

**NEW INSIGHTS INTO BODY CONDITION SCORE AND ITS ASSOCIATION WITH FATTY LIVER  
IN HOLSTEIN DAIRY COWS**

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*The aim of this study was to estimate the association between body condition and fatty liver in high-yielding dairy cows. One hundred dry Holstein cows were selected. Cows were scored once for body condition during the dry period, puerperium and month 2 of lactation, according to the system provided by Elanco Animal Health Buletin AI 8478. Body condition loss was determined as marked if loss was over 0.7 points between two consecutive phases of cycles and over 1.5 points between puerperium and month 2 of lactation. Liver tissue samples were taken 12 d after calving and tested for lipid content. 50% of cows had mild ( $3.92 \pm 3.33\%$  fat), 33% moderate ( $19.28 \pm 5.18\%$  fat), and 17% severe fatty liver ( $36.21 \pm 4.55\%$  fat). The mean body condition scores were  $3.79 \pm 0.55$  (dry period),  $3.18 \pm 0.34$  (puerperium) and  $2.90 \pm 0.29$  (month 2 of lactation). Marked body condition loss from the dry period to puerperium had 38% of cows, 20% from dry period to month 2 of lactation and 8% from puerperium to month 2 of lactation. Body condition scores out of the physiological range had 39% dry cows, 49 % cows in puerperium and 9% cows at month 2 of lactation.*

*After dividing cows into groups according to fatty liver degree, it was shown that only cows with severe fatty liver were obese during the dry period and that 76.47% of cows from this group had marked condition loss from the dry period to puerperium, 47.06% from dry period to month 2 of lactation and 23.53% from puerperium to month 2 of lactation. These indicate that in cows with severe fatty liver lipomobilisation is intensive and starts around calving, before milk production enhancement.*

*Our results indicate a strong association between body condition and fatty liver in cows, which can be estimated only when body condition is analyzed in details. Besides, our results clearly indicate that body condition is not the only etiological factor that leads to fatty liver in dairy cows.*

*Key words: body condition score, fatty liver, Holstein cows*

## INTRODUCTION

The onset of lactation is very stressful for high-yielding dairy cows, due to metabolic adaptations that are necessary to support increased milk production (Bauman and Currie, 1980). Since the postpartal period is characterized by negative energy balance (NEB), dairy cows mobilize large quantities of fatty acid from adipose tissue in order to meet energy demands (Hady *et al.*, 1994; Markusfeld *et al.*, 1997; Rukkwamsuk *et al.*, 1999). If nutrients and mobilized fat energy meet the increased energy demands, milk production is maintained, cows are healthy but they lose in body weight during the first weeks of lactation (Rukkwamsuk *et al.*, 1999). However, when energy demands for maintenance and milk production overcome the consumed energy and energy released by adipose tissue lipolysis, negative energy balance is profound and health disorders, especially fatty liver and ketosis, are usual (Gerloff, 2000). Ketosis is a metabolic disorder which develops when dairy cows have a good appetite, but dietary energy is not sufficient for generous lactation. Ketosis is characterized by stagnation in milk production and loss in body condition during early lactation (Duffield, 2000). Fatty liver is caused by increased and uncontrolled lipomobilisation that leads to accumulation of lipids in hepatocytes (Bobe *et al.*, 2004). A greater proportion of cows with high milk production that have been overfed during the dry period and obese during peripartal period have fatty liver. Syndrome called "fat cow syndrome" was described by Morrow (1976) and Morrow *et al.* (1979). It is well known that nutrition of high-yielding cows is primarily based on *ad libitum* intake of high-energy diets during early lactation. If this type of feeding is not restricted during late lactation and dry period the risk for appearance of obese cows in the population is high, especially if their service period is too long. Obese dry cows are more prone to metabolic disorders, especially fatty liver, during postpartal and early lactation period. Fatty liver is a disease with high incidence, since 30 to 60% of dairy cows in some populations have fatty liver in the first month after calving (Reid and Roberts, 1982; Bobe *et al.*, 2004). However, obesity in dry cows does not always lead to fatty liver indicating that there are risk factors other than obesity that predispose the cow to development of fatty liver (Grummer, 1993; Drackly, 1999; Bobe *et al.*, 2004; Šamanc *et al.*, 2010).

Body condition score (BCS) is a valid indicator of energy status of dairy cows, especially during the transition period when tremendous changes in energy metabolism occur (Drackley, 1999; Roche *et al.*, 2010; Bewley *et al.*, 2008; Bewley *et al.*, 2010). During the dry period body condition may be excessive, due to unrestricted feeding. Cows lose in body condition during early lactation due to NEB. As a result of NEB, cows have their lowest body condition score at approximately one to two months postpartum. Since BCS reflect energy balance during pregnancy and lactation, scientists strongly recommend scoring of cows as a useful and simple clinical indicator for evaluation of energy status in dairy cows (Roche *et al.*, 2009; van Straten *et al.*, 2009). Cows should be scored at least twice per year in order to avoid great oscillations in energy metabolism that may provoke fatty liver (Bobe *et al.*, 2004; Grummer, 2008). Obesity does not

necessarily cause fatty liver, especially when cows adapt their feed intake to their milk production (Smith *et al.*, 1997). Regardless to that, body condition scoring should be used for balancing feed requirements for dairy cows during critical phases of productive-reproductive cycle in order to prevent metabolic disorders caused by uncontrolled lipomobilisation.

