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The influence of some factors on body condition of high-yield Montbéliarde cows

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The study employed 4863 body condition scores, determined in the Montbéliarde cows from MONTAGRO farm. In 2011 an average cows' population of the herd was equal to 248 heads and their annual milk yield amounted to 9782 kg of milk. Body condition of the cows was determined once a month (from September 2009 to November 2011), according to the 5-point scale, with increments of 0.25 points. It was found that changes of cows' body condition as well as the frequency of various scores were significantly influenced by subsequent lactation, calving and scoring season, daily FPCM yield, period after calving and urea level in milk. The highest average scores were found in II-III lactation, in the cows calved in the autumn and in the cows characterized by the lowest daily milk yield. The lowest scores were found at the highest level of urea in milk (300 mg/l) and between the 5th to 7th month after calving. The study showed that not all cows were characterized by a proper condition, despite TMR feeding has been used. There was found an increase of the frequency of excessively high scores in successive lactations and periods after calving and in the case of the declining milk yield and in decreasing of milk urea level. The results obtained can serve as guidelines in dairy cattle management, especially in the nutrition optimizing in loose housing, including the managing of cows in each technological-nutrition group.

KEY WORDS: cows / Montbéliarde / body condition / high productivity

Body condition scoring (BCS) of cows makes it possible to conduct a non-invasive assessment of metabolic energy reserves accumulated in the adipose and muscle tissues. Despite its subjectivity this method adequately reflects the amount of subcutaneous fat deposited in the cow's body, as a highly significant correlation was found [16] between ultrasound measured thickness of subcutaneous adipose tissue and body condition scores (r=0.83).

The objective of herd management in the case of dairy cows is to prevent both excessive loss of body condition at the beginning of lactation and excessive fattening of animals before parturition [20]. A negative energy balance in dairy cows before calving is a physiological phenomenon. Parturition and the onset of lactation are a period, in which the cow's metabolism changes due to the transition from anabolic processes (pregnancy

and dry period) to predominantly catabolic metabolism. Peak milk production is typically reached in the 6th-8th week of lactation, while maximum feed dry matter intake is observed in the 12th-14th week after calving. This leads to a discrepancy between energy requirement and its potential supply provided by feed intake, manifested in the mobilisation of reserves accumulated in the cow's organism and a decrease in body mass [3, 5, 13, 22]. Around the 13th-14th week of lactation production requirement is balanced by the potential supply of energy with feed intake [15]. This facilitates restoration of lost reserves, which should be slow and completed with the cow's lactation.

It was shown that the level of fat reserves in cows and their changes in individual periods of the production cycle are connected with milk yield [1, 2, 3, 4, 10, 12] and reproduction parameters [1, 10, 14]. Studies concerning body condition of cows and its relationship with productivity and economically important production and non-production traits have been conducted mainly in herds of Holstein-Friesian cattle [1, 2, 3, 6, 7, 8, 9, 11, 12, 13, 16, 20]. Some studies have also shown [4, 10, 14, 22] applicability of body condition scoring in herds of dual-purpose cattle.

Recently, next to improvement of production traits, we have been observing increasingly often attempts to optimise reproduction and improve functional traits as well. For this reason breeders of dairy cattle are focusing on breeds characterised by slightly lower production potential than HF cattle, but showing greater adaptability to less advantageous environmental conditions and poorer nutrition, as may be observed on many farms. The French breed Montbéliarde is becoming increasingly popular in Poland, as it is indicated by the constant increase in the active population of these cows in Poland [17]. For this reason it is advisable to undertake studies on various aspects of performance potential of these animals.

The aim of this study was to assess the effect of selected non-genetic factors modifying body condition in Montbéliarde cows. Body condition of cows is an important functional trait and data provided by body condition scoring may be used to optimise nutrition.

Material and methods

In this study analyses were conducted on the farm belonging to MONTAGRO Ltd., in 2011 keeping 248 Montbéliarde cows with an average yield of 9782 kg milk containing 3.36% butterfat and 3.49% protein [17]. Cows were kept in a loose barn on deep litter and fed all-mash in the TMR system. The feed ration was based on maize silage, haylage and hay. Concentrates included distiller's grain, (ground) barley as well as soybean and rapeseed meals. The mixed ration was supplemented with feed additives, which type and amount were specifically selected for the respective nutrition group. Depending on the period after calving, physiological status and daily milk yield the cows were divided into 6 management groups and their feed rations were balanced according to the DLG standards.

