Feed intake and performance of growing lambs raised on concentrate-based diets under cafeteria feeding systems

A. B. Rodríguez†, R. Bodas, B. Fernández, O. López-Campos, A. R. Mantecón and F. J. Giráldez

Estación Agrícola Experimental (CSIC), Finca Marzanas, Grulleros, 24346 León (Spain)

(Received 31 March 2006; Accepted 6 November 2006)

Two trials were undertaken to study the effects of cafeteria feeding systems on the feed intake, animal performance and carcass characteristics of growing lambs. Trial 1 was designed to compare conventional and cafeteria feeding systems in terms of the growth of individually reared lambs. For this assay, 26 weaned Merino lambs (15.5 ± 0.20 kg live weight) were assigned to three dietary treatment groups: (1) a control group fed barley straw and commercial concentrate under a conventional feeding system, (2) group W100S, fed soya-bean meal, whole barley grain and a mineral-vitamin supplement under a cafeteria feeding system, and (3) group W100S-T, fed as in the W100S treatment but allowing the lambs an initial training period so they could learn to identify a number of feeds. The feeding system had no significant effect (P > 0.05) on either average daily live-weight gain, carcass weight, or carcass conformation. The food conversion ratio was lower (P < 0.05) for the cafeteria-reared animals (2.9 ± 0.16 v. 2.5 ± 0.08 g dry-matter intake per g average daily gain) than those of the control group. This might be related to the higher crude protein intake seen in the cafeteria groups (150 ± 5.6 v. 208 ± 12.5 g per animal per day; P < 0.001).

In trial 2, cafeteria and conventional feeding system were compared in terms of the growth of feedlot lambs. Two hundred weaned Merino lambs (13.1 ± 0.10 kg) were divided into two experimental groups: (1) a control group, offered commercial concentrate and barley straw, and (2) a cafeteria group fed the same diet as W100ST in trial 1. The average daily gain (282 ± 5.8 and 309 ± 6.5; P < 0.01) was greater in the cafeteria than in the control group. Whereas neither carcass conformation nor fatness were affected by the feeding system, the dressing percentage was slightly higher (P > 0.001) in the conventional than in the cafeteria system lambs.

The use of cafeteria systems for fattening lambs can improve the feed conversion efficiency and body growth rate over those achieved with conventional feeding systems, although the crude protein intake in these systems seems to be in excess of requirements.

Keywords: barley, carcass composition, food preferences, lambs, training of animals

Introduction

In Mediterranean countries, lambs are traditionally slaughtered for consumption at a low body weight (25 to 30 kg) (Sanudo et al., 1996; Russo et al., 2003). The production of fattening lambs commonly occurs on big farms where animals are usually fed cereal straw and concentrate ad libitum. When such feeding systems are employed, straw intake is very low, usually less than 15% of the diet (Manso et al., 1998; Landa et al., 2001).

Even though straw makes up a low proportion of the diet, its use has an important impact on the economy of farms since large facilities are required for its storage. Moreover, this feed is usually manually distributed, which has a negative effect on labour costs. Removing cereal straw from the diet would therefore offer a way of reducing both labour and storage costs. Several studies have shown that straw could be completely removed from the diet of fattening lambs with no negative impact on animal performance if whole cereal is provided (Tait and Bryant, 1973; Landa et al., 2001; Cañequé et al., 2003).

When concentrate is not pelleted or ground, animals can select among the different ingredients; the composition of the concentrate can therefore change over the day. The efficient selection of the different ingredients would probably not be a problem with individually penned animals, as has been shown in most experimental trials. However, in feedlot systems, the opportunities for dietary selection would not be the same for all animals and this could affect animal performance and carcass quality. An alternative

†E-mail: rganabel@hotmail.com
would be to use a cafeteria system, in which the composition of the offered foods would not change over time. Recently, Sahin et al. (2003) reported that Awassi lambs raised under a cafeteria feeding system successfully selected the diet to match their nutritional requirements and showed a performance similar to lambs raised under a conventional feeding system. Similar results have been reported by Görgülü et al. (1996) and Kyriazakis and Oldham (1993).

