

Risk factors for occurrence of displaced abomasum and their relation to nutritional management of Holstein dairy cattle

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ABSTRACT

The aim of the present study was to identify nutritional risk factors for the occurrence of displaced abomasum (DA) in Holstein dairy cattle raised in regions with highly variable nutritional management. Feeding program data were collected from 30 dairy farms throughout Kosovo via use of a standardized questionnaire, and an AgriNIR™ Analyser was used to analyze the nutrient composition of forage (hay, corn silage) fed to cattle on those farms. A diagnosis of DA was made via auscultation/percussion in the area of the last rib and hearing of a ping sound. Multivariate linear regression models were used to determine risk factors associated with the incidence of DA. The overall incidence of DA in this study was 4.9% (38 cases among 769 cows). Of cows diagnosed with DA, 81.6% (31/38) had left side DA and 18.4% (7/38) had right side DA. Nearly all DA occurred during the first month of the postpartum period - 92.1% (35/38); only 7.9% (3/38) were observed in the pre-partum period. Risk factors that elevated the occurrence of DA included increased intake of concentrate feed after parturition ($P<0.002$), increased body condition score at calving ($P<0.01$), larger herd size ($P<0.021$), and increased daily consumption of corn silage in the pre-partum transition period ($P<0.051$). An increase in daily consumption of grass hay in the pre-partum transition period decreased ($P<0.014$) the incidence of DA. The results of this study are useful for developing enhanced nutritional management protocols to reduce the incidence of DA in Holstein dairy cattle.

Key words: displaced abomasum, dairy cattle, forage to concentrate ratio, body condition score, transition cow feeding, Kosovo

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Introduction

Displaced abomasum (DA) is a commonly observed disorder of high producing dairy cattle. The incidence of DA varies widely from 0% to 20% of animals within a herd, but is typically reported in the range of 3.5% to 5.0% (GOFF, 2006; Van WINDEN, 2002). The DA condition develops as a result of gas accumulation in the abomasum. The accumulated gas dilates the abomasum, and the abomasum becomes displaced to either the left or right side of the abdominal cavity. This left- or right-sided abomasal displacement may occur with or without torsion of the abomasum. Most DA are left-sided (KARATZIAS and PANOUSIS, 2003), but both forms of DA have a similar etiology (Van WINDEN and KUIPER, 2003).

It is widely accepted that DA is a multi-factorial disease. Factors which predispose animals to develop DA include breed (Holstein, Jersey, Guernsey; DOLL et al., 2009; ZERBIN et al., 2015), advanced parity (GEISHAUSER, 1995; Van WINDEN and KUIPER, 2003), twin pregnancy (PARDON et al., 2012), high pre-partum body condition score (CAMERON et al., 1998), negative energy balance in the pre-partum period (HEUER, 2000; CAMERON et al., 1998), and health conditions (endometritis, mastitis; Van WINDEN et al., 2003). Additional predisposing factors include metabolic disorders (ketosis, metabolic alkalosis, hypocalcemia) which impact abomasal motility, leading to impaired abomasal emptying and increased gas accumulation (DOLL et al., 2009; Van WINDEN et al., 2003; MARTENS, 2000), as well as nutritional management factors such as low roughage and high concentrate diets (SHAVER, 1997; Van WINDEN et al., 2003) and corn silage particle size less than 8 mm (SIMÕES et al., 2013).

The transition period (from 3 weeks before to 4 weeks after calving) is considered a major risk period in the etiology of DA because cows undergo many physiological changes including depression of feed intake during the pre-partum period and a slow increase in feed intake in the early postpartum period (SHAVER, 1997; DRACKLEY, 1999; GRUMMER, 1995).

The economic impact of DA is usually significant and results from reduced milk yield (especially in early lactation), direct costs of treatment, replacement costs due to premature culling, and the lower slaughter value of the animal in cases when surgical intervention is unsuccessful (SHAVER, 1997; Le BLANC et al., 2005). Since the first report of a displaced abomasum in a cow in Kosovo (BEHLULI et al., 2008), the incidence of DA in dairy cattle is increasing within that country. The reasons for that increase are not clear but are likely related to inadequate cow nutritional management.

The aim of this study was to evaluate potential nutritional factors that influence the development of displaced abomasum in herds of Holstein dairy cattle. Special attention was paid to feed and feeding management, the forage:concentrate ratio during the transition period, herd size, body condition score at calving, and days open.

