SOMATIC CELL COUNT EVALUATION IN EARLY LACTATION BETWEEN PRIMIPAROUS AND MULTIPAROUS BOS INDICUS COWS (SDG’S)

Santiago Alexander Guamán-Rivera¹
Myriam Valeria Ruiz Salgado²
Nelson Rene Ortiz-Naveda³
Robinson J. Herrera-Feijoo⁴
Maria Fernanda Baquero Tapia⁵
Geovanny Marco Soldado Soldado⁶

ABSTRACT

Objective: A study examined the relationship between somatic cell count (SCC) and milk yield.

Theoretical Framework: The sustainable development of dairy farms will be key to stopping the growing agricultural frontier. In comparison to breeds from temperate regions, tropical bovine production is low in terms of milk kilos, composition, or udder health.

Method: We enrolled one hundred fifty cows (Primiparous, PM, 75 and Multiparous, MP 75) in early lactation (days in milk, PM = 134 ± 3; MP = 136 ± 5), milk production (9.88 kg/d, on average) of the creole breed Gyr lechers. Prior to the assignment to each treatment, the SCC values were lower than 220,000 cells/mL, on average. All cows were maintained to graze daily on Megathyrsus maximus and supplemented with Morus alba ad libitum, being hand-milking at 0700 daily. Before analysis, the SCC was logarithmically trans-formed (log10). Then, PROC Mixed from SAS version 9.4 was used to evaluate all measurements.

Results and Discussion: The MP had higher milk yields than PM cows (10.83 vs. 9.18 ± 0.38 kg/d; P = 0.003). Similar results were observed for fat-corrected milk (8.26 vs. 6.80 ± 0.34; P = 0.002), although the fat values did not differ between both groups (P = 0.86) being lower than referential values for these breeds (2.46 ± 0.16, on average). Additionally, no differences were observed in the other milk components (P = 0.65 to 0.85). Despite that, the somatic cell count (SCC) values indicated a statistical tendency in PM than in MP (1.89 vs. 2.13 ± 0.05; P = 0.07).

Research Implications: Low-fat contents were observed in both groups, possibly due to the low quality of foods used in ruminant feeding. Correspondingly, the parity and advanced lactation conditioned the SCC contents. Therefore, further studies may be relevant in order to identify complementary factors that possibly could be more determinants.

Originality/Value: The relevance and value of this research are very importance due to the main activity in this zone is livestock cattle.

Keywords: milk, tropical livestock, udder health, sustainable development goals (SDGs).

¹ Universidad Autónoma de Barcelona, Bellaterra, España.
E-mail: santyalex.guaman@hotmail.com

² Escuela Superior Politécnica de Chimborazo (ESPOCH), Sede Morona Santiago, Ecuador.
E-mail: myriam.ruiz@espoch.edu.ec

³ Laboratório de Biotécnicas Aplicadas à Reprodução, Departamento de Medicina Veterinária, Universidade Federal Rural de Pernambuco, Recife, Pernambuco, Brazil.
E-mail: nelson.ortiz@ufrpe.br

⁴ Universidad Técnica Estatal de Quevedo, Quevedo 120550, Ecuador.
E-mail: rherrera2@uteq.edu.ec

⁵ Escuela Superior Politécnica de Chimborazo (ESPOCH), Sede Morona Santiago, Ecuador.
E-mail: maria.baquero@espoch.edu.ec

⁶ Escuela Superior Politécnica de Chimborazo (ESPOCH), Sede Morona Santiago, Ecuador.
E-mail: geovannym.soldado@espoch.edu.ec
1 INTRODUCTION

