VETERINARSKI ARHIV 78 (2), 105-112, 2008

Influence of udder sanitation on hygienic quality of cow milk

Željko Pavičić[1]*, Marijan Cergolj[2], Tomislav Balenović[3], Anamaria Ekert-Kabalin[3], and Hrvoje Valpotić[4]

[1]*Department of Animal Hygiene, Environment and Ethology, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[2]*Clinic for Obstetrics and Reproduction, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[3]*Department of Animal Husbandry, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

[4]*Department of Animal Nutrition, Faculty of Veterinary Medicine, University of Zagreb, Zagreb, Croatia*

PAVIČIĆ, Ž., M. CERGOLJ, T. BALENOVIĆ, A. EKERT-KABALIN, H. VALPOTIĆ: Influence of udder sanitation on hygienic quality of cow milk. Vet. arhiv 78, 105-112, 2008.

ABSTRACT

The aim of this investigation was to determine the significance of udder disinfection before and after milking on the hygienic quality of fresh raw milk in dairy cowherds subject to primary udder hygiene with water. The research was conducted on 4 farms with differing hygienic milk quality, during which three farms (experimental groups) were selected for the assessment of udder disinfection before and after milking and the fourth farm (control group) continued to implement primary hygiene with water in the preparation of udders before milking**.** The disinfection in the experimental group prior to milking was performed by immerging the teats in a special cup containing active foam, based on surface active compounds, organic acids and hydrogen peroxide and after milking by an agent containing skin care substance and 1.94% linear dodecyl-benzene sulphonic acid (LDBS). Seven individual samplings of milk were performed on each cow in a period of 3 months for determining microorganisms and somatic cells. The samples were delivered to the laboratory, where somatic cell and microorganism count/mL of milk were established with the use of standard methods. According to the data from three experimental groups, a slight decrease in the average somatic cell count and a statistically significant decline of average microorganism count ($P<0.01$; $P<0.05$) were recorded in fresh raw milk. Unlike this, the somatic cell count in the control group continually increased, reaching the level of statistical significance ($P<0.01$), and the microorganism count showed slight oscillations. It was concluded that a change from primary udder hygiene with water to teat disinfection before and after milking significantly decreases average somatic cell and microorganism counts in fresh raw milk and hence improves hygienic milk quality over a certain time period.

Key words: cow, udder, sanitation, microorganisms, somatic cells, milk

*Contact address:

Prof. Dr. Željko Pavičić, Department of Animal Hygiene, Environment and Ehhology, Faculty of Veterinary Medicine, University of Zagreb, Heinzelova 55, 10000 Zagreb, Croatia, Phone: +385 1 2390 295; Fax: +385 1 2441 390; E-mail: zpavicic@vef.hr

