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Body condition as an indicator of cow welfare

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A B S T R A C T

The main objective of this research was to determine the quality level of welfare of milk cows at various stages of lactation (the first 60 days of the lactation period and the dry period) and of different breeds (Holstein-Friesian and Simmental) on farms (A, B, C, D) with different systems of housing (free and tie-stall), based on nutritional status as a direct individual indicator of well-being.

Results showed that the body condition scores of cows were statistically very highly significantly ($p<0.001$) influenced by breed, production stage and the breed x production stage interaction; statistically highly significantly ($p<0.01$) by the breed x housing system interaction, and significantly ($p<0.05$) by the housing system x production stage interaction.

Keywords: body condition, welfare of cows, Simmental breed, Holstein-Friesian breed.

И З В О Д

Главни циљ овог истраживања је био да утврди ниво добробити фарми млијечних крава (А, Б, Ц, Д) са различитим системима држања (слободним и везаним), у различитим фазама лактације (првих 60 дана периода лактације и период засушења) и различитог расног састава (холштајнско-фризијска и сименталска раса), заснованог на примјени директног појединачног показатеља благостања: нутритивни статус.

На основу постављених циљева, задатака и резултата испитивања утицаја тјелесног стања као директног показатеља добробити, може се закључити да је на оцјену тјелесног стања крава био статистички врло високо значајан ($p<0,001$) утицај расе, производне фазе и интеракција раса х фаза производње; на статистички високо значајан ($p<0,01$) утицала је интеракција расе х систем држања, док је интеракција систем држања х фаза производње учествовала статистички значајно ($p<0,05$).

Кључне речи: телесна кондиција, добробит крава, Сименталска раса, Холштајн-Фризијска раса.

1. Introduction

Body Condition Scoring (BCS) is measured subjectively, visually, by observing the animal from the side and the rear, by palpation of characteristic points in certain areas of the body (lumbar regions of the back, pelvic area, hip regions, sciatic humps, tail roots), and based on the condition of subcutaneous body fat reserves, which can change during lactation. The current state of nutrition, state of health and general appearance of the animal are used as principles for the assessment of this criterion, and the animal's body condition score is used as a measuring indicator. The condition of animals changes during their life in accordance with the way of breeding, their diet, and way of their utilisation. The body condition score of cows is influenced by age, stage of production cycle and genotype (Roche et al., 2009). Body condition scoring is the most sensitive and accurate indicator of the energy i.e. metabolic status of cows, and is used as a corrective measure in cows whose well-being is disturbed by a qualitatively or quantitatively unbalanced diet (Bewley and Schutz, 2008; Bewley et al., 2010; Roche et al., 2009). Assessment of body condition should be conducted at least twice a year to avoid large variations in energy metabolism and can therefore be used to correct the diet at critical stages of production and reproduction of cows. Antov and Janković (2006) conducted a multi-year assessment of the body condition of Holstein-Friesian cows. They examined the effect of housing system on the body condition of cows, and found a body condition score of 3 in the majority of cows in the free-range housing system and 3 and 3.5 in the majority of cows in the tie-stall housing system. In cows with a score of 1 and 2 for body condition the authors observed a greater number of animals with metabolic disorders and veterinary interventions during and after calving, as well as changes in their extremities. Cows at the beginning of lactation were also in this group. Body condition scores 4.5 and 5 were received by low-productive cows with shortened lactation and early dry periods, or cows with prolonged lactations due to a long service period, as well as by cows in advanced lactation. Cows in the tie-stall housing system, compared with cows in the free-range housing system, which received the same diet, had better body condition because they consumed less energy for physical activity, i.e. movement, and their milk yield was higher, but reproductive results were weaker.

The main goal of this research was to determine the quality level of well-being of milk cows at various

stages of lactation (the first 60 days of lactation, and during the dry period) and of different breeds (Holstein-Friesian and Simmental) on farms (A, B, C, D) with different housing systems (free and tie-stall), on the basis of nutritional status as a direct individual indicator of well-being.