The aim of this study was to investigate the influence of body condition score determined at the dry period, puerperium and month 2 of lactation, as well as body condition loss during dry and early lactation period, on incidence and degree of fatty liver at early puerperium.

#### MATERIAL AND METHODS

One hundred dry cows that had yielded 7000 liters of milk or more per annum in the previous lactation were chosen from the commercial dairy herd and placed in the study. The cows ranged from 4 to 6 years of age. The cows were housed in a tie-stall barn. Ingredients and chemical compositions of the dry and early lactation cow diets are listed in Tables 1 and 2.

Body condition scoring (using five-point scale with quarter-point divisions) was performed on 100 pregnant Holstein dairy cows by the same investigator using the system provided by *Elanco Animal Health Buletin AI 8478*. BCS was determined by palpation and careful visual examination. Cows were scored once for body condition during the dry period (prepartum day  $30 \pm 10$ ), puerperium (postpartum day  $7 \pm 3$ ) and at month 2 ( $\pm 5$  days) of lactation. Results for BCS are presented as mean BCS and as digress from physiological values at examined periods. The physiological range of body condition scores for high-yielding Holstein cows is 3.25 to 4.00 (dry period), 3.25 to 3.75 (puerperium) and 2.50 to 3.25 (month 2 of lactation). Besides, body condition loss was determined as physiologically acceptable if loss was up to 0.7 between two consecutive phases of productive-reproductive cycles (dry period/puerperium and puerperium/month 2 of lactation) and up to 1.5 between puerperium and month 2 of lactation.

On day 12 after calving, liver percutaneous biopsies were obtained using a biopsy instrument following the method of Hojovcova and Kacafirek (1967). The biopsy was performed at the right 11th intercostal space, approximately 15 to 20 cm below the horizontal line through the tuber coxae. A medium-sized cannula ( $\sim 6$  mm o.d. and  $\sim 4$  mm i.d; 20.5 cm long) surrounding a solid, retractable needle-pointed trocar was inserted through the intercostals muscles and peritoneum into the liver in the direction toward the left shoulder. After boring the cannula into the liver, a sample (3 to 5 cm long and 3 to 4 mm in diameter) was obtained through creating a vacuum by drawing back the trocar and then flexing the tip of the cannula upward and gently pushing forward. The liver sample was expelled onto a clean wipe, blotted free of blood, and placed into storage vials that contained 10% buffered phormaldehyde solution for fixation. Liver tissue lipid content was determined. For pathohistological determination of lipids, sections were made using a freezing microtome and stained with Sudan III. Lipid content in the hepatocytes was determined through computer image analysis (Software Q Win). Cows were divided into three groups based on the degree of lipid

accumulation in the liver: mild fatty liver (<10% fat), moderate fatty liver (10 to 30% fat), and severe fatty liver (>30% fat).

Table 1. Ingredients of cow's diets

Ingredient (kg)	During dry period	Until day 100 of lactation
Alfalfa hay	–	3.43
Grass hay	1.50	–
Wheat straw	0.60	–
Corn silage 44% DM	–	9.50
Corn silage 33% DM	10.0	–
Corn silage 33.94% DM	–	9.00
Alfalfa haylage 51.79% DM	2.50	–
Alfalfa haylage 47.40% DM	–	5.00
Brewer's grain 21.00% DM	–	5.00
Corn grain	0.98	2.50
Barley grain	0.50	1.50
Soybean grits	0.30	1.30
Soybean meal 44%N	1.10	1.13
Wheat flour	0.50	1.30
Sugar beet pulp	–	1.82
DextroFat SC	0.10	0.40
Optigen II, 41% N	–	0.14
Dextrose monohydrate	0.04	0.10
Dicalcium phosphate 18% P	–	0.27
Magnesium oxide	–	0.05
Sodium bicarbonate	–	0.15
Sodium chloride (iodized)	–	0.07
Calcium carbonate	0.04	0.03
Milkinal trocken 3%	0.08	–
Beta carotene	0.004	–
TOTAL	18.24	42.69