Materials and methods

Selection of dairy herds. A total of 30 Holstein dairy herds from different geographical regions within Kosovo were selected for this observational field study. Only closed-type intensive farming operations (without grazing) were considered for inclusion in the study, and only those farms where investigators gained access to milk production records, feed samples, and nutritional and health care management protocols, were included in the final study group. No prior information was available regarding the occurrence of DA on the farms involved in this investigation. The 30 participating farms had a total of 769 Holstein cows. Average herd size was 26 head (range: 10-120 head), and average daily milk production was 18.2 liters (range: 13-24 liters).

Nutrition data collection. Data were collected during on-farm visits that took place over a 12-month period (February 2013 - January 2014). Each farm was visited on a regular basis in cooperation with the contracted herd veterinarian, and during each visit data on the feeding program were collected using a standardized questionnaire. The amount of corn silage, grass hay and concentrate (corn, wheat, sunflower meal, soybean meal, wheat bran, and mineral premixes) being fed daily was recorded, and this enabled subsequent calculation on a farm-by-farm basis of the forage:concentrate feed ratio (particularly important during the transition period). The frequency with which feed was offered to cows varied from farm to farm, but the most common feeding frequency was three times per day. The AgriNIR™ Analyser (Dinamica Generale, Poggio Rusco, Mantova, Italy) was used to analyze the forages (but not concentrates) being fed to the animals in this study. This machine determined dry matter content, crude protein, starch, ADF, and NDF.

Body condition scoring and diagnosis of displaced abomasum. Body condition score (BCS) was determined for each individual animal using the standardized BCS scoring technique (EDMONSON et al., 1989). The BCS scale ranges from 1 (emaciated - too thin) to 5 (obese - too fat), and scores were assigned using 0.25-point increments. The BCS of cows at calving was recorded by the contracted herd veterinarian. Diagnosis of DA was based on clinical signs and tympanic ping sound at auscultation of the abdomen, diagnosed and confirmed in cooperation with the contracted herd veterinarian.

Statistical analysis. Data were analyzed via regression analysis (RAGSDALE, 2001). A multiple linear regression model was used to evaluate the impact of potential risk factors (independent variables) on the occurrence of DA (dependent variable). Potential risk factors studied included: the amount (kg) of grass hay, corn silage, and concentrate consumer per day before parturition; forage:concentrate ratio of feeds fed before parturition; the amount (kg) of concentrate fed daily after parturition; body condition score (BCS) at calving, number of days open, and herd size. A chi-square test was used to test for an association between DA and daily milk yield.

Results

On the farms in this study the overall incidence of displaced abomasum (DA) was 36.7% (11 of 30 farms). Statistics of the multiple regression model are shown in Table 1. The regression model explained 71% of the total variation in incidence of DA, and the true proportion of dairy farms in Kosovo having problems with DA lies between 18.4% and 55.0% (95% confidence interval limits).

Table 1. Statistics from the multiple regression model used to determine the association of potential risk factors with the incidence of displaced abomasum (DA) in Holstein dairy cattle

No. of observations	30
Dependent variable mean	0.367
Standard error of the estimate (RMSE)	0.304
Coefficient of variation (CV)	0.829
R-squared	0.708
Adjusted R-squared	0.615

Table 2. Descriptive statistics for some displaced abomasum (DA) risk factors in Holstein dairy farms that did (n=11) and did not (n=19) have an occurrence of DA

Farm number (positive DA farms)	Herd Size	No. of DA cases	Percent of cows with DA	Body condition score (at calving)	Days open	Kg concentrate fed	
						Before parturition	After parturition
1	120	8	6.7	4.0	202	1	5
2	90	8	8.9	3.75	155	2	7
3	60	7	11.7	4.0	188	1	8
4	38	3	7.9	3.75	140	2	7
5	22	3	13.6	4.0	110	1	8
6	45	2	4.4	3.5	129	2	7
7	24	2	8.3	4.0	183	2	6
8	17	2	11.8	3.75	212	1	5
9	27	1	3.7	3.75	188	0	7
10	19	1	5.3	3.75	150	1	7
11	12	1	8.3	4.0	151	1	9
Mean (SD) of farms with DA	46.2 (34.2)	3.7 (2.81)	8.2 (0.03)	3.8 (0.17)	164.3 (32.3)	1.30 (0.65)	6.70 (1.22)
Mean (SD) of farms without DA	15.5 (3.6)	0 (0)	0 (0)	3.5 (0.25)	107.1 (12.4)	1.45 (0.70)	5.05 (1.54)

