EFFECTIVENESS OF SOMATIC CELL COUNT DETERMINATION IN THE MILKING ROBOTS

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Abstract. Online cell counter (OCC) for assessing milk somatic cell count of an individual cow during milking was included in milking box in a DeLaval milking robot. To detect problem animals, somatic cell count (SCC) dynamic among milking sessions during one month (from 24th of September to 24th of October 2009) were evaluated in 35 animals. Precision of results from OCC were high comparing with results obtained by the reference method. As generally accepted in veterinary practice 200 000 somatic cells per ml of milk was used as mastitis diagnostic threshold. Results indicated that milking robot OCC is an effective tool to observe continuously somatic cell count and accurately find cows with more than 200 000 cells in ml of milk. It can be useful as a signal source for further management and veterinary activities.

Keywords: milking robot, online cell counter, somatic cell count.

Introduction

Since 2007 when automatic milking system (AMS) was introduced on the Latvia University of Agriculture teaching and research farm Vecauce, milking robot was implemented also on other commercial dairy farms in Latvia. AMS ensures benefit through not only doing traditional man-performed activities (substitution of a man by technique) but also opens new possibilities for health diagnostics, milk quality control and record keeping. Recently there are elaborated various on-line sensing systems to examine milk quality of the individual cow [1-3]. These sensing systems are constructed to replace in some way visual check of the milk for abnormalities or clinical mastitis at every milking. Special signals or alarm indexes calculated by milking system show problem cows and could be used for automatic divert of abnormal milk [4]. The signal suggests that cow needs more attention or should be checked by classical diagnostic procedures – clinical investigation, cytological and microbiological investigation, to decide whether a treatment should be implemented. According to research based recommendations, technical companies producing milking robots around the world implement different parameters for detecting problem cows with mammary infection, inflammation and other abnormality of secreted milk. Until now only one producer is represented in Latvia, namely, DeLaval, therefore our research is done with these particular AMS. The latest model of voluntary milking system (VMS) has an option to be equipped with online somatic cell counting system, which offers new facilities in mastitis diagnostic. Therefore information about new method accuracy and precision as well as practical application principles and possible benefits for improvement of milk quality and animals health is necessary.

The aim of the study was to evaluate effectiveness of milking robot online cell counter (OCC, DeLaval) to detect problem animals for further management and veterinary activities. To achieve the goal three tasks were put forward:

1. To compare online cell count with a result obtained by a reference method;
2. To evaluate somatic cell count dynamics among milking sessions, to detect problem cows in milking robots.
3. To propose practical method how to use results of somatic cell count detected by online somatic cell counter on farm.

Materials and methods

Online Cell Counter DeLaval. Online cell counter (OCC) for assessing milk quality of an individual cow during milking was constructed. The system was included in milking box in a milking robot (DeLaval) and consisted of funnel, syringe, cuvette and camera (Figure 1). Working steps of the cell counting process are explained in flow chart (Figure 2). Funnel collected milk bypassed from milking box to bulk tank. Syringe dosed and mixed milk with staining solution and incubated for 20 seconds. Cuvette and digital camera took picture of stained cells and sent a result to the dairy management system. To operate system continuously there was rinsing (cleaning and disinfection)

system and zero level check in between two samples. The request for measuring milk quality of the given cow was set by herd management system operator.