Table 2. Chemical composition of cow's diets

Chemical composition	During dry period	Until day 100 of lactation
DM kg	9.82	23.63
Net energy of lactation (NEL) MJ	65.50	163.03
Crude protein (CP) %	15.03	16.05
Rumen undegradable protein (RUP) %	5.09	5.06
Crude fat %	3.82	4.78
Acid detergent fibre (ADF) %	25.31	22.08
Neutral detergent fibre (NDF) %	40.59	35.48
Ca %	0.64	0.90
P %	0.42	0.52
Na %	0.13	0.36
Cl %	0.17	0.29
Mg %	0.27	0.34
K %	1.30	1.18
S %	0.22	0.22
Mn ppm	129.36	82.40
Cu ppm	39.81	25.64
Zn ppm	168.24	96.90
Co ppm	1.03	0.54
J ppm	3.06	1.64
Fe ppm	228.38	220.53
Se ppm	1.14	0.70
Vit A IU/kg	41 234.28	21 273.58
Vit D IU/kg	4 487.10	3 445.30
Vit E IU/kg	117.79	69.35

## RESULTS

Results of the content of lipids in the liver in cows (n=100) showed that 50% of cows had mild fatty liver ( $3.92\pm 3.33\%$  fat), 33% had moderate fatty liver ( $19.28\pm 5.18\%$  fat), and 17% had severe fatty liver ( $36.21\pm 4.55\%$  fat).

The mean body condition scores of examined cows (n=100) at dry period, puerperium and month 2 of lactation are presented at Table 3.

Table 3. Body condition score in different phases of productive-reproductive cycles

	Mean body condition score		
	Dry period	Puerperium	Mont 2 of lactation
X	3.79 ± 0.55	3.18 ± 0.34***	2.90 ± 0.29***aaa

\*\*\*p<0.001 compared to dry period; aaa p<0.001 compared to puerperium

From table 3 it can be seen that average body condition scores at dry period and month 2 of lactation were within the physiological ranges, while the value at puerperium was slightly under recommended physiological values for this phase of productive-reproductive cycle. Besides, mean body condition scores at puerperium and month 2 of lactation were significantly lower than at dry period (p<0.001 respectively) and BCS at month 2 of lactation was significantly lower than at puerperium (p<0.001).

Body condition losses were within physiological range: 0.61 points between dry period and puerperium; 0.28 points between puerperium and month 2 of lactation; 0.89 points between dry period and month 2 of lactation.

According to body condition loss, cows were divided into two groups: the moderate condition loss group and the marked condition loss group. Percents of cows with marked body condition loss (over 0.7 points between two consecutive phases of productive-reproductive cycles and over 1.5 points between puerperium and month 2 of lactation) are presented in Table 4.

Table 4. Percents of cows with marked body condition loss between different phases of productive reproductive cycle

Dry period / puerperium	38%
Dry period / month 2 of lactation	20%
Puerperium / month 2 of lactation	8%

Highest occurrence (38%) of marked condition loss was determined between dry period and puerperium, while the lowest (8%) was determined between puerperium and month 2 of lactation. These data suggests that marked condition loss has happened at the onset of lactation.

Distributions of individual body condition scores for all examined periods are shown in Figures 1, 2 and 3.

Analyses of Figures make a complete picture of body condition scores in the population, since Figures make a point on the direction of digression from physiological values ("shift to the left" refers to values that are lower than physiological; "shift to the right" refers to values that are higher than physiological). At dry period, 39% cows had BCS out of physiological range, in which 15% had lower and 24% higher values (obese cows) than recommended. During puerperium, 49% cows had BCS lower than physiologically accepted, while at month 2 of lactation only 9% of cows had BCS out of physiological range.

