Growth and Tissue Accretion of Lambs Fed Concentrate in Drylot, Grazed on Alfalfa or Ryegrass at Weaning, or After Backgrounding on Ryegrass

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ABSTRACT: Weaned Targhee × Hampshire lambs (average BW 27.6 kg) were used to determine the effects of concentrate feeding, forage grazing, or finishing on concentrate after grazing upon growth and carcass tissue accretion. Lambs were assigned randomly and balanced by weight and sex to five replicated treatments (12 lambs/treatment): all-concentrate in drylot (DL); rotational grazing alfalfa (ALF); rotational grazing ryegrass (RG); RG for 62 d, then DL (RGDL); RG for 62 d, then ALF (RGALF). Lambs were slaughtered when fat thickness over the ribeye was estimated at 3.8 to 5.6 mm. Lamb growth and carcass measurements included ADG, accretion of bone, lean, and fat in the carcass, and final BW. Lambs on DL had the highest \( P = .001 \) ADG, whereas lambs on RG treatments tended to have the lowest ADG and heaviest final BW. Compared with DL lambs, ALF lambs had lower \( P < .05 \) ADG but comparable final BW. Lambs that grazed RG had more \( P = .001 \) carcass lean weight than lambs fed in DL, but carcass lean weight of lambs grazed on ALF did not differ \( P > .05 \) from that of lambs on the DL or RG treatment. Carcass fat was less \( P = .001 \) for ALF lambs than for the DL, RGDL, or RGALF treatment group. Daily accretion of bone, lean, and fat was highest \( P = .001 \) for DL. Daily accretion of lean and fat for the RG group was less \( P = .001 \) than for the ALF group but did not differ \( P > .05 \) from that of RGALF lambs. Lean:fat ratio in weight gain for DL lambs was less \( P < .01 \) than ratios for the ALF and RG groups, which were similar to those for RGDL and RGALF lambs. When slaughtered at the same level of fat over the ribeye, DL-fed lambs had higher ADG and fewer days on test than grazed lambs. However, lambs finished or backgrounded on forage had high lean:fat tissue gain and a higher percentage of lean in their carcasses than DL-fed lambs.

Key Words: Lambs, Grazing, Forage, Concentrate, Growth, Carcass Composition

Introduction

When slaughtered at a constant final weight, lambs fed concentrate diets had carcasses that were fatter than carcasses of lambs grazed on forages (Ely et al., 1979; Arnold and Meyer, 1988; Murphy et al., 1994). A 32% reduction of fat was observed in carcasses of lambs grazed on alfalfa compared with finishing systems that included concentrate at some time during finishing (Murphy et al., 1994). Allen (1988) suggested that one approach to improving the nutritional attributes of meat products is to reduce the amount of associated adipose tissue.

McClure et al. (1994) reported that lambs grazed on alfalfa had lower ADG, smaller carcasses, the same amount of muscle and bone management, G. D. Lowe for technical assistance, data tabulation, and statistical analysis of results, and S. C. Loerch for presubmission review and statistical interpretation. Manuscript no. 32-95.

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accretion in the carcass as a result of feeding all concentrate in drylot, grazing legumes or grasses, or a combination of grazing and concentrate feeding on finishing lambs to the same market condition.

**Experimental Procedures**

*Animals and Management.* Sixty-four Targhee × Hampshire lambs (32 ewes, 32 wethers; average BW 27.6 kg) were used in a completely randomized design to compare the effects of finishing systems on rate of growth, time required to finish, carcass characteristics, and carcass tissue accretion. Finishing systems evaluated were all-concentrate (Table 1) offered with ad libitum access in drylot (DL) under cover, rotationally grazed alfalfa (ALF; Medicago sativa L. cv. WL320), rotationally grazed ryegrass (RG; Lolium perenne L. cv. Bastian), RG for 62 d then DL, (RDGL), and RG for 62 d then ALF (RGALF).