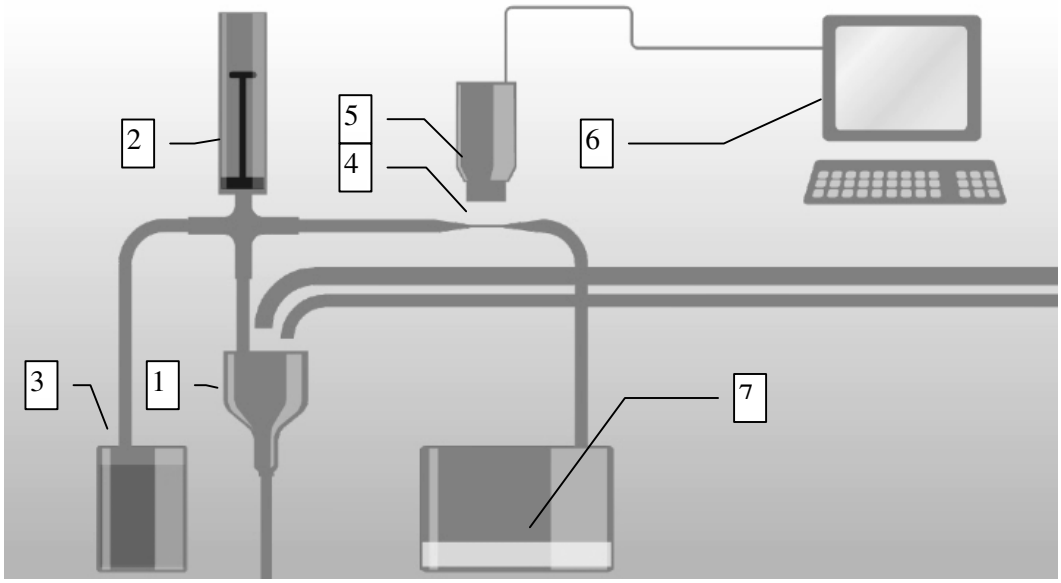

Fig. 1. **View of online cell counting system:**
1 – milk funnel; 2 – syringe; 3 – staining solution;
4 – cuvette; 5 – CCD camera; 6 – milking robot PC; 7 – waste liquids collector

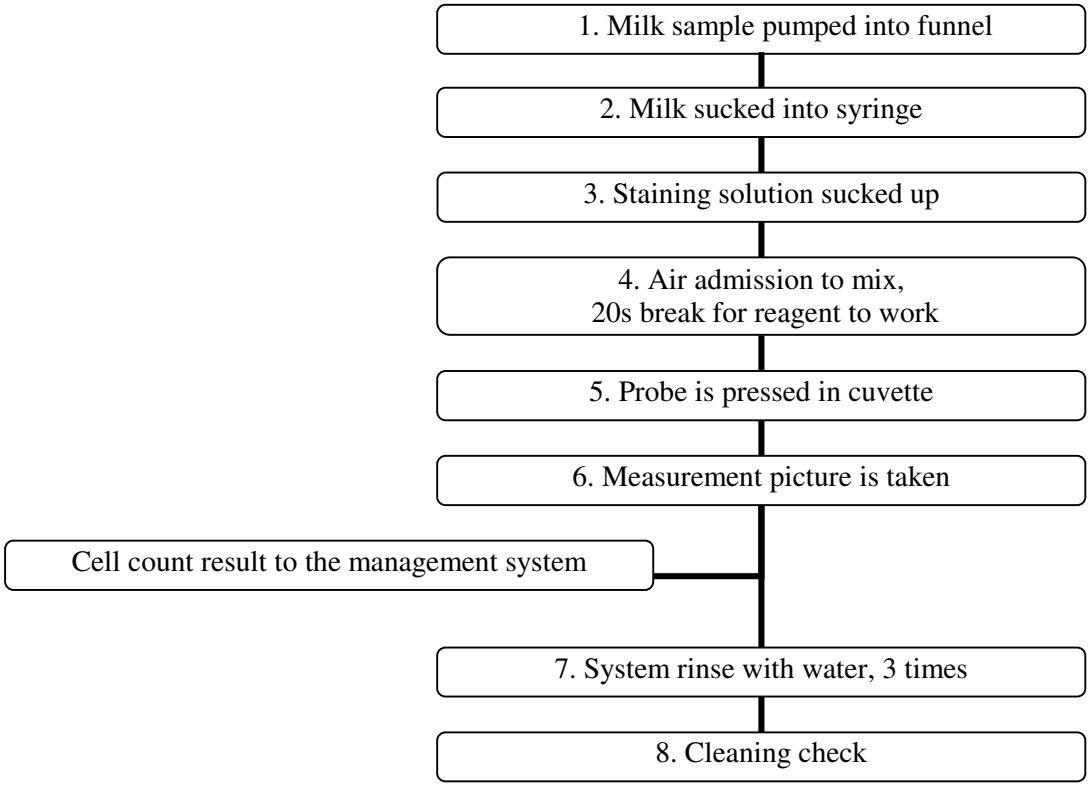

Fig. 2. **Flow chart of the milking robot OCC for assessing milk quality during milking**

Cows and milk samples. Research has been carried out on the dairy farm „Zemturi" in the Northern part of Latvia, where milking robot Voluntary Milking system (VMS, DeLaval) has been implemented for more than 1 year. On average 60 cows were milked by the robot. The somatic cell count was measured by online cell counter (OCC). To evaluate congruence of results of somatic cell count measured by OCC and by fluoro-opto-electronic method (automatic analyzer Somacount300) as

a reference method the whole milk samples from 23 cows were taken in one milking session and sent to accredited dairy laboratory.

