Livestock Science 168 (2014) 89–93

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

Short communication

Effects of maize maturity at harvest and dietary proportion of maize silage on intake and performance of growing/finishing bulls

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ARTICLE INFO

Article history:
Received 1 July 2013
Received in revised form
15 July 2014
Accepted 17 July 2014

Keywords:
Maize silage
Harvest time
Finishing bulls
Growth rate
Carcass characteristics

ABSTRACT

Whole-crop maize silage as forage in diets of finishing cattle can promote high intakes and thus, enhances animal performance. In the present study we evaluated the effect of whole-crop maize maturity at harvest and the proportion of maize-silage in diets of finishing bulls, on feed intake and performance. An indoor experiment with 64 dairy bulls was replicated over two consecutive rearing periods, under the same experimental design. Two groups of 4 light and two groups of 4 heavy bulls were randomly allocated into one of the 4 dietary treatments, which formed a 2×2 factorial arrangement of treatments, involving two maturity stages of maize at harvest (i.e. dough stage or dent stage) and two maize silage proportions (i.e. 100% maize silage or 50% maize and 50% grass silage). The diets were offered ad libitum as total mixed rations (TMRs) with inclusion of concentrates (i.e. rolled barley; dried distillers' grain plus soluble; cold-pressed rapeseed cake) in a 40% proportion on DM basis. All animals were slaughtered at a target body weight of 630 kg. Bulls fed on diets containing maize silage as sole forage achieved higher live-weight gain ($P < 0.01$) compared to their counterparts. This is likely due to the higher ME ($P < 0.01$) and CP ($P < 0.001$) intakes they achieved. Interestingly, the dough stage compared to dent stage maturity of maize at harvest tended to increase live-weight gain ($P = 0.06$).
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1. Introduction

Cultivation of maize has increased rapidly in Scandinavia during the recent years mainly due to developments in plant breeding, which have resulted in new, early mature varieties. The maturity stage widely accepted as optimal for harvesting whole-crop maize for silage is the early dent stage (2/3 milkline) at a dry matter (DM) content of 30–35% (Bal et al., 1997; Fernandez et al., 2004). In practice, harvesting at this stage of maturity (late harvest) is desirable as it reduces effluent losses during ensiling and results in a significant proportion of starch in the harvested material (Nadeau et al., 2010). However, the desirable characteristics of the late harvested maize can be compromised by the effects of frost, which can often occur early in autumn in northern latitudes. Harvesting after frost can negatively affect the microbial quality and the

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http://dx.doi.org/10.1016/j.livsci.2014.07.013
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feeding value of the maize silage. On the other hand, short growing season or choice of an inappropriate hybrid can force the farmer to harvest at an immature stage (Nadeau et al., 2010).

To our knowledge, the inclusion of maize silage in silage-based diets has been studied less intensively on the performance of growing cattle (Browne et al., 2005, 2004; Keady et al., 2007) compared to that of dairy cows (Bal et al., 1997; Keady et al., 2008; Phipps et al., 2000). The current study tested the hypotheses that finishing bulls will show higher intakes and better feed utilization and thus, performance (a) when offered diets containing solely whole-crop maize silage as forage or (b) when offered maize-silage based diets from whole-crop maize harvested at the dent stage of maturity.

2. Materials and methods

An indoor experiment was replicated over two consecutive years at the Götala Beef and Lamb Research Centre, Swedish University of Agricultural Sciences, Skara, Sweden. Experimental procedures were approved by Research Animal Ethics Committee (Swedish Animal Welfare Agency).

2.1. Forages

Whole-crop maize was harvested at two different stages of maturity; at the dough stage of maturity with 25% DM in year 1 and with 28% DM in year 2; at the dent stage of maturity with 34% DM in year 1 and 36% DM in year 2. The maize was harvested by a self-propelled forage harvester (Claas Jaguar 850, CLAAS KGaA mbH, Harsewinkel, Germany) and precision chopped to a theoretical length of 14 mm, using kernel processor and treated with Kofasil Stabil® (Addcon Europe, GmbH, Bonn, Germany) with 2 l t^{-1} of fresh herbage. Additive-treated herbages from each harvest were ensiled into round bales (MP Orkel 2000, Town, Norway) and thus, two different maize silages were produced, one from the dough stage of maturity (early-maize silage, EMS) and one from the dent stage of maturity (late-maize silage, LMS).