The average birth date for lambs was February 14, 1991. Lambs had access to a starter diet (Table 1) in a creep feeding area from 7 d of age until weaning. At weaning, lambs averaged 55 d of age and continued to be offered the starter diet with ad libitum access and were allowed access to pasture until 68 d of age when they started on their respective dietary treatments. Lambs on the DL treatment were fed the starter diet from d 1 to 28 and the finishing diet (Table 1) from d 29 to slaughter. Lambs on the RGDL treatment were adapted to the finishing diet during a 7-d period in drylot. During adaptation they were fed a blend of 70% alfalfa pellets (19.5% CP) and 30% finishing diet starting with DMI at 3% of BW. The finishing diet was increased and alfalfa pellets decreased 150 g/d until lambs were converted to the finishing diet. Lambs were considered on full feed of finishing diet from d 71 to slaughter. Lambs on the RGDL treatment were adapted to the finishing diet during a 7-d period in drylot. During adaptation they were fed a blend of 70% alfalfa pellets (19.5% CP) and 30% finishing diet starting with DMI at 3% of BW. The finishing diet was increased and alfalfa pellets decreased 150 g/d until lambs were converted to the finishing diet. Lambs were considered on full feed of finishing diet from d 71 to slaughter. Lambs on the RGDL treatment were adapted to the finishing diet during a 7-d period in drylot. During adaptation they were fed a blend of 70% alfalfa pellets (19.5% CP) and 30% finishing diet starting with DMI at 3% of BW. The finishing diet was increased and alfalfa pellets decreased 150 g/d until lambs were converted to the finishing diet. Lambs were considered on full feed of finishing diet from d 71 to slaughter. Lambs on the RGDL treatment were adapted to the finishing diet during a 7-d period in drylot. During adaptation they were fed a blend of 70% alfalfa pellets (19.5% CP) and 30% finishing diet starting with DMI at 3% of BW. The finishing diet was increased and alfalfa pellets decreased 150 g/d until lambs were converted to the finishing diet. Lambs were considered on full feed of finishing diet from d 71 to slaughter.

Initially and every 30 d through July, lambs were treated with Ivermectin (3 mL/11.8 kg BW) for control of internal parasites. In addition, fecal samples were collected by rectal grab every 30 d from 10 animals in each grazing group throughout the experiment. Ivermectin treatment was repeated if parasite egg count was greater than 50 eggs/g of feces.

Lamb weights 2 d before the start of the experiment were used for assignment weights. Lambs were weighed at the start of the experiment for initial weight. Lambs were weighed at 14-d intervals to monitor performance. Lambs were removed from experiment by subjective palpation on scheduled weigh days (weight intervals were reduced to 7 d when deemed necessary). All lambs were weighed between 0800 and 0900 and before feeding of concentrate diets. Average daily gain and days required to finish were determined. Daily DM intake of the concentrate diet was measured and feed efficiency calculated. Research protocols and animal care procedures followed guidelines stated in the Guide for the Care and Use of Agricultural Animals in Agricultural Research and Teaching (Consortium, 1988). Two lambs of each sex were slaughtered at the initiation of the experiment to estimate initial body composition. The remaining 60 lambs were allotted randomly within sex to the five treatments with six candidate lambs per drylot pen or grazing paddock replicate and two replicates per treatment. Four of the six candidate lambs (two ewes, two wethers) were selected randomly for slaughter at The Ohio State University Meat Laboratory when fat over the longissimus muscle (estimated by palpation) was 3.8 to 5.6 mm, on an individual lamb basis.

Carcasses were chilled for 48 h and then weighed. Linear and subjective carcass measurements were obtained, and carcasses were separated into right and left halves. Carcass halves were placed in labeled plastic bags and stored at −20°C. Frozen carcasses were transported to the USDA Meat Science Research Laboratory (Beltsville, MD) for dissection analysis. The left side of each carcass was physically separated into wholesale cuts, and each cut was in turn physically separated into lean, fat, and bone portions. Shank, neck, and tail weights were recorded as a combined weight but not included as a dissectible portion.

