Association of milk flow curve and prevalence of mastitis pathogens in dairy cows

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ABSTRACT

The objective of this work was to evaluate the association of bimodality of milk flow curves with microbiological status of mammary glands and parity of cows. We selected 167 primiparous and 148 multiparous Lithuanian Black and White dairy cows in 2nd to 4th month of lactation. The bimodality of milk flow was determined in 22.2% primiparous and in 38.6% multiparous cows (P<0.001). The most prevalent pathogens of mastitis were Staphylococcus aureus (15.3%), other staphylococci (22.2%) and streptococci (5.8%). Prevalence of mastitis pathogens in multiparous cows was 1.4 times and the bimodality of milk flow curves –1.7 times higher in comparison with primiparous cows (P<0.001). The bimodality of milk flow curve was mostly associated with the prevalence of Streptococcus agalactiae and Staphylococcus aureus (P<0.001). The increased frequency of mastitis pathogens (21.5%) in cows with the bimodal milk flow curves supports the negative effect of bimodality on udder health of cows (P<0.001).

Key words: Bimodality, Cow, Milk flow curve, Mastitis, Pathogens.

INTRODUCTION

Mastitis, as one of the most costly disease in the dairy industry, is the result of the interactions between a combination of microbiological factors, host responses in the udder and management practices (Biswa deep et al., 2015; Tufani et al., 2012). Bovine mastitis is characterized by inflammation of the mammary gland and depends on the causative agent and the host response (Barkema et al., 2006; Petzl et al., 2008; Singh and Garg, 2011). Earlier, Harmon (1994) opined that the magnitude of the inflammatory response may be influenced by the causative pathogen, stage of lactation, age, immune status of the cow, genetics and nutritional status. Jingar et al. (2014) estimated that older cows were at higher risk for the incidence of mastitis.

The primary focus of most subclinical mastitis control programs is to reduce the prevalence of contagious pathogens such as Streptococcus agalactiae, Staphylococcus aureus and other gram-positive cocci, most notably Streptococcus dysgalactiae (which may be contagious or be environmentally acquired) (Bhatt et al., 2012). Staph. aureus is a common pathogen associated with the serious form of disease and has for long been considered as a major problem from the view point of public health importance (Çiftçi et al., 2009; Gundogan et al., 2012; Gundogan et al., 2013).

Measures for the prompt and reliable mastitis diagnosis as well as monitoring of milk parameters are very important both for the animal health and for productivity (Tancin et al., 2007). Bimodal milk flow curves imply a non-continuous milk flow at the beginning of milking (Ambord et al., 2009) and can affect udder health and teat condition (Rasmussen, 2004; Mijic et al., 2005). In addition, it can have negative effects on further milking process as temporary overmilking (Tancin and Bruckmaier, 2001; Dzidic et al., 2004), a higher somatic cell score (Samoré et al., 2011) and health status of udder during the whole lactation (Tamburini et al., 2010). However, the effect of milk flow curve on the prevalence of mastitis pathogens has not been studied so far.

The objectives of this study were to evaluate the microbiological status of mammary glands, bimodality of milk flow curves and to establish the association between the primiparous and multiparous Lithuanian Black and White dairy cows.

MATERIALS AND METHODS

Experimental design: The research was carried out at the farm of the Lithuanian Black and White Cattle Improvement Association, State Laboratory for Milk Control, State Enterprise Agriculture Information and Rural Business Development Center, and the Animal Breeding Value Research and Selection Laboratory of the Lithuanian University of Health Sciences. We selected 167 primiparous and 148 multiparous Lithuanian Black and White dairy cows without clinical signs of lameness, metritis and clinical mastitis from a herd of 600 cows in 2nd to 4th month of
lactation. The experimental cows were maintained in a
uniform environment and received a uniform ration of feed.
The average milk SCC of cows was 357.6±51.24 thousand /
ml, milk yield - 28.9±0.38 kg. The cows were investigated for
an association between udder microbiota and bimodality in
milk flow.