The literature on diet selection in growing lambs mainly refers to animals older than 3 months; studies performed with lambs during the period immediately after weaning are scarce. In addition, although a training period was allowed in some of these studies, it would be better to avoid this under commercial conditions. The aim of the present work was to compare food intake and animal performance during the period immediately after weaning in lambs reared under conventional and cafeteria feeding systems, with and without a training period.

Material and methods

Animals and diets
This study involved two trials. Trial 1 involved 26 male Merino lambs weaned at approximately 6 to 7 weeks of age. Creep feeding was made available from 3 weeks of age. Prior to weaning, the animals were dewormed by dosing with Ivomec (Merial Labs, Spain), and vaccinated against enterotoxaemia (Miloxan, Merial Labs, Spain). At weaning, the animals were weighed and housed individually in similar 1.5 x 1.5 m pens in a naturally ventilated animal house. They were then assigned to one of three feeding systems groups until they reached a target slaughter weight of 25 kg; (1) a control group (no. = 10) offered barley straw and a commercial pelleted concentrate ad libitum in different troughs. The concentrate consisting of (per kg dry matter) 460 g barley, 210 g soya-bean meal (SBM), 120 g maize, 100 g oat, 50 g bran, 14 g molasses, 16 g bypass fat and 30 g mineral-vitamin mix; (2) group W100S (no. = 8), fed whole barley grain (WBG), SBM and a mineral-vitamin mix (ad libitum in three separate troughs) and (3) W100S-T (no. = 8), fed the same as the W100S group with the animals allowed an initial training period of 4 days. The mean live weight (LW) of animals in each group was similar (15.5 ± 0.20 kg). The position of the troughs for each feed was randomly assigned across pens; this order remained unchanged during the trial. During the training period, half of the lambs had access to WBG for 2 days and to SBM for the following 2 days. The remaining animals were fed the same feeds but in the opposite order. After training, the W100S-T lambs had free access to the different feeds.

Trial 2 was designed to evaluate the efficacy of the cafeteria system under commercial conditions. In this experiment, 200 weaned Merino lambs, half males (mean LW 13.1 ± 0.10 kg) and half females (mean LW 13.0 ± 0.09 kg), were distributed into two groups (50 : 50 male-female). The control group was fed commercial concentrate and barley straw ad libitum. The cafeteria group was given ad libitum and separately WBG, SBM and vitamin-mineral supplement. Each group was housed in an 8 x 10 m floor pen containing two metal troughs for offering the different feeds. In the cafeteria pen, another smaller feeder was included for providing the vitamin-mineral supplement. Table 1 shows the chemical composition of the experimental feeds used in both trials.

Experimental procedure

Trial 1 was performed between March and April under natural daylight and temperature conditions at the research farm of the Experimental Agriculture Station (EAE; belonging to the Spanish Council for Scientific Research (CSIC)) in León, Spain. Animal handling followed the recommendations of the European Commission (2003).

The experimental feeds were offered unmixed once a day. The quantities of the different feeds offered and refused were weighed daily and samples were collected for analyses. The amount of feed offered was adjusted every day on the basis of the previous day’s intake; with refusals of 15 to 20% of the maximum previous intake allowed (all animals complied). LW was recorded three times per week before morning feeding. Lambs were slaughtered individually when each lamb reached an LW of 25 kg. Slaughter was carried out by anaesthetisation with sodium pentobarbital and desanguination via the jugular vein. They were then skinned and eviscerated. The body of each lamb was dissected into carcass and non-carcass and the weights of the different components recorded. The carcass was chilled at 4°C for 24 h and then weighed again (cold carcass weight: CCW). The dressing percentage was calculated as the CCW expressed as a proportion of the slaughter weight. Carcasses were scored visually for conformation (1 = poor, 5 = excellent) (Colomer-Rocher et al., 1988) and for external fatness (1 = limited, 4 = important) according to European Commission (1994). The carcass compact index was calculated.

