

RELATIONSHIP BETWEEN ENERGY STATUS AND FERTILITY IN CZECH FLECKVIEH COWS

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Abstract

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The aim of this study was to confirm that a negative energy balance expressed by declining body condition score (BCS) can lead to the deterioration of fertility results of Czech Fleckvieh cows. The BCS of cows was evaluated before calving and during the first five weeks of lactation. The evaluation was based on 338 Czech Fleckvieh cows calved between the October 13th, 2009 and April 27th, 2010 at one dairy farm. Analysis of relationships between the energy balance results and fertility score expressed by the reproduction results (pregnancy rate after the first and all inseminations, the insemination interval, service period, insemination index, calving period) of the observed group were performed. The higher body condition score of the Czech Fleckvieh cows before calving turned out advantageously regarding the energy source during the postpartal period. No negative effect of higher BCS in cows before calving was confirmed. The best reproduction parameters were attained in the group of cows with no change or marked increase of body condition after calving recorded. However, statistically significant differences between the groups were detected only in the third week of lactation. Significant differences in the level of body condition were detected in relation to the length and type of oestrus onset.

reproduction, negative energy balance, body condition score, Czech Fleckvieh

Negative energy balance (NEB) is the main cause of fertility decline in early lactating dairy cows. It results in an increasing in the calving interval length and a decrease in dairy herd profitability (Wathes *et al.*, 2007; Rossi *et al.*, 2008). Energy deficiency causes extension of the interval from parturition to recovery of ovarian cyclicity and activity of *corpus luteum* (Banos *et al.*, 2004; Patton *et al.*, 2007). A low pregnancy rate was observed in dairy cows with severe BCS loss (> 10 % of live weight) during early lactation, or in cows losing weight from calving to fertilization by more than 1% weekly (McClure, 1994). Anestrus occurrence after parturition tends to be more expressive in high-yielding cows, which calve with a low BCS status and a loss of 0.75 – 1 BCS points (Moreira *et al.*, 2000, Vacek and Stádník, 2007). BCS status decline in the first month postpartum is associated with impaired conceiving (Pryce *et al.*,

2001). However, other authors did not find any significant relationship between BCS losses and fertility performance (Waltner *et al.*, 1993; Ruegg and Milton, 1995). Also, dependencies observed in dairy breeds were not conclusively confirmed in dual purpose breeds (Jílek *et al.*, 2008). Most of the investigations assessing the relationships between BCS status and BCS changes, recovery of ovarian cyclicity and fertility performances of dairy cows in detail, were related only to the Holstein breed. In accordance with the available results, it can be assumed that similar relationships would apply to other cattle breeds as well.

The hypothesis assumes, that different status of BCS at parturition and intensity of their changes during early lactation will affect ovarian function recovery after parturition and performance of the Czech Fleckvieh cows. Therefore, the objective of

this study was to evaluate the association between the energy status, its changes, and the fertility traits in Czech Fleckvieh cows and to confirm or refute the given hypothesis.

MATERIAL AND METHODS

The data presented in this study were collected at one dairy farm of Czech Fleckvieh cows which calved between October 13th, 2009 and April 27th, 2010. In total 370 multiparous and primiparous cows, were evaluated, and from these 8.65% were culled during the observation. A total of 338 cows from the 1st to the 6th lactation were finally included. The average milk yield of the herd in the observed period was 8039 kg milk during 305 days of lactation with a 4.02% fat and 3.55% protein content. Estrus detection was performed only visually twice a day during the movement of the cows to the milking parlour. Cows which do not show any signs of heat were also examined sonographically. If sonographic examination detected luteal or follicular cysts between 60 and 74 days after parturition, the cow was included to OVSYNCH program. In the case of detection of persisting *corpus luteum*, OESTROPHAN was applied, and cows with signs of heat were then inseminated. Pregnancy diagnosis was carried out sonographically 28 days after insemination and then at the 3rd month was verified by rectal palpation. Information about reproduction acquired from pregnancy detection in the 28th day after insemination as well as the results of sonographic examinations performed from the 60th day after parturition in cows without signs of heat, also information about the health status after parturition and synchronization methods were obtained from the farm records software. BCS was determined using a 5 point scale with quarter-point increments. The evaluation started 20 days before the expected calving date and continued weekly up to 5 weeks postpartum. The cows were divided into 3 various BCS groups according to their BCS at calving and BCS changes detected during first four weeks of lactation. The changes of BCS after four week were not evaluated because of the small number of observation per groups. The first group included cows without BCS change and even with BCS gain after calving. In the second group there were cows with a 0.25–0.5 point BCS decline, and in the third group with a more than 0.75 BCS point decline.

