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Highlights on the Effect of Somatic Cell Count on Some Milk Constituents

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Abstract

Increasing somatic cell counts (SCC) in milk has a great effect on the chemical characteristics of milk especially fat, protein, lactose, and casein. So, rapid detection of these changes lead to great improvement of milk investments as, it facilitates mastitis control process. For rapid detection of these changes, Bacsomatic™ instrument was used for SCC determination and Milkoscan™ for determination of fat, protein, lactose, and casein percent. There were significance differences between SCC and fat, protein, lactose and casein as $p \leq 0.0001$. Also, there were negative correlation (r) between SCC and fat, lactose and casein percent while, there was a positive correlation (r) between SCC and protein. So, control measures for prevention of mastitis, increased SCC (scc/ml) and monitoring were suggested to control changes in chemical constituents of milk.

KEYWORDS
Fat, Protein, Lactose, Casein, SCC.

INTRODUCTION

The quality and safety of milk have recently been the focus of extensive investigation worldwide (Gülzari *et al*., 2020). Thus, illustrating the significant contribution of the dairy sector to provide quality and nutritious milk as well as milk products for the growing human population (Didanna *et al*., 2018), as the traditional definitions of milk quality exclusively are related to milk composition such as fat, protein and lactose (More, 2009; Mwendia *et al*., 2018) and the microbiological properties (Opiyo *et al*., 2013). In addition, a growing body of research targeting a single or a collection of criteria or features, such as protein content or somatic cell count (SCC), is reporting changes in quality parameters for the definitions described above (Gülzari *et al*., 2020). As well as social variables like information integration, awareness and milk handling along the value chain are important (Ngasala *et al*., 2015; Restrepo *et al*., 2018). This is crucial because, even while the quality can be determined by utilizing one or more of the ideas discussed above (e.g., direct changes in milk quality), it can also be assumed (e.g., indirect changes in milk quality) as a result of an intervention.

Somatic cell counts (SCC) in milk rise as a result of mastitis, which has a very negative impact on the composition and chemical properties of milk (Guariglia *et al*., 2015).

Additionally, according to Andrade *et al*. (2007), mastitis is the illness that has the most negative impact on dairy farming both in Brazil and globally. It is one of the primary causes of lower milk quality and quantitative losses in milk production. Mastitis causes lesions in the milk-producing epithelial cells, raises somatic cell counts, and increases vascular permeability, all of which lead to a greater passage of substances from the blood into the milk, including sodium, chlorine, immunoglobulins, and other serum proteins (Kitchen, 1981). According to the industry, a high SCC causes issues with milk processing and lower yields because of the low casein, fat, and lactose levels that lead to products with poor quality and stability (Brito, 1999).

One of the most significant disaccharides, lactose is made up of glucose and galactose and is regarded as the main component of cow's milk (Costa *et al*., 2019b). Because milk is the primary source of lactose utilized in industry, researchers have cited their findings to support the use of lactose in the food business (Ferrari *et al*., 2004).

Somatic cell count (SCC) is a measure of the sanitary conditions and management procedures on dairy farms and can be used as a measure of the incidence of mastitis in a herd as well as the quality of milk (Vieira *et al*., 2021). Therefore, keeping an eye on the milk's quality and the condition of the mammary glands helps to reduce any potential financial losses (Mendes *et al*., 2010). Leukocytes, which are made up of scaling cells from the secretory epithelium and defense cells that migrate from the blood to the alveoli during infection, are a component of somatic cells in milk (Machado *et al*., 2000). Leukocyte numbers in milk rise as a result of the immune response when the breast is infected with pathogens (Sá *et al*., 2018).

Urea nitrogen concentration of milk is lower in samples with a high SCC (Hojman *et al*., (2004). Also, high SCC results in decreased economic profit for the producer due to reduced production, higher expenses for medical drugs, and penalties ap-

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plied by dairies (Magalhães *et al*., 2006). The goal of the current study was to study the relationship between somatic cell count (SSC) and the chemical components of milk.

MATERIALS AND METHODS

Sample collection

A total of 300 samples of milk were collected from apparently healthy German Holstein cow's that belong to dairy farms located in El Menoufia Governorate, during the period from December 2022 until March 2023. The samples were collected in vials under complete sterile condition with complete identification then placed in ice box, then transferred to Animal Health Research Institute lab without any delay.