Table 1 Chemical composition (g/kg DM) of the experimental feeds used in trials 1 and 2

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>NDF</th>
<th>Ash</th>
<th>EE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trial 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrate</td>
<td>175</td>
<td>159</td>
<td>84</td>
<td>45</td>
</tr>
<tr>
<td>Barley straw</td>
<td>35</td>
<td>813</td>
<td>47</td>
<td>12</td>
</tr>
<tr>
<td>Whole barley</td>
<td>124</td>
<td>213</td>
<td>26</td>
<td>25</td>
</tr>
<tr>
<td>Soya-bean meal</td>
<td>470</td>
<td>118</td>
<td>81</td>
<td>11</td>
</tr>
<tr>
<td>Trial 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concentrate</td>
<td>167</td>
<td>174</td>
<td>70</td>
<td>31</td>
</tr>
<tr>
<td>Barley straw</td>
<td>21</td>
<td>797</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>Whole barley</td>
<td>114</td>
<td>188</td>
<td>23</td>
<td>26</td>
</tr>
<tr>
<td>Soya-bean meal</td>
<td>468</td>
<td>135</td>
<td>71</td>
<td>11</td>
</tr>
</tbody>
</table>

CP: crude protein; NDF: neutral detergent fibre; EE: ether extract.
by dividing the CCW by the carcass external length, and
the buttck/pelvic limb ratio by dividing the buttck width
by the pelvic limb length (Colomer-Rocheret al., 1988).

Trial 2, which lasted 52 days, was conducted on a com-
mercial farm. Animals were assigned to two floor pens in
a semi-open and naturally ventilated animal house. Except
for the straw, all feeds were provided using an automatic
distribution system. In the Control group, the straw was
distributed daily by the farm workers. Refused feed was
removed and weighed weekly. Samples of the offered and
refused feeds were taken every week and analysed for
their dry matter content. The mean daily feed intake for
the whole fattening period was calculated by dividing the
total feed intake by the product of the number of lambs
and the number of days of the trial. During the trial, all
lambs were individually weighed once a week according
to the procedure of the farm. On day 38, all animals
showing a LW of > 25 kg were transferred to a commer-
cial abattoir and slaughtered. The remaining animals were
slaughtered at the end of the experimental period
day 52). CCW was recorded 24 h after slaughter. Carcass
conformation, compactness and fatness were determined
as described in trial 1.

**Analytical procedures**

The procedures outlined by the Association of Official Ana-
lytical Chemists (2003) were used to determine the dry
matter (DM, method ID 934.01), ash (method ID 942.05),
Kjeldahl N (CP, method ID 984.13) and crude fat content
(method ID 960.39) of the offered feeds. Neutral-detergent
fibre (NDF) was determined by the procedure of Van Soest
et al. (1991), using sodium sulphite in the neutral-deter-
genent solution. Alpha-amylase was only included in the NDF
assay for WBG and SBM.

**Table 2 Feed intake, average daily weight gain (ADG) and feed to gain ratio (FCR) of lambs individually reared (trial 1) on conventional (control group) or cafeteria (W100S and W100S-T groups) feeding systems**

<table>
<thead>
<tr>
<th></th>
<th>Control (n = 10)</th>
<th>W100S (n = 8)</th>
<th>W100S-T (n = 6)</th>
<th>Residual s.d.</th>
<th>Significance \†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry-matter intake</td>
<td>889</td>
<td>835</td>
<td>795</td>
<td>101.1</td>
<td></td>
</tr>
<tr>
<td>Organic-matter intake</td>
<td>817</td>
<td>773</td>
<td>722</td>
<td>95.8</td>
<td>t</td>
</tr>
<tr>
<td>Concentrate intake</td>
<td>850</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Barley straw (g/day)</td>
<td>39.1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Whole barley grain intake (g/day)</td>
<td>–</td>
<td>535</td>
<td>353</td>
<td>94.4</td>
<td>*</td>
</tr>
<tr>
<td>Soya-bean meal intake (g/day)</td>
<td>–</td>
<td>271</td>
<td>408</td>
<td>95.3</td>
<td>–</td>
</tr>
<tr>
<td>Mineral-vitamin mix intake (g/day)</td>
<td>–</td>
<td>29.0</td>
<td>35.1</td>
<td>7.4</td>
<td>–</td>
</tr>
<tr>
<td>Food conversion ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g DMI per g ADG</td>
<td>2.91</td>
<td>2.58</td>
<td>2.40</td>
<td>0.463</td>
<td>*</td>
</tr>
<tr>
<td>g CP per g ADG</td>
<td>0.49</td>
<td>0.60</td>
<td>0.71</td>
<td>0.108</td>
<td>**</td>
</tr>
<tr>
<td>Average daily gain (ADG, g/day)</td>
<td>312</td>
<td>324</td>
<td>334</td>
<td>50.0</td>
<td></td>
</tr>
<tr>
<td>Days on trial</td>
<td>31.5</td>
<td>31.3</td>
<td>34.6</td>
<td>7.57</td>
<td></td>
</tr>
</tbody>
</table>

\† P1 = probability for control v. cafeteria contrast; P2 = probability for W100S v. W100S-T contrast.

