A study regarding the relationship between somatic cell count and bacteriological exam at goat milk

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Abstract

Goat milk and goat milk products have a high rating among consumers concerned for their health. The importance and significance of cells in milk for consumer integrity is, in our time, a universally accepted fact. The number of somatic cells is a determining criterion of milk quality evaluation.

The purpose of this work is to establish a correlation between the number of somatic cells and the microbiological loading of goat milk. Different studies indicate that large numbers of somatic cells from raw milk create a preview of milk health condition from the respective goat flocks. The number of somatic cells from raw milk can be positively correlated with the existence of bacteria loading.

Samples were prepared for the numerical evaluation of somatic cells from milk by a rapid method called fluoro-opto-electronic ISO 13366-3/2001. The general working principle of the rapid method is a combination of flow-citometry and laser reading. The SOMACOUNT system is capable of processing 150 samples per hour. To establish a connection between the bacteria loading and the number of somatic cells from milk, samples were taken and a microbiological examination was carried out. In conclusion we can say that a high number of somatic cells present in raw milk can indicate a contamination of the milk with one or more germs.

Keywords: goat milk, somatic cell count, bacteria loading

1. Introduction

Somatic cells are represented by leukocytes and, occasionally, by epithelial cells, whose nuclei can be colored in different ways using either vital or postvital dyes [6].

The discovery and description of milk cells, their recognition as a regular tool for making correct estimations on the sanitary quality and integrity of milk has brought about extensive research on the subject of milk cell numbers. As with blood, various methods of numeric evaluation have been utilized for the cell count of a given sample volume[1].

Over the years, different methods have been employed for obtaining milk cell counts. These last few years, an automated and highly efficient system has been structured for the rapid evaluation of the cell number within a sample, allowing for the monitoring of the milk production network across the European Union countries [1, 2].

The monitoring process is so effective that if a producer is found showing somatic cell count in excess of accepted levels, he is automatically removed from the network until the causes are established and the suspect animals are eliminated [4].
The nutritional advantages of goat milk compared to cow or sheep milk come primarily from the differences in lipids, specifically in fatty acid composition [3]. Goat milk fat is much more digestable than sheep milk fat, due to the fact that goat milk fat globules are smaller in size and have a larger surface ratio, presumably allowing intestinal lipases to attack the lipids more rapidly [5,6].

2. Materials and methods

To ensure an adequate sample range, the number of herds chosen was as large as possible. Somatic cell counts were obtained from milk collected from goat herds in Bistriţa-Năsăud County. A total of 642 samples were taken from tanks, after the morning milking, for which the arithmetic and geometric average of somatic cell counts were calculated.

The results of the somatic cell counts from the collected milk were structured in 500,000 cells/mL categories, as follows:

- less than 500,000 cells/mL;
- between 500,000 and 1,000,000 cells/mL;
- between 1,000,000 and 1,500,000 cells/mL;
- more than 2,000,000 cells/mL.

Based on somatic cell counts from collected milk samples, three goat herds were selected for the study, according to the following criteria:

- herds with a minimum of 30 animals;
- enlisted in the national milk quality control program;
- farmer’s approval for forming groups of goats for study, during the first lactation period;
- geometric average of somatic cell counts from milk collected from the respective herd higher than 1,000,000 cells/mL;

The limit for the individual somatic cell count was set at 750,000 somatic cells per mL of milk.

The first tests were carried out between the 8th and the 20th day of lactation (on average on the 14th day), with subsequent tests on 30-day intervals. These values describe the first lactation period.

Samples were prepared for somatic cell count evaluation through the rapid fluoro-opto-electronic method ISO 13366-3/2001.

The microscopic method was used for the calibration of the electronic and mechanized procedure. The rapid method’s principle is a combination of flow-citometry and laser reading. The SOMACOUNT system can process 150 samples per hour.

The technique demands the use of a chemical reagent, edin bromide (glucount tablets), for the staining of DNA during the leukocyte count. The transport fluid takes the fluorescently marked cells through a cell flow. Because of the staining, every cell that passes through the ray of light produces a short burst of reflected light. These bursts of light are converted into electric impulses, which are amplified, electronically filtered and sorted according to magnitude. The computer counts the electric impulses.

All milk samples used for calibrating the electronic device must be warmed to 37 - 42°C without being maintained at this temperature for more than 30 minutes.

3. Results and discussion

The arithmetic average value of the total sample range was calculated at 1,403,333 cells/mL, with a geometric average value of 1,344,830 cells/mL, showing a moderate, constantly increasing monthly fluctuation. The lowest average was recorded in March, the highest average in August.

A comparison shows that the average somatic cell count of the study (Table 1) is generally higher that those obtained in other studies of milk collected from goat herds.

The value distribution over 500,000 cells/mL categories (Fig. 1) shows that the somatic cell count for the collected milk was: higher than 2,000,000 cells/mL in 5.6% of milk samples; between 1,500,000 and 2,000,000 cells/mL in 17% of milk samples; between 1,000,000 and 1,500,000 cells/mL in 32.4% of milk samples; between 500,000 and 1,000,000 cells/mL in 28.6% of milk samples; lower than 500,000 cells/mL in 16.4% of milk samples.
Table 1: Somatic cell count results from milk collected from goat herds

<table>
<thead>
<tr>
<th>Collection period</th>
<th>Number of samples</th>
<th>Arithmetic average value</th>
<th>Geometric average value</th>
</tr>
</thead>
<tbody>
<tr>
<td>March</td>
<td>108</td>
<td>1,165,000</td>
<td>1,185,000</td>
</tr>
<tr>
<td>April</td>
<td>110</td>
<td>1,285,000</td>
<td>1,367,000</td>
</tr>
<tr>
<td>May</td>
<td>109</td>
<td>1,524,000</td>
<td>1,346,000</td>
</tr>
<tr>
<td>June</td>
<td>110</td>
<td>1,376,000</td>
<td>1,311,000</td>
</tr>
<tr>
<td>July</td>
<td>107</td>
<td>1,487,000</td>
<td>1,388,000</td>
</tr>
<tr>
<td>August</td>
<td>98</td>
<td>1,583,000</td>
<td>1,472,000</td>
</tr>
<tr>
<td>Total</td>
<td>642</td>
<td>1,403,333</td>
<td>1,344,830</td>
</tr>
</tbody>
</table>

Table 2. shows the geometric average value of somatic cell count in collected milk, over a 3 month-period, in goat herds from which the groups of goats were chosen for the study (three goat herds).