For evaluation of somatic cell count (SCC) dynamics of individual cows, SCC was determined at each milking session by OCC during one month (from 24th of September to 24th of October 2009). Data were collected in management system and obtained from milking robot backup filed information. 35 cows with a permanent control of SCC and regularly performed milking, i.e. at least 60 milking sessions per month, were included in research. To achieve normal distribution of the data for dynamics analysis the somatic cell count was transformed into a logarithmic form (Equation 1) and expressed as somatic cell score (SCS). SCC threshold value 200 000 cells ml^{-1} corresponds SCS=4.0.

$$SCS = \log_2 (SCC/100000) + 3 \quad (1)$$

where SCS – somatic cell score;
SCC – somatic cell count, ml^{-1};

Research data were registered and analyzed with software STATA 9.0.

Results and discussion

The somatic cell count determined by online cell counter and reference method was compared in 23 dairy cows (Figure 3). As generally accepted in veterinary practice 200 000 somatic cells per ml of milk could be used as mastitis diagnostic threshold to divide cow population in healthy and mastitis groups (Meilin, 2009; Schukken, 2003; Ruegg, 2002). Drawing both threshold lines at the scatter graph, four quadrants (Q1-Q4) are formed. Q1 and Q4 represent discrepancy, in our data they are empty, but Q2 and Q3 represent congruence of results among both somatic cell counting methods. Our results suggest that Q2 includes 5 cases where both methods end up with result above 200 000 cells ml^{-1} and Q3 includes 18 cases where SCC was below the mentioned threshold.

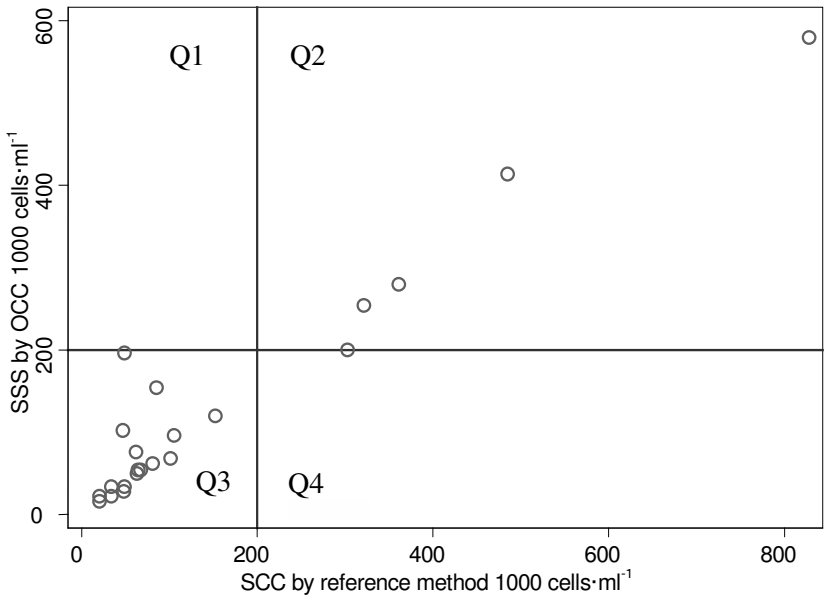

Fig. 3. **Comparison of somatic cell count determined by online cell counter (OCC) and reference method**

The obtained results show that the milking robot OCC diagnostic device accurately finds cows with high SCC. High congruence of results justifies the use of OCC for semi - quantitative estimation of SCC in milk from individual cows.

On the second part of our study we investigated individual dynamics of somatic cell count during a month. During 30 days period 35 cows had from 63 to 106 individual milking sessions, on average 2.8±0.3 sessions per cow each day. At every milking session SCC of each cow was determined by OCC and results were depicted as points on the graph (Figures 4-7). According to SCC pattern cows were assigned to four dynamic types (groups).