Body condition of cows was assessed on milk testing days using a 5-point scale (with 0.25 point increments) in the period from September 2009 to November 2011. It included a visual and palpation evaluation of fatness over spinous and transverse processes of the lumbar region of the spine. The degree of fatness was also evaluated over the points of the

hip and points of the buttock as well as the gluteal region over the pin bones and the tail base. Body condition score of 1 point indicated extreme emaciation of the animal, while the score of 5 points – obesity. A total of 4863 body condition scores were recorded, of which 741 were for dry cows. In all cases body condition was assessed by the same person.

Experimental factors and their levels were established based on the data retrieved from herd documentation (dates of calving and results of successive test day milkings). Daily milk yields (in kg) were converted into yields of fat and protein corrected milk (FPCM) according to formula [21]:

$$FPCM\ (kg) = [0.337 + 0.116 \times fat\ (\%) + 0.06 \times protein\ (\%)] \times milk\ (kg).$$

Statistical calculations were performed using the SAS software [19]. The F test was applied to verify the significance of the effect of tested factors and their interactions on body condition of cows. Significance of differences between means was assessed using the Duncan test. The following linear model was applied:

$$Y_{ijklmn} = \mu + a_i + b_j + c_k + d_l + f_m + g_n + (af)_{im} + (df)_{lm} + e_{ijklmn}$$

where:

μ – total mean;

a_i – the effect of i-th lactation (I, II-III, >III);

b_j – the effect of j-th season of analyses (summer – months May-October, winter – November-April);

c_k – the effect of k-th calving season (spring – March-May, summer – June-August, autumn – September-November, winter – December-February);

d_l – the effect of l-th period after calving (up to 3rd month, 4th-6th, 7th-10th, >10th month after calving, dry period);

f_m – the effect of m-th daily FPCM yield (up to 20.0 kg; 20.1-30.0; 30.1-40.0; >40.0 kg);

g_n – the effect of n-th urea level in milk (up to 150, 151-300, >300 mg/litre);

$(af)_{im}$ and $(df)_{lm}$ – interactions, for which the F test was significant: successive lactation × daily FPCM yield and period after calving × daily FPCM yield;

e_{ijklmn} – random error.

Within the analysed factors the frequency of respective body condition scores was assessed (max. 2.25 points; 2.50-3.00; 3.25-3.75 and >3.75 points). Significance of the effect of these factors was estimated applying the χ^2 test (test of independence).

Results and Discussion

The mean body condition score of Montbéliarde cows during lactation was 3.40 points (Table 1). For the BSC total this value was by 0.06 points higher. In a study by Walsh et al. [22] fat reserves in cows of that breed were much smaller, as in the course of lactation they were assessed at 3.15 BCS.

Body condition of primiparous cows was significantly ($P \leq 0.01$) lower in comparison to cows in the next lactations, which may have been connected with the utilisation of feed components for growth and development in those cows. The BSC was 3.39 points. Mean values for that trait in lactations II-III and >III were comparable and did not differ

Table 1
Body condition of Montbéliarde cows taking into account the effect of the factors analysed

Factors	Number of scores	Body condition scores (pts)	
		$\bar{x}$	SD
Successive lactation			
I	971	3.39^{A}	0.42
II-III	1945	3.49^{B}	0.60
>III	1947	3.47^{B}	0.66
Scoring season			
summer	2893	3.44^{A}	0.59
winter	1970	3.50^{B}	0.60
Calving season			
spring	964	3.39^{A}	0.61
summer	1006	3.47^{B}	0.56
autumn	1673	3.49^{B}	0.60
winter	1220	3.48^{B}	0.60
Successive periods after calving			
up to the 3th month	1118	3.14^{A}	0.52
4.-6.	1064	3.31^{B}	0.57
7.-10.	1327	3.53^{B}	0.53
11th and next months	613	3.71^{D}	0.53
dry period	741	3.84^{E}	0.58
Total and average	4863	3.46	0.59
Daily milk yield (kg FPCM)			
≤20.0	632	3.78^{A}	0.56
20.1-30.0	1345	3.45^{B}	0.54
30.1-40.0	1379	3.29^{C}	0.53
>40.0	766	3.18^{D}	0.54
Milk urea level (mg/l)			
≤150	628	3.51^{A}	0.58
151-300	2693	3.41^{B}	0.57
>300	801	3.27^{C}	0.53
Total and average	4122	3.40	0.57

