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Milk production based on grass/clover silage and cereal feeding

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Introduction

When producing milk according to the rules for organic production, one of the problems is the supply of protein. There is a general shortage of organically produced protein rich feeds and the prices for these feeds are high. Therefore, it is interesting for these producers to evaluate the effect of offering the cows a diet based on home grown feeds only. In most cases, cereals in combination with high quality grass silage makes up a diet that can be produced entirely on Swedish farms. Milk production for cows on such a diet would be lower compared with a diet where a protein rich supplement also is included but there is a lack of information about how large the production drop would be. With this knowledge, it would be easy for the producers to utilize current prices for organically produced milk and feeds to calculate if it would be economically beneficial to exclude protein rich supplement from the cows' diet. High prices for concentrate feeds, in combination with comparatively low milk prices during the last year, have made the following question highly relevant: Which diet is economically most favourable?

The aim with the present experiment was to study the effect of exclusion of protein concentrates in the diet for dairy cows using silage with high or low crude protein contents. The response was evaluated in terms of yield and composition of milk and feed intake. Economic calculations of milk income minus feed cost were made using the result of the experiment and current prices of feed and milk in spring 2013.

Materials and Methods

In a production experiment, a diet with only cereals and grass/clover silage to dairy cows was compared to a diet where protein rich supplements including soybean and rapeseed products, were also included. These two diets were combined with two grass/clover silages with different contents of crude protein (130 and 170 g kg^{-1} DM) in a factorial design with 37 cows of the Swedish Red (SRB) breed during 20 experimental weeks. The silages, offered *ad libitum*, were of first cut and to achieve the higher protein content additional pure red clover silage was added (32% of DM) in a mixer wagon prior to feeding. The low protein silage was to 95 % dominated by timothy (*Phleum pretense)* and meadow fescue (*Festuca pratensis*) . Concentrates were fed according to yield with the assumption of a silage DM intake of 15 kg DM day^{-1} and adjusted regularly.

The four treatments summarized:

1. Silage170 + cereals and protein concentrate
2. Silage170 + cereals
3. Silage130 + cereals and protein concentrate
4. Silage130 + cereals

The data was statistically analyzed with SAS, version 9.1 (SAS Institute Inc., Cary, N.C., USA). Means of the milk production data (kg milk, kg energy corrected milk (ECM) and milk composition), feed intake and nutrient intake throughout the period were analyzed by analysis of variance (Proc GLM, SAS). The fixed factors: silage type, concentrate type and days in milk were treated as independent variables. The interaction between silage type and concentrate type was tested but found to be non-significant and was therefore omitted in the final model. The milk yield at start of the experiment was used as covariate when milk yield was analyzed. Milk fat and milk protein were used as covariates in the same way when they were analyzed. The effect of lactation number was found non-significant and was therefore omitted from the model. When analyzing the data of milk cell counts, logarithmic values were used.

Table 1 Composition of feeds used. Cereals consisted of 36% barley, 34% wheat and 25% oats. Protein concentrate consisted of soy expeller 47%, rapes seed cake 16%, oats 15%, rapeseed 11%. Both cereals and protein concentrate were pelleted and contained binding material, minerals and vitamins. Means with standard deviation within brackets

Item[1]	Cereals	Protein concentrate	Silage170	Silage130
DM, %	89.4 (1.50)	92.0 (1.79)	35.0 (1.20)	36.4 (1.76)
ME, MJ/ kg DM	13.0	15.5	11.3 (0.21)	11.6 (0.11)
AAT, g/kg DM	84	160	72	73
PBV, g/kg DM	-17	99	44	6
CP, g kg DM	125 (17.7)	328 (6.2)	169 (4.3)	132 (3.7)
EE, g/kg DM	34	130	NA	NA
Ash, g/kg DM,	58 (2.0)	76 (3.4)	86 (4.7)	75 (5.9)
Starch, g/kg DM	559	99	NA	NA
NDF, g/kg DM	205	183	414 (19.9)	471 (13.9)

[1)] AAT = metabolizable protein; PBV = protein balance in the rumen, both calculated according to Spörndly (2003); CP = crude protein; EE = ether extract; NDF = neutral detergent fiber.

Results and Discussion

Feed intake data is presented in Table 2 and response in milk production is presented in Table 3. No effects of concentrate type on silage intake were detected (P>0.05). The higher intake of Silage 130 as affected to silage type was partly due to one malfunctioning feeding trough, resulting in 1.75 kg DM of Silage170 consumed by the cows assigned for Silage130. Reducing the intake of Silage130 with this quantity, to 14.7 kg DM, erased the difference in intake between the silages (P>0.05).

The production results showed that milk yield without protein supplement gave a lower milk production but a higher milk fat content (P<0.01), resulting in 30.9 kg ECM and 35.3 kg ECM, respectively. Studying cows over 70 days in milk separately resulted in a slightly lower effect of concentrate type; 3.8 kg ECM less milk instead of 4.5 kg less ECM for cows fed cereals only. There was, however, no effect of silage type on the production parameters (P>0.05), with the exception of a tendency to lower live weight gains when Silage130 was fed (P<0.10). The diet without protein supplement gave an increase in nitrogen efficiency by 20% compared with the diet with the protein supplement.

