

SUBCLINICAL KETOSIS AND MILK PRODUCTION IN FINNISH DAIRY COWS

P.V.A. Miettinen, J.J. Setälä*

Department of Anatomy, University of Kuopio, P.O. Box 1627, SF-70211 Kuopio, Finland

*Finnish Co-Operative Dairies' Association, Helsinki, Finland

INTRODUCTION

Many dairy cows are unable to consume sufficient food to meet their production and maintenance requirements in early lactation and mobilize body reserves for milk production. Bovine ketosis results from an input / output imbalance in energy metabolism. The economic consequences of disturbances due to bovine ketosis are of great importance.

The subsequent reproductive performance (5) and the energy balance (2) are negatively associated with milk yield and so the energy intake is positively related to reproductive performance (2, 4, 7). In contrast to measured energy balance (energy balance = consumed energy - required energy) subclinical ketosis; a stage of low energy balance, reflected as elevated levels of ketone bodies, reduced milk yield (3) as well as negatively affects reproductive performance in dairy cows (6, 7, 8), thus a cow with a low milk production should be less fertile, too.

The aim of this study was to determine the relationship between milk production and subclinical ketosis in Finnish dairy cattle.

MATERIALS AND METHODS

A total of 104 dairy cows (aged 3-10 years) from 42 herds were included in this study. They were housed indoors and fed grass silage, concentrate and hay according to Finnish feeding practice and standard. The calving season studied was from February to June.

Individual milk samples were obtained at the first, second and third monthly milk recording for determination of milk components. For determination of acetone and urea a milk sample was obtained at the first and second milk recording and once between the monthly controls. In addition, for determinations of urea, as an indicator of excess feeding of protein, a milk sample was obtained at dry up.

Fat and protein contents of milk were analyzed using automated Fossomatic analyzer. In whole milk samples the acetone content was determined by flow injection analysis with a FIAstar 5010/5020 chromatograph analyzer and the urea content was analysed according to RAJAMÄKI and RAURAMAA (9).

The relationship between milk production and acetone concentration was evaluated for different stages of puerperium; the cows were divided into groups according to the time of sampling after calving. At dry up the body condition of the cows was estimated according to the following scoring system: 3 = fat, 2 = moderately fat, 1 = thin. To determine a threshold for effect of increased ketone level on milk production, the cows were also divided into groups according to different levels of acetone. The cows were inseminated from 6 weeks postpartum and pregnancy was confirmed by rectal palpation 2-4 months after insemination.

Student's t-test and regression analysis were used in statistical evaluation using

the SPSS-PC statistical package.

RESULTS

The milk production was negatively correlated with acetone concentration in early lactation (Table 1).

Table 1. Correlations between components of milk in three successive milk recording after calving (1,2,3) and acetone concentration in milk by 3-4, 5-6 and 7-8 weeks postpartum. Milk = milk yield, Prot % = percentage of milk protein, Fat % = percentage of milk fat, Prot = yield of milk protein, Fat = yield of milk fat, P / F = protein / fat ratio in milk, r = regression coefficient; significance, * = $p \leq 0.05$, ** $p < 0.01$, *** = $p < 0.001$.

Parameter	3 - 4 weeks p.p.		5 - 6 weeks p.p.		7 - 8 weeks p.p.	
	r	p	r	p	r	p
Milk 1	-0.388	***	-0.105	ns.	-0.185	ns.
Milk 2	-0.337	**	-0.107	ns.	-0.152	ns.
Milk 3	-0.160	ns.	+0.080	ns.	+0.048	ns.
Prot% 1	-0.015	ns.	-0.163	ns.	-0.093	ns.
Prot% 2	+0.001	ns.	-0.139	ns.	-0.082	ns.
Prot% 3	+0.109	ns.	-0.153	ns.	-0.250	*
Fat% 1	+0.132	ns.	+0.017	ns.	+0.255	*
Fat% 2	+0.130	ns.	+0.059	ns.	+0.148	ns.
Fat% 3	+0.094	ns.	-0.089	ns.	+0.041	ns.
Prot 1	-0.346	**	-0.187	ns.	-0.232	ns.
Prot 2	-0.297	**	-0.151	ns.	-0.163	ns.
Prot 3	-0.119	ns.	+0.018	ns.	-0.044	ns.
Fat 1	-0.221	*	-0.092	ns.	+0.007	ns.
Fat 2	-0.193	ns.	-0.133	ns.	+0.019	ns.
Fat 3	-0.068	ns.	-0.007	ns.	+0.062	ns.
P / F 1	-0.130	ns.	-0.110	ns.	-0.300	*
P / F 2	-0.106	ns.	-0.040	ns.	-0.210	ns.
P / F 3	-0.012	ns.	+0.015	ns.	-0.128	ns.

Those cows that had by 3-4 weeks after calving more than 0.05 mmol/l acetone in their milk had a lower milk yield and a lower protein yield in early lactation than cows with a low level of acetone .

