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Impact of Somatic Cell Count on Milk Yield, Milk Composition, and Growth Performance in Zaraibi Goats During Different Physiological Stages of Lactation Period

Ahmed Abdelrazek Gabr[1, *], Mohamed Ibrahim Ahmed[2], Rasha Abdalla Hawas[1, 2]

[1]Department of Animal Production, Faculty of Agriculture, Mansoura University, Mansoura, Egypt
[2]Animal Production Research Institute, Ministry of Agriculture, Giza, Egypt

Email address:

ahmedagabr@yahoo.com (Ahmed Abdelrazek Gabr), mebrahim2022@yahoo.com (Mohamed Ibrahim Ahmed), rashahawas3722@gmail.com (Rasha Abdalla Hawas)

[*]Corresponding author

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Abstract: The study investigated the effect of different somatic cell count (SCC) classes on milk production traits and growth of Zaraibi does and kids at three distinct physiological stages during lactation. A total of 150 milk samples obtained from 50 goats at milk peak, kids weaning, and meeting periods (days of 50, 100 and 150) were analyzed. The goats were selected based on strict criteria, including the same age, kidding date, low milk SCC, and no udder problems. The goats were divided into three classes based on overall milk SCC values: SCG1 (≤315x10^3 cells/mL), SCG2 (316-335x10^3 cells/mL), and SCG3 (>335 x10^3 cells/mL). The results showed that although there were significant differences between SCC1 and SCC2 classes in SCC and log SCC at different stages of lactation, there were no significant differences in milk production and composition. The daily milk yield decreased significantly with increased SCC level (> 335x10^3 cells/mL), and the highest milk losses were observed. The milk composition followed the same pattern of significant differences among SCC classes during different lactation stages, with the highest values observed in the highest SCC class (> 335x10^3 cells/mL). The daily milk yield decreased gradually with increasing lactation stage, while SCC values increased gradually. The does' body weight did not change significantly by lactation stage. Overall, the findings suggest that SCC level of > 335x10^3 cells/mL has a significant effect on milk production and composition, but not on growth traits of Zaraibi does' and kids during different stages of lactation. These findings could be useful for dairy farmers to manage their herds and optimize milk production to produce high-quality dairy products.

Keywords: Somatic Cell Count, Milk Production, Milk Composition, Growth Performance, Zaraibi Goats

1. Introduction

The level of somatic cell count (SCC) in milk is often used as an indirect measure of milk hygienic quality, with higher values beyond the typical physiological range indicating potential microbial inflammation in the mammary gland [1]. However, this is not always applicable to goat milk, which generally has a higher SCC content than cow milk. Numerous studies have demonstrated that typically higher SCC in goat milk than in cow milk due to the apocrine milk secretion process in goats [2]. However, somatic cells are primarily composed of leukocytes (neutrophils, eosinophils, macrophages, lymphocytes), which are white blood cells that play a critical role in the immune system's response to infection and injury. Polymorphonuclear neutrophils comprise the major cell type in milk from healthy uninfected goats (40–80%) [3]. Generally, research has documented significant physiological differences in the milk secretion process between cows and goats, which suggests that cow milk regulatory standards are not suitable for goat milk [4]. However, according to Kaskous et al. [3], the healthy goats' average physiological level of milk SCC fluctuated between 200×10^3 and 1500×10^3 cells/mL.

There are numerous non-infectious factors that can greatly impact the SCC in goat milk. However, the goat milk SCC is subject to greater physiological variability than cow milk SCC as reviewed by Kaskous et al. [3]. The SCC of goat milk can be influenced by several physiological stages, such as lactation stage, reproductive condition, and health status. The hormonal changes during these stages can increase the stress on the udder and result in higher SCC levels, which can make the goats more susceptible to infections. Moreover, parity, calving age, season, birth type, and environmental conditions such as temperature, humidity, and sanitation are additional features that can affect SCC in goat milk. However, some breeds of dairy goats may be more susceptible to udder infections and have higher SCC than others.

