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ScienceDirect
Livestock Science 119 (2008) 1 – 11
LIVESTOCK SCIENCE
www.elsevier.com/locate/livsci

Effects of replacing grass silage with maize silages, differing in maturity, on performance and potential concentrate sparing effect of dairy cows offered two feed value grass silages

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Received 7 June 2007; received in revised form 8 February 2008; accepted 11 February 2008

Abstract

A partially balanced change-over design experiment, consisting of four 3-week periods, was undertaken to evaluate the effects of stage of maturity of maize silage at harvest, when included in the forage component of two contrasting feed value grass silage based diets offered to 24 lactating dairy cows, on animal performance and potential concentrate sparing effect. Four maize silages were ensiled which had dry matter (DM) concentrations of 202, 280, 298 and 384 g/kg and starch concentrations of 100, 273, 270 and 332 g/kg DM, respectively. Low (L) and high (H) feed value grass silages were ensiled from the primary growth of predominantly perennial ryegrass swards. For the L and H feed value grass silages, DM concentrations were 193 and 326 g/kg and metabolisable energy (ME) concentrations were 9.80 and 11.96 MJ/kg DM, respectively. The grass silages were offered either as the sole forage supplemented with 7 or 11 kg concentrate/cow daily or in addition to one of the four maize silages at a ratio of 40:60, on a DM basis, maize silage: grass silage supplemented with 7 kg concentrate/cow daily. The forages were offered *ad-libitum*. There were no interactions ($P > 0.05$) between grass silage feed value and maturity of maize at harvest for food intake or animal performance. For the grass silage supplemented with 7 and 11 kg concentrate and the 202, 280, 298 and 384 g/kg maize silages, total DM intakes were 16.9, 19.0, 18.2, 18.5, 18.1 and 18.4 (s.e. 0.31) kg/day; milk yields were 26.8, 29.9, 27.2, 28.0, 27.5 and 27.8 (s.e. 0.37) kg/day; milk fat concentrations were 39.8, 39.0, 42.4, 41.7, 41.4 and 40.2 g/kg; and milk protein concentrations were 31.5, 32.7, 32.3, 32.4, 32.1 and 32.5, respectively. The potential concentrate sparing effects of the maize silages with DM concentrations of 202, 280, 298 and 384 g/kg, as determined by fat plus protein yield, were 2.1, 3.4, 2.1 and 2.0 kg fresh weight, respectively. It is concluded that including maize silage in grass silage based diets improved milk output due to increased ME intake. There are no interactions between grass silage feed value and maturity of maize at harvest on subsequent animal performance. The optimum stage of maturity to harvest maize silage for feeding to dairy cows is approximately 300 g/kg. There is a negative relationship between maturity of maize silage and milk fat concentration. The potential concentrate sparing effect of including maize silage as 0.40 of the forage component of grass silage based diets is up to 3.4 kg/cow daily.

Keywords: Dairy cows; Maize silage maturity; Concentrate feed level; Grass silage feed value

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doi:10.1016/j.livsci.2008.02.006

1. Introduction

Traditionally in many parts of Europe, Scandinavia, New Zealand, Australia and North America, grass silage was offered to dairy cattle during the indoor feeding period. However, in recent times, other ensiled forages, such as forage maize, have increased in popularity and have partially replaced grass silage in the diet. Major developments in plant breeding coupled with improvements in agronomic practices, particularly the development of the complete cover plastic mulch (CCPM) system has considerably increased the yield potential and feeding value of maize at more Northern latitudes (Keady, 2005). Previous studies undertaken in Northern Ireland have shown the yield potential of maize has increased from 4.1 t dry matter (DM)/ha (McAllister, 1961) and 4.9 t DM/ha (Bartholomew and Chestnutt, 1979) in the 1960s and 1970s, respectively, to 12 t DM/ha in the late 1990s (Easson, 2000) primarily due to improvements in plant breeding. The CCPM system which involves total cover of the maize plants with unperforated plastic mulch (the growing plant eventually forces through the degrading sheet), has considerably increased the yield potential of maize as outlined by Keady (2003, 2005). The use of the CCPM system enables earlier sowing of the crop, as the mulch protects the plants against late frosts, and the use of later maturing, higher yielding varieties. The response to the CCPM can be as high as 5 t DM/ha depending on sowing date and variety sown (Keady, unpublished data). The increased yield potential of forage maize has reduced the cost of producing maize silage similar to that of grazed grass when offered to lactating dairy cows (Keady, 2005).

