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Body Weight and Body Condition Score of Holstein Cows at Different Lactation Stages under Practice-Usual Feeding Conditions on Dairy Farms in Kosovo

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Abstract

Monitoring body weight (BW) and body condition score (BCS) of dairy cows during the production cycle are of crucial importance for the assessment of nutritional status of cows in dairy farms management. During the entire production cycle, BW and BSC were assessed in four dairy farms, involving 24 Holstein dairy cows in total, under usual feeding practices on dairy farms in Kosovo. 24 dairy cows in the third lactation (12 red Holstein and 12 Black Holstein) with calving interval within 15 days were included in this study. BW in kg and BCS (1-5 points) were measured 5 times in following intervals: at the day of calving (after calving); three times during the lactation in 100-day intervals, as well as at the end of the study (after dry period) or last week before next calving. Results show variations in BW in different lactation stages. After calving, cows lost in average 11.68% of their initial BW (69.29 kg). Cows recovered 1.17%; 3.0% and 3.41% of the weight during the first, second and third lactation stage, respectively. The highest recovery was observed during the dry period (5.63%). At the end of the study (which corresponded also to the end of the dry period), final BW was 7.75 kg or 1.41% higher than before calving. The similar trend is also observed in terms of BCS. Cows entered into lactation with 2.75 BCS points and dropped to 1.75 points after the first 100d of lactation. During the study, BCS increased to 1.88, 2.25 and 2.88 at second, third lactation stage and dry period, respectively. In conclusion, although cows succeeded to satisfactorily recover BW and BCS at the end of study or before next calving, dynamics of changes were not in full compliance with the recommendations for Holstein dairy cows, due to the much higher recovery during the dry period.

Keywords: Holstein dairy cow; body weight; BCS; lactation stage.

1. Introduction

Milk production is an important part of animal production in Kosovo and considerably influences countries agricultural and food production. After the war as a consequence of the loss of animals, as a part of economic support, many donors imported a considerable number of dairy cows of Holstein breed, which considerably improved genetic potential and milk productivity of local farms. However, milk production at countries level between 2000-5000 kg per lactation [29] is still far below the genetic potential of dairy cows.

Milk production of dairy cows depends on many factors, of which body weight (BW) and body condition score (BSC), as indicators of nutritional status of cows, are of high importance to support cow's performance during the entire production cycle. Transition period (three weeks prior and three weeks after calving) are considered critical because of negative energy balance [15], [37]. During this period animals go through many physiological, hormonal and metabolic changes which may be associated with nutritional and other disorders [16]. In an attempt to overcome this energy gap, high yielding cows do normally mobilize body reserves [14] and consequently loose in body weight. However, their capacity to satisfy maintenance and production energy requirements are limited [34].

During the early lactation with a depressed feed intake, mobilization of body reserves for milk production causes a negative energy balance known to affect the reproductive performance of dairy cows [6]. In response to the energy deficit, cows, especially

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high yielding dairy cows, mobilize body tissue reserves [4], which is from a normal biological response, an evolutionary perspective since all mammals are designed to convert body lipid stores of energy to milk during lactation [9]. This normally happens because nutrient requirements for lactation, growth in first-calving cows, and maintenance exceed the feed and energy intake capacity of the cow. In general, this negative energy balance lasts for about 2 to 4 months following calving, or until dry matter intake increases to a point where energy input is higher than energy output [9]. Studies of [23], report that positive balance of dairy cows is achieved between 12 and 18 weeks of lactation, while results of body weight gain were positive after the sixth week. The mobilisation of body reserves during 1st lactation period occurs also at dairy cows herds with moderate-high milk production (5000-5500 kg milk/lactation year) when fed roughages of low and moderate quality and limited availability of concentrate on a dairy farm [10]. During the first and second lactation stage, an important contribution in body weight recovery is ascribed to an increase in the digestive tract. It is reported that the gastro-intestinal tract (GIT) weight at the beginning of lactation is 98 kg compared to 68 kg at the end of gravidity[2]. The third stage of lactation and dry period are known to contribute the most in body weight recovery because during these periods the mass of digestive tract is of less importance [2]. As suggested by [31] due to high intensity of foetus growth and development during later pregnancy (gravidity anabolism), the target recovery of body weight should not exceed 0.6 kg/day during last four weeks of gravidity. Due to lower milk production and foetus growth, third or late lactation stage is considered the most favourable period for cows to recover their lost weight, while care should be taken especially during dry period.