The data were analyzed using SAS STAT 9.1 (SAS/STAT® 9.1, 2004) based on a model equation with fixed effects of calving month, parity and BCS status. In total five models with different groups classification of BCS were used. These models were selected on the basis of experience with previous evaluation of negative energy balance. The level of significance was set at $P < 0.05(*)$, $P < 0.01(**)$.

$$Y_{ijkl} = \mu + MO_i + PA_j + BCS_k + e_{ijkl}$$

where:

- Y_{ijkl}measured value of dependent variable (pregnancy rate after the first and all inseminations, insemination interval, service period, insemination index, calving period),
 μoverall mean of dependent variable,
 MO_ifixed effect of i - month of calving (i = October, n = 29; November, n = 55; December, n = 52; January, n = 55; February, n = 58; March, n = 64; April, n = 25),
 PA_jfixed effect of j-group of parity (j = 1–1st parity, n = 95; 2–2nd parity, n = 103; 3–3rd parity, n = 74; 4–4th and subsequent parity, n = 66),
 BCS_kfixed effect of k-group of BCS at calving or BCS changes during 1, 2, 3 and 4 weeks of lactation using the following distribution:
 a) BCS at calving (BCS0): 1st group < 3.75, n = 82; 2nd group = 4–4.25, n = 144; 3rd group = 4.5–5, n = 112 or
 b) BCS changes from calving to first week of lactation (BCS 1–0): 1st group = from 0 to +1, n = 91; 2nd group = from –0.25 to –0.5, n = 178; 3rd group = from –0.75 to –1.25, n = 68 or
 c) BCS changes from calving to second week of lactation (BCS 2–0): 1st group = from 0 to +0.75, n = 67; 2nd group = from –0.25 to –0.5, n = 147; 3rd group = from –0.75 to –2, n = 120 or
 d) BCS changes from calving to third week of lactation (BCS 3–0): 1st group = from 0 to +0.5, n = 36; 2nd group = from –0.25 to –0.5, n = 137; 3rd group = from –0.75 to –2, n = 119 or
 e) BCS changes from calving to fourth week of lactation (BCS 4–0): 1st group = from 0 to 0.5, n = 22; 2nd group = from –0.25 to –0.5, n = 65; 3rd group = from –0.75 to –1.5, n = 94,
 e_{ijkl}random error term.

RESULTS AND DISCUSSION

Basic statistic parameters of evaluated fertility traits are presented in Tab. I.

In the observed group of Czech Fleckvieh cows, parity was equivalent to the composition of the whole dairy cattle population in the Czech Republic, whereas pregnancy rate values, resp. insemination index values, are on a significantly lower, it means better level. The high insemination interval length is a consequence of the management reproduction system. The service period and calving interval are in comparison with population results excessively higher than average (Kvapilík *et al.*, 2011), thus shorter, and reflect successful Czech Fleckvieh cattle fertility management approach. Sonographically 261 cows (77.2%) were examined due to the absence of heat signs up to 60 days pp, while examination took place 64.2 days post partum (pp) on the average. Mostly, *corpus luteum* occurrence (44.06%) and follicular cysts (37.55%) were detected.

I: Fertility traits of evaluated cows

Parameter	n	min	max	mean	S _d
parity	338	1	6	2.46	1.35
pregnancy rate after the first insemination (%)	337	0	100	52.52	50.01
pregnancy rate after all inseminations (%)	337	0	100	95.55	20.65
Insemination index	337	1	6	1.79	1.09
Insemination interval (days)	337	45	166	71.79	12.11
Service period (days)	321	45	272	99.90	43.68
Calving interval (days)	212	330	487	372.75	29.16

II: Sonographic examination results in cows without heat signs 60 days post partum

Sono finding	n	%
Without evidence	2	0.77
Luteal cyst	27	10.34
Follicular cyst	98	37.55
Luteal and Follicular cysts	7	2.68
Follicular cyst and corpus luteum	3	1.15
Corpus luteum	115	44.06
OESTROPHAN treatment	9	3.45

Garverick (1997) state that, ovarian follicular cysts occur in 10 to 13% of dairy cows. Our results suggest that the most occurrence of cysts results to decrease of reproduction performance. Detailed results of the examinations are shown in Tab. II.

