

REDUCTION IN BODY CONDITION OF COWS AFTER CALVING AND THEIR LACTATION YIELD

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Abstract. The aim of the study was to analyse the effect of the magnitude of losses in body condition after calving and the duration of the period of its decline on yield in 435 standard lactation periods in Polish Black-and-White Holstein-Friesian cows kept in five barns. The magnitude of losses in body condition after calving and the duration of the period of its decline were estimated on the basis of monthly body condition scores in the 5-point BCS scale, and data pertaining to productivity were obtained from the SYMLEK system. It was determined that the greater the mobilization at the start of lactation of fat accumulated by cows before parturition, the higher was the production of milk, fat, protein and dry matter. The decrease in body condition score was less strongly associated with the basic composition of the milk obtained in the standard lactation period. Longer duration of the negative energy balance was also associated with higher yield of milk, fat and dry matter and with higher content of fat in the milk. Increased length of the period of body condition decline was accompanied by a decrease in protein content in the milk.

Key words: body condition of cows, calving, yield, negative energy balance

INTRODUCTION

Nutrients supplied to cows during the dry period are necessary to maintain their health and improve their body condition, for the development of the foetus

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and placenta, and for lactogenesis [Van Knegsel et al. 2014]. This period is characterized by endocrine changes, a decline in food ingestion and an increase in nutrient requirements [Drackley 1999, Adamski 2010]. After calving the cow's need for energy increases, leading to an energy deficit and to excessive activation of the body's fat reserves [Januś et al. 2007, Matthews et al. 2012]. Hence it is important that cows have an appropriate amount of fat tissue during the dry period, because it is mobilized when there is a negative energy balance [Gearhart et al. 1990, Haile-Mariam et al. 2003, Roche et al. 2009]. A body condition score of 3.0–3.5 in cows entering the dry period guarantees a high production level and good health in the upcoming lactation [Contreras et al. 2004]. Inadequate fat reserves in the perinatal period may cause reductions in yield and exacerbate health and reproductive problems [Waltner et al. 1993, Duffield et al. 2009, Adamski 2010, Mann et al. 2015]. According to Bewley and Schutz [2008], the ideal BCS represents a level of fat in the organism that optimizes milk production while minimizing metabolic and reproductive disorders. Busato et al. [2002] and Olechnowicz and Jaśkowski [2005] suggest that there is a correlation between the quantity of fat deposited in tissues and the ability to tolerate a negative energy balance at the start of lactation. Hence cows with higher body weight are better able to tolerate the consequences of high production than thin cows, as even a loss of adipose tissue of up to 50 kg during the first 100 days of lactation is normal. Only exceeding this limit can cause health disorders.

The aim of the study was to analyse the effect of the magnitude of losses in body condition after calving and the length of the period of its decline on yield in standard lactation in Polish Black-and-White Holstein-Friesian cows.

MATERIAL AND METHODS

The study was carried out in 5 cow barns housing Polish Black-and-White Holstein-Friesian cows with average annual yield of about 7,500 kg of milk. The cows were fed according to INRA norms. The feed ration was based on maize silage, haylage and hay. Concentrate feeds consisted of spent grain, barley (ground meal) and soybean and rapeseed meal. The feed was supplemented with vitamin and mineral additives and other nutritional supplements, the type and amount of which depended on the cows' stage after calving, their physiological condition, and their daily milk yield. The body condition of the cows in the herds studied was assessed in the first week after calving, and then once a month using the five-point BCS scale [Edmonson et al. 1989], with accuracy to within 0.25. The body condition scores were used to estimate the size of the negative energy balance (SNEB), defined as the difference between the score obtained in the first month after calving and the lowest score determined during lactation. Three levels were

established for SNEB: 1 – BCS \leq 0.75; 2 – BCS 1 and 3 – BCS $>$ 1. Also calculated was the length (in months) of the period in which body condition declined, from parturition to the time when the lowest score was obtained (duration of negative energy balance – DNEB). Three levels were distinguished: 1 – \leq 1 month; 2 – 2 months; 3 – $>$ 2 months.

