Technical note

Effect of whole and rolled corn or barley on growth and carcass quality of lambs

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Abstract

Lambs were assigned to a $2 \times 2$ factorial design with corn or barley fed either whole or rolled. Hay was fed for ad libitum intake while concentrates were fed in similar amounts. Dry matter intake of hay, ADG, the gain:feed ratio, and warm carcass weight (WCW) were higher ($P < 0.05$) for lambs fed corn than for those fed barley. Cereal processing had no effect ($P > 0.05$) on hay dry matter intake, ADG, the gain:feed ratio, and WCW. Time of fattening (23–46 kg) was similar ($P > 0.05$) among treatments. Carcass characteristics generally were similar among treatments. Corn was more beneficial than barley to increase the ADG and carcass weight. Crown Copyright © 2000 Published by Elsevier Science B.V. All rights reserved.

Keywords: Lambs; Carcass; Grain; Processing

1. Introduction

Extensive processing such as grinding generally increases ruminal degradability and digestion of cereal starch (Theurer, 1986). However, grinding can have negative effects on carcass quality as it results in more rapid starch fermentation in the rumen and increased production of branched chain fatty acids that leads to soft carcass fat syndrome in lambs fed barley (Duncan, 1974). On the other hand, feeding whole compared to ground cereals decreases rate of starch ruminal fermentation, which in turn increases ruminal pH and decreases propionic acid production, overall resulting in increased eating and ruminating times by lambs and improved carcass fat quality (Ørskov et al., 1974). Whole cereal grains can appear in the faeces of sheep, but the fibre of the digested grain is usually digested more completely so that the net effect is often an increase rather than a decrease in digestibility (Tait and Bryant, 1973).

Corn and barley are the main cereals used in the diet of growing lambs in Eastern Canada. Starch of corn is less ruminally degradable than that of barley (Herrera-Saldana et al., 1990) and its digestibility generally increases following processing while that of barley does not change (Theurer, 1986). Moreover, Economides et al. (1990) reported no effect of grain processing on weight gain of growing lambs fed a concentrate based on barley. The effects of cereal processing on weight gain and carcass quality could...
then depend on grain source. There is little information on the effect of cereal processing on the performance and carcass quality of growing lambs fed high amounts of grain at restricted level and ad libitum intake of hay. Feeding forage could help in improving ruminal fermentation and maintaining a more stable ruminal pH (Ørskov and Fraser, 1975), thus partly compensating for the negative effects obtained when feeding high amounts of concentrate. Therefore, the objectives of this experiment were to compare the effects of feeding either whole or rolled barley or corn to lambs fed similar amounts of concentrate with ad libitum access to hay on animal performance and carcass characteristics.

2. Materials and methods

2.1. Animals

44 Suffolk and Hampshire crossbred male lambs and 36 Suffolk and Hampshire crossbred female lambs were obtained from 15 local producers. All the lambs were born between September 19 and November 20, 1997 and were weaned at 60 d of age. Upon arrival, all lambs received a 2-ml intramuscular injection of antibiotic (Liquamycin©, Rogar/SDI, Montreal, QC, Canada) to prevent shipping fever and were allowed ad libitum access to a medium quality timothy hay cut at midbloom stage until beginning of the experiment on January 15, 1998. Lambs were allotted randomly to eight pens (2.6 m × 2.0 m) of four male lambs per pen and 12 pens of three female and one male lambs. Each pen provided adequate feeding space and drinking facilities. Straw was used for bedding. Animals were cared for according to the guidelines of the Canadian Council on Animal Care (1980).

2.2. Diets

The four diets consisted of either corn or barley fed whole or rolled mixed with a protein supplement. Each diet contained 73% cereal and 27% of protein supplement. Protein supplements for the corn and barley diets contained on an air-dry basis, respectively, 60.0% and 42.2% soybean meal, 17.5% and 47.8% oats, 15.0% and 0% canola meal, 0% and 2.5% groats, 2.5% and 2.5% molasses, 5.0% and 5.0% minerals. All diets were designed to provide similar CP (16.0% of hay dry matter (DM)) and energy (2.70 Mcal/kg of DM) concentrations and were formulated to meet the NRC requirements (National Research Council, 1985). Hay was harvested at the boot stage at the beginning of June, 1997, and averaged 28% ADF. Hay was fed once daily in quantities to allow daily orts of 5–10%. Orts consisted only of hay because the concentrates were adjusted on a weekly basis to ensure a total consumption similar among treatments. Lambs had access to two different feeders, one for hay and the other for concentrate. Hay refusals were weighed every 2 weeks with fresh hay weighed and added daily. Samples of feed were taken weekly and frozen for chemical analyses.