The most frequent BCS status of Czech Fleckvieh cows in parturition (BCS₀) was from 4 to 4.5 points with an average value of 4.17 points. After parturition, BCS declined significantly up to 3 weeks pp (on the average 3.6 points). In the following weeks the declines were less noticeable (Fig. 1).

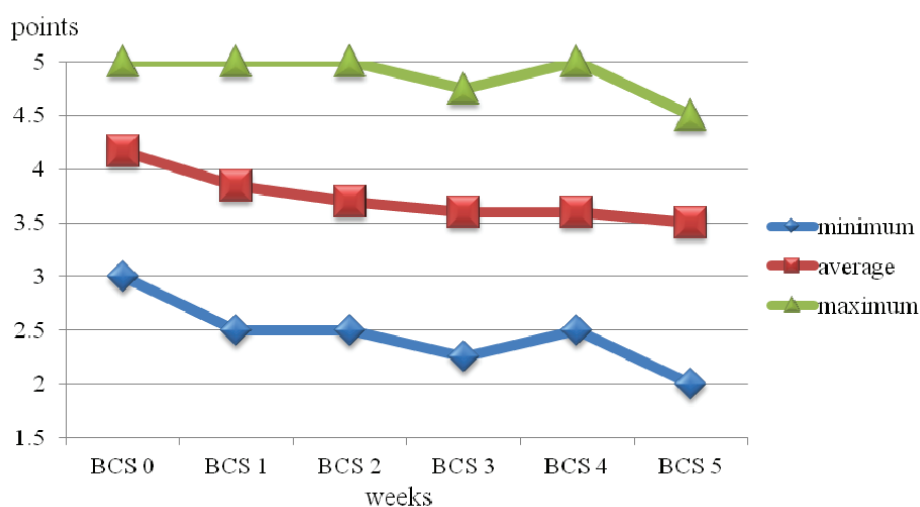
The cows were divided into 3 various BCS groups according to the BCS₀. The group with the lowest BCS₀ (from 3 to 3.75 points) had non-significantly the worst results in all the evaluated parameters.

The best results were achieved by the 3rd group with BCS from 4.5 to 5 points before calving. The calving interval length was significantly the lowest within this group. In comparison with the 1st group it was about 14.59 days ($P < 0.01$) and about 9.42 days ($P < 0.05$) compared to the 2nd group.

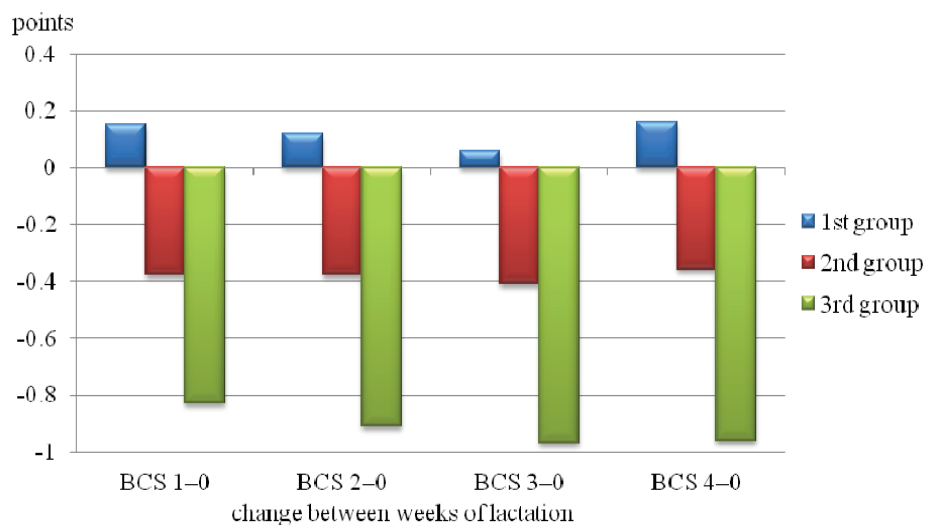
BCS before parturition ranged from 3 to 5 points with an average value of 4.17 points. Jílek *et al.* (2008) stated that Czech Fleckvieh cows can reach the 4 BCS point before parturition (in the dry period). In this case, it is evident that the cow created sufficient body reserves for production in subsequent lactation.