\* Approaching significance (P < 0.10).

**Calculations and statistical analysis**

Diet selection patterns were traced by plotting the cumu-
lative difference between the intakes of WBG and SBM
(CD = WBG - SBM) against the cumulative feed intake
(CFI = WBG + SBM), as described by Kyriazakis et al.
(1990). The crude preference values were calculated divid-
ing the consumption of SBM by the total feed consumption
(WBG + SBM) as described Robertson et al. (2006). Daily
weight gain was estimated as the regression coefficient of
the LBW against time (using the REG procedure; Statistical
Analysis Systems Institute (SAS), 1999). Data were ana-
ysed by one-way ANOVA to determine the effects of the
feeding systems, recognising that, in trial 2 feeding system
was confounded totally with pen. In trial 1, orthogonal
contrasts were used to test the differences between the
control and cafeteria feeding (control v. W100S + W100S-
T) groups, or between the two cafeteria groups (W100S v.
W100S-T). All analyses were performed using the GLM pro-

**Results**

In trial 1, two lambs in the W100S-T group had to be
removed due to leg lesions; their data were excluded from
analysis. Intake of organic matter tended (P < 0.083) to be
greater in the control group than in the cafeteria groups
(Table 2). No significant (P > 0.05) differences were seen
among dietary treatments in daily LW gain. Nevertheless,
the feed/LW gain ratio was significantly influenced
(P < 0.05) by the feeding system, with the lowest values
Corresponding to the W100S and W100S-T groups. Control
lambs utilised CP more efficiently than those in the cafe-
teria groups (P < 0.01, Table 2).

As expected, the concentrate formed the major com-
ponent of the control group diet, straw intake making
up < 10%. The lambs that underwent a training period
consumed a greater proportion of SBM and lower of WBG than W100S lambs. The mean percentage intake values for WBG, SBM and mineral-vitamin mix for the entire experimental period were, respectively, 63.1 (s.e. 3.96), 32.9 (s.e. 4.09) and 4.0 (s.e. 0.44) for the W100S group, and 42.7 (s.e. 2.27), 51.0 (s.e. 2.28) and 6.3 (s.e. 1.01) for the W100S-T group. The crude preference values for SBM in W100S and W100S-T treatments were 0.34 (s.e. 0.043) and 0.55 (s.e. 0.025) respectively.

Figures 1 and 2 show there was a strong individual variation in the diet selection pattern. In the W100S group, most of the lambs consumed more WBG than SBM from the beginning to the end of the experimental period, although the percentage of WBG varied between 47 and 77%. In the W100S-T group, most of lambs showed a preference for the SBM, but its percentage contribution to the selected diet also varied over a wide range (41 to 60%).

In trial 1, differences in the dressing percentage between the control and cafeteria group showed a trend towards significance ($P = 0.09$). Control animal tended to have higher dressing percentage than cafeteria animals (Table 3). No significant differences or trends ($P > 0.10$) were observed between feeding systems in terms of carcass conformation, compactness or fatness.

The feeding system did not affect ($P > 0.05$) the blood or white and red offal weights (see Table 3). Nevertheless, the weights of the digestive fat deposits were greater and the wool weight lower (both $P < 0.05$) in the control group than in the cafeteria system animals.

In Trial 2, the mean values for total DM intake for the control and cafeteria animals were 898 and 830 g DM per animal per day, respectively. Figure 3 shows the trend in the diet selection pattern of the cafeteria group. The figure shows the animals to have a slight preference for SBM. The proportions of the different feed ingredients in the diet consumed by the cafeteria lambs were: 46% WBG, 51% SBM, and 3% mineral-vitamin mix. The average LW gain was 9% greater ($P < 0.001$) for the lambs in the cafeteria-fed pen than the lambs in the control pen.

