Variation in blood leucocytes, somatic cell count, yield and composition of milk of crossbred goats

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Abstract

Ten multiparous crossbred goats, five each of alpine × beetal (AB) and saanen × beetal (SB) were selected from the National Dairy Research Institute goat herd immediately after parturition. These were managed as per the practices followed in the institute’s goatherd. Blood and milk samples were collected at biweekly intervals from day 14 post-kidding for 22 weeks (154 days). Somatic cell count, electrical conductivity, fat, protein and lactose contents of milk were determined using standard methods. In the blood samples total leucocytes and differential leucocytes were also determined. Somatic cell counts were high immediately after parturition on day 14 of lactation and declined gradually with advanced lactation. There were individual variations (P < 0.01) in somatic cell counts between different lactation periods. Somatic cell count of milk was negatively correlated with neutrophils only (P < 0.05) and was neither correlated with milk yield, or with fat, protein, lactose content of milk. Electrical conductivity of milk was low up to four weeks of lactation and thereafter increased as the lactation advanced. Lactose content of milk declined gradually with the advancement of lactation. Fat content of milk was stable up to the eighth week and thereafter increased with advancement of lactation while the protein content of milk did not change significantly during lactation. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Somatic cell counts; Blood cells; Electrical conductivity; Milk composition; Crossbred goats; Lactation

1. Introduction

The somatic cells that are sloughed off during the normal course of milking have been characterized as an index of udder inflammation like mastitis and for the assessment of suitability of milk for marketing and for manufacturing purpose (Smith and Roquinsky, 1977). The normal secretion in goats consists of cytoplasmic particles, which break off and are shed with the milk. Stage of lactation and season also affect secretion of somatic cell counts in the milk (Dulin et al., 1983; Lee et al., 1994; Wilson et al., 1995). Information on the pattern of change of somatic cell counts during entire lactation and also season in crossbred goats under tropical condition is not available. The present study was therefore undertaken to determine the levels of somatic cells in milk during different stages of lactation and possible relations, if any, with haematological parameters viz., total leucocytes, lymphocyte, monocyte, neutrophil, eosinophil, basophil and the yield and composition of milk.

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2. Materials and methods

2.1. Experimental

Ten healthy crossbred goats, five alpine × beetal (AB) and five saanen × beetal (SB) were selected from the Institute’s goatherd immediately after parturition. The experiment was started during the month of November, 1996 and continued up to April, 1997 for a period of 22 weeks. All experimental goats were in their second or third lactation. For the entire experimental period goats were kept in a loose housing system with brick flooring. They received ad lib green fodder, which consisted of berseem (Trifolium alexandrinum) and mustard (Brassica campestris). The concentrate mixture having 70% total digestible nutrients and 20% crude protein was fed based on milk production (400 g per kg milk) at the time of milking. The water was offered ad libitum to all the goats.

2.2. Blood and milk samples

The goats were hand-milked at 5:00 and 17:00 hours daily and the milk yields were recorded. Well mixed milk samples were collected during morning milking at biweekly intervals for 154 days. Aliquots of milk samples from each goat in proportion to their milk yields were taken and used for analysis of milk constituents. Jugular blood samples were collected in heparinized vacutainer tubes at 05:00 hours before the start of milking. The maximum and minimum ambient temperatures, relative humidity and vapor pressure were also recorded during the period of study.

2.3. Statistical analysis

Statistical analysis of data was carried out using two-way analysis of variance (ANOVA) as described by Snedecor and Cochran (1980). Mean and standard error of the different parameters and the correlations among the parameters were calculated for each biweekly period.

2.4. Analytical methods

In the fresh milk sample from each goat, milk fat was determined by Gerber’s method (ISI, 1958). The lactose content of milk was estimated by picric acid method (Perry and Doon, 1950) and the protein by formaldehyde titration method (Singhal and Raj, 1989). Electrical conductivity (EC) of fresh milk was measured using digital conductivity meter (century make cc 601) standardized with goat milk. Somatic cell counts (SCC) in fresh milk were counted by the method of IDF (1984). 10 μl smear of milk was made in an area of 20 × 5 mm on a glass slide and the somatic cells were stained using methylene blue dye. The somatic cells were counted in 50 fields and were multiplied by the microscopic factor. In fresh blood samples, total leucocyte count (TLC) and differential leucocyte counts (DLC) namely, lymphocyte, monocyte, neutrophil, eosinophil and basophil cells were determined by the method of Jain (1986).