### Table 1. Concentrate diet composition

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Starter diet</th>
<th>Finishing diet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alfalfa</td>
<td>29</td>
<td>—</td>
</tr>
<tr>
<td>Whole shelled corn</td>
<td>—</td>
<td>80.5</td>
</tr>
<tr>
<td>Ground shelled corn</td>
<td>48.6</td>
<td>—</td>
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<tr>
<td>Soybean meal</td>
<td>16</td>
<td>12.7</td>
</tr>
<tr>
<td>Molasses</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Urea</td>
<td>.5</td>
<td>—</td>
</tr>
<tr>
<td>Limestone</td>
<td>.55</td>
<td>1.40</td>
</tr>
<tr>
<td>Dicalcium phosphate</td>
<td>1.10</td>
<td>1.17</td>
</tr>
<tr>
<td>Lasalocid, 149 g/kg</td>
<td>.018</td>
<td>.018</td>
</tr>
<tr>
<td>Bentonite</td>
<td>2</td>
<td>—</td>
</tr>
<tr>
<td>Propionic acid</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>Ammonium chloride</td>
<td>.5</td>
<td>.5</td>
</tr>
<tr>
<td>Trace mineral salt</td>
<td>.5</td>
<td>.5</td>
</tr>
<tr>
<td>Selenium, 201 mg of Se/kg</td>
<td>.1</td>
<td>.15</td>
</tr>
<tr>
<td>Vitamin A, 30,000 IU/g</td>
<td>.007</td>
<td>.007</td>
</tr>
<tr>
<td>Vitamin D, 3,000 IU/g</td>
<td>.018</td>
<td>.018</td>
</tr>
<tr>
<td>Vitamin E, 44 IU/g</td>
<td>.088</td>
<td>.088</td>
</tr>
</tbody>
</table>

aCalculated from NRC (1985).
component when determining bone, lean, and fat percentages in the carcass half. Those combined weights, as a percentage of total carcass side weight, were 10.2% for the initial lambs and ranged from 7.0 to 8.6% for treatment lamb carcasses. Absolute (shank, neck, and tail) weight was less ($P < .007$) for initial (540 g) than treatment (730 to 800 g) lambs, with no difference ($P > .05$) between treatment lamb carcasses. These data are not shown or included in data analysis.

Initial lamb carcass weight as a percentage of live BW was determined and used to calculate slaughter lamb initial carcass weight from initial BW according to sex. Percentage of tissue composition (bone, lean, fat) of initial lamb carcasses was used to calculate weights of bone, lean, and fat in the carcasses of individual treatment lambs at the beginning of the experiment. Total accretion of bone, lean, and fat was determined by subtracting initial from final tissue weights. Accretion rates (grams per day) of bone, lean, and fat were determined by dividing total tissue accretion by days required to finish.

Forage Management. Forages were seeded as pure stands in autumn of 1989. Nitrogen (67 kg/ha) was applied to RG replicates in April, June, and August. Phosphorus (54 kg/ha) and potassium (206 kg/ha) were applied to ALF replicates in the autumn prior to the grazing season.

Management of alfalfa and ryegrass forages was an adaptation of previous grazing research at this location (McClure et al., 1994). Alfalfa grazing was an eight paddock rotation; lambs grazed 4 to 5 d on each paddock. Ryegrass grazing was a four paddock rotation with lambs grazed 3 to 4 d on each paddock. Immediately after lambs were moved to new paddocks, sufficient numbers of mature, nonpregnant, nonlactating ewes were moved to the vacated paddocks to consume the coarse forage stubble in $\leq 1$ d. This resulted in 23 to 25 d of rest for alfalfa paddocks and 12 to 16 d of rest for ryegrass paddocks.

With the forage management system used in the present study height of alfalfa before grazing was 43 cm, and maturity was pre-bud stage, whereas height of ryegrass before grazing was 25 cm, and maturity was vegetative. When mature ewes were moved from paddocks, stubble height was 7 cm for alfalfa and 5 cm for ryegrass.

Although results are not reported in this paper, we suggest that the chemical composition and organic matter digestibilities of the alfalfa and ryegrass forages discussed in this experiment were comparable to those reported earlier from this laboratory (McClure et al., 1994).