Carcass conformation, compactness and fatness were not significantly affected by the feeding system ($P < 0.05$, Table 4).

**Discussion**

It has been suggested that, given the choice, animals try to minimise excess nutrient intake in order to maximise feed efficiency (Arsenos and Kyriazakis, 1999; Ferguson et al., 1999). Therefore, according to theoretical nutritional requirements, it would be expected that lambs in the cafeteria feeding system would consume higher proportions of WBG than protein supplement since 20% SBM would provide enough protein to meet their requirements. Nevertheless, the pattern of diet selection of the cafeteria feeding lambs did not support this hypothesis. In fact, although the W100S lambs showed a moderate preference for WBG, the consumption of SBM was greater than expected. Consequently, in the present study, the protein supply in the cafeteria feeding systems was theoretically in excess of the animals’ tissue requirements (Agricultural and Food Research Council, 1995) and the efficiency of utilisation of CP, in terms of LW gain, was worse in these groups than in the control group.

The training period did not reduce the trend for high protein intake by lambs reared under the cafeteria feeding systems. On the contrary, the animals of this group consumed a greater amount of SBM and therefore protein supply was also higher. Obviously, it is possible that the training period was insufficiently long to teach the animals the different post-ingestion effects of the different foods. However, Keskin et al. (2004), who used a training period longer than that of the present study, also observed that lambs reared in a cafeteria feeding system consumed more protein than those fed the same ingredients in a mixed feed. Similar results were reported by Fedele et al. (2002) in goats. Moreover, Tolkamp and Kyriazakis (1997) reported that, in dairy cows, a training period did not result in a more consistent diet choice after the adaptation period.
In the present study, however, it is plausible that the high protein intake was beneficial to the lambs and hence they selected a CP-rich diet. Lambs in the cafeteria groups consumed large amounts of starch-rich feeds, the mean values for starch intake being 490 (s.e. 24.8) g DM per day and 483 (s.e. 26.0) g DM per day for the W100S and W100S-T animals respectively (estimated data from Ministry of Agriculture, Fisheries and Food (1992)). This high intake can produce digestive disorders such as ruminal acidosis (Fraser and Ørskov, 1974; Gaebe et al., 1998; Bodas et al., 2006) and it has been suggested that high levels of rumen degradable protein in the diet might help maintain a higher ruminal pH (Van Soest, 1994). This feeding behaviour is in agreement with evidence suggesting that the objective of sheep, when selecting diets, is to achieve a high nutrient intake while maintaining a stable ruminal environment (Cooper et al., 1996; James et al., 2002).

It has been shown (James et al., 2002) that, in free choice systems, the intake of urea-supplemented diets seems to be reduced by the addition of a buffer such as sodium bicarbonate. This suggests that lambs might select diets with a high degradable protein content to reduce ruminal acidosis. However, as for protein intake excess, an excess of starch could induce negative post-ingestion consequences and lead to an aversion (Provenza, 1996; Arsenos and Kyriazakis, 1999). Arsenos and Kyriazakis (1999) reported that sheep can develop a conditioned aversion to casein, which is rapidly degraded to ammonia in the rumen. As a consequence, the diet selection pattern of the lambs might be partly associated with gradual changes in the degree of preference/aversion towards WBG and SBM.

**Table 3** Carcass and non-carcass characteristics of lambs individually reared (trial 1) on conventional (control group) or cafeteria (W100S and W100S-T groups) feeding systems