By 2067, the world’s population is predicted to reach 10.4 billion, reducing the arable land available for food production (Britt et al., 2018). Therefore, the sustainability of dairy farms will be key to avoid a growing agricultural frontier. In comparison to breeds from temperate regions, tropical bovine production is low in terms of milk kilos, composition, or udder health. As a result, developing and tropical nations continue to face difficulties in increasing milk output (Guaman-Rivera et al., 2023; Millogo et al., 2009). Nevertheless, mastitis is one of the costliest diseases affecting the dairy cattle industry (Damm et al., 2017). The majority of the immune cells in milk are lymphocytes, polymorphonuclear neutrophils (PMN), and macrophages, which are represented by the somatic cell count (SCC) (Kirkeby et al., 2020). This udder inflammation often result to be subclinical and chronic, but both forms have serious risks to obtaining milk of good hygienic quality and farming profitability (Juárez et al., 2010). In addition, the resilience of high-yielding animals, poor efficacy of therapies and prevention, such as antibiotic resistance, and dubious efficacy of vaccines could be associated factors (Riva et al., 2022). In this sense, one of most indicators used to assess milk quality and to define milk prices is SCC (Raynal-Ljutovac et al., 2007). Hereby, the first and principal tool used by technicians and farmers to evaluate udder health in flocks is SCC, so it is an important tool with easy application (Juárez et al., 2010). Although much scientific evidence has been reported from other continents (Shangraw et al., 2019, 2020; Shangraw & McFadden, 2022) using breeds of Bos taurus, at the Latin American level only a few studies have been realized where the raising Bos indicus predominate. Data from MAGAP (MAGAP, 2022) have demonstrated that in the Amazon region, cattle raising represents one of the more important activities to generate money resources for these families (Guaman-Rivera et al., 2023). In fact, of 5236 agricultural productive
units (UPA’s) identified in Orellana province, approximately 46% are developed as small livestock farmers with low technological levels and bad management of their biotic resources (Fuentes et al., 2023; González Marcillo et al., 2021; Guaman-Rivera et al., 2023; Guamán Rivera et al., 2019). Therefore, based on the given scenario, no studies have been conducted to explore the udder’s health status which may allow to recommend some mastitis control practices. Subsequently, this present pioneer study has been conducted in the Orellana province in NE Ecuador, which aimed to explore the udder health in early lactation in Bos indicus cows.

2 MATERIALS AND METHODS

The theoretical framework in a study comprises a critical and organized analysis of the literature relevant to the topic, providing a theoretical contextualization and defining the key concepts. It must comprehensively contain theories, models and previous research, identifying gaps, contradictions and consensuses in the literature that are important for the focus of the work being developed.

2.1 DAIRY FARMS

The current study collected milk samples from one livestock farm in Joya de los Sachas, Orellana, NE Ecuador. Hence, the humid tropical rainforest conditions that characterize this area’s climate (González Marcillo et al., 2021). The altitude of the study area is of about some 275 m above sea level, and the average annual rainfall is of 2942 mm. The average annual temperature is 29.7 °C.

We enrolled one hundred fifty cows (Primiparous, PM, 75 and Multiparous, MP 75) in early lactation (days in milk, PM =134 ± 3; MP = 136 ± 5), milk production (9.88 kg/d, on average) of the creole breed Gyr lechers. The cows were maintained to graze daily on (Megathyrsus maximus, CP 12%) and supplemented with white mulberry (Morus alba) ad libitum, while all cows were everyday hand-milked at 0700. Before being assigned to each treatment, the
SCC values were lower than 220,000 cells/mL, on average.

2.2 MILK SAMPLES

A complete design block with a randomized PM and MP was used to disperse the cows. The investigation lasted for 21 days. As a result, 50 mL samples of milk were aseptically collected, conserved with antimicrobial tablets (Bronopol, Broad Spectrum Micro-tabs II, D&F Control Systems Inc., San Ramon, CA), and maintained at 4°C until processing for milk composition and SCC analyses. Then, in the Uyunbicho at the Central University of Ecuador, milk composition was examined using infrared absorption, while SCC was calculated using an automatic somatic cell counter that had previously been calibrated for cow milk (Fossomatic 500, Foss-Electric, Hillerd, Denmark).