There is no direct evidence to suggest that SCC has a direct effect on body weight of goats and its kids' growth performance. Gabr et al. [5] found a negative correlation between SCC values with does' body weight and in Zaraibi goats at 90 days of lactation. Therefore, it is important to manage both udder health and overall goat health to support optimal milk production, goats' body weight and growth of goat kids. This may include providing a balanced diet, maintaining clean and hygienic milking conditions, and monitoring SCC levels regularly to identify and address any potential issues.

The impact of goat SCC on milk composition is not well understood [6]. Although some goat studies have suggested a correlation between SCC and the milk composition, but it is still controversial [7]. The dairy industry and producers can suffer significant economic losses due to high SCC [8]. The primary reason for these losses is a decrease in milk yield [9]. In addition, high SCC levels in milk can have adverse effects on the quality of raw milk and dairy products, resulting in poor flavor quality and shelf life [10]. Therefore, understanding the relationships between SCC and milk production and components can help to inform management practices and breeding strategies to improve udder health and milk quality in dairy goat production.

While there is a general agreement on the need to select against high SCC, there is a difference of opinion on selecting for extremely low SCC levels [11]. Therefore, the aim of the study is not only to study the effect of the level of the number of somatic cells in milk on the productive performance and milk components, but to determine the level from which the appearance of the significant effect begins. Furthermore, there is a need for investigations to assess the degree of variation in SCC and its relationship with productive performance and milk components at different physiological stages throughout the milking period.

The main objective of the present study was to evaluate the changes in milk SCC during lactation and their relationships to daily milk yield, milk components, and productive performance in healthy Zaraibi goats. Additionally, an important aspect of the study was to investigate the impact of three distinct and crucial physiological stages during goats' lactation period on the aforementioned traits.

2. Material and Methods

The current study was carried out at El-Serw Animal Production Research Station, Animal Production Research Institute (APRI) Agricultural Research Center, Ministry of Agriculture, Egypt, in cooperation with the Department of Animal Production, Faculty of Agriculture, Mansoura University, Egypt. The study was approved by the Animal Production Research Institute, Agricultural Research Center, Egypt (protocol code 851429).

2.1. Animals and Experimental Design

A total of 150 milk samples, obtained from 50 Zaraibi goats, were utilized in this study to investigate the influence of somatic cell count (SCC) on milk yield, milk composition, and productive performance. However, the dataset used in the study is not extensive because of the strict criteria for does selection. Only goats that were of the same age, had the same kidding date, had low milk SCC, and did not have any obvious udder problems were included in the experiment.

The milk samples analyzed in the present study were obtained at three distinct and crucial physiological stages during goats' lactation period. The first stage was at the peak of milk production (day 50 of lactation), the second stage was after the weaning of the kids (day 100 of lactation), and the third stage was during the mating season of the goats (day 150 of lactation). These three stages were specifically chosen to provide a more comprehensive understanding of the changes in body weights, milk yield and composition by SCC levels throughout the lactation period. The samples were divided based on the overall SCC values of the lactation parity into 3 different classes: SCG1 ($\leq 315 x10^3$ cells/mL), SCG2 ($316\text{-}335 x10^3$ cells/mL), and SCG3 ($>335\ x10^3$ cells/mL).

2.2. Animal Management

The animals in the study were housed in semi-open pens and fed twice daily (8:00 am and 3:00 pm) with diets that varied based on the season. During the winter and spring seasons, the diet consisted of green Egyptian clover (*Trifolium Alexandrinum*), while clover hay and/or crop stubbles or rice straw were provided during autumn and summer seasons, when available. A concentrate mixture was also given to cover the nutritional requirements according to the National Research Council [12]. Drinking water was available, along with mineral blocks.