Statistical Analysis. The data were analyzed as a completely randomized design using the GLM procedure of SAS (1988). The model for performance, carcass characteristics, carcass composition, and tissue accretion included effects due to treatment, sex, and treatment $\times$ sex. Sex within each pasture or drylot pen replicate served as an experimental unit for performance data. Lambs served as the experimental unit for carcass data. Treatment means were compared using Duncan's new multiple range test protected by a significant ($P < .05$) F-value (Snedecor and Cochran, 1980).

Results and Discussion

There were no sex $\times$ treatment interactions for lamb performance or carcass measurements. During backgrounding, both ADG and total gain were greater ($P < .03$) for wethers than for ewes (100 vs 54 g and 6.2 vs 3.4 kg). Overall, wethers gained more ($P < .02$) weight and had heavier ($P < .01$) final BW than ewes (23.8 vs 20.0 kg and 51.2 vs 47.8 kg). Daily accretion of bone, lean, and fat were greater ($P < .003$) for wethers (7.5, 21.9, 25.3 g, respectively) than for ewes (1.9, 17.0, 19.5 g, respectively).

Average Daily Gain and Feed Efficiency. Lambs placed directly in drylot with ad libitum access to the all-concentrate diet had the highest ($P < .001$) ADG (Table 2). This level of ADG (351 g) was similar to that of lambs fed similar diets (Notter et al., 1991) and higher than gains reported by others (Ely et al., 1979; Arnold and Meyer, 1988; Murphy et al., 1994). The next highest ADG was for ALF-grazed lambs (223 g), but their ADG were not different ($P > .05$) from that for lambs on RGDL. Lambs grazing RG throughout the entire experiment had lower ($P = .001$) ADG than those on DL, ALF, and RGDL.

During the background phase, when all backgrounded slaughter lambs were grazing together on ryegrass, there were no differences in lamb ADG for lambs assigned to RG, RGDL, or RGALF treatment; ADG was approximately 80 g. These were similar to gains reported by Murphy et al. (1994) during a 42-d ryegrass grazing period. We have no explanation for this relatively low ADG. During the finishing phase, lambs on the RGDL treatment gained 20.1 kg in 71 d (ADG 285 g). This gain was lower than that for DL lambs but apparently higher than for lambs finished on forage (RG and RGALF). Fewer days were required in the finishing phase for lambs switched to the concentrate diet than for lambs switched to alfalfa, and lambs switched to alfalfa required fewer days in the finishing phase than those remaining on RG throughout the trial.

Lambs on the DL treatment gained 20.3 kg in 58 d (Table 2), whereas RGDL lambs gained 20.1 kg during 71 d in drylot after gaining 4.7 kg during 62 d...
of grazing RG. During the drylot period, daily DMI
was 230 g more for RGDL treatment lambs than for
DL-fed lambs, with 39% lower feed efficiency (230 vs
140 g of gain/kg of feed) for the RGDL treatment
lambs. The level of efficiency for DL treatment lambs
was similar to that of concentrate-fed lambs in other
reports (McClure et al., 1994; Murphy et al., 1994).
Feed efficiency of RGDL lambs during finishing was
similar to that reported by Ely et al. (1979); in that
study lambs had been on bluegrass-clover pasture to
32 kg BW before being finished in drylot. Those lambs
had more efficient feed conversion when slaughtered
at 40.8 kg than when slaughtered at 49.9 kg (Ely et
al., 1979). All lambs backgrounded on ryegrass had
more total gain and heavier final BW than lambs
grazed on ALF (P < .02), and lambs on RG and RGDL
treatments had heavier final BW than DL-fed lambs.
Although the difference was not significant, lambs
backgrounded on RG had more total gain than DL-fed
lambs.

