Evolution and factors influencing somatic cell count in raw milk from farms in Viçosa, state of Minas Gerais

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ABSTRACT. The somatic cell count (SCC) of refrigerated raw milk reflects the occurrence of mastitis in the herd and the management of rural property. Therefore, this study aimed to evaluate the SCC of the refrigerated raw milk and its determinant factors in dairy properties of Viçosa, State of Minas Gerais. Monthly, milk samples were taken from 44 cooling tanks during 2012. A structured questionnaire was applied to evaluate the production and management characteristics of the herds. There was a significant variation (p < 0.05) in the mean SCC of the milk, which was lower from June to August. Higher mean SCC and percentages of samples above the limit set by the legislation were observed in months of higher rainfall and ambient temperature (p < 0.05). Mechanical milking, lower milk yield, productivity, inadequate milking procedures, equipment hygiene, and water quality were all factors that influenced (p < 0.05) the SCC of raw refrigerated milk. Milker training is required for production of low SCC milk.

Keywords: environment, SCC, mastitis, milking, seasonality.

Evolução e fatores que influenciam a contagem de células somáticas em leite cru de fazendas em Viçosa, Minas Gerais

RESUMO. A contagem de células somáticas (CCS) do leite cru refrigerado reflete a ocorrência de mastite no rebanho e manejo da propriedade rural. Portanto, este trabalho objetivou avaliar a CCS do leite cru refrigerado e seus fatores determinantes em propriedades leiteiras de Viçosa, estado de Minas Gerais. Mensalmente, foram coletadas amostras de leite de 44 tanques de refrigeração durante o ano de 2012. Um questionário estruturado foi aplicado para avaliar as características de produção e manejo dos rebanhos. Houve variações significativas (p < 0,05) na CCS média do leite, sendo menores nos meses de junho a agosto. Maiores CCS médias e porcentagens de amostras acima do limete estabelecido pela legislação foram observadas em meses de maiores precipitações de chuva e temperatura ambiente (p < 0,05). A ordenha mecânica, menor produção de leite, produtividade, procedimentos inadequados de ordenha, higiene dos equipamentos e qualidade da água são fatores que influenciaram (p < 0,05) a CCS do leite cru refrigerado. A capacitação dos ordenhadores é necessária para produção de leite com baixa CCS.

Palavras-chave: ambiente, CCS, mastite, ordenha, sazonalidade.

Introduction

The production of quality milk results from several factors related to the management in the rural property, which determines the health of the mammary gland of the cows. Bovine mastitis, inflammation of the mammary gland due mainly to pathogenic microorganisms, causes a series of alterations in the composition, volume and physical-chemical characteristics of the milk (Bueno et al., 2005; Wickström, Persson-Waller, Lindmark-Månsson, Östensson, & Sternesjö, 2009; Vargas et al. 2014).

Losses in milk production during the infectious process can reach up to 26% of the total production, according to the degree of intensity of the inflammatory process and the stage of lactation at which the infection occurs. Mastitis causes economic damage and risks to human health due to the transmission of infectious agents (Martins et al., 2007).

One of the consequences of mastitis is the increase of somatic cells in milk. These are the epithelial cells of desquamation of the mammary gland and defense cells of the organism, such as neutrophils, macrophages and lymphocytes. These cells impair the processing of dairy products, altering taste and industrial yield (Paiva, Cerqueira, Souza, & Lana, 2012).

The somatic cell count (SCC) is indicative of the occurrence of intramammary inflammation in the
animal, if it reaches values above 200,000 cells mL\(^{-1}\) milk (Beaudeau, Fourichon, Seegers, & Bareille, 2002; Dias, 2007). In milk of the cooling tank, the SCC may reflect the inadequate management in the dairy properties, such as the lack of hygiene during milking and in the environment of the animals. Other factors related to the occurrence of mastitis and consequent increase in SCC in dairy herds are: rearing system, diet balance, stress sources, stage and order of lactation (Guimarães & Langoni, 2005).

Due to the seasonality of the Brazilian territory, the seasons of the year are well defined in the period of drought and rain, which influences the occurrence of mastitis (Bueno et al., 2005; Martins et al., 2006; Noro, González, Campos, & Dürre, 2006; Roma, Montoya, Martins, Cassoli, & Machado, 2009). The incidence of the disease is higher in times of higher rainfall and temperature, due to the accumulation of organic matter in the environment and favoring the proliferation of infectious microorganisms. This results in higher SCC in the milk of expansion tanks (Bueno et al., 2005; Martins et al., 2006, Noro, González, Campos, & Dürre, 2010; Coentrão, Souza, Brito, Brito, & Lilenbaum, 2008; Zafalon, Langoni, Benvenutto, Castelani, & Broccolo, 2008; McDougall, Parker, Heuer, & Compton, 2009).