Newly presented does were mated at around 15 months of age, with an average body weight of 30 kg. Two weeks before the mating season, supplementary feed was offered at a rate of approximately 0.25 kg/doe/day, and again during the last 2-4 weeks of pregnancy and the first week of lactation, if available. Zaraibi does were randomly divided into mating groups of 25-30 does per buck, and to avoid inbreeding, mating bucks were replaced after two seasons. Mating took place in either the autumn or spring, with half of the herd mated in each season. After parturition, kids were ear-tagged and kept with their dams until weaning at about 3 months of age.

Throughout the study, all the goats were housed together under the same conditions, received the same nutrition, and were managed similarly without any observable variations.

2.3. Milk Recording and Sampling

Individual milk recording and sampling of each goat were conducted at 50, 100, and 150 days of lactation. All monitored goats were hand-milked in the days when milk recording and sampling were carried out. The daily milk yield was determined on the day of sampling by adding the yields from both the morning and evening milkings. The milk samples were only taken from the morning milking only.

To obtain uncontaminated milk samples, the udder and teats were cleaned with a moist cotton pad and the first few streams of milk were discarded. Approximately 20 ml of milk per goat was collected using a sterile sample tube with a screw cap. The sample tubes were labeled and transported in an ice-box at 4°C to the laboratory for analysis. The milk was analyzed for its fat, protein, ash, total solids, solids not fat, and lactose content using MilkoScan (FOSS, Electric, Denmark). The results were obtained by averaging the values from the milk analysis.

2.4. Statistical Analysis

Statistical analyses were performed by the general linear model (GLM) procedure of SAS version 9.3 (SAS Institute Inc. Cary, NC, USA) by using the following statistical model, $Yij = \mu + SCCi + SLj + Eij$, where Yij is the observation from doe; μ is the overall mean; SCCi is the experimental SCC effect; SLj is the stage of lactation effect; and Eij is the residual error. Least square means and their standard error are described. The Tukey's test was used to assess the differences between groups at a 5% probability level. To ensure the homogeneity of variance, the somatic cell count (SCC) data was transformed to log10 base (log SCC).

3. Results

3.1. Effect of SCC Classes

Among different SCC classes and stages of lactation, the daily milk yield ranged from 0.873±0.060 to 1.901±0.069 kg and the SCC values ranged from 286.3±2.43 to 361.6±2.64 $x10^3$ cell/mL (Table 1). At all the lactation stages, the daily milk yield could be found significantly similar between SCG1 and SCG2, while decreased ($p \leq 0.004$) by increased SCC (SCG3, >335 $x10^3$ cell/mL milk). However, at 50 days of lactation, the daily milk yield decreased ($p=0.001$) by 24.6%, and 24.5% moving from SCG1, and SCG2 to SCG3, respectively. While at 100 days of lactation, it decreased ($p=0.003$) in SCG3 than SCG1, and SCG2 by 22.0%, and 20.8%, respectively. The highest decrease ($p=0.004$) of daily milk yield in SCG3 was at 150 days of lactation by 26.7%, and 25.5% compared to SCG1, and SCG2, respectively. On the other hand, in 50, 100, and 150 days of lactation the average milk losses were 0.466, 0.326, and 0.302 kg milk, respectively, when moving from SCG1 and SCG2 to SCG3.

The SCC and log SCC values were differed ($p<0.001$) among SCC classes obtaining similar trend across 50 and 100 days of lactation (Table 1). While in 150 days of lactation, there was no significant difference between the SCG1 and SCG2 classes in the SCC and log SCC values, but both were significantly lower ($p<0.001$) than the SCG3 class by 12.34% and 7.13%, respectively for SCC values.