The cows were subsequently divided according to BCS changes during 1, resp. 2, 3 and 4 week pp (BCS₁-0, resp. 2-0, 3-0, and 4-0). The average BCS changes in particular groups and weeks of evaluation are illustrated in Fig. 2, which show that the BCS of cows in the 1st group did not decline. In cows of the 2nd group it declined approximately by 0.4 points, whereas in the 3rd group BCS declined on the average by more than 0.8 points during the evaluated period.

In the case of BCS change effect, the best reproductive performance was achieved by the group of cows with no BCS loss or even BCS gain in the first week pp. Only the pregnancy rate after all insemination was higher in the 2nd group of



1: BCS decline from calving to 5 week post partum



2: Average BCS changes according to group from the 1st to the 4th week post partum

cows with average BCS loss of 0.38 points. However, detected differences were not statistically significant.

Concerning BCS changes during the first two weeks pp, cows in the 2nd group with BCS loss 0.25–0.5 points had the lowest pregnancy rate, but concurrently achieved the shortest service period and calving interval. On the contrary, in the 3rd group with an average BCS loss of 0.91 point, there was a higher pregnancy rate, however with a longer service period and calving interval, although also without statistically significant differences.

By grouping according to BCS changes from calving to the 3rd week pp, the 1st group with no BCS loss or even BCS gain achieved the significantly highest pregnancy rate after all inseminations and the lowest insemination index of all other evaluated groups for the observed period. Simultaneously the service period value did not exceed 85 days and the calving interval was the lowest of all observations ($P < 0.01$). The 2nd and 3rd group results were comparable, only the pregnancy rate after the 1st insemination was significantly ($P < 0.05$) lower in the second group.

The lowest pregnancy rate after the first insemination was determined in cows which lost 0.75–1 point in the period from parturition to the 4th week pp, which is related to insemination index increase to 2.0 and service period extension over 105 days. Cows with BCS loss from 0.25 to 0.5 points in this period achieved significantly ($P < 0.05$) the longest insemination interval, compared to the 1st group for 6.22 days, and the 3rd group for 4.42 days.

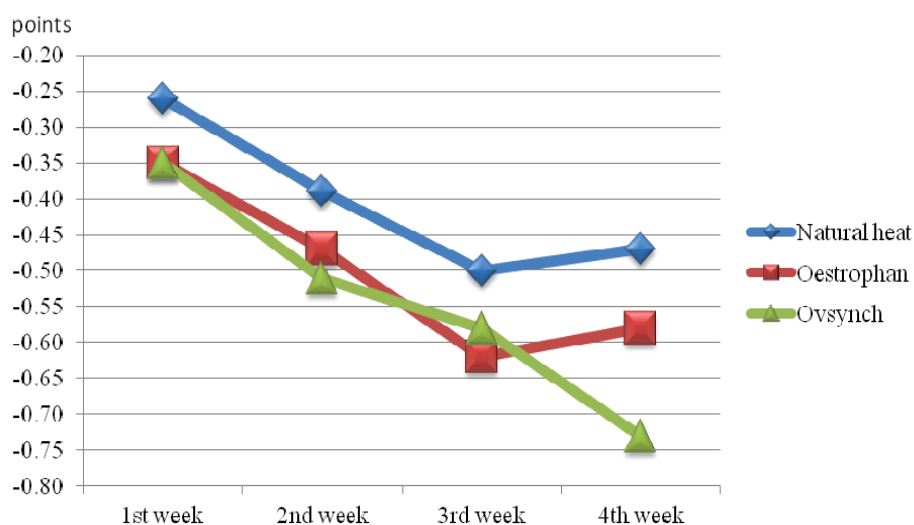
Generally the 1st group, where BCS did not change or even gain, achieved in all observed weeks the best results of all. In the 3rd, respectively the 4th week post partum the most pronounced and concurrently significant changes in achieved results between groups in all the observed periods were determined.