The occurrence of DA among cows on the 30 farms in this study was 4.9% (38 cases diagnosed in 769 cows). When examining only those farms in which DA was diagnosed, the occurrence of DA was 8.2% (38 cases in 474 cows) and ranged from 3.7% to 13.6% (Table 2). Of the 38 cases of DA, 35 (92.1%) were diagnosed in the first month of the postpartum period, whereas 3 (7.9%) were observed in the last month of gestation. Seven cases (18.4%) were right displaced abomasum (RDA), and 31 cases (81.6%) were left displaced abomasum (LDA).

Table 3. Analysis of forage (grass hay and corn silage) for NDF, ADF, protein and starch content using an AgriNIR™ Analyser

Farm number (DA positive farms)	Grass hay				Corn silage				
	Kg fed per day*	ADF (%)‡	NDF (%)‡	Crude protein (%)‡	Kg fed per day*	ADF (%)‡	NDF (%)‡	Crude protein (%)‡	Starch (g)
1	3	45	68	1.7	26	27	42	7.0	170
2	5	48	64	1.0	23	32	46	7.0	230
3	5	42	62	2.5	25	31	44	7.4	155
4	12	39	71	5.0	15	28	39	8.5	240
5	5	48	66	4.5	15	31	48	8.3	160
6	5	47	66	2.0	15	29	43	9.0	180
7	2	49	60	2.5	28	33	45	8.8	200
8	4	42	64	4.0	12	31	38	8.5	150
9	4	41	64	3.0	21	31	44	8.5	170
10	4	43	62	4.0	19	26	41	8.7	170
11	4	48	58	1.8	15	29	46	8.6	210
Mean (SD) of farms with DA	4.9 (2.6)	44.7 (4.0)	64.1 (3.6)	2.3 (1.3)	19.9 (8.0)	29 (1.7)	43 (2.5)	8.2 (0.7)	185 (26.6)
Mean (SD) of farms without DA	8.4 (4.7)	36 (3.1)	61 (2.1)	4.4 (1.1)	11.2 (10.0)	24 (2.5)	42 (2.6)	7.8 (0.5)	210 (34.3)

* fed during the pre-partum transition period; ‡ on a dry matter basis

The results of forage analyses are shown in Table 3. Grass hay averaged 44.7% ADF and 64.1% NDF on farms with an occurrence of DA. In farms where no cases of DA were diagnosed, analysis of grass hay revealed an average of 36% ADF and 61% NDF. Corn silage analysis on farms with DA revealed an average ADF of 29% and NDF of 43%, while farms with no incidence of DA had 24% ADF and 42% NDF. Recommended ADF and NDF values for forages fed to dairy cows are $\leq 40\%$ NDF and $\leq 30\%$ ADF on a dry matter basis (POTTHAST et al., 2009).

Five risk factors that caused DA in animals were identified in this study. Herd size influenced ($P < 0.021$) the incidence of DA. For every cow added to a herd, the number of DA cases increased by 0.08 cases.

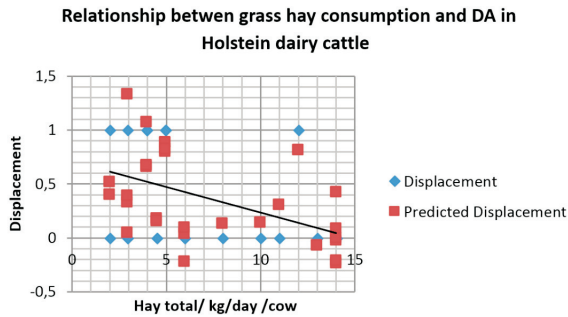


Fig. 1. The relationship between daily consumption of grass hay (kg) during the pre-partum transition period and the incidence of displaced abomasum (DA) in Holstein dairy cattle

