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Effects of maize crop maturity at harvest and dietary inclusion rate of maize silage on feed intake and performance in lambs fed high-concentrate diets

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ABSTRACT

This study investigated the effects of maize maturity at harvest and dietary inclusion rate of maize silage on feed intake, average daily gain (ADG) and carcass traits of growing ram lambs fed high-concentrate diets. Precision-chopped maize was harvested at two stages of maturity (Early: dough stage and Late: dent stage) and ensiled as round bales. Early or late cut maize silage was fed as the sole forage or together with grass silage, to 40 ram lambs in each of two consecutive years. The four treatments in each year were: (1) early cut maize silage as 50% of the forage dry matter (DM) proportion (E50), (2) early cut maize silage as 100% of the forage DM proportion (E100), (3) late cut maize silage as 50% of the forage DM proportion (L50) and (4) late cut maize silage as 100% of the forage DM proportion (L100). The proportion of forage in each of the diets was on average 42% on a dry matter (DM) basis and the concentrate consisted of dried distillers' grains plus solubles, rolled barley and cold-pressed rapeseed cake in year 1 (Y1) or heat-treated rapeseed expeller in year 2 (Y2). Daily DM intake (DMI) was 1.24 and 1.40 kg, averaged over treatments, in Y1 and Y2, respectively. Increasing the dietary inclusion rate of maize silage from 50 to 100% of the forage DM proportion resulted in increased DMI in Y1 ($P < 0.05$) and increased carcass fatness in Y2 ($P < 0.01$), whereas increased maturity stage at harvest tended to result in increased DMI in Y2 ($P < 0.10$). Feed conversion ratio (FCR; kg DMI per kg ADG), was lower for the treatments E100 and L50 than for E50 and L100, respectively ($P < 0.01$) in Y2. The body weight of the lambs increased linearly over time, in both years. In conclusion, maize silage can replace grass silage in the diets of high-producing lambs. Increased metabolizable protein (MP) to metabolizable energy (ME) ratio of the diet increased ADG of the lambs. Also, increased ADG decreased mega joule ME intake per kg ADG, in finishing lambs.

1. Introduction

The nutrient requirements of growing lambs are determined by the production potential of the animal, i.e. to enable lambs to grow with a growth rate of above 400 g/day, diets in practice often consist of ad libitum concentrate and

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silage or of more than 50% concentrate in TMR. It has been shown that growing lambs can cope with as low roughage proportions as the equivalence of 2% straw in the diet dry matter (DM; Weston, 1974). In the Nordic countries, the forage part of the diet most often consists of grass silage, as the favourable climate conditions enable production of grass silages of high digestibility.

As early maturing varieties of forage maize have been developed in recent years, it is now possible to obtain yields above 10 t DM/ha of a forage with high starch concentrations (> 350 g/kg DM) even in Northern countries (Mussadiq, 2012). However, when the growing season becomes shortened by cold spring or early frost in the autumn, the harvest must occur at an earlier than desired maturity stage, leading to lower starch concentrations (< 300 g/kg DM; NCIS, 1998; Ritchie et al., 1997). Nevertheless, whole-crop maize silage can be produced at similar costs as grass silage (Nadeau et al., 2012) and inclusion of maize silage has been shown to increase feed intake and performance in beef and dairy cattle (Keady, 2005). Furthermore, maize silage has been shown to increase feed intake and diet digestibility in wethers when partly replacing early and late harvested grass silages (Vranić et al., 2008). Contrariwise, when replacing grass silage with maize silage in diets of pregnant and lactating ewes, O'Doherty et al. (1997) found no effect on intake or performance. Also, Keady and Hanrahan (2013) showed no effect on performance in finishing lambs fed high feed value maize silage (28% starch of DM) as compared to medium feed value maize silage (3.3% starch of DM). As maize silage typically contains less than 100 g crude protein (CP) per kg DM (Mussadiq et al., 2012), to meet the requirements (NRC, 2007) and to fully exploit the high growth potential of finishing lambs, it is necessary to supplement maize silage with additional protein. The authors of the present study found no previous studies on the effects of maize maturity stage at harvest or dietary inclusion rate of maize silage in lambs with high growth capacity (> 400 g/day), when fed concentrate-based diets.