Evaluation of milk flow curve and udder microbiota: The
study was conducted in two stages. In the first stage, milk
flow measurements of cows were carried out using the
continuous electronic mobile milk meter (LactoCorder®,
WMB, Balgach, Switzerland) and processed using the
software package LactoPro 5.2.0 (Biomektechnik Swiss).
The bimodality of milk flow was defined as delayed milk
erection at the start of milking. It is known that bimodality
of milk flow is usually detected when a curve has a flow
pattern with two increasements separated by a clear drop in
milk flow for more than 200 g/minute within 1 minute after
the start of milking (Dzidic et al., 2004). The cows were
divided into two groups according to the bimodality in
milk flow (presence and absence of bimodality).

In the second stage the cows were tested for udder
microbiota. The microbiological testing of milk samples from
cows for mastitis diagnosis was performed at the State
Laboratory for Milk Control, as per the standard procedures
(Harmon et al., 1990). The SCC in milk was determined by
flow cytometry using the Somascope CA-3A4 (Delta
Instruments, the Netherlands).

Statistical analysis: All records included the measurements
for bimodality of milk flow curves, SCC, milk yield and
microbiological testing of milk samples. Descriptive statistics
(mean±standard error) and Pearson’s chi-squared test (χ²)
were calculated using the program package SPSS 20.0 (SPSS
Inc., Chicago, IL, USA). Normal distribution of variables
was assessed by Kolmogorov–Smirnov test. Student’s t-test
was used in order to detect significant differences between
compared groups. The results were considered reliable under
P<0.05.

RESULTS AND DISCUSSION

Bimodality in milk flow and microbiological status of
mammary glands of cows: In the present study, the
bimodality of milk flow was determined in 22.2%
primiparous and 38.6% multiparous cows (P<0.001). Similar
results of the bimodality (27.4 - 35.1%) were reported by
Sandrucci et al. (2007) and Strapak and Antalik (2011).
However, Strapak et al. (2011) observed higher frequency
(57.1%) of bimodality in the second lactation of cows.

Mastitis is an important production disease which
causes huge economic losses to dairy industry (Sharma,
2012; Saravanan et al., 2015). Earlier, Sharma (2007) stated
that the incidence of subclinical mastitis ranges from 20%
to 83% in cows. The isolation and identification of mastitis
pathogens are important tools for the management of the
disease. Str. agalactiae and Staph. aureus pose a serious
problem in dairy herds and are the most problematic
contagious pathogens in dairy cattle (Brezoyn et al., 2010;
Bhatt et al., 2012; Cervinkova et al., 2013).

We estimated that the most prevalent pathogens of
mastitis were Staph. aureus (15.3%), other staphylococci
(22.2%) and streptococci (5.8%). Further, in 24.8% cases
mixed microbiota (more than two genera of bacteria) were
recovered. In other cases, different gram-positive and gram-
negative bacteria were found as potential mastitis pathogens.

Hammer et al. (2012) and Sitkowska et al. (2018)
observed that higher parity lactations increased the risk of
mastitis in cows which concurs with the findings of our study
(Figure 1). The prevalence of mastitis pathogens in
multiparous cows was 1.4 times higher in comparison with
primiparous cows (P<0.001). These findings are in
accordance with Sharma et al. (2012) and Jingar et al. (2014)
who reported that increase in parity results in increased
incidence of mastitis. As shown in Fig 1, the frequency of
Staph. aureus and Str. agalactiae in multiparous cows was
5-6 times higher (P<0.001) when compared to primiparous
cows.

Relationship between prevalence of mastitis pathogens
and bimodality in milk flow curve: The prevalence of
pathogens isolated from mammary glands of cows with
bimodal milk flow was 21.5% greater (P<0.001) when
compared with the prevalence of pathogens isolated from
mammary glands of cows with the absence of bimodality in
milk flow.

In primiparous cows with bimodal milk flow curve,
Str. agalactiae increased by 13% and Staph. aureus – by
21%, comparing with the cows with a normal milk flow
(P<0.001).