2. Material and Method

Examination of the influence of housing system, breed and production stage on direct indicators of dairy cows' welfare was conducted on four Simmental and Holstein-Friesian dairy cow farms (A, B, C, D) in free-range and tie-stall housing systems. On farm **A,** Simmental cows were kept in a tie-stall housing system in closed barns, on medium-long beds, on which they spent their entire production life. In one barn, at full capacity, there were a total of 80 dairy cows housed in two rows of beds (2 x 40) facing "head to head". The total capacity of this farm was 320 dairy cows (4 dairy facilities x 80 cows in the facility). The diet was combined through mono meals. On farm B, Holstein-Friesian cows were housed in semi-open facilities, in a tie-stall housing system on the so-called medium-sized beds, on which they spent their entire production life, regardless of the stage of production. The maximum capacity of this farm was about 1300 cows, plus all other categories of cattle. On farm C**,** Simmental cows were kept in a free-range system, in closed-type stables with individual boxes-beds for individual rest of each animal. The full capacity of the farm was 300 cows, divided into two stables for dairy cows with about 100-120 cows per barn, plus one for cows in the dry period (about 60–80 cows) and for offspring. On farm D**,** there were Holstein-Friesian cows in a free-range system, in closed-type stables with individual rest boxes and with a fenced range that directly connected to the barn. The full capacity of this farm was about 1200 cows with accompanying categories of cattle. There were about 60–70 cows in one barn with range. The cows were constantly allowed to use the range. The assessment of body condition as an indicator of the welfare of cows involved the following: body condition score, Simmental cows in tie-stall housing system from day 10 to day 60 of lactation; body condition score, Simmental cows in a free-range system from day 10 to day 60 of lactation; body condition score, Simmental cows in a free-range system in the dry period; body condition score, Simmental cows in a tie-stall housing system in the dry period; body condition score, Holstein-Friesian cows in a tie-stall housing system from day 10 to day 60 of lactation; body condition score, Holstein-Friesian cows in a tie-stall housing system in the dry period; body condition score, Holstein-Friesian cows in a free-range housing system from day 10 to day 60 of lactation; body condition score, Holstein-Friesian cows in a free-range housing system in the dry period. On each farm (4 farms in total: A, B, C, D),80 cows were selected and divided into 2 groups, the first group consisting of 40 cows that were in the first phase of lactation, i.e. in the period from day 10 do day 60 of lactation, and the second group including 40 cows in the dry period. Therefore, the size of the whole sample was 320 cows, for both breeds (Simmental and Holstein-Friesian) and for both housing systems (free and tie-stall). The body condition of dairy cows was assessed using the method described by Jakšić (2009). According to this method, by observation and palpation of the cows' body regions, the following body regions were evaluated separately using a scoring system on a scale of 1 to 5: the area of the pit around the root of the tail (inserts);the area of sciatic and lateral humps; the area of the lateral extensions of the lumbar vertebrae; the area of the vertical extensions of the vertebrae and ribs (Table1).

Table 1.
Scoring system and indicators of body condition

Rating	Tail pits	Sciatic and lateral humps	Lateral extensions of the lumbar vertebrae	Vertical extensions and ribs
1	Deep	Sharply pointed	Sharp, clearly visible	Sharply pointed out
2	Shallow	Prominent	Visible	Well tangible
3	Moderately fulfilled	Moderately rounded	Tangible	Can be felt
4	Fulfilled	Well tangible	Hard to feel	Rounded
5	Completely fulfilled	Hard to feel	Covered with adipose tissue	Invisible, covered with fat

After the assessment of individual body areas, the score of body condition was calculated by adding the number of points awarded to each assessed body region and dividing by 4, which is the number of body regions on the basis of which the body condition is assessed. Thus, extremely lean cows received a score of 1, lean cows a score of 2, well fed cows a score of 3, fat cows a score of 4, and very fat cows a score of 5. Based on the percentage of individual indicators of cow welfare, i.e. on the basis of satisfactory body condition scores (score 3), welfare assessment was performed for each group of cows. The assessment was performed based on international recommendations for the assessment of cow welfare (Welfare Quality® Assessment Protocol for Cattle, 2009). The basic parameters of descriptive statistics were calculated for all examined traits in the experiment. The influence of three factors (housing system, breed and stage of production) on body condition was observed, and each factor had two levels (housing system: free and tie-stall; breed: Holstein-Friesian and Simmental, and production stage: lactating cows from day 10 to day 60, and cows in the dry period). The analysis of variance according to the model 2 x 2 x 2 was used to examine the influence of each individual factor on body condition as an indicator of well-being and their interaction. The obtained results were statistically processed using the statistical program VassarStats (© Richard Lowry 1998–2012, http://vassarstats.net/).