Previous studies have shown that the inclusion of maize silage in grass silage based diets has had variable effects on animal performance. Keady (2005) from a review of 34 and 9 comparisons of including maize silage in the forage component of grass silage based diets offered to lactating dairy cows and beef cattle, concluded that the mean response was an increase of 1.4 kg milk/cow daily and 0.11 kg carcass gain/beef animal daily, respectively. However, the response varied from −1.1 to +5 kg milk/day for lactating dairy cows and −0.13 to +0.3 kg carcass gain/day for finishing beef cattle, respectively (Keady, 2005). Whilst many studies (Keady, 2005) have reported differences in the response to the inclusion of maize silage in grass silage based diets offered to beef and dairy cattle, few have evaluated if the response depends on the feed value of maize silage or that of the grass silage.

Whilst the optimum stage of maturity of harvesting grass silage for feeding finishing beef cattle and lactating dairy cows is at the leafy immature stage (Gordon, 1980a; Keady et al., 1999, 2000a, 2003, 2008), for maize silage the intention is to increase starch content and consequently harvest as a mature crop. Major changes occur in the composition of the maize plant as it matures. Neutral detergent fibre (NDF), acid detergent fibre (ADF) and crude protein (CP) concentrations decrease, whilst starch concentrations increase (Bal et al., 1997; Phipps et al., 2000). Whilst a number of studies (Bal et al., 1997; Phipps et al., 2000) have evaluated the effect of maturity of maize at harvest, none have evaluated the effect when maize was incorporated into the forage component of diets consisting of contrasting feed value grass silages.

In a quota system of production, or when the price of concentrate relative to animal product is high, one of the potential benefits of including maize silage in the diet of lactating dairy cows or finishing beef cattle is the ability to maintain animal performance whilst reducing the levels of concentrate supplementation required, consequently reducing the costs of production. The objective of the present study was to evaluate the effect of including maize silage, harvested at different stages of maturity, on the performance of lactating dairy cattle offered two contrasting feed value grass silages. Furthermore, the potential concentrate sparing effect of including maize silage in the forage component of grass silage based diets was also determined.

2. Materials and methods

2.1. Forages

Two grass silages were produced from herbage harvested from the primary growth of predominantly perennial ryegrass swards. The high feed value (HFV) silage was ensiled on the 9 May precision chopped, untreated, following a 32 h wilting period. The low feed value (LFV) silage was ensiled on the 9 June precision chopped treated with a bacterial inoculant (Ecosyl, Ecosyl Products) at the rate of 3 l/t, following a 12 h wilt. The inoculant was applied through a pump applicator and discharged into the auger chamber of the harvester. The silages were mown using a mower conditioner with a built-in spreading mechanism (Vicon-Grassland KM 300 HPC) and rowed up shortly prior to ensiling using a precision chop forage harvester (Reco-Mengele, Model SH40W). During filling each silo was consolidated between loads by rolling with an industrial loader and for a further 60 min after filling was completed. Following consolidation two polythene sheets were used to seal each silo. The entire surface was then weighed down with a layer of tyres.

Four maize silages were produced. Maize was planted on either 17 April or 20 May. During each sowing date the crop was planted either in the open or under CCPM using the Samco maize drill (Samco Engineering Ltd. Adare, Co. Limerick, Ireland). The varieties planted were Hudson and Noveta and were sown in four replicates per treatment. All the maize