By 5-6 weeks p.p. cows with a low (≤ 0.05 mmol/l) acetone level had the highest level of milk protein in all three milk recordings. The difference was significant ($p <$

0.01) in the third milk recording.

Cows that had a low (≤ 0.05 mol/l) acetone level by 7-8 weeks had a low fat yield and a high percentage of milk protein in the third milk recording.

High urea levels in late lactation were associated with a low percentage of milk protein at the first and second milk recording; $r = 0.30$, $p < 0.01$ and 0.26 , $p < 0.05$, respectively.

Body condition at dry up was associated with the milk composition in subsequent lactation. Cows with a thin body condition had the highest percentage of protein and a highest protein/fat ratio, whereas cows with a fat body condition had the highest percentage of fat and the highest yield of fat as well as the highest milk yield. The protein yield was similar in thin and fat body condition groups.

By 3-4 weeks p.p. the yield of milk protein and that of milk affected significantly the interval from calving to conception, $r = 0.31$, $p < 0.05$. By 7-8 weeks p.p. a high percentage of milk fat and a high fat yield were correlated with the time of first insemination, $r = 0.28$, $p = 0.06$; $r = 0.27$, $p = 0.07$, respectively, whereas the time from calving to conception was significantly associated with a high protein yield, high milk yield and high fat yield; $r = 0.41$, $p < 0.01$; $r = 0.40$, $p < 0.01$; $r = 0.35$, $p < 0.05$, respectively.

A low percentage of milk protein in the third milk recording was associated with a long interval from calving to first insemination and to conception, $r = 0.22$, $p < 0.05$; $r = 0.26$, $p < 0.05$, respectively.

DISCUSSION

Subclinical ketosis may be defined as a stage of increased level of ketone bodies without clinical signs. The critical threshold for subclinical ketosis should in any way affects adversely the health of dairy cattle including productivity for example fertility (8) or milk production. According to this study, acetone levels in milk more than a threshold of 0.05 mmol/l acetone negatively influenced the milk production. Although the high-yielding cows had a low acetone levels the high milk production was associated with curtailed fertility. A high yielding cow might make the most of ketogenesis or of other metabolic pathways in the liver forming less ketone bodies.

A cow with thin (=normal) body condition at dry up, fed restricted in late lactation with a high and adequate feeding in early lactation gives the highest protein yield with a low fat yield. The protein / fat ratio in milk might be helpful in monitoring the feeding balance.

It is concluded ketotic cows could not achieve the potential milk yield. Subclinical bovine ketosis in early lactation reduces milk production, especially milk protein yield. In an individual cow a high milk production curtail reproductive performance.

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SUMMARY

The relationship between subclinical ketosis and milk production in dairy cattle were studied in 104 dairy cows in middle Finland. By 3-4 weeks p.p. a low acetone concentration in milk was significantly associated with high milk yield and high yield of milk protein in the first and second milk recording. By 7-8 weeks p.p a high level of acetone was correlated with a high percentage of milk fat and with a low protein/fat ratio by 3-4 weeks postpartum as well as with a low percentage of milk protein in the third milk recording. A high milk yield curtailed significantly the interval from calving to conception.

Subclinical bovine ketosis in early lactation reduces milk production, especially milk protein yield. In an individual cow a high milk production curtails reproductive performance. A high-yielding cow might make the most of ketogenesis or other metabolic pathways in the liver forming less ketone body.

ZUSAMMENFASSUNG

Beziehungen zwischen der subklinischen Ketose und der Milchleistung wurden bei 104 Milchkühen untersucht. Eine niedrige Azetongehalt in Milch p.p. war mit einer hohen Milch- und Eiweissmenge korreliert. Eine hohe Tagesmilchleistung beeinträchtigt die Fruchtbarkeit.

RÉSUMÉ

Les rapports entre la cétose subclinique et la production de lait chez les bovins ont été étudiés sur 104 vaches laitières dans le centre de la Finlande. Trois à quatre semaines après la parturition, une faible concentration d'acétone dans le lait a été associée, d'une façon significative, à une production élevée de lait et de protéine de lait, lors du premier et deuxième contrôle mensuel. 7 à 8 semaines après parturition, un haut niveau d'acétone était en corrélation avec un taux élevé de graisse de lait et avec une faible proportion de la protéine et de la graisse, trois à quatre semaines après parturition ainsi qu'avec un taux faible de la protéine de lait au troisième contrôle mensuel. Un rendement élevé de lait a raccourci sensiblement l'intervalle entre le vêlage et la conception.

La cétose bovine subclinique au début de la lactation diminue la production de lait, en particulier celle de la protéine de lait. Sur une vache individuelle, une production élevée de lait raccourcit la performance reproductive. Une vache avec une production élevée de lait bénéficie mieux de la cétogénèse ou d'autres phénomènes métaboliques dans le foie en formant moins de corps cétoniques.