Table 1. *The daily milk yield and SCC of Zaraibi goats with different somatic cell count classes in 50, 100, and 150 days of lactation.*

	Somatic cell count, $x10^3$ cell/ml			SEM	P-value
	SCG1*	SCG2	SCG3		
50 days of lactation					
Daily milk yield, kg	1.901 ^{a}	1.899 ^{a}	1.434 ^{b}	0.091	0.001
SCC, $x10^3$ cell/ml	286.3 ^{c}	303.3 ^{b}	326.6 ^{a}	2.309	<0.001
log SCC	2.456 ^{c}	2.482 ^{b}	2.515 ^{a}	0.003	<0.001
100 days of lactation					
Daily milk yield, kg	1.533 ^{a}	1.510 ^{a}	1.196 ^{b}	0.074	0.003
SCC, $x10^3$ cell/ml	300.0 ^{c}	315.8 ^{b}	337.9 ^{a}	1.916	<0.001
log SCC	2.477 ^{c}	2.499 ^{b}	2.529 ^{a}	0.003	<0.001
150 days of lactation					
Daily milk yield, kg	1.167 ^{a}	1.149 ^{a}	0.856 ^{b}	0.064	0.004
SCC, $x10^3$ cell/ml	345.6 ^{b}	350.0 ^{b}	361.6 ^{a}	2.755	<0.001
log SCC	2.538 ^{b}	2.547 ^{b}	2.559 ^{a}	0.003	<0.001

a-c: Means within each row with different superscripts are significantly different at $p<0.05$. SCG1 ($\leq 315x10^3$ cells/ml), SCG2 (316-335$x10^3$ cells/ml), and SCG3 (>335 $x10^3$ cells/ml)

Although the percentages of milk components differed during the stages of lactation, the same trend in terms of significant differences was found for the different SCC classes (Table 2). However, the greatest values for all milk components were observed in SCG3. With no significant difference between SCG1 and SCG2, the milk fat, ash, solid not fat, and total solids percentages were significantly higher ($p \leq 0.032$) in SCG3 than both SCG2 and SCG1 classes. The percentage of protein and lactose did not significantly change between the SCC classes in the different stages of lactation.

Table 2. *The milk composition of Zaraibi goats with different somatic cell count classes in 50, 100, and 150 days of lactation.*

	Somatic cell count, x10^3 cell/ml			SEM	P-value
	SCG1	SCG2	SCG3		
50 days of lactation					
Fat, %	3.318^b	3.337^b	3.479^a	0.035	0.003
Protein, %	2.906	2.907	2.920	0.007	0.338
Lactose, %	4.627	4.629	4.636	0.015	0.903
Ash, %	0.696^b	0.695^b	0.701^a	0.002	0.026
Solid not-fat, %	8.172^b	8.187^b	8.259^a	0.018	0.015
Total solids, %	11.55^b	11.54^b	11.74^a	0.049	0.009
100 days of lactation					
Fat, %	3.451^b	3.481^b	3.649^a	0.034	<0.001
Protein, %	2.944	2.947	2.968	0.008	0.063
Lactose, %	4.636	4.646	4.651	0.008	0.385
Ash, %	0.697^b	0.699^b	0.704^a	0.002	0.015
Solid not-fat, %	8.278^b	8.281^b	8.378^a	0.017	0.031
Total solids, %	11.74^b	11.78^b	11.97^a	0.046	0.001
150 days of lactation					
Fat, %	3.539^b	3.599^b	3.736^a	0.026	<0.001
Protein, %	2.964	2.972	2.982	0.007	0.259
Lactose, %	4.657	4.664	4.667	0.007	0.568
Ash, %	0.706^b	0.705^b	0.711^a	0.002	0.025
Solid not-fat, %	8.360^b	8.354^b	8.406^a	0.015	0.032
Total solids, %	11.80^b	11.88^b	12.11^a	0.044	<0.001

a-c: Means within each row with different superscripts are significantly different at p<0.05. SCG1 (≤315x10^3 cells/ml), SCG2 (316-335x10^3 cells/ml), and SCG3 (>335 x10^3 cells/ml)

Among different SCC classes and stages of lactation, the does' weights ranged from 31.50±0.557 to 34.17±0.771 kg (Table 3). Although there were no significant differences for all the studied growth traits with the levels of SCC during the different stages of lactation, there are some differences between those levels. It is evident that the does' body weights in the SCG3 class are lower than those in both the SCG1 and SCG2 classes. On the other hand, the kids' body weight, growth rate, and weight gain differed among SCC classes, with the highest performance for SCG3 and the lowest for SCG1.