In the milk of the multiparous cows with normal
milk flow, mixed microbiota and staphylococci other than
Staph. aureus predominated (Figure 3). The increase of
bimodality was mostly related with the increase in the
prevalence of Str. agalactiae (by 20%) and Staph. aureus
(by 14%). (P<0.001).

Samore et al. (2011) demonstrated that bimodality
was negatively associated with milk production which
concurs with our findings. The data of the bimodality
influence on the productivity of the cows are presented in
Table 1 which reveals that the amount of milk was 9.6%
lower in cows with bimodal milk flow curve (P<0.001).

We estimated that productivity of all multiparous
cows was 3.4-8.5% lower when compared with that of
primiparous cows and the milk quality, based on SCC, in
the multiparous cows was worse (Table 2). In our study, 83%
multiparous and 75% primiparous cows had SCC >200 000/
ml which could be related to a higher (1.7 times) bimodality
in the milk flow of multiparous cows.
Table 1: Influence of bimodality of the milk flow on the productivity of cows

<table>
<thead>
<tr>
<th>Bimodality of milk flow</th>
<th>n</th>
<th>Milk, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primiparous cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence</td>
<td>130</td>
<td>30.2±0.64</td>
</tr>
<tr>
<td>Presence</td>
<td>37</td>
<td>28.2*±0.70</td>
</tr>
<tr>
<td>Multiparous cows</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absence</td>
<td>91</td>
<td>29.2±0.82</td>
</tr>
<tr>
<td>Presence</td>
<td>57</td>
<td>26.0*±0.96</td>
</tr>
</tbody>
</table>

Explanations: * – means differ statistically significant at \( P \leq 0.05 \).

Sharma et al. (2011) stated that SCC is a useful predictor of subclinical udder infection and therefore, it is considered as an important marker for assessing the quality and milk hygiene for mastitis control protocols.

Investigation on the relationship between bimodality of milk flow and the milk SCC \( (P=0.001-0.009) \) suggested that the milk flow curve is a likely predictor of udder health with respect to animal’s susceptibility to mastitis. Our investigation has proved that the bimodality had a correlation with SCC and the presence of pathogenic microorganisms in the udder. In our study, the frequency of pathogens isolated from mammary glands of cows with bimodal milk flow was 21.5% higher when compared with the frequency of pathogens in cows with absence of bimodality of milk flow curve. In cows with bimodal milk flow curve, the number of milk samples which contained \( \text{Str. agalactiae} \) increased by 13-20% and \( \text{Staph. aureus} \) – by 14-21%, when compared with the normal milk flow \( (P<0.001) \).

CONCLUSION

Based on the findings of the study it is concluded that prevalence of mastitis pathogens in multiparous cows was 1.4 times and the bimodality of milk flow curves – 1.7 times higher in comparison with primiparous cows \( (P<0.001) \). Our results indicated that bimodality in milk flow of cows was significantly related with prevalence of mastitis \( (P<0.001) \) and was mostly associated with the prevalence of \( \text{Str. agalactiae} \) and \( \text{Staph. aureus} \) \( (P<0.001) \).

Table 2: Influence of bimodality of the milk flow on the milk SCC of cows

<table>
<thead>
<tr>
<th>Milk SCC level</th>
<th>Primiparous cows</th>
<th>Multiparous cows</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Distribution of cows (%) by milk flow bimodality</strong></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Absence</th>
<th>Presence</th>
<th>Absence</th>
<th>Presence</th>
</tr>
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<tbody>
<tr>
<td>&gt;100 000/ml</td>
<td>66.9</td>
<td>32.4</td>
<td>41.8</td>
<td>19.3</td>
</tr>
<tr>
<td>100 000 - 200 000/ml</td>
<td>19.2</td>
<td>40.5</td>
<td>39.6</td>
<td>45.6</td>
</tr>
<tr>
<td>200 000/ml ≥</td>
<td>13.8</td>
<td>27.0</td>
<td>18.7</td>
<td>35.1</td>
</tr>
</tbody>
</table>

\( \chi^2 = 14.225; \text{DF} = 2, P = 0.001 \)  
\( \chi^2 = 9.420; \text{DF} = 2, P = 0.009 \)
REFERENCES