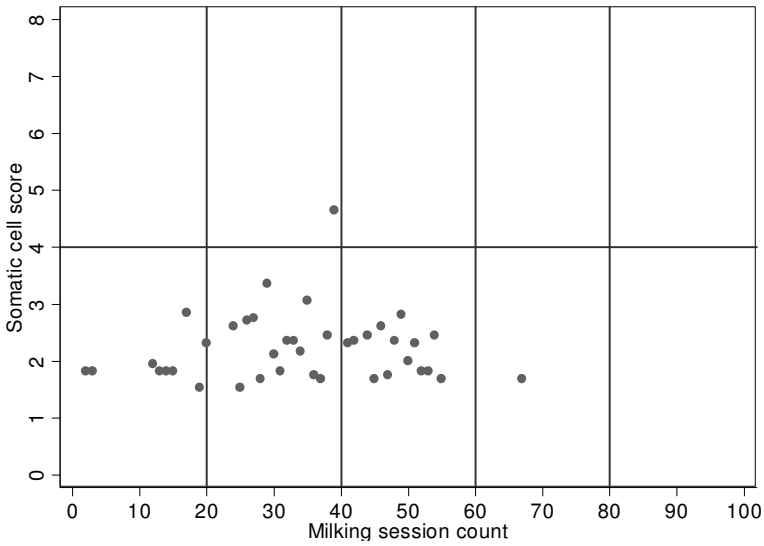

Fig. 4. **Cow number 7292 with permanently low somatic cell count: dynamic below threshold.**

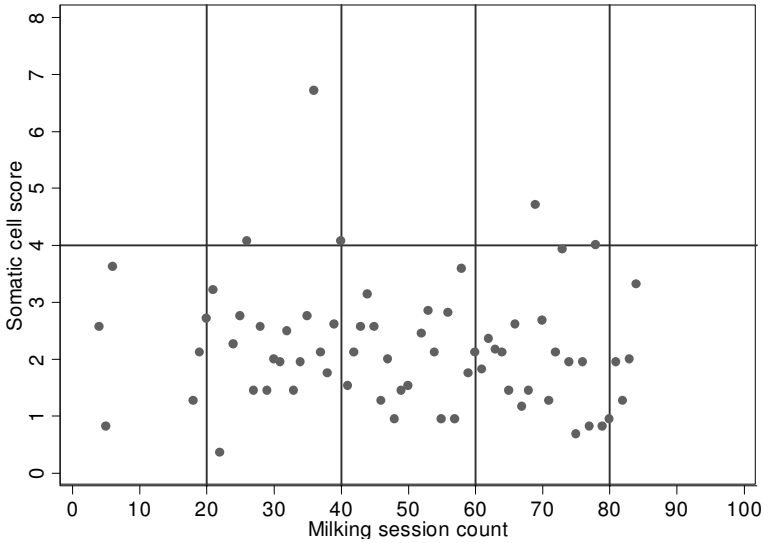

Fig. 5. **Cow number 7248 with sporadic increases of the somatic cell count above threshold: dynamics below threshold with separate increases.**

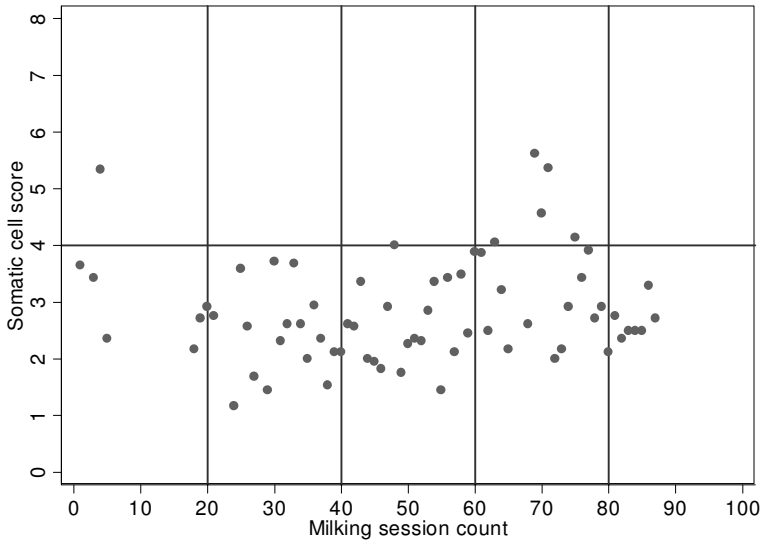

Fig. 6. **Cow number 7467 with several increases of the somatic cell count above threshold: dynamics near threshold**