Carcass Tissue Composition and Tissue Accretion.
Subjective estimation of live fat depth over the rib
inadvertently overestimated the actual carcass fat
thickness on lambs grazed on ALF and was at the
upper limit of the desired depth on DL-fed lambs
(Table 3). However, end live weights of lambs grazed
on ALF were not different (P > .05) from those of DL-
fed lambs. Carcasses of ALF-grazed lambs were 13
and 13.3% lighter (P = .053) than those of lambs on
RGDL and RGALF treatments, respectively (Table
3). For these reasons and others, such as tissue
accretion ratios, discussed later, the relative relation-
ship of lean, fat, and bone of lambs receiving the ALF
treatment should be only slightly affected by less fat
depth.

The fat depth of carcasses of RGDL lambs did not
differ (P > .05) from those of the DL, RG, and RGALF
lambs. However, the RGDL treatment lamb carcasses
had more absolute lean (P = .001) and a higher
percentage of lean (P = .002) than DL lamb carcasses.

Table 2. Overall performance and days on test for slaughter lambs

<table>
<thead>
<tr>
<th>Item</th>
<th>DL</th>
<th>ALF</th>
<th>RG</th>
<th>RGDL</th>
<th>RGALF</th>
<th>SEM</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial wt, kg</td>
<td>27.0</td>
<td>29.0</td>
<td>26.8</td>
<td>26.9</td>
<td>28.3</td>
<td>.94</td>
<td>.320</td>
</tr>
<tr>
<td>Final wt, kg</td>
<td>47.3\textsuperscript{wx}</td>
<td>46.0\textsuperscript{x}</td>
<td>51.9\textsuperscript{y}</td>
<td>51.7\textsuperscript{y}</td>
<td>51.1\textsuperscript{yw}</td>
<td>1.5</td>
<td>.016</td>
</tr>
<tr>
<td>ADG, g</td>
<td>351\textsuperscript{v}</td>
<td>223\textsuperscript{w}</td>
<td>140\textsuperscript{y}</td>
<td>185\textsuperscript{wx}</td>
<td>148\textsuperscript{wy}</td>
<td>15</td>
<td>.001</td>
</tr>
<tr>
<td>Days on test</td>
<td>58\textsuperscript{z}</td>
<td>77\textsuperscript{y}</td>
<td>178\textsuperscript{v}</td>
<td>133\textsuperscript{x}</td>
<td>154\textsuperscript{w}</td>
<td>4.5</td>
<td>.001</td>
</tr>
<tr>
<td>DMI, kg/d\textsuperscript{d}</td>
<td>1.41</td>
<td>ND</td>
<td>ND</td>
<td>1.64</td>
<td>ND</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Gain:feed\textsuperscript{e,f}</td>
<td>230</td>
<td>ND</td>
<td>ND</td>
<td>140</td>
<td>ND</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Total gain, kg</td>
<td>20.3\textsuperscript{wx}</td>
<td>17.0\textsuperscript{w}</td>
<td>25.1\textsuperscript{v}</td>
<td>24.8\textsuperscript{y}</td>
<td>22.8\textsuperscript{w}</td>
<td>1.8</td>
<td>.014</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Dietary treatments were as follows: DL, drylot concentrate; ALF, alfalfa; RG, ryegrass; RGDL, RG 62 d then DL; RGALF, RG 62 d then ALF.
\textsuperscript{b}One slaughter lamb died during the finish phase.
\textsuperscript{c}Dry matter intake and gain:feed data reported for 71-d finishing period only.
\textsuperscript{d}Lamb numbers in each replicate: candidate, n = 6; slaughter, n = 4.
\textsuperscript{e}DMI and gain:feed were determined on candidate lambs.
\textsuperscript{f}ND = Not determined.
\textsuperscript{v,w,x,y,z}Within a row, means without a common superscript letter differ.

