Evaluation and implementation of good pratices in main points of microbiological contamination in milk production

Avaliação e implantação de boas práticas nos principais pontos de contaminação microbiológica na produção leiteira

Éder Paulo Fagan[1]; Vanerli Beloti[1*]; Márcia A. F. Barros[1]; Ernst E. Muller[1]; Luís A. Nero[2]; Elsa H. W. Santana[1]; Douglas Furtado Magnani[1]; Emanuel R. Vacarelli[1]; Luiz C. Silva[1]; Mykell S. Pereira[1]

Resumo

Buscando a melhoria da qualidade microbiológica de leite e derivados produzidos no Brasil, nos últimos anos algumas medidas vêm sendo implantadas na produção leiteira como a refrigeração e coleta a granel. A refrigeração é um procedimento eficiente no controle de aeróbios mesófilos, mas permite multiplicação de psicrotróficos, encontrados em altas contagens em leite produzido com pouca higiene. Para garantia e melhoraria da qualidade microbiológica do leite é necessária a implantação de medidas higiênicas, conhecidas como Boas Práticas de Produção (BPP). Neste estudo, diversas práticas higiênicas foram testadas nos principais pontos de contaminação na produção leiteira, previamente determinados: tetos (pré-dipping com diversas concentrações de cloro), latões e refrigeradores (técnicas de higienização), e água residual (eliminação). As práticas recomendadas foram escolhidas quanto à eficiência na redução de microrganismos, praticidade e viabilidade econômica. Quando as práticas foram aplicadas conjuntamente, obteve-se reduções consideráveis nas contagens microbianas. Após 48 horas de refrigeração do leite, as contagens foram reduzidas de 11,95x10^6 CFU/mL para 12,48x10^3 CFU/mL de aeróbios mesófilos, e de 18,10x10^6 CFU/mL para 5,38x10^3 CFU/mL de psicrotróficos. Os resultados mostram que as práticas propostas são eficientes, viáveis e facilmente adotáveis por produtores leiteiros, representando uma importante alternativa na produção de leite com alta qualidade.

Palavras-chave: Qualidade do leite, BPP, aeróbios mesófilos, psicrotróficos

Abstract

In order to improve the microbiological quality of Brazilian milk and dairy products some measures have been implemented in the milk-producing sector throughout the years, such as milk refrigeration and bulk collection. Refrigeration is a very efficient procedure, however allows psychrotrophics multiplication, which are largely found in milk produced in poor hygienic conditions. To assure and improve the microbiologic quality of milk turns out to be necessary the implementation of hygienic measures, known as Good Manufacturing Practices (GMP). In this study, several hygienic practices were tested in the main contamination points in milk production, previously determined: teats (different chlorine concentrations pre-dipping), cans and bulk tanks (hygienic techniques) and residual water (elimination). The recommended practices were picked up considering their efficiency in microbial reduction, practiced and economic viability. When the practices were all applied, reduction in microbial counts was observed. After 48 hours the final and refrigerated milk showed a reduction of 11.95x10^6 CFU/mL to 12.48x10^3 CFU/mL of mesophilic aerobes, and a reduction of 18.10x10^6 CFU/mL to 5.38x10^3 CFU/mL of psychrotrophics. The results show that the procedures proposed by LIPOA is efficient, viable and easily adopted by milk farmers, representing an important alternative in producing high quality milk.

Key words: Milk quality, GMP, mesophilic aerobes, psychrotrophics

[1] Laboratório de Inspeção de Produtos de Origem Animal, (LIPOA) DMVP, CCA, Universidade Estadual de Londrina, Caixa Postal 6001, 86051-970 - Londrina, PR, Brasil. e-mail: neli@sercomtel.com.br
[2] Departamento de Alimentos e Nutrição Experimental, FCF, Universidade de São Paulo, Av. Prof. Lineu Prestes 580, 05508-900 - São Paulo, SP, Brasil.
* Autor para correspondência.

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Introdução

Raw milk quality is directly related to the initial contamination, time and temperature at which the milk remains from milking to processing (COUSIN, 1982; BRAMLEY; McKINNON, 1990; MORAIS et al., 1992; SOLER et al., 1995). More contaminants and higher storage temperature result in a shorter product shelf life (SILVEIRA et al., 1989).

In Belo Horizonte city State of Minas Gerais, Brazil, was verified the poor microbiological quality of *in natura* milk finding mean counts of 4.5 million CFU/mL of mesophilic aerobes (CERQUEIRA et al., 1994). The microbial quality of raw milk produced and commercialized in the city of Cornélio Procópio, Paraná State reported a mean of 7.5 million CFU/mL of mesophilic aerobes and 9,000 MPN/mL of fecal coliforms (BELOTI et al., 1999). The high mesophilic aerobes microorganism and coliform counts detected in *in natura* milk produced in Brazil indicate poor hygiene conditions during production.