Analysis of somatic cell count

The somatic cell count was analyzed in milk samples (20 mL) by flow cytometry using BacSomatic™ 6007 5318. The results were expressed as somatic cells per milliliter (SC/mL) $\times 10^3$.

Analysis of chemical composition

Using a MilkoScanTM FT1, the analytical principle was used to assess the levels of fat, protein, lactose, and casein. This approach is based on how differently the components of milk absorb infrared wavelengths. Percentages (%) were used to express the results.

Statistical analysis

A completely randomized design for the experiment was followed. Individual means were compared using Tukey's test at a $p<0.0001$ probability level. Descriptive statistics such as minimum, maximum values and coefficient of variance of milk components were determined using the Excel (2010) statistical software. The correlation matrix between fat, protein, lactose and casein were compared to the levels of SCC (r) using graph pad prism 8.0.2.

RESULTS

The data evaluated in Table 1 showed that the minimum values of chemical constituent of milk (fat, protein, lactose, casein) were 2.92%, 2.83%, 4.1%, and 2.2%, respectively while, the minimum value of SCC in milk was 139 (SC/ml$\times 10^3$). Furthermore, the maximum values of chemical constituent of milk (fat, protein, lactose, casein) were 3.98%, 3.57%, 4.8%, and 2.63%, respectively while, the maximum value of SCC in milk was 1999 (SC/ml$\times 10^3$). These changes between minimum and maximum are related to changes in SSC as the correlation factor between chemical constituent of milk and SCC differed especially at three different levels of SCC (Table 2). As seen in Fig. 1, the SCC was less than 200 SC/ml and the results showed great significance difference p <0.0001 between SCC and chemical constituent of milk. Also there was a negative correlation between SCC and (fat, lactose and casein) as factor (r) was -0.97, -0.98, -0.98, respectively. While there was a positive correlation between SCC and protein as (r) factor was 0.95.

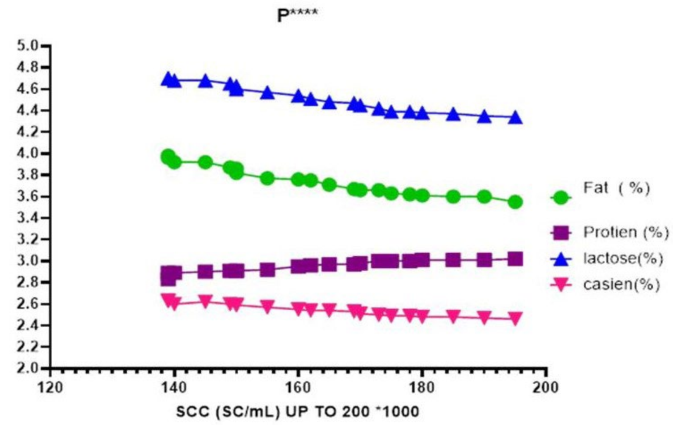

Fig. 1. Correlation between SCC of <200000 cells/ mL and fat, protein, lactose and casein (%).
P**** = p≤0.0001

Table 1. Descriptive statistics of fat, protein, lactose, casein and somatic cell count (SCC) in milk samples.

Parameter	Fat (%)	Protein (%)	Lactose (%)	Casein (%)	Somatic cell count (SC/mL) $\times 10^3$
Minimum	2.92****	2.83****	4.1****	2.2****	139****
Maximum	3.98****	3.57****	4.8****	2.63****	1999****
Mean	3.37	3.13	4.46	2.42	472.02
SD	0.33	0.19	0.2	0.13	442.59
CV	9.95	5.95	4.48	5.19	93.77

SD: Stander deviation; CV: Coefficient of variance; **** = p≤ 0.0001

Table 2. the effect of different levels of SCC on Chemical composition of milk (fat, protein, lactose and casein).

Groups	Fat (%)	Protein (%)	Lactose (%)	Casein (%)	SCC(sc/ml) $\times 10^3$
Up to 200 (sc/ml) $\times 10^3$	3.73 ± 0.14^a	2.96 ± 0.05^a	4.57 ± 0.14^a	2.54 ± 0.06^a	165.19 ± 18.66^a
Correlation coefficient (r)	-0.97	0.95	-0.98	-0.98	
From 201 to 600 (sc/ml) $\times 10^3$	3.24 ± 0.16^b	3.14 ± 0.07^b	4.53 ± 0.13^b	2.39 ± 0.10^b	380.25 ± 123^b
Correlation coefficient (r)	-0.95	0.92	-0.94	-0.96	
Above 600 (sc/ml) $\times 10^3$	2.96 ± 0.03^c	3.39 ± 0.13^c	4.18 ± 0.06^c	2.25 ± 0.03^c	1161.91 ± 429^c
Correlation coefficient (r)	-0.93	0.94	-0.87	-0.94	

Means within a column with different superscripts differ (P<0.0001). Values are given as Mean ± Standard deviation (SD).

