Acta Univ. Sapientiae, Alimentaria, **8** (2015) 45–54

Somatic cell count of milk from different goat breeds

J. Csanádi
e-mail: csanadi@mk.u-szeged.hu

J. Fenyvessy
e-mail: fessy@mk.u-szeged.hu

S. Bohata

University of Szeged, Faculty of Engineering,
Department of Food Engineering 6724 Szeged, Mars Sq. 7, Hungary

Abstract. There is no standard limit value for somatic cell count (SCC) of raw goat milk in the EU despite that excellent hygienic quality milk is needed for the manufacture of fermented milk products or cheese varieties. Mastitis often results such high SCC – besides the potential risk for humans – that the clotting of milk will not be perfect, resulting slack curd with higher whey releasing; furthermore, wrong structure, ripening, bad sensory properties of cheese can also be its consequences. In this paper, we report the SCC of milk samples from five different goat breeds bred in Hungary, measured with two fast methods compared with the results from the reference method. Furthermore, we investigated the applicability and the accuracy of the MT-02 (Agro Legato Ltd., Hungary) instrument. We determined that the White Side test and the instrument MT were suitable for the estimation of possible risks and consequences in the case of the use of high SCC milk before production. The general summarized average milk SCC was $6.64 \times 10^5\,\mathrm{ml}^{-1}$. The highest difference between the results from MT-02 and the fluorometric (reference) method was $5 \times 10^5\,\mathrm{ml}^{-1}$, but it was a singular, extreme value. The r^2 of the calculated linear calibration equation was 0.7819; consequently, this method seems to be applicable in the measurement of SCC with MT-02 instrument. Furthermore, the SCC of samples did not differ significantly by genotypes and by seasons (spring: $5.85 \times 10^5\,\mathrm{ml}^{-1}$, autumn: $6.22 \times 10^5\,\mathrm{ml}^{-1}$).

Keywords and phrases: SCC, goat milk, fast test.

1 Introduction

The popularity of milk products – mainly cheeses – from goat milk having high physiological value shows a rising tendency. Mainly soft cheeses are made from goat milk and they show a high variety of shape, size and flavouring. Usually, goat milk is processed in small creameries (farmer creameries) by hand on the base of the traditions regarding the consumers' demands. The fermentation ability of milk is a very important criterion of cheese making.

The fermentation ability of milk and the quality of cheese are also decisively influenced by the hygienic quality of raw milk (*Unger*, 2001). One of these hygienic properties is Somatic Cell Count (SCC), which has a strict regulation for limit values in many countries (e.g. $4 \times 10^5\,\mathrm{ml}^{-1}$ for cow milk). However, in most of the countries, the SCC of raw goat milk is not regulated. The SCC of milk has been strongly investigated also by many Hungarian researchers in the past; so, nowadays, we already have knowledge related to the adverse effects of mastitis and subclinical mastitis on cheese making (*Merényi, Wágner*, 1985; *Gulyás*, 2002; *Varga*, 2008).

Several researchers reported a close relationship between the high SCC of milk and cheese yield and the losses of constituents in whey (*Barbano et al.*, 1991; *Politis* & *Ng-Kwai-Hang*, 1988; *Mitchel et al.*, 1986). Similar observations were also published by some researchers (*Kukovics et al.*, 1995; *Zeng* & *Escobar*, 1995; *Pajor et al.*, 2009; *Chen et al.*, 2010) in the case of goat milk, having proved the fast determination of SCC of raw goat milk, essentially for making fermented milk products and cheeses. So, there is a need for fast methods – due to the specialty of small-scale milk processing and the lack of regulation – in order to select the goat milk with very high SCC because this milk can be mentioned as unsuitable for cheese making.

Our goal was monitoring the SCC of raw milk samples from different goat breeds and from different lactation periods. White Side test and MT-02 instrument (Agro Legato, Budapest, Hungary) were used for SCC determination. Additionally, we evaluated the applicability and the precision of MT-02 instrument – a fast test for the SCC determination. For this aim, calibration samples data were used from official fluoro-optical method (Fossomatic instrument).

2 Materials and methods

Materials

The samples were collected from two farms located on the Hungarian Great Plain. Kidding was scheduled for spring (February-March) in both farms. Samples were collected from ten Alpine and ten Saanen goats in spring and in autumn on three occasions in the first farm. Samples were collected in the second farm from Alpine and from Alpine x Saanen cross-bred goats also in spring and autumn, but only in autumn from Native goats.