Analysis of variance was used to estimate the effect of SNEB and DNEB on the productivity of cows in 435 standard (305-day) lactations. Data pertaining to productivity were obtained from the SYMLEK system and included yield of milk, fat, protein and dry matter and content of fat, protein and dry matter in the milk. Yield of fat and protein corrected milk (FPCM) per day of milking was calculated as well, using the following formula for conversion to FPCM [Subnel et al. 1994]:

$$\text{FPCM (kg)} = [0.337 + 0.116 \times \text{fat (\%)} \times \text{protein (\%)}] \times \text{milk (kg)}.$$

Statistical analysis was performed in STATISTICA ver. 6. by StatSoft Inc. [2003], and the significance of differences between means was estimated using Duncan's test. Pearson's correlation coefficient was also calculated between SNEB and DNEB values and the productivity characteristics analysed.

RESULTS AND DISCUSSION

In recent decades the increased genetic potential of cows has led to an increase in their productivity. This exacerbates the problem of the negative energy balance occurring at the start of lactation because the amount of energy supplied with feed is insufficient for milk production. During this period lipids mobilized from the body's reserves are substantially used up to meet the demand for energy for milk production [Remppis et al. 2011]. Ferguson et al. [1994] determined that the body condition score of an adult cow during the first two months of lactation should decrease by no more than 0.5 to 1 point. A study by Lüttgenau et al. [2016] showed that during the first 28 days postpartum, pluriparous cows had lower BCS loss compared to primiparous ones (median, 0.5 vs. 0.75). Table 1 shows that in the case of 205 lactations (47.1%) the decrease in body condition score from the first week after calving to the lowest value obtained during lactation was 0.75 or less. A decrease in BCS of more than 1 was noted in only 86 lactations. The size of the negative energy balance significantly affected most of the characteristics analysed. In cases in which body condition score decreased by a maximum of 0.75, milk production in standard lactation was on average 6,575 kg. This value was 295 kg lower than in the case of a 1-point decrease in BCS, and 671 kg lower than in cases where BCS decreased by more than 1. For milk yield converted to FPCM the differences between these groups were 400 and 300 kg of milk. With

regard to yield of fat, protein and dry matter depending on the size of the negative energy balance after calving, fewer statistically significant differences were noted. The differences were greatest between the smallest (up to BCS 0.75) and largest (BCS > 1) decrease in body condition score: 33 kg of fat, 15 kg of protein and 77 kg of dry matter. The differences in these traits between the intermediate and greatest loss of body condition were 12, 5 and 29 kg and were statistically insignificant. The data in Table 1 show that the magnitude of the loss in body condition was also associated with FPCM per day of lactation. Dechow et al. [2002] claims that selection for yield appears to increase body condition score loss by lowering postpartum BCS. Loker et al. [2012] found milk production to be associated with both the body condition of cows at the start of lactation and the magnitude of the changes in it. Greater mobilization of fat was accompanied by higher yield of milk and its basic components. This view has also been confirmed by other studies [Chillard 1992, Dechow et al. 2002]. Bewley and Schutz [2008] recommend monitoring changes in the body condition of cows, and at the same time claim that a successful strategy for managing body condition should also consider changes in the state of fat reserves.

Analysis of the effect of the size of the decrease in body condition on the basic composition of milk (i.e. its content of fat, protein and dry matter) showed no clear tendencies. The data in Table 1 show that as the negative energy balance increased, protein content in the milk decreased from 3.38% for SNEB up to BCS 0.75 to 3.37% for SNEB = BCS 1 and 3.27% for SNEB > BCS 1. The highest content of fat and dry matter (4.44% and 13.27%, respectively) was noted in the case of a 1-point loss in body condition, while the milk obtained from cows whose BCS decreased by 0.75 or less contained the most protein (3.38%). The results presented correspond to a small extent with the claim made by Remppis et al. [2011] that cows that have lost a lot of body weight in early lactation produce milk with higher fat content, because the mobilized fat passes directly to the mammary gland. A reduction in protein content may result from lower intake of dry matter at the start of lactation, which leads to decreased microbial synthesis and a lack of amino acids for synthesis of milk proteins. Chillard [1992] suggests that decreased protein content in the milk of cows with a large energy deficit is probably linked to the limited ability of the body to activate protein reserves.

