Journal of Agricultural Science and Technology A 11 (2021) 47-52
doi: 10.17265/2161-6256/2021.01.003

Somatic Cell Count in Relation to Udder and Morphometry in Holstein Friesian Dairy Cows

Găvan Constantin and Riza Mihaela
Agriculture Research and Development Station Şimnic-Craiova, ŞoseauBălceşti, No. 54, Dolj, Romania

Abstract: In the present study authors present some aspects regarding udder health as well as the udder teat morphometry. The udder health was defined on the basis of somatic cell count (SCC) in milk. The morphometry parameters included: distance from rear teat-tip to the floor, distance from fore teat-tip to the floor, udder depth, udder length, udder width, udder volume, fore teat length, rear teat length, fore teat diameter, and rear teat diameter. The present investigation involved 92 Holstein Friesian cows, from an experimental herd. Considering particular structural elements of a cow udder, three location groups were distinguished: 1st, 2nd, and 3rd (L_1, L_2 and L_3 respectively). From the study result, primiparous cows (L_1 group) were characterized by a relatively low SCC in milk, as compared to multiparous cows (L_2 group or L_3 group). The cows in the 3rd lactation in relation to the first lactation cows, head SCC increased over 3 times, which indicates the increase of the chance of the cows to be susceptible to intramammary infections. All data showed a gradual increase in depth length, width and volume of the udder as the number of parity increases. The differences observed in udder morphometry in different parities were found significant ($p < 0.05$) to highly significant ($p < 0.01$). The values of the coefficients of correlation for the analyzed udder and teat conformation traits and SCC in milk, were statistically varied and ranged from -0.32 to +0.28. Accordingly, the udder and teat morphometry characteristics such as distance from rear are fore teat-tip to the floor, udder depth, volume, teat diameter, can be said to have some degree of association with the udder health in Holstein Friesian cows evaluated in this study. Hence their inclusion in breeding program as indicator traits may help reduce the incidence of intramammary infections.

Key words: Somatic cell, udder, milk.

1. Introduction

The morphological characteristics of udder and teat of dairy cows not only affect milk production, but also enhance the risk of intramammary infections [1, 2]. Several researchers [3-6] have reported genetic associations between udder conformation (UC) traits and somatic cell count (SCC) in milk. Because genetic relationship exists between UC traits and SCC the accuracy of an udder health index may be increased by including UC traits. Nordic countries have implemented selection programs based on direct data of mastitis [7]. Somatic cell score (SCS) is often used as an indirect selection criterion for reducing the incidence or severity of mastitis [8-11]. Higher heritability and strong genetic relationship with resistance to mastitis have made SCS a good indicator of mammary health.

Several studies suggested that selection for the same conformation traits, especially the udder traits, might help to reduce the SCS of milk and susceptibility to mastitis [9, 12]. The relationship between type traits and SCS is not consistent across populations and breeds [13].

In Brown Swiss and Red and White cows, an extremely large size or high score of dairy form was associated with high SCS, but this was not the case in Holstein cows [14].

However, a strong genetic correlation of SCS with udder depth, rear udder width, and fore attachment was more consistent across breeds and populations [12, 15, 16]. Some previous studies on Italian Brown Swiss [3] and French Holstein [15] cows revealed a negative genetic correlation between udder depth and SCS (0.46 and -0.40, respectively). Ptak *et al*. [12, 17] suggested that the Polish Holstein cows with deep and wide udders

Corresponding author: Găvan Constantin, Ph.D., professor, research fields: zootechnics, animal breeding, animal genetic, animal health.

had a higher SCS than the cows with an optimum score for these traits. Ptak *et al*. [17] found no genetic or phenotypic relationship between SCS and suspensory ligament, teat placement, or teat length. However, a genetic correlation of 0.22 was found between teat length and SCS in Italian Brown Swiss cattle [3].

In Dutch Holstein cows, the genetic correlation of average SCS over 3 lactations with udder depth and fore udder attachment was 0.35 and 0.30 respectively, where as a low value (-0.15) was reported for teat length [9].

Therefore, it has been suggested that selection of cows with desirable udder and teat morphometry might help to reduce the incidence of intramammary infections and improve the milk quality.

The present study was undertaken to evaluate the association of udder health with the udder and teat morphometry in Holstein Friesian cows exploited at Agricultural Research and Development Station (ARDS) Șimnic, Craiova, Romania.

2. Material and Methods

Animals involved in this study were from ARDS, Șimnic, Craiova. All Holstein Friesian cows are results of a long-term selection experiment for genotype × environment interactions. The selected cows have average to high genetic merit for kilograms of fat plus protein yield. The dairy cows were managed in loose housing throughout the year, located in south west of Romania. Milking was carried out 2 times daily (morning and evening) in a DeLaval milking parlour.

