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SUSTAINABLE GOAT BREEDING AND GOAT FARMING IN CENTRAL AND EASTERN EUROPEAN COUNTRIES

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SOMATIC CELL COUNT OF MILK FROM DIFFERENT GOAT BREEDS IN HUNGARY

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Abstract

There is no standard limit value for the somatic cell count (SCC) of raw goat milk in the European Union (EU) despite the need to have milk of very high hygienic quality for the manufacture of fermented milk products and cheeses. Mastitis often results in high SCCs, which – besides the potential risk for humans – cause imperfect milk clotting resulting in slack curd with higher whey releasing properties. Cheese of poor structure and ripening, and bad sensory properties can be the consequence. This study reports on the SCCs of milk samples from five goat breeds in Hungary, measured through two rapid methods and compared with the results from the reference method. The study investigated the applicability and accuracy of the MT-02 02 (Agro Legato Ltd., Hungary) instrument. The authors found that the Whiteside test and the MT-02 instrument were suitable for estimating possible risks and consequences of high SCC in milk before it is processed. The general summarized average milk SCC was 6.64 x 105 ml-1. The greatest difference between the results from MT-02 and the fluoro-optical (reference) method was 5 x 105 ml-1, but this was an isolated extreme value. The r2 of the calculated linear calibration equation was 0.7819; consequently, the MT-02 instrument seems to be appropriate for measuring SCC. The SCCs of the samples did not differ by genotype or season (spring: 5.85 x 105 ml-1; autumn: 6.22 x 105 ml-1).

Key words: SCC, goat milk, rapid test

Introduction

The popularity of milk products – mainly cheeses – made from goat milk with high physiological value, is rising. Mainly soft cheeses are made from goat milk, and they come in a wide variety of shapes, sizes and flavourings. The goat milk is usually processed at small creameries (farmers' creameries) by hand and based on traditional methods, in line with consumers' demand.

The fermentation ability of milk is a very important criterion in cheese making. Both it and the quality of cheese are decisively influenced by the hygienic quality of raw milk (Unger, 2001). The somatic cell count (SCC) reflects these hygienic properties and is strictly controlled through directives giving its limit value in many countries (e.g. 4 x 105 ml-1 for cow milk). However, in most countries there is no regulation of the SCC of raw goat milk. The SCC of milk has been widely investigated by Hungarian researchers, contributing important knowledge on the adverse effects of mastitis, and subclinical mastitis on cheese making (Merényi and Wagner, 1985; Gulyas, 2002; Varga, 2008).

Other researchers have published findings on the close relationship between high SCC in milk and cheese and losses of the constituents in whey (Barbano, Rasmussen and Lynch, 1991; Politis and Ng-Kwai-Hang, 1988; Mitchell, Fedrick and Rogers, 1986). Similar observations published by researchers investigating goat milk proved that rapid determination of the SCC of raw goat milk is essential when making fermented milk products and cheeses (Kukovics et al., 1996; Zeng and Escobar, 1996; Pajor et al., 2009; Chen et al., 2010). Because of the special nature of small-scale milk processing and the lack of regulation, rapid methods are needed to identify goat milk with very high SCCs, which is of poor quality and not suitable for cheese making.

The objective of the research was to monitor the SCCs of raw milk samples from different goat breeds and in different lactation periods. The Whiteside test and the MT-02 instrument (Agro Legato, Budapest, Hungary) were used for SCC determination. The applicability, and precision of the MT-02 instrument for rapid SCC determination was also evaluated, using data from the official fluoro-optical method (Fossomatic instrument) for benchmarking.

Materials and methods

Materials

Samples were collected from two farms on the Great Hungarian Plain. Kidding was scheduled for spring (February–March) on both farms. At farm A, samples were collected on three occasions from ten Alpine and ten Saanen goats in the spring and autumn; and on three occasions from ten Hungarian White goats in July, August and September. At farm B, samples were collected from ten Alpine and ten Alpine x Saanen cross-bred goats in spring and autumn; and only in autumn from ten domestic (native) goats. Goats were hand-milked twice a day. Samples were prepared by mixing the morning and evening milk of individual goats, and were stored at 5 °C until classification. The samples were investigated at the laboratory of the Department of Food Engineering, Faculty of Engineering, University of Szeged, Hungary. Samples used for calibrating the MT-02 instrument were investigated at the Hungarian Dairy Research Institute (HDRI), Budapest, Hungary.