2.3. Management

Pens were assigned randomly to a 2 × 2 factorial arrangement of treatments consisting of two different grains and two types of processing, with two pens of males and three pens of three females and one male per treatment. Lambs were weighed every 2 weeks. Feed was withheld overnight before initial and final weighings. The lambs were fed from an initial weight of approximately 23 kg to a slaughter weight of approximately 47 kg live weight. Average age of lambs at the beginning of the feeding period was 80 d. Intake and gain:feed were determined on a pen basis.

2.4. Carcass data

Lambs were shipped to a commercial abattoir when they reached the assigned slaughter weight of 47 kg. Time required to reach that BW was recorded and slaughter data were collected on warm carcasses. Carcass data obtained included: warm carcass weight (WCW), dressing percentage, total tissue depth (TTD), carcass lean yield, and conformation. Total tissue depth was measured with a steel ruler on the left carcass side, between the 12th and 13th ribs and 11 cm from the carcass midline. Grade reading (GR) was obtained by the equation: \( GR = [6.38 + (0.88 \times TTD)] \) (Anonymous, 1992). Carcass lean yield was estimated from WCW and GR by the regression equation: carcass lean yield (\%) = \[ (65.80 - (0.074 \times WCW) - (0.432 \times GR)) \] (Anonymous, 1992). Muscular
development was coded as: 1, extremely deficient; 2, deficient; 3, moderate; 4, good; and 5, excellent (Anonymous, 1992). No problems with feet, legs, stiffness, or health of the lambs were noticed. Only one male lamb died during the experiment due to urinary calculi.

2.5. Statistical procedures

Intake and gain:feed were determined on a pen basis, whereas data on growth and carcass were determined for each lamb. All data were subjected to analysis of variance using the GLM procedures of SAS Institute (1988) according to a $2 \times 2$ factorial design with pen used as the experimental unit for intake, gain:feed, BW, ADG and carcass characteristics; when pen effect was not significant for BW, ADG, and carcass characteristics, lamb was used as the experimental unit (Montgomery, 1984). Data on carcass measurements were analysed using slaughter weight as covariant. Significance was declared ($P < 0.05$) unless noted otherwise.

3. Results and discussion

Intake of concentrate DM was similar among treatments as planned (Table 1). Dry matter intake of hay was significantly higher for lambs fed corn than for those fed barley, which could be explained by the fact that starch is more ruminally degradable in barley than in corn (Herrera-Saldana et al., 1990); this might lead to a lower ruminal pH with barley than with corn-based diets, resulting in a lower cellulolytic bacteria count (Mann and Ørskov, 1975) and decreased digestibility (Noon et al., 1998). According to Ørskov and Fraser (1975), higher voluntary intake of dried grass when feeding less ruminal degradable starch would result in greater ruminal pH and more forage DM being digested in the rumen of sheep. As there was no

Table 1
Voluntary intake, gain:feed, body weight, ADG, and carcass characteristics of lambs fed corn or barley either whole or rolled with ad libitum feeding of hay