The small seasonal variation provides better planning for the processing of dairy products by the industry at certain times of the year (Takahashi, Cassoli, Zampar, & Machado, 2012). Moreover, SCC is a well-considered criterion for the payment of milk, as it affects yield and quality of products (Coelho et al., 2014). Therefore, the objective of this study was to evaluate the evolution of the CCS of the refrigerated raw milk and the factors related to the production and management characteristics of dairy herds in Viçosa, State of Minas Gerais.

**Material and methods**

Samples of refrigerated raw milk from 44 refrigeration tanks in rural properties of Viçosa, State of Minas Gerais, were collected monthly during the year 2012. The collection was performed with a ladle disinfected with 70% alcohol after stirring the milk for five minutes. Samples were packaged in Pleon bottles containing Bronopol® preservative, to be sent under refrigeration to the Laboratory of Quality of Milk of Embrapa (Brazilian Company of Agricultural Research).

CCS was determined by flow cytometry using the Bentley Combi System 2300® (Bentley Instruments Incorporated, Chaska, USA) according to the methodology established by the International Dairy Federation (IDF). The results were expressed in cells mL\(^{-1}\).

A questionnaire was applied to the employees and owners of the herds in January (summer) and July (winter) of 2012. It was considered the main aspects of management and characteristics of dairy properties reported in the literature that may interfere with the occurrence of mastitis and, consequently, in the SCC of the produced milk (Prestes, Filippi, & Cecim, 2002; Guimarães & Langoni, 2005; Souza, Brito, Moreira, Brito, & Bastos, 2005; Svensson, Nyman, Waller, & Emanuelson, 2006; Oliveira, Galvão, Paixão, & Munhoz, 2010; Coentrão, Souza, Brito, Brito, & Lilenbaum, 2008; Zafalon, Langoni, Benvenutto, Castelani, & Broccolo, 2008; McDougall, Parker, Heuer, & Compton, 2009).

The production characteristics evaluated were: the type of milking (manual or mechanical), milking with calf at foot (yes or no), lactating animals (below and above 20 animals), milk production (below or above 100 L day\(^{-1}\)), milk yield (below or above 5 L day\(^{-1}\)) and lactation phase (beginning and end).

The management aspects analyzed were: adequate facilities (yes or no), adequate milking procedures (yes or no), milker hygiene (yes or no), equipment hygiene (yes or no), adequate feeding of cows (yes or no), sanitary of the herd (yes or no), clinical mastitis treatment (yes or no), treatment of dry cow (yes or no), hygiene of cows' environment (yes or no), hygiene of calves' environment (yes or no), hygiene of heifers' environment (yes or no) and water quality (yes or no).

Samples of water were taken in sterile plastic bags in the milking parlor, flambing the faucets with 98% alcohol. The analyses were performed for pH, color, turbidity, hardness, chlorides, total and thermo tolerant coliforms, following methodology established by MAPA. In order to consider adequate the water samples, the results were compared with the parameters established by the Ministry of Health.

To check the influence of seasonality on milk SCC, average data of rainfall (mm) and monthly temperatures (°C) throughout 2012 in Viçosa were obtained from the National Institute of Meteorology (INMET). The results were subjected to linear regression at the 5% level of significance.

SCC data were subjected to logarithmic transformation and subjected to the Kruskal Wallis non-parametric test, at the 5% level of significance, for comparison of means over the months.

To verify the risk factors, SCC was categorized into properties with more and less than 600,000 cells mL\(^{-1}\), a parameter established by MAPA at the time of sample collection. The results were subjected to statistical analysis of frequency, using the Fisher's
test at the level of significance of 5%, obtaining the
Odds Ratio. All statistical analyses were run using
Stata 12.0 software (StataCorp LP, Texas, USA).

Results and discussion

Most of the animals in the evaluated properties
consisted of crossbred animals (Holstein x Gyr),
kept year-round on pasture and supplemented with
forage during drought periods. Herds had on
average 15 lactating animals characterized as little
specialized, producing on average 80 liters per day
and predominantly milked manually. Pastures were
formed by tropical forages and many pens were
unpaved, with no area reserved exclusively for
milking.

During collection of milk samples from the
tanks, lower rainfall volumes tended to occur in
the middle of the year, mainly from June to
August (Figure 1). Higher volumes tended to
occur at the beginning and end of the year,
however, little rainfall was observed in February
and April. The average temperatures presented
the same behavior, with lower temperatures in the
middle of the year.

According to Lima et al. (2004), pronounced
variations in temperature and rainfall in Brazil occur
in winter and summer periods, culminating in
seasonal variations in forage growth rates. From May
to October, it is observed a drier climate with
pastures of lower nutritional quality, which results
in lower content of milk solids. Rainfall usually
occurs from November to April, when the grasses
present superior nutritional quality and higher solid
contents.

