EFFECT OF VARIATION IN THE QUALITY OF FORAGE MAIZE SILAGE IN IRELAND ON FORAGE INTAKE AND ON MILK PRODUCTION OF DAIRY COWS

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ABSTRACT
In three experiments maize silages which varied in quality, i.e. starch content and dry matter digestibility (DMD) replaced a high proportion (60-67%) of grass silage in the diet of cows in early or mid-lactation. In each experiment the forages were supplemented with concentrates (4 or 6 kg/cow/day). Replacing high quality grass silages (DMD 750 g/kg) with high quality maize silages (starch 219 or 355 g/kg DM, DMD 694 or 754 g/kg) significantly increased forage intake, milk yield, milk protein concentration and the yield of fat and protein (Experiments 1 and 3). Replacing grass silage with a low starch maize silage (starch 15 g/kg DM, DMD 703 g/kg) had no effect on forage intake or milk production (Experiment 3). However, replacing a moderate quality grass silage (DMD 684 g/kg) with either a low quality maize silage (starch 37 g/kg DM, DMD 610 g/kg) or a moderate quality maize silage (starch 146 g/kg DM, DMD 618 g/kg), with a reduced digestibility due to late harvesting (November), resulted in a reduction in milk yield despite an increase in forage intake (Experiment 2). Yield of fat and protein on the maize based diets in Experiment 2 were maintained compared with the grass silage based diet. These results show that a high quality maize silage (> 200 g starch/kg DM) will increase forage intake and milk production compared with good quality grass silage. Low starch maize silage grown in a poor season is equivalent to good quality grass silage for milk production provided that it is harvested in October before its digestibility declines.

KEY WORDS
Maize silage, quality, grass silage, milk production

INTRODUCTION

Ireland, in common with other North Western regions of Europe, is a marginal area for growing forage maize due to a cool, moist climate with limited sunshine. Conserved grass silage is the predominant winter forage. However, recent advances in the breeding of early maturing maize hybrids more suited to these regions has created an interest in the crop among dairy farmers as a complementary forage to grass silage. Nevertheless, variable weather conditions has resulted in considerable variation in the yield and quality (cob development) of the crop in Ireland. These studies were undertaken to assess the effect of such variation in forage maize quality on the feeding value of maize silage relative to grass silage for milk production under Irish conditions.

MATERIALS AND METHODS

Three experiments were conducted at Moorepark Research Centre to evaluate maize silages which differed in quality, i.e. starch content and DM digestibility (DMD) for milk production. The maize silages replaced a large proportion of grass silage in a mixed forage and were compared with all grass silage (Control). The forages were supplemented with a common level of concentrates in each experiment.

Experiment 1. A maize crop with well developed cobs was harvested and ensiled in late October. The resulting maize silage was of good quality, as indicated by its starch content and DM digestibility (Table 1). It was compared with a high quality grass silage when replacing 67% of the grass silage in the diet of cows in early lactation (8 weeks). The grass silage and mixed forages were supplemented with concentrates (6 kg/cow/day) containing 160 or 250 g crude protein (CP) /kg, respectively.

Experiment 2. Two maize crops which differed in cob development (poor or moderate) were harvested and ensiled in November. The silages were poor or moderate in terms of starch content but the DM digestibility of the silages was reduced due to late harvesting after frost damage (Table 1). The maize silages were compared with a moderate quality grass silage when replacing 67% of the grass silage in a mixed forage. The forages were fed to cows in early or mid lactation for a period of 8 weeks and were supplemented with concentrates (6 kg/cow/day) containing 250 g CP/kg.

Experiment 3. An immature maize crop with poor cobs was harvested and ensiled in late October. The silage contained very little starch but was of high digestibility (Table 1). It was compared with a high quality grass silage when fed as a mixed forage containing 60% maize silage. A “high starch” maize silage was also produced by incorporating ground maize grain into the low starch maize silage (40% maize grain : 60% maize silage on a DM basis) prior to feeding. This silage was also compared with grass silage when fed in a mixed forage (60% maize silage). The forages were fed to cows in early or mid-lactation for a period of 7 weeks and were supplemented with concentrates containing 250 g CP/kg @ 4 kg/cow/day.

RESULTS

Experiment 1. Replacing 67% of a high quality grass silage with a good quality maize silage significantly increased forage intake (+18%), milk yield (+8%), protein yield (+12%), liveweight gain and marginally improved milk protein concentration (+1.0 g/kg) (Table 2). Intake of digestible DM was increased on the diet containing maize (11.5 v. 10.8 kg/day) even though the digestibility of the diet was reduced compared with the grass silage based diet.

Experiment 2. Replacing 67% of a moderate quality grass silage with either a low or moderate quality maize silage significantly increased forage intake (+12 to 18%) but reduced milk yield (-7 to 9%) (Table 2). Milk fat and protein concentration were improved on the maize silage based diets resulting in similar yields of fat and protein compared with grass silage. The higher intake of the maize silage based diets offset the reduction in digestibility of the total diet resulting in similar intakes of digestible dry matter for all diets.