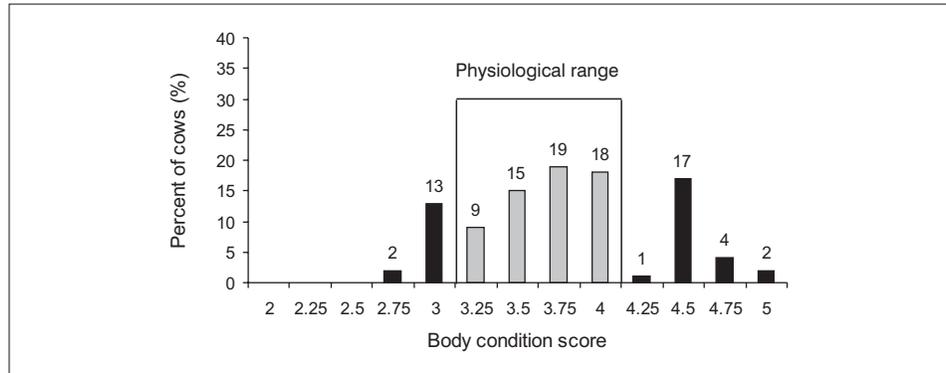


Figure 1. Distribution of individual body condition scores in cows at dry period

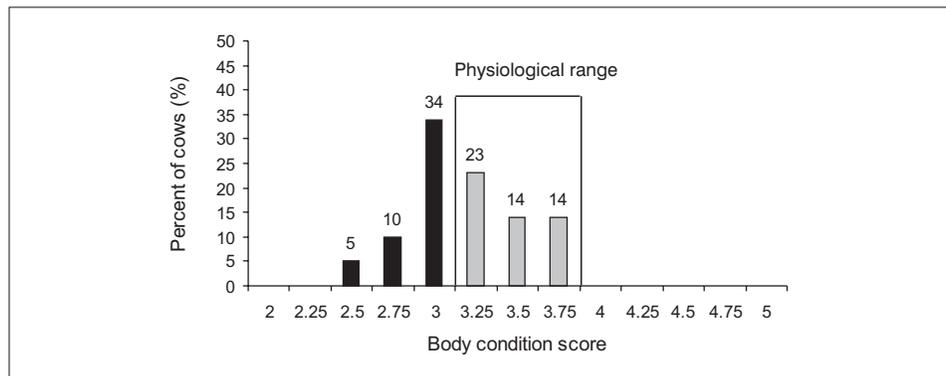


Figure 2. Distribution of individual body condition scores in cows at puerperium

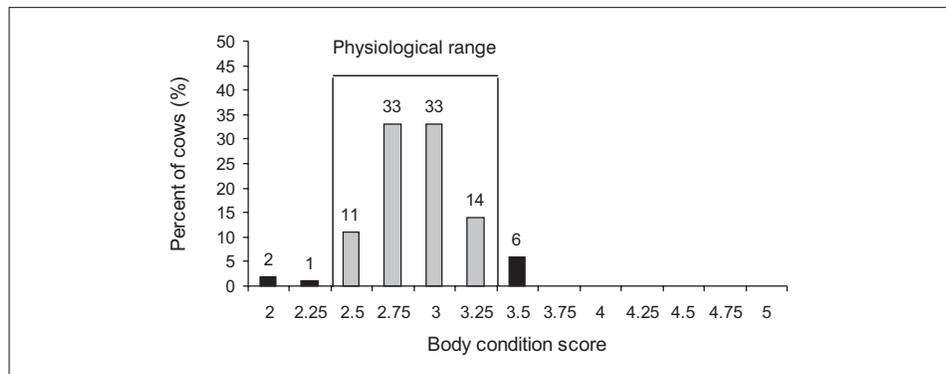


Figure 3. Distribution of individual body condition scores in cows at month 2 of lactation

Data for BCS were grouped according to fatty liver degree in cows (mild, moderate and severe) in order to get a better picture about the relationship between BCS and fatty liver (Table 5).

Table 5. Body condition score in different phases of productive reproductive cycle for cows divided into groups according to fatty liver degree

Fatty liver degree	Mean body condition score		
	Dry period	Puerperium	Mont 2 of lactation
Mild (n = 50)	3.56 ± 0.55	3.06 ± 0.31	2.86 ± 0.27
Moderate (n = 33)	3.91 ± 0.43**	3.26 ± 0.33**	2.96 ± 0.33
Severe (n = 17)	4.23 ± 0.46***a	3.38 ± 0.31***	2.95 ± 0.28

\*\*p<0.01 compared to mild fatty liver; \*\*\*p<0.001 compared to mild fatty liver;  
<sup>a</sup>p<0.001 compared to moderate fatty liver

Only dry cows with severe fatty liver had BCS higher than physiological values, meaning that they were obese (Table 5). Body condition losses were, as expected, highest in cows with severe fatty liver: 0.85 (dry period/puerperium), 1.28 (dry period/month 2 of lactation) and 0.43 (puerperium/month 2 of lactation).

The percents of cows that had marked condition loss within groups with different fatty liver degree are shown in Table 6.

Table 6. Percents of cows with marked body condition loss between different phases of productive reproductive cycle

Fatty liver degree	Dry period / puerperium	Dry period / month 2 of lactation	Puerperium / month 2 of lactation
Mild (n = 50)	18	16	4
Moderate (n = 33)	48.49	12.12	6.07
Severe (n = 17)	76.47	47.06	23.53

Marked losses in body condition were more often in cows with severe fatty liver than in cows with moderate and mild fatty liver. Additionally, in most cases marked changes in body condition were detected between the dry period and puerperium cows with moderate and mild fatty liver showed a similar trend.

Distributions of individual body condition scores for cows with different fatty liver degree and at different stages of productive reproductive cycles are presented in Figures 4 to 12.

It can be seen from Figures 4, 5 and 6 that 12% of dry cows with mild, 21.21 % dry cows with moderate and 67.72% dry cows with severe fatty liver had body condition higher than physiologically recommended ("shift to the right").

"Shift of body condition to the left" was detected in 62% of puerperal cows with mild, 45.45% of cows with moderate and 17.64% of cows with severe fatty liver (Figures 7, 8 and 9).