Goats were milked by hand twice a day. Samples were prepared by mixing of morning and evening individual milk and they were refrigerated at 5 °C until investigation. The samples were investigated in the laboratory of the Department of Food Engineering at the Faculty of Engineering, University of Szeged, Hungary. The calibration samples were investigated at the Hungarian Dairy Research Institute Ltd., Budapest, Hungary.

Methods

White Side test

The White Side test is based on the complex molecule formation between the sodium-hydroxide and the DNA of somatic cells, and then the denaturation phenomenon. Samples can be evaluated with naked eyes based on the ratio of denaturation (*Szakály*, 1966). The milk is accepted (the test is negative; ("-") if there is no change in any visible milk properties, including consistency. The result is positive ("+") if visible small (clumping) particles appear in the sample (approx. of 0.5 mm in diameter, like semolina). In this case, the SCC is between $2.5 \times 10^5\,\mathrm{ml}^{-1}$ and $1.0 \times 10^6\,\mathrm{ml}^{-1}$. The used samples enter only these two classification groups in the evaluation.

MT-02 instrument

The principle of this test is very similar to the White Side test. The SCC determination is based on the change of the viscosity of the milk sample. 10 ml of milk sample (37 °C) has to be mixed with 5 ml 20% reagent (diluted with distilled water) rapidly; then it has to be filled into the funnel and measuring has to start immediately. The structure of the instrument is very similar to a Höppler viscometer: the viscometer pipe is rotated to an adjusted angle after 20 sec. The results can be read from the scale built in the pipe. The measuring range is $10 \times 10^3 - 2 \times 10^6\,\mathrm{ml}^{-1}$. This method was developed for cow milk measuring; so, we had to make a calibration for goat milk with known SCC goat milk samples. For this purpose, first of all, twenty Saanen goat milk samples were investigated both with MT-02 instrument and with official fluoro-optical method (Fossomatic).

3 Results and discussion

Estimation of the applicability of MT-02 instrument, calibration

In order to evaluate the accuracy of data from MT-02 instrument, we measured 20 raw milk samples from Saanen goats. The samples were measured first by MT-02 instrument, and then the selected 10 samples that seemed to be useable were sent to the official laboratory. After receiving the data, we looked for the correlation between the data groups obtained with different methods. Our hypothesis was that if the correlation is sufficiently close, by using this correlation equation and the data from the MT-02 instrument, we can create similarly acurate data as those obtained with the reference method. *Figure 1* shows the founded correlation between the official data and the data from the MT-02 instrument. The acceptable determination coefficient of this linear trend line gives us a chance to receive a more precise evaluation of the SCC of goat milk as compared to the White Side test. The presented correlation equation was used for SCC determination in the further investigation.

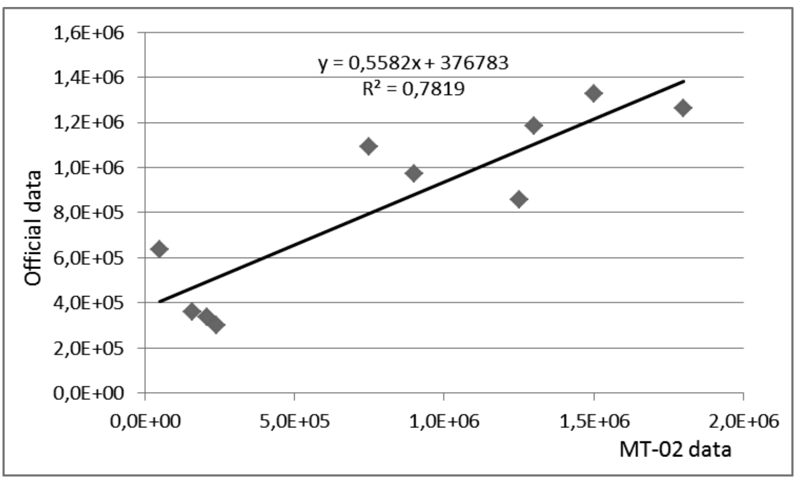

Figure 1: Correlation between official data and MT-02 data

Results from different goat breeds

The average SCC of all measured samples determined with MT-02 was $5.69 \times 10^3\,\mathrm{ml}^{-1}$, but the values varied within a very wide range. The summarized data of all measured samples are presented in *Table 1.*

Table 1: Comparison of the original MT-02 and the modified data, using explored calibration (n=116)

