

**ENERGY LEVEL AND STRATEGY OF FEEDING FOR DAIRY  
COWS IN THE DRY PERIOD****O. Aaes, K. L. Ingvarsten, J. B. Andersen****Abstract**

The effect of feeding strategy in the dry period on performance and health was investigated in two experiments comprising 80 and 96 dairy cows. In exp. 1 the effect of energy level (Normal and High (1.5 x N) and the effect of a daily ruminal SCFA-burst (+ and -) in the last 4 weeks of the dry period were examined. In exp. 2, only SCFA-burst was included. Sixteen cows were slaughtered for ruminal examination. SCFA-burst was induced by allocating 4.5 kg barley in the morning and roughage in the evening. After calving concentrate was gradually increased to a level of 9 kg DM and grass silage was ad. lib in all groups.

The SCFA-burst increased grass silage intake in the first 5 weeks post partum in exp. 1 but not in exp. 2. In exp. 1 there was an interaction between feeding level and SCFA-burst on milk production, while no difference between treatments were seen in exp. 2. The SCFA bursted cows had a lower incidence of ketose and digestive disorders in the first experiment but not in the second, and there was a tendency to increased activity in the ruminal mucosa but without any macroscopical differences. It is concluded that none or only small benefits are obtained from SCFA-bursts in the dry period on feed intake, performance, health, and reproduction.

*Introduction*

Increasing yield capacity has opened the gap between energy intake capacity and energy requirement for milk production in early lactation. To avoid excessive mobilization of body stores, energy concentrations in the feed is increased by exchanging digestible cell walls with sugar and starch in concentrates. Rumen fermentation of these feedstuffs is rapid and result in accumulation of short-chain fatty acids (SCFA), low pH, decreased

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digestibility of cell wall carbohydrates in the rumen and lowered feed intake and increasing number of rumen acidosis and other related disorders. To reduce these problems an increased SCFA absorption capacity at calving would be desirable. It is known that changes in rumen papillae can be nutritionally induced (Mayer et al., 1986). At low feeding intensity, as in the dry period, the rumen papillae decreases in size and number and the total area of the rumen wall and probably the absorption capacity are reduced.

Feeding intensity is generally increased around calving which induces the rumen papillae to increase in number and size, but regeneration to maximal dimension last about 7-10 weeks (Mayer et al., 1986). It is shown that fluctuations, rather than constant high amounts of SCFA, stimulate the rumen epithelial growth (Sakata & Tamata, 1978). Therefore it has been suggested that manipulation of the SCFA concentration by a SCFA-burst once a day through the dry period, might be a possible method to obtain maximal development of the ruminal mucosa at calving (Nørgaard, 1988).

SCFA-burst is a feeding strategy in the dry period where the intention is to stimulate the growth of the rumen papillae without increasing the energy level. SCFA-burst can be induced by allocating a starch or sugar rich feedstuff at one feeding and roughage at another feeding during the day.

The objective of this work are to examine the effect of feeding level and a feeding strategy with a feeding induces SCFA-burst once a day on rumen mucosa development, feed intake, performance, health and reproduction.

#### *Material and Methods*

Two experiments with 176 HF cows were conducted to evaluate the effect of a feed induces SCFA-burst. The first experiment was designed as a 2 x 2 factorial experiment with two energy levels (Normal, N; High, H) and two strategies for concentrate feeding (Control; SCFA-burst). In the second experiment the treatments were Control or SCFA-burst during the dry period. The experimental plans are shown in table 1. The two energy levels in exp. 1 were 6.5 and 10.0 Feed Units (FU, Weisbjerg & Hvelplund, 1993) per cow per day at normal and high energy level, respectively. The control groups were fed two times daily with grass silage and concentrates according to the plan. The SCFA-burst groups were fed with 4.5 kg rolled and pelleted barley in the morning (4.5 kg barley = 4.5 FU) while grass silage were fed in the afternoon only.

The cows were dried off 7-8 weeks before expected calving and feed 5.5 FU of grass silage until the beginning of the experimental period 4 weeks before calving. After calving all cows in exp. 1 were fed grass silage al lib. and concentrate was increased from 2.5 kg to 10.2 kg in 15 days. In exp. 2 one third of the cows were treated as exp. 1 another third was subjected to slower

increase of concentrate (through 26 days instead of 15 days) and the last third were fed a total mixed ration with 50% grass silage DM ad libitum. No interactions were observed between prepartum and post partum treatments. The effect of post partum treatments are reported elsewhere (Ingvartsen & Aaes, 1995).