Milk production of dairy cows depends not only from the accurate fulfilment of nutrient requirements because there are other factors affecting the quality of feed ration such is, BCS at calving and genetic potential of the cow [31]. The BCS of a dairy cow is an assessment of the proportion of body fat that it possesses, and it is recognized by animal scientists and dairy farmers as being an important factor in dairy cattle management [39]. The system of the evaluation of the nutrition status of the animal known as BCS is a useful method to assess body energy reserves and it is widely used also by dairy farmers to evaluate the nutrition status of lactating and dry dairy cows [45], [17], [22], [28], [43]. Being an easy, practice-usual and inexpensive method to evaluate the body tissue reserves of lactating cows, independent of frame size and body weight [41], BCS has been widely accepted as the most practical method for assessing changes in energy reserves and the nutrition status in many species, including dairy cattle [9]. Although BCS is a subjective measure of the amount of metabolizable energy stored in a live animal it is however considered to be an indicator of the extent and the duration of postpartum negative energy balance [4]. The first reference to a subjective BCS system was in the early 1960s with a scoring system developed for sheep [25]. During the last 25 years, various BCS systems have been described using different scales to measure BCS [9] but, in general, all systems agree that low values reflect emaciation and high values reflect obesity [40]. A 5-point chart system, with 1 for emaciated and 5 describing the obese cow, is developed by [17] in the USA describing changes corresponded to body condition change for eight body locations identified as important for predicting BCS. BCS 1 and 5 are practically not recommended. In an extensive review by [42], a more detailed description of the five-point scale system was given in relation to the backfat thickness and total body fat (Table 1).

BCS is a fast, simple and cheap method based on the visual and manual evaluation of energy reserves independent of body weight and the size of the body format [22], [19]. The assessment of changes in body condition is more useful and easier indicator to implement in practice than the changes in body weight because BSC is easier by implementation and BW is often affected by the volume of the rumen [45], [33]. However, it is considered that body weight loss could be a better indicator of some reproductive indices than BCS in postpartum dairy cows [41].

BCS is already a practical method which is extensively used also by dairy farmers to assess the nutrition status of dairy cows. However, this method is still not used in dairy farms in Kosovo, even in farms of high milk yields.

The objective of this study was to monitor both the changes in BW and BCS of Holstein dairy cows during the entire production cycle, under practice-usual feeding conditions applied by dairy farms in Kosovo. A further objective was to promote the using of BCS method in dairy farms management in Kosovo.

Table 1. Body Condition descriptors (BCS), Back Fat Thickness (BFT), and Total Body Fat content (TBF)

Description	BCS	BFT, mm	TBF, kg
Emaciated	1.0	<5	<50
Very poor	1.5	5	50
Poor	2.0	10	76
Moderate	2.5	15	98
Good	3.0	20	122
Very good	3.5	25	146
Fat	4.0	30	170
Adipose	4.5	35	194
Obese	5.0	>35	>194

Source: Schröder and Staufenbiel (2006)

2. Material and Methods

1.1. Animals and diets

This study was done during January 2015 to January 2016 and included all three lactation stages as well as the dry period. All animals were in third lactation year and the interval in calving was not more than 15 days. Cows were kept in closed barns and were subjected to practice-usual housing conditions. The daily rations used were composed of meadows hay, alfalfa hay, wheat straw, maize silage and grass silage (haylage). The concentrate part of the ration was composed of cereals (maize, wheat, and barley), wheat bran, soybean meal and sunflower meal. The diets were also supplemented with a vitamin-mineral premix made specifically for dairy cows. All feeds were fed in a form of Total Mixed Ration (TMR) once a day in the morning. The assessment of BW and BCS was done in four dairy farms involving 24 Holstein dairy cows in total. The amount of consumed feed was assessed monthly by measuring the amount of the feed given to animals. The chemical composition of the diet was done in the premises of the Faculty of Agriculture and Veterinary in Prishtina (Animal Feed and Nutrition Laboratory) using NIR technology (NIRS 6500 apparatus and ISI Scan Software).