Experiment 3. Replacing 60% of a high quality grass silage with a low starch maize silage resulted in a similar intake of forage and a similar level of milk production and composition to the grass silage based diet (Table 2). Increasing the starch content of the maize silage to a high level resulted in a considerable improvement in forage intake (+31%), milk yield (+11%), milk protein concentration and yield of fat and protein (+13%) compared with all grass silage (Table 2). The digestibility of the maize silage diet was improved by increasing its starch content to a level similar to that of the grass silage based diet.

DISCUSSION

In these studies the replacement of a high proportion of grass silage with maize silage generally increased forage intake, with the exception of the low starch maize silage in Experiment 3. However, the yields of milk and fat + protein were improved compared with all grass silage only when the maize silage contained an appreciable amount of starch (>200 g/kg DM) and was of high digestibility, i.e. Experiments 1 and 3. A reduction in the digestibility of the maize silage, due to late harvesting in Experiment 2, resulted in a reduction

in milk yield despite an increase in forage intake. However, the yield of fat and protein in these diets was maintained. Studies in the UK with generally more mature maize silages than in these experiments and with grass silages of similar or lower digestibility have shown consistent improvements in forage intake, milk yield and, in some studies, improvements in milk protein concentration when maize silages replaced 50% to 75% of the grass silage (Phipps et al., 1988, 1992a, 1992b, 1995).

The starch content and digestibility of maize silage grown in Ireland varied considerably between years due to variation in growing conditions and harvesting date. Good quality maize silage (> 200 g/kg DM) has the potential to increase forage intake, milk production and milk protein concentration in a mixed forage compared with high quality grass silage. Maize silage containing low or moderate amounts of starch (<150 g/kg DM) but with good digestibility is capable of producing similar levels of milk to good quality grass silage. However, if this type of forage is harvested late, due to inclement weather, its digestibility will be reduced and consequently milk yield will be reduced compared with grass silage.

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Table 1
Chemical composition of grass and maize silages.

	Experiment 1		Experiment 2			Experiment 3		
Silage type	Grass	Maize High Starch	Grass	Maize (1) Low Starch	Maize (2) Moderate Starch	Grass	Maize (1) Low Starch	Maize (2) High Starch
DM (g/kg)	223	257	184	241	278	192	228	331
Crude protein (g/kg DM)	155	91	181	128	121	183	124	116
ND fibre (g/kg DM)	630	565	440	549	540	493	561	512
MAD fibre (g/kg DM)	306	272	296	322	271	326	291	252
Starch (g/kg DM)	-	219	-	37	146	-	15	355
In-vitro DMD (g/kg)	758	694	684	610	618	755	703	754
pH	3.9	4.0	3.9	4.0	4.0	4.0	3.8	3.9
NH_3-N (% total N)	11.1	6.3	13.4	7.1	6.1	6.9	5.3	3.6
Lactic acid (g/kg DM)	142	50	125	55	45	60	68	-

Table 2
Effect of maize silage quality in a mixed forage on feed intake and milk production.

Silage Type	Experiment 1			Experiment 2				Experiment 3			
	Grass	HS Maize	s.e.m.	Grass	LS Maize	MS Maize	s.e.m.	Grass	LS Maize	HS Maize	s.e.m.
Maize silage (%)	0	67		0	67	67		0	60	60	
Conc. level (kg/d)	6	6		6	6	6		4	4	4	
Feed Intake											
Silage (kg DM/d)	8.8[a]	10.4[b]	0.35	9.3[a]	10.4[b]	11.0[b]	0.35	10.2[a]	10.5[a]	13.4[b]	0.46
Total "	14.0[a]	15.7[b]	0.35	14.5[a]	15.6[b]	16.2[b]	0.35	13.7[a]	14.0[a]	16.9[b]	0.46
Yield											
Milk (kg/d)	21.4[a]	23.1[b]	0.48	23.8[a]	21.6[b]	22.2[b]	0.50	19.7[a]	20.4[a]	21.9[b]	0.49
Fat (kg/d)	0.81	0.86	0.021	0.80	0.78	0.80	0.024	0.82[a]	0.84[a]	0.90[b]	0.022
Protein (kg/d)	0.65[a]	0.73[b]	0.014	0.69	0.66	0.70	0.016	0.61[a]	0.63[a]	0.71[b]	0.017
Composition											
Fat (g/kg)	37.7	37.6	0.73	33.5[a]	36.0[b]	36.4[b]	0.79	42.5	42.1	41.5	0.84
Protein (g/kg)	30.6	31.6	0.04	29.3[a]	30.6[b]	31.5[b]	0.40	31.1[a]	31.7[a]	32.7[b]	0.33
Lwt. Gain (kg/d)	0.10[a]	0.39[b]	0.07	0.35	0.13	0.38	0.10	0.13	-0.05	0.28	0.14
Diet DMD (g/kg)	768[a]	732[b]	7.0	753	688	688	21.0	740[a]	713[b]	749[a]	6.8

[a, b, c] In each experiment, mean values within rows not showing a common superscript differ significantly (P<0.05).