UDDER QUARTERS MORPHOLOGICAL AND MILKING TRAITS RISK FACTORS INFLUENCING PRODUCTIVITY AND SUBCLINICAL MASTITIS IN DAIRY COWS

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Abstract

SLYZIUS, E., V. JUOZAITIENE, A. JUOZAITIS, V. ZILAITIS, B. SLYZIENE and E. CERESKIENE, 2014. Udder quarters morphological and milking traits risk factors influencing productivity and sub clinical mastitis in dairy cows. *Bulg. J. Agric. Sci.*, 20: 1502-1507

The aim of the research was to evaluate the morphological and physiological characteristics of the cow's udder quarters (n=1360) and to estimate the relationship with the productivity and health of the udder; to identify the main risk factors influencing sub clinical mastitis in dairy cows. Microbiological test of mastitis showed that 86.4% of cows and 60.2% of udder quarters (35.6% of the front and 50.8% of the rear quarters) milk samples were positive. The distance between the front teats of the cow's udder (on the average it was 2.51 times higher than the distance between the rear teats, P<0.001) influenced the productivity of cows and sub clinical mastitis rate (5.94% less positive samples from udder quarter and 12.8% higher milk yield in cows with the difference of up to 5 cm was found, P<0.05). The milk yield of the front quarters ($\overline{X}$ =41.80 ± 0.46%) and the difference of productivity between udder quarters ($\overline{X}$ =14.09±0.51%.) were related with sub clinical mastitis (12.21% more positive samples from udder quarters when milk yield of cow's front quarters was up to 45%, P<0.05 and 3.1% less positive samples when the difference of milk yield between quarters was up to 11%). The substantial difference of milking time ($\overline{X}$ =26.17±0.70%) in udder quarters was estimated. We have found 15.4% less positive samples from udder quarters in milk of cows whose difference of the milking time in the quarters was up to 15% (P<0.05).

Key words: cows, milk, traits of udder quarters, mastitis risk factors

Introduction

Milk quantity and quality and production efficiency of cows is directly dependent on the udder health (Prithard et al., 2010; Szencziová et al., 2013). The udder is the most important part of the body of the dairy cow and its morphological and physiological characteristics affect health of cows (Gulyas and Ivancsics, 2002; Žakas, 2002; Umzay et al., 2003; Weiss et al., 2004; Tilki et al., 2005; Tancin et al., 2007c).

The most appropriate udder for mechanized milking is the one which quarters are evenly developed (Berglund, 2007; Tancin et al., 2007b). Svennersten-Sjaunja et al. (2005), Bach and Busto (2005), Berglund et al. (2007), Forsbäck et al. (2011), Haghkhah et al. (2011) argue that development of the cow's udder quarters is very important for better milk production.

Stankūnienė et al. (2008) indicate that the difference of the cow's milk yield between the front and rear quarters, which are more than 10-15% and the difference of milking time between quarters, which is more than 1 min, have a negative effect on their productivity and health of the udder.

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Morphological characteristics of the udder and teats affects not only milk, but also increase the risk of infections of the udder (Haghkhah et al., 2011; Singh et al., 2013). Mastitis is the most common disease of dairy cattle that causes a lot of loss in milk production industry worldwide. In addition, the mammary mastitis increases somatic cell count (SCC) and creates problems associated with animal welfare (Mitev et al., 2012; Müller et al., 2013).

E. Kul and H. Erdem (2008), Sharma et al. (2011) determined that morphological characteristics of the udder correlate with somatic cell count and the frequency of mastitis; therefore, it is necessary to consider this while performing cow selection.

The **aim of the research** was evaluate the relationship between the morphological and physiological characteristics of the cow's udder quarters and the productivity and health of the udder.

Materials and Methods

The scientific research was carried out in the herds of "The Association of Improvement of Lithuanian Black and White Cattle" as well as in Laboratory of the Research of Animal Breeding and Breeding Values of the Veterinary Academy of the Lithuanian University of Health Sciences in the period of 2012–2013.

The morphological indices of 340 cow's udders were evaluated before evening milking during the 2nd – 6th lactation months. Cows in the researched farms were kept tied and were milked in line. The morphological indices of the udder were evaluated (in centimeters): distance between the front teats, distance between the rear teats, distance between the right-side teats, distance between the left-side teats, length of teats, thickness of teats.