1.1. Body weight changes

The dynamics of body weight changes (BWc) of cows is assessed during the entire study period (12 months). This is done by weighing each cow after calving, every 100 days during lactation and at the end of gravidity (last week prior to next calving). The weighing was always done before morning feeding of animals between 06:00-07:30 am using a mechanical animal scale. To determine the relative BW difference (BD %) during lactation, the modified formula proposed by [41], [36] was used:

$$BD, \% = (BW_{(2,3,4,5 \text{ or } 6)} - BW1) \times 100/BW1$$

Table 2. Average DM, energy, nutrient intake and characteristics of diets offered at different farms during all period of observation.

Feeding parameters	Farm 1	Farm 2	Farm 3	Farm 4	*P-Value*
Dry Matter Intake, kg/d	16.97±0.243^{b}	16.73±0.243^{b}	18.55±0.243^{a}	17.52±0.243^{b}	*<0.0001*
ADF, %	20.77±0.715	22.81±0.715	23.11±0.715	22.59±0.715	*0.1116*
NDF, %	42.98±0.966	43.54±0.966	45.41±0.966	44.56±0.966	*0.3073*
Crude protein (XP), %	12.12±0.496	10.37±0.496	9.54±0.496	9.16±0.496	*0.0009*
XP, g/day	2055.2±83.74^{a}	1730.9±83.74^{b}	1690.9±83.74^{b}	1670.0±83.74^{b}	*0.0082*
ENL, MJ/kg DM	7.16±0.122^{a}	6.62±0.122b	6.92±0.122^{ab}	6.95±0.122^{ab}	*0.0338*
ENL, MJ/day	122.17±2.031^{a}	111.46±2.031^{b}	128.69±2.031^{a}	122.46±2.031^{a}	*<.0001*
Roughage, kg DM/day	11.72±0.102^{d}	12.132±0.102^{c}	13.81±0.102^{a}	12.75±0.102^{b}	*<.0001*
Roughage, % ration DM	69.15±1.102^{b}	72.72±1.102^{ab}	74.42±1.102^{a}	72.75±1.102^{ab}	0.0149
Concentrate, kg/d	5.29±0.098^{a}	4.53±0.098^{b}	4.62±0.098^{b}	4.78±0.098^{b}	<.0001
Concentrate, % ration DM	31.17±0.632^{a}	27.16±0.632^{b}	24.91±0.632^{b}	27.28±0.632^{b}	<0.0001

Levels not connected by the same letter are significantly different.

The body weight before calving was used as a reference value (BW-1), while body weights in respective lactation stages were BW_2 (after calving), BW_3 (end of first lactation stage-100d), BW_4 (After 200 d), BW_5 (after 300d) and $_6$ (before next calving).

1.2. Body Condition Score

Because routine measuring of the energy balance status of the dairy cow is difficult [36], five scale Body Condition Scoring (BCS) (with 1 being emaciated, 2 thin, 3 average, 4 fat, and 5 obese) was the indirect indicator used to assess cows condition [17]. BCS was evaluated in weeks 1, 10, 20, 30, 40 and 50 of the study.

1.3. Statistical analysis

Lactation stage was the independent variable used to explain the variations in body weight and BCS changes. Microsoft Excel Analysis Tool Pack (2010) and JMP 7 statistical software (a business unit of SAS) are used to do statistical processing of the data. One way Analysis of Variance is used to test whether significant differences exist (at alfa levels of 0.05 and 0.01), and Students t-Test was the post hoc test applied to compare individual means.

