AGRICULTURAL AND FOOD SCIENCE

Vol. 14 (2005): 346–353.

Introduction of automatic milking system in Finland: effect on milk quality

Heidi Salovuo, Pilvi Ronkainen, Antti Heino

Department of Food Technology, PO Box 66, FI-00014 University of Helsinki, Finland

Antti Suokannas

MTT Agrifood Research Finland, Agricultural Engineering Research, Vakolantie 55, FI-03400 Vihti, Finland

Eeva-Liisa Ryhänen

MTT Agrifood Research Finland, Food Research, FI-31600 Jokioinen, Finland, e-mail: eeva-liisa.ryhanen@mtt.fi

When an automatic milking system (AMS) is introduced on a farm the milking of cows and related work is changed in many ways compared to farms with traditional milking systems. The objective of this paper was to study the effect of the introduction of robotic milking in Finland on the composition and hygienic quality of milk. The study was carried out on three farms which were the first in Finland to introduce the automatic milking system (Volontary Milking System™). Main chemical composition, somatic cell count, total bacteria count, freezing point, free fatty acids, as well as *Bacillus cereus, Clostridium* spores, psychrotrophic bacteria and coliforms were determined. After the introduction of the automatic milking system an increase in somatic cell count and total bacteria count, psychrotrophic bacteria and coliforms was observed; however, the differences were not statistically significant. The counts for *Clostridium* spores were at the same level in the automatic and the conventional milking system. *Bacillus cereus* counts were very low in both milking systems studied. Milk fat content and free fatty acids were elevated when AMS was introduced. The introduction of AMS resulted in a significant increase ($P < 0.01$) in the freezing point during the first three months. Though there was a trend that the overall quality of milk was impaired after the introduction of AMS, the quality of milk remained at premium class.

Key words: automatic milking, milk quality, somatic cell count, total bacteria count

Introduction

The first automatic milking system (AMS) was introduced in the Netherlands in the beginning of the 1990s. Since then the AMS has been installed at a number of farms in Europe, USA and Japan. In Finland the system was introduced in 2000 and the number of farms with AMS has steadily increased since then.

The milking of cows changes in many ways when traditional milking systems are replaced by an AMS. The system includes voluntary visits for milking and milking may occur more than twice

Manuscript received June 2005

Vol. 14 (2005): 346–353.

daily. In AMS human presence is not required during milking. The machine prepares the cow for milking independently according to settings that are pre-programmed. The AMS includes the cleaning of teats in order to minimise the transmission of mastitis or other harmful bacteria. The machine is also programmed to indicate cows with abnormal milk or milk with high somatic cell count (SCC), by use of different sensors. The cleaning process of milking equipment is automatic and is carried out two to three times a day (24 h). After an idle period the milking equipment is automatically flushed. A flush is also given when a cow with abnormal milk, for example with a high SCC, has visited the milking unit. (Schuling et al. 2001)

The effects of AMS on udder health and milk quality have been evaluated in a number of experiments. According to several studies the total bacteria counts (TBC) and SCC and the free fatty acid (FFA) level elevate after the introduction of AMS (van der Vorst and Hogeveen 2000, Everitt et al. 2002, Rasmussen et al. 2002). However, no effects (Klungel et al. 2000) or even an improvement (Berglund et al. 2002) in SCC have also been reported. The health, stage of lactation, (living) environment and feeding of the animal affects the quality and chemical composition of milk (Akam et al. 1989). Elevated SCC are usually a sign of mastitis. The TBC of milk is an indicator of the milking hygiene and the cooling of milk but can also imply hazards in animal health (Hayes et al. 2000). It has been suggested that factors related to AMS, such as increased milking frequency, may also have an impact on milk quality (Escobar and Bradley 1990, Hamann and Gyodi 2000, Klungel et al. 2000, Hogeveen et al. 2001). Klungel et al. (2000) suggested that increased levels of free fatty acids may be partly explained by shorter intervals. According to Hogeveen et al. (2001) the variation in the milking interval could be part of the explanation for an apparent increase in SCC with automatic milking. However, more research on the relationships between milking intervals and milk quality is required.