ISSN 0372-5480
Printed in Croatia

Introduction

From an ethological perspective, the cow rests in a lying position, which inevitably leads to contact of the udder skin with filth on the bedding surface. For example, as much as 1 x 10^{10} of total microorganisms can be found in one gram of filth from the udder surface (REINEMANN et al., 2000). With unsuitable udder hygiene, the microorganisms present on the teat skin can contaminate the milk during milking or through the teat tip penetrate the teat canal increasing the possibility of mastitis (SUAREZ and FERREIROS, 1991; PAVIČIĆ et al., 2003a). Hence it is necessary to implement hygienic-prophylactic measures in maintaining cleanliness and udder health before and after milking of dairy herds, with the aid of disinfecting agents (GEDEK, 1994). At the end of the last century most members of the international dairy federation relied only on washing the udder with water and drying with a cloth in the preparation of udder for milking (SARAN, 1995). However, it has been demonstrated that this procedure does not sufficiently decrease postsecretory milk contamination and does not result in acceptable udder health status (LAM et al., 1996). Therefore, it is necessary to include disinfection with highly effective agents that are active in low concentrations and do not pose a threat regarding chemical residues in the milk (INGAWA et al., 1992; OLIVER et al., 1993; RUEGG and DOHOO, 1997). Furthermore, they have to be economically acceptable to farmers and easy to use with minimal time consumption. There are many procedures for udder hygiene prior to milking such as: washing by spraying water and wiping of teats, washing of teats with a cloth immersed in warm disinfectant solution and drying with a dry cloth, immersing of teats in disinfectant and wiping with a paper cloth. Appropriate hygiene, such as dry cleaning, is necessary for lowering teat contamination whereas only the substantially soiled udders require washing with water (EBERHART et al., 1983). Therefore, if the udder is not substantially soiled, the teats should be immersed in active foam disinfectant and wiped with disposable paper cloths after 1-2 minutes (WINTER, 1999). The implementation of udder hygiene after milking is a very rational method for maintaining acceptable udder health status, and is conducted by immersing teats in a disinfecting agent. This procedure removes the milk droplets that are left behind which can serve as a breeding ground for surrounding pathogenic microorganisms. Subsequent drying of the disinfectant creates a thin layer over the teat orifice, mechanically preventing the incursion of microorganisms through the teat canal (ERSKINE, 2001). The benefits are manifested through a decrease in postsecretory milk contamination (PAVIČIĆ et al., 2003b), reduction of udder infections by so-called environmental microbes (PANKEY et al., 1987), and by a decrease in the number of subclinical mastitis (LAM et al., 1996). Nowadays, the priority in conducting udder hygiene is given to ecologically acceptable disinfecting agents that are not harmful to animals and the environment. In this manner, the standard disinfecting agents based on iodine and chlorine are being phased out and replaced by agents with a high degree of biodegradability and that are not aggressive to the skin (WINTER, 1999; PAVIČIĆ

et al., 2005). Thereby, we investigated the applicability of such agents with the aim of establishing the degree of efficient udder sanitation on the quality of fresh raw milk in dairy herds on small farms.

Materials and methods

The investigation was conducted on 4 small farms with differing milk quality regarding somatic cell and microorganism counts, but with an identical udder hygiene method based on washing with water and wiping with disposable cloths. Three farms (experimental groups) were selected for evaluating the effect of udder sanitation on the hygienic quality of fresh raw milk including the disinfection prior to milking by immersing teats in a special cup, containing active foam based on surface active compounds, organic acids and hydrogen peroxide, and disinfection after milking by immersing teats in the agent containing 1.94% linear dodecyl-benzene sulphonic acid (LDBS) and skin care substances. The remaining fourth farm (control group) continued to wash the udders with water and wipe with disposable cloths. The usual milking procedure was conducted twice a day on all farms with the use of milking machines. Milk samples were collected on day 0 to determine the nominal condition and after the introduction of disinfection every 14 days throughout a period of almost 3 months. Individual milk samples from each cow were used in the investigation to determine somatic cell and microorganism counts. Each sample was an equal quantity of milk obtained from every quarter of the udders and was collected in a 40 mL sterile bottle immediately after completing udder hygiene and squeezing out the first gushes of milk into a separate dish. The samples were delivered to the laboratory, where somatic cell numbers were determined by the fluorescent-optical method. In addition, basic dilutions of milk samples were created, placed on growth medium, and incubated at 30 ^{0}C for 72 hours from which the total number of colonies was recorded with the counter. The number of colonies obtained represented the number of live microorganisms in 1 mL of milk.

Basic statistical analysis of the collected data was performed using the Statistica 7.1 software (StatSoft Inc., 2005). The Student *t*-test was used to determine the significance of differences between the cows in the three experimental groups subject to daily disinfection of teats before and after milking and the fourth group. During the investigation ANOVA Repeated Measures were used to establish variations in somatic cell and microorganism count in individual groups.

