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Relationship between Shape of Teat and Teat Tip and Somatic Cell Count (SCC) in Dairy Cows

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ABSTRACT

***Background*:** Mastitis is characterized by inflammation of the mammary gland, usually caused by pathogens, these infections may be classified as either clinical or subclinical, which are responsible for physical, chemical and bacteriological changes in milk and/or changes in the glandular tissue. The shape of both teat and teat tip are among the factors that may predispose to the development of clinical and subclinical mastitis, it is therefore important that they have a desirable morphology so that they are less susceptible to pathogens. The aim of this study was to investigate the relationship between teat shape and Somatic Cell Count (SCC) in dairy cattle.

***Materials, Methods & Results*:** The research was carried out in two dairy farms located in the municipality of Arapongas, Parana state, Brazil. Data were obtained from 150 Holstein cows variety black and white, where 597 teat shape and teat tip were evaluated during entry into the milking parlor. The teat shape was classified as desirable; bottle-shaped; cone-shaped; short; funnel-shaped; plump; and pencil-shaped, while the teat tip was classified as round; flat; funnel shape (inverted); disk, and pointed (hyperkeratosis). The somatic cell count (SCC) was carried out by flow cytometry by the equipment Somacount 500®[1]. The variable SCC was evaluated taking into account the shape of the teat, then two groups were formed: G1 - Four teats of desirable shape, and G2 - animals with two teats of desirable shape and two short teats. To analyze the SCC on shape of teat tips, the animals were divided into three groups: G3 - Four flat teats, G4 - Four rounded teats, and G5 - two rounded teats and two flat teats. Descriptive statistics on frequency of shape of teats and teat tips was applied. The variable SCC was analyzed by ANOVA followed by multiple comparison of means by Tukey test after meeting the assumptions of normality and random errors distribution, being considered statistically significant when *P* value is less than 5% ($P < 0.05$). Groups with combinations of teat and tips in small number of animals were excluded from the study. The following percentage was found: desirable shape (74.21%), short (11.39%), bottle-shaped (5.86%), funnel-shaped (4.69%), cone-shaped (2.68%), pencil-shaped (0.67%) and plump shape (0.50%). The teat tip conformation was classified as round (59.30%), flat (33%), pointed (7.37%), disk (0.34%) and crater (0%). No statistical significance ($P > 0.05$) was observed between teat shape/teat tip shape and SCC, where the group G1 showed 287.4 x 10^3 cells/mL and G2 421.5 x 10^3 cells/mL, while the teat tip shape groups G3, G4 and G5 showed respectively 458.5 x 10^3, 427.2 x 103 and 344.5 x 10^3 cells/mL. Animals from group G1 showed 31.8% less SCC than G2, and 37.3%, 32.7%, 16.6% less SCC than G3, G4 and G5, respectively.

***Discussion*:** In the present study was observed 74.20% (443/597) teats with desirable morphology and 25.8% (154/597) with undesirable morphology, although the last one has the teats conformation as risk factor for clinical or subclinical mastitis, according to several reports, when was carried out the evaluation of SCC did not showed differences between the groups that had desirable and undesirable formats, showing SCC count below 600 x103 cells/mL. Probably, this predisposition was impaired by the effective health care management adopted in the two dairy farms. This indicates that sanitary measures may overcome the effects of pathogens on morphology changes of the teats.

Keywords: mastitis, teat conformation, teat tip conformation, mammary gland.

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INTRODUCTION

Teats and teat tips conformation in female cattle can be classified according to their shape, ranging from undesirable to desirable shapes [7]. Cows with teats and teat tips with undesirable conformation are more susceptible to injury and infection by pathogens, increasing the risk of mastitis [2,14,30,35].

Bovine mastitis is one of the main diseases responsible for economic losses in dairy herds [9,12,37], which can be predicted by determining somatic cell count (SCC), which are body defense cells, being considered an indirect method to indicate mammary infection [3,10,22,31].

The morphological characteristics of teats have moderate to high heritability, and is used in breeding programs to improve milk production and quality, also resulting in lower SCC levels [5,18,19].

However, the unfavorable conformation of teats and teat tips leading to mastitis in cows can be perceived by farmers when machine milking begins, so this relationship is usually observed after the first parturition. In Brazil, literature on the subject is scarce.

Several studies have shown udder and teats conformation as risk factor for clinical mastitis [2,30,35]. Similar results are found in literature on the genetic correlation between udder depth, udder attachment, milk production, and the association of these factors with mastitis incidence [15,23,36].

Considering the importance of conformation of the mammary gland in the occurrence of bovine mastitis, the present study aimed to evaluate the anatomical shapes of the teats and teat tips, and their correlation with somatic cell counts.

MATERIALS AND METHODS

Animals and study location

The study was conducted with 597 teats from 150 Holstein cows, variety Black and White (BPH) in two dairy farms (dairy farm 1 and dairy farm 2), located in Arapongas count (23° 25' 8"S 51° 25' 26") in north-central mesoregion of Parana state, of which three teats were considered lost. Animals were evaluated during entry and stay into the milking parlor, and had access to pasture, shade, and water. After each milking, animals were fed corn silage, oat hay, and concentrate feed with 22% crude protein at the feeder.