The present study was carried out as part of a larger Finnish project investigating the impact of AMS on udder health, animal welfare and milk quality on three Finnish farms. The objective of this work was to study the effect of the introduction of robotic milking on the composition and hygienic quality of milk.

Material and methods

Dairy cows and milking

Three farms participated in this study; two private farms (PF1 and PF2) and the Helsinki University's research farm. The farms are located in south-western Finland. The research farm had an average 26 cows and private farms from 33 to 55 cows. The cows were mainly of the Holstein Friesian breed.

The cows were milked with the Voluntary Milking System™ (VMS; DeLaval Group, Tumba, Sweden). The mean milking frequency was 2–3 times per day. The AMS included the cleaning of the teats with a special teat cup. After milking the teat cups were automatically detached.

Collection and analysis of milk samples

Bulk tank milk samples were collected once a week for three months on the research farm and farm PF2 before the new milking equipment was adopted. From farm PF1 samples were taken once a week for one month before installation. After installation of the new equipment bulk tank milk samples were collected twice a week during the first three months and later on once a week from all farms. The samples were taken for the first year of using AMS during years 2000 and 2001. Before drawing samples from farm tank, milk was stirred for five minutes. Samples were stored in refrigerator at +4°C and transported to the laboratory by milk-lorry within 24 hours.

The results were compared to a reference group which included the conventional milking parlour of the research farm and 26 farms on a milk collecting route located in south-western Finland.

The fat, protein and lactose content (g l^{-1}), SCC (cells ml^{-1}) and freezing point (°C) were determined using CombiFoss 6000, (Foss A/S, Hillerod, Denmark), which is a combination of MilcoScan FT 600 and Fossomatic 5000. The TBC (cfu ml^{-1}) was determined by automated fluorescence microscopy (BactoScan 8000, Foss A/S, Hillerod, Denmark). The samples were analysed by Valio Ltd Kouvola until 1 April 2001 and after that by Valio Ltd Seinäjoki.

Milk samples to analyse of FFA were collected once a week for seven months (research farm and PF1) or for four months (PF2) after installation of AMS. The FFA (mEq 100 g^{-1} fat) were determined according to the method of FIL-IDF (1989) with slight modification.

Bacillus cereus count in raw milk was determined using the ISO method 7932 (ISO 7932). In total 19 samples were taken from the three AMS equipments during a period from November 2001 to February 2002. Control samples (n = 20) were taken from conventional milking parlours. *Clostridium* spores were determined according to Bergere and Sivelä (1990) from samples collected once a week for seven months from April to October 2001 (n = 60). Samples from conventional milking parlours (n = 84) were taken in April, May and October 2001.

Psychrotrophic bacteria and coliforms were also determined from bulk milk samples. Samples were collected once a week for seven months after the introduction of AMS. The determination of coliforms was performed using a standard method (FIL-IDF 1985). Psychrotrophic bacteria were determined according to the IDF Standard (FIL-IDF 1991). All determinations were performed in duplicate.

Statistical analysis

The study was divided into five periods: the first period was before AMS was adopted. The following periods are 1–3, 4–6, 7–9 and 10–12 months after installation. Mean values for the parameters were calculated separately for each farm. From these results an overall mean and standard deviation were calculated.

Geometric means and standard deviation (SD) were calculated for the SCC and TBC. Arithmetic means and SD were calculated for fat, protein and lactose content as well as for the freezing point.

The data were statistically analysed by analysis of variance using SPSS 9.0 statistical software. Statistical analyses were only performed to normally distributed parameters within the test group. Within the group differences were tested with Tukey's test.

Results

Somatic cell count and total bacteria count

TBC and SCC are presented in Table 1. The SCC elevated from 142 000 (log 5.15) to 208 000 (log 5.31) cells ml^{-1} during the first nine months compared to the situation before installation of AMS. There was a slight improvement in SCC during the last period, which can be seen as a decrease of cell count by 32 000 (log 0.07) cells ml^{-1}. The TBC was elevated about three fold during the AMS period from 3 800 (log 3.54) to 12 400 (log 4.07) cfu ml^{-1}. However, the increases in SCC and TBC were not statistically significant ($P > 0.05$).