When designing the experiments, it was believed by some that the higher protein content of Silage170 (compared with Silage130) would result in a higher milk production for the group fed silage170 when only cereals were fed. The higher crude protein content in Silage170 resulted in an excess of soluble protein in the rumen (higher PBV value) but similar estimated amounts of AAT were achieved (1549 and 1625 g AAT for cows fed cereals with Silage170 and Silage130, respectively). As no additional metabolizable protein or energy was added with Silage170, there was no production response (Table 3).

Table 2 Feed intake data. Least square means (LSM) with standard error in brackets

	Effect of concentrate N=37			Effect of silage N=37		
Intake per day	Cereals/conc	Cereals	Sign[1]	Silage170	Silage130	Sign[1]
Silage, kg DM	15.8 (0.58)	14.4 (0.58)	NS	13.8 (0.57)	16.4 (0.57)	(**)[2]
Cereals, kg	1.9 (0.47)	7.1 (0.48)	***	4.8 (0.47)	4.2 (0.48)	NS
Protein conc, kg	4.0 (0.29)	0.0 (0.30)	***	2.0 (0.29)	1.9 (0.30)	NS
Total DM, kg	21.2 (0.74)	20.4 (0.74)	NS	19.7 (0.73)	22.0 (0.74)	NS
ME, MJ	257 (9.7)	246 (10.0)	NS	239 (9.7)	264 (10.0)	Tend
AAT, g	1854 (72.7)	1572 (74.6)	*	1641 (72.7)	1788 (74.6)	NS
PBV, g	777 (37.4)	514 (38.4)	***	876 (37.4)	415 (38.4)	***
Crude protein, g	3887 (153.0)	3096 (157.1)	**	3588 (153.0)	3396 (157.1)	NS
NDF, g	7943 (256.8)	7642 (263.7)	NS	6874 (256.8)	8710 (263.7)	***
Starch, g	1281 (234.4)	3455 (240.7)	***	2526 (234.4)	2209 (240.7)	NS

[1] $P<0.10$ = Tendency; $P<0.05$ = *; $P<0.01$ = **; $P<0.001$ = *** NS= Not significant

[2] The significantly higher silage intake of Silage 130 was partly due to a technical error. One malfunctioning feeding trough made it possible for cows assigned for Silage 170 to steal Silage 130. The quantity of stolen fodder was 1.75 kg DM and made up 11% of the total silage intake. Deducting this amount, the silage intake was reduced to 14.7 kg DM in the Silage 130 group and the difference to Silage 170 was no longer statistically significant.

Table 3 Energy corrected milk (ECM), live weight gain (LWG), body condition score (BCS) and N efficiency. Least square means and standard error in parentheses

	Effect of concentrate N=37			Effect of silage N=37		
	Cereals/conc	Cereals	Sign[1]	Silage170	Silage130	Sign[1]
Kg milk	35.7 (0.97)	30.0 (1.00)	***	32.9 (0.96)	32.8 (0.99)	NS
Kg ECM	35.3 (0.86)	30.9 (0.89)	**	33.6 (0.85)	32.7 (0.87)	NS
Fat, %	4.01 (0.10)	4.40 (0.10)	**	4.21 (0.10)	4.21 (0.10)	NS
Protein, %	3.16 (0.05)	3.25 (0.05)	NS	3.24 (0.05)	3.17 (0.05)	NS
Lactose, %	4.80 (0.02)	4.77 (0.02)	NS	4.80 (0.02)	4.77 (0.02)	NS
Cell counts, log	1.57 (0.10)	1.61 (0.11)	NS	1.55 (0.10)	1.63 (0.11)	NS
LWG, kg	36.8 (7.02)	25.2 (7.02)	NS	40.6 (7.02)	21.4 (7.02)	Tend
BCS	0.28 (0.148)	0.34 (0.125)	NS	0.30 (0.128)	0.31 (0.145)	NS
N efficiency[2], %	28.0 (1.14)	33.6 (1.17)	**	30.6 (1.14)	31.0 (1.17)	NS

[1] $P<0.10$ = Tendency; $P<0.05$ = *; $P<0.01$ = **; $P<0.001$ = ***; NS= $P>0.05$

[2] Calculated as 100*nitrogen in milk /nitrogen intake

From milk production and feed intake data obtained from the experiments, the milk revenue minus feed costs for these diets were calculated using current feed prices in Sweden (February 2013). For organic milk, the price was 3.76 SEK/kg ECM and for cereals and protein supplement mix and grass silage the cost was 3.40 SEK/kg, 6.06 SEK/kg and 1.30 SEK/kg dry matter respectively. This resulted in milk revenues of SEK 2.31 per kg ECM for the protein concentrate treatment and SEK 2.37 for the silage-cereals treatment. As cows on the silage-cereal diet yielded less, they showed a SEK 8.20 lower profit when expressed per cow and day. With prices from the previous year, the results came out differently, demonstrating the importance of always applying the prices relevant for the actual situation to draw the correct conclusion.

Conclusions

Feeding grass/clover silage and cereals only, without protein concentrate, can be expected to decrease the milk production with about 13 %. Increased silage crude protein content above 130 g per kg DM did not increase milk production when fed with concentrate consisting of cereals only.

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