Table 1. - EXPERIMENTAL PLAN

Energy level	Treatment Feeding strategy	No. of cows		Period		
		Exp. 1	Exp. 2	7-5 week before calving	Least 4 weeks before calving	After calving
Normal (N)	Control (C)	15	47	Grass silage 5.5 FU	Grass silage 5.5 FU Concentrate 1.0 FU	Exp. 1 Grass silage ad lib. Concentrate
	SCFA-burst (S)	16	46	Grass silage 5.5 FU	Grass silage 2.0 FU Barley 4.5 FU	increased from 2.5 kg to 10.2 kg in 15 days
High (H)	Control (C)	15		Grass silage 5.5 FU	Grass silage 6.5 FU Concentrate 3.5 FU	Exp. 2 1/3 like exp. 1, 1/3 like exp. 1 except slower increase in concentrate (26 days instead of 15).
	SCFA-burst (C)	16		Grass silage 5.5 FU	Grass silage 5.5 FU Barley 4.5 FU	1/3 total mixed ration ad lib. with 50% grass silage DM.

\* SCFA-burst: Feed induced SCFA-burst in the rumen over a day by 4.5 kg barley  
FU = Feed Unit (Weisbjerg & Hvelplund, 1993).

In exp. 1 16 non-pregnant cows (4 of each treatment) were slaughtered at the end of the experimental period for a macroscopical and histological examination of the rumen epithelium. The rumen was rinsed and tissue from the atrium area was collected immediately after slaughter for examination of papillae size and form scored after a scala modified from Mgasa (1991). Tissue samples were fixed in formalin, cut in 4 to  $\mu\text{m}$  thick section and stained for a histological examination.

### Results and Discussion

The effect of prepartum treatments on daily feed intake, milk production, digestion and metabolic disorders from exp. 1 and 2 are presented in Table 2-4. Prepartum energy level did not significantly affect any of the measured

parameters. However, there was a tendency to higher milk yield in cows fed high energy level prepartum. This results support the findings of others who reports no significant effect of energy level, composition of the ration or steaming up with concentrate before calving (Boisclaer et al., 1986; Nocek et al., 1986 and Flipot et al., 1988). Others reports that high energy level in the dry period had a negative effect on feed intake and health after calving without any positive effect on performance, especially if the cows were over conditioned at calving (Emery et al., 1969; Fronk et al., 1980 and Johnson, 1984).

Table 2. - DAILY FEED INTAKE DEPENDED ON ENERGY LEVEL AND DAILY RUMINAL SCFABURST IN THE DRY PERIOD (LSM)

	Weeks post partum	Experiment 1				Standard deviation	Experiment 2 (Normal energy level)		
		Normal energy level Control	SCFA-burst	High energy level Control	SCFA-burst		Control	SCFA-burst	Standard deviation
No. of animals		15	16	15	16		47	46	
Concentrate mix. kg DM	0-5	7.7	7.5	7.8	7.6	2.0	7.3	7.1	0.6
	6-12	9.1	9.1	9.1	9.1	0.4	9.3	9.3	0.8
	0-12	8.5	8.4	8.6	8.5	1.5	8.5	8.4	0.7
Grass silage kg DM	0-5	6.7	7.7	7.1	7.9	2.2	8.5	7.9	1.8
	6-12	9.0	8.8	8.8	9.0	2.1	9.6	9.5	1.7
	0-12	8.0	8.4	8.1	8.5	2.3	9.1	8.8	1.1
Total Dm intake, kg	0-5	14.5	15.2	14.9	15.5	2.9	15.8 <sup>a</sup>	15.0 <sup>b</sup>	1.8
	6-12	18.1	17.9	17.9	18.0	2.1	18.9	18.7	2.2
	0-12	16.6	16.8	16.6	17.0	2.9	17.6	17.2	1.9
Scandinavian Feed Units	0-5	15.4	16.0	15.8	16.2	3.0	15.8 <sup>a</sup>	15.1 <sup>b</sup>	1.6
	6-12	18.9	18.8	18.7	18.9	1.8	19.4	19.2	2.0
	0-12	17.4	17.6	17.5	17.8	2.8	17.9	17.5	1.8

<sup>ab</sup> Different letter mean significant difference P<0.05

Silage intake in week 2 to 4 was depressed in the control groups causing a significant higher intake of grass silage in the first 5 weeks in the SCFA burst groups in exp. 1. In exp. 2 which include 50% more cows this difference was opposite although not significant. After 5 weeks post partum no difference was observed in intake in any of the experiments. It is difficult to explain the inconsistent results during the 5 first weeks in lactation in the two experiments, but a possible explanation could be a higher frequency of metabolic disorders in the control groups in exp. 1.

