Comparative evaluation of grass silage, fermented whole crop wheat silage, urea-treated processed whole crop wheat silage and maize silage in the diet of early lactation cows

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Introduction

Whole crop cereal silage is generally made from autumn or spring-sown wheat or barley but can also be made from oats or triticale. The cereal is grown as for high yielding grain production and has conventionally been harvested at DM concentrations of 350-450 g/kg and allowed to ferment in the silo. Urea-treated processed whole crop (UP-WC) is a relatively recent development in conserving mature cereal crops. For UP-WC the whole crop is harvested (with a harvester having a special processing unit capable of milling/cracking the grain passing through it) at a DM concentration of greater than 700 g/kg and treated with an additive containing urea and urease enzyme. Work evaluating the effects of processing at harvesting and the effects of cutting height and the type of supplement offered to dairy cows with UP-WC has been reported (Jackson et al. 2003, 2004) but the comparative feeding value of this feed with other ensiled crops has not been published. The objectives of these trials were to compare the effects of including fermented whole crop wheat, urea-treated processed whole crop wheat, or maize silage with grass silage on intake and milk production and composition of dairy cows.

Materials and Methods

Crops

In 2002 winter-sown wheat was harvested on July 30 for fermented and on August 23 for urea-treated processed whole crop. Biotal Whole Crop Gold was applied as an additive to the fermented crop. In 2003 spring-sown wheat was harvested on August 15 for fermented and September 2 for urea-treated processed whole crop. No additive was used on the fermented crop. In both years Home'n'Dry additive was applied at the clamp to the urea-treated processed whole crop at an estimated rate of 30 kg/t. Approximately 60 % and 95 % of the grain was milled/cracked in the urea-treated processed whole crop in 2002 and 2003, respectively. In both years the grass silage was from second cut material field wilted for approximately 24 h and ensiled without additive. The maize silage was from material harvested in mid October in 2002 and late September in 2003.

Feeding trials

The forage treatments were offered to autumn calving cows in both trials. In 2002/2003 the experiment was a Latin Square design with 4 periods of 4 weeks duration each. Data from weeks 3 and 4 of each period were used to compare the treatments. A total of 16 cows (4 squares of 4 cows each) were on treatments between weeks 8 and 24 of lactation approximately. In 2003/2004 the experiment was a randomised block design with a total of 60 cows. The trial lasted 11 weeks, with the first week used as an adaptation week, and data from weeks 2 to 11 being used to compare treatments. Cows were on trial between weeks 4 and 15 of lactation approximately.

In both experiments the forage treatments consisted of:
(1) grass silage (GS)
(2) a mixture of grass silage and fermented whole crop wheat (F-WCW)
(3) a mixture of grass silage and urea-treated processed whole crop wheat (UP-WCW)
(4) a mixture of grass silage and maize silage (M).
Grass silage made up 33 % of the forage mixtures on a DM basis. Cows were offered 10 kg and 8 kg per head per day of concentrates in 2002/2003 and 2003/2004, respectively and the crude protein content of the concentrates was varied so that crude protein content of the total diets would be similar. In 2002/2003 the grass silage was changed in week 10 of the 16-week trial because of apparently deteriorating quality of the first silage used. The chemical composition of the forages at feeding is shown in Table 1.

Measurements
Milk yield was measured daily and milk composition (fat protein and lactose contents) was measured on one consecutive AM and PM sample weekly. Forage and concentrate intakes were measured daily in an electronic feeding system (Griffith Elder and Company Ltd., Bury St. Edmunds, Suffolk, IP33 2RU, England). Forage dry matter intakes were calculated by applying the DM contents of the forages sampled on Tuesdays and Thursdays (determined by oven drying at 40 °C for 48 h) to the fresh forage intakes. Blood samples obtained in the last week of each period in the 2002/2003 trial were analysed for glucose, non-esterified fatty acids, ß- hydroxy butyrate, total protein and urea. Live weight and body condition score (BCS) were measured at the start and finish of the 2003/2004 trial.

Statistical Analysis
In 2002/2003 mean data from weeks 3 and 4 of each period were analysed to compare treatments. These data were analysed for a balanced Latin Square design taking out effects of treatment, period, square, treatment by square and cow within square. In 2003/2004 the mean data between weeks 2 and 11 of the experiment (first week taken as an adaptation week) were analysed as a randomised block using lactation number, calving date and data in the immediate pre-experimental week as covariates. Differences between means were tested for significance using Students t-test. The effect on performance of including another forage with grass silage was measured by performing an orthogonal contrast between GS and the combined forage mixture treatments.