Table 3. Carcass characteristics of slaughter lambs

<table>
<thead>
<tr>
<th>Item</th>
<th>DL</th>
<th>ALF</th>
<th>RG</th>
<th>RGDL</th>
<th>RGALF</th>
<th>SEM</th>
<th>P-value</th>
</tr>
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<tbody>
<tr>
<td>n</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chilled carcass, kg</td>
<td>23.2\textsuperscript{xy}</td>
<td>21.5\textsuperscript{y}</td>
<td>23.5\textsuperscript{xy}</td>
<td>24.7\textsuperscript{x}</td>
<td>24.8\textsuperscript{x}</td>
<td>.87</td>
<td>.053</td>
</tr>
<tr>
<td>Leg conformation\textsuperscript{b}</td>
<td>10.7</td>
<td>10.2</td>
<td>10.9</td>
<td>11.1</td>
<td>11.2</td>
<td>.35</td>
<td>.226</td>
</tr>
<tr>
<td>Fat depth, mm\textsuperscript{c}</td>
<td>5.6\textsuperscript{x}</td>
<td>3.3\textsuperscript{z}</td>
<td>4.1\textsuperscript{yz}</td>
<td>4.6\textsuperscript{yx}</td>
<td>4.8\textsuperscript{y}</td>
<td>.38</td>
<td>.001</td>
</tr>
<tr>
<td>Rib eye area, cm\textsuperscript{d}</td>
<td>14.6\textsuperscript{x}</td>
<td>12.5\textsuperscript{y}</td>
<td>15.5\textsuperscript{x}</td>
<td>15.1\textsuperscript{x}</td>
<td>15.3\textsuperscript{x}</td>
<td>.53</td>
<td>.001</td>
</tr>
<tr>
<td>Kidney pelvic fat, %</td>
<td>3.3</td>
<td>3.0</td>
<td>3.1</td>
<td>2.9</td>
<td>3.4</td>
<td>.18</td>
<td>.326</td>
</tr>
<tr>
<td>Yield grade</td>
<td>3.8\textsuperscript{x}</td>
<td>2.9\textsuperscript{y}</td>
<td>3.1\textsuperscript{yz}</td>
<td>2.9\textsuperscript{y}</td>
<td>3.4\textsuperscript{y}</td>
<td>.14</td>
<td>.001</td>
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</table>

\textsuperscript{a}Dietary treatments were as follows: DL, drylot (concentrate); ALF, alfalfa; RG, ryegrass; RGDL, RG 62 d then DL; RGALF, RG 62 d then ALF.
\textsuperscript{b}10 = Choice− and 12 = Choice+.
\textsuperscript{c}Fat depth over the center of the longissimus muscle between the 12th and 13th ribs.
\textsuperscript{d}Within a row, means without a common superscript letter differ.
than did lambs fed concentrate diets. Furthermore, which lambs fed forage diets stored less energy as fat (Murphy et al., 1994; Weston and Margan, 1994) in agreement with studies reported by others (McClure et al., 1994; McClure et al., 1994; Poppi and McLennan, 1995).

This suggests that lambs grazing forages, ALF and RG, with RGDL and RGALF treatment groups intermediate. There were no differences in bone weights or percentages of bone in carcasses of lambs across treatments (P > .05). This is in agreement with Murphy et al. (1994).

Table 4. Lean, bone, and fat weights and percentage of composition of carcass sides of initial and experimental lambs

<table>
<thead>
<tr>
<th>Item</th>
<th>Initial</th>
<th>DL</th>
<th>ALF</th>
<th>RG</th>
<th>RGDL</th>
<th>RGALF</th>
<th>SEM</th>
<th>P value</th>
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<tr>
<td>Tissue weights, kg</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean</td>
<td>2.67z</td>
<td>4.42y</td>
<td>4.58y</td>
<td>5.14x</td>
<td>5.05x</td>
<td>5.18x</td>
<td>.26</td>
<td>.001</td>
</tr>
<tr>
<td>Bone</td>
<td>1.55y</td>
<td>2.09x</td>
<td>2.04x</td>
<td>2.20y</td>
<td>2.12x</td>
<td>2.17x</td>
<td>.10</td>
<td>.001</td>
</tr>
<tr>
<td>Fat</td>
<td>1.09y</td>
<td>3.67x</td>
<td>2.65y</td>
<td>3.15y</td>
<td>3.55x</td>
<td>3.57x</td>
<td>.28</td>
<td>.001</td>
</tr>
<tr>
<td>Tissue composition, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lean</td>
<td>51.21x</td>
<td>43.42z</td>
<td>49.48y</td>
<td>49.01xy</td>
<td>47.18y</td>
<td>47.39y</td>
<td>1.54</td>
<td>.002</td>
</tr>
<tr>
<td>Bone</td>
<td>29.73x</td>
<td>20.50y</td>
<td>22.07y</td>
<td>20.99y</td>
<td>20.04y</td>
<td>19.85y</td>
<td>1.08</td>
<td>.001</td>
</tr>
<tr>
<td>Fat</td>
<td>19.06z</td>
<td>36.08z</td>
<td>28.45y</td>
<td>30.00y</td>
<td>32.78xy</td>
<td>32.76xy</td>
<td>.88</td>
<td>.001</td>
</tr>
</tbody>
</table>