Methods

Whiteside test

The Whiteside test is based on the complex molecule relation between the sodium hydroxide and DNA of somatic cells, and the denaturation phenomenon. Evaluation is based on the ratio of denaturation as determined by the naked eye (Szakály, 1966). Milk is accepted (the result is negative) if there is no visible change in any of its properties, including consistency. The result is positive if visible small particles of approximately 0.5 mm in diameter (similar to semolina) appear in the sample (clumping). In these cases, the SCC is between 2.5 x 105 ml-1 and 1.0 x 106 ml-1. Only samples with values between these two classifications were used in the evaluation.

MT-02 instrument

The principle of this test is very similar to that of the Whiteside test. SCC determination is based on changes in the viscosity of the milk sample.

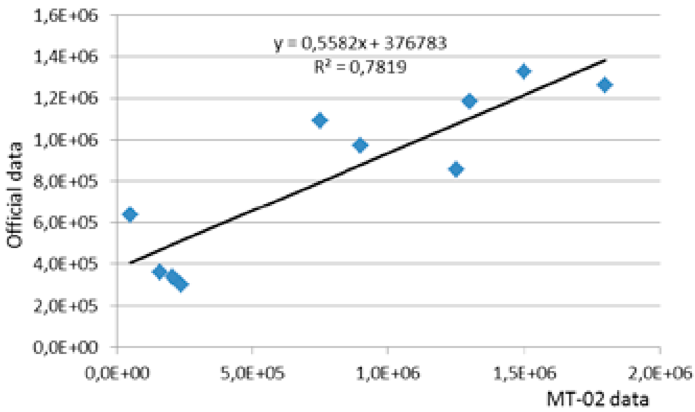
A 10-ml milk sample (at 37 °C) is mixed rapidly with 5 ml of 20-percent reagent (diluted with distilled water) and poured into the instrument's funnel, as measurement has to start immediately. The structure of the instrument is very similar to that of the Höppler viscometer, with the viscometer pipe forced to rotate at an adjusted angle after 20 seconds. The results can be read from the scale built into the pipe. The measuring range is between 10 x 103 and 2 x 106 ml-1. This method was developed for measuring cow milk; HDRI calibrated it for goat milk by using milk samples of known SCC. For this purpose, 20 Saanen goat milk samples were investigated with both the MT-02 instrument and the official fluoro-optical method.

Results and discussion

Estimation of the applicability and calibration of the MT-02 instrument

To evaluate the precision of data from the MT-02 instrument, 20 raw milk samples from Saanen goats were measured with the MT-02 instrument and the fluoro-optical method; the ten suitable samples were then sent to the HDRI laboratory. The resulting data were examined to identify correlations between the two methods. The hypothesis was that if the correlation was sufficiently close, it could be assumed that data from the MT-02 instrument were similarly precise to those from the reference method. Figure 1 shows the correlation between the two sets of data. The acceptable determination coefficient of the trend line made it possible to obtain a more precise evaluation of the SCC of goat milk than from the Whiteside test. This correlation equation was used for SCC determination in the other investigations.

FIGURE 1. CORRELATION BETWEEN OFFICIAL DATA AND DATA FROM THE MT-02 INSTRUMENT



Results from different goat breeds

The average of measured samples determined through MT-02 was 5.69 x 103 ml-1, but the values varied widely. Data from all the samples are summarized in Table 1.