<table>
<thead>
<tr>
<th>Cereal</th>
<th>Treatment</th>
<th>$P$ value</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corn</td>
<td>Barley</td>
<td>Whole</td>
</tr>
<tr>
<td>DM intake (g/d)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrate</td>
<td>1106</td>
<td>1118</td>
<td>1108</td>
</tr>
<tr>
<td>Hay</td>
<td>180</td>
<td>149</td>
<td>172</td>
</tr>
<tr>
<td>Total</td>
<td>1286</td>
<td>1267</td>
<td>1280</td>
</tr>
<tr>
<td>Initial BW (kg)</td>
<td>25.1</td>
<td>25.1</td>
<td>25.0</td>
</tr>
<tr>
<td>Final BW (kg)</td>
<td>47.4</td>
<td>46.6</td>
<td>47.0</td>
</tr>
<tr>
<td>ADG (g/d)</td>
<td>362</td>
<td>332</td>
<td>347</td>
</tr>
<tr>
<td>Gain:feed (kg/kg of DM)</td>
<td>0.287</td>
<td>0.262</td>
<td>0.276</td>
</tr>
<tr>
<td>Time of fattening (d)</td>
<td>62.8</td>
<td>66.1</td>
<td>64.6</td>
</tr>
<tr>
<td>Carcass weight (kg)</td>
<td>22.8</td>
<td>21.9</td>
<td>22.2</td>
</tr>
<tr>
<td>Dressing (%)</td>
<td>48.0</td>
<td>47.3</td>
<td>47.4</td>
</tr>
<tr>
<td>TTDab (mm)</td>
<td>13.0</td>
<td>12.1</td>
<td>11.9</td>
</tr>
<tr>
<td>Carcass lean yieldac (%)</td>
<td>56.4</td>
<td>56.8</td>
<td>56.9</td>
</tr>
</tbody>
</table>

a Adjusted using slaughter weight as a covariant.
b TTD: total tissue depth on the left carcass, between the 12th and 13th ribs, and 11 cm from the carcass midline.
c Estimated lean yield \( \% = [65.80 - (0.074 \times WCW)] - (0.432GR), \) where \( GR = [6.38 + (0.88 \times TTD)] \).
d Conformation: coded 1, 2, 3, 4, and 5 to represent extremely deficient, deficient, moderate, good, and excellent muscling.
difference in DM intake of hay between whole and
rolled cereals, this would suggest that the effect of
the type of cereal used in the present experiment was
greater than the one due to grain processing. Total
daily DM intake was similar among treatments, which
is in agreement with the results of Ørskov and Fraser
(1975) who observed no difference in hay plus grain
intake between whole and processed barley based-
diets when dried grass was fed for ad libitum intake.

Initial and final BW were similar among treatments
(Table 1). Lambs fed corn had a higher ADG than
those fed barley. Higher DM intake of hay for lambs
fed corn compared to those fed barley could have
maintained a more stable ruminal pH, contributing to
increase the ADG. Moreover, higher digestibility of
corn- than barley-based diets by calves has been
shown to result in greater ADG (Noon et al., 1998).
Cereal processing had no effect on ADG and the
gain:feed ratio in agreement with Ørskov et al.
(1974) who found no difference between lambs fed
restricted amounts of whole and ground-pelleted
grains. Similar conformation were reported by Economides
et al. (1990) for lambs fed ad libitum intake of barley-
based concentrates. The gain:feed ratio was signifi-
cantly greater for lambs fed corn than for those fed
barley, indicating that lambs fed corn required less kg
of DM per kg of gain.

Time of fattening was similar among treatments
although lambs fed corn tended ($P = 0.13$) to require
less days to reach market weight as a result of sig-
nificantly higher ADG. Carcass weight was signifi-
cantly higher for lambs fed corn compared to those fed
barley as previously observed for veal calves (Noon
et al., 1998). There was no difference in carcass weight
due to cereal processing. Dressing percentage, TTD,
 carcass lean yield, and back fat were all similar among
treatments. Conformation of hind leg roast was better
for lambs fed whole than rolled corn while the inverse
was observed for lambs fed barley, which resulted in a
significant interaction between cereal and processing.
Conformation of loin tended ($P = 0.10$) to be
improved by feeding corn compared to barley but
there was no difference due to cereal processing.
Shoulder conformation was better for lambs fed whole
than rolled corn while there was no difference for
lambs fed barley, which resulted in an interaction
between cereal and processing. In general, corn-based
compared to barley-based diets result in better carcass
conformation of veal calves (Noon et al., 1998) as
observed for lambs in the present experiment. Feeding
high levels of concentrate (>400 g/d) usually result in
similar carcass characteristics (Petit and Castonguay,
1994).

4. Conclusion

There was no advantage of feeding rolled compared
to whole corn or barley on the performance of growing
lambs. However, feeding corn increased the ADG and
carcass weight and tended to reduce time required to
reach market weight. Hay DM intake was higher for
lambs fed corn compared to those fed barley, which
could have contributed to maintain a more stable
ruminal fermentation and result in better animal per-
formance.

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