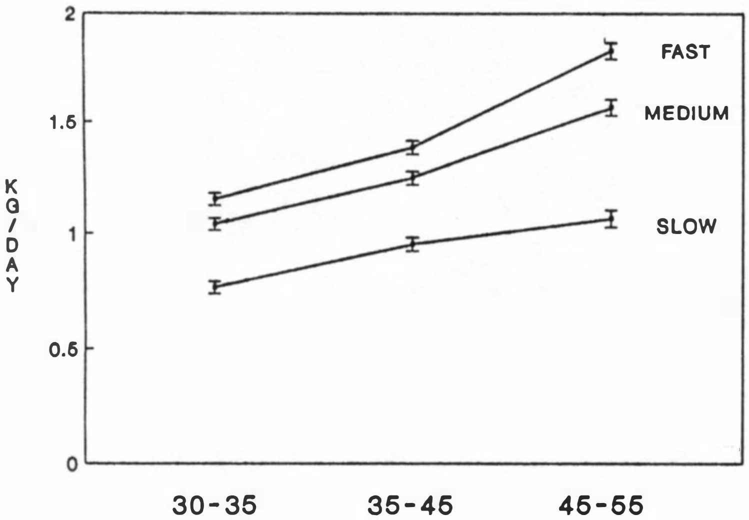
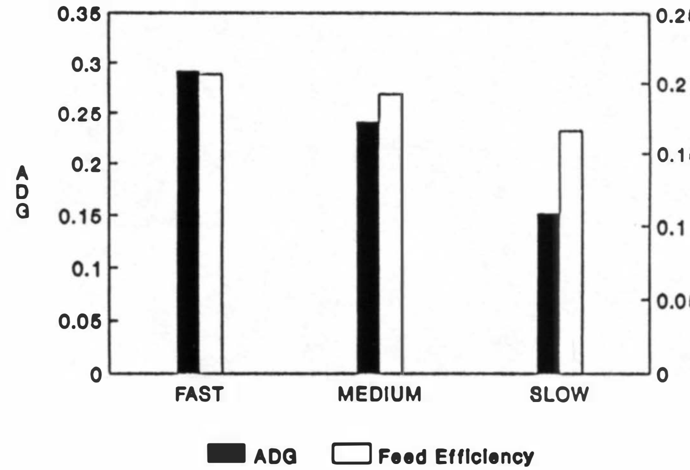
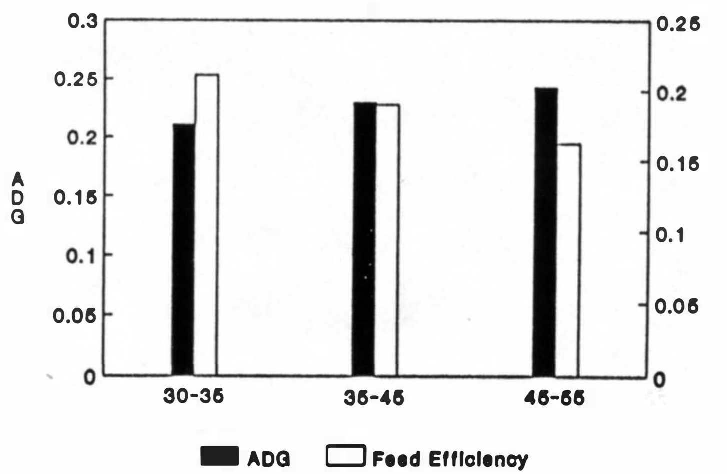


FIG 2. EFFECT OF GROWTH RATE ON ADG AND
FEED EFFICIENCY OF LIMIT FED LAMBS [a]



[a] Linear effect of GR on ADG (P<0.01) and FE (P<0.01).

FIG 3. EFFECT OF PERIOD ON ADG AND
FEED EFFICIENCY OF LIMIT FED LAMBS [a]



[a] Linear effect of PERIOD on ADG (P<0.02) and FE (P<0.01).

TABLE 2. EQUATIONS FOR PREDICTING COLD CARCASS COMPOSITION FROM RACK COMPOSITION (N = 54)

Carcass (%)	Rack (%)[a]	Intercept	SE	Slope	SE	RMSE	R^2
Water	Water	17.179	.325	.713	.029	1.62	.9205
	DM[b]	88.488	1.615	-.713	.029	1.62	.9205
Ether extract	EE (f)[bc]	.267	1.509	.747	.036	2.36	.8891
	EE (d)	-41.333	4.952	.991	.068	3.15	.8025
Lean	Lean (f)	6.550	1.446	.653	.102	.99	.4388
	Lean (d)[b]	11.235	.517	.171	.019	.83	.6038
Ash	Ash (f)	2.647	.460	2.209	.653	.59	.1804
	Ash (d)[b]	3.325	.268	.649	.194	.59	.1777

[a] f refers to component expressed as a percentage on a fresh basis. d refers to component expressed as a percentage on a dry matter basis.

[b] These regressions were used to estimate carcass composition of the initial slaughter group.

[c] The intercept of this regression is statistically different from that published by Hankins (1946). However, the slope is not different.

All carcass composition percentages were linearly related to HCW (Table 3). However, the relationships for carcass water and ether extract were affected by treatment. This resulted in the slow gaining group having more fat and less water at a given HCW. One reason for this may have been that lean tissue accretion was inhibited by the low total crude protein intake and excess energy was deposited as fat. Providing adequate protein to meet an animal's requirement in a severely intake restricted diet is difficult to do and in many cases would be cost prohibitive.

Limit feeding high concentrate diets to growing lambs appears to be a viable option for lamb feeders. However, in spite of its managerial advantages, the point to which animals can be limit fed without detrimentally affecting feedlot performance and carcass composition is not known and would require further study. Challenges of limit feeding programs include 1) selection of an optimum target daily weight gain, 2) reliable estimates of the net energy value of the diet, 3) general applicability of the net energy equations for partitioning energy intake into components of gain and 4) the necessity that animals readily consume their daily feed allotments (Zinn, 1986).

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TABLE 3. PREDICTED CARCASS COMPOSITION[a] FROM HCW IN LIMIT FED GROWING LAMBS

Component	Avg of initial group	Live weight 35	45	55	65	RMSE
HCW, kg	15.87	19.09	25.56	32.04	38.51	
Water, %	61.47					
Fast		58.62	52.88	47.14	41.41	3.38
Medium		58.66	53.02	47.37	41.73	.97
Slow		58.11	51.37	44.62	37.88	.57
Ether extract, %	16.02					
Fast		19.49	26.46	33.44	40.40	3.78
Medium		19.45	26.34	33.24	40.13	1.33
Slow		19.90	27.70	35.50	43.30	.75
Lean, %	18.56	17.90	16.56	15.23	13.90	.57
Ash, %	4.93	4.73	4.32	3.91	3.50	.40

[a] Percentages were adjusted to deviations from the average of the initial slaughter group and then regressed against HCW. A zero intercept model was used in each regression.