3. Results and Discussion

a. Body weight changes

To assess the dynamics of body weight changes in relation to the physiology of production and reproduction, cows were individually weighed and some of the descriptive parameters are presented in Table 1. Results show that significantly large change in body weight ($P<0.01$) happened after calving since cows lost in average 69.29 kg (or 11.68%) of their body weight before calving. Loss of more than 60 kg in weight at the beginning of lactation is considered high [35] and it may negatively affect the fertility of the cow. There is no significant difference in BW during the 1st lactation period, which is probably related to the moderate level of milk production in this lactation period.

However, there is positive body weight recovery of 6.71 and 17.79 kg during the first and second lactation stage, respectively. In terms of body weight change, this agrees with the findings of [23] who reports positive body weight recovery starting from 6th lactation week, although cows went into positive energy balance between 12th to 18th lactation week, which is justified with a higher weight of digestive tract at the beginning of the lactation. [8] and [38], consider that body weight gain is relative and may be influenced by nutrition since cows consume the highest amount of dry matter in order to maintain high milk production. Some contribution on increased BW at this stage may be a result of the increased weight of the rumen and intestines, but there are individual differences. However, the overall size of the rumen and intestines is linked with the size of the cow. Higher BW recovery is observed during late lactation (third lactation stage) and during the dry period, occurred at farm level (Table 3) and in average terms (Figure 1). Cows recovered in average 20.21 and 32.33 kg during late lactation (last 100 days of milking) and during drying period, respectively.

The higher body weight recovery during late lactation and especially during dry period can be partly explained by results of Dry Matter (DM, kg/day), Net Energy of Lactation (NEL, MJ/day) and Crude protein (CP, g/day) consumption (Table 4). Results show that there were no significant differences in consumption ($P>0.05$) of DM, NEL and CP in different lactation stages and dry period. This confirmed that practice-usual feeding systems on dairy farms in Kosovo, even of high yielding cows, did not consider the lactation stage. This leads to an overfeeding or hipernutrition during the late lactation and an undernutrition or hiponutrition during the 1st lactation stage. This practice-usual feeding strategy on dairy farms in Kosovo is physiologically imbalanced and economically inefficient, i.e. leads to low utilisation of feed energy and nutrients for milk production, low to moderate milk yielding as well as to high milk costs of dairy farm in Kosovo, which is also confirmed in our study [26], [27]. Roughages fed in studied dairy farms resulted on low to moderate quality which caused a disproportional increase of concentrate level in dairy farms and, as a consequence, an increase of the milk costs [26], [27].

Results presented in Table 3 show that there is no significant effect ($P<0.05$) of variable “farm” on BW at any lactation stage. However, it is important to be noted here that there was a high recovery of total body weight at the end of the experiment in all farms, which was observed also by [38]. Moreover, average body weight recovery in all farms slightly exceeded body weight of cows at the start of the experiment

(before calving) and was higher for 7.75 kg or 1.41%. This recovery ranged from 100.3% in farm four to 102.8% in farm two.

As seen in Figure 1, a positive BW recovery trend in our study was observed starting from the 10th week which is comparable with the results of other authors [10], [1], [24] who reported similar BW trends of dairy cows having relatively high BW gain and good condition score during a dry period of the previous calving.

Table 3. Body weight (kg) parameters in different lactation stage ($\bar{X}$±SEM; n = 24)

Dairy farm	Before calving	After calving	1st Lactation period	2nd Lactation period	3rd Lactation period	End of experiment*
F-1	602.44±13.182	532.11±13.143	538.78±12.090	557.89±12.174	576.56±11.547	606.44±11.848
F-2	572.50±23.816	507.88±21.769	514.750±21.248	531.38±22.113	550.63±22.694	589.13±18.200
F-3	626.00±50.083	554.67±48.320	559.67±47.754	576.33±46.742	599.33±48.821	629.00±34.790
F-4	598.75±5.836	524.00±6.416	531.750±5.633	549.75±7.052	573.250±6.019	600.75±4.250
P value	*0.4901*	*0.5756*	*0.5743*	*0.5644*	*0.5331*	*0.5741*