A study by Januś et al. [2007] showed that both the magnitude of the loss in body condition after calving and the length of the period of decline in BCS depended on the state of fat reserves before parturition. The body condition of cows with BCS above 4 during the dry period declined for the longest period and in the greatest degree. The data in Table 1 show that the decline in body condition score (DNEB) lasted only one month in 179 cases (41.2% of the total). The negative energy balance lasted 2 months in the case of 121 lactations (27.8%), and

longer in 135 (31.0%). The length of the period during which the body condition of the cows declined at the beginning of lactation had a smaller effect (in comparison with the size of the loss of energy reserves) on milk yield and composition. Analysis of the effect of this factor showed that the differences between the DNEB levels determined in the study were at most 515 kg of milk (572 kg FPCM), 29 kg of fat, 12 kg of protein and 70 kg of dry matter, and only some of these differences were significant at $P \leq 0.05$. FPCM yield per day of standard lactation increased (from 22.6 to 23.8 to 24.4 kg) with the length of the period during which BCS declined. Also, as the duration of the decline in body condition increased, the content of fat and dry matter in the milk increased (insignificant differences), while protein content decreased from 3.39% to 3.35% to 3.32%. In the case of this trait only the difference between the shortest (up to 1 month) and the longest (>2 months) DNEB, at 0.09%, was statistically significant at $P \leq 0.05$.

Table 1. Yield in standard lactation in cows differing at the start of lactation in the rate of changes in body condition and the duration of its decline

Tabela 1. Wydajność w laktacjach standardowych krów różniących się na początku laktacji tempem zmian kondycji oraz długością okresu jej obniżania

Characteristics Cechy	Factor – Czynniki						Total and mean Ogółem i średnio
	SNEB, BCS WUBE, pkt. BCS			DNEB, months DUBE, miesiące			
	≤ 0.75	1.0	> 1.0	≤ 1	2	> 2	
Number of lactations Liczba laktacji	205	144	86	179	121	135	435
Mean length of lactation Przeciętna długość laktacji	300	301	302	300	302	301	301
Yield, kg – Wydajność, kg							
milk – mleka	6.575 ^{Ab}	6.870 ^b	7.246 ^{Bc}	6.547 ^a	6.874 ^b	7.062 ^c	6.805
FPCM – FPCM	6.811 ^{Ab}	7.211 ^b	7.511 ^{Bc}	6.800 ^a	7.151	7.372 ^b	7.082
fat – tłuszczu	282 ^A	303 ^B	315 ^B	282 ^a	298	311 ^b	295
protein – białka	221 ^{Ab}	231 ^b	236 ^B	222	229	234	227
dry matter – suchej masy	861 ^{Ab}	909 ^b	938 ^B	862 ^a	907 ^b	932 ^c	892
FPCM yield per day of milking, kg Wydajność FPCM na dzień doju, kg	22.7 ^{Ab}	23.9 ^b	24.8 ^{Bc}	22.6 ^a	23.8 ^b	24.4 ^c	23.5
Content in milk, % – Zawartość w mleku, %							
fat – tłuszczu	4.28 ^a	4.44 ^b	4.36	4.30	4.36	4.41	4.35
protein – białka	3.38 ^A	3.37 ^A	3.27 ^B	3.39 ^a	3.35	3.32 ^b	3.35
dry matter – suchej masy	13.14 ^a	13.27 ^b	13.10 ^a	13.16	13.19	13.20	13.18

^{AB} Significant at $P \leq 0.01$; ^{abc} significant at $P \leq 0.05$.

^{AB} Różnice istotne przy $P \leq 0.01$; ^{abc} różnice istotne przy $P \leq 0.05$.