2.3 STATISTIC EVALUATION

PROC Mixed from SAS 9.4 (SAS Institute Inc., Cary, NC, USA) was used to analyze the data. The SCC was logarithmically converted (log10) prior to analysis. While residual error and cows were regarded as random variables, our fixed effects (PM and MP) were included in the model. With SAS's PDIFF option, differences between least squares means were calculated, and the Tukey test was used to compare them (FALTA REFERENCIA DE TUKEY TEST). Additionally, the PRO CORR of SAS was associated with the milk composition and SCC. Statistical differences and trends were announced at $P \leq 0.05$ and $P \leq 0.10$, respectively.

3 RESULTS

Table 1 lists the milk composition and SCC when compared to primiparous (PM) and multiparous (MP).

Days in milk were estimated to be 134 and 136 days for primiparous and multiparous does, respectively, at the start of the trial ($P > 0.05$). Comparing primiparous and multiparous women's milk yields revealed differences ($P =$
0.003); the MP indicated a 15% higher milk yield than those in PM (10.83 vs. 9.18 ± 0.38 kg/d; Table 1). As for FCM values, although the fat contents did not change between treatments (2.46 ± 0.16%, on average; P = 0.68), the corrected milk by fat was higher in MP than those obtained for PM (8.26 vs. 6.80 ± 0.34%; Table 1)

Table 1.
Comparisons between the somatic cell counts (SCC) and milk yield features of 120 primiparous and multiparous Bos indicus cows

<table>
<thead>
<tr>
<th>Item</th>
<th>Treatments</th>
<th>SEM</th>
<th>P = value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Milk yield, kg/d</strong></td>
<td>Primiparous</td>
<td>0.38</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>Multiparous</td>
<td>0.34</td>
<td>0.002</td>
</tr>
<tr>
<td><strong>FCM, L/d</strong></td>
<td>Primiparous</td>
<td>6.80</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiparous</td>
<td>8.26</td>
<td></td>
</tr>
<tr>
<td><strong>Milk composition, %</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total solids</td>
<td></td>
<td>11.10</td>
<td>0.17</td>
</tr>
<tr>
<td>Solids no fat</td>
<td></td>
<td>8.68</td>
<td>0.66</td>
</tr>
<tr>
<td>Fat</td>
<td></td>
<td>2.41</td>
<td>0.16</td>
</tr>
<tr>
<td>Protein</td>
<td></td>
<td>3.24</td>
<td>0.50</td>
</tr>
<tr>
<td>Lactose</td>
<td></td>
<td>4.71</td>
<td>0.02</td>
</tr>
<tr>
<td>Fat yield, g/d</td>
<td></td>
<td>208b</td>
<td>16</td>
</tr>
<tr>
<td>Protein yield, g/d</td>
<td></td>
<td>299a</td>
<td>14</td>
</tr>
<tr>
<td>Somatic cell count, log</td>
<td></td>
<td>1.89</td>
<td>0.05</td>
</tr>
</tbody>
</table>

1 Fat corrected milk at 4%; FCM = kg of milk yield × [0.4+ 0.15 × (fat %)]

In contrast, the other milk components did not differ between treatments (P = 0.60 to 0.85%; Table 1). Overall, the mean values were for total solids (11.14 ± 0.17%), solids non-fat (8.67 ± 0.66%), protein (3.24 ± 0.50%) and lactose (4.7 ± 0.02%). Nevertheless, when comparing the fat and protein contents expressed as g/d, the MP had greater fat contents than PM cows (261 vs. 208 ± 16; P 0.02) but with lower protein contents (253 vs. 299 ± 14; P 0.01; Table 1). On the other hand, statistical tendencies were observed for SCC (P = 0.07). In the current study, the overall averages of SCC were 153.703 × 103 mL-1 (log SCC 1.89) and 394.560 × 103 mL-1 (log SCC 2.13) for primiparous and multiparous cows, respectively. As illustrated in Figure 1, the regression analysis demonstrated strong significant associations between total solids and fat (P < 0.001) and solids non-fat and CP (P < 0.001), as well as for SCC and lactose contents (P < 0.001).
Figure 1.