Mean values within a factor designated with different letters differ significantly at P≤0.01

significantly (3.49 and 3.47 points, respectively). Similar dependencies were reported in other studies [9]. They showed that multiparous cows in comparison to primiparous cows started lactation with greater fat reserves and in the course of the entire lactation and in the dry period these cows had higher body condition scores. A study by Jankowska et al. [8] showed that body condition of cows in successive lactations was dependent on the season of the year. Primiparous cows and cows in their IInd-IIInd lactations received highest scores in the summer, cows in their IVth-Vth lactation – in the spring, while in >Vth lactation – in the autumn. Kertz et al. [11] recorded the lowest BCS in cows after the second calving.

Energy reserves of Montbéliarde cows from May to October were assessed on average at 3.44 points, while from November to April at 3.50 points. The difference between these

values was significant at P≤0.01 and may have resulted from the differing intensity of fat reserve accumulation, connected with the quality of feeds comprising the mixed ration fed in individual months of the year. Seasonal changes in body condition of cows were also observed by Borkowska [2] and Jankowska et al. [8].

The lowest BSC was found for cows, which calved in the period from March to May. They were assessed at 3.39 points. In the case of summer, autumn and winter calvings the mean BSC values were comparable and ranged from 3.47 to 3.49 points. These were values differing at P≤0.01 from those calculated for the spring calvings. The relationship between the season of calving and changes in body condition of cows was also analysed in other studies [9]. It was stated that body condition of cows calving in the autumn-winter period, in comparison to those calving in the spring and summer, deteriorated to a lesser extent at the beginning of lactation and they regained their fat reserves more slowly during lactation.

Many authors indicate significant changes in body condition of cows in individual periods of the production and reproduction cycles [2, 3, 6, 10, 13, 16]. Nogalski et al. [16] stated that HF cows at the onset of lactation typically used body fat reserves up to the 9th-12th week after calving, while the mean difference in the level of fat reserves between calving and the lowest BSC during lactation was 0.5 point. Walsh et al. [22] reported that depending on the nutrition regime BSC started to increase from the 25th-28th or 29th-32nd week after calving. It results from studies conducted on the modification of that trait in the course of lactation in cows of various breeds [13] that from the 2nd to the 8th week after calving the greatest reduction of body condition was observed in Norwegian Red and Holstein-Friesian cows (by 0.19 and 0.15 BCS, respectively), while it was lowest in Montbéliarde and crosses of the Holstein-Friesian and Normande breeds (by 0.09 BCS). Dillon et al. [6] stated that up to the 8th week after calving Montbéliarde cows in comparison to Holstein-Friesian cows to a lesser degree mobilised their fat reserves, while in the period between the 12th and 40th week of lactation regained them more intensively. Results of our study indicate highly significant variation in body condition of Montbéliarde cows in successive periods after calving. The lowest BSC (3.14 points) was given in the first three months after calving. In the 4th-6th months BSC for fat reserves indicated an improvement of body condition, since it was by 0.17 points higher in comparison to the previous period. In the next months this trend was maintained, while scores increased through 3.53 points in the 7th-10th month of lactation to 3.71 points in the period of its extension over the 305-day standard (the 11th and successive months). The mean calculated for the dry period was 3.84 points. In other studies [14] body condition of Montbéliarde cows in the last month before calving was assessed at 3.46 points. In the opinion of many authors [4, 7, 10, 14], the volume of energy reserves accumulated in the dry period determines later productivity of cows and influences reproductive efficiency and health of the animals. Bouška et al. [4] and Jílek et al. [10] also showed a significant dependence between body condition in the dry period and its fluctuations in the course of lactation.

With an increase in daily milk yields the level of fat reserves in Montbéliarde cows decreased significantly (at P≤0.01). At milk yields of up to 20.0 kg FPCM body condition was on average assessed at 3.78 points. For daily yields ranging from 20.1 to 30.0 kg milk it was 3.45 points, while the mean BSC for cows with yields of 30.1-40.0 kg FPCM was 3.29 points and it was by 0.11 points higher than that calculated for the group with the

highest daily FPCM yields (>40 kg).Negative dependencies between milk production and body condition of cows were also indicated by Borkowska [2], Loker et al. [12] and Pryce et al. [18]. Berry et al. [1] reported that values of coefficients of genetic correlation calculated for these traits ranged from –0.51 to –0.14.