Aiming to improve the microbial quality of milk and dairy products, modifications have been made in the dairy sector including refrigeration of the milk on the farm and bulk milk collection, currently in implantation in Brazil (BRASIL, 2002). Cooling has been an important resource to maintain the desired characteristics of the milk (AZEVEDO, 1996; FURTADO, 1999; SANTANA et al., 2001), controlling the multiplication of mesophilic aerobes that present acidifying metabolism. However, storing milk at between 4 and 7^{o}C before processing permits the growth of psychrotrophics that can develop under refrigeration temperatures, regardless of their optimal growth temperature (SORHAUNG; STEPANIAK, 1997; FURTADO, 1999; FONSECA; SANTOS, 2000; SANTANA et al., 2001).

The psychrotrophics found in milk are mostly gram negative, originated in the environment and milking utensils. Although they are easily destroyed by pasteurization, they have a proteolytic and lipolytic metabolism, producing thermoduric enzymes that cause physical and organoleptical alterations in milk and the dairy products, even after heat treatment (COUSIN; BRAMLEY, 1981; BRAMLEY; McKINNON, 1990; AMERICAN PUBLIC HEALTH ASSOCIATION, 1992; DOMMETT, 1992; MUIR, 1996).

In a study to determine the main contamination points of milk on farms in the region of Londrina, Paraná State, it was found that the surface and residual water of milk cans and bulk tanks and poorly cleaned teats were the main contamination points by mesophilic aerobes, while psychrotrophics contamination points were more frequent in the residual water, milk can surfaces, bulk tanks and poorly cleaned teats (SANTANA et al., 2001).

Thus the rapid reduction in milk temperature after milking should be accompanied by good hygiene procedures while it is obtained, proper cleanliness and disinfections of the teats, dairy utensils and equipment, good quality water and mastitis control measures (FONSECA; SANTOS, 2001).

The planning and implantation of GMP aim to optimize production. Regardless of the production volume, size or investment capacity of each farm, the milk should be produced, stored and transported as hygienically as possible (SAKATE et al., 1999).

The profile of most Brazilian farms is low production, with hand milking and when it is mechanical predominate the system that the milk is conducted to milk scans, and then it is cooled. These farms are characterized by poor hygiene conditions for production, low productivity and farmers discouraged by the low prices paid for milk. Considering this reality, the objective of this study was to assess the efficiency and viability of simple procedures that can be implanted by the producer at the main contamination points (SANTANA et al., 2001), that include teats, cans and bulk milk tanks.

Material and Methods

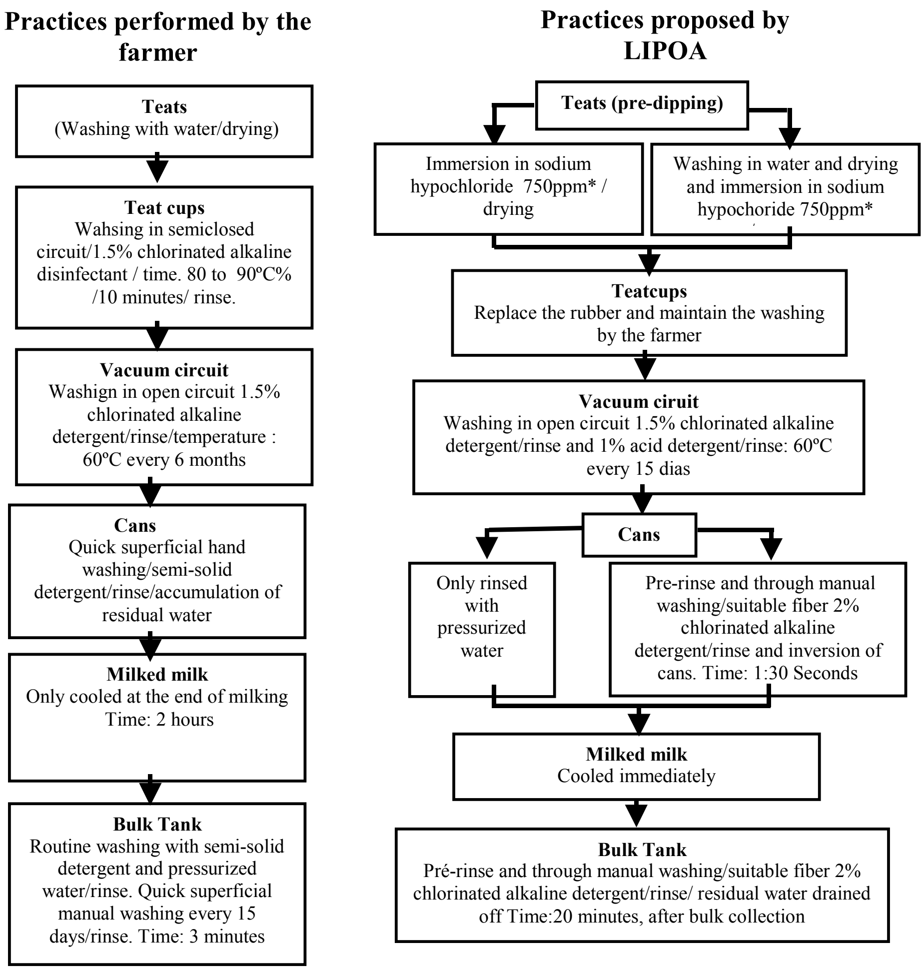
This study was carried out from May 2001 to April 2003 on a farm producer of C type milk, located in the region of Londrina (north Paraná State). The farm was selected by orientation of a local cooperative as representing the most common reality in milk production in the region.