Using the „УРВ-1"milking device for the evaluation of the udder quarters (Maryakhin et al., 2003), milk yield from each quarter was estimated together with the time and the speed of milking. In total 1360 udder quarters were evaluated.

The following was determined according to the data: the duration of milking for each udder quarter (front right, front left, rear right, rear left) in minutes, the average milking speed from each udder quarter (kg/min), udder index (milk yield (%) from front quarters), the difference between the longest and shortest duration of the milking time of udder quarters.

The research of the somatic cell count and microbiological test of milk according to mastitis were carried out in the State enterprise „Pieno tyrimai".

The accuracy of the methods of evaluation of the quality of samples was ensured in agreement with the technical regulations of applying the methods of analysis of raw and thermally processed milk, in accordance with the European Council Decision 91/180/EEB.

Average characteristics of analyzed traits ($\overline{X}$) and standard errors (m_x), coefficients of variation (Cv) were calculated using the SPSS (license No. 9900457; version 15, SPSS Inc., Chicago, IL) statistical package. Analysis of microbiological test of milk samples and the characteristics of the udder quarters was evaluated with the $\chi2$ test.

Cows were divided into two classes while analyzing characteristics of the udder quarters: difference of the distance between the front and the rear teats (class 1 - up to 5 cm, class 2 - 5 cm and more), milk yield from the front quarters of the udder (class 1 up to 45%, class 2 - 45% and more) and the difference of the milk yield between quarters (class 1 - up to 11%, class 2 - 11% and more) and the difference of milking time between quarters (class 1 - up to 15%, class 2 - 15% and more).

Results

The average age of cows was 2.59 ± 0.09 lactation; studies were carried out on the average 3.61 ± 0.13 lactation month. Descriptive statistics of the morphological and milking traits of the tested cows are presented in Table 1.

Figure 1 shows that the distance between the front teats of the cow's udder was 2.51 times (7.56 cm) larger than the distance between the rear teats (P<0.001). The variation of the distance between the rear teats (Cv=58.50%) was 28.7% higher than the variation between the front teats.

The analysis of the length and thickness of the teats of the individual udder quarters showed that the longest and thickest teats of the cows we had studied were of the right front udder quarters (Figure 2).

The front teats of the cows were 0.7 cm longer than the rear teats (P<0.001). The length of the teats of the udder varied from 20.75% (rear right) to 25.46% (front left). The front teats of the cows were on the average 0.33 cm thicker than the rear teats (P<0.05).

Table 1
Descriptive statistics of traits

Parameters	$x \pm m_x$
Cows	340
Udder quarters	1360
Milk yield, kg	12.92±0.27
Somatic cells count, thousand/ml	348.8±36.6
Average milking time, min.	6.84±0.12
Average milking speed, kg/min.	1.77±0.03

Having performed the analysis of the milking characteristics of different udder quarters (Table 2), the milking time of the front quarters was determined to be 0.99 min shorter in comparison with the rear quarters (P<0.05). The average milking speed of the front quarters was 0.01 kg/min lower in comparison with the rear quarters.

After examining the milking time and speed of the udder quarters, substantial difference of milking time ($\overline{X}$ =26.17±0.70%) and milking speed ($\overline{X}$ =33.47±0.97%) in the udder quarters was found.

As shown in Table 3, on the average 16.78% more milk was produced from the rear udder quarters than from the front udder quarters (P<0.001). The difference between milk yield from the right side quarters and the left side quarters was determined 0.77% (P<0.001). The most milk was produced from the rear right quarter (29.79%) while the least milk was produced from the right front udder quarter (20.59%).

The evaluation of the productivity of the udder quarters showed the difference of productivity ($\overline{X}$ =14.09±0.51%) between quarters.

After the research of somatic cells in udder quarters had been carried out, it was determined that the rear quarters of the udder had 73.01 thousand/ml more somatic cells than the front quarters (P<0.001).
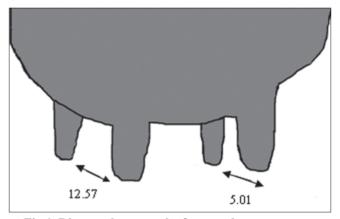

Fig 1. Distance between the front and rear teats, cm
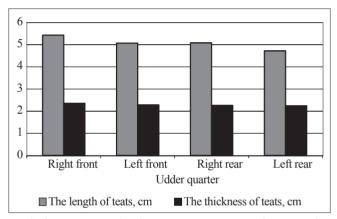

Fig 2. The analysis of the lenght and the thickness of the teats of individual udder quarters

