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THE RELATIONSHIP BETWEEN ENERGY BALANCE AFTER CALVING AND REPRODUCTIVE FUNCTIONS IN HOLSTEIN DAIRY COWS TREATED BY THE OVSYNCH SYSTEM

Martina Doležalová, Luděk Stádník, Michaela Nejdlová, Dana Němečková, Jan Beran, Jaromír Ducháček

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Abstract

DOLEŽALOVÁ MARTINA, STÁDNÍK LUDĚK, NEJDLOVÁ MICHAELA, NĚMEČKOVÁ DANA, BERAN JAN, DUCHÁČEK JAROMÍR: *The relationship between energy balance after calving and reproductive functions in Holstein dairy cows treated by the OVSYNCH system.* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 3, pp. 601–610

The objective of this research was to evaluate the relationship between the course and the depth of negative energy balance (NEB) rated by changes of the body condition after calving and subsequent recovery of reproductive abilities of Holstein dairy cows treated by OVSYNCH. The body condition was evaluated by the BCS system one week before calving and subsequently at 30-day intervals for the period of 6 months of lactation. Recovery of ovarian functions was evaluated by the results of ultrasound examination of all the dairy cows' ovaries in two controls after calving. The first one was performed on an average of 67 days after calving, and the second at a 60–day interval. The occurrence of individual findings – the presence of corpus luteum, ovarian cysts or ovaries without findings was evaluated as an effect of NEB on the recovery of the ovarian cycle of dairy cows and their subsequent possibility of conception. The suitable cows were treated by the OVSYNCH system after the 1st and 2nd ultrasound examination. Therefore, the insemination interval was calculated and in the case of dairy cows, pregnancy detection, also the number of services per conception and the length of open days. Twice performed hormonal treatment of 73.6% of the animals delayed the period by 50.2 days. In all, 202 dairy cows calved in the period from 29th July 2011 to 7th February 2012 were included in this observation. Significant effects of the body condition change on the ovarian activity as documented by sonographic examination and reproductive indicators appeared primarily in the second month of lactation. The best reproductive indicators were found in cows with the lowest body condition change, thus with a small decline or even increase of body condition score (–0.0 to +0.75 points, $P < 0.05$). On the contrary, the worst level of indicators of recovery of the reproduction functions were documented in the dairy cows with the most marked decline of BCS ($P < 0.05$).

dairy cattle, energy balance, body condition, ovarian functions, reproduction

The most common problem in dairy cows is health and fertility (Garnsworthy, 1988). Milk yield in dairy cows increased through intensive breeding (Říha *et al*., 2003) as a result of one-sided selection; however, fertility and reproductive parameters simultaneously declined in most herds (Motyčka *et al*., 2005). The rapid increase of energy requirements after calving are related to the start of lactation and result in a negative energy balance (Říha *et al*., 2000). The result of the NEB effect at the beginning of lactation is reduction of conception ability, which causes prolongation of the calving interval (Collard *et al*., 2000) and is related to deterioration of the economy of dairy cow breeding (Patton *et al*., 2007). According to Butler and Smith (1989), the extent and duration

of the NEB is negatively associated with the reproductional abilities of dairy cows. The energy status in dairy cows is evaluated by energy intake and output (Rukkwamsuk *et al*., 1999) and expressed by body condition score (Pavlata *et al*., 2008). When the losses of body condition are 1 point or more, a significant decrease of fertility demonstrated by a lower conception rate is detected (Říha *et al*., 2000). The presence and intensity of NEB documented by increased mobilization of body fat during the first three weeks of lactation is in direct correlation with the first ovulation interval (Říha *et al*., 2000). Energy deficiency in the postpartum period can be manifested by abnormal follicular development, ovulation disorders or abnormal development of the corpus luteum. Subsequently the onset of the ovarian cycle is also delayed, the incidence of anoestrus, silent heat and ovarian cysts increases, conception is reduced and embryonic mortality after conception increases (Hofírek *et al*., 2009). Stress reduction and increase of the cow's comfort in the period before and after calving leads to a reduced period of negative energy balance, meaning that dairy cows have a better possibility of becoming pregnant earlier with no loss in production (Kvapilík and Vacek, 2011). Dairy cows with a higher body condition score at calving may have enough energy reserves for activation of the ovarian cycle and signs of oestrus (Zotto *et al*., 2007). The level of energy reserves during early lactation influences the duration of postpartum anoestrus as well as the probability of conception (Butler, 2000). A low rate of conception was detected in dairy cows with excessive loss of body weight during early lactation. On the contrary, weight increase meant a better rate of conception after the first insemination (Vacek and Kubešová, 2009). Impairment of fertility evoked by NEB is rated among the main causes of premature elimination of dairy cows (Kvapilík and Vacek, 2011).