Results

It is evident from Table 1. that the average somatic cell number in three experimental groups on day 0 of trial ranged from 5,621-5.656 log10/mL milk and was decreasing through the course of trial, reaching values from 5.584-5.613 log10/mL milk at day 84

Table 1. Somatic cell count in cow milk (log_{10}/mL)

Days	Group 1 (n = 10)*	Group 2 (n = 11)*	Group 3 (n = 14)*	Group 4 (n = 13)*
	mean ± SD	mean ± SD.	mean ± SD.	mean ± SD.
0.	5.620969 ± 0.047143	5.630861 ± 0.051192	5.656422 ± 0.099825	5.381613 ± 0.175630
14.	5.612301 ± 0.047137	5.624756 ± 0.051207	5.655936 ± 0.099479	5.416950 ± 0.158351
28.	5.610702 ± 0.047272	5.619606 ± 0.051195	5.653618 ± 0.099787	5.422421 ± 0.156241
42.	5.594315 ± 0.047156	5.611532 ± 0.051189	5.652389 ± 0.099820	5.467971** ± 0.119040
56.	5.586581 ± 0.046833	5.590678 ± 0.051195	5.660717 ± 0.092349	5.467397** ± 0.112436
70.	5.584612 ± 0.055132	5.586225 ± 0.051185	5.642768 ± 0.099798	5.476523** ± 0.098031
84.	5.584251 ± 0.058658	5.584314 ± 0.053625	5. 0612845 ± 0. 99802	5.486246** ± 0.090614

* number of animals in group, ** statistically significant higher value (significance level P<0,01) regarding values established in first milk sample analysis

Table 2. Total viable count in cow milk (TVC log_{10}/mL)

Days	Group 1 (n = 10)*	Group 2 (n = 11)*	Group 3 (n = 14)*	Group 4 (n = 13)*
	mean ± SD	mean ± SD	mean ± SD	mean ± SD
0.	5.548796 ± 0.036904	5.659433 ± 0.021601	5.582693 ± 0.084169	5.557715 ± 0.064491
14.	5.535136 ± 0.036779	5.639884 ± 0.021106	5.580457 ± 0.084189	5.557936 ± 0.054327
28.	5.517046 ± 0.037411	5.634009 ± 0.021230	5.546364^{a} ± 0.084145	5.559690 ± 0.049414
42.	5.498377^{a} ± 0.035232	5.622766^{b} ± 0.021592	5.532461^{a} ± 0.084157	5.563392 ± 0.053212
56.	5.462450^{a} ± 0.037076	5.618402^{a} ± 0.021571	5.522217^{a} ± 0.084141	5.557808 ± 0.054221
70.	5.443313^{a} ± 0.129187	5.594199^{a} ± 0.021635	5.517991^{a} ± 0.084044	5.564656 ± 0.053343
84.	5.433476^{a} ± 0.032349	5.539846^{a} ± 0.021594	5.469045^{a} ± 0.084122	5.559959 ± 0.046864

*number of animals in group; [a]statistically significant lower value (significance level P<0,01) regarding values established in first milk sample analysis before the treatment; [b]statistically significant lower value (significance level P<0,05) regarding values established in first milk sample analysis before the treatment

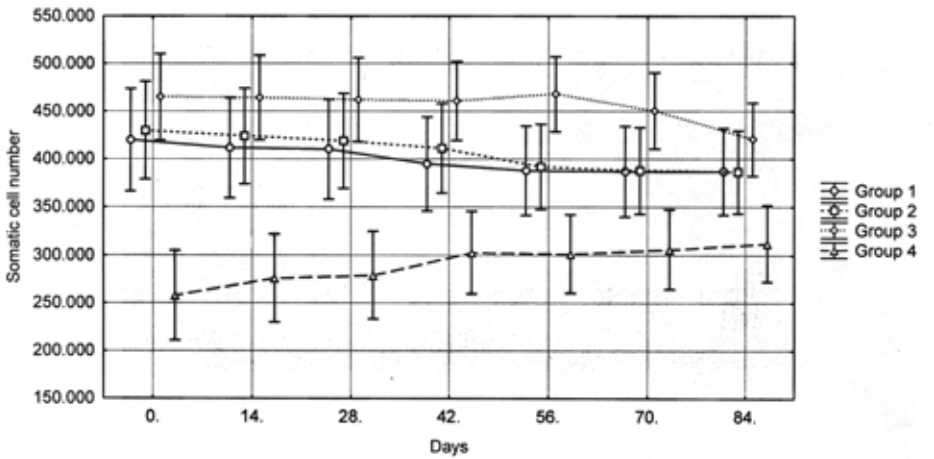

Fig. 1. Monitoring of average somatic cell numbers in individual groups. Vertical bars denote 0.95 confidence intervale.