Evaluation of teats and teat tips morphology

To evaluate the teats, their location in the mammary glands was considered, denominating as anterior right and left teats, and posterior right and left teats. The same was done with the teat tips. The shape of the teat was classified as desirable; bottle-shaped; cone-shaped; short; funnel-shaped; plump; and pencil-shaped, while the teat tip was classified as round; flat; funnel shape (inverted); disk, and pointed (hyperkeratosis) [7].

Sampling and Somatic Cell Count (SCC)

Official milk recording was performed monthly by the Paraná Holstein Breeders Association, and CCS was determined by flow cytometry in equipment Somacount 500®1. Milk sampling was performed in accordance with the milking management on the dairy farms, which was made twice a day in one farm, and three times a day in the other. Both dairy farms used herringbone milking parlour, and pre-milking and post-milking teat dipping were used.

Experimental design and statistical analysis

Descriptive statistics on frequency of shape of teats and teat tips was applied. The variable SCC was analyzed by ANOVA followed by multiple comparison of means by Tukey test after meeting the assumptions of normality and random errors distribution by Minitab software (Minitab 16.0)2, being considered statistically significant when P value is less than 5% ($P < 0.05$). Groups with combinations of teat and tips in small number of animals were excluded from the study. Thus, two groups were formed for the analysis of teat shape: G1 - Four teats of desirable shape, and G2 - animals with two teats of desirable shape and two short teats. To analyze the shape of teat tips, the animals were divided into three groups: G3 - Four flat teats, G4 - Four rounded teats, and G5 - two rounded teats and two flat teats.

RESULTS

Teat shape

Of 597 teats, 443 teats (74.21%) had desirable shape, 68 (11.39%) were short teats, 35 (5.86%) were bottle-shaped teats, 28 (4.69%) were funnel-shaped teats, 16 (2.68%) were cone-shaped teats, 4 (0.67%) were pencil-shaped teats, and 3 (0.50%) were plump teats (Table 1).

Teat tip shape

From 597 teats, 354 (59.30%) were rounded teats, 197 (33.00%) were flat teats, 44 (7.37%) were peaked teats (hyperkeratosis), 2 (0.34%) were disk, and zero (0.00%) was funnel shape (inverted teats) (Table 2).

Effect of teat and teat tip shape on SCC

No significant ($P > 0.05$) differences were observed between somatic cell count and teat tip shape for the group G1 ($287.4 \times 10^3 \pm 371.4 \times 10^3$ cells/mL) and G2 (421.5 x 103 ± 743.9 x 103 cells/mL) as shown in Figure 1A. Animals from Group G1 showed 31.8% less SCC than G2.

In addition, no statistical significance ($P > 0.05$) was observed between somatic cell counts and teat tip shape for the groups G3 (458.5 x 103± 475.6 x 10^3 cells/mL), G4 (427.2 x 103 ± 694.0 x 10^3 cells/mL) and G5 (344.5 x 103 ± 490.8 x 10^3 cells/mL) (Figure 1B).

Table 1. Classification of 597 teats from two dairy farms in northern Paraná according to anatomical shape.

Type of teats shape	Dairy farm 1		Dairy farm 2		TOTAL	RF
	AF	RF	AF	RF		
Desirable	277	73.28%	166	75.80%	443	74.20%
Short	53	14.02%	15	6.85%	68	11.39%
Funnel	19	5.03%	9	4.11%	28	4.69%
Bottle	14	3.70%	21	9.59%	35	5.86%
Cone	8	2.12%	8	3.65%	16	2.68%
Pencil	4	1.06%	0	0.00%	4	0.67%
Plump	3	0.79%	0	0.00%	3	0.50%
TOTAL	378	100.00%	219	100.00%	597	100.00%

AF: Absolute Frequency; RF: Relative Frequency.

Table 2. Variations of the teat tip shape of 597 teats from two dairy farms in northern Paraná according to anatomical shape.

Type of teats tip	Dairy farm 1		Dairy farm 2		TOTAL	RF
	AF	RF	AF	RF		
Rounded	199	52.65%	155	70.78%	354	59.30%
Flat	162	42.86%	35	15.98%	197	33.00%
Crater	0	0.00%	0	0.00%	0	0.00%
Disk	0	0.00%	2	0.91%	2	0.34%
Pointed	17	4.50%	27	12.33%	44	7.37%
TOTAL	378	100.00%	219	100.00%	597	100.00%

AF: Absolute Frequency; RF: Relative Frequency.

