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Growth performance of lambs fed different protein supplements in barley-based diets

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ABSTRACT

This paper explores the potential of using locally produced protein sources in diets for growing lambs in northern Europe. The aim of the research was to evaluate the effects on lamb growth performance of peas, rapeseed cake and hempseed cake as protein supplements in barley-based diets. Forty-eight crossbred (White Swedish Landrace × Texel) ewe lambs were penned, forming experimental units allotted to one of four experimental diets. The lambs were on average 87 (SD = 9) days of age at the start of the eight-week continuous trial, during which their live weight (LW) was recorded weekly. The four experimental diets were barley-based, with 101 g hay/kg diet on a dry matter (DM) basis. The control diet (B-0), without protein supplement, contained 112 g crude protein (CP) and the calculated metabolisable energy (ME) value was 13.0 MJ/kg DM. The other diets contained peas (B-P), rapeseed cake (B-RC) or hempseed cake (B-HC) and had similar CP concentrations (160–162 g/kg DM), but varied in ME content (13.4, 13.4 and 12.2 MJ/kg DM, respectively). Rumen undegradable CP (RUP) was 231, 99, 298 and 291 g/kg CP, with an intestinal digestibility of 605, 707, 528 and 307 g/kg RUP for the concentrates of barley, peas, rapeseed cake and hempseed cake, respectively. There were no significant differences in DM intake, which varied between 860 and 989 g/d, for the lambs on the different diets. However, CP intake was higher for lambs fed B-P and B-HC ($P<0.001$) and calculated ME intake was higher for lambs fed B-P ($P=0.037$) than for the other diets, among which there were no significant differences in these respects. Initial LW of the lambs did not differ significantly between treatments, but final LW was higher for lambs fed B-P and B-RC ($P=0.029$). Total gain and average daily gain were highest for the B-P treatment, followed by the B-RC treatment ($P<0.001$). Feed conversion (DM intake/LW gain) was more efficient for lambs fed B-P and B-RC, compared with the other treatments ($P<0.001$). No significant differences in growth performance or feed conversion were found between the B-0 and the B-HC treatments. In conclusion, supplementing barley-based diets with peas or rapeseed cake significantly improved growth performance of the lambs, but including hempseed cake did not.

1. Introduction

In order to identify profitable production systems that meet market requirements, lamb producers in northern Europe are interested in novel indoor feeding systems for finishing lambs. Although it is possible to fatten lambs on forage alone, inclusion of concentrate in the diets has resulted in higher growth rates (Webster and Povey, 1990; Bernes et al., 2009). Intensive finishing of early weaned lambs with rapid growth rates requires readily fermentable diets, and young lambs have high protein requirements, thus supplementing cereal-based diets with high quality protein sources of low rumen degradability can improve growth performance (Webster and Povey, 1990). Traditionally, soybean meal has been used as a protein supplement in lamb diets. However, there is growing interest in increasing the use of locally produced protein feeds in animal production, in order to reduce dependence on imported protein sources.

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Peas and rapeseed are high-protein crops that are commonly cultivated in northern Europe. Replacement of soybean meal with peas as the main protein source in lamb diets, has given comparable growth performances (Lanza et al., 2003). Canola (rapeseed) meal has been shown to be comparable to fish meal, as a protein source in lamb diets (Plaisance et al., 1997). Another, relatively unexplored, protein feed is hempseed cake (HC), the pressed residue after oil extraction of hempseed. Hemp (*Cannabis sativa* L.) can be cultivated at high latitudes (Callaway, 2002), hence HC is a source of protein that can be locally produced in northern Europe. Crude protein (CP) concentrations between 319 and 385 g/kg dry matter (DM) have been reported for cold-pressed HC (Hessle et al., 2008; Karlsson et al., 2009). Additionally, hempseed may be a good source of rumen undegradable CP (RUP) (Mustafa et al., 1999; Karlsson et al., 2009).