After parturition, BCS development was related to the energy balance of the cow (Vacek and Stádník, 2007). Hofírek *et al.* (2009) stated that in dual purpose

breeds, BCS should not decline below 3.25 points 14 days before parturition. At the end of the second third of lactation, BCS should be approximately 3.5 points and in the dry period, cows should not exceed 4 points BCS. In comparison with the recommended values, our average BCS in parturition was higher (4.17 points). There were only 4.44% of cows in the group with BCS lower than 3.25 points in the first week pp, and 11.9% in the second week. The average BCS of this group was 3.84, resp. 3.70 points in these weeks. Říha *et al.* (2004) considered 2.5–3.5 points as an ideal breeding BCS status in the Czech Fleckvieh breed. On the contrary, Jílek *et al.* (2008) stated that higher BCS before parturition, at parturition and during early lactation is connected with a higher probability of heat recording before planned return to reproduction and with higher probability of fertilization after the first insemination. This confirms the results of the pregnancy rate in our evaluated groups. The best pregnancy rate, although no significantly was achieved by the 3rd group of cows with the highest BCS status before parturition (from 4.5 to 5 points). Simultaneously this group had the significantly shortest calving interval ($P < 0.05$ –0.01).

Hanuš *et al.* (2004) found a significant relationship between higher BCS decline and subsequent levels of reproduction. Also, Říha *et al.* (2004) stated that numerous studies imply that negative energy balance (NEB) in the first 3 weeks post partum is in direct correlation with the interval to the first ovulation.

The first group, where BCS after parturition did not change or even increase, overall often reached the best results in all the observed weeks. Our results correspond to the conclusions of Jílek *et al.* (2008), according to which cows with higher BCS before parturition have higher BCS after parturition and achieve the lowest insemination intervals. Thus findings published about dairy cows do not apply to the Czech Fleckvieh breed.



3: BCS change development in relation to subsequent natural heat appearance or its induction requirement

III: Fertility traits results of cows with natural and induced heat

		Pregnancy rate after the first insemination	Pregnancy rate after all inseminations	Ins. index	Ins. interval	Service period	Calving interval
Natural heat	$\mu + \alpha$	56.58	92.11	1.79	60.28	80.71	360.75
	SE	49.90	27.14	1.17	10.20	37.27	28.92
OESTROPHAN	$\mu + \alpha$	44.00	96.00	1.88	71.40	104.34	372.46
	SE	49.83	19.67	1.12	10.81	45.58	24.53
OVSYNCH	$\mu + \alpha$	58.08	97.06	1.69	78.59	106.08	380.78
	SE	49.52	16.96	1.00	8.84	42.47	30.49
P		*1-2, **2-3	*1-3		**1-2, **1-3, **2-3	**1-2, **1-3	**1-2, **1-3

An interesting thing is the different levels of BCS decrease during the first 4 weeks pp in relation to subsequent natural heat return, or heat induction requirement after 60 days pp (OESTROPHAN treatment in the case of sonographic examinations of *corpus luteum* or the OVSYNCH method used in cases of cyst occurrence). No significantly the lowest BCS declines (up to 0.5 points) are apparent in the case of cows with natural heat in all the observed weeks pp. Significant differences were in the 4th week pp, when BCS increased in some cows. In cows with BCS decline between parturition and the 3rd week pp up to 0.5 points and BCS increase in the 4th week pp, spontaneous natural heat appeared subsequently. Cows with BCS decline between parturition and the 3rd week pp more than 0.5 points and simultaneously increase BCS in the 4th week pp, did not show spontaneous natural heat and were sonographically examined with *corpus luteum* detection. OESTROPHAN application with fast induced heat appearance enabled easy *corpus luteum* examination. In the last group there were cows with BCS decline of 0.73 point ($P < 0.05$) during the entire observed period. In these cows (43.79% of the observed group, in 56.7% of cows sonographically

examined) one variant of ovarian cysts, luteal or follicular cyst, were detected during sonographic examinations. Changes in development are shown in Fig. 3.