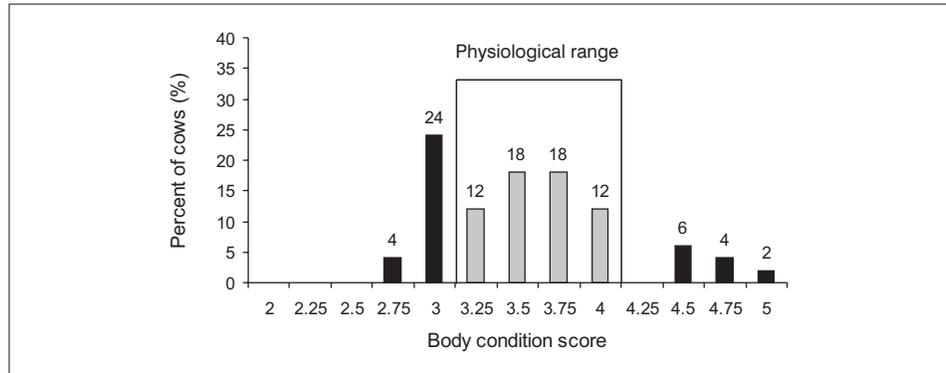


Figure 4. Distribution of individual body condition scores at dry period in cows with mild fatty liver

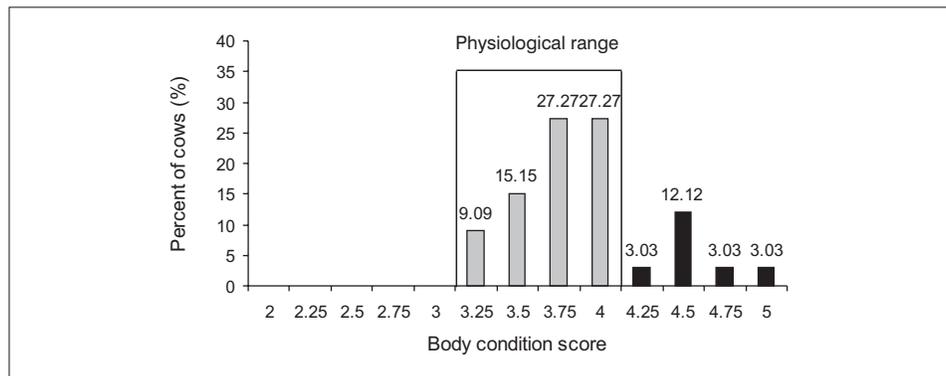


Figure 5. Distribution of individual body condition scores at dry period in cows with moderate fatty liver

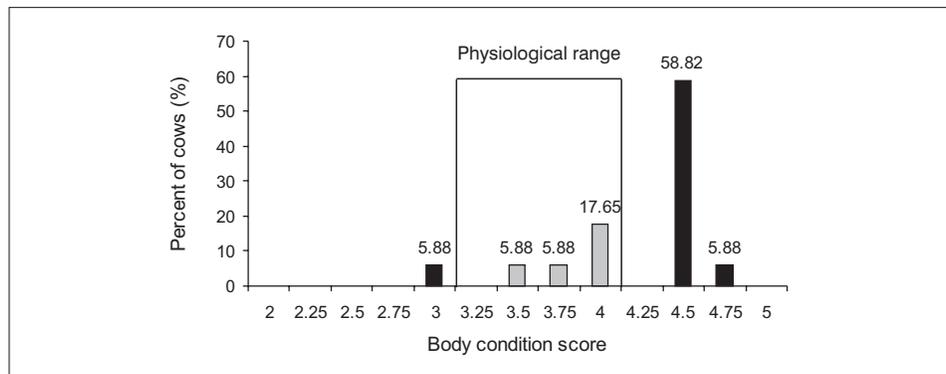


Figure 6. Distribution of individual body condition scores at dry period in cows with severe fatty liver

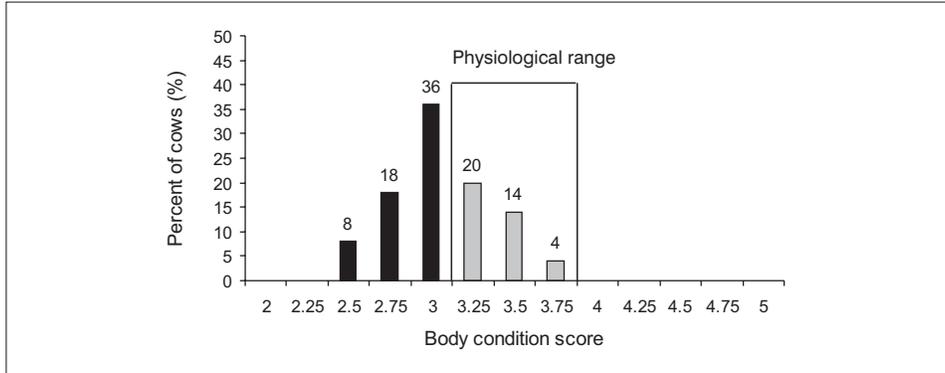


Figure 7. Distribution of individual body condition scores at puerperium in cows with mild fatty liver