There are only a few published studies on the use of hempseeds in diets for cattle (Gibb et al., 2005; Hessle et al., 2008; Turner et al., 2008) and sheep (Mustafa et al., 1999). Substituting rapeseed meal with hempseed meal, up to 200 g/kg DM, has no detrimental effects on feed intake or nutrient utilization by sheep according to Mustafa et al. (1999). However, no effects on the growth performance of lambs appear to have been reported in the literature. Therefore, there is a need to explore the potential of including locally produced protein sources in diets for growing lambs and to investigate the effects on live weight (LW) gain. The aim of this study was to evaluate the effects of peas, rapeseed cake (RC) and HC, as protein supplements in barley-based diets, on the growth performance of lambs.

2. Material and methods

2.1. Animals, diets and experimental design

Forty-eight crossbred (White Swedish Landrace × Texel) ewe lambs were divided into four blocks, consisting of 12 lambs each, based on their herd origin and LW. The blocks were light lambs (17.2 ± 1.3 kg LW), medium (21.1 ± 1.6 kg LW) and heavy lambs (28.2 ± 0.7 kg LW), all from herd A, and heavy lambs (29.7 ± 1.1 kg LW) from herd B (means ± standard deviations are presented). Within each block, the 12 lambs were penned in groups of three, forming four experimental units, each allocated to one of four experimental diets. Litter size and pre-weaning diets were considered, in order to balance the experimental units. The lambs were on average 87 (± 9) days old at the start of the experiment, which was conducted as an eight-week continuous trial. Prior to the start of the proper experiment, the lambs were given a two-week baseline period in which to adapt to their diets.

The four experimental diets were barley-based, with inclusion of 100 g hay/kg diet on a DM basis. The control diet (B-0) contained no protein supplement, while the other diets contained peas (B-P), rapeseed cake (B-RC) or hempseed cake (B-HC) and were each formulated to the same protein content (160 g CP/kg DM). The compositions of the ingredients are presented in Table 1, while the compositions of the experimental diets are presented in Table 2. The barley and peas were crushed, the rapeseed cake was expeller-pressed and heat-treated, and the HC was cold-pressed. The lambs were fed twice a day and had free access to water. Barley, protein supplement and mineral

Table 1
Chemical composition (g/kg DM, if not otherwise stated) and estimations of *in situ* CP degradability and *in vitro* CP digestibility (g/kg CP, if not otherwise stated) of diet ingredients.

	Grass hay	Barley	Peas	Rapeseed cake	Hempseed cake
Chemical composition					
DM (g/kg)	920	886	881	907	927
Ash	54	22	29	79	69
CP	67	118	227	311	336
Fat	na	29	19	172	127
Starch	na	589	493	8	7
NDF	582	140	76	207	382
ADF	363	67	72	201	336
Buffer soluble CP (g/kg CP)	319	249	794	265	191
Non-protein nitrogen (g/kg CP)	201	137	151	182	66
Acid detergent insoluble CP (g/kg CP)	52	28	7	78	79
Indigestible NDF[a] (g/kg NDF)	na	164	16	379	845
Metabolisable energy (MJ/kg DM)	10.9	13.4	14.2	14.9	9.5
AAT	69	91	83	70	32
PBV	−51	−39	88	170	227
In situ/in vitro CP estimations					
Ruminal CP disappearance (/h)	na	0.18	0.25	0.13	0.14
EPD[b]	na	769	901	702	709
RUP[c]	na	231	99	298	291
Intestinal digestibility (g/kg RUP)	na	605	707	528	307
Intestinally available dietary CP[d]	na	140	70	157	90
Indigestible CP	na	91	29	141	202

DM = dry matter; CP = crude protein; NDF = neutral detergent fibre; ADF = acid detergent fibre; AAT = amino acids absorbed in the small intestine; PBV = protein balance in the rumen; na = not analyzed.
[a] Standard feed table values (NorFor Nordic Feed Evaluation System, 2010) for feeds other than hempseed cake.
[b] Effective CP degradation, calculated at a passage rate of 0.06/h.
[c] Rumen undegradable CP, calculated at a passage rate of 0.06/h.
[d] Calculated as RUP × (intestinal digestibility/1000).