3. Results

Mean somatic cell counts, yield and composition of milk and electrical conductivity for different experimental periods has been shown in Table 1. The average maximum and minimum ambient temperatures varied from 16.73°C to 29.37°C and 4.46°C to 15.35°C during the experimental period. The average values of THI (temperature humidity index) during morning and evening were 49.35–76.67 and 48.95–78.00, respectively. Mean SCC was higher during the first biweekly period of lactation and declined steadily with advanced lactation, but in individual goats considerable variation (8.09–44.10 × 10⁵ cells/ml) in SCC existed. Goat AB-138 had very high SCC in comparison to other goats from the beginning to the end of the experiment. The goat when tested for mastitis using California mastitis test was found to have normal milk. On the other hand in another goat SB-536, SCC was very low and varied between 5.50 and 8.09 × 10⁵ cells/ml during lactation which indicated that SCC varied between the animals. The variations in SCC between the goats and between different experimental periods were highly significant (P < 0.01). Further, the variation in SCC between the two breeds of goats was also significant (P < 0.05). The SCC changes were almost stabilized from the sixth biweekly period to the end of lactation. Cytoplasmic particles were more in early lactation as compared to mid-lactation (data not presented). Electrical conductivity of milk was low during first two
### Table 1
Mean ± standard error values of somatic cell counts, yield, percentage of fat, protein and lactose and electrical conductivity

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Experimental period (biweekly)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Somatic cell count (×10^5 cells/ml)</td>
<td></td>
<td>15.18±3.11</td>
<td>12.31±1.70</td>
<td>10.48±0.92</td>
<td>9.50±0.89</td>
<td>9.40±0.75</td>
<td>9.00±0.77</td>
<td>8.92±0.72</td>
<td>9.11±0.64</td>
<td>9.51±0.70</td>
<td>8.75±0.54</td>
<td>8.04±0.49</td>
</tr>
<tr>
<td>Milk yield (kg)</td>
<td></td>
<td>1.08±0.20</td>
<td>1.61±0.16</td>
<td>1.83±0.14</td>
<td>1.80±0.10</td>
<td>1.56±0.08</td>
<td>1.31±0.09</td>
<td>1.27±0.10</td>
<td>1.17±0.09</td>
<td>1.20±0.11</td>
<td>1.05±0.09</td>
<td>0.97±0.06</td>
</tr>
<tr>
<td>Fat (%)</td>
<td></td>
<td>3.48±0.06</td>
<td>3.58±0.07</td>
<td>3.43±0.09</td>
<td>3.46±0.08</td>
<td>3.61±0.06</td>
<td>3.58±0.05</td>
<td>3.71±0.04</td>
<td>3.84±0.06</td>
<td>3.96±0.05</td>
<td>4.27±0.05</td>
<td>4.32±0.05</td>
</tr>
<tr>
<td>Protein (%)</td>
<td></td>
<td>2.64±0.06</td>
<td>2.68±0.06</td>
<td>2.71±0.04</td>
<td>2.82±0.06</td>
<td>2.77±0.05</td>
<td>2.75±0.05</td>
<td>2.73±0.03</td>
<td>2.79±0.04</td>
<td>2.74±0.08</td>
<td>2.74±0.09</td>
<td>2.68±0.09</td>
</tr>
<tr>
<td>Lactose (%)</td>
<td></td>
<td>5.00±0.14</td>
<td>5.02±0.19</td>
<td>4.89±0.15</td>
<td>4.72±0.18</td>
<td>4.63±0.16</td>
<td>4.48±0.17</td>
<td>4.41±0.18</td>
<td>4.43±0.17</td>
<td>4.35±0.17</td>
<td>4.33±0.16</td>
<td>4.22±0.16</td>
</tr>
<tr>
<td>Electrical conductivity (mhos)</td>
<td></td>
<td>2.10±0.03</td>
<td>2.01±0.01</td>
<td>2.15±0.04</td>
<td>2.36±0.05</td>
<td>2.48±0.06</td>
<td>2.86±0.05</td>
<td>3.13±0.06</td>
<td>3.72±0.11</td>
<td>4.10±0.13</td>
<td>3.69±0.08</td>
<td>3.53±0.06</td>
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</table>