3. Results

Table 2 shows the results of descriptive statistics for assessing the body condition of cows across groups. As seen from Table 2, the average body condition score was the lowest in Holstein-Friesian cows in the free-range system during lactation, and it was 2.43 ± 0.64 (HFFL). The highest mean score in Simmental cows in the free-range system during lactation was 3.80 ± 0.72 (SFL). In Holstein-Friesian cows, the highest average body condition score was found in the tie-stall housing system during the dry period, and it was 3.63 ± 0.54 (HFTD). In Simmental cows, the lowest body condition score was found in cows kept in the tie-stall housing system during the dry period, and it was 3.30 ± 0.46 (STD).

The influence of breed, housing system and production stage on the body condition score of cows is shown in Table 3.

Table 2.
Statistical indicators of scores of body condition of cows

Group/ farm	Group label	N	$\bar{h}$	Sd	CV%	Min	Max
Holstein-Friesian breed Free-range system Lactation/ (farm D)	HFFL	40	2.43	0.64	26.23	1	3
Holstein-Friesian breed Free-range system Dry period/ (farm D)	HFFD	40	3.58	0.68	18.88	2	5
Holstein-Friesian breed Tie-stall system Lactation/ (farm C)	HFTL	40	2.93	0.69	23.72	2	4
Holstein-Friesian breed Tie-stall system Dry period/ (farm C)	HFTD	40	3.63	0.54	14.90	3	5
Simmental breed Free-range system Lactation/ (farm B)	SFL	40	3.40	0.78	22.88	2	5
Simmental breed Free-range system Dry period/ (farm B)	SFD	40	3.80	0.72	19.03	3	5
Simmental breed Tie-stall system Lactation/ (farm A)	STL	40	3.30	0.46	14.06	3	4
Simmental breed Tie-stall system Dry period/ (farm A)	STD	40	3.50	0.60	17.12	3	5

Table 3.
Analysis of variance in the body condition score of cows

Factor	DF	F	p
Breed	1	25.20	<0.000001
Housing system	1	0.27	= 0.603839
Production stage	1	72.00	<0.000001
Breed x housing system	1	10.80	= 0.001118
Breed x Production stage	1	18.70	= 0.000020
Housing system x Production stage	1	5.07	= 0.025094
Breed x housing system x Production stage	1	0.75	= 0.387324
Error	312		
In total	319		

The analysis of variance in the 2 x 2 x 2 experiment showed that differences between the average body condition scores of cows were statistically very highly significantly ($p<0.001$) influenced by breed, production stage and the breed x production stage interaction, highly significantly ($p<0.01$) by the breed x housing system interaction, and significantly ($p<0.05$) by the housing system x production stage interaction (Table 3).

Table 4 shows the difference in body condition scores among all groups of cows analysed by the Tukey test. Differences in body condition scores in Holstein-Friesian cows were statistically very highly significant ($p<0.001$), except between the Holstein-Friesian breed in a free-range system during lactation (HFFL) and the Holstein-Friesian breed in a tie-stall system during lactation (HFTL), between which statistically significant differences were found ($p<0.05$).

Table 4.
Differences in average values of body condition scores among groups of cows

Group label	Group label	Differences	DF	q	p
HFFL	HFFD	-1.150 t	78	11.26	<0.001
	HFTL	-0.5000	78	4.897	<0.05
	HFTD	-1.200	78	11.75	<0.001
	SFL	-0.9750	78	9.549	<0.001
	SFD	-1.375 t	78	13.47	<0.001
	STL	-0.8750	78	8.570	<0.001
	STD	-1.075	78	10.53	<0.001
HFTD	HFTL	0.6500	78	6.366	<0.001
	HFTD	-0.0500	78	0.4897	ns
	STL	0.1750	78	1.714	ns
	SFD	-0.2250	78	2.204 t	ns
	STL	0.2750	78	2.693 t	ns
	STD	0.07500	78	0.7346	ns
HFTL	HFTD	-0.7000	78	6.856	<0.001
	SFL	-0.4750	78	4.652	<0.05
	SFD	-0.8750	78	8.570	<0.001
	STL	-0.3750	78	3.673	ns
	STD	-0.5750	78	5.632	<0.01
HFFD	SFL	0.2250	78	2.204	ns
	SFD	-0.1750	78	1.714	ns
	STL	0.3250	78	3.183	ns
	STD	0.1250	78	1.224	ns
SFL	SFD	-0.4000	78	3.918	ns
	STL	0.1000	78	0.9794	ns
	STD	-0.1000	78	0.9794	ns
SFD	STL	0.5000	78	4.897	<0.05
	STD	0.3000	78	2.938 t	ns
STL	STD	-0.2000	78	1.959	ns