Grass silage (GS) was produced from leys composed of perennial ryegrass, timothy and meadow fescue. Harvested herbage was treated with the silage additive Promyr NT® 570 (Perstorp Inc., Perstorp, Sweden), 3 l t^{-1}, prior to ensiling in a bunker silo. The chemical composition and nutritional characteristics of the silages for each experimental year are shown in Table 1.

Table 1
Mean chemical composition of grass silage (GS) and of maize silage produced from dough stage of maturity (EMS) or dent stage of maturity (LMS) at harvest (g kg^{-1} dry matter, unless stated otherwise).

Item	GS mean	EMS mean	LMS mean
DM (g kg^{-1})	306.00	272.50	375.50
Ash	85.50	49.50	46.00
Crude protein	145.00	89.50	88.50
Water-soluble carbohydrates	41.50	43.50	34.00
Starch		222.00	362.50
Neutral detergent fibre (NDF)	520.50	413.50	379.50
Acid detergent fibre	317.00	232.00	203.50
Acid detergent lignin	48.00	28.00	26.00
Indigestible NDF[a]	100.50	73.00	77.00
IVOMD[b]	839.00	756.00	753.50
Metabolisable energy	10.50	11.00	11.20
pH	4.00	3.70	4.10
NH_3–N (g kg^{-1} of total N)	95.00	63.00	67.00
Lactic acid	105.50	63.00	37.00
Acetic acid	15.60	16.20	7.10
Butyric acid	1.85	0.00	0.00
Ethanol	3.55	2.40	1.55

[a] Neutral-detergent fibre, determined in situ (288 h).
[b] *in vitro* organic matter digestibility (g kg^{-1} OM).

2.2. Animals, diets and experimental design

Sixty-four dairy bulls (49 Swedish Holstein and 15 Swedish Red) were used in each experimental year and similar husbandry procedures and protocols were followed in both years. Based on their initial live weight (LW), measured in 2 weeks before the start of the experiment, half of the bulls were blocked to a heavy group (422 SD 22 and 410 SD 22 kg for each year, respectively) and half into a light group (361 SD 24 and 358 SD 16 kg for each year, respectively). Within each heavy or light block, bulls were assigned to 8 groups with 4 bulls per group penned together. Two groups of heavy and two groups of light bulls were then randomly allocated into one of four dietary treatments.

Experimental diets were offered as TMRs and contained as forage either EMS or LMS in a 100% proportion (diets E100 and L100, respectively) or in a 50% proportion with equal proportion of GS (diets E50 and L50) on a DM basis. The diets were formulated to meet the requirements for maintenance and a daily LW gain (LWG) of 1400 g. Concentrates used were rolled barley (DM 85.5%; CP 118; starch 640; NDF 169 and ME 13.5 g kg^{-1} DM), dried distillers' grain plus soluble (DM 90%; CP 354; starch 48.5; NDF 320 and ME 13.7 g kg^{-1} DM) and cold-pressed rapeseed cake (DM 91%; CP 311; starch 55; NDF 278 and ME 16.6 g kg^{-1} DM). The forage to concentrate ratio (F:C) was 60:40 on a dry matter (DM) basis. The animals had ad libitum access to the diets and daily offered amounts accounted for about 110% of the average daily intake measured over the previous 3 days. Each bull was slaughtered at the target LW of 630 kg and the experiment ceased when the last bull(s) had reached the target LW.

2.3. Sample collection and measurements

Samples of EMS, LMS and GS were collected daily and pooled weekly samples were used for determination of nutrient composition of the silages. Total nitrogen (N) was determined following the Kjeldahl procedure with digestion on a Gerhardt Vapodest 45 device (Gerhardt GmbH & Co. KG, Germany) and CP was calculated as N × 6.25. Neutral detergent and acid detergent fibre (NDF and ADF, respectively) were determined by an Ankom220® fibre analyzer with addition of amylase and corrected for ash (Ankom Technology, Macedon, NY, USA). Acid detergent lignin (ADL) was determined according to Van Soest et al.

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