This hypothesis assumes the existence of delayed recovery and lower functionality of ovarian activity of the dairy cows with a deeper negative energy balance and posibility of this fact solution by using the OVSYNCH system. The objective of this work was to evaluate the relationship between the course and the depth of negative energy balance and the recovery of the reproductive abilities of Holstein dairy cows treated by the OVSYNCH system.

MATERIAL AND METHODS

In all, 202 Holstein dairy cows calved in the period from 29th July 2011 to 7th February 2012 were included in this observation. Their parity ranged from the 1st to the 7th lactation and came from the same stock. The relationship between negative energy balance rated by changes in the body condition from calving to subsequent recovery of reproductive abilities after calving as well as reproduction indicators was evaluated.

The body condition was evaluated by BCS points (a 5 – point scale with an accuracy of 0.25 point) (Parker, 1989) one week before calving and subsequently at 30-day intervals for a period of 6 months of lactation. Recovery of ovarian functions, which is critical for dairy cows' conception, was evaluated by the results of ultrasound examination of all the dairy cows' ovaries. According to previous low pregnancy rate of dairy cows inseminated earlier after calving (from 40 to 60 days), beginning of dairy cows' reproduction starts in herd observed at least after 60 days of lactation. The first one was performed an average of 67 days after calving, and the second at a 60-day interval. Individual findings – the presence of corpus luteum, cysts or ovaries without findings were used to judge the influence of NEB on the recovery of the ovarian cycle of dairy cows and the subsequent possibility of conception as soon as possible after calving. On the basis of ultrasound examination, cows were included in the hormonal treatment by the OVSYNCH system and inseminated (Pulley *et al*., 2013).

Then the date of oestrus synchronization, the date of individual inseminations and their results were recorded. Subsequently, the insemination interval was calculated for all inseminated cows, and for pregnant cows the service per conception and the length of days open as well.

First, the arithmetical average and standard deviation were calculated. Then it was necessary to divide the entire data set into several groups according to the change of the cows' body condition during the first two months of the lactation.

The data were evaluated by the SAS 9.1. statistical programme. The significance level $P<0.05$ was used for confirmation of the statistical significance of the results. The general linear model included the fixed effects of lactation, the changes in body condition in the first and second months of lactation, and groups in relation to morning milk yield.

$$Y_{ijkl} = \mu + LACT_i + NEB_j + ML_k + e_{ijkl},$$

where

Y_{ijkl} ..... measured value of the dependent variable (finding in the ultrasound examination, insemination interval, days open, service per conception, pregnancy rate after 1. insemination, pregnancy rate after 2. insemination),

μ ..... general value of the dependent variable,

$LACT_i$ .. fixed effect of i- rank of the lactation (i = the 1st lactation, n = 57; the 2nd lactation, n = 78; the 3rd and subsequent lactations, n = 67),

NEB_j ..... fixed effect of j- indicator of body condition – change of BCS in the 1st month (j = ≤ –1, n = 53; j = from –0.5 to –0.75, n = 83; j = from 0.25 to –0.25, n = 66) or decrease in the BCS in the 2nd month (j = ≤ –0.5, n = 50; j = –0.25, n = 61; j = from 0 to 0.75, n = 91),

ML_k ..... fixed effect of k-group, by morning milk yield when BCS was evaluated in the first

month of the lactation (k = the 1st group to 14.50 l of milk; n = 66; the 2nd group 14.51–9.0 l l of milk; n = 74; the 3rd group from 19.01 l of milk; n = 62) and in the second month of the lactation (k = the 1st group to 14.50 l of milk; n =61; the 2nd group 14.51–19.0 l l of milk; n =74; the 3rd group from 19.01 l of milk; n = 67),

e_{ijkl} ..... random error.