Table 3. *The growth performance of Zaraibi goats with different somatic cell count classes in 50, 100, and 150 days of lactation.*

	Somatic cell count, x10^3 cell/ml			SEM	P-value
	SCG1	SCG2	SCG3		
50 days of lactation					
Does body weight, kg	34.06	34.17	32.31	0.759	0.157
Kids weight, kg	6.531	7.118	7.079	0.223	0.129
Kids growth rate, g	91.25	100.53	99.50	3.748	0.074
Kids weight gain, kg	4.450	5.047	5.021	0.201	0.072
100 days of lactation					
Does body weight, kg	33.09	33.17	31.50	0.740	0.207
Kids weight, kg	10.28	11.14	11.31	0.397	0.165
Kids growth rate, g	76.25	80.71	84.71	3.762	0.234
Kids weight gain, kg	3.781	4.053	4.250	0.188	0.239
150 days of lactation					
Does body weight, kg	33.06	32.94	31.50	0.650	0.174
Kids weight, kg	13.48	14.59	14.99	0.586	0.202
Kids growth rate, g	63.75	70.12	73.21	3.990	0.273
Kids weight gain, kg	3.185	3.357	3.659	0.199	0.272

a-c: Means within each row with different superscripts are significantly different at p<0.05. SCG1 (≤315x10^3 cells/ml), SCG2 (316-335x10^3 cells/ml), and SCG3 (>335 x10^3 cells/ml)

3.2. Changes by Stages of Lactation

The daily milk yield, SCC, and log SCC of different somatic cell count classes by stage of lactation are presented in Table 4. The most noticeable for all groups, a gradually decrease (p<0.001) in daily milk yield and gradually increases (p<0.001) in SCC, and log SCC values were found by lactation stage. However, between 50 and 150 days of lactation, the daily milk yield decreased by about 38.61%, 39.49%, and 40.31% for SCG1, SCG2, and SCG3, respectively, and the SCC values increased by about 17.45%, 13.34%, and 9.68%, respectively.

***Table 4.** The daily milk yield and somatic cell count of Zaraibi goats with different somatic cell count classes by stages of lactation.*

	Stage of lactation			SEM	P-value
	50 d	100 d	150 d		
Daily milk yield, kg					
SCG1	1.901^{a}	1.533^{b}	1.167^{c}	0.069	<0.001
SCG2	1.899^{a}	1.510^{b}	1.149^{c}	0.089	<0.001
SCG3	1.434^{a}	1.196^{b}	0.856^{c}	0.060	<0.001
Somatic Cell Count, x10^3 cell/ml					
SCG1	286.3^{c}	300.0^{b}	345.6^{a}	2.430	<0.001
SCG2	303.3^{c}	315.8^{b}	350.0^{a}	1.866	<0.001
SCG3	326.6^{c}	337.9^{b}	361.6^{a}	2.644	<0.001
Log SCC					
SCG1	2.456^{c}	2.477^{b}	2.538^{a}	0.003	<0.001
SCG2	2.482^{c}	2.499^{b}	2.557^{a}	0.002	<0.001
SCG3	2.515^{c}	2.529^{b}	2.559^{a}	0.003	<0.001

a-c: Means within each row with different superscripts are significantly different at $p<0.05$. SCG1 (≤315x10^3 cells/ml), SCG2 (316-335x10^3 cells/ml), and SCG3 (>335 x10^3 cells/ml)

The milk composition of all SCC classes followed the same pattern by lactation stages (Table 5). The fat, protein, and total solids percentages were higher ($p<0.001$) in 150 and 100 days of lactation than in 50 days. The ash, and solid not fat obtained higher percentages ($p<0.001$) in the 150 days of lactation than in 100 and 50 days of lactation in all SCC classes. On the other hand, lactose percentages of SCG1, and SCG2 did not significantly change by stage of lactation, while SCG3 was higher ($p<0.001$) in 150 days than in 50 days of lactation.