"Method"	Average ($10^3\,\mathrm{ml}^{-1}$)	Variation ($10^3\,\mathrm{ml}^{-1}$)	CV (%)
Original MT-02 data	569	669	117.5
Data from calibration	665	365	54.9

30% of samples did not fit in the measurement range – which was $1.0 \times 10^3\,\mathrm{ml}^{-1}$ $-2.0 \times 10^6\,\mathrm{ml}^{-1}$ – maybe due to the abnormal composition of milk samples, causing extreme low or extreme high milk viscosity. We did not investigate the reasons of this phenomenon; consequently, we have no proper explanation for this. According to our results, the SCC values from MT-02 were underestimated. The calibrated SCC average was "only" $9.5 \times 10^5\,\mathrm{ml}^{-1}$ higher than the original MT-02 value, but the difference between the data pairs from the different methods showed a very high variation ($5.0 \times 10^4 - 5.0 \times 10^5\,\mathrm{ml}^{-1}$).

Anisity (2008) investigated the precision of the MT-02 instrument, measuring cow milk samples, and determined a $1.18 \times 10^5\,\mathrm{ml}^{-1}$ average difference from the official data. Our calculated difference stands very close to his data, suggesting that MT-02 can be used also for measuring the SCC of goat milk, but mainly below the $1 \times 10^6\,\mathrm{ml}^{-1}$ SCC value. We explain this limited application with the special resolution of the scale of the instrument because its resolution is fine enough only below $1 \times 10^6\,\mathrm{ml}^{-1}$ value and – due to the limited number of samples – we were not able to use an optimal sample series for the calibration.

The smallest difference between the official and the MT-02 data was explored in the range of $5.0 \times 10^5\,\mathrm{ml}^{-1} - 8.0 \times 5 \times 10^5\,\mathrm{ml}^{-1}$. We strongly suggest taking these comments into consideration, reviewing our detailed results.

Alpine goats

The milk samples from the Alpine goats were measured in spring and autumn on both goat farms (*Table 2*). The first sampling was carried out during the suckling period in farm "A".

Table 2: SCC of milk samples from Alpine goats ($10^5\,ml^{-1}$) n = 120

	Farm A		Farm B	
	Autumn	Spring	Autumn	Spring
Min.	3.80	4.90	3.90	2.60
Max.	11.00	14.00	8.60	12.00
Average	**7.28**	**9.25**	**5.90**	**5.78**
Variation	3.50	4.76	2.69	3.02
CV%	48.08	51.46	45.59	52.25
WST (%)	**67.90**	**63.40**	**70.80**	**68.80**

Data represent the result of White Side tests and they show the summarized ratio (%) of negative and "+" samples: estimated SCC $< 1.0 \times 10^6\,ml^{-1}$.

The SCC averages of Farm B from spring and autumn were very similar. We noticed that one of the samplings was carried out before the separation of the kids. Furthermore, the SCC average value of this sampling was lower than the summarized average from this farm; consequently, the suckling had no adverse effect on the SCC of milk; it did not cause SCC increase.

The average SCC values on Farm A were higher than on Farm B, but none of the averages exceeded the $1 \times 10^6\,ml^{-1}$ threshold. This result differs from *Varga's* (2008), who explored higher SCC than $1 \times 10^6\,ml^{-1}$ in the case of all investigated samples from refrigerated storage. In our investigation, only 28% of the Alpine goats' milk samples have reached this limit. This result can be mentioned as a good result regarding the large number of samples exceeding the measuring limit of the MT-02 instrument during our whole experiment.

Other breeds

The SCC averages of samples from Hungarian White goats presented much higher values (*Table 3*). Most frequently, mastitis was explored in the population of this breed. Higher SCC values were typical, and we found more samples displaying extremely high SCC at each sampling. Extreme viscosity increase and stickiness were explored. In the case of the extreme samples, adding the reagent to the milk made measuring impossible.

Results of Native, Saanen and Alpine x Saanen cross-bred goats are presented in *Table 4*. Native goats varied very much regarding the horn and colour varieties. There were black & white, fawn-coloured, grey and white goats as well. The results from Native goats showed the highest variation.

Table 3: SCC of milk samples from Hungarian white goats ($10^5\,ml^{-1}$) n = 90

	July	August	September	Average
Min.	3.60	5.80	5.60	5.00
Max.	9.30	11.00	17.00	12.40
Average	**6.93**	**9.05**	**11.2**	**9.06**
Variation	3.54	2.94	5.07	3.85
CV%	51.08	32.49	45.27	42.49
WST	**71.80**	**63.20**	**57.40**	**64.10**

Data represent the result of White Side tests and they show the summarized ratio (%) of negative and "+" samples: estimated SCC $< 1.0 \times 10^6\,ml^{-1}$.