RESULTS AND DISCUSSION

Tab. I shows the basic statistical reproduction results of the monitored dairy cows. All the monitored cows were on the average at 2.2 lactation. Conception after the second insemination was higher (50.0%) than that after the first insemination (34.9%). The average insemination interval was 97 days, the length of the open days 108 days, and the service per conception was 1.3. The sequence of lactation and conception after the first insemination was lower in the evaluated group of dairy cows than in the general population of dairy cattle in the Czech Republic. Values for insemination intervals were even worse, being longer by 16.4 days than in the population, but on the other hand, the evaluated group of dairy cows achieved better values in days open, 12.9 days shorter compared with the population (Kvapilík *et al.*, 2012). Insemination intervals and days open point to the general use of hormonal treatment, which built on the results of the sonographic examination which took place on the average between the 60th and the 70th day after calving. In all, 202 dairy cows were sonographically examined on the average 66.5 days after calving, and 140 (69.3%) animals from this group were included in the OVSYNCH program after the 1st ultrasound examination. This program lasted 17 days, and at least 30 days after AI a pregnancy ultrasound check was performed, on the average 116.7 days after calving. Of the original number of 140 animals, 103 dairy cows were not pregnant, and after the second sonographic examination they were again included in the OVSYNCH system. The following sonographic examination was performed on the average 168.2 days after calving on 103 dairy cows (treated with OVSYNCH twice). Of these 103 cows, 39 animals were again not pregnant and were repeatedly included in the OVSYNCH system at the third sonographic examination. The results suggested that the systems of hormonal treatment which are used in herds of dairy cattle enable management control of sexual functions and targeted oestrus induction between the 60th and 70th days of the lactation. However, in dairy cows without spontaneous oestrus and no pregnancy after AI (detected by early pregnancy ultrasound check) the insemination interval or length of days open was significantly prolonged. In this observation the twice performed hormonal treatment of 73.6% of the animals delayed the period by 50.2 days, and subsequently 37.9% of the cows from this group were repeatedly treated for the third time, which delayed this period by a further 51.5 days compared to the second treatment, meaning that the total delay was 101.7 days. The question is whether it would be preferable to start hormonal treatment later, for example 80 days or more after calving. Because the prolongation of the calving interval is above the optimal rate, this represents an economic loss of 63–72 Czech crowns per feeding day under conditions in the Czech Republic (Kvapilík and Vacek, 2011).

Ultrasound findings of the corpus luteum during the first control were recorded in 32.9% of the dairy cows, during the second control, in 24.3% of the dairy cows, and during the third control, only in 12.8% of the dairy cows. A similar downward trend was documented in the percentage of the dairy cows with findings of luteal cysts or ovaries

I: *Reproduction indicators in the evaluated group*

Parameter	minimum	maximum	average	S_d
rank of the lactation	1	7	2.2	1.14
conception after the 1st insemination	0	100	34.9	47.87
conception after the 2nd insemination	0	100	50.0	50.80
service per conception	1	2	1.3	0.46
insemination interval	43	169	96.9	33.89
days open	43	179	108.1	37.15

II: *Results of the ultrasonographic examination in the evaluated group*

Sonographic finding	1. control		2. control		3. control	
	n	%	n	%	n	%
corpus luteum	46	32.9	25	24.3	5	12.8
ovaries without findings	40	26.4	19	18.4	6	15.4
follicular cyst	40	28.6	25	24.3	10	25.6
luteal cyst	3	2.1	2	1.9	0	0
oestrus synchronization	85	60.7	63	61.2	24	61.5

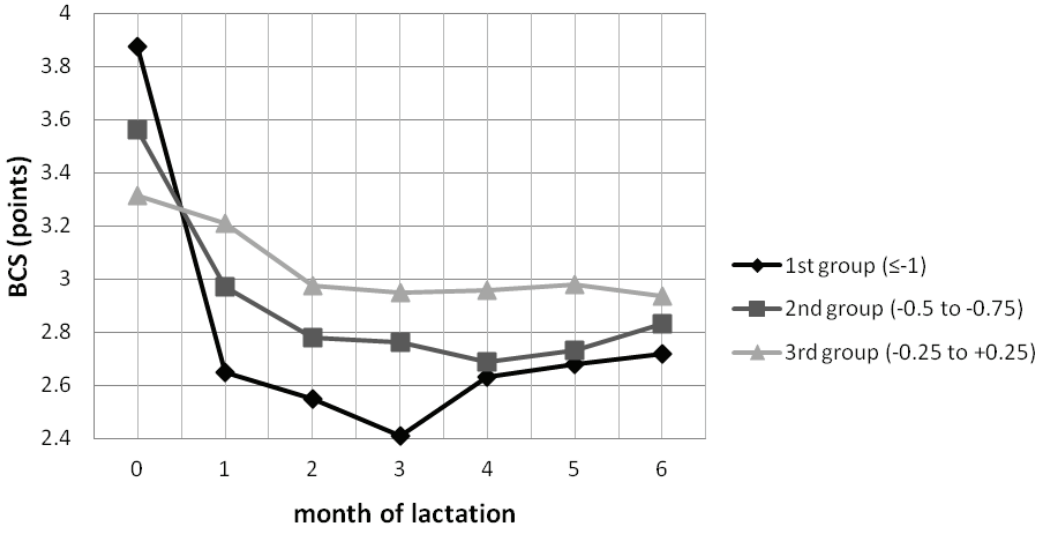
without findings. Luteal cysts occurred the least in the second ultrasonographic control (24.3%). Oestrus synchronization followed by insemination was performed in 61.1% of dairy cows after each ultrasound examination. Details are given in Tab. II.