Moreover, data seen in Fig. 2 Showed that SCC was from 200 to 600 (SC/ml×10^3) showed great significance difference p<0.0001 between SCC and chemical constituent of milk. Also there was negative correlation between SCC and (fat, lactose and casein) as (r) factor was -0.95, -0.94, -0.96, respectively. While there was positive correlation between SCC and protein as (r) factor was 0.92.

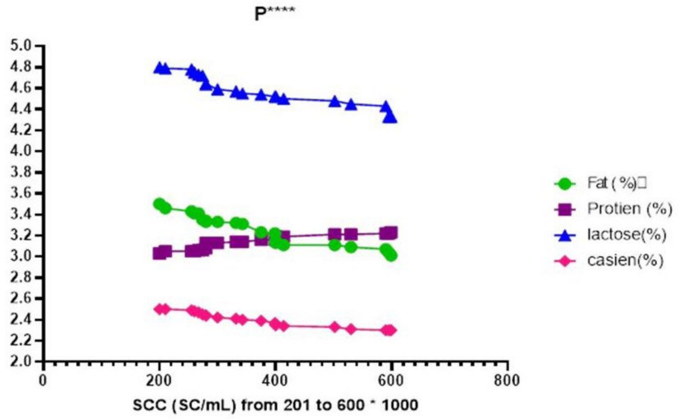

Fig. 2. Correlation between SCC from 201000 to 600000 cells/ mL and fat, protein, lactose and casein (%).
P**** = p≤0.0001

Also, data seen in Fig. 3 revealed that SCC was over 600 (SC/ml×10^3) and showed great significance difference p <0.0001 between SCC and chemical constituent of milk. Also there was negative correlation between SCC and (fat, lactose and casein) as (r) factor was -0.93, -0.87, -0.94, respectively. While there was positive correlation between SCC and protein as (r) factor was 0.94.

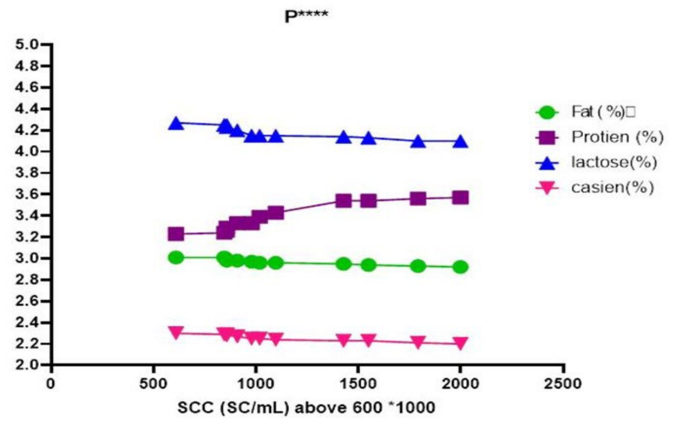

Fig. 3. Correlation between SCC above 600000 cells/ mL and fat, protein, lactose and casein (%).
P**** = p≤0.0001

DISCUSSION

Cow's milk is a nutrient-dense, chemically complicated fluid containing hundreds of different components. The most important constituent are fat, protein, lactose and casein (Foroutan *et al.*, 2019). In the past many researches directed to improve milk quality and safety worldwide. But, these studies only consider a small subset of bacteriological characteristics when assessing milk quality (Gülzari *et al.*, 2020) while, SCC contribute more importance as it directly affected the chemical constituent of milk (Guariglia *et al.*, 2015).