Table 4: SCC of samples from Native, Saanen and Alpine x Saanen cross-bred goats ($10^5\,ml^{-1}$) n = 150

	Native		Saanen		Alpine x Saanen cross-bred	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
Min.	2.10	nd	4.90	1.80	1.60	5.90
Max.	8.20	nd	8.10	8.80	9.20	9.60
Average	**6.87**	**nd**	**6.22**	**5.85**	**5.91**	**8.87**
Variation	3.24	nd	2.95	3.10	3.17	2.63
CV%	47.16	nd	47.43	52.99	53.64	29.65
WST	48.20	nd	73.40	75.10	69.80	61.10

Data represent the result of White Side tests and they show the summarized ratio (%) of negative and "+" samples: estimated SCC $< 1.0 \times 10^6\,ml^{-1}$.
nd= There is no data.

Evaluating our results, we can mention that these results are very similar to the results of certain cited Hungarian foreign authors (*Turin et al.*, 2004; *Gomes et al.*, 2006; *Stella et al.*, 2007). But our SCC averages do not reach the results published by *Garcia-Hernandez* et al. (2006) and *Delgado-Petrinez* et al. (2003). Furthermore, the different authors, including us, agree that the SCC of goat milk is higher than that of the cow milk, but goats may not suffer from mastitis. This observation also implies that there is not a very close relationship between the SCC of milk and the health condition of goats, contrary to the cows. The instrument seemed to be the most precise between the SCC range of $4.0 - 8.0 \times 10^5\,ml^{-1}$.

The results of the White Side tests also proved that the SCC of goat milk (can be called as good, quality milk) can well exceed the SCC of cow milk. The action limit (threshold) for the SCC of goat milk is $1 \times 10^6\,\mathrm{ml}^{-1}$ in the USA. This can be explained by the different physiology and different milk secretion mechanisms of the goats and cows (*Mc Dougall* &, *Voermans*, 2002). Regarding the results of the White Side tests, it is presumable that the "negative" and "+" samples give 60-70% of all goat milk on a typical goat farm. But it is very important to mention that the milk having "++" or "+++" White Side test classification has a limited value, it exceeds the $1 \times 10^6\,\mathrm{ml}^{-1}$ SCC value in every case, it is not homogenous and it contains sticky and mucous precipitations very often. We can confirm that goat milk having very high SCC, as mentioned above, is not suitable for making fermented goat milk products. Furthermore, it is absolutely sure that very high SCC goat milk (with serious precipitations) is not suitable for making any milk product. Based on our result, we agree with the suggestion of *Zeng* (1996), who offered different standards (made from goat milk and not from cow milk) for the calibration of SCC measuring instruments. Additionally, the producer should create a new scale of MT-02 instrument for measuring goat milk samples. There is a need to investigate a huge number of samples in future research to refine the precision of this method, and we suggest the exclusive application of the range of $2.0 \times 10^5\,\mathrm{ml}^{-1} - 1.5 \times 10^6\,\mathrm{ml}^{-1}$ in order to attain the highest reliability.

References

[1] M. Anisity, Tehéntej szomatikus sejtszáma gyorsvizsgálati módszereinek összehasonlítása. *Szakdolgozat*, Szegedi Tudományegyetem Mérnöki Kar. (2008) 28–41.

[2] D. M. Barbano, R. R. Rasmussen, J. M. Lynch, Influence of milk somatic cell count and milk age on cheese yield. *Journal of Dairy Science*, 74. (1991) 369–388.

[3] S. X. Chen, J. Z. Wang, J. S. Van Kessel, F. Z. Ren, S. S. Zeng, Effect of somatic cell count in goat milk on yield, sensory quality, and fatty acid profile of semisoft cheese. *Journal of Dairy Science*, 93. (2010) 1345–1354.

[4] M. Delgado-Pertinez, M. J. Alcalde, J. L. Guzmán-Guerrero, J. M. Castel, Y. Mena, F. Caravaca, Effect of hygiene-sanitary management on goat milk quality in semi-extensive systems in Spain. *Small Ruminant Research*, 47. (2002) 51–61.

[5] R. Garcia-Hernandez, G. Newton, S. Horner, C. Nuti Lou, Effect of photoperiod on milk yield and quality, and reproduction in dairy goats. *Livestock Science*, 110. (2006) 214–220.