The diet consists of high energy ration based on some by-products and on homegrown components (forage maize, grazed grass, lucerne, forage beet, maize silage, grains and beans). Additionally the ration is balanced with purchased mineral. The calves are detached from the dams after birth and fed in individual calf pens.

Considering particular structural elements of a cow udder, three lactation groups were distinguished: 1st, 2nd and 3rd (L_1, L_2 and L_3 respectively). Udder size analyses and SCC in milk were carried out at 90 ± 15 days of lactation. Udder measurements were done once, just before afternoon milking using zoometric tools.

SCC in milk was determined with Somascope MK II (Netherlands). The data for the present study were collected from 92 milking cows. The following udder traits were analyzed: distance from rear teat-tip to the floor, distance from fore teat-tip to the floor, udder length, udder width, udder depth, teat length, teat diameter, and udder volume.

The udder length was measured from the rear attachment of the udder, near the escutcheon, to the front of the udder where it blends smoothie with the cowboy. The udder width was measured as a distance between two lateral lines of attachment of the udder to abdominal wall, beneath the flank. The measuring tape was kept in position on one side of the cow, under flank, near the femorotibial joint and it was passed over in between fore and rear teats to the other side. The udder depth was measured by subtracting distance from the concrete floor to the udder floor from distance from de barn floor to the base of the udder. The udder volume (cm^3) was calculated from measurements of udder length, width and depth.

Teat length was measured from the upper part of the teat, where it hangs perpendicularly from the quarter to the tip. Teat length was measured with Verrier Caliper (nearest 0.01 cm). Teat diameter was measured at the mid-point length by Verrier Caliper.

Udder health evaluation was done basing on SCC in milk samples collected during routine official control of milk performance.

All the measurements were taken after securing animals properly in a standing position on a leveled concrete floor.

The results were tested with one way ANOVA. Mean values, standard deviations and phenotype correlation indices were calculated. The differences between the means were tested the means were tested with Duncan's multiple range test (DMRT).

3. Results and Discussion

The mean and standard deviation values of SCC in milk of cows in different lactation number ranged from 95.3 to 211.6 and to 301.0 × 1,000 cells/mL of milk (Table 1). From the study results primiparous cows (L_1 group) were characterized by a relatively low SCC in milk, as compared to multiparous cows (L_2 group or L_3 place). The somatic cell numbers in milk are closely associated with inflammation and udder health.

In this study, there is a significant trend toward an increment of SCC as parity progresses. The cows in the 3rd lactation in relation to the first lactation cows, had SCC increased over 3 times, which indicates the increase of the chance of the cows to be susceptible to intra mammary infections.

Several studies revealed a significant effect of lactation number on level of milk SCC [4, 18-20].

The mean and standard deviation values of the distance from rear teat-tip to the floor in different parities ranged from 45.64 to 52.85 cm (Table 1). The data showed a gradual decrease of the distance from teat-tip to the floor as the number of parity increases. The distance from rear teat-tip to the floor was higher in primiparous cows as compared to multiparous cows. Also, the distance from teat-tip to floor decreases as the number of parity increases (Table 1).

The mean and standard deviation values of udder depth, length, width and volume in different parities ranged from 26.15 ± 1.30 to 31.70 ± 1.66 cm, 48.64 ± 3.33 to 50.78 ± 3.07, 47.47 ± 2.63 to 50.52 ± 1.47 cm and 60.4 ± 8.58 to 81.3 ± 6.72 dm^3, respectively (Table 1). All data showed a gradual increase in depth, length, width and volume of the udder as the number of parity increases. Results indicated that multiparous cows had significant ($p < 0.05$) larger size of udder than the primiparous cows. The differences observed in udder volume in different parties, were statistically significant ($p < 0.01$). Similar finding were reported by Kuczaj *et al*. [4] and Patel *et al.* [21].

Avarvarei [22] reported an increase of udder circumference from 106.74 cm, in first lactation to 114.32 cm, in second lactation in black spotted cows located in NE of Romania.

The mean and standard deviation values of various teat measurements of cow's udders in different parties are presented in Table 2.

Mean fore teat length and rear teat length of Holstein Friesian cows in different parities ranged from 5.11 ± 0.37 to 6.18 ± 0.32 cm, and 4.79 ± 0.36 to 5.41 ± 0.38 cm respectively. The data showed a gradual in length of fore and rear teats with advancement of the parity.

The differences observed in fore teat length, and rear teat length in different parities, were not statistically significant ($p < 0.05$).

Patel *et al.* [21] reported that differences observed in fore teat length and rear teat length in different parities, were statistically significant ($p < 0.05$) in crossbreed cows.

Table 1 Changes in UC traits and SCC in milk in relation with lactation number of the dairy cows.