<table>
<thead>
<tr>
<th>Carcass characteristics</th>
<th>Control (n = 10)</th>
<th>W100S (n = 8)</th>
<th>W100S-T (n = 6)</th>
<th>Residual s.d.</th>
<th>Significance†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold carcass weight (kg)</td>
<td>11.85</td>
<td>11.46</td>
<td>11.38</td>
<td>0.650</td>
<td>P1</td>
</tr>
<tr>
<td>Dressing percentage (%)</td>
<td>47.6</td>
<td>45.8</td>
<td>45.6</td>
<td>2.46</td>
<td>P2</td>
</tr>
<tr>
<td>Carcass conformation (1–5)</td>
<td>2.90</td>
<td>2.75</td>
<td>2.60</td>
<td>0.422</td>
<td></td>
</tr>
<tr>
<td>Carcass fatness (1–4)</td>
<td>2.80</td>
<td>2.88</td>
<td>2.60</td>
<td>0.426</td>
<td></td>
</tr>
<tr>
<td>Carcass kidney knob channel fat (g)</td>
<td>229</td>
<td>188</td>
<td>160</td>
<td>81.1</td>
<td></td>
</tr>
<tr>
<td>Carcass compact index (g/cm)</td>
<td>229</td>
<td>226</td>
<td>217</td>
<td>13.8</td>
<td></td>
</tr>
<tr>
<td>Buttock/pelvic limb ratio (cm/cm)</td>
<td>0.65</td>
<td>0.68</td>
<td>0.70</td>
<td>0.052</td>
<td></td>
</tr>
<tr>
<td>Non-carcass characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Blood (g)</td>
<td>1219</td>
<td>1213</td>
<td>1255</td>
<td>64.0</td>
<td></td>
</tr>
<tr>
<td>Wool (g)</td>
<td>347</td>
<td>478</td>
<td>426</td>
<td>85.2</td>
<td></td>
</tr>
<tr>
<td>Head and skin (g)</td>
<td>3703</td>
<td>3967</td>
<td>3811</td>
<td>253.7</td>
<td></td>
</tr>
<tr>
<td>Red offals (g)</td>
<td>1446</td>
<td>1483</td>
<td>1557</td>
<td>111.8</td>
<td></td>
</tr>
<tr>
<td>White offals (g)</td>
<td>1824</td>
<td>1809</td>
<td>1927</td>
<td>175.5</td>
<td></td>
</tr>
<tr>
<td>Digestive fat (g)</td>
<td>488</td>
<td>417</td>
<td>385</td>
<td>85.4</td>
<td></td>
</tr>
</tbody>
</table>

† P1 = probability for control v. cafeteria contrast; P2 = probability for W100S v. W100S-T contrast.
‡ Approaching significance (P < 0.10).
Feed intake showed a tendency to be lower in the cafeteria groups. This effect on feed intake is in agreement with that reported by Cañete et al. (2003), who indicated that the use of WBG in fattening lamb diets might negatively affect feed intake because of a reduction in the rate of digesta passage. However, if the reduction in feed intake is related to this, a greater feed intake would have been expected for the W100S-T than for the W100S lambs since the former selected a diet with a lower WBG content. In this regard, Askar (2004) observed no differences in rumen outflow in fattening lambs with respect to the form of barley grain administration (whole or ground). In addition, Rodríguez et al. (2003) reported the feed intake of Assaf lambs reared under a cafeteria system with barley grain and protein supplement (32% CP) to be higher than that of lambs fed barley straw and commercial concentrate. Similarly, other authors have failed to find differences in feed intake as a consequence of the use of whole or ground cereal grain (Askar et al., 2006).

Differences between the present feeding systems in feed conversion ratio might have been due to differences in the starch source (WBG v. ground barley) rather than to the feeding system per se. Other authors have reported an improvement in fibre digestibility (Askar, 2004), or cellulolytic activity (Ørskov et al., 1974; Castrillo et al., 1989) when WBG is used. Although the differences in feed efficiency among the treatments could be partly due to effects on the digestive utilisation of feed, differences in the chemical composition of the LW gain may also be involved. Certainly, the fat content and dressing percentage were slightly higher for the control group lambs. The weights of digestive fat deposits in these animals were greater and the weights of wool lower, which suggest that the protein supply was insufficient in relation to the energy available for tissue protein synthesis, and as a consequence more energy was deposited as fat than in the cafeteria system lambs. These differences were not manifested in other carcass characteristics, such as fatness or conformation,

---

**Table 4 Feed intake, animal performance and carcass characteristics of lambs reared on conventional (control group) or cafeteria system (trial 2)**