Coliforms and psychrotrophic bacteria

The count of coliforms bacteria in AMS was elevated compared to traditional system. The coliformic counts (geometric mean) were 57 cfu ml^{-1} and 18 cfu ml^{-1} for AMS-milk and conventional milk, respectively. The variation in bacterial counts was substantial; in the AMS-milk the highest counts were 28 000 cfu ml^{-1} and in the reference group 9 900 cfu ml^{-1}. As can be seen in Table 2, counts over 100 cfu ml^{-1} are more frequent in AMS milk than in conventional milk. The count of psychrotrophic bacteria in AMS-milk was 1 281 cfu ml^{-1} and was 10 fold higher than in the reference group (119 cfu ml^{-1}).

Vol. 14 (2005): 346–353.

Table 1. The somatic cell count and total bacteria count in milk before and after the introduction of the automatic milking system in three months periods.

	Somatic cell count (Log cells ml^{-1})		Total bacteria count (Log cfu ml^{-1})	
	Geometric mean	Standard deviation	Geometric mean	Standard deviation
Before introduction	5.15	0.16	3.54	0.54
After introduction, months				
1–3	5.22	0.11	3.92	0.21
4–6	5.29	0.09	3.96	0.37
7–9	5.31	0.10	4.05	0.18
10–12	5.24	0.12	4.07	0.40

Table 2. Coliforms in milk produced using automatic milking system (n = 56) or by conventional parlour milking (n = 72).

cfu ml^{-1}	Automatic milking system		Conventional	
	n	%	n	%
< 100	35	63.5	55	76.4
100–1000	15	26.8	15	20.8
> 1000	6	10.7	2	2.8

n = number of observations

Table 3. *Clostridium* spores in milk produced using automatic milking system (n = 60) or by conventional parlour milking (n = 84).

Most propable number l^{-1}	Automatic milking system		Conventional	
	n	%	n	%
< 300	50	83.3	69	82.1
300–1000	8	13.3	10	11.9
> 1000	2	3.3	5	6.0

n = number of observations

Bacillus cereus and *Clostridium* spores

In the present study the content of *Bacillus cereus* in raw milk was very low (1 cfu ml^{-1}) and bacteria were detected in only two of the 39 raw milk samples studied (one positive sample in each groups). The level of *Clostridium* spores is presented in Table 3 showing that the majority of the raw milk samples contained *Clostridium* spores under 300 l^{-1}; 80 and 83%, in conventional and AMS, respectively. Most of the samples had less than 1 spore ml^{-1}.

Main chemical composition, freezing point and free fatty acids

The fat content of milk was elevated from 3.85 up to 4.20% when AMS was introduced. However, the increase was not statistically significant. Only minor changes in protein and lactose content were detected after introduction of AMS (Table 4).

The freezing point (FP) elevated significantly ($P < 0.01$) from –0.531 to –0.518°C during the first three months after the introduction of AMS. After that the FP returned to the same level as before AMS (Table 4).

The introduction of AMS elevated the level of FFA. The mean values (±SD) were 0.52 ± 0.09 and 0.82 ± 0.16 mEq 100 g^{-1} fat for conventional milking (n = 40) and AMS (n = 88), respectively.

Discussion

Even though in the present study the TBC and SCC had a tendency to increase, the quality of milk still remained good. The upper limits for high quality milk in Finland (E-class, extra) are for the SCC 250 000 cells ml^{-1} (log 5.40) (3 months geometric mean) and for the TBC 50 000 cfu ml^{-1} (log 4.70) (2 months geometric mean). In present study the levels measured did not exceed these limits.

Table 4. The chemical composition and freezing point of milk before and after the introduction of the automatic milking system in three months periods. Values are arithmetic means.