Table 3. - DAILY MILK YIELD AND MILK COMPOSITION DEPENDED ON ENERGY LEVEL AND DAILY RUMINAL SCFA-BURST IN THE DRY PERIOD (LSM)

	Weeks post partum	Experiment 1				Standard deviation	Experiment 2 (Normal energy level)		
		Normal energy level Control	Normal energy level SCFA-burst	High energy level Control	High energy level SCFA-burst		Control	SCFA-burst	Standard deviation
No. of animals		15	16	15	16		47	46	
ECM, kg	0-5	33.1	31.3	33.4	34.3	3.5	34.7	33.7	4.0
	6-12	34.0	32.4*	32.3	34.6	3.8	33.6	33.6	2.9
	0-12	33.6	31.8*	32.8	34.5	3.4	34.0	33.6	3.3
Milk, kg	0-5	31.7	30.4	31.8	32.7	3.0	32.4	31.6	3.7
	6-12	34.7	33.4	33.4	35.3	3.7	34.3	34.6	2.9
	0-12	33.4	31.8	32.7	34.1	3.2	33.4	33.3	3.0
Fat%	0-5	4.39	4.32	4.44	4.49	0.47	4.66	4.60	0.57
	6-12	3.93	3.89	3.83	3.97	0.46	3.94	3.90	0.41
	0-12	4.12	4.09	4.09	4.19	0.41	4.34	4.19	0.53
Protein	0-5	4.78	4.77	4.74	4.80	0.19	3.35	3.35	0.21
	6-12	4.93	4.89	4.85	4.93	0.15	3.06	3.03	0.11
	0-12	4.87	4.84	4.87	4.88	0.15	3.18	3.17	0.16

\* Significant effect of energy level \* feeding strategy (P<0.05).

Table 4. - DIGESTIVE AND METABOLIC DISORDERS IN THE FIRST 5 WEEKS POST PARTUM DEPENDED OF ENERGY LEVEL AND SCFA-BURST IN THE DRY PERIOD

	Experiment 1				Experiment 2	
	Normal energy level Control	Normal energy level SCFA-burst	High energy level Control	High energy level SCFA-burst	Normal energy level Control	Normal energy level SCFA-burst
No. of animals	15	16	15	16	47	46
Ketose	3	0	3	1	4	4
Rumen acidose	1	0	3	0	5	2
Diarre	6	1	5	1	4	7
Total*	10	1	11	2	13	13

\*Total = Ketose + Rumen acidose + Diarre

At normal energy level in the dry period the SCFA-burst group produced 1.8 kg ECM less than the control group, but this was opposite in the cows fed the high energy level. However, none of the interaction between energy level and SCFA-burst was significant in the first 5 weeks. In exp. 2 there was no significant difference in milk yield or milk composition.

The numerically lower milk yield and higher feed intake of the group on low energy and SCFA-burst in the dry period, agrees with a shorter mobilizing period and less kg body weight mobilized than in the other groups. But at the same feeding regime in exp. 2 no difference was found in weight loss or length of mobilizing period.

Table 4 shows the frequency of ketose and digestive disorders during the first 5 weeks of lactation. In exp. 1 the frequency was very high and nearly all cases were in the control groups. The high frequency of disorders in the control groups is difficult to explain since it is much higher than normal for this treatment which is the standard treatment of dry cows in Denmark. Furthermore, no such difference was observed in exp. 2. Olsson et al. (1991) found more diarrhea in cows fed 8 kg concentrate at calving and Nocek et al. (1986) found that corn-silage alone in the dry period gave more displaced abomasum after calving, but others did not find any effect of feeding strategy in the dry period on disorders (if the condition score was not altered) (Emery et al., 1969; Johnson and Otterby, 1981). No significant differences in days to first oestrous and days to pregnancy was found in neither of the two experiments.

Table 5. - DRY WEIGHT OF STRIPPED DRIED RUMEN MUCOSA, HEIGHT OF LAMINA EPITHELIALIS AND STRUCTURE OF THE PAPILLAE IN THE ATRIUM

Energy level	Feeding strategy	Mucosa dry weight <sup>1</sup> mg per 25 cm <sup>2</sup>	Height of lamina epithelialis <sup>1</sup> , µm	Structure of papillae <sup>2</sup>
Normal	Control	1042±90	328±22	3(3-3)*
	SCFA burst	1036±90	376±22	3 (2-4)
High	Control	902±104	371±25	4 (3-4)
	SCFA burst	918±90	356±22	3 (3-4)

\* Score: 1 = Short and slender/pointed; 2 = Short and leaflike; 3 = Long and slender; 4 = Long and leaflike.

1: Data are least squares means ± Std. err.; 2: Data are the median (minimum - maximum).