Evaluation of reproduction depending on body condition changes in the 1st month after calving

Figure 1 shows the significant differences in the course of BCS between groups. The group of dairy cows with the highest body condition change after calving (≤ –1 point) had the highest body condition (3.8 points) before calving. During the first month of lactation their body condition decreased on the average by 1.25 points. It reached the maximum reduction after calving by the 3 rd month, when it was 1.46 points. In the fourth and the next month the body condition score rose. The highest decrease of the BCS was in the second group of the dairy cows (decrease of the body condition from –0.5 to –0.75 point) and also in the first month, and the highest difference in BCS, compared to calving, was detected in the fourth month after calving by 0.87 points on the average. In group 3 with the lowest change in body condition score in the first month of lactation (from –0.25 to +0.25 points), the dairy cows were calved at the lowest body condition, and this decrease ended by the 3rd month of lactation, when the difference was only 0.36 points. In this group the body condition from the second month was maintained at around 3 points to the end of the monitoring. According to Butler and Smith (1989), the ideal decline in body condition from calving to the first insemination is from 0.5 to 1 point. Therefore, group 1 with a decline in body condition after calving (about 1.25 points) had the worst conception parameters and the highest occurrence of ovarian cysts, while the second group with a physiologically acceptable decrease of body condition (0.87 points) had the highest conception parameters.

Sonographic evaluation findings according to changes in body condition in the first month after calving are documented in Tab. III.

According to the available literature, in the 1st group of the dairy cows with the highest body condition decline in the first month of lactation after calving (≤ –1 point), the ovarian cycle should be restored over a longer period due to the high level of NEB. Differences in corpus luteum incidence during the first control were statistically inconclusive, with values ranging from 34.3% to 37.5% (P >0.05) in all groups. Stádník *et al.* (2007) claim that dairy cows with fewer body condition changes during the first month of lactation had a significantly earlier onset of



1: *Development of body condition according to (BCS) change in the first month of lactation*

III: *The results of the sonographic examination depending on the decline in body condition in the first month after calving*

	CL 1 (%)		OWF 1 (%)		CYSFOL 1 (%)		CYSLUT 1 (%)	
BCSCH1	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**
≤ –1	37.5	8.54	14.2	7.70	30.3	8.02	3.2	2.19
–0.5 to –0.75	36.3	6.93	24.4	6.24	27.5	6.50	2.1	1.77
0.25 to –0.25	34.3	7.16	32.9	6.45	26.2	6.74		

BCSCH1 – body condition change up to the 1st month of lactation, CL 1, OWF 1, CYSFOL 1, CYSLUT 1 – finding of the corpus luteum, resp. ovaries without finding, resp. follicular cysts, resp. luteal cysts during the first sonographic examination

ovarian activity accompanied by a higher incidence of CL. Our results documented a relatively similar incidence of corpus luteum during the first control and did not confirm the above-mentioned finding. However, this finding does not agree with the presence of ovaries without findings in cows of the 3rd group with the lowest body condition change during the first month of lactation (–0.25 to +0.25 points), because these percentages were the highest (+8.5% to +18.7%) during the first control. This may be related to low body condition during calving (Moreira *et al*., 2000). The results were statistically inconclusive at $P > 0.05$.

The levels and trends of luteal and follicular cyst occurrence did not correlate in any way with body condition changes during the first month of lactation. In the study of Vanholder *et al*. (2005), an average of 27% of follicular cysts was detected in the evaluated set early after calving, which corresponds to our results, where the percentage of follicular cysts was 28% on the average at the first examination.

The lowest pregnancy rate after the first insemination (–13.1% to –5.4%) was found in group 1, thus the group with the highest decrease of body condition during the first month of lactation (≤ –1 point). With an average insemination interval time of 94.7 days these dairy cows were inseminated in the period when they were in the most significant BCS reduction (on the average 2.4 points). In these dairy cows, however, due to intensive metabolism, body condition subsequently began to recover, which suggests a transition to a positive energy balance phase. Therefore, the values of conception increased in the second insemination on the average by 28.4%.

