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The effect of changing the carbohydrate composition of the concentrate component of the diet of grass silage fed cows on milk yield and composition

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Introduction

With the current production targets and pricing structures prevailing within the UK dairy industry, the incentives for the dairy farmer are to maximise milk protein content whilst controlling the yield of milk and milk fat within individual farm quotas. Manipulation of milk fat content by nutritional means is relatively easy, but increasing the protein content of milk by similar means is more difficult and certainly less predictable. Increasing the crude protein content of the diet will invariably stimulate the synthesis of milk protein, but these changes are often associated with a parallel increase in milk volume, such that milk protein content shows little change. In contrast, several studies have shown that changing the nature and amount of carbohydrate in the diet can substantially improve milk protein content; Krohn et al., (1985), Roberts & Martindale, (1990), Yan & Roberts (1992, 1993) and Phipps et al (1993). At the same time, the increased use of caustic treated wheat (soda grain) on U.K dairy farms has in part been associated with consistent improvements which have been observed in milk protein content. The primary aim of this study was to consider the effect of replacing part or all of the concentrate portion of grass silage fed cows with alternative carbohydrate rich feeds on the yield of milk and milk constituents. The second objective was to compare the use of soda grain with a 50:50 mixture of rolled wheat and sugarbeet feed on dairy cow performance.

Methods

Twelve early/mid lactation Friesian cows were individually stall fed in two 6x4 incomplete latin square designs. The diets comprised of ad libitum grass silage (pH 3.98, DM 206, Crude protein 153 (NH_3-12.06 % Total N), NDF 599g/kg DM basis, with an estimated DMD of 78.7%($\pm$0.6) after 72h incubation in the rumen. The concentrate feeds are described in table 1. Each period lasted 5 weeks with measurements of feed intake and milk yield and composition in the final week. Milk samples were taken on separate occasions in the final week and analyzed for fat, protein and lactose using a Foss IRMA (model 133b -Denmark). Statistical Analyses (ANOVA) were carried out for the overall data and included effects of period, cow, diet. A similar comparison was also made between diets SG and RWSBF. Multiple range test (Duncan) was made to compare difference ($P<0.05$) between means of periods, cows, and diets.

Results and Discussion

Silage DM intake averaged 7.6 kg/day with total diet DMI ranging from 14 to 14.8 kg/d. Intakes of DM, OM, ME, FME and CP were all significantly ($P<0.05$) increased on the wheat diets, which had significantly [$P<0.001$] higher FME/ME ratios. Milk yield ranged from 18.7 to 21.2 kg/d, whilst fat content varied between 41.2 and 49.4 g/kg. Milk protein contents showed less variation (30.1 to 33.2 g/kg), but were stimulated by the wheat diets [$P<0.001$] which supplied more protein and energy. Diet BGSBF supplied more protein only, and gave the highest milk yield with the lowest milk fat content, comparable to diet SG. A linear regression model to predict milk Protein Content (PC) was developed from the data-viz:

1. PC= - 4.26 (se6.2) + 45.4 (FME/ME) (se7.9) (R^2= 0.42) (see fig1) whilst multiple regression models based on protein intake- viz:
2. PC = 27.7 (se1.6) - 0.86 Live Weight-Change (kg/d) (se0.4) - 17.9 UDP (kg/d) (se4.8) + 5.9 CP (kg/d) (se0.97) (R^2= 0.50) or energy intake viz:
3. PC = 27.44 (se2.7) - 7.88 DMI (kg/d) (se1.4) + 0.7 ME (se0.12) - 1.12 Starch intake (kg/d) (se0.3) (R^2= 0.47) marginally improved the proportion of biological variation accounted for.

Conclusion

It is concluded that inclusion of wheat in the diet significantly enhanced milk protein content, whilst BG significantly increased milk yield and reduced milk fat content when SBF comprised 40% of the concentrate. Use of rolled wheat and SBF in contrast to soda grain gave the same response in milk protein content, but both milk fat content and yield were increased. This experiment established the positive benefits of either NaOH-treated or rolled wheat on milk protein content whilst indicating that a diet based on barley dark grains and molassed sugar beet feed can stimulate milk protein yield whilst reducing the yield of milk fat.