**End of experimental period corresponded to the end of the dry period.*

Table 4. Results of DM, NEL and CP consumption

	1st Lactation period	2nd Lactation period	3rd Lactation period	*P value*
DMI, kg/d	16.98	17.51	17.17	*0.8386*
NEL, MJ/d	120.49	122.94	121.08	*0.9809*
CP, g/d	1918.87	1829.56	1710.26	*0.5756*

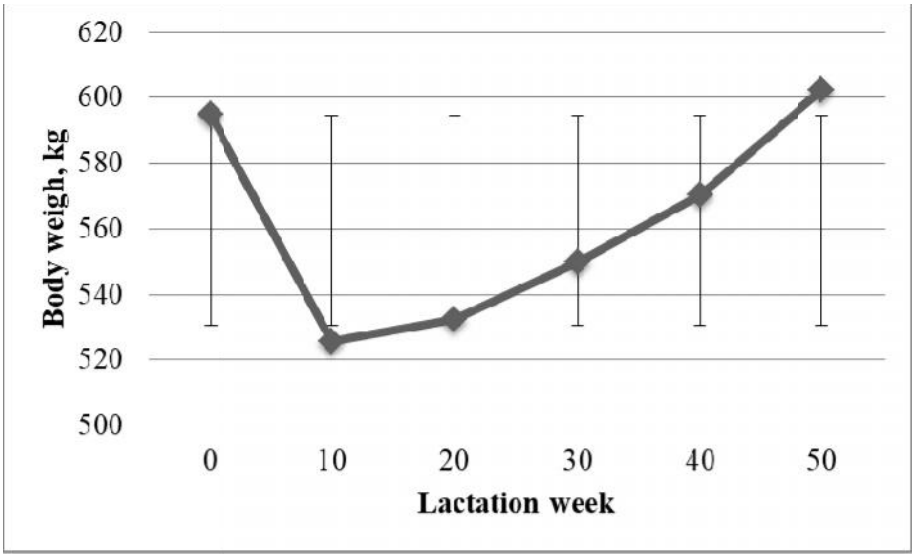

Figure 1. Body weight changes during milking and dry period

b. Body Condition Score (BCS)

The periodic evaluation of BCS of animals is an important management tool in dairy cow farms because it reflects the actual nutrition and health status of the animal and makes possible the correction of eventual feeding mistakes. The ideal body condition or state in every lactation stage helps to optimize milk production and to minimize the reproductive and health disorders, which therefore contributes to more economic returns [21], [5].

Results of the evaluation of BCS are presented in table 5 and figure 2.

BCS on calving can directly influence milk production, reproduction and the health of the animal [11], [44], [28]. As seen from the table 5, the average body condition score 2.75 of cows at the start of lactation may be considered ideal score, referring to [32] who categorized lactating cows into the following categories: too thin (<2.5), ideal (2.5 to 3.5), and too fat (> 3.5), while for dry and pregnant cows recommended BCS scores are 3 to 3.5, < 3 and > 3.5, for ideal, too thin and too fat animals, respectively.

When comparing our results (Table 5) during 10th to 40th lactation weeks, where a BCS under 2.5 is observed, cows may be considered too thin. Cows needed a period of 40 weeks (the end of lactation) to enter into "ideal" condition state (condition >2.5). During dry period cows further improved BCS averaging 2.88 points. Results agree with [44], [10], [18], [3], who reported that moderate BW gain and increase of BCS until parturition (from 2-3) will positively affect milk production, but the increase in BCS over 3.5 will negatively affect milk yield.

Management practices should all aim at preparing cows to enter the dry period in possibly recovered BW (Bogdani et al., 1986) and good BCS and keep it as stable as possible. This is important because the cows with "ideal" condition will much better utilize the diet's energy during first lactation stages compared to those with higher BCS, which needs a longer period to overcome negative energy balance.

Table 5. Results of body condition scoring (BCS) in different physiological stages.