Precisely in this group of dairy cows, restoration of the ovarian cycle should be the longest because of the intensive NEB. According to previously published results, it should be reflected during the first control after about 67 days. This assertion is confirmed, for example, by Butler and Smith (1989), who stated that dairy cows with a loss of 1 point or more of BCS in the first month had lower conception after the first insemination than dairy cows whose losses were from 0.5 to 1 point only, and subsequently reached a higher percentage in conception.

At the same time, however, this first group of dairy cows with the highest BCS decline in the first month of lactation (≤ –1 point) had the shortest insemination interval (–3.6 to –7.7 days), days open (–4.0 to –22.6 days) and the lowest service per conception (–0.1), which contradicts the assertion of Roche *et al*. (2007) that higher loss of BCS at the beginning of lactation worses the mentioned indicators. The lowest values of the insemination interval and days open were achieved by the first group, with the difference between them being from 3.6 to 7.7 days ($P > 0.05$), respectively from 4.9 to 22.6 days ($P < 0.05$).

Dairy cows in the second group (from –0.5 to –0.75 points) and in the third group (from –0.25 to +0.25 points) had a lower decrease of BCS than dairy cows in the first group, which could be a reason why the results of conception after the first insemination were higher (+13.1% and +5.4%, $P > 0.05$). On the contrary, Westwood *et al*. (2002) demonstrated that dairy cows which lost more body weight in the first 42 days after calving had better conception values than those which lost less body weight in early lactation. Our results, as well as the findings of Spiekers *et al*. (1991), do not agree.

Group 3, dairy cows, with the lowest decrease in BCS after calving (from –0.25 to +0.25 points), had minimal decrease of body condition during the entire lactation and was still around 3 BCS from the second month of lactation. Body condition score in this group of dairy cows did not increase, and that should cause a deficiency of energy to become pregnant at the optimal lactation period. They had the longest days open, which was 22.6 days longer than in the first group ($P < 0.05$) and the highest service per conception, on the average 1.4 ($P > 0.05$). The results are described in Tab. IV. The results of the fertility of the dairy cows treated by the OVSYNCH hormonal system did not correspond to previous results in herds in which this system of hormonal treatment was not used. The positive gains of procedures which optimize reproduction of dairy cows using systems of hormonal treatment can be seen in the reproductive indicators of cows with a significant decrease in BCS, which are comparable to the results of other dairy cows.

Except BCS suitable indicator for determining the level of dairy cows' NEB is, for example, a change in the fat content in the milk (Pechová and Pavlata, 2005). Excessive loss of body condition in dairy cows is the result of greater breaking down of body fat in the liver, which, in addition to increased production of ketone is also shown in the increased ratio of fat

IV: *Reproduction indicators depending on the decline in body condition in the first month after calving*

	CONC 1 (%)		CONC 2 (%)		INSINT (day)		DO (day)		SPC (pc)	
BCSCH1	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**
≤ –1	27.3	10.01	55.7	21.79	94.7	7.10	98.0^{A}	12.00	1.3	0.15
–0.5 to –0.75	40.4	7.67	55.9	15.63	102.4	5.44	102.9	8.06	1.3	0.10
0.25 to –0.25	32.7	7.29	31.8	12.55	98.3	5.17	120.6^{A}	8.21	1.4	0.10

BCSCH1 – BCS change from calving to the first month of lactation, CONC 1, CONC 2 – % conception after the first, resp. the second insemination, INSINT – insemination interval, DO – days open, SPC – service per conception, A – the same letters upper script means significant difference ($P < 0.05$)