### Table 2
Mean ± standard error value of hematological parameters for the experimental period

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Experimental period (biweekly)</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total leucocyte count (×10^9 cells/ml)</td>
<td></td>
<td>14.71±0.59</td>
<td>14.95±0.60</td>
<td>14.55±0.58</td>
<td>14.29±0.57</td>
<td>14.04±0.55</td>
<td>13.98±0.59</td>
<td>14.13±0.57</td>
<td>14.38±0.55</td>
<td>14.63±0.61</td>
<td>13.80±0.56</td>
<td>13.51±0.63</td>
</tr>
<tr>
<td>Lymphocyte (%)</td>
<td></td>
<td>5.50±0.79</td>
<td>5.80±0.98</td>
<td>5.70±0.98</td>
<td>5.90±1.09</td>
<td>6.00±1.01</td>
<td>6.10±1.13</td>
<td>6.20±1.41</td>
<td>6.00±1.32</td>
<td>6.50±1.42</td>
<td>5.60±1.30</td>
<td>5.80±1.09</td>
</tr>
<tr>
<td>Monocyte (%)</td>
<td></td>
<td>5.30±0.43</td>
<td>5.80±0.54</td>
<td>5.10±0.54</td>
<td>5.90±0.48</td>
<td>5.00±0.90</td>
<td>5.00±0.99</td>
<td>5.00±0.30</td>
<td>5.00±0.20</td>
<td>5.00±0.53</td>
<td>5.00±0.56</td>
<td>5.00±0.53</td>
</tr>
<tr>
<td>Neutrophil (%)</td>
<td></td>
<td>33.60±0.65</td>
<td>34.00±0.01</td>
<td>35.40±0.75</td>
<td>37.10±0.71</td>
<td>37.80±1.15</td>
<td>37.80±1.14</td>
<td>37.60±1.62</td>
<td>36.50±1.54</td>
<td>36.60±1.31</td>
<td>37.20±1.42</td>
<td>35.90±1.40</td>
</tr>
<tr>
<td>Eosinophil (%)</td>
<td></td>
<td>4.80±0.46</td>
<td>4.10±0.79</td>
<td>3.10±0.87</td>
<td>2.30±1.00</td>
<td>1.80±0.64</td>
<td>0.70±0.28</td>
<td>0.70±0.25</td>
<td>0.80±0.28</td>
<td>1.20±0.42</td>
<td>1.10±0.39</td>
<td>1.70±0.32</td>
</tr>
<tr>
<td>Basophil (%)</td>
<td></td>
<td>0.80±0.19</td>
<td>0.90±0.26</td>
<td>0.80±0.31</td>
<td>0.70±0.45</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>0.20±0.13</td>
<td>0.40±0.15</td>
<td>0.50±0.21</td>
<td>0.50±0.16</td>
</tr>
</tbody>
</table>

### Table 3
Summary of ANOVA of complete data on SCC, milk yield and composition, EC and the hematological parameters

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f</th>
<th>Mean sum of square</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SCC</td>
<td>Milk yield</td>
</tr>
<tr>
<td>Between animals</td>
<td>4</td>
<td>12454b</td>
</tr>
<tr>
<td>Between groups</td>
<td>1</td>
<td>7767a</td>
</tr>
<tr>
<td>Between experimental period</td>
<td>10</td>
<td>4186b</td>
</tr>
</tbody>
</table>

aP < 0.05  
bP < 0.01.
periods and increased thereafter till the ninth experimental period of lactation \((P < 0.01)\). The significant changes in EC \((P < 0.01)\) during different periods of experiment with no changes in EC of two breeds of goats and between the goats indicated that EC of milk changes with stages of lactation. Percentage of fat, protein and lactose of milk varied \((P < 0.01)\) between the animals. The percentage of fat and lactose also varied significantly during different stages of lactation \((P < 0.01)\) but the protein content did not vary during different periods of lactation. Somatic cell counts were not correlated with any of the parameters viz., milk yield, fat, protein, lactose and electrical conductivity of milk. EC of milk was positively correlated with fat content of milk \((P < 0.01)\) and negatively with lactose and milk yield. Fat content of milk was negatively correlated with lactose \((P < 0.01)\) and milk yield \((P < 0.05)\).