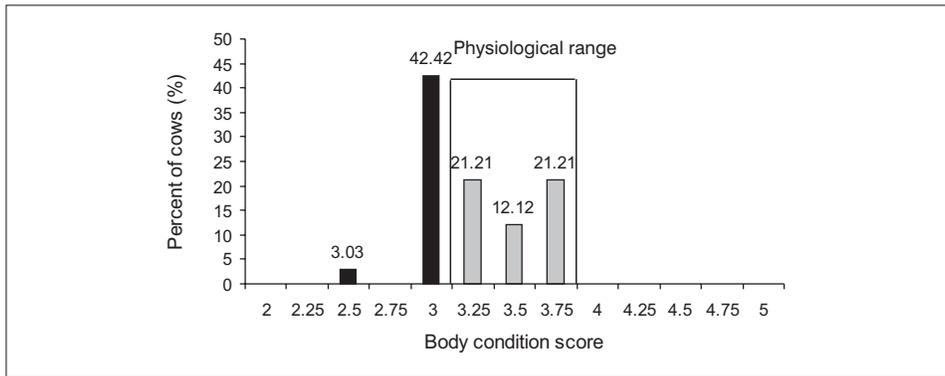


Figure 8. Distribution of individual body condition scores at puerperium in cows with moderate fatty liver

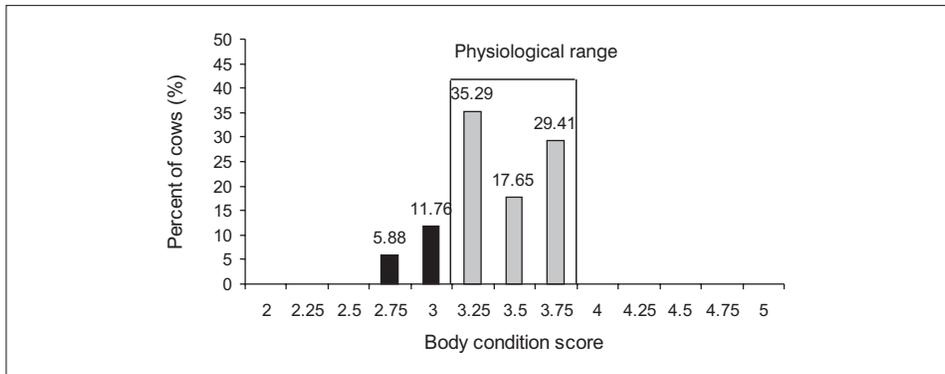


Figure 9. Distribution of individual body condition scores at puerperium in cows with severe fatty liver

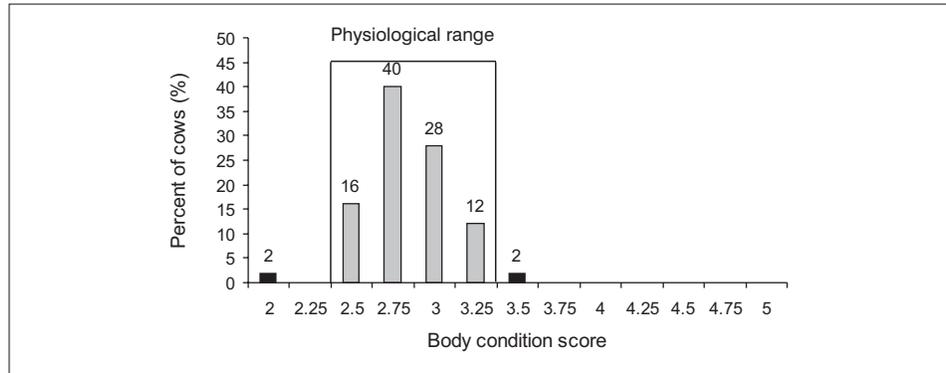


Figure 10. Distribution of individual body condition scores at month 2 of lactation in cows with mild fatty liver

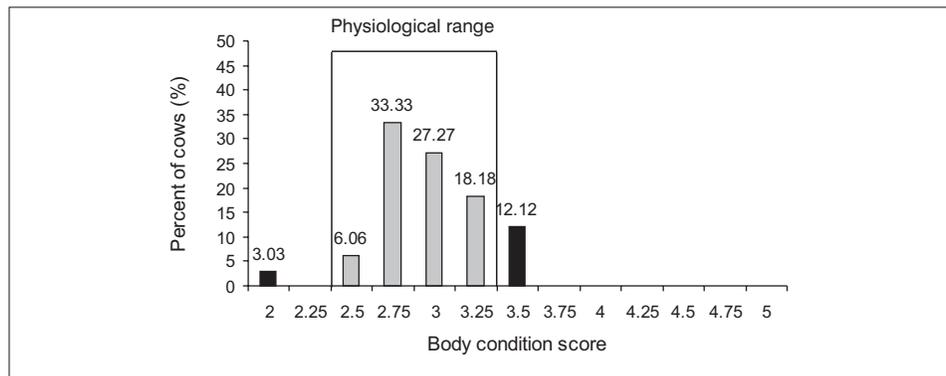


Figure 11. Distribution of individual body condition scores at month 2 of lactation in cows with moderate fatty liver