***Table 5.** The milk composition of Zaraibi goats with different somatic cell count classes by stages of lactation.*

	Stage of lactation			SEM	P-value
	50 d	100 d	150 d		
Fat, %					
SCG1	3.318^{b}	3.451^{a}	3.539^{a}	0.028	<0.001
SCG2	3.337^{b}	3.481^{a}	3.599^{a}	0.037	<0.001
SCG3	3.479^{b}	3.649^{a}	3.736^{a}	0.026	<0.001
Protein, %					
SCG1	2.906^{b}	2.944^{a}	2.964^{a}	0.007	<0.001
SCG2	2.907^{b}	2.947^{a}	2.972^{a}	0.007	<0.001
SCG3	2.920^{b}	2.968^{a}	2.982^{a}	0.009	<0.001
Lactose, %					
SCG1	4.627	4.636	4.657	0.013	0.293
SCG2	4.629	4.646	4.664	0.011	0.072
SCG3	4.636^{b}	4.651^{ab}	4.667^{a}	0.005	<0.001
Ash, %					
SCG1	0.696^{b}	0.697^{b}	0.706^{a}	0.002	<0.001
SCG2	0.695^{b}	0.697^{b}	0.705^{a}	0.002	<0.001
SCG3	0.701^{b}	0.704^{b}	0.711^{a}	0.002	<0.001
Solids not-Fat, %					
SCG1	8.172^{b}	8.278^{b}	8.360^{a}	0.019	<0.001
SCG2	8.187^{b}	8.281^{b}	8.354^{a}	0.016	<0.001
SCG3	8.259^{c}	8.378^{b}	8.406^{a}	0.010	<0.001
Total solids, %					
SCG1	11.55^{b}	11.74^{a}	11.80^{a}	0.042	<0.001
SCG2	11.54^{b}	11.78^{a}	11.88^{a}	0.053	<0.001
SCG3	11.74^{b}	11.97^{a}	12.11^{a}	0.037	<0.001

a-c: Means within each row with different superscripts are significantly different at $p<0.05$. SCG1 (≤315x10^3 cells/ml), SCG2 (316-335x10^3 cells/ml), and SCG3 (>335 x10^3 cells/ml)

The does' body weight, and kids' growth performance of different somatic cell count classes by stage of lactation are presented in Table 6. The does' body weight of all SCC classes did not statistically change by stage of lactation. However, between 50 days and 150 days of lactation, the kids' body weight increased ($p<0.001$) by about 51.55%, 51.20%, and 52.77%, for SCG1, SCG2, and SCG3, respectively, and the kids' growth rate decreased ($p<0.001$) by about 30.14%, 30.16%, and 26.42%, respectively. However, the kids' weight gain of all SCC classes decreased ($p<0.001$) between 50 days and 100 days of lactation, but thereafter, insignificant differences were found between 100 days and 150 days of lactation.

Table 6. *The productive performance of Zaraibi goats with different somatic cell count groups by stages of lactation.*

	Stage of lactation			SEM	P-value
	50 d	100 d	150 d		
Does body weight, kg					
SCG1	34.06	33.09	33.06	0.739	0.547
SCG2	34.17	33.17	32.94	0.771	0.495
SCG3	32.31	31.50	31.50	0.557	0.498
Kids body weight, kg					
SCG1	6.53 ^{c}	10.28 ^{b}	13.48 ^{a}	0.361	<0.001
SCG2	7.12 ^{c}	11.14 ^{b}	14.59 ^{a}	0.447	<0.001
SCG3	7.08 ^{c}	11.31 ^{b}	14.99 ^{a}	0.491	<0.001
Kids growth rate, g					
SCG1	91.25 ^{a}	76.25 ^{b}	63.75 ^{c}	3.448	<0.001
SCG2	100.53 ^{a}	80.71 ^{b}	70.12 ^{c}	3.805	<0.001
SCG3	99.50 ^{a}	84.71 ^{b}	73.21 ^{c}	4.425	0.001
Kids weight gain, kg					
SCG1	4.450 ^{a}	3.781 ^{b}	3.185 ^{b}	0.171	<0.001
SCG2	5.047 ^{a}	4.053 ^{b}	3.457 ^{b}	0.204	<0.001
SCG3	5.021 ^{a}	4.250 ^{b}	3.659 ^{b}	0.220	<0.001

a-c: Means within each row with different superscripts are significantly different at p<0.05. SCG1 (≤315x10^3 cells/ml), SCG2 (316-335x10^3 cells/ml), and SCG3 (>335 x10^3 cells/ml)