[6] V. Gomes, A. M. Libera, M. Paiva, K. Medici Madureira, W. P. Araújo, Effect of the stage of lactation on somatic cell counts in healthy goats (Capraehircus) breed in Brazil. *Small Ruminant Research*, 64. (2006) 30–34.

[7] L. Gulyás, A nyerstej szomatikus sejtszámát befolyásoló néhány biológiai és környezeti tényező vizsgálata. *Doktori értekezés*, Mosonmagyaróvár. (2002) 83–122.

[8] G. F. W. Haenlein, Relationship of somatic cell counts in goat milk to mastitis and productivity. *Small Ruminant Research*, 45. 2. (2002) 163–178.

[9] S. McDougall, M. Voermans, Influence of estrus on somatic cell count in dairy goats. *Journal of Dairy Science*, 85. (2002) 378–383.

[10] S. Kukovics, A. Molnár, M. Ábrahám, T. Schuszter, Phenotypic correlation between the somatic cell A count and milk components. Influence of somatic cell count in goat milk on yield and quality of soft cheese. *Proceedings of the IDF/Greek National Committee of IDF/CIRVAL Seminar on Production and Utilization of Ewe and Goat Milk.* (1995) 135–141.

[11] I. Merényi, A. Wágner, A szubklinikailag enyhén megváltozott összetételű tejek megtévesztő hatása a tenyésztői – és ezzel kapcsolatos egyéb – munkákra. *Tejipar*, 34. 1. (1985) 5–8.

[12] G. E. Mitchell, I. A. Fedrick, S. A. Rogers, The relationship between somatic cell count, composition and manufacturing properties of bulk milk. *Australian Journal of Dairy Technology*, 41. (1986) 12–14.

[13] F. Pajor, Sz. Németh, L. Gulyás, F. Barcza, P. Póti, A tőgybimbó alakja és a kecsketej néhány minőségi tulajdonságának kapcsolata. *Animal Welfare, Etológia és Tartástechnológia*, 5. 4. (2009) 218–224.

[14] I. Politis, K-F. Ng-Kwai-Hang, Effects of somatic cell count of milk and composition on cheese composition and cheese making efficiency. *Journal of Dairy Science*, 71. (1988) 1711–1719.

[15] A. V. Stella, R. Paratte, L. Valnegri, G. Cigalino, G. Soncini, E. Chevaux, V. Dell'Orto, G. Savoini, Effect of administration of live Saccharomyces cerevisiae on milk production, milk composition, blood metabolites, and faecal flora in early lactating dairy goats. *Small Ruminant Research*, 67. (2007) 7–13.

[16] S. Szakály, A Whiteside próba alkalmazása a tehenek tőgygyulladásának felismerésére és a szekréciós hibájú (masztitiszes) tej szelektálására. *Brossura. Tejipari Válallatok Trösztje Tejtermék Ellenőrző Állomása*. Budapest. (1966) 1–21.

[17] L. Turin, G. Pisoni, M. L. Giannino, M. Antonini, S. Rosati, G. Ruffo, P. Moroni, Correlation between milk parameters in CAEV seropositive and negative primiparous goats during an eradication program in Italian farm. *Small Ruminant Research*, 57. (2004) 73–79.

[18] A. Unger, A nyerstej minősége, minősítése és ára. In: S. Szakály (ed.), *Tejgazdaságtan*. Dinasztia Kiadó, Budapest, (2001) 115–119.

[19] Y. Vahid, J. Kóbori, Korszerű tejtermelés és feldolgozás. *Szaktudás Kiadó Ház*, Budapest. (2003) 99.

[20] L. Varga, Kecsketej mikrobiológiai-higiéniai és fizikai-kémiai jellemzőinek alakulása a laktáció során, a fejéstől a hűtve tárolásig (Changes in microbiological-hygienic and physical-chemical properties of goat's milk during lactation from milking to refrigerated storage). *Tejgazdaság*, 68. 1–2. (2008) 83–91.

[21] S. S. Zeng, E. N. Escobar, Influence of somatic cell count in goat milk on yield and quality of soft cheese. *Proceedings of the IDF/Greek National Comittee of IDF/CIRVAL Seminar on Production and Utilization of Ewe and Goat Milk*. (1995) 109–113.

[22] S. S. Zeng, Comparison of goat milk standards with cow milk standards for analyses of somatic cell count, fat and protein in goat milk. *Small Ruminant Research*, 21. 3. (1996) 221–225.