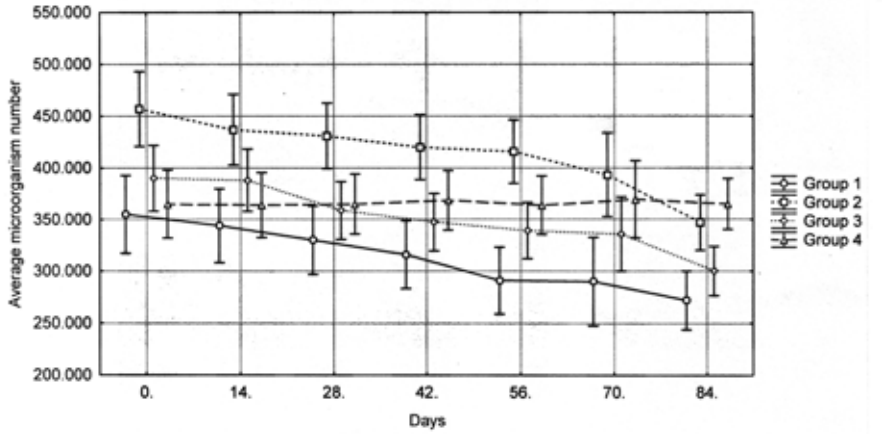

Fig. 2. Monitoring of average microorgganism numbers in individual groups. Vertical bars denote 0.95 confidence intervale

from the start of disinfection. Average somatic cell number in cow milk of the control group on day 0 was lower within boundaries established in three experimental groups and numbered 5.382 log10/mL milk. However, during further measurements it continually increased to 5.486 log10/mL milk. More detailed monitoring of average somatic cell numbers in individual groups is presented in Fig. 1.

Table 2. shows that the average microorganism number in three experimental groups on day 0 of monitoring was in the range from 5.549 - 5.659 log10/mL milk and was

continually decreasing in the course of trial reaching values from 5.433 - 5.540 log10/mL milk on day 84 from the start of disinfection. Average microorganism number in cow milk of the control group on day 0. of monitoring was within boundaries established in three experimental groups and numbered 5.558 log10/mL milk. However, during further measurements it showed variations up to 5.565 log10/mL milk at most. More detailed monitoring of average microorganism numbers in individual groups is presented in Fig. 2.

Discussion

The effect of certain disinfection agents on hygienic milk quality and udder health status has been evaluated in many studies. Thus it was established that LDBS application, as a teat disinfectant, reduces the numbers of mastitis-causing bacteria *S. agalactiae* and *S. aureus* by 71-80% (BARNUM et al., 1982), and decreases the number of new infections in relation to udders treated with iodine (PANKEY et al., 1985). Besides, the application of identical disinfecting agents, before and after milking, used in this study, already demonstrated the prevention of newly emerging infections, primarily ones caused by *S. aureus* (WINTER, 1999). However, it seems that the reduction of infection risk causes a drop in somatic cell and microorganism count, which was also observed with the use of other disinfecting agents (INGAWA et al., 1992). According to the data obtained, it is evident that the average somatic cell count in the experimental groups demonstrates a tendency to decrease in comparison to the starting values, but below the level of statistical significance.

In contrast, the average somatic cell count in the control group demonstrates a continuous increase in such a degree that from day 42 until the end of the trial this number was significantly larger ($P<0.01$) in relation to the average somatic cell number at the beginning of the trial. By observing the average microorganism count in the cow's milk of the three experimental groups, it is evident that there is a decreasing trend during which there is a statistically significant reduction from day 42 of the trial continuing to the end of the investigation.