There was a significant variation (p < 0.05) in
the mean SCC of the refrigerated raw milk, which
was lower from June to August (Figure 2), that is, in
months of lower temperatures and rainfall. The
coefficients of variation indicate that the data varied
differently in each month, being higher in
September and lower in August.

Mean values with distinct letters are significantly
different by the Kruskal Wallis test (p < 0.05).

The regression analysis indicated that rainfall
volumes and average temperatures influenced
(p < 0.05) indirectly the mean SCC throughout the
year. Higher SCC values were observed in months
of higher rainfall (r = 0.805) and ambient
temperature (r = 0.511).

During spring, summer and fall, months are
characterized by high rainfall volumes, which
increase the exposure of herds to pathogens that
cause mastitis (Henrichs, Macedo, & Karam, 2014).
Unhygienic conditions were observed in the
pastures, with accumulation of mud and feces. The
animals lay down and are contaminated with
excessive organic matter, which is carried to the
pens where the animals are milked and to the
milking equipment.

The reduced immunity of animals due to heat
stress increases the risk of being affected by mastitis
and, consequently, increases the SCC of the milk of
animals on pasture (Teixeira, Freitas, & Barra, 2003;
Roma et al., 2009). In the present study, the stress
cased by heat in months with high temperature
may have influenced the higher SCC, since the
animals were raised in an extensive system.

As to the percentage of milk samples that did not
comply with national legislation, there were
variations between 6.8 and 25.0% samples above the
limit set by the legislation at the time of sample
collection, i.e., above 6x10^5 cells mL^-1 (Figure 3).

Along the year, the volume of rainfall and
average temperatures also influenced (p < 0.05)
directly the percentage of samples with SCC
above the limit established by the legislation. Higher
percentages of samples above the limit were found
in periods of higher rainfall (r = 0.629) and ambient
temperature (r = 0.740).

In properties with mechanical milking, daily
milk production of less than 80 L day^-1 and yield
lower than 5 L cow^-1 day^-1, the milk SCC was higher
(p < 0.05) than 6x10^5 cells mL^-1 in the summer.
The chances of SCC being high in milk from properties with mechanical milking, low production and yield is 8.7, 7.3 and 5.6 times higher, respectively, than in properties with manual milking, high production and yield.

Figure 3. Percentage of milk samples from rural properties in Viçosa, State of Minas Gerais, which did not comply with the Brazilian legislation regarding SCC in 2012.

In Viçosa (Minas Gerais state), Nero, Viçosa and Pereira (2009) observed that small farmers had poor knowledge of milk management, due to lack of information from technical assistance. The farmers were unaware of the measures to produce quality milk and keep herd healthy. Poor knowledge of small farmers regarding milk quality and lack of technical assistance may have influenced the high SCC observed in the present study.

Nevertheless, Braga, Briezke, Araújo, Garcia and Peixoto (2006) observed that the increase in the level of milk production in Marechal Cândido Rondon, State of Paraná, was related to the increase in the percentage of farmers supplying milk with SCC above 1 x 10^6 cells mL\(^{-1}\), a limit established at the time. Braga et al. (2006) associated low milk SCC in properties of low milk yield with the ease of milking and cow environment. Because they have fewer animals, farmers spend more time on daily tasks.

In the winter, productivity had no association (p > 0.05) with milk SCC in the present study. The chances of milk SCC being high in properties with mechanical milking and low production were 29.8 and 14.8 times higher than in properties with manual milking and high production. This indicates that in properties with high SCC in milk, the management of mechanical milking and low production are determinant factors, given the increased chances of SCC being high in the winter.

Incorrect use of the mechanical milking machine, lack of preventive maintenance and lack of knowledge of the farmers regarding these practices may have increased the risk of transmission of infectious diseases among animals, impairing the udder health and milk SCC. The incidence of mastitis due to the influence of milking machines is because this equipment can carry pathogens from one cow to another or between breast quarters of the same cow, which increases the SCC of the milk stored in the tank (Coentrão et al., 2008).

The SCCs higher (p < 0.05) than 6 x 10^5 cells mL\(^{-1}\) in properties with inadequate milking procedures such as poor drying of teats with paper towel and use of pre- and post-dipping, in addition to inefficient equipment hygiene and poor water quality (Table 2). In summer, the chance of SCC of milk being higher in properties with inadequate milking procedures, equipment hygiene and poor water quality is 15.7, 7.0 and 41.3 times higher, respectively, than in properties with adequate practices.