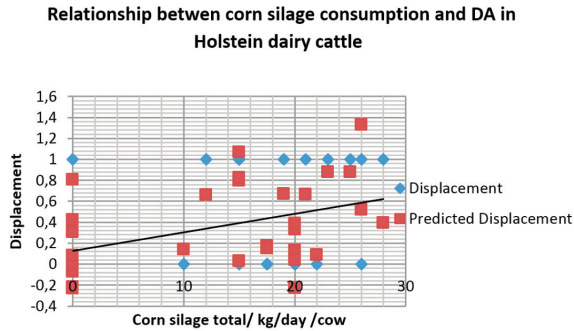


Fig. 2. The relationship between daily consumption of corn silage (kg) during the pre-partum transition period and the incidence of displaced abomasum (DA) in Holstein dairy cattle

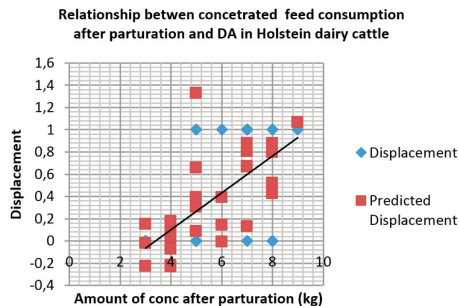


Fig. 3. The relationship between daily consumption of concentrate (kg) in the post-partum period and the incidence of displaced abomasum (DA) in Holstein dairy cattle

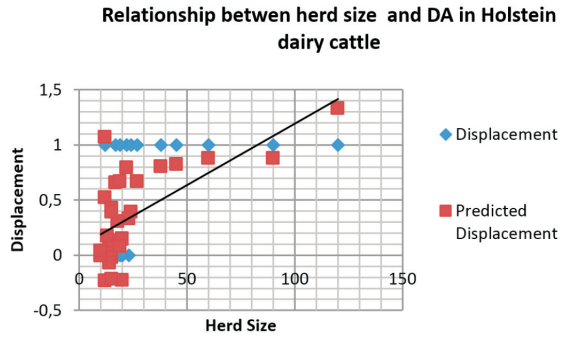


Fig. 4. The relationship between herd size (number of head) and the incidence of displaced abomasum (DA) in Holstein dairy cattle

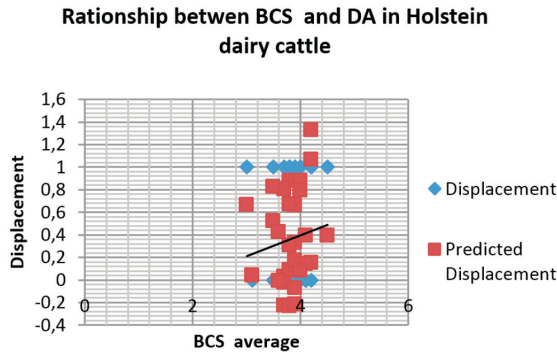


Fig. 5. The relationship between body condition score (BCS) at calving and the incidence of displaced abomasum (DA) in Holstein dairy cattle

The mean BCS at calving influenced ($P < 0.01$) the incidence of DA, and the average BCS (3.8) on farms with DA was higher than the average BCS (3.4) observed on farms without DA. For every 0.25-point increase in cow BCS the number of DA cases increased by 0.54 cases. To test the association between average open days and BCS at calving, linear regression analysis was used. There was a positive correlation ($P < 0.05$) between the average days open and BCS. For each additional day a cow was open, the BCS increased by 0.05 points.

The amount of grass hay consumed daily by cows in the pre-partum transition period was inversely related ($P < 0.014$) to the incidence of DA. For every kg of grass hay added to the daily feed ration, the incidence of DA decreased by 0.10 cases.

On the other hand, the amount of corn silage consumed by cows each day during the pre-partum transition period was positively correlated ($P < 0.051$) with the number of

DA cases. For every kg of corn silage added to the daily feed ration, the incidence of DA increased by 0.04 cases.

The amount of concentrate fed daily after calving had a strong ($P < 0.002$) influence on the occurrence of DA. For every kg of concentrate fed after parturition, the incidence of DA increased by 0.12 cases.

The amount of concentrate feed consumed daily during the pre-partum transition period was not correlated with the incidence of DA ($P > 0.19$, respectively). No significant correlations between daily consumption of other specific feed ingredients and the incidence of DA were found in this investigation.

There was no association ($P > 0.26$) between the incidence of DA and milk yield ($P = 0.262$). Daily average milk yield of cows on farms with and without DA was 19.5 ± 0.72 liters/day and 17.4 ± 0.65 liters/day, respectively.