The objective of this study was to evaluate the hypothesis that feed intake will increase and performance of lambs will be improved by (1) delaying maize harvest from dough to dent stage, and by, (2) increasing the inclusion rate of maize silage from 50 to 100% of the forage proportion of the diets, when the diets are formulated for equal concentrations of metabolizable energy and crude protein in DM.

2. Materials and methods

The experiment was carried out at Götala Beef and Lamb Research Centre (58°22′N, 13°29′E, altitude 120 m above sea level), Swedish University of Agricultural Sciences (SLU), Skara, Sweden. Experimental procedures used in the study were approved by the Research Animal Ethics Committee.

2.1. Experimental forages

The maize cultivar used was the early maturing Avenir (FAO: 180), which was sown on April 28 in 2009 (Y1) and on April 20 in 2010 (Y2). The early cut maize (E) was harvested for silage at the dough stage of maturity on September 15 in Y1 and on September 14 in Y2, at a DM of 25 and 28%, respectively. The late cut maize (L) was harvested at the dent stage of maturity on October 13 in Y1 and on October 12 in Y2, at a DM of 34 and 36%, respectively. The soil was fertilized prior to seeding with 50 t liquid cattle manure (approx. 75 kg N) per ha in both years and in May with artificial fertilizers equivalent to 73 and 93 kg N per ha in Y1 and Y2, respectively. The maize crop was treated with chemical herbicides at two occasions; 1st at the end of May and 2nd in the beginning of June in both years. At harvest, the whole-crop maize was chopped to 14 mm theoretical chopping length using a self-propelled forage harvester (Claas Jaguar 850, CLAAS KGaA mbH, Harsewinkel, Germany) and 2 L/t herbage was added of the chemical additive Kofasil® Stabil (sodium benzoate 250 g/L and potassium sorbate 150 g/L, ADDCON Europe GmbH, Bonn, Germany). The maize was ensiled in round bales (Orkel MP2000, Norway) and covered with eight layers of 0.025 mm RaniWrap® plastic film (Ab Rani Plast Oy, Teerijärvi, Finland). The grass for silage consisted mainly of perennial ryegrass, timothy and meadow fescue and was cut as a third harvest in Y1 and as a second harvest in Y2. The grass was harvested with a mower conditioner in both years and wilted to approximately 35% DM in the second year. At harvest the grass was chopped to 25 mm theoretical chopping length, ensiled with 3 L/t herbage of the additive Promyr® NT570 (50.0% formic acid, 17.1% propionate and 5.6% sodium, Perstorp Inc., Perstorp, Sweden), covered with a 0.15 mm plastic film and stored in a bunker silo in Y1 and covered with eight layers of 0.022 mm plastic film in round bales in Y2. The chemical composition of the silages and the concentrates are shown in Tables 1 and 2, respectively.

2.2. Animals, feeding and experimental design

In both years, 40 weaned (twin or triplet) crossbred entire ram lambs (Finewool/Dorset × Texel) were selected from a commercial sheep flock at weaning. At the start of the experiment, the lambs were 61 (s.d. 5.1) and 68 (s.d. 9.8) days old and weighed 24 (s.d. 2.2) and 27 (s.d. 2.3) kg in Y1 and Y2, respectively.

The lambs were grouped in four groups with similar age and body weight (BW) and penned in pairs in barley straw-bedded pens of 6 m^2. The four groups of 10 lambs each were then allocated to the four dietary treatments. Siblings were divided between treatments and approximately the same number of twins and triplets were allocated to each treatment.

The treatments were fed as total mixed rations (TMR) consisting of ca 42% forage and 58% concentrate on a DM basis. The TMR were mixed in a Cormall stationary mixer (Cormall A/S, Sønderborg, Denmark) with one mixing auger. The treatments were: (1) early cut maize silage as 50% of the forage DM proportion (E50), (2) early cut maize silage as 100% of the forage DM proportion (E100), (3) late cut maize silage as 50% of the forage DM proportion (L50) and (4) late cut maize silage as 100% of the forage DM proportion (L100).