TABLE 1. COMPARISON OF THE ORIGINAL MT-02 DATA AND MODIFIED DATA USING THE CALIBRATED MEASURES (N = 116)

Method	Average (103 ml-1)	Variation (103 ml-1)	CV (%)
Original MT-02 data	569	669	117.5
Data from calibration	665	365	54.9

Thirty percent of all samples did not fit into the measurement range of 1.0 x 103 ml-1 to 2.0 x 106 ml-1, perhaps because the abnormal composition of the milk samples caused extremely low or extremely high viscosity. The reasons for this phenomenon have not been investigated; consequently, it cannot yet be explained. The results show that the SCC values obtained from the MT-02 instrument were underestimates. The calibrated SCC average was only 9.5 x 105 ml-1 higher than the original MT-02 value, but the differences in data pairs from the two methods showed very high variation (5.0 x 104 to 5.0 x 105 ml-1).

The precision of the MT-02 instrument has already been investigated using cow milk, and an average difference of 1.18 x 105 ml-1 was determined from the official data (Anisity, 2008). The calculated difference found in the current study was very close to this data, suggesting that the MT-02 instrument can also be used for measuring the SCC of goat milk, but mainly for SCC values below 1 x 106 ml-1. This limited applicability of the instrument is explained by the resolution of its scale, which is sufficiently fine only for values below 1 x 106 ml-1, and by the use of only a few samples for calibration. The smallest difference between the official and the MT-02 data was in the range of 5.0 x 105 ml-1 to 8.0 x 5 x 105 ml-1. These observations should be taken into consideration when reviewing the study's detailed results.

Alpine goats

Milk samples from Alpine goats were measured in spring and autumn at both farms (Table 2). The first sampling occurred during the suckling period at farm A. Average SCCs at farm B were very similar in the two seasons.

TABLE 2. SCCS OF MILK SAMPLES FROM ALPINE GOATS IN HUNGARY (105 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 from the Whiteside test, showing the overall ratio (as a percentage) of negative and positive samples. Estimated SCC < 1.0 x 106 ml-1.

One sampling was carried out before the kids were separated from their mothers. The average SCC from this sampling was lower than the overall average for the farm; consequently, the suckling had no adverse effect on the SCC of milk, and did not cause an increase in SCC. Average SCC values at farm A were higher than at farm B, but none of the averages exceeded the 1 x 106 ml-1 threshold. This result differs from that of Varga (2008), who explored SCCs of more than 1 x 106 ml-1 in all investigated samples from refrigerated storage. In the current investigation, 28 percent of the milk samples from Alpine goats reached this limit. This can be viewed as quite a good result given the large number of samples exceeding the measuring limit of the MT-02 instrument.

Other breeds

The average SCCs of samples from Hungarian White goats presented somewhat higher values (Table 3). Mastitis was identified most frequently in this breed. Higher SCC values were typical, and more samples with extremely high SCCs were found at each sampling. Extreme viscosity and stickiness were visible in the samples after adding the reagent to the milk after measuring.

Results from samples from Native, Saanen and Alpine x Saanen cross-bred goats are presented in Table 4. Domestic goats showed wide variation regarding their horns and colours. There were black and white, fawn-coloured, grey, and white goats. Results from domestic (Native) goats showed the highest variation.

TABLE 3. SCCS OF MILK SAMPLES FROM HUNGARIAN WHITE GOATS IN HUNGARY (105 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 from the Whiteside test, showing the overall ratio (as a percentage) of negative and positive samples. Estimated SCC < 1.0 x 106 ml-1.

Evaluating the results shows that they are very similar to the results found by some other authors (Turin et al., 2005; Gulyas, 2002; Stella et al., 2007). However, the average SCCs did not match those published by other authors (Garcia-Hernadez et al., 2007; Delgado-Pertinez et al., 2002). Many authors, including those of the current study, agree that the SCC of goat milk is higher than that of cow milk, even though goats do not suffer from mastitis. This observation also implies that the relationship between the SCC of goat milk and the goat's health status is not as clear as it is in cow milk. The MT-02 instrument seemed to be most precise in the SCC range of 4.0–8.0 x 105 ml-1.

Table 4. SCCs of samples from Native, Saanen and Alpine x Saanen cross-bred goats in Hungary (105 ml-1) (n = 150)

	Domestic		Saanen		Alpine x Saanen	
	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 from the Whiteside test, showing the overall ratio (as a percentage) of negative and positive samples. Estimated SCC < 1.0 x 106 ml-1.
nd = no data.