Average body condition scores in Simmental cows did not differ statistically significantly except between Simmental cows in the free-range system during the dry period (SFD) and Simmental cows in the tie-stall housing system during lactation (STL), showing statistically significant difference ($p<0.05$), (Table 4).

Table 5 shows the frequency distribution of body condition scores of cows across groups, based on which cow welfare was estimated.

Table 5.
Frequency distribution of body condition scores of cows

Group sign	HFFL		HFFD		HFTL		HFTD		SFL		SFD		STL		STD	
Rating	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
1	3	7.5	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
2	17	42.5	2	5.0	11	27.5	0	0.0	3	7.5	0	0.0	0	0.0	0	0.0
3	20	50.0	15	37.5	21	52.5	16	40.0	22	55.0	15	37.5	28	70.0	22	55.0
4	0	0.0	21	52.5	8	20.0	23	57.5	11	27.5	18	45.0	12	30.0	16	40.0
5	0	0.0	2	5.0	0	0.0	1	2.5	4	10.0	7	17.5	0	0.0	2	5.0
Σ	40	100	40	100	40	100	40	100	40	100	40	100	40	100	40	100

The results in Table 5 show that 50.00% of Holstein-Friesian cows in the free-range system during lactation (HFFL) received a score of 3, which indicates satisfactory body condition, while 50% of cows were lean and received lower scores for body condition. In Holstein-Friesian cows in the free-range system during the dry period (HFFD), only 37.50% of cows were in satisfactory body condition and received a score of 3, while 5.00% were lean and 52.00% of cows were obese.

In Holstein-Friesian cows in the tie-stall system during lactation (HFTL), 52.50% of cows received a score of 3, i.e. they had satisfactory body conditions, while 27.50% of cows were lean, and 20.00% of cows were fat. Satisfactory body condition, which is a score of 3, was determined in 40.00% of Holstein-Friesian cows in the tie-stall system during the dry period (HFTD), and in 55.00% of Simmental cows in the tie-stall housing system during dry period. There were 7.50% lean cows and 37.5% fat cows in the group of Simmental cows in the free-range system during lactation (SFL).. In the other groups of Simmental cows, the proportion of fat cows was 62.50% (SFD), 30.00% (STL) and 45.00% (STD).

4. Discussion

For agronomists, the assessment of the body condition of cows is of inestimable importance, because it enables the correction of the diet based on its value and the prevention of health, reproductive and production problems that would jeopardise the economy of production. Although in the first phase of lactation, weight loss and lowering of the body condition score are expected, cattle breeders must try to keep this decline as small as possible. Assessing body condition is a practical and easy way to group cows in herds according to their energy needs. The best time to group cows is in the phase of maximum lactation and in the period of late lactation, when the energy balance in their organism is positive.

Timely grouping of cows in relation to the assessment of body condition allows sufficient time to notice cows in which metabolic disorders can be expected and whose diet, in the period of early lactation, can be adjusted, for example, by adding monensin or choline to avoid or mitigate the clinical picture of ketosis (Duffield et al., 2008).

In dairy herds, manipulating body condition is not an easy task. There are at least three levels of manipulation within the herd, which means that breeders must monitor changes in body condition in different production stages of cows, between periods of body condition assessment and between different groups of cows, which are based on nutritional and energy needs. Assessment of body condition should be made as often as possible during the dry period, at the time of calving, at day 30, 60, 90, 150 and 200 of lactation.

Depending on the production stage, body condition score in cows should be (Grubić et al., 2009): at the time of calving – optimal 3.5, range 3.25–3.75; in the period of early lactation (days 1 to 30) – optimal 3.0, range 2.75–3.25; in the period of maximum lactation (days 31 to 100) – optimal 2.75, range 2.50–3.00; in the middle of lactation (days 101 to 200) – optimal 3.0, range 2.75–3.25; in late lactation (days 201 to 300) – optimal 3.25, range 3.00–3.75; and in the dry period (after day 300 of the production cycle) – optimal 3.5, range 3.00–3.75.