In contrast, milk from the control group of cows whose udders were treated with water, showed no significant difference in the average microorganism count during the trial duration, because of the slight oscillations in these values. This method of milking hygiene is certainly not in accordance with proper udder hygiene, because it has been demonstrated that washing the udder with water decreases the microorganism number on the teat skin by only 54.5-57.1% (PAVIČIĆ et al., 2003a; PAVIČIĆ et al., 2003b). By an overall assessment of the trial results obtained from the control group, it is clear that they confirm current findings that without udder disinfection before and after milking the milk obtained can be of poor quality and unsuitable for processing (KALIT and LUKAČ-HAVRANEK, 2001). Besides, the results obtained from the experimental groups

are in agreement with current studies of sanitation in milking hygiene, where it has been established that implementation of disinfesting agents in udder hygiene prior to and after milking can significantly reduce the average microorganism count in fresh raw milk (PAVIČIĆ et al., 2003a; PETROVIĆ et al., 2006). This effectively improves the microbiologic quality of the milk in a relatively short time period, with the proviso that other sanitation procedures, including sanitation of milking equipment, are conducted in primary milk production (PETROVIĆ et al., 2006).

References

BARNUM, D. A., R. E. JOHNSON, B. W. BROOKS (1982): An evaluation of a teat dip with dodecyl benzene sulfonic acid in preventing bovine mammary gland infection from experimental exposure to *Streptococcus agalactiae* and *Staphylococcus aureus*. Can. Vet. J. 23, 50-54.

EBERHART, R. J., P. L. LeVAN, L. C. GRIEL jr., E. M. KESLER (1983): Germicidal teat dip in a herd with low prevalence of *S. agalactiae* and *S. aureus* mastitis. J. Dairy Sci. 64, 1390-1395.

ERSKINE, J. R. (2001): Mastitis control in dairy herds. In: Herd Health: Food animal production medicine (Radostits, O. M., Ed.). W. B. Saunders Company, Philadelphia, pp. 397-433.

GEDEK, W. (1994): Praxisnahe Maßnahmen der Mastitisprophylaxe. Prakt. Tierarzt 75, 54-56.

INGAWA, K. H., R. W. ADKINSON, R. H., GOUGH (1992): Evaluation of a gel teat cleaning and sanitizing compound for premilking hygiene. J. Dairy Sci. 75, 1224-1232.

KALIT, S., J. LUKAČ-HAVRANEK (2001): Primjena sanitacijskih sredstava u proizvodnji i preradi mlijeka. Mljekarstvo 51, 197-204.

LAM, T. J. G. M., M. C. M. de JONG, Y. H. SCHUKKEN, A. BRAND (1996): Mathematical modelling to estimate efficacy of postmilking teat desinfection in split-udder trials of diary cows. J. Dairy Sci. 79, 62-70.

OLIVER, S. P., M. J. LEWIS, T. L. INGLE, B. E. GILESPIE, K. R. MATTHEWS, H. H. DOWLEN (1993): Premilking teat disinfection for the prevention of environmental pathogen intramammary infections. J. Food Protect. 56, 852-855.

PANKEY, J. W., J. L. WATTS, S. C. NICKERSON (1985): Field studies on linear dodecyl benzene sulfonic acid teat dips. J. Dairy Sci. 68, 1523-1530.

PANKEY, J. W., E.E. WILDMAN, P.A. DRECHSLER, J. S. HOGAN (1987): Field trial evaluation of premilking teat disinfection. J. Dairy Sci. 70, 867-872.

PAVIČIĆ, Ž., T. BALENOVIĆ, M. VUČEMILO, A. TOFANT, K. MATKOVIĆ (2003a): Application of disinfectant in the preparation of the udder for milking. Proceedings of Actual Questions of Animal Bioclimatology, 8. December, Brno, Czech Republic, pp. 86-90.

PAVIČIĆ, Ž., M. VUČEMILO, A. TOFANT, M. CERGOLJ, T. BALENOVIĆ, K. MATKOVIĆ (2003b): Značenje primijenjene dezinfekcije u smanjenju onečišćenja mlijeka mikroorganizmima i sprječavanju upala mliječne žlijezde. Zbornik radova, Veterinarski dani, 9.-12. listopada, Šibenik, Hrvaska, 132-142.

PAVIČIĆ, Ž., A. TOMAŠKOVIĆ, T. BALENOVIĆ, M. CERGOLJ, N. PRVANOVIĆ (2005): Significance og udder sanitation on total number of bacteria on teats and in milk of ewes. Abstract book of the 4th IDF International Mastitis Conference, 12-15 June, Maastricht, The Netherlands, p. 932.