The results presented in Table 1 were confirmed by the correlation coefficients (Table 2). Milk yield and composition in standard lactation were most influenced by the decline in body condition scores at the start of lactation. The correlation

coefficients between this trait and yield of milk (also FPCM and kg FPCM per day of milking) and fat were identical ($r = 0.20$) and significant at $P \leq 0.01$. For yield of protein and dry matter the coefficients were $r = 0.14$ and $r = 0.18$, respectively ($P \leq 0.05$). These coefficients indicate that we can expect higher yield of milk and its components during the standard lactation period from cows with greater declines in body condition after parturition. The coefficients between the size of the decrease in BCS score and the content of fat and dry matter in the milk were insignificant ($r = 0.06$ and $r = -0.03$, respectively). It was also found that a greater decrease in body condition score at the beginning of lactation may be accompanied by a decrease in protein content in the milk, as the correlation coefficient between SNEB and this characteristic was $r = -0.17$ ($P \leq 0.01$). According to Dechow et al. [2002] increased body condition loss was correlated with increased ME milk, fat and protein yield both genetically and phenotypically. Genetic correlation estimates ranged from 0.17 to 0.50, whereas phenotypic correlations ranged from 0.06 to 0.10.

Table 2. Correlation coefficients for the magnitude of changes in body condition after calving and the length of the period of decline in BCS with yield in standard lactation

Tabela 2. Współczynniki korelacji pomiędzy wielkością zmian kondycji po wycieleniu oraz długością okresu obniżania ocen BCS a wydajnością w laktacjach standardowych

Characteristics – Cechy	SNEB, BCS WUBE, pkt. BCS	DNEB, months DUBE, miesiące
Yield, kg Wydajność, kg		
milk – mleka	0.20**	0.11*
FPCM – FPCM	0.20**	0.13*
fat – tłuszczu	0.20**	0.14*
protein – białka	0.14*	0.06
dry matter – suchej masy	0.18*	0.10*
FPCM yield per day of milking, kg Wydajność FPCM na dzień doju, kg	0.20**	0.12*
Content in milk, % Zawartość w mleku, %		
fat – tłuszczu	0.06	0.10*
protein – białka	-0.17*	-0.14*
dry matter – suchej masy	-0.03	0.02

** Significant at $P \leq 0.01$; * significant at $P \leq 0.05$.

** Współczynniki istotne przy $P \leq 0.01$; * współczynniki istotne przy $P \leq 0.05$.

The correlations between the length of the period of decline in body condition (DNEB) and the yield and composition of milk ranged from $r = 0.14$ to $r = -0.14$. All coefficients except for those pertaining to protein yield and content of dry matter in the milk were significant at $P \leq 0.05$.

CONCLUSIONS

To sum up, the greater the mobilization at the start of lactation of fat accumulated by cows before parturition, the higher was the production of milk, fat, protein and dry matter. The decrease in body condition score was less strongly associated with the basic composition of the milk obtained in standard lactation. Moreover, longer duration of the negative energy balance was associated with higher yield of milk, fat and dry matter and with higher fat content in the milk. Increased length of the period of body condition decline was accompanied by a decrease in protein content in the milk.

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OBNIŻANIE SIĘ KONDYCJI KRÓW PO WYCIELENIU A ICH LAKTACYJNA WYDAJNOŚĆ

Streszczenie. Celem pracy była analiza wpływu wielkości strat kondycji po wycieleniu i długości okresu jej obniżania się na wydajność w 435 laktacjach standardowych krów rasy polskiej holsztyńsko-fryzyjskiej odmiany czarno-białej utrzymywanych w 5 oborach. Do oszacowania wielkości strat kondycji po wycieleniu i długości okresu jej obniżania się wykorzystano comiesięczne oceny kondycji krów w 5-punktowej skali BCS, a dane dotyczące produktywności pozyskano z systemu SYMLEK. Stwierdzono, że im większa na początku laktacji była mobilizacja tłuszczu zgromadzonego przez krowy przed porodem, tym wyższa była produkcja mleka, tłuszczu, białka i suchej masy. Zmniejszanie się punktowych ocen kondycji w mniejszym stopniu związane było z podstawowym składem mleka pozyskiwanego w laktacjach standardowych. Ponadto z dłużej trwającym ujemnym bilansem energii związana była wyższa wydajność mleka, tłuszczu i suchej masy oraz wyższa zawartość tłuszczu w mleku. Wydłużaniu okresu obniżania się kondycji mógł towarzyszyć spadek zawartości białka w mleku.

Słowa kluczowe: kondycja krów, wycielenie, wydajność, ujemny bilans energetyczny

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