	Fat ($g\ l^{-1}$)		Protein ($g\ l^{-1}$)		Lactose ($g\ l^{-1}$)		Freezing point (°C)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Before introduction	38.5	3.3	33.5	1.6	49.1	0.6	–0.531[a]	0.003
After introduction, months								
1–3	39.7	1.4	32.1	1.0	48.1	0.4	–0.518[b]	0.002
4–6	42.0	2.0	33.1	0.5	48.4	0.2	–0.524[ab]	0.002
7–9	40.3	0.8	33.6	0.9	48.5	0.5	–0.528[ab]	0.005
10–12	40.4	1.1	33.6	0.2	48.6	0.5	–0.530[a]	0.002

[a,b] values within same column marked with different letters are statistically different ($P < 0.01$)
SD = standard deviation

Since 1998 over 90% of Finnish milk has been in the E-class (Finnish Association for Milk hygiene 2004). It can be suggested that although some adverse effects on milk quality were observed, the overall hygienic quality of milk was not markedly changed by the introduction of AMS. However the amount of data was quite small, the variation in counts was high and there was only three farms participating in the study. Also the farms differed from each other among other things in feeding, living environment and hygienic status. Moreover, it should be noted that one farm was a research farm.

Others have also reported increases in TBC and SCC due to the introduction of AMS. In the Netherlands, according to Klungel et al. (2000), the TBC increased from 8 000 to 19 000 cfu ml^{-1}, although the SCC did not rise after the introduction of AMS. Van der Vorst and Hogeveen (2000) discovered that both TBC (from 8 000 to 12 000 cfu ml^{-1}) and SCC (181 000 to 192 000 cells ml^{-1}) increased during the first year of automatic milking. In Denmark the TBC increased from 7 400 to 14 000 cfu ml^{-1} and the SCC increased from 246 000 to 302 000 cells ml^{-1} (Rasmussen et al. 2002). Increase in TBC may be caused by failures in the cleaning system (Hayes et al. 2000). The main reason for high SCC seems to be that farms with AMS have been reported to have more new infections during the first year of AMS (Rasmussen et al. 2001). The same phenomenon was also found in our larger project studying the impact of AMS on udder health and animal welfare. According to this larger study significantly more infections were reported on all farms. Unreliable detection of subclinical infections was suggested to be the most important reason for increase of infections (Suokannas et al. 2005).

Coliforms are an indicator of milking and cowhouse hygiene, especially environmental contamination. According to Schuling et al. (2001), the amount of coliforms in raw milk should be below 100 cfu ml^{-1}. High counts of coliforms can be attributed to coliform mastitis or environmental contamination (Hayes et al. 2000). In this study the high counts of coliforms might originate from environmental contamination which could have been caused by temporary problems in the cleaning process.

The count of psychrotrophic bacteria in AMS-milk was 10 fold higher than in the reference group. Sources of contamination of psychrotrophs include soil, dust, air, water, vegetation and faeces as well as milking equipment (Shah 1994). Higher psychrotrophic counts in this study may be an indication of failures in the AMS cleaning system. Psychrotrophic bacteria can cause problems in the manufacture of milk products, such as cheese making, due to enzymatic activity when counts increase to 10^4–10^7 cfu ml^{-1} (Cromie 1992). The counts of psychrotrophic bacteria in this study remained below 10^4 cfu ml^{-1} and represented a share under 10% of total bacteria indicating good milking hygiene.

Vol. 14 (2005): 346–353.

In our study the content of *Bacillus cereus* in raw milk was very low. *Bacillus cereus* is a well known organism of food poisoning and a common contaminant in raw milk (te Giffel et al. 1995). The spore content in milk is strongly associated with the degree of contamination of the teats with soil Christiansson et al. (1999). According to Christiansson et al. (1999) the milking equipment, the air in the barn and animal feeding do not significantly affect the spore content. Slaghuis et al. (1997) reported that restricted pasturing during summer reduced the contamination level of milk and suggested that automatic milking will lower the level of *Bacillus* spores in milk. To our knowledge, so far no reports on the incidence of *Bacillus cereus* in milk produced by an AMS have been published. Our study suggests that AMS poses no risk for contamination of aerobic spores.