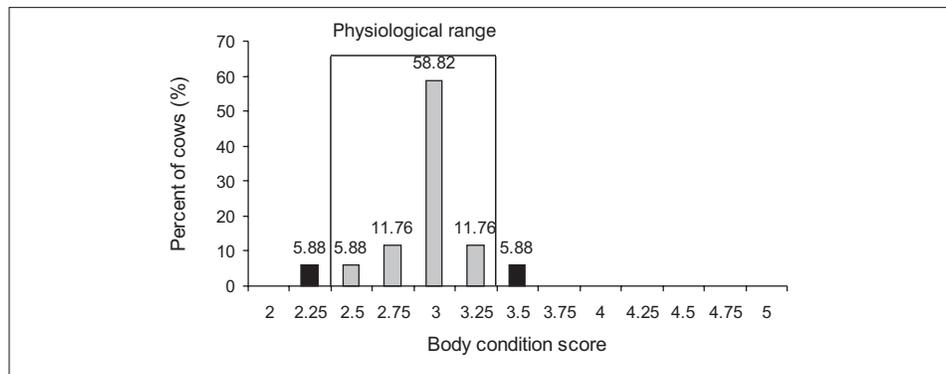


Figure 12. Distribution of individual body condition scores at month 2 of lactation in cows with severe fatty liver

Finally, distributions of individual body condition scores at month 2 of lactation were similar in all three groups of cows (Figures 10, 11 and 12) with a note that the percent of cows with body conditions that were out of the physiological range was lowest in the group of cows with mild fatty liver.

#### DISCUSSION

Fatty liver is one of the major metabolic disorders in Holstein cows (Kato, 2002; Jorristma, 2003; Bobe *et al.*, 2004) with high incidence in populations (Gall, 2007; Šamanc *et al.*, 2008). Investigations performed in Holstein cows in European Union and the United States showed that moderate fatty liver appears more often than severe fatty liver (Reid, 1980; Gröhn *et al.*, 1987; Mazur *et al.*, 1988; Acorda *et al.*, 1995; Jorristma *et al.*, 2001; Gerloff *et al.*, 1986; Herdt, 1991). Our previous work showed that incidence of fatty liver on two dairy farms in Serbia was 18.33% and 43.32%, respectively (Šamanc *et al.*, 2008). At farm with higher incidence of fatty liver, marked digresses of body conditions from physiological values were detected in late lactation and dry cows. It is well known that obese dry cows have a greater decrease in feed intake around calving, and therefore, have a pronounced negative energy balance which leads to severe fatty liver (Morrow, 1976; Jorristma, 2003; Stockdale, 2001). Namely, in obese cows (BCS>4), lipolysis of adipose tissue is more intensive than in the cows with normal BCS (Rukkwamsuk *et al.*, 1998). Our results showed significant difference between body conditions at dry period and puerperium, puerperium and month 2 of lactation and dry period and month 2 of lactation (Table 3). These findings are in accordance with the change in energy balance during the transition period which continue until month 2 of lactation i.e. until energy balance is established again. Namely, onset of lactation is characterized by negative energy balance which is followed by marked body condition loss (Jorristama *et al.*, 2003; Rukkwamsuk *et al.*, 1999).

However, some authors indicate that obesity does not necessarily cause fatty liver, especially when cows adapt their feed intake to their milk production (Smith *et al.*, 1997). Even more, it is an open question if fatty liver can occur in cows with body condition score lower than 2.5 points around calving, since those cows have not stored excessive lipids in the body (Bobe *et al.*, 2004). It is not unusual that average body condition scores are within the physiological range, but health problems in cows indicate disturbance in energy metabolism. That was the case in this study, since average body condition scores for all examined cows at three periods were not out of the physiological range (Table 3), although data for the percent of liver fat indicated that disturbance of energy metabolism in cows occurs, since 50% of cows had moderate or severe fatty liver. That was the main reason why we analyzed body condition of cows in detail. By analyzing body condition losses between different phases of productive-reproductive cycle, as well as the distribution of individual body conditions within different phases of cycles, we tried to estimate the possible relationship between these indicators and fatty liver. According to Kim and Suh (2003) and Šamanc *et al.* (2008) physiologically accepted loss in body condition between two consecutive phases

of productive-reproductive cycles (dry period/puerperium and puerperium/month 2 of lactation) is up to 0.7 and up to 1.5 between puerperium and month 2 of lactation. It may be seen from table 4 that as much as 38% of cows had marked body condition loss between the dry period and puerperium, while 20% of cows had marked body condition loss between dry period and month 2 of lactation. This indicates that difference in body conditions between different phases of cycles may be used as an additional, ease to use, diagnostic indicator for assessment of energy status of cows.

Interesting conclusions can be made when data for body conditions are presented as distribution of individual values for cows (Figures 1 to 3). Regardless that average body condition scores were within the physiological range, individual values for body condition in the dry period and puerperium were, in a significant percent, out of the physiological range (39 and 49% respectively).

In our study, we presented data for average BCS, body condition loss and distribution of individual values separately for cows with different fatty liver degree (mild, moderate and severe). Only dry cows with severe fatty liver had body condition score higher than physiologically acceptable. All the other values were within physiological (Table 5).

