

# Milk production with or without protein supplement in combination with forage at two protein levels

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## Abstract

With the aim to study the effect of protein supplement, two concentrate diets, one consisting of cereal grain only, and one with protein supplements added, were combined with two grass-clover silages with different contents of crude protein (130 and 170 g kg<sup>-1</sup> dry matter) and fed to 37 cows of the Swedish Red breed during 20 weeks. The silages, offered *ad libitum*, were of first cut, and to achieve the higher protein content additional pure red clover silage was added in a mixer wagon prior to feeding. The low protein silage was 95% dominated by timothy and meadow fescue. Concentrate type did not affect silage intake. Cows fed concentrate without protein supplement had a lower milk yield but a higher milk fat content ( $P < 0.01$ ), resulting in 30.9 kg and 35.3 kg energy corrected milk yield (ECM), respectively. There was no effect of silage type on milk yield or milk composition. The diet without protein supplement gave an increase in nitrogen efficiency by 20% compared with the diet with the protein supplement. The experiment was repeated a second year including only one silage quality. Results confirmed reduction in milk yield by excluding protein supplement, from 40.0 to 37.3 kg ECM ( $P < 0.05$ ).

**Keywords:** milk yield, grass-clover silage, cereal grain, feed protein level

## Introduction

Milk production according to the rules for organic production often encounters problems with sufficient supply of feed protein. Shortage of organically produced protein feeds results in high prices. It is also attractive to base organic milk production on solely on-farm produced feeds. Cereal grain (wheat, barley and oats) in combination with high quality grass silage can be produced on most farms with a temperate climate. Milk production on such a diet is expected to be lower compared to a diet including protein concentrates such as soybean meal, but there is a lack of recent information about the likely reduction in milk yield. When excluding the protein supplement from the concentrate, and feeding a low protein concentrate consisting of cereals only, cows would be expected to perform better on protein-rich silage than on silage low in protein. The potential of forage protein to compensate for protein in concentrate supplement has, however, been questioned recently (Huhtanen, 2014). To study these questions two experiments were performed. In the first, the concentrate protein supplement was excluded from the diet for dairy cows using silage with high or low crude protein contents. In a second study the effect of excluding the concentrate protein supplement was studied using only one quality of silage. The response was evaluated in terms of milk yield and composition and feed intake. Economic calculations of milk income minus feed costs were made using the results of the experiments and current prices of feed and milk.

## Materials and methods

### Experiment I

Four diets with feeds described in Table 1 were fed to 37 dairy cows of the Swedish Red breed during 20 weeks of mid lactation. The diets are summarized as:

1. silage170 *ad lib* + cereals and protein concentrate;
2. silage170 *ad lib* + cereals;
3. silage130 *ad lib* + cereals and protein concentrate;
4. silage130 *ad lib* + cereals.

Table 1. Composition of feeds used. Means with standard deviation within brackets.

Item <sup>1</sup>	Cereals	Protein suppl. concentrate	Silage 170 experiment I	Silage 130 experiment I	Silage experiment II
DM, g kg <sup>-1</sup>	894 (150)	920 (179)	350 (120)	364 (176)	252 (25.6)
ME, MJ kg <sup>-1</sup> DM	13.0	15.5	11.3 (0.21)	11.6 (0.11)	11.6 (0.08)
AAT, g kg <sup>-1</sup> DM	84	160	72	73	73
CP, g kg <sup>-1</sup> DM	125 (17.7)	328 (6.2)	169 (4.3)	132 (3.7)	179 (6.5)
EE, g kg <sup>-1</sup> DM	34	130	NA	NA	NA
Starch, g kg <sup>-1</sup> DM	559	99	NA	NA	NA
NDF, g kg <sup>-1</sup> DM	205	183	414 (19.9)	471 (13.9)	431 (22.0)

<sup>1</sup> DM = dry matter; ME = metabolisable energy; AAT = metabolizable protein; CP = crude protein; EE = ether extract; NDF = neutral detergent fibre; NA = not applicable.

Silages were of first cut; low protein (130) herbage was 95% dominated by *Phleum pratense* and *Festuca pratensis*. To obtain the high protein (170) silage, second-cut red clover silage was added in a mixer wagon (32% of dry matter (DM)).

### Experiment II

In this experiment only one silage quality (Table 1) was fed to 32 dairy cows during 12 weeks in early to mid-lactation. Concentrates were identical in both experiments, consisting of 36% barley, 34% wheat and 25% oats (cereals) and soy expeller 47%, rapeseed cake 16%, oats 15% and whole rapeseed 11% (protein suppl.). Both cereals and protein concentrate were pelleted and contained binding material, minerals and vitamins.

### Analysis

The data was statistically analysed by Proc GLM with SAS, version 9.1 (SAS Institute Inc., Cary, NC, USA). The effects of lactation number and interaction between silage type and concentrate type were non-significant and therefore omitted from the final model.