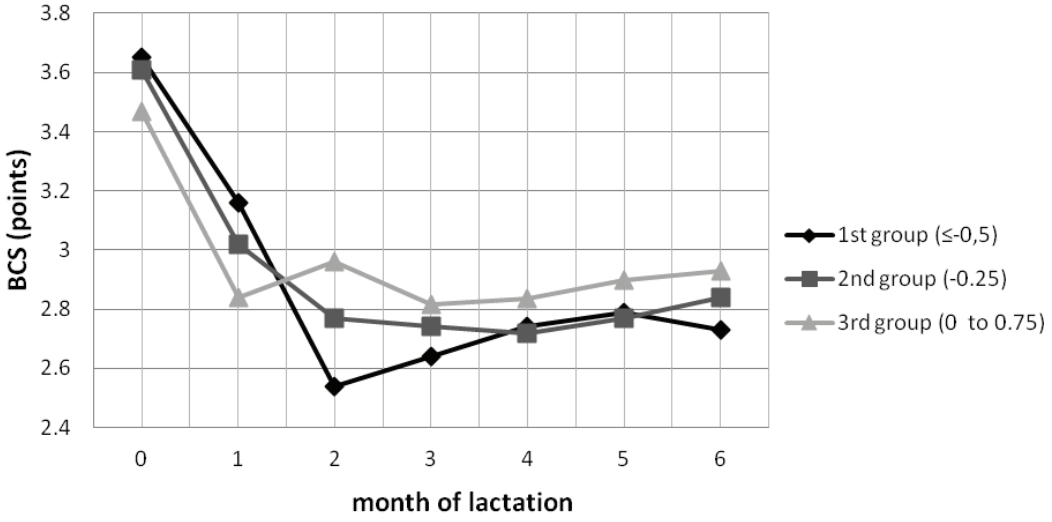
content and proteins in the milk. Therefore, energy deficiency during lactation causes fat mobilization from the body deposits, increased concentration of non - saturated fatty acids in the blood and increased milk fat synthesis in the mammary gland (Pechová and Pavlata, 2005). Decline in the total content of non - saturated as well as increase of saturated fatty acid content in milk occurs during the balancing of negative energy balance (Ducháček *et al*., 2011). Lactose content, urea, ketone, citric acid content, blood glucose, insulin and IGF – 1 belong among many factors signalising the level of energy balance in the milk (Hofírek *et al*., 2009). The relationships of these NEB indicators to the traits which we evaluated were not monitored, which suggests the possibility of future research in this area.

Evaluation of reproduction according to the change in body condition in the 2nd month after calving

Among dairy cows grouped according to body condition changes in the second month after calving (Fig. 2), the most significant body condition decline was reached in the first group (≤ –0.5 points), and the overall body condition decline from calving up to the second month was 1.11 points. After the large decline the body condition began to increase during the following month. Group 2 (–0.25 points) had a slower curve of decline in the second month after calving, but BCS decreased until the fourth month, when the overall body condition decline from calving was 0.89 points compared to the other groups. Group 3 (+0 to +0.75 points) reached the lowest body condition values in the third month of lactation, when the maximum decrease was 0.65 points and the body condition gradually started to rise only in the following months. These facts document the significant individual variability of the NEB course in the observed period of lactation.

The results of the sonographic examination of the dairy cows according to decline in their BCS in the second month are presented in Tab. V. The worst values during the first sonographic examination were detected in the first group of dairy cows with the greatest body condition decrease (≤ –0.5 points), which also had the lowest BCS. They had the lowest proportion of corpus luteum (–11.1% to –13.6%, $P < 0.05$), the highest proportion of ovaries without findings (+2.1% to +5.2%) and of follicular cysts (+5.8% to +16.9%, $P < 0.05$). These results agree with those of Diskin *et al*. (2003), who claim that low body condition during lactation is associated with delayed onset of ovarian activity or irregular pulses of LH.

On the contrary, the greatest proportion of corpus luteum (+11.1% to +13.6%, $P < 0.05$) was detected in group 3 with no body condition decline (0 to +0.75



2: *Development of body condition according to its change during the second month of lactation*

V: *Results of the sonographic examination depending on the decline in body condition in the second month after calving*

	CL 1 (%)		CL 2 (%)		OWF 1 (%)		OWF 2 (%)		CYSFOL 1 (%)		CYSFOL 2 (%)		CYSLUT 1 (%)		CYSLUT 2 (%)	
BCSCH2	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**
≤ –0.5	29.5^{A}	9.23	17.7	9.19	28.2	8.42	30.6	8.22	39.0^{A}	8.57	21.0	9.19	0.2	2.40	4.3	2.95
–0.25	32.0	7.91	22.3	7.80	25.1	7.22	15.1	6.98	27.9	7.34	27.0	7.80	2.8	2.06	0.2	2.50
0 to 0.75	43.1^{A}	6.28	29.2	6.33	23.0	5.73	14.9	5.66	22.1^{A}	5.83	22.9	6.33	1.5	1.64	2.0	2.03