Clostridium spores represent a minority of bacteria found in raw milk, contamination levels being around $10–10^2$ spores ml^{-1}. If lactating cows are fed with heavily contaminated silage, levels can increase to over 10^3 spores ml^{-1} (Aureli and Franciosa 2002). Spores in milk originate from the udder, and go from the teats and teat cups to the milk. Dirty cows, spores in the air and milking equipment also affect the butyric acid bacteria content of milk (Stadhouders and Jørgensen 1990). In contrast to our study, Rasmussen et al. (2002) reported a significant increase in spores of anaerobes going from conventional to automatic milking, and this phenomenon was observed throughout the first year. Most of the clostridial species relevant in dairy products are nonpathogenic for humans but can cause defects in final products (Aureli and Franciosa 2002) such as late blowing in hard cheese caused by *Clostridium tyrobutyricum* (Klijn et al. 1995).

The fat content of milk tended to increase when AMS was introduced. However, the differences were not significant. This phenomenon may partly be caused by shorter intervals in milking, which was also seen in the traditional milking system with increased milking frequency. Bruckmaier et al. (2001) found that the fat content increases when the milking interval is shorter. However, our results are in disagreement with the studies of Klungel et al. (2000) and Everitt et al. (2002). Klungel et al. (2000) found that fat and protein content was significantly decreased after the introduction of AMS (from 4.41 and 3.49 to 4.37 and 3.42, respectively). In a Swedish study carried out by Everitt et al. (2002) the fat (from 4.18 to 4.09%) and protein (from 3.31 to 3.26 %) contents dropped after installation of AMS.

Elevated FFA levels indicate increased lipolysis of milk. Escobar and Bradley (1990) suggest that lipolysis is mainly caused by milk pipelines, but it can also be caused by bacteria, such as psychrotrophic bacteria (Shah 1994). The effect of mechanical treatment on milk causing lipolysis continues during storage (Needs et al. 1986). However, rapid cooling of milk has been reported to delay the lipolysis (Escobar and Bradley 1990). A recent report from Klungel et al. (2000) supports our findings. They also found a significant increase in FFA after introduction of AMS.

The FP of milk is measured to find out possible water addition in milk. In Finnish dairies the limit for rejection is adjusted to –0.512°C. A similar elevation of FP observed in our study, has also been observed by others (Klungel et al. 2000, Rasmussen et al. 2002). In our study the FP decreased after the introduction period. This phenomenon has also been reported by Everitt et al. (2002). Cleaning procedures can leave residues of water in pipe lines and thus changes in the FP can be a mark of water in the pipelines. Further, air intake and more frequent milking with the AMS can cause changes in the FP of milk (Klungel et al. 2000).

Conclusion

The present work was conducted on the first Finnish farms equipped with an AMS. The study showed that the bulk milk was not seriously altered by the implementation of AMS. The introduction of AMS tended to increase SCC, TBC, psychrotrophic and coliformic counts and the level of FFA and fat content of milk in Finland. However, the changes were not statistically significant.

There were no major differences in counts of *Clostridium* spores and *Bacillus cereus* between the conventional system and AMS. The freezing point of milk was significantly increased after the installation of AMS and returned to the original level after an introduction period. Though the overall quality of milk tended to be impaired after the introduction of AMS, the quality of milk remained at premium class.

Acknowledgements. The authors gratefully thank the farmers and technical staff on the research farm for participating in this study. We also thank Valio Ltd for analysing samples, and the Finnish Ministry of Agriculture and Forestry and Valio Ltd for funding this research.

References

Akam, D.N., Dodd, F.H. & Quick, A.J. 1989. Milking, milk production hygiene and udder health. *FAO Animal Production and Health Paper* 78. 119 p.