x,y,zWithin a row, means without a common superscript letter differ.

Absolute lean weight did not differ (P > .05) between DL-fed and ALF-grazed lambs (Table 4). This is consistent with data reported by McClure et al. (1994), in which lambs were slaughtered on a time constant basis, and by Murphy et al. (1994), in which lambs were slaughtered at the same final weight. However, lean tissue weight of DL-fed lambs was less (P = .001) than for RG, RGDL, and RGALF treatment lambs.

The percentage of lean in the carcass of DL-fed lambs (43.4%) was less (P = .002) than for other treatment groups. Carcass lean percentage for lambs grazing ALF (49.5%) or RG (49.0%) did not differ (P > .05) from that for initially slaughtered lambs (51.2%). These values are comparable to those reported by Murphy et al. (1994), in which carcass lean percentages were 42.5% for concentrate-fed lambs, 49.9% for initial lambs, and 48.4% for lambs grazed on alfalfa.

This suggests that lambs grazing forages, ALF and RG, were presented with a type of diet that supported carcass tissue accretion, albeit at different daily amounts, and maintained carcass lean tissue proportions the same as in initial lambs. This is consistent with studies reported by others (McClure et al., 1994; McClure et al., 1994; Weston and Margan, 1994) in which lambs fed forage diets stored less energy as fat than did lambs fed concentrate diets. Furthermore, although live ADG was greater (P = .001) for lambs grazing ALF than for lambs grazing RG, the lambs grazed on RG had longer (P = .001) days on test, more total gain (P = .014), and heavier final weights (P = .016) than lambs grazed on ALF. These differences in performance are most likely attributable to greater DMI by lambs grazing ALF than by lambs grazing RG (McClure et al., 1994; Poppi and McLennan, 1995).

Weight of carcass fat was less (P = .001) for lambs grazed on ALF than for other treatment groups except RG. The percentage of fat in the carcasses of lambs on the ALF and RG treatments was less (P = .001) than for lambs in the DL treatment group, with RGDL and RGALF treatment groups intermediate. There were no differences in bone weights or percentages of bone in carcasses of lambs across treatments (P > .05). This is in agreement with Murphy et al. (1994).

Daily accretion (g) of bone, lean, and fat was greater (P < .001) for DL lambs than for all other treatment groups (Table 5). Daily accretion of lean was greater (P = .001) for ALF-grazed lambs than for RG and RGALF treatment lambs, and daily accretion of fat was greater (P = .001) for lambs grazed on ALF than for those grazed on RG, but daily accretion of bone was not different (P > .05) among treatments that included ALF or RG grazing at some time. In the DL-fed lambs, daily accretion of fat was apparently greater than daily accretion of lean. In the other treatment groups, fat and lean were deposited at similar rates (Table 5). Although daily accretion (g) of bone was greater (P = .001) for DL-fed lamb carcasses than for the other treatment groups, daily percentage of bone accretion did not differ (P > .05) among treatments. The percentage of lean accretion was less (P < .003) for DL-fed lambs than for other groups. The percentage of fat accretion was greater (P < .004) for DL-fed lambs than for lambs grazed on ALF or RG, with RGDL and RGALF treatment groups intermediate.