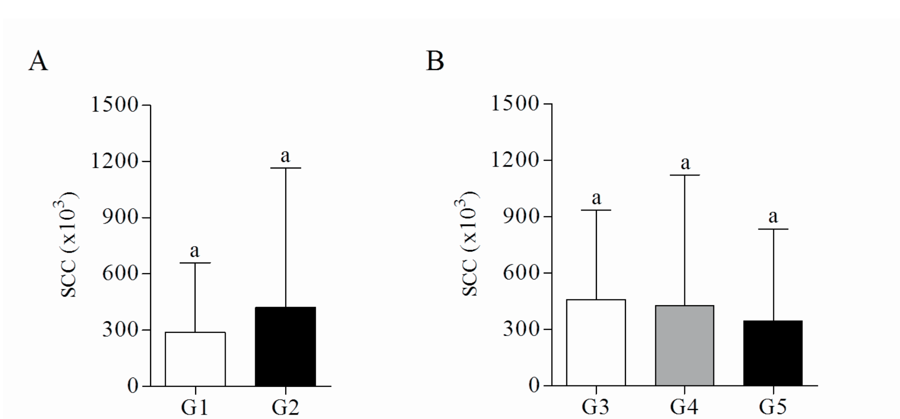

Figure 1. Somatic cell count (SCC), mean and standard deviation corresponding to groups (A) G1 (n=54; four teats of desirable shape), G2(n=21; animals with two teats with desirable shape and two short teats), and groups (B) G3 (n=35; four flat teats), G4 (n=31; four rounded teats) and G5 (n=15; two rounded teats and two flat teats). Same letters indicate no significant difference ($P > 0.05$) between groups by ANOVA.

DISCUSSION

The teat canal is the main defense barrier against mastitis because it prevents entry of microorganisms into the udder between milkings. The main mode of transmission for mastitis occurs by bacterial penetration through the teat [1], thus changes in teat shape are associated with the incidence of mammary inflammation.

Teats of desirable shape have a lower incidence of clinical and subclinical mastitis, when compared to plump and bottle-shaped teats [11,29]. These data are consistent with the present study, in which animals with teats of desirable shape (G1) had low SCC (287.4 x 103 cells/mL).

The teat shape of the animals of the present study exhibited the following percentages: 74.21% (443/597) teats of desirable shape, 11.39% (68/597) short teats, 5.86% (35/597) bottle-shaped teats, 4.69 % (28/597) funnel-shaped teats, and 3.85% (23/597) having other shapes. Different results was observed in Carora dairy cattle and in Dutch cattle, showing percentages ranging from 24.73% to 48.33% of teats of desirable shape, 32.26% and 74.31% of plump teats, and 1.94% and 16.22% of bottle-shaped teats [29].

In the present study, plump teats accounted for 0.5% (3/597) of all teats, which contributes to the low SCC observed. Plump teats have a higher incidence of mastitis due to their anatomy that prevents the flow of milk during suckling and may cause injury to the teat [28], furthermore, this type of teat hampers milking due to its greater thickness, short size and solid consistency [7].

In a study that evaluated funnel-shaped teats was observed lower incidence of mastitis than cylindrical-shaped teats [11], these results are consistent with those found in Holstein Frisian cows, in which was observed lower SCC for funnel-shaped teats (280 x 10^3 cells/mL) and higher SCC values for cylindrical-shaped teats (441 x 10^3 cells/mL) [25]. It is likely that funnel-shaped teats have lower SCC due to occurrence of complete milking as compared with cylindrical or bottle-shaped teats, which have residual milk due to incomplete milk ejection [27]. In the present study, if funnel/cone-shaped teats and bottle/pencil-shaped teats are grouped, the percent occurrence will be 7.37% and 6.53%, respectively, tending to lower SCC values

Short teats 11.39% (68/597) associated with lower SCC in milk were also observed in the present study. There is no consensus on this subject in literature, since there are reports that cows with short teats have higher SCC [4] and the same occurs when there was an increase in length of teats [33], whereas no relationship between SCC and the length of teats or the increase in the length of teats as shown by some studies [16,21].

Studies have shown that the prevalence of teat tips with callosities (pointed teats) ranges from 12.3% to 45% [5,8,34]. Most of the cows that have this type of teat tip may be associated with clinical mastitis [21]. In the present study only 7.37% had this type teat tip. Teat hyperkeratosis is present more often in cylindrical-shaped teats than in funnel-shaped teats [26] and may occur due to milking practices, in which continuous suction by teat cup liners is observed after milk letdown [28,32].

Teat tip is an important factor in the resistance of the pathogenesis of bovine mastitis [17]. When injured, it favors colonization of the mammary gland by pathogenic microorganisms, often associated with the presence of *Staphylococcus* spp. and *Streptococcus dysgalactiae* [13,24].

The low SCC values observed in the dairy farms of the present study may be due to the adoption of control measures, such as dry cow therapy, which is the realization of intramammary infusion of antibiotics in dairy cows at the time of drying off [38]. It is an essential component of a mastitis control program, together with milker training strategies, and strict hygiene control measures on the farms.

In contrast, other points must be taken into account in the control of mastitis as pre- and post-milking teat antisepsis, disposal of animals with chronic mastitis, adequate and prompt treatment of cases of inflammation of mammary gland and udder, dry cow therapy, proper maintenance of milking system [6]. In addition, the selection of dairy cows may consider udder and teat conformation [20].

CONCLUSION

No correlation was observed between teat and teat tip shape and somatic cell count. The teats investigated in the present paper were healthy and only 2% of the animals have lost a teat. SCC scores in milk from both dairy farms are considered low, evidencing that preventive measures are effective to reduce incidence of mastitis.

MANUFACTURERS
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