In the present study fat percent decreased with increasing SCC as there were negative correlation between SCC (sc/ml) and fat %. Moreover, there was great significance difference p <0. 0001 also appeared between SCC (sc/ml×10^3) and fat %. High SCC in milk that related to mastitis contained high level of lipase enzyme that leads to fat degeneration. Similar results obtained by Sharma *et al.* (2011) who examined the effect of SCC at different concentrations on fat percent and reported that the fat % decrease from 3.74 to 3.13(%) when SCC increase from 100×10^3 to 1000×10^3 (cells/ml) also, Isae, and Kurtu (2018) mentioned that fat % decrease due to increase of SCC that affected the fatty acids content of milk. Different results reported by Rangel *et al.* (2009) who revealed that the percentage of fat increased with increasing SCC when the authors evaluated the correlation between the SCC and milk components due to decrease milk yield. Furthermore, Malek dos Reis *et al.* (2013) revealed that there is no correlation between fat % and SCC.

Protein percent increased with increasing SCC as there were positive correlation between SCC (sc/ml) and protein %. This rise has been related to the import of blood proteins such serum albumin and immunoglobulins (low-quality protein) (Andrews *et al.*, 2003). These plasma proteins travel to the inflammatory site to condense the infection, which causes the milk protein percentage to increase. This has a significant impact on the protein content of milk. However, the presence of these proteins should not be taken into account when assessing the quality of milk (Pereira *et al.*, 1999). Many writers, including Noro *et al.* (2006); Sharma *et al.* (2011) and Isae and Kurtu (2018) observed that protein percentage increased with increased SCC levels. Additionally, Taffarel *et al.* (2010) noted that protein values ranged from 3.15 to 3.17 percent when analysing the impact of various five SCC intervals on the composition of milk. Lactose is considered as one of the most important chemical milk constituents that attributed to raw milk quality while the hygienic status of milk attributed to SCC (More, 2009) so, decrease levels of milk lactose is used for early identification of subclinical mastitis that set SSC equal 1×105 cells/mL) so, Lactose concentration in cows' milk was positively associated with their reproductive success (Televičius *et al.*, 2021).

Due to alterations in the homeostasis of the mammary glands, the number of somatic cells increased and was accompanied by a drop in lactose % in milk during subclinical mastitis (Pessoa *et al.*, 2012). In addition, Miglior *et al.* (2007) discovered that lactose had a negative correlation with milk's SCC number. Berglund *et al.* (2007) revealed that a decrease in lactose (from 4.86 to 4.69) is related with an increase in SCC (from 3.1×104 to 4.5×105 somatic cells/mL).

It is well accepted that mastitis causes a decrease in the concentration of milk lactose (Andrews *et al.*, 2003; Malek dos Reis *et al.*, 2013; Isae and Kurtu, 2018).

The impact of SCC on casein, lactose, and protein was also evaluated by Raynal-Ljutovac *et al.* (2007). According to Bansal *et al.* (2005), healthy quarters had a higher lactose content (5.02%) than quarters with an SCC of more than 100,000 cells/ml and a negative culture (non-specific mastitis) (4.71%). The negative Pearson correlation between milk lactose concentration and SCS (- 0.471) with p <0.001) was also noted by Antanaitis *et al.* (2021). Additionally, a rise in lactose supports a negative correlation between milk SCC and p<0.001. Furthermore, Costa *et al.* (2019a) found that cows with a lactose content of 4.553% or less had more severe health issues than cows with a lactose content of 5.045% or more. A correlation of r=-0.518 exists between milk lactose and subclinical mastitis.

Similar to Forsbäck *et al.* (2010) and Ramos *et al.* (2015) who explained that the reason for such findings can be attributed to mastitis as there is increase in the permeability of the blood-milk barrier that results in an increased influx of proteins from serum of blood and leads to an increase in proteolysis, the results of our study showed that an increase in the SCC is associated with a decrease in casein percentage milk.

Additionally, higher SCC in milk causes heightened plasminogen activation into plasmin, which in turn causes increased casein proteolysis (Fox and Kelly, 2006). Additionally, the findings of Bobbo *et al.* (2017); Ottalwar *et al.* (2018) and Ahmed *et al.* (2021) who discovered a significant difference (p≤0.0001) and negative connection between the count of SCC and casein percentage in milk, agreed with the low casein% in cases with high SCC in milk.

CONCLUSION

SCC affects the chemical constituent of milk especially protein, fat, lactose and casein. Increasing SCC leads to percentage. Also, the study indicated the great importance for rabid increase of protein percentage and decrease of fat, lactose and casein detection of milk constituents' changes as SCC, protein, fat, lactose and casein that can impair milk investments.

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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