PETROVIĆ, M., Ž. PAVIČIĆ, A. TOMAŠKOVIĆ, M. CERGOLJ (2006): Učinak higijene mužnje na mikrobiološku kakvoću mlijeka. Stočarstvo 60, 403-411.

REINEMANN, D., G. MEIN, D. BRAY, D. REID, J. BRITT (2000): Troubleshooting high bacteria counts in farm milk. J. Microbiol. 23, 65-79.

RUEGG, P. L., I. R. DOHOO (1997): A benefit to cost analysis of the effect of premilking teat hygiene on somatic cell count and intramammary infections in a commercial dairy herd. Can. Vet. J. 38, 632-636.

SARAN, A. (1995): Disinfection in the dairy parlour. Rev. sci. tech. Off. int. Epiz. 14, 207-224.

SUAREZ, B., C. M. FERREIROS (1991): Psychotrophic flora of raw milk: resistence to several common disinfectants. J. Dairy Res. 58, 127-136.

WINTER, P. (1999): Klinische Überprüfung von P3 Oxy-Foam und Blu-Gard bei Milchkühen. Tierärztl. Umschau 54, 699-704.

*StatSoft, Inc. (2005). STATISTICA (data analysis software system), version 7.1.

Received: 22 December 2006
Accepted: 3 March 2008

PAVIČIĆ, Ž., M. CERGOLJ, T. BALENOVIĆ, A. EKERT-KABALIN, H. VALPOTIĆ: Učinak sanitacije vimena na higijensku kakvoću mlijeka krava. Vet. arhiv 78, 105-112, 2008.

SAŽETAK

Cilj istraživanja bio je utvrditi značajnost dezinfekcije vimena prije i poslije mužnje na higijensku kakvoću svježega sirova mlijeka u stadima mliječnih krava, gdje se dotada obavljala samo primarna higijena vimena s vodom. Istraživanje je provedeno na 4 obiteljska gospodarstva s različitom higijenskom kakvoćom mlijeka, pri čemu su za utvrđivanje učinka dezinfekcije vimena prije i poslije mužnje odabrana tri gospodarstva (pokusne skupine), a preostalo četvrto gospodarstvo nastavilo je u pripremi vimena za mužnju koristiti primarnu higijenu vodom (kontrolna skupina). Dezinfekcija prije mužnje na pokusnim skupinama obavljala se uranjanjem sisa u specijalnu čašu s aktivnom pjenom na osnovi površinski aktivnih tvari, organskih kiselina i vodikova peroksida, a dezinfekcija nakon mužnje uranjanjem sisa u sredstvo, koje uz supstanciju za njegu kože sadrži 1,94 %-tnu linearnu dodecyl-benzen-sulfonsku kiselinu (LDBS). Za određivanje somatskih stanica i mikroorganizama ukupno je uzeto sedam pojedinačnih uzoraka mlijeka od svake krave u istraživanju u razdoblju od 3 mjeseca. Nakon uzimanja uzorci su dostavljeni u laboratorij, gdje je standardnim metodama utvrđen broj somatskih stanica i mikroorganizama/ml mlijeka. Prema dobivenim podatcima u tri pokusne skupine zabilježeno je statistički značajno smanjenje oba pokazatelja: broj somatskih stanica smanjio se za 7,68 - 10,12%, a broj mikroorganizama za 23,02 - 24,07%. Za razliku od navedenog, broj somatskih stanica u kontrolnoj skupini je porastao tijekom promatranog razdoblja za 20,97%, uz manje kolebanja u broju mikroorganizama. Zaključeno je da prelazak s primarne higijene vimena vodom na dezinfekciju sisa prije i poslije mužnje kod krava znatno smanjuje prosječan broj somatskih stanica i mikroorganizama u svježem sirovom mlijeku i time poboljšava higijensku kakvoću mlijeka u određenom razdoblju.

Ključne riječi: krava, vime, sanitacija, mikroorganizmi, somatske stanice, mlijeko

---