Results
The grass silage, fermented whole crop wheat silage and the maize silage were all well preserved as indicated by their pH values. The starch content of the maize harvested in 2002 was low which reflected the growing conditions in that year. In both years the starch content of the urea-treated processed whole crop was 40-60 g/kg DM higher than that of the fermented whole crop. The addition of the urea containing Home‘n’Dry additive increased the crude protein content of the urea-treated processed whole crop wheat by 30-40 g/kg DM over the fermented whole crop wheat. The performance of the cows on the treatments is shown in Table 2. In both trials the forage mixtures (F-WCW, UP-WCW and M) resulted in greater ($P<0.001$) forage DM intakes than grass silage alone (GS), with UP-WCW having the highest intake. Milk yield was similar on the forage mixtures in 2002/2003 and was greater ($P<0.01$) than on GS. In 2003/2004 milk yield on M was greater ($P<0.05$) than on GS whereas milk

yields on F-WCW and UP-WCW, though numerically greater, were not significantly greater than on GS. In both trials the yield of fat plus protein was similar on the three forage mixtures and was greater ($P<0.01$) than on GS. In both trials milk protein content was not significantly different between mixed forage treatments and was greater ($P<0.05$) on UP-WCW than GS. Live weight and body condition score (BCS) change were not measured in 2002/2003 because of the trial design but they were measured in 2003/2004. BCS change was not significantly different between treatments but live weight gain was significantly greater on UP-WCW than M. Blood metabolite concentrations were similar on all treatments when measured in 2002/2003.

Conclusions

The results indicate that fermented whole crop wheat, urea-treated processed whole crop wheat and maize silage in mixtures with grass silage increase dry matter intake and milk fat plus protein production compared to grass silage as the sole forage for dairy cows. The largest effect on intake was obtained with the urea-treated processed whole crop and this was partly reflected in significantly greater live weight gain on this forage compared to the maize silage. This however did not fully account for the higher intake on the urea-treated processed whole crop.

References

Jackson, M. A., Sinclair, L. A., Readman, R. and Huntington, J. A. 2003. BSAS Winter Meeting, p117.

Jackson, M. A., Readman, R., Huntington, J. A. and Sinclair, L. A., 2004. Animal Science, 78: 467-476.

Table 1. The chemical composition of the forages (g/kg DM unless specified otherwise)

2002/2003	**Forage Type**				
	Grass Silage		**Fermented Whole Crop Wheat**	**Processed Whole Crop Wheat**	**Maize Silage**
	1	2			
DM (g/kg)	222	257	406	733	221
CP	151	143	86	127	102
NDF	536	520	434	424	553
Ash	78	76	35	28	39
Starch	-	-	282	324	140
pH	4.08	3.98	4.24	6.79	4.20
2003/2004					
DM (g/kg)	231		370	763	302
CP	151		102	132	88
NDF	548		500	498	511
Ash	75		42	42	40
Starch	-		323	341	324
pH	3.99		4.16	6.26	4.14

Table 2. Cow performance on the different forage treatments 2002/2003 and 2003/2004.

	Forage Type[1]				
2002/2003	**GS**	**F-WCW**	**UP-WCW**	**M**	**s.e.m.**
Milk (kg/d)	27.6[a2]	29.7[b]	29.4[b]	29.6[b]	0.57
Fat (kg/d)	1.081[a]	1.132[ab]	1.101[a]	1.194[b]	0.027
Protein (kg/d)	0.846[a]	0.938[b]	0.929[b]	0.919[b]	0.019
Fat (g/kg)	39.6	38.4	37.8	40.4	0.89
Protein (g/kg)	30.7[a]	31.7[b]	31.7[b]	31.2[ab]	0.23
Fat + protein (kg/d)	1.928[a]	2.070[b]	2.030[ab]	2.113[b]	0.040
Forage DMI	8.8[a]	12.8[b]	14.8[c]	11.2[d]	0.38
Total DMI	16.5[a]	20.8[b]	22.7[c]	19.7[b]	0.51
2003/2004					
Milk (kg/d)	30.8[a]	32.8[ab]	31.2[ab]	33.7[b]	0.87
Fat (kg/d)	1.128[a]	1.184[ab]	1.255[b]	1.276[b]	0.045
Protein (kg/d)	0.909[a]	1.015[b]	0.995[b]	1.044[b]	0.025
Fat (g/kg)	36.7[a]	36.2[a]	40.2[b]	38.5[ab]	0.87
Protein (g/kg)	29.7[a]	30.8[ab]	31.9[b]	31.5[b]	0.49
Fat + protein (kg/d)	2.046[a]	2.189[ab]	2.256[b]	2.317[b]	0.065
Forage DMI	8.7[a]	14.3[b]	16.4[c]	13.2[b]	0.44
Total |DMI	15.5 [a]	21.1[b]	23.2[c]	19.9[b]	0.43
Weight change (wk 11-2)	7.1[ab]	16.2[ab]	24.1[a]	3.4[b]	6.15
CS change (wk 11-2)	0.11	0.15	0.15	0.05	0.073

[1] GS = grass silage; F-WCW = grass silage/fermented whole crop wheat (0.33/0.67 on DM basis); UP-WCW = grass silage/urea-treated processed whole crop wheat (0.33/0.67 on DM basis); M = grass silage/maize silage (0.33/0.67 on DM basis)

[2] Means with different superscripts differ significantly (P<0.05)