Lean accretion in the leg was greater (P < .004) for DL-fed lambs than for other treatment groups (Figure 1). In all groups, lean accretion in the leg was numerically greater than fat or bone accretion. In the

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aDietary treatments were as follows: DL, drylot (concentrate); ALF, alfalfa; RG, ryegrass; RGDL, RG 62 d then DL; RGALF, RG 62 d then ALF.
Figure 1. Daily accretion of lean, fat, and bone in lamb carcass leg, shoulder, loin, rack, and breast. Dietary treatments were as follows: DL, drylot (concentrate); ALF, alfalfa; RG, Ryegrass; RGDL, RG 62 d then DL; RGALF, RG 62 d then ALF. Means depicted by bars within a primal cut and within lean, fat, and bone components without a common letter differ (P < .004).

shoulder and breast, lean accretion did not differ (P > .05) between DL and ALF lambs, but lean accretion in the shoulder was greater (P = .004) for DL lambs than for the RG, RGDL and RGALF groups. Daily accretion of fat in all of the primal cuts was greater (P < .004) for DL lambs than for other treatment groups. In loin, rack, and breast, daily accretion of fat was apparently more than that of lean, but the most exaggerated fat accretion was in DL-fed lambs.

Lambs that grazed on ALF and RG treatments had higher (P < .014) carcass lean:fat ratios (g/d) than the DL treatment lambs, with the RGDL and RGALF treatment groups intermediate (Figure 2). These results support observations by others that forage feeding results in less fat accumulation in lamb carcasses. Ely et al. (1979) observed that lambs grazing bluegrass-white clover pasture and supplemented with concentrate had leaner carcasses than
counterparts fed concentrate in drylot. Weston and Margan (1994) concluded that energy from protein contributed more to energy balance with forage diets than with concentrate diets when environmental conditions and energy storage rates were held relatively constant. Carcasses were observed to be fatter when lambs were allowed ad libitum access to concentrate diets in drylot compared with grazing alfalfa when the experimental end point was either time constant (McClure et al., 1994) or weight constant (Murphy et al., 1994). Karnezos et al. (1994) observed that lambs grazed on alfalfa and supplemented with corn had 30% more backfat thickness than their unsupplemented counterparts when slaughtered at a constant time.

Results of this experiment demonstrate that when slaughter end point was based on live subjective fat over the rib, lambs grazed on RG during some portion of their finishing period had heavier final BW than lambs fed in drylot. Carcass yield grades were higher for drylot lambs than for other treatment groups, indicating they had fatter carcasses. Those lambs had lower absolute lean weight than did the other groups, except ALF lambs. Percentage of lean was less for

![Figure 2. Daily accretion lean to fat ratio in lamb carcass primal cuts. Dietary treatments were as follows: DL, drylot (concentrate); ALF, alfalfa; RG, ryegrass; RGDL, RG 62 d then DL; RGALF, RG 62 d then ALF. Means depicted by bars within a primal cut without a common letter differ ($P < .04$).](image)
DL-fed lamb carcasses than for other treatment
groups. This is inconsistent with the conclusion that
carcass fat percentage is directly related to carcass
weight (Lambuth et al., 1970; Kemp et al., 1976). It is
apparent from this experiment that high ADG and
feed efficiency do not correspond with maximizing
muscle accretion and minimizing fat accretion. These
are important measures of total productivity, but type
and quantity of tissue accretion need to be considered
as well.

Implications

Early-weaned lambs fed all-concentrate diets with
ad libitum access have high daily gains and deposit
bone, lean, and fat rapidly; however, this excessive
energy intake results in disproportionate fat accretion.
When slaughtered at the same market body condition,
lambs grazed or backgrounded on ryegrass have lower
daily gains, slower accretion of body tissues, heavier
final weights and more carcass lean than lambs placed
in drylot and fed a high concentrate diet immediately
following weaning. Lambs grazed on alfalfa finish
sooner than those grazed on ryegrass but have similar
carcass lean and fat. Alfalfa-grazed and concentrate-
fed lambs have similar final weights, carcass weights,
and carcass lean, but alfalfa-grazed lambs have less
carcass fat.

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