BCSCH2 – body condition change up to the 2nd month of lactation, CL 1, Cl 2 OWF 1, OWF 2 CYSFOL 1, CYSFOL 2, CYSLUT, CYSLUT 2 – finding of the corpus luteum, resp. ovaries without finding, resp. follicular cysts, resp. luteal cysts during the first, resp. the second sonographic examination, A – the same letters upper script means significant difference ($P < 0.05$)

points) in the second month of lactation. This group also reached the lowest proportion of ovaries without findings (–2.1% to –5.2%), follicular cysts (–5.8% to –16.9%, P < 0.05) and a low proportion of luteal cysts. During the first six months of lactation the body condition in the third group (0 to 0.75 points) was higher than in the others (+0.1 point). This means that its level, together with the lowest decline in the second month, showed a positive effect on the onset of ovarian activity. According to Hofírek *et al*. (2009), ovarian activity started earlier and had a better onset with more gradual deepening and shorter duration of negative energy balance. Veerkamp *et al*. (2000) detected negative correlations between BCS change and the first luteal activity in the first 100 days of lactation. Whereas the group with the greatest BCS changes after calving had the worst recovery of luteal activity, on the other hand the lowest BCS change meant the best recovery of luteal activity. Despite the apparent trends, only part of our detected differences was statistically significant (P < 0.05).

Conception after the first and second insemination was the lowest (–11.7% to 23.8%, P < 0.05) in the first group with the greatest body condition decline (≤ –0.5 points) in the second month (Tab. VI). Although the body condition in some cows started to recover and rise in the second month, in dairy cows with increasing BCS, conception improved only at the second insemination, by 15.2%. In group 1 with a significant BCS decrease, conception percentage also increased by 8.9%; however, these values were still significantly below the average. We can agree with the claim of Van Straten *et al*. (2009) that the greatest BCS changes in the period of the deepest NEB limit the reproductive indicators. The organism of the cows was exhausted during the period of body condition decline, and these cows could not become pregnant even during subsequent BCS rise. Service per conception was the highest in group 1 (with the greatest BCS decline), and this agrees with Berry *et al*. (2002), who stated that dairy cows with a higher loss of BCS in early lactation need more insemination doses per conception.

Dairy cows with an average loss of body condition in the second month of lactation (group 2) lost an average of energy; however, decline and subsequent increase of the body condition were gradual as the body condition started to recover, and the dairy cows were inseminated earlier and became pregnant in the shortest time after calving (days open –3.7 to –21.2 days, P < 0.05). This finding agrees with the results of Van Straten *et al*. (2009).

The best conception values after the first and second insemination were achieved by group 3, the cows with no BCS decline (0 to 0.75 points) and the highest condition from the second month in comparison with the other groups (Fig. 2). Conception values were high because these dairy cows had sufficient energy in contrast to the others. However, they were inseminated later because of fluctuations of their body condition after calving. This was evident in the first month, when they reached the lowest BCS. From the point of view of genetic aspects, dairy cows with a predisposition to greater BCS decline do not have sufficient energy at the beginning of lactation necessary for activation of ovarian activity. Therefore, they are inseminated later, and the time to the first insemination and days open are prolonged (Dechow *et al*., 2001). Our results documented that prolongation of the insemination interval cannot be eliminated even by the OVSYNCH system.

These findings demonstrate the existence of completely different types of energy metabolism in dairy cows raised under the same conditions in one herd, as well as the importance of dairy cows, individuality in the sense of the intensity of their energy metabolism.

In accordance with these characteristics, it is possible to evaluate the influence of energy balance on recovery of the ovarian cycle. Decline of the body condition in the second month influenced ultrasonic findings during the first as well as the second control and also conception results after the first and second insemination. Greater body condition change in the second month of lactation meant a lower proportion of corpus luteum, a higher proportion of dairy cows without findings and a lower percentage of conception after the first and second insemination. Vacek and Kubešová (2009) found that the conception capability in Holstein cows was more closely related to body condition change in the short period directly before the first insemination than to body condition at calving or to BCS changes directly after calving. According to Diskin *et al*. (2003), lower body condition during lactation was shown in poor response to follicle stimulating gonadotropin and reduced follicular function. This fact is documented by our results. As well Stádník *et al*. (2002) described

VI: *Reproduction indicators depending on the decline in body condition in the second month after calving*

	CONC 1 (%)		CONC 2 (%)		INSINT (day)		DO (day)		SPC (pc)	
BCSCH2	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**	**μ ± α**	**SE**
≤ –0.5	$21.0^{A,B}$	9.93	29.9^{A}	17.38	95.9	6.90	99.8^{A}	12.46	1.4	0.16
–0.25	40.1^{A}	8.73	41.6	17.33	90.8	6.07	96.1^{B}	9.72	1.2	0.12
0 to 0.75	40.5^{B}	6.79	55.7^{A}	13.94	107.1	4.72	$117.3^{A,B}$	6.86	1.3	0.09