Dynamics below threshold (1). Figure 4 shows an example of the cow with permanently low somatic cell count. In our investigation this group included 8 of 35 cows (23 %). **Dynamics below threshold with some increases (2).** Figure 5 represents a cow with sporadic increases of the somatic cell count above threshold however most of points were below score 3. This category included 11 of 35 cows (31 %). **Dynamics near threshold (3).** Figure 6 shows a cow with several increases of the somatic cell count above threshold and most of points were near the threshold. This group included 11 cows (31 %). **Dynamics in wide range around threshold (4).** Figure 7 represents a cow with large scale fluctuations of the somatic cell count, where more than 30 % of values are exceeding the threshold. This group included 5 animals (15 %) out of 35 investigated cows.

The relative size of four groups with different SCC dynamic has an impact on the bulk milk somatic cell count. Especially the high ratio of group 4 against groups 1 and 2 could be a reason for a low bulk milk quality. In such cases cows at group 4 are considered to be "problem cows".

To find out how many SCC parameters are needed in succession, to characterize the types of dynamics (Figures 4-7) there are vertically lines in every 20 milking sessions. Evaluating points, representing SCC, between parallel and vertical lines a conclusion can be drown that 20 milking sessions in succession, is sufficient amount to find out large-scale fluctuation.

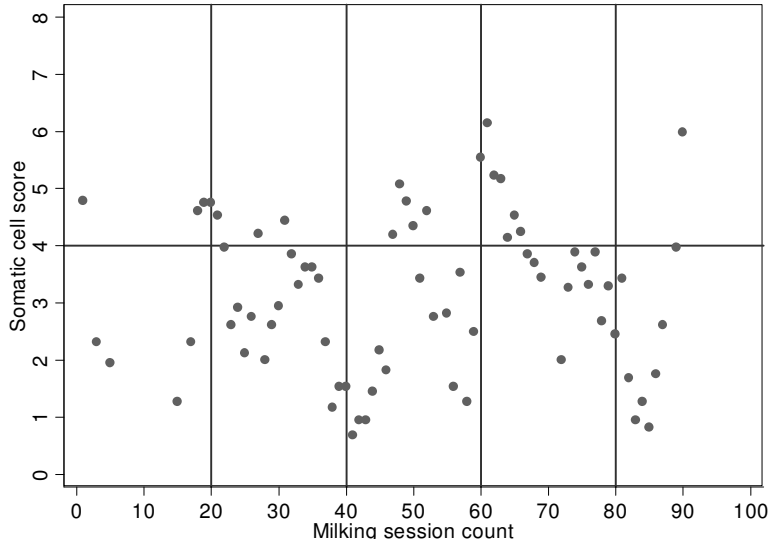

Fig. 7. **Cow number 7071 with large scale fluctuations of the somatic cell count: dynamics in wide range around threshold**

Conclusions

1. Milking robot online cell counter as a diagnostic device accurately finds cows with more than 200 000 cells in ml of milk and can be useful as a signal source for further management and veterinary activities.
2. Online cell counter is an effective tool to observe continuously somatic cell count and the obtained results of 20 milking sessions that equals one week, show dynamics with large-scale fluctuations of somatic cell count in "problem cows".

References

1. Hesti Meilina, Shinichiro Kuroki, B.M. Jinendra, Kentarou Ikuta, Roumiana Tsenkova (2009). Double threshold method for mastitis diagnosis based on NIR spectra of raw milk and chemometrics. Bio systems engineering, 104, 243–249.
2. Kawasaki M., Kawamura S., Tsukahara M., Morita S., Komiya M., Natsuga M. Near-infrared spectroscopic sensing system for online milk quality assessment in a milking robot. Computers and Electronics in Agriculture, 2008, 63, pp. 22-27.
3. Dohoo I.R., Leslie K.E. Evaluation of changes in somatic cell counts as indicators of new intramammary infections. Prev. Vet. Med., 1991, 10, pp. 225-237.
4. Hovinen M., Kasanen I., Pyörälä S. Monitoring of udder health in automatic milking. Proceedings of the First American Conference on Robotic milking, Toronto, Canada, 2002, pp. 71-74.