<table>
<thead>
<tr>
<th>Control (n = 95)</th>
<th>Cafeteria (n = 100)</th>
<th>Residual s.d.</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry-matter intake (g/day)</td>
<td>898</td>
<td>830</td>
<td>–</td>
</tr>
<tr>
<td>Organic-matter intake (g/day)</td>
<td>837</td>
<td>770</td>
<td>–</td>
</tr>
<tr>
<td>Commercial concentrate (g/day)</td>
<td>807</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Barley straw (g/day)</td>
<td>91</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Whole barley grain (g/day)</td>
<td>–</td>
<td>382</td>
<td>–</td>
</tr>
<tr>
<td>Soya-bean meal (g/day)</td>
<td>–</td>
<td>424</td>
<td>–</td>
</tr>
<tr>
<td>Mineral and vitamin mixture (g/day)</td>
<td>–</td>
<td>24</td>
<td>–</td>
</tr>
<tr>
<td>Average daily gain (g/day)</td>
<td>282</td>
<td>309</td>
<td>60.7</td>
</tr>
<tr>
<td>Days on trial</td>
<td>47.9</td>
<td>45.7</td>
<td>6.37</td>
</tr>
<tr>
<td>Slaughter weight (kg)</td>
<td>26.0</td>
<td>26.6</td>
<td>2.01</td>
</tr>
<tr>
<td>Cold carcass weight (kg)</td>
<td>11.90</td>
<td>11.70</td>
<td>1.052</td>
</tr>
<tr>
<td>Dressing percentage (%)</td>
<td>45.8</td>
<td>44.1</td>
<td>2.02</td>
</tr>
<tr>
<td>Carcass conformation (1–5)</td>
<td>2.43</td>
<td>2.51</td>
<td>0.500</td>
</tr>
<tr>
<td>Carcass fatness (1–4)</td>
<td>2.52</td>
<td>2.52</td>
<td>0.523</td>
</tr>
<tr>
<td>Carcass compact index (g/cm)</td>
<td>235</td>
<td>229</td>
<td>0.02</td>
</tr>
</tbody>
</table>

---

**Figure 3** Selection path of W100S group given a choice between barley grain (WBG) and soya-bean meal (SBM) (trial 2).
probably due to the low weight at which the lambs were slaughtered.

Trial 2 was performed on a commercial farm to evaluate the cafeteria feeding system under commercial conditions. Generally speaking, the results were in agreement with those obtained in Trial 1. Male and female lambs were reared together, as is usual in current feedlot practice; therefore the effect of sex on diet selection could not be studied. Nevertheless, the feeding system appeared to have no effect on LW gain in females (263 (s.e. 6.9) g/day and 272 (s.e. 6.4) g/day under the control and cafeteria feeding systems respectively), while the males of the cafeteria group appeared to grow faster than those of the control group (347 (s.e. 8.3) g/day and 301 (s.e. 8.4) g/day for cafeteria and control, respectively). These results are in agreement with those reported by González et al. (2000).

From a practical point of view, it is noteworthy that under the cafeteria feeding system no animal showed health problems and all were sent to slaughter. In the control group, however, two lambs were removed due to urolithiasis and another three lambs showed very low daily weight gains (less than 140 g/day).

Considering only the current cost of the different feeds, the cost of processing (grinding and pelleting) the experimental and commercial diets (0.17 €/kg DM intake), and the improvement in the feed to gain ratio and animal health, it seems that cafeteria feeding systems could contribute to the reduction of production costs. Further research is required to assess the factors influencing diet selection and how to improve the global efficiency of young lambs reared under cafeteria feeding systems.

Acknowledgements
This research was funded by Magnus S.A., with additional support from the collaboration between Caja Española and the Estación Agrícola Experimental (CSIC, Spanish National Research Council).

References


Colomer-Rocher F, Delfa R and Sierra Alfranca I 1988. Metodo normalizado para el estudio de los caracteres cuantitativos y cualitativos de las canales ovinas producidas en el area Mediterránea, según los sistemas de producción (1). Cuadernos del INIA 17, 19-41.


Landa R, Mantecón AR, Frutos P, Rodriguez AB and Giráldez FJ 2001. Efecto del tipo de cereal (cebada vs maíz) sobre la ingestión, la ganancia de peso y las características de la canal de corderos alimentados con pienso y paja o solo con pienso. ITEA 97A, 204-216.