The results of Whiteside tests also proved that the SCCs of goat milk imply good-quality milk that far exceeds cow milk in terms of SCC. This difference can be explained by the different physiologies and milk secretion mechanisms of goats and cows (McDougall and Voermans, 2002). For example, in the United States of America, the action limit (threshold) for the SCC of goat milk is 1 x 106 ml-1. It can be assumed that the negative (-) and positive (+) results that this study obtained from Whiteside tests are representative of 60–70 percent of the goat milk on a typical goat farm. It can be noted that milk samples scoring "++" or "+++" in the Whiteside test classification have limited value: their SCCs exceed 1 x 106 ml-1, they are usually not homogenous, and they often contain sticky and mucous precipitations. Goat milk with such high SCCs is not fit for use in fermented goat milk products. In fact, goat milk with very high SCCs (and serious precipitations) is not fit for making any kind of milk product. Based on their findings, the authors of this study agree with the suggestion made by Zeng (1996): that instruments for measuring SCC in goat milk should be calibrated for goat milk rather than cow milk. The producer of the MT-02 instrument should create a new scale for measuring goat milk samples.

There is also a need to investigate very large numbers of samples in future research to refine the precision of this method, which should be used only for SCCs in the range of 2.0 x 105 ml-1 to 1.5 x 106 ml-1 to ensure reliability.

Conclusions

The demand from industrial consumers and the gastronomy sector for good-quality goat milk, including milk of low SCC, is becoming stronger and stronger. Because the correct threshold for SCC is still fiercely debated, there are no SCC requirements for goat milk in many countries, including in the European Union. In this study, the SCCs of milk samples from different goat breeds showed a wide range, confirming data from the literature. However, the use of goat milk with SCCs above 106 ml-1 for high-quality milk products is not recommended, and can result in products with bad sensory and texture properties. In addition, milk with an SCC of more than 106 ml-1 probably comes from goats that are suffering from subclinical mastitis. Rapid tests can help breeders to produce goat milk with low SCCs and support the process for determining a limit SCC value for high-quality milk. The MT-02 instrument (Agro legato Ltd, Hungary) can be used to evaluate the SCC of goat milk using the correlation equation described in this study. This method is more precise than the Whiteside test, but more data are needed from which to develop a reliable and more precise version of the instrument.

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References

Anisity, M. 2008. Tehéntej szomatikus sejtszáma gyorsvizsgálati módszereinek összehasonlítása, [Comparison of fast SCC tests for cow milk], pp. 28–41. University of Szeged, Faculty of Engineering, Hungary. (B.Sc. thesis)

Barbano, D.M., Rasmussen, R.R. & Lynch, J.M. 1992. Influence of milk somatic cell count and milk age on cheese yield. Journal of Dairy Science, 74(2): 369–388.

Chen, S.X., Wang, J.Z., Van Kessel, J.S., Ren, F.Z. & Zeng, S.S. 2010. Effect of somatic cell count in goat milk on yield, sensory quality, and fatty acid profile of semisoft cheese. Journal of Dairy Science, 93(4): 1345–1354.

Delgado-Pertiñez, M., Alcalde, M.J., Guzmán-Guerrero, J.L., Castel, J.M., Mena, Y. & Caravaca F. 2002. Effect of hygiene-sanitary management on goat milk quality in semi-extensive systems in Spain. Small Ruminant Research, 47(1): 51–61.

Garcia-Hernandez, R., Newton, G., Horner, S. & Nuti L.C. 2007. Effect of photoperiod on milk yield and quality, and reproduction in dairy goats. Livestock Science, 110(3): 214–220.

Gomes, V., Libera, A.M., Paiva, M., Medici Madureira, K. & Araújo W.P. 2006. Effect of the stage of lactation on somatic cell counts in healthy goats (Caprae hircus) breed in Brazil. Small Ruminant Research, 64(1–2): 30–34.

