A RELATIONSHIP BETWEEN THE ACTIVITY AND NEFA-LEVEL OF POSTPARTUM DAIRY COWS.

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Key words: energy balance, NEFA, pedometer, post partum period

Introduction

As summarized by Rukkwamsuk et al. [12], in dairy cows, overfeeding during the dry period leads to overcondition at calving and to depression of appetite after calving. As a consequence, at calving, overconditioned high-producing dairy cows inevitably go into a more severe negative energy balance (NEB) postpartum than cows that have a normal appetite. During the period of NEB, the energy requirements of the cow are satisfied by lipolysis and proteolysis. Lipolysis results in an increased concentration of non esterified fatty acids (NEFA) in the blood. In the liver, these NEFA are predominantly esterified to triacylglycerols (TAG) that are secreted in very low density lipoproteins (VLDL). In early lactation in cows with a severe NEB, the capacity of the liver to maintain the export of the TAG in the form of VLDL in balance with the hepatic TAG production is not always adequate. As a result, the excess amount of TAG accumulates in the liver, leading to fatty infiltration of the liver (hepatic lipidosis or fatty liver). The NEB and/or fatty liver postpartum are frequently associated with postparturient problems. In general, a severe NEB induces changes in biochemical, endocrinological, and metabolic pathways that are responsible for production, maintenance of health, and reproduction of the postparturient dairy cow. These changes include a decrease in blood glucose and insulin concentrations, and an increase in blood NEFA concentrations. High NEFA concentrations caused by intensive lipolysis are accompanied by impairment of the immune system, making the cows more vulnerable to infections [2,13]. Metabolic diseases such as ketosis, milk fever, and displaced abomasum are related to overcondition at calving. The changes in biochemical, endocrinological, and metabolic pathways are associated with delay of the first visible signs of oestrus, an increase in the interval from calving to first ovulation, a decrease in conception rate, and a prolonged calving interval [6,10]. It is possible that the increased blood NEFA concentration directly impairs ovarian function [8] or that the effects are mediated through leptin [1,7].

For a dairy farmer it is, therefore, important to know the energy status of the individual cows. The energy balance of the herd can be predicted by calculations of the ration. However, for individual cows this is not possible in practical conditions [5]. The veterinarian can take a blood sample to determine e.g. the level of Non Esterified Fatty Acids (NEFA) as an indication for the energy status of the particular cow. However, this takes time to be assayed and is also rather expensive. It would be useful to have a simple, non invasive, way of determining the energy status of the individual cow. Such a method could be the estimation of the body condition score (BCS) by the farmer [3,4,9]. However, this is not a very precise method. A number of dairy farms use pedometers to measure the walking activity of the cows automatically. This activity is related to estrous behavior and used in the detection of estrus. If the activity of a dairy cow would be related to the energy status, this instrument could also be used for determining this status, thus providing the farmer a method to monitor the energy balance of individual cows on a daily basis and with a non-invasive, automated, cheap method.

Materials and methods

In a trial, 32 cows were equipped with a pedometer (Nedap, the Netherlands) immediately after calving. These pedometers recorded the number of steps in periods of 2 hours. In the first 3 weeks post partum 5 blood samples were taken. The blood samples were centrifuged and the plasma was frozen and stored at –21ºC until assayed. In the blood sample, the NEFA level was determined [11]. Statistical analysis (Spearman correlation) was performed using the SPSS program. For the activity analysis, the number of steps made during day 2-21 postpartum was used. The data were analyzed in periods of 4 days. For each 4 day period, the average number of steps per 2 h, the maximum number of steps during 2 h and the minimum number of steps per 2 h period was correlated with the NEFA-level in the five blood samples. Furthermore, the average of the maximum and minimum number of steps of a 2h period of each day was calculated.

Results

It appeared that there was a negative correlation between NEFA levels and activity as expressed in the maximum level per 2 h period. The correlation was highest during 9-12 days post partum. These correlations are presented in table 1.

	AVR	MAX	MIN	AVRMAX	AVRMIN
S1	-0.2 (0.312)	-0.4 (0.017)	0.3 (0.121)	-0.3 (0.076)	0.2 (0.268)
S2	-0.4 (0.026)	-0.5 (0.002)	0.1 (0.468)	-0.4 (0.021)	-0.0 (0.901)
S3	-0.4 (0.018)	-0.6 (0.000)	0.1 (0.490)	-0.5 (0.008)	-0.1 (0.588)
S4	-0.2 (0.400)	-0.4 (0.022)	0.4 (0.058)	-0.3 (0.089)	0.3 (0.111)
S5	-0.4 (0.016)	-0.6 (0.001)	0.2 (0.246)	-0.5 (0.002)	-0.0 (0.983)

Table 1. Spearman's rho and (2-tailed significance) for the Nefa level in the 5 blood samples taken in the first 21 days post partum and activity during day 9 to 12 pp. S1 – S5 is blood sample 1 – 5; AVR is the average activity per 2 h period during day 9-12 pp; MAX is the maximum activity per 2 h period during day 9-12 pp; MIN is the minimum activity per 2 h period during day 9-12 pp; AVRMAX is the average maximum activity per 2 h period per day during day 9-12 pp; AVRMIN is the average minimum activity per 2 h period per day during day 9-12 pp.

Discussion

In the present study is shown that there is a negative correlation among the NEFA level of the blood and the physical activity of a cow post partum. The correlations among NEFA level and both maximum activity and average maximum activity in the period between 9-12 days pp are most striking. This indicates that the animals with a low NEFA-level have certain periods of the day that they are substantially more active than their herdmates. NEFA's are toxic, but can also serve as "fuel" for muscular activity. Theoretically, it could therefore be possible that the cows with a higher activity, "burn" their NEFA's while walking. In this way they reduce the toxic effect of the high NEFA-level.

Farmers use pedometers in order to detect their cows in estrus. The results of the present study indicate that these devices might also provide information about the NEFA-level of the cow. This phenomenon can be used in the feeding management of the individual cow or of the entire herd. Because the activity data are gathered digitally and automatically, they can easily be implemented in a herd monitoring program in order to fine-tune the ration. Also, one could think of inducing "activity" for the lazy cows post partum in order to reduce the level of toxic NEFA in their blood.

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