Fertility traits results of cows grouped according to natural heat appearance, resp. induced heat appearance is documented in Tab. III.

Cows inseminated in natural heat showed significantly the highest pregnancy rate after the first insemination ($P < 0.05$ – 0.01) with significantly the shortest insemination interval ($P < 0.05$), service period ($P < 0.01$) and calving interval ($P < 0.01$), whereas cows inseminated in induced heat achieved worse fertility trait results. In comparison of both heat induction methods it is evident that the more difficult hormonal treatment system OVSYNCH ensured a significantly higher pregnancy rate ($P < 0.01$) in relation to a single OESTROPHAN application. However, due to repeated hormonal preparation application it led to insemination interval extension ($P < 0.01$) and thereby to a longer service period and calving interval as well as to increase of costs.

The results obtained from observation of BCS change development during 4 weeks of lactation

correlated to subsequent natural heat appearance or its induction requirement after 60 days pp. Roche *et al.* (2009) confirmed the opinion, that there is a negative relationship between BCS status before parturition and BCS changes in early lactation and days to first heat. This relationship is associated with delayed ovarian activity return, reduced luteinizing hormone pulse, deficient follicle sensitivity to gonadotropines and reduced follicle function ability. There is a very strong dependence between negative energy balance during early lactation and postpartal anestrus (Garnsworthy *et al.*, 2008). In our work, the lowest BCS losses in all the observed periods after parturition were among cows where heat returned and spontaneously appeared within 60 days pp without other zootechnical or veterinary treatment necessity.

CONCLUSION

A negative influence of excessive BCS before parturition in Czech Fleckvieh cows on their subsequent conceiving was not confirmed in this

work. High BCS before parturition did not cause higher BCS declines in early lactation.

The best fertility trait results were obtained in the group, where BCS after parturition did not change or even increase. Statistically significant differences between groups were detected only in relation to BCS changes in the 3rd week pp.

Significant differences were identified in BCS change level in relation to subsequent heat appearance. The lowest BCS losses in all the observed weeks pp were in cows where heat returned and spontaneously appeared within 60 days pp without other zootechnical or veterinary treatment necessity. These cows achieved significantly the shortest insemination interval, service period and calving interval. On the contrary, higher BCS losses on the average of 0.1 points in all the evaluated weeks were observed in cows with heat induction necessity after 60 days pp.

Higher BCS in Czech Fleckvieh cows before parturition have proven to be appropriate in terms of energy source in the postpartum period.

SUMMARY

The objective of this study was to confirm the hypothesis that a negative energy balance expressed by declining body condition score (BCS) can lead to the decline of fertility results of Czech Fleckvieh cows. The BCS of cows was evaluated before calving and during the first five weeks of lactation. The evaluation was based on 338 Czech Fleckvieh cows calved between the October 13th, 2009 and April 27th, 2010 at one dairy farm. The dataset was analyzed using SAS STAT software. Analysis of relationships between the energy balance results and fertility score expressed by the reproduction results (pregnancy rate after the first and all inseminations, the insemination interval, service period, insemination index, calving period) of the observed group were performed.

The OVSYNCH hormonal therapy program was used for reproduction regulation. The share 56.8% of the dairy cows were engaged in the hormonal therapy program after sonographic examinations, when the case of follicular or luteal cysts reports were detected. The higher body condition score of the Czech Fleckvieh cows before calving turned out advantageously regarding the energy source during the postpartal period. No negative effect of higher BCS in cows before calving was confirmed. The higher body condition before calving does not, in the case of Czech Fleckvieh cattle, mean greater loss of body condition in early lactation. The best reproduction parameters were attained in the group of cows in which no change or marked increase in body condition after calving was recorded. However, statistically significant differences between the groups were detected only in the third week of lactation. Significant differences in the level of body condition were detected in relation to the onset of oestrus. The lowest loss of body condition during all the observed weeks after calving were detected in dairy cows, which showed evident signs of natural oestrus within 60 days after calving without any necessary zootechnical-veterinary intervention. On the contrary, in the case of cows with oestrus induced after the 60th day of lactation, higher body condition losses (avg. 0.1 points) were determined. Significant differences were detected, especially in the fourth week after calving.

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