Table 2. Results of somatic cell counts from milk collected from goat herds

<table>
<thead>
<tr>
<th>Study group</th>
<th>Somatic cells/mL</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>1,685,000</td>
</tr>
<tr>
<td>L2</td>
<td>1,457,000</td>
</tr>
<tr>
<td>L3</td>
<td>1,646,000</td>
</tr>
</tbody>
</table>

Data shows that the geometric average values obtained for the individual herds (calculated between 1,457,000 and 1,685,000 cells/mL) from which the animal study groups were selected are higher that the geometric average value obtained overall (1,344,830 cells/mL).

Bacteriological analysis. In order to establish a correlation between the extent of the microbial contamination of the milk and somatic cell count, samples were collected and a bacteriological analysis was performed, to determine the potential presence of pathogenic bacteria (Staphylococcus aureus, non-aureus staphylococcus or other germs).

94 goats were selected from the three herds that showed a geometric average value of the somatic cell count in collected milk higher than 1,000,000 cells/mL. The goats were distributed into different groups, according to somatic cell counts, as follows:

- **Group N2**: 31 goats, in which the 750,000 cells/mL limit was never crossed;
- **Group E2**: 39 goats, which had at least double the limit number of somatic cells in determinations;
- **Group F2**: 17 goats, which had a somatic cell count below limit in determinations;
- **Group M2**: 7 goats, which had a somatic cell count above the limit in determinations.
After the aseptic collection of the samples, the following stages were performed for the bacteriological analysis:
- bacterioscopic examination;
- inoculation on the usual culture mediums;
- performing smears after 24 hours;
- striating from the isolated colonies onto selective mediums.

Only cultures showing to be monocultures or containing two colony types at the most, one of which predominant, were studied. Mediums showing mixed colony types were ignored, due to the fact that it is impossible to assert which germs have a determining role and which are opportunistic.

Samples were classified to contain pathogenic bacteria if they displayed one or more \textit{Staphylococcus aureus}, \textit{Streptococcus agalactiae} colonies, two or more polluting staphylococcus or streptococcus colonies, or more than ten colonies of minor pathogenic germs.

\textit{Bacteriological analysis during the lactation period.}

When analyzing the germs responsible for infecting goat milk during lactation (figure 2) it is shown that: non-\textit{aureus} \textit{Staphylococcus} were isolated from 76.09\% of analyzed samples, \textit{Staphylococcus aureus} were isolated from 13.04\% of samples; non-\textit{Staphylococcus} germs were isolated from 13.04\% of samples (4.35\% \textit{Streptococcus sp.}, 2.17\% \textit{Citrobacter sp.}, 4.35\% \textit{Corynebacterium sp.} and 2.17\% \textit{Bacillus sp.}).

\textit{Bacteriological analysis at the end of the lactation.}

106 bacteriological examinations were performed on samples collected from goats at the end of the lactation period. In 12 of the goats, bacteriological examination led to the isolation of 3 or more germs.

Figure 3 shows that 80.30\% of total germs isolated during lactation period were non-\textit{aureus} \textit{Staphylococcus}; 10.61\% were \textit{Staphylococcus aureus} and 9.09\% were germs other than \textit{Staphylococcus} (1.52\% were \textit{Streptococcus sp.}, 1.52\% \textit{Citrobacter sp.}, 1.52\% \textit{Enterobacter sp.}, 3.03\% \textit{Corynebacterium sp.} and 1.52\% \textit{Bacillus sp.}).

From 5 of the goats (1 from L1 group, 3 from L2 group and 1 from L3 group) \textit{Staphylococcus aureus} was isolated in all of the examinations performed throughout the lactation period.

\textbf{4. Conclusion}

Bacterial germs was isolated in 93.48\% of bacteriological examinations performed on samples with somatic cell counts higher that 750,000 cells/mL, showing that the increase in somatic cell count was caused by the existence of pathogenic germs. Direct bacterioscopic examination of the milk was inconclusive, although it is a mandatory stage in analysis. Identification of bacterial agents from milk samples showing somatic cell counts above the set limit was, in most cases, only possible after isolation on suitable culture media.

It can be observed from the data gathered that bacterial germs were isolated in all bacteriological examination performed during the lactation period (samples from the goats that exceeded 750,000 somatic cells/mL).
All the goats from which *Staphylococcus aureus* was isolated during the lactation periods still displayed this germ at the end of the lactation period, showing that it is very persistent.

The absence of pathogenic germs in examined goats that showed an increased number of somatic cells only at the end of the lactation period can be explained the physiological increase of the number of cells in milk towards the end of the lactation.

The increase in somatic cell count was in 100% of cases shown to be caused by an infection in the mammal gland.

References

1. Bentley Instruments 2004, Compact, easy to use Somatic Cell Count Analysis, Inc. P.O. Box 150, Chaska, Minnesota 55318 USA: Somacount 150.