Discussion

Similar to many other parts of the world, the dairy industry in Kosovo has changed over the past 15 years from a traditional extensively managed farming system using Simmental cows to an intensively managed farming system based on high-production Holstein cows. These changes in breed type and management style have led to a dramatic need for substantial changes in cow nutritional management, particularly the inclusion of a higher proportion of concentrate feed in the ration. Improper feeding of rations to high-production cows can lead to various metabolic disorders as well as to an increased incidence of DA.

We evaluated a number of potential risk factors for the development of DA in Holstein dairy cattle. Significant associations were found between five risk factors (herd size, BCS at calving [and its related days open], kg of grass hay consumed per day in the pre-partum period, kg of corn silage consumed per day in the pre-partum period, and kg of concentrate feed consumed per day after parturition) and the occurrence of DA.

The incidence of DA among cows in the present study (4.9%) is comparable to that reported by others: 3.5% (GOFF, 2006), and 5.0% (GEISHAUSER et al., 2000). Similarly, the occurrence of DA in the postpartum period in our study (92.1%) is in strong agreement with a previous report where 92.11% of DA cases were diagnosed in the postpartum period (SEXTON et al., 2007). The incidence of displaced abomasum on the left side in our study (81.6%) is highly consistent with a previous finding of 81.85% (KARATZIAS and PANOUSIS, 2003).

The results from our study also confirm a previous report (SHAVER, 1997) that the daily feeding program during the transition period of the dairy cow (i.e., kg concentrate after parturition, kg grass hay and kg corn silage fed pre-partum) represents a major risk for development of DA. During the transition period there is ordinarily a physiological depression of feed intake in late gestation, concomitant with a slow increase in feed intake in the postpartum period.

The findings from our study highlight the importance of pre-partum nutritional management to reduce the occurrence of DA in the postpartum period. There was a positive correlation in the present study between BCS in the calving period and DA. One report (MULLIGAN et al., 2006) suggested a BCS of 3.0-3.5 for dairy cows at calving, with subsequent nutritional management in the postpartum period to ensure a maximum loss of 0.5 BCS points over the entire lactation period.

The results from our study revealed a positive correlation between days open and pre-partum BCS, and this is in accordance with results reported previously (AL-HILFE, 2009). An increase in the number of days open could easily lead to an increased BCS if farmers neglect to reduce the amount of feed being fed to cows during the end of the lactation period and during the dry period (where daily nutrient requirements are much lower). Fine tuning of the feeding programs at various stages of life cycle production (i.e., throughout all stages of lactation and during the dry period) is critical to avoid a vicious cycle of nutritional health problems for the dairy cow. Feeding dietary nutrients in excess of those required can be a permanent risk factor for increased BSC and occurrence of DA.

Prevention of obesity in cows during the dry period has major importance (Le BLANC et al., 2005), but other feeding concerns during the pre-partum period also exist. During late gestation, cows typically reduce feed intake, which in turn leads to lower blood concentrations of calcium, glucose and insulin. These altered metabolic conditions contribute to an increased incidence of DA.

One of the farm characteristics that influenced the occurrence of DA in the present study was herd size. Although herd size on farms where DA was diagnosed varied considerably, the mean herd size was approximately 3 times greater than that on farms where no DA was observed (46.2 and 15.5 head, respectively). Our results confirm the previous finding (ERB and GROHN, 1988) that a correlation exists between the number of cows in the herd and the incidence of DA. It seems logical that as herd size increases the ability to closely monitor the nutritional status of all the cows decreases.

Consistent with Van WINDEN (2002), who reported that increasing the amount of grass hay in the ration reduced the incidence of DA, our study also found an inverse relationship between kg of grass hay consumed daily and the occurrence of DA. Similarly, our finding that the amount of corn silage consumed daily is positively correlated with the number of DA cases, is in agreement with a previous report (CAMMACK, 1997).

Analysis of forage samples obtained during our study revealed that most forage fed was of extremely poor quality (Table 2). Grass hay possessed a high content of NDF and ADF, and a low content of protein; similarly, corn silage had a low starch content. Poor forage quality could potentially influence the occurrence of DA because roughage with a bad taste leads to lower feed intake by the cow (Van WINDEN et al., 2003; JACOBSEN, 1995).