Table 1. Production characteristics determining SCC of refrigerated raw milk from rural properties of Viçosa, State of Minas Gerais, during the summer and winter of 2012.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Summer</th>
<th>P</th>
<th>Odds Ratio</th>
<th>Winter</th>
<th>P</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>&lt; 6 x 10^5 cells mL(^{-1})</td>
<td></td>
<td></td>
<td>&gt; 6 x 10^5 cells mL(^{-1})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Type of milking</td>
<td>mechanical</td>
<td>5</td>
<td>6</td>
<td>0.008*</td>
<td>31</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>manual</td>
<td>29</td>
<td>4</td>
<td></td>
<td>20</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Milking with calf presence</td>
<td>with calf</td>
<td>16</td>
<td>5</td>
<td>1.000</td>
<td>20</td>
<td>2</td>
<td>1.000</td>
</tr>
<tr>
<td></td>
<td>without calf</td>
<td>18</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lactating animals</td>
<td>&lt; 15 cows</td>
<td>17</td>
<td>8</td>
<td>0.072</td>
<td>24</td>
<td>4</td>
<td>0.279</td>
</tr>
<tr>
<td></td>
<td>&gt; 15 cows</td>
<td>17</td>
<td>2</td>
<td></td>
<td>16</td>
<td>0</td>
<td>6.1</td>
</tr>
<tr>
<td>Milk production</td>
<td>&lt; 80 L day(^{-1})</td>
<td>12</td>
<td>8</td>
<td>0.027*</td>
<td>15</td>
<td>8</td>
<td>0.029*</td>
</tr>
<tr>
<td></td>
<td>&gt; 80 L day(^{-1})</td>
<td>22</td>
<td>2</td>
<td></td>
<td>25</td>
<td>0</td>
<td>14.8</td>
</tr>
<tr>
<td>Milk yield</td>
<td>&lt; 5 L cow(^{-1}) day(^{-1})</td>
<td>10</td>
<td>7</td>
<td>0.030*</td>
<td>21</td>
<td>3</td>
<td>0.614</td>
</tr>
<tr>
<td></td>
<td>&gt; 5 L cow(^{-1}) day(^{-1})</td>
<td>24</td>
<td>3</td>
<td></td>
<td>19</td>
<td>1</td>
<td>2.7</td>
</tr>
<tr>
<td>Lactation phase</td>
<td>&lt; 3 months</td>
<td>23</td>
<td>4</td>
<td>0.149</td>
<td>24</td>
<td>1</td>
<td>0.300</td>
</tr>
<tr>
<td></td>
<td>&gt; 3 months</td>
<td>11</td>
<td>6</td>
<td></td>
<td>16</td>
<td>3</td>
<td>4.5</td>
</tr>
</tbody>
</table>

*Significant association between SCC and the variable by Fisher's test at 5% significance.
Inadequate condition and lack of cleanliness of the milking machine can carry microorganisms that cause mastitis into the udder, which increases the SCC of the milk. In farms where milkers were not trained in maintaining the equipment, the animals were 2.51 times more likely to have SCC above 200,000 cells mL⁻¹.

In winter, the SCC of the tank was not associated (p > 0.05) with equipment hygiene. The low rainfall and lower environmental temperatures favor the cleaning of milking equipment due to the low risk of contamination by organic matter in the environment. The hygienic detergents work efficiently, since the risk of contamination by organic matter is low (Lima et al., 2004; Bueno et al., 2005; Cavalcanti, Cavalcanti, Souza, & Araújo, 2010).

Milk production requires sufficient drinking water to meet animal needs, cleaning and sanitizing the teats, equipment and facilities (Brito, Brito, & Verneque, 2000). In agreement with Guerrero, Machado, Braga, Gasparino and Franzener (2005), environmental sources of milk contamination include water used for cleaning equipment and other tasks. It is important to use potable water for these purposes, with low contamination by coliforms and other microorganisms, such as *Pseudomonas* spp. and *Bacillus* spp.

In winter, the chances of SCC being high in milk from tanks of properties with inadequate water quality decreased to 15.0 times more than properties with adequate water quality. The water quality has a greater influence on the occurrence of mastitis and increase in the SCC of the milk of the tank in the rainy season, because the risk of water contamination is higher and the udders of the animals are washed more frequently. The chance of SCC being higher in properties with inadequate milking procedures did not show a significant variation.

**Conclusion**

SCC of refrigerated raw milk from dairy herds from Viçosa, State of Minas Gerais, varies throughout the year. The higher rainfall and temperatures caused by seasonality provide higher SCC in the milk of the tank.

Mechanical milking, lower milk production, yield, inadequate milking procedures, equipment hygiene, and water quality are factors that influence the SCC of refrigerated raw milk. Training of milkers is mandatory for the production of milk with SCC below the limits set by the legislation.

**References**


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