In cows with severe fatty liver, marked loss in body condition appeared more often than in cows with moderate and mild fatty liver, especially between the dry period and puerperium (76.47% of cows). These results indicate that intensive lipomobilisation starts early around calving, before milk production encasement. It is possible that severe fatty liver develops during the last days of pregnancy (Gerloff *et al.*, 1986). Additionally, results indicate that, besides nutrition and body condition, other risk factors are involved in etiology of fatty liver (Bobe *et al.*, 2004; Šaman *et al.*, 2010).

Analyzing data for distribution of individual body condition scores it can be noticed that only 12% cows with mild fatty liver were obese during the dry period ("shift to right"), while that percent was 64.71 for dry cows with severe fatty liver (Figures 4 and 6). It can be concluded that in more than half of the cases (64.71%) obesity may cause fatty liver. In other cases, other etiological factors may be included (Grummer, 1993; Katoh, 2002; Kapp *et al.*, 1979; Jorristma *et al.*, 2000; Goff and Horst, 1997; Šamanc *et al.*, 2010). At month 2 of lactation distribution of individual values for body condition was very similar between cows with a different degree of fatty liver, indicating that most intensive lipomobilization is close to calving. If lipomobilization is too high it may lead to fatty liver.

In conclusion, average body condition score is a valid indicator of energy status of dairy cows, and should be used in everyday practice due to its simplicity. Besides, body condition loss should be used as an additional diagnostic tool for determining energy status of dairy cows, especially loss between dry period and puerperium, since it may indicate on early lipomobilisation which probably starts before calving (Bobe *et al.*, 2004). Our results indicate that severe fatty liver is associated with obesity in dry cows and mark body condition loss between dry period and puerperium. For valid assessment of energy status of dairy cows, it is strongly recommended to analyze the distribution of individual values for body condition at different phases of the productive-reproductive cycle, since it may

indicate on percent of cows with body condition scores out of physiological range ("shift to left" and "shift to right"). Finally, our results indicate that there is a strong association between average body condition score and body condition loss on fatty liver degree but that, in some cases, factors other than body condition cause fatty liver. These other risk factors are not yet clearly determinate and should be a subject of further investigations.

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**NOVI PRISTUP U OCENI TELESNE KONDICIJE I NJENOM UTICAJU NA ZAMAŠĆENJE JETRE KOD KRAVA HOLŠTAJN RASE**

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## SADRŽAJ

Cilj istraživanja u ovom radu je bio da se ispita povezanost telesne kondicije i zamašćenja jetre kod visoko-mlečnih krava. Za ogled je izabrano 100 krava holštajn rase u zasušenju. Telesna kondicija je ocenjena jedanput u zasušenju, puerperijumu i 2. mesecu laktacije prema sistemu Elanco Animal Health Buletin AI 8478. Gubitak u telesnoj kondiciji je označen prekomernim ako je iznosio preko 0,7 poena između dve uzastopne faze ciklusa, odnosno preko 1,5 poena između zasušenja i 2. meseca laktacije. Uzorci jetre su uzeti 12 dana nakon teljenja i ispitani na sadržaj masti. Polovina (50%) krava je imalo blag ( $3,92 \pm 3,33\%$  masti), 33% srednji ( $19,28 \pm 5,18\%$  masti), a 17% krava visok stepen zamašćenja jetre ( $36,21 \pm 4,55\%$  masti). Prosečne OTK krava su iznosile  $3,79 \pm 0,55$  (zasušenje),  $3,18 \pm 0,34$  (puerperijum) i  $2,90 \pm 0,29$  (2. mesec laktacije). Prekomeran gubitak u telesnoj kondiciji između zasušenja i puerperijuma je imalo 38% krava, 20% između zasušenja i 2. meseca laktacije i 8% između puerperijuma i 2. meseca laktacije. Telesnu kondiciju izvan fizioloških granica je imalo 39% krava u zasušenju, 49% krava u puerperijumu i 9% krava u 2. mesecu laktacije.

Kada su krave podeljene na osnovu stepena zamašćenja jetre, utvrđeno je da su samo krave sa visokim stepenom zamašćenja jetre bile pregojene u zasušenju, kao i da je kod ove grupe krava u 76,47% slučajeva nastao prekomeran gubitak u telesnoj kondiciji od zasušenja do puerperijuma, u 47,06% od zasušenja do 2. od meseca laktacije i u 23,53% od puerperijuma do 2. meseca laktacije što ukazuje da pojačana lipomobilizacija kod ove grupe krava počinje u periodu oko teljenja vrlo rano, pre nego što nastane značajan porast u proizvodnji mleka.

Naši rezultati ukazuju na postojanje značajne povezanosti telesne kondicije i zamašćenja jetre koja se može utvrditi jedino detaljnom analizom telesne kondicije krava u zapatu. Pored toga, rezultati jasno ukazuju da telesna kondicija nije jedini etiološki faktor u nastanku masne jetre kod krava.