Regression analysis is linear for total solids and fat (A), solids non-fat and CP (B) and SCC and lactose (C)

Table 2 displays the simple correlation coefficients for milk yields, composition, and SCC. Milk yield and SCC were not linked in this study (-0.04 to 0.67; P = 0.50 to 0.64). Nevertheless, there were significant correlation
coefficients for PM and MP between total solids and fat \( (r = 0.92 \text{ to } 0.94; \ P < 0.001) \) and solids non-fat and CP \( (r = 0.79 \text{ to } 0.90; \ P < 0.001: \text{Table 2}) \).

**Table 2.**

*Somatic cell counts of primiparous (PM) and multiparous (MP) Bos indicus cows were correlated simply with milk yield attributes (n = 120)*

<table>
<thead>
<tr>
<th>Variable</th>
<th>Milk, kg/d</th>
<th>Fat</th>
<th>CP</th>
<th>TS(^1)</th>
<th>SNF(^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PM</td>
<td>MP</td>
<td>PM</td>
<td>MP</td>
<td>PM</td>
</tr>
<tr>
<td>Milk, kg/d</td>
<td>– 0.25</td>
<td>– 0.22</td>
<td>0.14</td>
<td>0.22</td>
<td>– 0.15</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>0.069</td>
<td>0.16</td>
<td>0.06</td>
<td>0.14</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>0.28</td>
<td>0.013</td>
<td>0.01</td>
<td>0.035</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>0.069</td>
<td>0.16</td>
<td>0.06</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>0.17</td>
<td>0.16</td>
<td>0.36</td>
<td>0.54</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>– 0.15</td>
<td>– 0.08</td>
<td>0.94</td>
<td>0.92</td>
<td>0.30</td>
</tr>
<tr>
<td></td>
<td>0.14</td>
<td>0.52</td>
<td>0.001</td>
<td>0.003</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>0.36</td>
<td>0.54</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>0.28</td>
<td>0.035</td>
<td>0.17</td>
<td>0.90</td>
</tr>
<tr>
<td></td>
<td>0.013</td>
<td>0.01</td>
<td>0.73</td>
<td>0.16</td>
<td>0.001</td>
</tr>
<tr>
<td></td>
<td>0.36</td>
<td>0.54</td>
<td>0.001</td>
<td>0.001</td>
<td>0.001</td>
</tr>
</tbody>
</table>

\(^1\) TS, total solids; 2SNF, Solids non-fat; PM, primiparous cows and MP, multiparous cows

**4 DISCUSSION**

It has been observed that the evaluation of milk yield of lactating cows in tropical conditions is confounded by the fact that the calf must initiate milk let down (Coulibaly & Nialibouly, 1998). By using creole, Gujarat have reported at 210 DIM a higher milk yield \( (22 \pm 1.7 \text{ kg/d}) \) and fat \( (2.81 \pm 0.1\%) \) than those obtained in our study (Martínez-Velázquez et al., 2010). However, in zebu dairy cattle at 41 ± 6 DIM observed lower milk yields than this study \( (1.3 \text{ vs. } 10 \text{ kg/d}, \text{on average}) \) but with greater fat contents \( (4.88 \text{ vs. } 2.46 \%) \) (Millogo et al., 2009)). We hypothesized that our lower fat contents observer could be related to poor forage quality for bad grazing management practices, as previously evidenced in Orellana province (Guaman-Rivera et al., 2023; Guamán-Rivera et al., 2023)). Nonetheless, the fat content in milk reflects supplementary feeding for the entire dry period, which in our conditions was not done (Bonfoh et al., 2005; Farahani et al., 2017).

However, it’s crucial to remind that the variation in the amount of milk the calf suckled had a strong impact on the daily variance in saleable milk yield. Additionally, since milk fat content rises during udder emptying, variation in
the degree of udder evacuation and calf suckling may have an impact on the fat content (Millogo et al., 2009). Another fundamental point to consider in the present study is that the fat contents did not vary between PM and MP, although a higher fat content has been reported of Malian Zebu milk when the milk yield decreased (Farahani et al., 2017). Based on the aforementioned evidence, estimating milk production in lactating zebu cows has always been difficult since it is necessary to use their calves to stimulate milk letdowns (Coulibaly & Nialibouly, 1998). We decided to realize this work at 134 DIM, avoiding the suckled effect.