Aureli, P. & Franciosa, G. 2002. *Clostridium* spp. In: Roginski, H. et al. (eds.). *Encyclopedia of Dairy Sciences*. London, UK: Academic Press. p. 456–463.

Bergere, J.L. & Sivelä, S. 1990. Detection and enumeration of clostridial spores related to cheese quality – classical and new methods. *IDF Bulletin* 251: 18–23.

Berglund, I., Petterson, K. & Svannersten-Sjaunja, K. 2002. Automatic milking: effects on somatic cell count and teat end-quality. *Livestock Production Science* 78: 115–124.

Bruckmaier, R.M., Macuhova, J. & Meyer, H.H.D. 2001. Specific aspects of milk ejection in robotic milking: a review. *Livestock Production Science* 72: 169–176.

Christiansson, A., Bertilsson, J. & Svensson, B. 1999. *Bacillus cereus* spores in raw milk: factors affecting the contamination of milk during the grazing period. *Journal of Dairy Science* 82: 305–314.

Cromie, S. 1992. Psychrotrophs and their enzyme residues in cheese milk. *Australian Journal of Dairy Technology* 47: 96–100.

Escobar, G.J. & Bradley, R.L., Jr. 1990. Effect of mechanical treatment on the free fatty acid content of raw milk. *Journal of Dairy Science* 73: 2054–2060.

Everitt, B., Ekman, T. & Gyllenswärd, M. 2002. Monitoring milk quality and udder health in Swedish AMS herds. In: *The First North American Conference on Robotic Milking*, Toronto, Canada. V-72–V-75.

FIL-IDF 1985. Milk and milk products. Enumeration of coliforms – Colony count technique and most probable number technique at 30°C. *FIL-IDF Standard* 73A:1985. 8 p.

FIL-IDF 1989. Milkfat products and butter. Determination of fat acidity. *FIL-IDF Standard 6B: 1989* (Provisional). 3 p.

FIL-IDF 1991. Milk. Enumeration of psychrotrophic microorganisms. Colony count technique at 6.5°C. *FIL-IDF Standard 101A:1991*. 3 p.

Finnish Association for Milk Hygiene 2004. E-luokan osuus maidosta 1998–2004. http://www.maitohygienialiitto.fi/laatu_E-luokan_os_03.html. Cited 14 September 2004.

Hamann, J. & Gyodi, P. 2000. Somatic cell counts and electrical conductivity in relation to milking frequency. *Milchwissenschaft* 55: 303–307.

Hayes, M.C., Ralyea, R.D., Murphy, S.C., Carey, N.R., Scarlett, J.M. & Boor, K.J. 2000. Identification and characterization of elevated microbial counts in bulk tank raw milk. *Journal of Dairy Science* 84: 292–298.

Hogeveen, H., Ouweltjes, W., de Koning, C.J.A.M. & Stelwagen, K. 2001. Milking interval, milk production and flow-rate in an automatic milking system. *Livestock Production Science* 72: 157–167.

ISO 7932. *Microbiology – General guidance for the enumeration of Bacillus cereus – Colony count technique at 30°C*. 2nd edition. International Organization of Standardization, Geneva, Switzerland. 1993.

Klijn, N., Nieuwnhof, F.F.J., Hoolwerf, J.D., van der Waals, C.B. & Weerkamp, A.H. 1995. Identification of *Clostridium tyrobutyricum* as the causative agent of late blowing in cheese by species-specific PCR amplification. *Applied and Environmental Microbiology* 61: 2919–2924.

Klungel, G.H., Slaghuis, B.A. & Hogeveen, H. 2000. The effect of the introduction of automatic milking systems on milk quality. *Journal of Dairy Science* 83: 1998–2003.

Needs, E.C., Anderson, M. & Morant, S.V. 1986. Interaction of factors which influence the extent of lipolysis during milking and storage of raw milk. *Journal of Dairy Research* 53: 203–210.

Rasmussen, M.D., Bolm, J.Y., Nielsen, L.A.H. & Justesen, P. 2001. Udder health of cows milked automatically. *Livestock Production Science* 72: 147–156.