4. Discussion

Comparing the findings of this study with previous research on dairy animals, especially goats, is challenging. This is because most previous studies have focused on SCC concentrations up to the point of mastitis, and their impact on milk yield and its components was evaluated. In contrast, this study was conducted on healthy goats with low levels of somatic cells to identify the threshold at which significant differences in milk yield and components occur. Generally, in this experiment the average SCC values ranged from 286.3±2.43 to 361.6±2.64 x10^3 cell/mL, which are considered far below the threshold values of SCC for Zaraibi goats in previous studies. Despite the absence of wide variations in the SCC values among this study classes, discernible impacts on the examined traits were observed.

The results showed that, over all the lactation stages, the lowest SCC class in current study (SCG1), which corresponded to SCC ≤315x10^3 cells/ml, had daily milk yield, and milk components that were statistically similar to those observed in SCG2 (SCC from 316 to 335 x10^3 cells/ml). The class of SCC > 335x10^3 cells/ml, significantly showed the lowest daily milk yield and the highest values of SCC and log SCC values, and the highest percentages of milk components, compared to the other two SCC classes. Moreover, between 50 and 150 days of lactation, the daily milk yield of SCG3 class decreased by 40.31% compared to 38.61% and 39.49% for SCG1 and SCG2 classes, respectively. These result means that the higher SCC3 class, which produced the lowest daily milk production at 50 days of lactation, is more affected by the loss of milk production at 150 days of lactation, compared to both SCG1 and SCG2 classes, which were lower in SCC values and higher in daily milk production than SCG3 class. However, when moving from SCG1 and SCG2 to SCG3, the average milk loss was higher at 50 days of lactation (0.466 kg milk) then the average milk loss decreased between the classes at 150 days of lactation (0.302 kg). Additionally, the results obtained a strongly negative correlation (p=0.003) between SCC and daily milk yield. The current findings were supported by Kaskous et al. [3], as reviewed several studies results for dairy goats, which indicated that less milk production without infection lead to higher SCC values. However, several experiments have provided evidence to support the theory that the decrease in milk production in goats is likely caused by the impaired competence of the alveolar cells in the mammary gland [3]. Consequently, there is a significant increase in SCC in the milk, indicating that the alveoli have a diminished ability to secrete.

However, the SCC values in currant study increased between 50 and 150 days of lactation by 17.45%, 13.34%, and 9.68% for SCG1, SCG2, and SCG3, respectively. Generally, the explanation for these contradictions is that the increased SCC value at the 150 days of lactation is due to the less daily milk that goats produced at the end of lactation. Similar results have been shown in previous studies, where SCC levels in goat milk tend to increase as lactation progresses. For example, Vacca et al. [13] and Albenzio et al. [14] stated that SCC in goat milk increases as lactation advances. In a study by Corrales et al. [15], it was found that SCC was significantly elevated at the end of lactation, and it was difficult to differentiate between infected and healthy mammary glands based on SCC. It has been suggested that the increase in SCC in milk from goats in the later stages of lactation is due to a dilution effect [16, 17], meaning that the SCC in milk is higher at the end of lactation due to the low milk produced [18, 19]. Thus, the increase in SCC was linked to the progression of lactation in goats, regardless of whether they had an intramammary infection diagnosis. Additionally, a similar trend obtained for goats by Rychtarova et al. [20], the lowest goats' SCC value was at early lactation, and it reached a maximum at the end of lactation. While Kuchtik et al. [2] concluded that the stage of lactation did not have any significant impact on the SCC values of healthy White

Short-haired goats. However, the higher SCC at the end of lactation could be due to an elevation in polymorphonuclear leukocytes and macrophages during this phase, which play a role in the defense of the udder during the dry period [3].