As expected, the lactose contents did not differ between PM vs. MP (4.70 ± 0.02% on average), being their values like those reported by Bonfoh et al. (2005) (4.84%), Martínez-Velázquez et al. (2010) (4.71%), Sidibe-Anago et al. (2006) (4.6%). Despite weak correlations in PM and MP cows between SCC and lactose contents (r = 0.22 to 0.25), it was significant (P = 0.03 to 0.04).

Lactose is the main carbohydrate in milk at a concentration of around 4.6% on an anhydrous basis (Portnoy & Barbano, 2021). Consequently, it is a key component in milk synthesis and secretion, regulating the osmotic equilibrium in the mammary cell. Decreased milk yield and compositional changes in milk, particularly concerning lactose concentration, have been reported in infected mammary glands in cows(Gross et al., 2020; Kvidera et al., 2017; Silanikove et al., 2011). High-quality milk production is a primary factor for the safety and quality of dairy products (Albenzio et al., 2019). Mastitis is a significant problem in dairy farming globally (Kirkeby et al., 2020), occasioning also considerable economic losses. Furthermore, it has been stated that mastitis is a predominant reason for antibiotic use in dairy products and can impair animal welfare (Kirkeby et al., 2020).

The SCC in milk indicates the inflammatory response in the mammary gland (Wall et al., 2018). In cattle breeds of origin Bos taurus, ample scientific evidence stated that the optimal cut-off points to distinguish between infected and uninfected quarters should have less than 200,000 cells/mL (Bradley & Green, 2005; IDI, 2013). However, in Bos indicus cattle breeds, information is scarce and confused on referential SCC values to consider as uninfected. At the level of Ecuador, legal normative declared by INEN (INEN, 2012) is considered
an uninfected quarter when the SCC values are less than 500,000 cells/mL. Hereby, it has been reported a 9% of cows with a mean value of SCC greater than 654,000 cells/mL (Bonfoh et al., 2005). Similar results have been observed with SCC 800,000 cells/mL (Juozaitiene et al., 2006). In this pioneering study, in PM cows (n = 75), 57 and 43% had lower SCC values than 39,000 and 180,000 cells/mL, respectively, whereas for MP cows (n = 75), the SCC values were 65% (> 81,000 cells/mL) and 35% (> 979,000 cells/mL).

Based on these findings, the MP cows demonstrated to have more risk of obtaining subclinical mastitis (Juozaitiene et al., 2006). In SCC values of dairy ewes, a negative correlation was reported between milk yield and parity (Orman et al., 2011). This supported our results, in which the PM cows indicated lower SCC values when compared to those of MP cows. In these tropical conditions, due to high ambient temperatures with high relative humidity, the cattle could face heat stress through physical, biochemical, and biological changes, which may result in decreased production performance and poorer immunity (i.e., a high SCC), such as observed Rakib et al. (2020). Although most of the milk parameters yield strong mastitis-related changes, no correlations were encountered between SCC and all milk components. Nevertheless, we did not discard possible seasonal effects, stage of lactation, genetics (breed), productive systems and udder and teat morphology-like associated factors in Bos indicus cows (Collier et al., 2006).

5 CONCLUSION

Summarizing based on the obtained results, the lower fat contents observed in PM and MP cows may be related to forages of poor nutritional quality. In addition, the present investigation evidenced a progressive increase in SCC with parity and advanced lactation. Therefore, this very first study performed Ecuador might be a starting point to formulate some feeding strategies in order to achieve higher and lower milk composition and SCC, respectively.
ACKNOWLEDGEMENTS

We thank to project Silvopastoral system in Orellana Province. In addition, we thank to Theofilos Toulk-eridis for grammar check of this manuscript.
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https://doi.org/10.3390/agriculture11020117