Rasmussen, M.D., Bjerring, M., Justesen, P. & Jepsen, L. 2002. Milk quality on Danish farms with automatic milking systems. *Journal of Dairy Science* 85: 2869–2878.

Schuling, H.J., Verstappen-Boerekamp, J.A.M., Knappstein, K. & Benfalk, C. 2001. *Optimal cleaning of equipment for automatic milking*. Deliverable D16. Available on the Internet: http://www.automaticmilking.nl. Cited 18 March 2003.

Shah, N.P. 1994. Psychrotrophs in milk: a review. *Milchwissenschaft* 49: 432–437.

Slaghuis, B., te Giffel, M.C., Beumer, R.R. & Andre, G. 1997. Effect of pasturing on the incidence of *Bacillus cereus* spores in raw milk. *International Dairy Journal* 7: 201–205.

Stadhouders, J. & Jørgensen, K. 1990. Prevention of the contamination of raw milk by a hygienic milk production. *IDF Bulletin* 251: 32–36.

Suokannas, A., Salovuo, H., Ronkainen, P., Heino, A., Hovinen, M., Kasanen, I., Raussi, S., Kaihilahti, J., Aisla, A.-M., Saastamoinen, S., Alasuutari, S. & Manninen, E. 2004. Maidon laatu, eläinten utareterveys, käyttäytyminen ja hyvinvointi automaattilypsyssä. Abstract: Effects

Vol. 14 (2005): 346–353.

of automatic milking on the milk quality, udder health, behaviour and welfare of cows. *Maa- ja elintarviketalous* 62. 97 p.

te Giffel, M.C., Beumer, R.R., Slaghuis, B.A. & Rombouts, F.M. 1995. Occurrence and characterization of (psychrotrophic) *Bacillus cereus* on farms in the Netherlands. *Netherlands Milk and Dairy Journal* 49: 125–138.

Van der Vorst, Y. & Hogeveen, H. 2000. Automatic milking system in the Netherlands. In: *Robotic milking proceedings of the international symposium*. Lelystad, Netherlands. p. 73–82.

SELOSTUS

Automaattisen lypsylaitteiston käyttöönoton vaikutus maidon laatuun

Heidi Salovuo, Pilvi Ronkainen, Antti Heino, Antti Suokannas ja Eeva-Liisa Ryhänen
Helsingin yliopisto ja MTT (Maa- ja elintarviketalouden tutkimuskeskus)

Lypsy ja siihen liittyvät työt muuttuvat tilalla, kun automaattinen lypsyjärjestelmä otetaan käyttöön. Tämän tutkimuksen tarkoituksena oli tutkia automaattisen lypsyjärjestelmän käyttöönoton vaikutusta maidon koostumukseen ja laatuun Suomessa. Tutkimus toteutettiin kolmella tilalla, jotka olivat ensimmäisiä automaattilypsytiloja Suomessa. Maidon kemiallinen koostumus, somaattiset solut, kokonaisbakteerit, jäätymispiste, vapaat rasvahapot, *Bacillus cereus*, klostridi-itiöt, psykrotrofit bakteerit, ja koliformiset bakteerit määritettiin. Automaattilypsyn käyttöönoton jälkeen somaattisten solujen, kokonaisbakteerien, psykrotrofisten ja koliformisten bakteerien määrät olivat korkeampia kuin perinteisesti lypsettäessä, mutta erot eivät olleet tilastollisesti merkitseviä. Klostridi-itiöiden määrä oli samalla tasolla automaattilypsymaidossa ja perinteisesti lypsetyssä maidossa. *Bacillus cereuksen* määrä oli hyvin alhainen molemmilla lypsytavoilla. Maidon rasvapitoisuus ja vapaiden rasvahappojen määrä kohosivat automaattisen lypsyn käyttöönoton jälkeen. Jäätymispiste kohosi ensimmäisten kolmen kuukauden kuluessa laitteiston käyttöönotosta. Vaikka maidon laatu heikkeni, se oli edelleen E-luokan maitoa.