BCSCH2 – BCS change from calving to the second month of lactation, CONC 1, CONC 2 – % conception after the first, resp. the second insemination, INSINT – insemination interval, DO – days open, SPC – service per conception, A, B – the same letters upper script means significant difference (P < 0.05)

findings that with an increasing degree of BCS at the time of AI, the higher the pregnancy rate was. Our results in Tab. V and VI confirm that the greatest body condition decline after calving decreases the capability of the following conception. On the contrary, a minimal decrease in body condition at the beginning of lactation is characterized by higher values of the pregnancy rate after AI. De Haas *et al*. (2007) recorded the strongest relationship between BCS and fertility in the middle of lactation, which is also the most critical period. This period is characterized by loss of most of the body reserves due to NEB, and at the same time it is necessary for the cow to become pregnant in order to maintain the optimum length of the calving interval.

CONCLUSION

Based on our performed monitoring, we can assume that a considerable influence of the body condition change on ovarian activity as documented by ultrasound examination and reproductive indicators appeared primarily in the second month of lactation. The best reproductive indicators were found in cows with the lowest body condition change. On the contrary, the worst level of indicators of recovery of the reproduction functions, or classic reproductive indicators, were documented in the dairy cows with the most marked decline of BCS.

The above-described findings confirm the direct influence of the depth of actual NEB and the indirect influence of the course of NEB in the first month of lactation. At the same time it is clear that evaluation of body condition changes can be used as NEB indicators in individual months after calving.

We can conclude that the hypothesis was confirmed, because the results clearly documented the trend of impaired recovery of ovarian functions and reproductive results in dairy cows with a deeper NEB. The results also documented the contribution of OVSYNCH hormonal treatment, which includes estrus synchronization and AI timing, for reproduction in problematic dairy cows with the significantly highest decline in body condition score during the period close to conception.

SUMMARY

The objective of this research was to evaluate the relationship between the course and the depth of negative energy balance (NEB) rated by changes of the body condition after calving and subsequent recovery of reproductive abilities of Holstein dairy cows treated by OVSYNCH. The hypothesis assumes the existence of significant delaying of recovery as well as lower functionality of ovarian activity in relation to deeper negative energy balance.

The body condition was evaluated by the BCS system one week before calving and subsequently at 30-day intervals for the period of 6 months of lactation. Recovery of ovarian functions was evaluated by the results of ultrasound examination of all the dairy cows' ovaries in two controls after calving. The first one was performed on an average of 67 days after calving, and the second at a 60–day interval. The occurrence of individual findings – the presence of corpus luteum, ovarian cysts or ovaries without findings was evaluated as an effect of NEB on the recovery of the ovarian cycle of dairy cows and their subsequent possibility of conception. The suitable cows were treated by the OVSYNCH system after the 1st and 2nd ultrasound examination. Therefore, the insemination interval was calculated and in the case of dairy cows, pregnancy detection, also the number of services per conception and the length of open days. Twice performed hormonal treatment of 73.6% of the animals delayed the period by 50.2 days. In all, 202 dairy cows calved in the period from 29th July 2011 to 7th February 2012 were included in this observation. Significant effects of the body condition change on the ovarian activity as documented by sonographic examination and reproductive indicators appeared primarily in the second month of lactation. The best reproductive indicators were found in cows with the lowest body condition change, thus with a small decline or even increase of body condition score (–0.0 to +0.75 points, $P < 0.05$). On the contrary, the worst level of indicators of recovery of the reproduction functions were documented in the dairy cows with the most marked decline of BCS ($P < 0.05$).

The all findings confirm the direct effect of the depth of actual NEB and the indirect influence of the course of NEB in the first month of lactation. Concurrently, it is clear that evaluation of body condition in individual months after calving can be used as NEB indicators. We can conclude that the hypothesis was confirmed. All the results clearly document the trend of an impaired recovery of ovarian functions and reproductive results of dairy cows with a deeper NEB. The results also documented the contribution of hormonal treatment, which evokes oestrus synchronization and timing of insemination for reproduction in problematic dairy cows with the significantly highest changes in body condition score in the period close to conception.

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Address

Ing. Martina Doležalová, doc. Ing. Luděk Stádník, Ph.D., Ing. Michaela Nejdlová, Ing. Dana Němečková, Ing. Jan Beran, Ph.D., Ing. Jaromír Ducháček, Ph.D., Department of Animal Husbandry, Faculty of Agrobiology, Natural and Food Resources, Czech University of Life Sciences Prague, Kamýcká 129, Prague 6 – Suchdol, 165 21, Czech Republic, e-mail: dolezalovamartina@af.czu.cz