In this research, the average score of cows was generally above the recommendations found in the literature, with slightly higher average scores in cows during the dry period (Grubić et al., 2009). The only major deviation in the average score of body condition was found in Holstein-Friesian cows in the free-range system during lactation, in which the score of this direct indicator of well-being was lower than the recommended values, 2.43 ± 0.64. However, when using a cow body condition system that neglects the production stage and breed differences, the ideal cow body condition score should be 3.0 (three). Deviations in body condition score from the ideal score indicate that, on farms where the welfare of cows was assessed, obesity was more of a problem than leanness, except in Holstein-Friesian cows in the free-range system during lactation. In addition to fat cows, obese cows were present on the same farm, and their body condition score was 5, especially in the Simmental breed. Low body condition scores and the problem of malnutrition were found in Holstein-Friesian cows in the free-range system during lactation. In addition to all the factors that could have caused malnutrition of cows in this group of cows, we should certainly take into account social factors i.e. an insufficiently stable social hierarchy and the presence of more dominant and aggressive cows. It is possible that due to fear and agonistic interactions, malnourished cows were prevented from consuming sufficient amounts of food due to the presence of dominant and aggressive cows. Similar results were obtained by other researchers, who assessed the body condition of cow farms in Serbia and Croatia, which refers to the presence of obese animals in herds of cows (Šamanc et al., 2008). The finding of a large number of lean cows in herds was confirmed in research conducted by Popescu et al. (2010) in Transylvania.

The analysis of the influence of certain factors on the body condition of cows showed that the body condition score of cows was statistically very highly significantly ($p < 0.00$) influenced by breed, production stage and the breed x production stage interaction. Statistically high significance ($p < 0.01$) was found for the breed x housing system interaction, while the housing system x production stage interaction had a statistically significant effect ($p < 0.05$). Simply put, the differences in average body condition scores were influenced by all three factors examined. This result is also consistent with the results of other researchers, who evaluated the body condition of different breeds of cows, in different housing systems and at different production stages. Antov and Janković (2006) found that the body condition score in the largest number of cows of the Holstein-Friesian breed in the free-range was 3, while most cows in the tie-stall housing system received scores of 3 and 3.5.

The results of this research indicate that the body condition score was higher for cows in the dry period as well as in cows in the tie-stall housing system, except in Simmental cows in the tie-stall system during the dry period, in which the average body condition score was lower than in cows of the same breed in the same production stage, but in a free-range system.

With regard to the effect of breed on the body condition of cows, the dual-purpose breeds of cows have more developed muscles than high-milk breeds. In high-milk breeds of cows, fat is mainly deposited intra-abdominally, i.e. in the interior of the abdomen, unlike meat breeds of cattle. That is why change in body condition in cows of dual-purpose breeds, such as the Simmental breed, is most noticeable as a loss of muscle mass, while in high-milk cows, such as the Holstein-Friesian breed, a decrease in body condition is observed as adipose tissue loss (Bewley and Schutz , 2008). It is precisely for this very reason that the body condition scores of the Simmental breed of cows were higher than those of the Holstein-Friesian breed of cows.

5. Conclusion

The objectives and results of the research on the impact of body condition as a direct indicator of the welfare of cows indicate the following conclusions:

The average body condition score of cows was generally above the recommendations found in the literature, and a larger deviation in the average body condition score was found in Holstein-Frisian cows in the free-range housing system during lactation, in which the score of this direct indicator of welfare was

lower than the recommended values, and it was 2.43 ± 0.64.

The differences in average body condition scores were influenced by all three examined factors (breed, production stage, housing system).

Body condition score was higher in cows during the dry period as well as in cows in the tie-stall housing system, except in Simmental cows in the tie-stall housing system during the dry period, whose average score of body condition was lower than in cows of the same breed in the same production stage, but in a free-range housing system.

Overall, dual-purpose cow breeds have much better developed muscles than high-milk breeds, and changes in body condition in dual-purpose cows are most noticeable as a loss of muscle mass, while in high-milk cows, a decrease in body condition is observed as a loss of adipose tissue. For this reason, the body condition scores of the Simmental breed of cows were higher than those of the Holstein-Friesian breed of cows.

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