Mean scores for energy reserves in Montbéliarde cows calculated at various urea levels in milk differed highly significantly. At the urea content in the range of 151-300 mg/l body condition of cows was assessed at 3.41 points. A value higher by 0.1 points for that trait was found for cows, in which urea concentration in milk did not exceed 150 mg/l. The lowest mean (3.27 points) was calculated for the cows producing milk containing the highest levels (>250 mg/l) of urea.

Body condition of Montbéliarde cows was most frequently (50.4% total and 52.3% scores of cows recorded in the course of lactation) assessed at 3.25-3.75 points (Table 2). Scores indicating emaciation (≤2.25 points) were recorded with the lowest frequency (5.1% and 5.7%, respectively). In the course of lactation scores exceeding 3.75 points constituted 20.8%, while in the case of their total number they accounted for 25.5%. The frequency of varying scores for fat reserves of cows was affected (at $P \leq 0.01$) by all factors analysed in this study.

In successive lactations body condition was most frequently assessed at 3.25-3.75 points. The share of such scores was highest in primiparous cows (65.1%) – Table 2. The lowest BSC (max. 2.25 pts) were found for 1.5% primiparous cows, while in 13.6% cases they received the highest scores (over 3.75 pts). In the next lactations an increase was found both in the percentage of scores indicating emaciation (4.2% in the 2nd-3rd lactation to 7.7% in the next lactations) and in the excessively high (27.1% and 29.9%, respectively).

The season of analyses had a significant effect ($P \leq 0.01$) on the frequency of various body condition scores. In the summer season (May-October) scores from 2.50 to 3.00 points and those within the range of 3.25-3.75 points were more common, while the highest scores were less frequent (Table 2). Scores of max. 2.25 points were given to cows in both seasons with identical frequency (5.1%).

The frequency of individual body condition scores varied depending on the calving season. Scores exceeding 3.75 points were recorded most frequently (27.4%) in the case of calvings in the winter months. A similar frequency (27.1%) was found for the highest scores given to cows calving in the autumn. The share of scores of max. 2.25 points and ranging from 2.50 and 3.00 points was highest (7.1 and 21.3%) for spring calvings. The effect of calving season on fluctuations in body condition of cows was confirmed by the χ^2 test, which value was 33.9 ($P \leq 0.01$).

In the first three months of lactation in 43.2% cases body condition of Montbéliarde cows was assessed at max. 3.00 points, while the share of the highest scores was 7.4%. In the successive periods after calving the percentage of scores indicating emaciation decreased successively (≤2.25 points), similarly as it was for those of 2.50-3.00 points, while the frequency of scores exceeding 3.75 points increased. In the course of lactations extended over the 305-day standard (i.e. in the 11th and next months) they accounted for 41.0% total. For the dry period such high scores were recorded in as many as 52.1% cases. Mouffok et al. [14] showed that in dry Montbéliarde cows the largest number of scores (46%) ranged from 2.75 to 3.50 points, while in 38% cases scores exceeding 3.50 points were given. The lowest scores (<2.75 points) constituted as little as 16%. Those authors stated that in

Table 2

Frequency of different body condition scores of cows, taking into account the effect of the factors analysed