However, when linking the current results of SCC and milk production, it becomes clear that the effect of the negative relationship between them is not only at specific stage of the study but extends when moving through the stages of lactation period. These stages of lactation may lead to an increase in SCC in response to goats' hormonal changes that can affect the udder tissue and milk production. Overall, while lactation stages can potentially influence SCC in goat milk, effective management practices can help to minimize the impact and maintain optimal milk quality and udder health.

The effect of SCC on milk composition in goats is not well established [6]. While some studies on goats have proposed a link between SCC and milk composition, this remains a topic of controversy [7]. Generally, the measured milk composition (fat, protein, and lactose) show a normal trend for Zaraibi goat milk. However, in agreement with current results, Gabr et al. [5] obtained a strong positive correlation between SCC and milk components in Zaraibi goats. The study also found a significant increase in milk composition contains as SCC levels increased beyond 500 x10^3 cells/ml in these goats [5].

Numerous investigations have demonstrated that milk production decreases and the levels of SCC, fat, and protein gradually increase after the lactation peak. The current study also observed similar patterns, with lactation stage significantly affecting all aforementioned traits, which is consistent with the findings of Králíčková et al. [21], Albenzio et al. [14], and Kuchtik et al. [2]. However, Salari et al. [22] did not find any notable impact of lactation stage on either fat or protein content. Kovácová et al. [23] discovered that the fat content in goat milk tends to be notably higher during the early and late stages of lactation compared to the middle stage. Gecaj et al. [24] also observed that protein levels in two goat breeds tended to rise during the later stages of lactation, which was similar to the findings of Kuchtik et al. [25] and could be associated with a reduction in milk volume. However, the effects of SCC on lactose content in goat milk are less clear, with some studies suggesting a negative correlation between SCC and lactose [26-28], while current results have found no significant relationship.

Although the current results showed that there was a decrease in does' body weights in the third SCC class compared to both the first and second SCC classes at all the study stages, statistically these differences were not significant. In addition, the changes in does' body weights by the stages of lactation did not differ significantly for all SCC classes. On the other hand, results showed a significantly negative correlation ($p=0.034$) between does' body weights and SCC values. In agreement with current findings, Gabr et al. [5] indicated a significant negative relationship between the weight of Zaraibi goats and their SCC levels at 90 days of lactation.

At each stage of lactation, results showed a higher growth efficiency for the kids of the third SCC class than both the first and the second SCC classes without any significant differences among the classes. Moreover, the kids' growth performance significantly changed by lactation stages for all the SCC classes. While the SCG3 class, between 50 days and 150 days of lactation, obtained the highest increase of the kids' body weight (52.77%) compared to 51.55% and 51.20% for SCG1 and SCG2 classes, respectively. However, this finding may be interpreted as a response to the birth type and the high concentration of the milk components in the third SCC class, as shown in the results of the study, which could cause better growth of the kids. The litter size was also found to be affected by SCC levels, with Zaraibi goats that suckled more kids having significantly lower SCC values (≤470x103 cells/ml) than those that suckled less kids [5].

5. Conclusion

Current results reported that the threshold of SCC >335×10^3 cells/mL was determined as an indicator of a change in Zaraibi goats' milk production and composition. The effect of SCC class (>335×10^3 cells/mL) on milk composition was more pronounced for percentages of fat, solid not fat, and total solids than protein and lactose. Moreover, it showed more milk loss by lactation stage than lower SCC classes. Therefore, maintaining SCC levels below 335×10^3 cells/mL through effective management control strategies is crucial for maintaining high milk quality and productivity in Zaraibi goats. Nonetheless, this study provides useful insights for dairy farmers and producers to manage their herds and optimize milk production to produce high-quality dairy products.

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