	First stage		Second stage	Third stage		Fourth stage
	(First 100 lactation days)		*(Second 100 lactation days)*	*(Third 100 lactation days)*		*Dry period*
	Calving	Week 10	Week 20	Week 30	Week 40	Week 50
Average	2.75	1.75	1.88	2.25	2.50	2.88
Min	2.5	1.5	1.5	2	2.5	2.5
Max	3	2	2	2.5	2.5	3
St.Dev	0.29	0.29	0.25	0.29	0.00	0.25

As presented in table 5 and figure 2, due to depressed feed intake and negative energy balance at the beginning of lactation, the BCS of cows dropped by one point at the end of first lactation stage, but this loss started to recover after 20 weeks. The changes in one BCS point corresponds to the changes of 35 to 44 kg BW, 21 to 29 kg of body fat or 837 to 1256 MJ of body energy. This may also be calculated about 39.8-43.3 MJ/kg body fat or 23.9-28.54 MJ/kg BW) [38]. These changes in BCS may be considered normal because as reported by [18], high milking cows should not lose more than 0.5 points until 30 days after calving, while the increase is expected to happen from week 12 to 14. Results are also comparable with findings of [20].

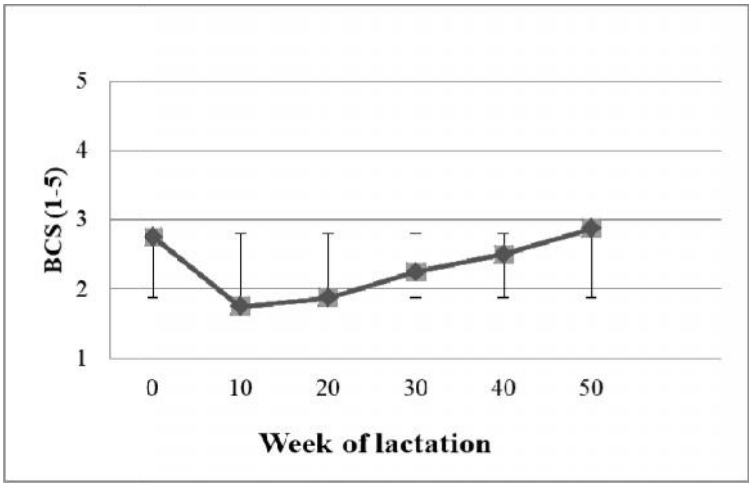

Figure 2. BCS changes during milking and dry period

The rationale behind the BSC loss during the first lactation is given by [7], who reports that during first 16 weeks of lactation, cows normally mobilise 50 to 60 kg of body fat reserves (about 10% of their body weight or 50% of energy reserves) which is expected to be restored with the progress of lactation. Studies of [13], suggest that underfed cows may mobilize up to 80% of energy reserves (fat) and not more than 15- 20 % protein reserves because the largest part of body proteins are structural components and therefore their mobilization from body tissues is limited [12].

The effect of high BCS before calving is low, but its effect on dry matter intake and milk production is more expressed after calving [40]. During the dry period and at the time of calving, there should be no under/over conditioning and the targeted BCS should be at 3.25 to 3.5 [32]. Studies of [38] have also demonstrated that cows exceeding body weight during gravidity are at risk of depositing more body fat. This will after calving be associated with lower dry matter consumption increasing the need for body fat mobilization. Under such circumstances, lower milk production in the following lactation is a logical consequence compared with cows properly fed during gravidity in which lower energy reserve mobilization after calving is more likely to happen.

4. Conclusions

Results of this study demonstrate that in average, the BW and BCS recovery at the end of the dry period was satisfactorily in all studied dairy farms. All cows successfully recovered their body weight loss at calving. Moreover, some animals exceeded the body weight loss for 7.75kg or 1.41%. However, the highest recovery observed during the dry period (5.63%) is not associated with a significantly higher milk production and suggests that feeding management practices were not in full compliance with the recommendations according to lactation stage. Application of the nearly the same feeding level and ration composition on all studied dairy farms in Kosovo can be considered as not appropriate and efficient not only physiologically but also economically. Using feeding strategies according to the physiological stage by dairy farms in Kosovo is important in order to increase not only the milk production level but also the economic efficiency. Moreover, monitoring of the nutritive status of dairy cows through BCS and BW changes is important in order to adjust the feeding level during the lactation and to avoid nutrition disorders in dairy cow farms in Kosovo.

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