The results of the macroscopical and histological examination are shown in table 5 and 6. No effect of the parturition treatments were observed in epithelial dry weight of stripped rumen mucosa, in the height of lamina epithelialis, or in the size of the papillae. The overall qualitative histological description of ruminal mucosa from the atrium area showed a tendency to increased activity since a higher degree of hyperplasia, acanthosis and rete-peg formation was observed. There were no sign of patho-anatomical effects of the treatments. These findings agrees with findings in sheep by Holtenius et al. (1994). Epithelial growth might therefore not be the primary mechanism in the

adaptation of the forestomach to increased feed intensity at dairy cows. It could instead be the capacity of a SCFA transport mechanism in the epithelial (Sehested, 1994) which could be a subject for a feed-induced adaptation, but the production experiments did not confirm that.

Table 6. - OVERALL QUALITATIVE HISTOLOGICAL DESCRIPTION OF RUMINAL MUCOSA FROM THE ATRIUM AS AN EFFECT OF ENERGY LEVEL AND FEEDING STRATEGY FOR DRY COWS

Feeding Level	Feeding Strategy	Overall qualitative histological description of the ruminal mucosa from the atrium	
		Normal evolution picture (a)	Patho-anatomic picture (b)
Normal	Control	Smallest development. Low degree of hyperplasia and acantosis. Few occurrences of rete-peg formations. No sign of hyperkeratosis.	No patho-anatomic occurrence. Low degree of cell infiltrations in the lamina propria
	SCFA-burst	Largest development. Severe degree of hyperplasia, acantosis and rete-peg formations. Hyperkeratosis in the stratum corneum.	No patho-anatomic occurrence. Low degree of cell infiltrations in the lamina propria and occurrence of granulocytes, lymphocyt and micro abscesses in connection with high dilatation of the lymph vessels.
High	Control	High variation and no general tendency.	No patho-anatomic occurrence in two cows. One cow showed same tendency as for SCFA-burst.
	SCFA-burst	Largest development. Severe degree of hyperplasia, acantosis and rete-peg formations. Hyperkeratosis in the stratum corneum.	No patho-anatomic occurrence. Low degree of cell infiltrations in the lamina propria and occurrence of granulocytes, lymphocyt and micro abscesses in connection with high dilatation of the lymph vessels.

### Conclusion

The results confirmed that there is not benefits from increasing energy level in the dry period compared to normal standard if the supply of nutrients is sufficient according to requirments.

Although there were inconsistent results in the two experiments the conclusion is that there is not or only minor effects of the feeding strategy with SCFA-burst on performance, feed intake, health, reproduction and development of rumen mucosa. However, there was a tendency to increased activity in the mucosa. This could mean that if cows are feed very low quality of roughage for long time before calving, there might be a benefit of the feeding strategy with a SCFA-burst.

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## RAZINA ENERGIJE I STRATEGIJA HRANIDBE MLIJEČNIH KRAVA U SUHOSTAJU

### Sažetak

Djelovanje strategije hranidbe u suhostaju na proizvodnju i zdravlje istraživalo se u dva pokusa što su obuhvatila 80 i 96 mliječnih krava. U pokusu br. 1 ispitivalo se djelovanje razine energije (normalna i visoka (1.5 x N)) i djelovanje dnevnog sagorjevanja kratkolančanih masnih kiselina (KLMK) u preživača (+ i -) u zadnja četiri tjedna suhostaja. U pokusu br. 2 uključeno je samo sagorjevanje KLMK. Šesnaest je krava zaklano radi ruminalnog pregleda.

Sagorjevanje KLMK je inducirano davanjem 4.5 kg ječma u jutro i kabaste hrane (roughage) na večer. Nakon telenja koncentracija je postepeno povećavana do razine od 9 kg ST a sliža trave bila ad lib. u obje skupine.

Sagorjevanje KLMK povećalo je uzimanje silaže trave u prvih pet tjedana post partum u pokusu br. 1, ali ne u pokusu br. 2. U pokusu br. 1 postojalo je međusobno djelovanje između razine hranjena i sagorjevanja KLMK na proizvodnju mlijeka, dok u pokusu br. 2 nije primijećena nikakva razlika. U krava s pojačanim sagorjevanjem KLMK došlo je do rjeđe pojave ketoze i probavnih smetnji u prvom pokusu ali ne u drugom, te je postojala tendencija povećanja aktivnosti u mukozi rumena, no bez makroskopskih razlika. Zaključeno je da se sagorjevanjem KLMK ne postiže nikakvo ili samo neznatno pozitivno djelovanje u suhostaju na uzimanje hrane, proizvodnju, zdravlje i reprodukciju.

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