Gulyás, L. 2002. A Nyerstej szomatikus sejtszámát befolyásoló néhány biológiai és környezeti tényező vizsgálata, [Investigation of the effect of some biological and environmental factor on SCC of raw milk], University of West Hungary, pp. 83–122. Mosonmagyaróvár, Hungary. (Ph.D. thesis)

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

Kukovics, S., Molnár, A., Ábrahám, M. & Schuszter, T. 1996. Phenotypic correlation between the somatic cell count and milk components. Influence of somatic cell count in goat milk on yield and quality of soft cheese. In Production and utilization of ewe and goat milk: Proceedings of the IDF/Greek National Committee of IDF/CIRVAL Seminar, pp. 135–141. Crete, Greece, 19–21 October 1995.

McDougall, S. & Voermans M. 2002. Influence of estrus on somatic cell count in dairy goats. Journal of Dairy Science, 85(2): 378–383.

Merényi I. & Wágner, A. 1985. A szubklinikailag enyhén megváltozott összetételű tejek megtévesztő hatása a tenyésztői és ezzel kapcsolatos egyéb munkákra [The effect of milk having special composition from cows suffering from subclinical Mastitis on the breeding and other tasks]. Tejipar Hungarian Dairy Journal], 34(1): 5–8.

Mitchell, G.E., Fedrick, I.A. & Rogers, S.A. 1986. The relationship between somatic cell count, composition and manufacturing properties of bulk milk. Australian Journal of Dairy Technology, 41(2): 12–14.

Pajor, F., Németh, Sz., Gulyás, L., Barcza, F. & Póti, P. 2009. A tőgybimbó alakja és a kecsketej néhány minőségi tulajdonságának kapcsolata [Relation of teat type and certain quality traits of goat milk] Animal Welfare, Etológia és Tartástechnológia, [Animal Welfare, Ethology and Housing Systems] 5(4): 218–224.

Politis, I. & Ng-Kwai-Hang, K.-F. 1988. Effects of somatic cell count and milk composition on cheese composition and cheese making efficiency. Journal of Dairy Science, 71(7): 1711–1719.

Stella, A.V., Paratte, R., Valnegri, L., Cigalino, G., Soncini, G., Chevaux, E., Dell'Orto, V. & Savoini, G. 2007. 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(1): 7–13.

Szakály, S. 1966. A Whiteside próba alkalmazása a tehenek tőgygyulladásának felismerésére és a szekréciós hibájú (masztitiszes) tej szelektálására, [The use of Whiteside Test for the exploration of mastitis and the selection of milk from cows suffering from mastitis] Magyar Tejipari Tröszt lapja, [Journal of Hungarian Dairy Trust], pp. 1–21. Budapest.

Turin, L., Pisoni, G., Giannino, M.L., Antonini, M., Rosati, S., Ruffo, G. & Moroni P. 2005. Correlation between milk parameters in CAEV seropositive and negative primiparous goats during an eradication program in Italian farm. Small Ruminant Research, 57(1): 73–79.

Unger, A. 2001. A nyerstej minősége, minősítése és ára. [Quality, classification and price of raw milk] In S. Szakály, ed. Tejgazdaságtan [Dairy economics], pp.115–119. Budapest, Dinasztia Kiadó [Dinasztia Publishing Company]

Vahid, Y. & Kóbori, J. 2003. Korszerű tejtermelés és feldolgozás [Modern milk production and milk processing] pp.99. Szaktudás Kiadó Ház [Szaktudás Publishing House], Budapest, Hungary

Varga, L. 2008. Kecsketej mikrobiológiai-higiéniai és fizikai-kémiai jellemzőnek 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, [Hungarian Dairy Journal–Science and Practice] 68(1–2): 83–91.

Zeng, S.S. 1996. 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): 221–225.

Zeng, S.S. & Escobar, E.N. 1996. Influence of somatic cell count in goat milk on yield and quality of soft cheese. In Production and utilization of ewe and goat milk: Proceedings of the IDF/Greek National Committee of IDF/CIRVAL Seminar, pp. 109–113. Crete, Greece, 19–21 October 1995.