3.1. Hematology of the goats during lactation

The mean values of hematological parameters and the summary of ANOVA of all parameters (Tables 2 and 3) showed that mean TLC was \(14.95 \times 10^3\) cells/ml during second period of lactation and declined gradually to low values of \(13.98 \times 10^3\) cells/ml in the sixth period of lactation and thereafter fluctuated. The changes in TLC during different experimental periods in both breeds of goat were not significant. Blood lymphocytes also exhibited an increase in cell number upto the 12th lactation and thereafter fluctuated being 50–70% in both the AB and SB breed. Due to greater variability \((P < 0.01)\) in lymphocytes of the two breeds, the changes in blood lymphocytes between different lactation periods and between the animals were significant \((P < 0.01)\). The monocyte numbers varied between 4 and 9% with mean values of 5.30% during the first two biweekly periods of lactation and thereafter declined. During the fifth and sixth periods of lactation the monocyte counts were minimal and in some of the goats was absent beginning fourth period of experiment. Due to greater individual variation, the changes in monocytes between the goats and between different periods of lactation were significant \((P < 0.01)\). Further, breed difference in monocyte counts was also significant \((P < 0.01)\). Average values of blood neutrophils were low during the first period, increased gradually up to the seventh period and thereafter remained fluctuating. On percent basis during entire lactation of 154 days neutrophils were 30–47%. The changes in neutrophil cell numbers between animals were not significant while differences in experimental periods were significant \((P < 0.01)\). The changes in neutrophil percent of the two breeds of goats were also significant \((P < 0.01)\). Blood eosinophils were high during the first period and declined as lactation advanced up to the sixth period of lactation. The pattern of change in eosinophil was similar to the changes observed for blood monocytes. In some of the goats, the eosinophils were almost absent in the blood from the fourth period of lactation and thereafter, while in the remaining goats, their number varied between 1% and 8% only. The variation in eosinophils between the goats and during different fortnights of lactation were highly significant \((P < 0.01)\). However, both breeds of goats did not exhibit significant changes in eosinophil counts during different lactation periods. Blood basophil cells did not exhibit a distinct change during entire lactation. The basophil were absent in blood of AB cross from the fifth period of lactation while in SB crosses, the cells were absent from third to seventh period of lactation. Since there was no distinct pattern of change in basophils in different goats, the changes in the basophil cells between animals and between breeds were not significant. However, variations in basophil cells were significant \((P < 0.05)\) between lactation periods.

4. Discussion

In the present study the SCC in different goats were highly variable during different periods of lactation. The high SCC in goat AB-138 was probably due to inherent characteristics, as the goat udder remained healthy throughout the period of study. The SCC values observed in this study were similar to earlier reports in goat (Park, 1991; Haenlein, 1987; Randy et al., 1991; Hahn, 1992). The SCC are influenced by season, stage of lactation and productive stage of the goats (Dulin et al., 1983; Randy et al., 1991; Wilson et al., 1995; Muggli, 1995). Kasireddy (1983) reported that SCC increase during second half of lactation and were inversely related to milk yield. Hinckley (1984) reported high SCC and high amounts of cytoplasmic
particles in goat milk as observed in this study. Fat and protein percents were significantly correlated with SCC in goat milk representative samples (Park and Humphrey, 1986) but such correlations were not found in the present study. Further, the kidding of goats occurred in the month of November and lactation continued up to April, but the effect of temperature on SCC and other parameters studied was not clearly discernible in this study. The trend in SCC during different periods of lactation indicated that SCC remains high during early lactation and with establishment of lactation the SCC gets stabilized to basal levels. The change in EC during lactation period was influenced by change in milk yield during lactation but there was no correlation between SCC and EC of milk as reported earlier by Park (1991). However, Lee et al. (1994) reported a close relationship between SCC and proportions of raw goat milk from individual goats sampled once in a month. SCC from individual goat milk was higher than those in goat bulk milk. EC of milk depends on the concentration of cations and anions in milk. Since sodium and chloride content of milk increase during late lactation, the EC of milk also increases with stage of lactation. The decline in total leucocyte counts, basophils, eosinophils and monocytes up to fifth period of lactation indicated their migration from blood into milk for more efficient phagocytosis and mammary gland defense against pathogens (Paape et al., 1992). Hinckley and Williams (1981) reported poor correlation between SCC and the leucocyte count. The role of neutrophils in lactation is not clear but the increase in neutrophils may probably be due to the increase in milk yield during early lactation and thus contribute to high SCC in milk (Drake et al., 1992). Since lymphocytes are of different types, their role in lactation can only be predicted when different types of lymphocytes are determined. El-Nouty et al. (1984) reported that during mid-lactation lymphocyte numbers increase while remaining types of leucocyte decrease as observed in this study also. The individual variations in cell numbers and the absence of monocytes, basophils and eosinophils in the blood during certain periods of lactation indicated that these cells probably do not have any significance with stage of lactation and the SCC of milk, and therefore, it is very difficult to establish reference values of these cells in goats (Masoni, 1985).

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References