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Table 1 **Ingredient Content of diets as offered on fresh wt basis to cows fed with grass silage. Analysis (ME MJ/kg***, CP, Starch & NDF g/kg) presented in DM basis.**

	Ingredient								
Diet	**CPD**	**SBF**	**BG**	**SG**	**RW**	**Pmix****	**ME**	**CP**	**Starch**	**NDF**
C	8						11.8	162	189	466
CSBF	6	2					11.8	155	144	466
CSBF1*	5.5	2					11.8	154	134	474
BGSBF		3.2	4.8				11.6	188	11	550
SG				4.5		4	12.0	191	165	479
RWSBF		2			2	4	11.9	197	120	483

* SBF given as mid day meal
** Diets with protein mix: SG plus rape, maize & soya (2.5:2:1); RWSBF (2:3:1).
*** ME estimated on table basis (AFRC - 1993).

Table 2 **The effect of concentrate composition on feed intakes: DM, OM, Crude Protein (kg/day); ME, FME (MJ/day)**

	Diet							
Intake	**C**	**CSBF**	**CSBF1**	**BGSBF**	**SG**	**RWSBF**	**SEM'S**	**SIG**
Silage DM	7.5	7.3	7.6	7.5	8.0	8.0	0.35	NS
Total DM	14.3^{ab}	14.0^{ab}	14.0^{b}	14.1^{ab}	14.8^{a}	14.8^{a}	0.39	P<0.03
Total OM	13.1^{ab}	12.7^{b}	12.7^{b}	12.8^{b}	13.6^{a}	13.5^{a}	0.35	P<0.01
CP	2.3^{c}	2.2^{d}	2.2^{d}	2.6^{b}	2.8^{a}	2.9^{a}	0.06	P<0.0001
ME	169^{bc}	166^{c}	165^{c}	164^{c}	179^{a}	177^{ab}	4.07	P<0.001
FME	127^{b}	129^{b}	128^{b}	129^{b}	145^{a}	145^{a}	3.22	P<0.0001
FME/ME	0.76^{d}	0.78^{c}	0.78^{c}	0.79^{b}	0.81^{a}	0.82^{a}	0.003	P<0.0001

Means in the same line with different superscripts differ significantly (P<0.05)

Table 3 **Cows performance: Milk yield (kg/day); Milk composition (g/kg); Milk constituents (g/day), Energy value of milk (EVl)(MJ/kg) and Live weight (LW)(kg)**

	Diet							
	C	**CSBF**	**CSBF1**	**BGSBF**	**SG**	**RWSBF**	**SEM'S**	**SIG**
Milk yield:	19.9^{bc}	19.6^{cd}	18.7^{d}	21.2^{a}	19.9^{bc}	20.9^{ab}	0.78	P<0.0002
Milk composition:								
Fat	45.8^{b}	49.2^{a}	49.4^{a}	41.2^{c}	41.9^{c}	45.4^{b}	1.3	P<0.0002
Protein	30.1^{c}	30.8^{bc}	30.9^{bc}	31.1^{b}	33.2^{a}	32.7^{a}	0.5	P<0.0001
Lactose	49.2^{a}	47.7^{b}	48.7^{a}	48.6^{a}	48.0^{b}	47.1^{c}	0.8	P<0.03
Milk constituents:								
Fat	907	959	922	870	832	942	46.1	NS
Protein	596^{b}	601^{b}	577^{b}	654^{a}	654^{a}	678^{a}	25.7	P<0.0001
Lactose	978^{ab}	937^{bc}	909^{c}	1026^{a}	956^{bc}	977^{ab}	48.7	P<0.005
EVl	3.3^{b}	3.4^{a}	3.4^{a}	3.1^{c}	3.2^{bc}	3.3^{b}	0.05	P<0.001
LW	598	579	582	583	589	594	10.6	NS

Figure 1 **The effect of FME/ME on milk protein concentration**