In the drying off period, farmers reduce the daily amount of concentrate fed to cows; yet immediately after parturition they substantially increase the daily amount of concentrate they feed. Our results indicate that the amount of concentrate given during the early postpartum period is a significant risk factor positively correlated with DA occurrence. Farmers that fed poor quality roughages (hay, silage) attempted to compensate for this low quality feed by substantially increasing the amount of concentrate fed in the postpartum period, resulting in an increased incidence of DA. Our results are in accordance with those of INGVAERTSEN (2006) who reported that low intake of concentrates during the pre-partum period, coupled with a too rapid increase in concentrate feeding after calving, may reduce roughage intake and potentially increase the risk of DA. This happens due to a reduction of the absorptive capacity of the ruminal papillae, reduction of abomasal motility, and a microbial population of the rumen that is not adapted to the high energy postpartum diet (SHAVER, 1997).

Our study revealed five nutritional factors associated with the incidence of DA in Holstein dairy cattle: (1) the amount of concentrate fed daily during the postpartum period, (2) BCS, (3) herd size, (4) the amount of grass hay consumed daily during the pre-partum transition period, and (5) the amount of corn silage consumed daily during the pre-partum transition period. The improper feeding of dairy cows (alteration of the amount of concentrate fed and feeding with low quality forage) during the drying off period and postpartum periods is an important risk factor for the occurrence of DA. Cows with an increased number of days open will have an increased BCS, which increases the risk for DA occurrence, resulting in a vicious circle for the etiology-pathology of DA. Dairy farmers should adjust feed rations, especially the amount of concentrate feed, according to the cow's daily nutrient needs which differ between the dry period and the lactating period. Proper nutritional management can assist the attainment of proper BCS and a reduction in the incidence of DA. The occurrence of DA in intensive dairy farming systems is a serious health problem that decreases the profitability of dairy farms. This disorder is mainly caused by poor nutritional management of dairy cows by inexperienced dairy farmers. This situation is exacerbated by the lack of field veterinarians who are well informed about dairy cattle nutrition and its importance in prevention of DA.

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SAŽETAK

Cilj istraživanja bio je identificirati čimbenike rizika u hranidbi koji doprinose pojavi dislokacije sirišta (DS) kod mliječnih goveda holštajnske pasmine, uzgajanih u područjima s različitim uvjetima hranidbe. Podatci o programu hranidbe prikupljeni su pomoću standardnog upitnika na 30 farmi za proizvodnju mlijeka širom Kosova, a analiza nutritivnog sastava u krmivima (sijeno, kukuruzna silaža) koja su na tim farmama korištena za hranidbu goveda obavljena je AgriNIR™ analizatorom. Dislokacija sirišta dijagnosticirana je osluškivanjem timpaničnog zvuka, uz primjenu metoda auskultacije/perkusije u području posljednjeg rebra. Modeli multivarijantne linearne regresije korišteni su za određivanje čimbenika rizika koji su povezani s incidencijom dislokacije sirišta. Ukupna incidencija dislokacije sirišta u ovom istraživanju bila je 4,9 % (38 slučajeva od 769 krava). Među kravama s dijagnosticiranom dislokacijom sirišta 81,6 % (31/38) krava imalo je dislokaciju u lijevu stranu, a 18,4 % (7/38) u desnu stranu. Gotovo sve dislokacije (92,1 %; 35/38) dogodile su se tijekom prvog mjeseca nakon teljenja, a samo 7,9 % (3/38) u razdoblju prije teljenja. Čimbenici rizika koji doprinose pojavnosti dislokacije sirišta uključivali su povećani unos koncentriranih krmiva nakon teljenja ($P < 0,002$), višu ocjenu tjelesne kondicije pri teljenju ($P < 0,01$), veću veličinu stada ($P < 0,021$) i povećano dnevno uzimanje kukuruzne silaže u tranzicijskom razdoblju prije teljenja ($P < 0,051$). Povećanje dnevnog uzimanja sijena od trave u tranzicijskom razdoblju prije teljenja doprinijelo je sniženju incidencije dislokacije sirišta ($P < 0,014$). Rezultati ovog istraživanja korisni su za razvijanje boljih protokola u upravljanju hranidbom kojima bi se smanjila incidencija dislokacije sirišta u mliječnih goveda holštajnske pasmine.

Cljučne riječi: dislokacija sirišta, mliječna goveda, krmiva, tjelesna kondicija, hranidba, Kosovo