Table 2
Parameters of milking of different udder quarters

Parameters/Quarters	Right front[a]	Left front[b]	Right rear[c]	Left rear[d]
Milking time, min	6.23±0.12*[b]	6.47±0.13*[a]	7.33±0.14*[d]	7.34±0.14*[c]
Milking speed, kg/min.	0.46±0.01	0.45±0.01	0.56±0.01*[d]	0.53±0.01*[c]

[abcd] Means with different superscript letters indicate significant differences between quarters.
*P<0.05**; P<0.01***; P<0.001

Table 3
Research of the productivity of the udder quarters and mastitis

Udder quarters	Milk yield, kg	Somatic cells count, thousand/ml	Positive milk sample according to microbiological test of mastitis from udder quarters, %
Right front[a]	2.66±0.07***[cd]	298.56±42.83*[d]	57.63
Left front[b]	2.72±0.06***[cd]	362.55± 67.19	62.71
Right rear[c]	3.85±0.07***[abd]	354.11± 62.30	59.32
Left rear[d]	3.69±0.05***[abc]	380.01±60.32*[a]	61.02

[abcd]Means with different superscript letters indicate significant differences between quarters.
*P<0.05**; P<0.01***; P<0.001

Analysis of microbiological test of milk showed that 86.4% of cows and 60.2% of udder quarters samples (35.6% of the front and 50.8% of the rear quarters; P<0.01) were positive.

Results of the research of the relationship between the productivity of cows as well as mastitis and indicators of the udder quarters are presented in Table 4.

Influence of the difference between the distance of the front and rear teats was statistically significant for the productivity of cows (P<0.05). Cows with more even udders had 12.8% higher difference of the distance between the front and rear teats. The examination showed that 5.94% less positive samples of milk according to mastitis were found in the udders of cows whose difference of the distance between the front and the rear teats was up to 5 cm than in the udders of cows whose difference of the distance between the front and the rear teats was greater than 5 cm.

The data analysis showed that 12.21% more of the positive samples of milk from udder quarters were found in cows whose index of the udder was up to 45% than in cows whose index of the udder was greater than 45% (P<0.05); 3.1% cases of mastitis were found in the milk samples of udder quarters of cows whose difference of the milk quantity in udder quarters was up to 11% than in udder quarters of cows whose difference of the milk quantity in the udder quarters was greater than 11%.

After grouping the data according to the difference of the milking time in quarters, we found 15.4% cases of mastitis in the milk of udder quarters of cows whose difference of the milking time in the quarters was up to 15% than of cows whose difference of the milking time in the quarters was greater than 15% (P<0.05).

Discussion

Udder and teat morphology is very heritable (Seykora and McDaniel, 1985) and could serve as a marker trait for selection to reduce mastitis in dairy cattle (Nakov and Trajcev, 2012; Nakov et al., 2014).

According to the studies carried out by the Turkish scientists (Tilki et al., 2005), the distance between the front teats was 1.6 times larger than the distance between the rear teats. Polish scientist Kuczaj (2003), who had investigated the characteristics of black and white cow's udders, estimated that the distance between the front teats was 2.5 times larger compared to the distance between the rear teats.

The analysis of the average measurements of the teats of the cow's udder showed that the teats of the cows we had tested were 0.58 cm longer and 0.45 cm thinner than the teats analyzed by Kuczaj et al. (2000). Tilki et al. (2005) carried out the study in which they estimated the teats which were 0.47 cm longer and 0.15 cm thinner than the teats of cows we had analyzed. Other researchers (Kuczaj et al., 2000; Weiss et al., 2004; Tilki et al., 2005) also reported that the front teats were longer than the rear teats.

Kuczaj et al. (2000) estimated that the rear teats were 0.05 cm thicker than the front teats. Weiss et al. (2004) estimated that the rear teats were 0.1 cm thicker than the front teats.

The shortest and thinnest teats were estimated on the rear left side of the udder quarters. Weiss et al. (2004) also found the longest teats on the front right side of the udder quarters, and the shortest – on the rear right side of the udder quarters.