Trait	Groups of cows						Significance of differences between groups of cows		
	L_1		L_2		L_3		L_1-L_2	L_1-L_3	L_2-L_3
	Mean ± SD		Mean ± SD		Mean ± SD				
Number of cows	34		30		28				
SCC (× 1,000 cells/mL of milk)	95.3	27.7	211.6	45.7	301	56.6		*	
Distance from rear teat-tip to the floor (cm)	52.85	3.84	48.53	3.24	45.64	3.41	*	**	*
Distance from fore teat-tip to the floor (cm)	53.03	3.95	49.2	3.46	46.50	3.14	*	**	
Udder depth (cm)	26.15	1.3	30.63	1.73	31.7	1.66	**	**	
Udder length (cm)	48.64	3.33	50.16	3.11	50.78	3.07		*	
Udder (with (cm)	47.47	2.63	48.76	1.87	50.52	1.47		*	

Udder volume (dm^3)	60.4	8.58	74.9	9.18	81.3	6.72	**	**	**

SD = standard deviation; * = $p < 0.05$; ** = $p < 0.01$.

Table 2 Mean and standard deviation values of length and diameter of the udder teats of dairy cows in subsequent lactations.

Trait	Groups of cows						Significance of differences between groups of cows		
	L_1		L_2		L_3		L_1-L_2	L_1-L_3	L_2-L_3
	Mean ± SD		Mean ± SD		Mean ± SD				
Number of cows	34		30		28				
Fore teat length (cm)	5.11	0.37	5.59	0.37	6.18	0.32			
Rear teat length (cm)	4.79	0.36	5.07	0.36	5.41	0.38			
Fore teat diameter (cm)	2.55	0.22	2.61	0.21	2.64	0.22			
Rear teat diameter (cm)	2.53	0.21	2.70	0.22	2.73	0.21	*	*	

SD = standard deviation; * = $p < 0.05$.

Table 3 Values of coefficient of correlation (*r*) for udder and teat conformation traits vs SCC in milk.

Trait	SCC	Trait	SCC
Distance from rear teat-tip to the floor	-0.32**	Fore teat length	+0.03
Distance from fore teat-tip to the floor	-0.30**	Rear teat length	+0.04
Udder depth	+0.24*	Fore teat diameter	0.26**
Udder length	+0.14	Rear teat diameter	+0.28**
Udder width	+0.14		
Udder volume	0.26*		

* = $p < 0.05$; ** = $p < 0.01$.

With age, fore teat diameter did not grow significantly in different parities but rear teat diameter grew significantly ($p < 0.05$) except for the groups L_2-L_3 lactation.

Table 3 presents the coefficients of correlation for udder and teat conformation traits and volume and the SCC in milk.

The values of the coefficient of correlation for the analyzed traits of udder and teat conformation and SCC in milk were varied. They ranged between -0.32 (distance from rear teat-tip to floor and SCC) and +0.28 (rear teat diameter and SCC). Negative coefficients of correlation were found between SCC in milk and distance from rear- and fore-tip to the floor (-0.32 and -0.30 respectively).

Positive coefficients of correlation were found between SCC in milk and fore or rear teat diameter (+0.26 and +0.28 respectively), udder volume (0.26), as well as udder depth (+0.24). The rest of the coefficients of correlation were low and statistically non-significant.

The results similar to this study were obtained by Kuczaj [4] and Singh *et al.* [23] in Holstein Friesian × Sahiwal crossbred dairy cows.

Some of the previous researchers also reported a significant association between the udder morphometry and mastitis [24, 25] with respect of udder depth, the cows having an udder base at a lower level to the hock joint, showing higher susceptibility to mastitis. The deeper udders were found to be at higher risk of developing intramammary infection due to their increased tendency to become soiled and, hence, being contaminated with environmental pathogens [5]. The deeper udders may hinder the cow when lying down and increasing the risk for teat lesions. Also, lower udders had more liner slips and required longer milking time which adversely affects the udder health. The liner slips lead to new infection as they cause an abrupt loss of vacuum that may have the pathogens located at the teat opening or within the streak canal into teat cistern [26]. The decreasing teat-tip to floor distance also showed some association with udder health.

The present results suggested that thicker teats may be a risk for intramammary infections ($p < 0.01$). Similar results were reported by Coban *et al.* [2] and Bardakcioglu *et al.* [6]. Also, the teats with larger diameter tended to be associated with increased liner slips which may act as a risk for intramammary infections [26].

In the present study the various udder and teat morphometry parameters when considered simultaneously may not show statistically significant associations with the udder health, but could not be ignored, because it may be the interaction of different variable affecting the results.

4. Conclusions

In subsequent lactations, SCC in milk showed rising trend which demonstrates a higher vulnerability of the cows to intramammary infections.

Based on the results of this study, the udder and teat morphometry characteristics such as distance from rear or fore teat-tip to the floor, udder depth, and volume, teat diameter, can be said to have some degree of association with the udder health in Holstein Friesian cows evaluated at ARDS Șimnic-Craiova, Romania.

Their inclusion in breeding program as indicator traits may help reduce the chance of the cows to be susceptible to intramammary infections.

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