## Results

Feed intake and production results of Experiment I are presented in Table 2. No effects of concentrate type on silage intake were detected ( $P > 0.05$ ). The higher intake of Silage 130 seen as an effect of silage type was partly due to one malfunctioning feeding trough, resulting in 1.75 kg DM of Silage 170 consumed by the cows assigned for Silage 130. Reducing the intake of Silage 130 by this quantity, to 14.7 kg DM, removed 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 and 35.3 kg energy corrected milk (ECM), respectively (Table 2). There was, however, no effect of silage type on the production parameters ( $P > 0.05$ ), with the exception of a tendency for lower live weight gains when Silage 130 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.

The result of Exp II is shown in Table 3. Since no effect of silage protein content was shown in Exp I only one silage quality was used. Instead of offering silage *ad libitum* the diet was balanced with the aim of providing maximum metabolizable protein from the forage and cereal-only diet. This resulted in a less pronounced drop in milk production for cows on the cereal-only and silage diet.

## Conclusions

Feeding grass-clover silage and cereals only, without protein concentrate, decreased fat corrected milk production by 7-12%. Increased silage crude protein content above 130 g per kg DM did not increase milk production when cows were fed a concentrate consisting of cereals only. The milk revenue minus

Table 2. Feed intake and production results in Experiment I. Least square means with standard error in brackets

Effect per day <sup>1</sup>	Effect of concentrate (n=37)			Effect of silage (n=37)		
	Cereals/conc	Cereals	Sign <sup>2</sup>	Silage170	Silage130	Sign <sup>2</sup>
Silage intake, kg DM	15.8 (0.58)	14.4 (0.58)	NS	13.8 (0.57)	16.4 (0.57)	**
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
Energy intake, MJ	257 (9.7)	246 (10.0)	NS	239 (9.7)	264 (10.0)	*
AAT intake, g	1,854 (72.7)	1,572 (74.6)	*	1,641 (72.7)	1,788 (74.6)	NS
CP intake, g	3,887 (153.0)	3,096 (157.1)	**	3,588 (153.0)	3,396 (157.1)	NS
NDF intake, g	7,943 (256.8)	7,642 (263.7)	NS	6,874 (256.8)	8,710 (263.7)	***
Milk yield, kg	35.7 (0.97)	30.0 (1.00)	***	32.9 (0.96)	32.8 (0.99)	NS
ECM, kg	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
LWG, kg	36.8 (7.02)	25.2 (7.02)	NS	40.6 (7.02)	21.4 (7.02)	*
N efficiency <sup>2</sup> , %	28.0 (1.14)	33.6 (1.17)	**	30.6 (1.14)	31.0 (1.17)	NS
CP content, g kg <sup>-1</sup>	183	152		182	154	

<sup>1</sup> ECM = energy corrected milk yield; DM = dry matter; AAT = metabolizable protein; CP = crude protein; NDF = neutral detergent fibre; LWG = liveweight gain.

<sup>2</sup> P<0.05 = \*; P<0.01 = \*\*; P<0.001 = \*\*\*; NS = not significant.

Table 3. Feed intake and production results in Exp. II. Least square means (LSM) with standard error in brackets

Effect per day <sup>1</sup>	Cereals/conc	Cereals	Sign <sup>2</sup>
Silage intake, kg DM	10.4 (0.22)	12.0 (0.22)	***
Cereal intake, kg	8.5 (0.27)	10.6 (0.27)	***
Prot. Conc. intake, kg	4.2 (0.05)	0.0	***
Energy intake, MJ	273 (4.6)	58 (4.6)	*
AAT intake, g	1,980 (31.4)	1,649 (31.4)	***
CP intake, g	4,103 (61.4)	3,343 (61.4)	***
NDF intake, g	6,142 (108.2) (256.8)	6,586 (108.2)	**
Milk yield, kg	41.4 (0.93)	36.4 (0.93)	***
ECM, kg	40.0 (0.71)	37.3 (0.71)	*
Fat, %	3.76 (0.131)	4.15 (0.131)	*
LWG, kg	15.4 (4.91)	-5.3 (0.107)	**
N efficiency <sup>2</sup> , %	31.5 (0.72)	35.4 (0.72)	***

<sup>1</sup> ECM = energy corrected milk yield; DM = dry matter; AAT = metabolizable protein; CP = crude protein; NDF = neutral detergent fibre; LWG = liveweight gain.

<sup>2</sup> P<0.05 = \*; P<0.01 = \*\*; P<0.001 = \*\*\*; NS = not significant.

feed-costs calculated, using feed prices in Sweden as of January 2015, resulted in better net revenue for milk income minus feed-cost per kg ECM for cows fed forage and cereals only. This was the case based on applying conventional prices but it was most evident when prices for organically produced feeds and organic milk was used.

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## References

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