Analysis of literature indicates that similar results of milking time and speed of the individual udder quarters were

Table 4
Investigation of udder quarters morphological and milking traits risk factors influencing subclinical mastitis in dairy cows

Indicators of the udder		Milk yield, kg	Somatic cells count, thousand/ml	Positive milk sample according to microbiological test of mastitis from udder quarters, %
Parameters	Class			
Difference of the distance between the front and the rear teats	1	13.39±0.39	342.8±58.5	54.17
	2	11.67±0.79*	531±230	60.11*
Milk yield from the front quarters of the udder	1	12.88 ±0.48	489±119	66.38
	2	13.04±0.54	276.2±53.4	54.17*
Difference of the milk yield between the quarters	1	13.43±0.41	343.4±79.4	58.33
	2	12.47±0.64	436±114	61.43
Difference of milking time between quarters	1	13.41±0.46	372.1±94,7	55.71
	2	12.78±0.51	387.1±90,7	71.11*

*P<0.05; **P<0.01; ***P<0.001

found by other researchers (Weiss et al., 2004; Karas and Gá-lik, 2005; Tancin et al., 2007a). Weiss et al. (2004) found that the milking time was 1.1 min longer and the milking speed was 0.13 kg/min higher in the rear quarters of the cow's udder than in the front quarters. Tancin et al. (2007) showed that the difference of milking time between the rear and the front quarters of the udder was 0.6 min, and the difference of the milking speed was 0.14 kg/min.

Weiss et al. (2004) estimated development indicators of the cow's udder quarters -19.68% milking time differences between the individual udder quarter and 21.62% milking speed difference between udder quarters. Tancin et al. (2007a) estimated smaller difference indicators of the udder for Holstein cows than for cows we had examined - 12.65% milking time difference between the individual udder quarter and 15.60% milking speed difference between udder quarters.

The study of milk yield of the front and the rear udder quarters performed in various countries confirmed trends we had estimated (Wellnitz et al., 1999; Ipema and Hogewerf, 2002; Weiss et al., 2004; Forsbäck et al., 2009). Minimum difference of milk yield between the front and the rear quarters of the udder was estimated in the study of Tancin et al. (2007b). 47% of the total milk yield was milked from the front quarters and 53 % was milked from the rear quarters. Bach and Busto (2005), Berglund et al. (2007) found 20% higher milk yield from the rear quarters than from the front quarters.

As reported in literature, milk yield from udder quarters is different. It depends from what part of the quarters (front or rear) milk is produced (Tancin et al., 2006) as well as the state of health (Berglund et al., 2007).

The evaluation of the productivity showed the difference of udder quarters. Similar results were estimated by Weiss et al. (2004) that is 15.55%, while Tancin et al. (2007a) determined the difference of milk yield between udder quarters to be only 6.20%.

Tancin et al. (2007c) found more somatic cells in milk of the rear quarters of the udder as well, and Berglund et al. (2007) performed analogous studies and found more somatic cells in milk of the front udder quarters.

According to Kocak (2006) the higher prevalence rate of mastitis in the rear udder quarters may be due to their lowest position in relation to front one, which make them more prevalent to injures or damage and also the greater milk yield produced by the rear quarters, because prevalence of mastitis tends to increase with increases in milk production which is also risk factor for mastitis in dairy cows.

Therefore, our work confirms that, increasing the productivity of cows and improving their health, it is more effective to control the milk yield and milking characteristics of each quarter individually than from all the udder in general (Ipema

and Hogewerf, 2002; Kohler and Kaufmann, 2003; Macuhova et al., 2003; Karas and Gálik, 2005; Tancin et al., 2006).

Knowledge of the udder quarters morphological and milking traits risk factors influencing productivity and mastitis in dairy cows might provide better understanding of the disease process and may help to identify or resolve problems related to selection, milking management or environment.

Conclusions

We found that the distance between the front teats of the cow's udder influenced the productivity and sub clinical mastitis rate of cows (5.94% less positive samples from udder quarter and 12.8% higher milk yield in cows with the difference between the front teats of up to 5 cm was found, P<0.05).

After the evaluation of the productivity of udder quarters, it was found that the yield of the front quarters (41.80 ± 0.46%) and the difference of productivity between udder quarters (14.09±0.51%.) were related with subclinical mastitis (12.21% more positive milk samples from udder quarters when milk yield of cow's front quarters is up to 45 %; P<0.05 and 3.1% less positive samples of quarters when the difference of the milk yield between quarters is up to 11%).

After examining milking time and speed of udder quarters, the substantial difference of milking time (26.17±0.70%) and milking speed (33.47±0.97%) in udder quarters was estimated. We have found 15.4% less cases of mastitis in milk of udder quarters in cows whose difference of the milking time in the quarters was up to 15% (P<0.05).

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