Factors	Number (%) of body condition scores of cows (pts)				χ^2
	≤2.25	2.50-3.00	3.25-3.75	>3.75	
Successive lactation					
I	15 (1,5)	192 (19.8)	632 (65.1)	132 (13.6)	181.7*
II-III	82 (4,2)	391 (20.1)	945 (48.6)	527 (27.1)	
>III	149 (7,7)	342 (17.6)	873 (44.8)	583 (29.9)	
Scoring season					
summer	146 (5,1)	570 (19.7)	1491 (51.5)	686 (23.7)	13.0*
winter	100 (5,1)	355 (18.0)	959 (48.7)	556 (28.2)	
Calving season					
spring	69 (7,1)	205 (21.3)	782 (50.0)	208 (21.6)	33.9*
summer	32 (3,2)	200 (19.9)	529 (52.6)	245 (24.3)	
autumn	89 (5,3)	286 (17.1)	844 (50.5)	454 (27.1)	
winter	56 (4,6)	234 (19.2)	595 (48.8)	335 (27.4)	
Successive periods after calving					
up to the 3th month	106 (9.5)	377 (33.7)	552 (49.4)	83 (7.4)	
4.-6.	78 (7.3)	250 (23.5)	573 (53.9)	163 (15.3)	816.3*
7.-10.	37 (2.8)	191 (14.4)	740 (55.8)	359 (27.0)	
11th and next months	13 (2.1)	56 (9.1)	293 (47.8)	251 (41.0)	
dry period	12 (1.6)	51 (6.9)	292 (39.4)	386 (52.1)	
Total	246 (5.1)	925 (19.0)	2450 (50.4)	1242 (25.5)	×
Daily milk yield (kg FPCM)					
≤20.0	14 (2.2)	52 (8.2)	263 (41.6)	303 (48.0)	470.0*
20.1-30.0	59 (4.4)	242 (18.0)	746 (55.5)	298 (22.1)	
30.1-40.0	84 (6.1)	349 (25.3)	767 (55.6)	179 (13.0)	
>40.0	77 (10.0)	231 (30.2)	382 (49.9)	76 (9.9)	
Milk urea level (mg/l)					
≤150	31 (4.9)	101 (16.1)	317 (50.5)	179 (28.5)	71.1*
151-300	143 (5.3)	556 (20.7)	1419 (52.7)	575 (21.3)	
>300	60 (7.5)	217 (27.1)	422 (52.7)	102 (12.7)	
Total	234 (5.7)	874 (21.2)	2158 (52.3)	856 (20.8)	×

*Values for the χ^2 test significant at P≤0.01

cows, which body condition in the last month before lactation was assessed at 2.75-3.50 points, the period from calving to the 1st insemination and interpregnancy period were shortest (54 and 81 days, respectively), while the worst values of these indexes (131 and 150 days, respectively) were recorded for cows having the lowest reserves. According to Broster [5], changes in body condition of cows in the course of lactation, particularly the decrease observed in its initial period, are dependent to a greater extent on the level of this trait before calving rather than genetic predispositions of the animals.

In the group of cows with daily yields up to 20.0 kg FPCM almost a half (48.0%) were scores exceeding 3.75 points, and only in 2.2% cases body condition was assessed at max. 2.25 points. At yields ranging from 20.1 to 30.0 kg milk the percentage of the highest scores was as low as 22.1%, while the frequency of the lowest scores increased two-fold. Increasing yields (30.1-40.0 kg to >40.0 kg) were accompanied by a successive decrease in the share of the highest scores (to 13.0 and 9.9%, respectively). In the group with yields exceeding 40.0 kg FPCM the frequencies of the highest and lowest scores were comparable (9.9 and 10.0%, respectively) – Table 2.

The frequency of individual values of body condition scores was also diversified by milk urea content. The result of the χ^2 test calculated for that factor, amounting to 71.1, was significant at $P \leq 0.01$. The higher the milk urea content, the more frequent were the scores of max. 3.00 points. With an increase in the concentration of that compound the share of the highest scores decreased. Dependencies between milk urea content and body condition of cows were not confirmed by a study of Loker et al. [12]. Genetic correlations calculated by those authors indicate that BCS values were not correlated with milk urea content.

Summing up, it needs to be stressed that body condition in Montbéliarde cows and the frequency of various BSC values were significantly affected by lactation number, calving season, daily FPCM yield, period after calving and milk urea level. Moreover, significant differences were also recorded between means calculated for the summer (May-October) and winter (November-April) seasons of the analyses. The highest mean scores were found for the IInd-IIIrd lactations in cows calving in the autumn and those with the lowest daily yields. At the milk urea levels exceeding 300 mg/l and in the first three months after calving energy reserves of cows received the lowest scores. These investigations indicate that despite the TMR system adopted in that herd not all cows showed optimal body condition. This is suggested by the increased frequency of scores indicating excessive fatness of cows in successive lactations and periods after calving, as well as in the case of decreasing milk yields and decreasing milk urea contents. These results may be applied to a considerable degree in practice in herd management, particularly in order to optimise nutrition regimes in loose barns, e.g. when assigning cows to individual management (nutrition) groups.

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