The efficiency of the practices routinely performed by the farmer were assessed at the points detected as most important in milk contamination (SANTANA et al., 2001), on this same farm, that is: milk cans, bulk tank, poorly cleaned teats and residual water and were compared with those proposed by Laboratory of Animal Products Inspoction (LIPOA) Figure 1.

Samples were collected to assess the efficiency of the practices performed by the farmer and proposed by LIPOA. The following points were evaluated:

· Teats: swabs were taken on four teats of 26 animals, before and after performing the practices. The right side teats were cleaned according to the farmer practices, and the teats on the left side were cleaned following the practices proposed by LIPOA.

· Cans and bulk tank: a total of 40 sample swabs were taken on the can sides and bottom. In the bulk tank, swabs were taken on the side and bottom totaling 20 samples. The swabs were taken before and after the practices executed by the farmer and proposed by LIPOA.



Rinse and Pre-rinse: high pressure water 24 Kgf/cm^2
*Concentrations of 250, 500, 750, 1000, 1250 and 1500ppm were also tested

Figure 1. Milking practices performed by the farmer and proposed by the Laboratory of Animal Products Inspection - LIPOA, to compare their efficiency, on a dairy farm producing C type milk in the Londrina/PR region.

A 3cm^2 area was sampled on the teats, compatible with the dimensions of these structures (SANTANA et al., 2001). The area sampled was 25 cm^2 in the cans and bulk tanks (BRAMLEY; McKINNON, 1990). Sterile plastic templates were used to limit the areas developed in the Laboratory. The swabs were taken with flexible sterile rods with a rayon tip and Letheen broth for transport to neutralize the action of the sanitizing residues. The material collected was transported under refrigeration to LIPOA, where the analyses were made.

After assessing the efficiency of the practices one by one, the most efficient were chosen, establishing a flowchart of work to check the impact of the joint implantation of these procedures on milk quality, compared to those routinely performed by the farmer. Milk was collected from the milk can, immediately after milking and before refrigeration in the bulk tank, after the mixing the milk from each milking and after 12, 24, 36 and 48 hours refrigeration during 4 consecutive milking, to research mesophilic aerobes, psychrotrophics and inhibitors residues. The inhibitor research was also carried out in the can rinsing water and the bulk tank. The experiment with the joint implantation of the practices was repeated three times, totalizing 12 milking assessed.

The collected samples were diluted in sterile saline (0.85%) in decimal dilutions, according the presumptive contamination level, for microbiological analysis. A vortex-type automatic shaker was used for homogenization of diluted samples. To count the mesophilic aerobes of the samples, 1 mL of the chosen dilution was sown pour plate at Plate Count Agar (PCA, Bio, Minas Gerais, Brazil) in duplicates, and incubated at 35^{o}C for 48h (BRASIL, 1991-1992). For psychrotrophics, 0.1mL of samples was sown by surface at PCA in duplicates, and incubated at 21^{o}C for 25h (OLIVEIRA; PARMELEE, 1976; AMERICAN PUBLIC HEALTH ASSOCIATION, 1992). The final result was the medium of the counts, considering the dilution and expressed in CFU/mL or CFU/cm^2.

Three samples were collected of water used to clean the animals teats, bulk tank and milking equipment and/or utensils. The samples were placed in sterile amber flasks and transported under refrigeration in a thermal case to LIPOA. The counting of mesophilic aerobes and psychrotrophics were researched, as already explained. Total coliforms and *E. coli* counts were made using Petrifilm tm plates (3M Microbiology, St. Paul, MN, USA); 5mL of the diluted sample were sown on HS plates and 1mL on EC plates, incubated at 35^{o}C for 24/48h. Red colonies with gas formation were enumerated as total coliforms and blue colonies with gas formation as *E. coli*, and the results were expressed in CFU/mL.

The final counting results were compared considering the distinct procedures tested (LIPOA and farmer) and each point of sample collected, with help of Microsoft Excel 2000 (Microsoft 2000).

Results and Discussion

Tables 1, 2 and 3 show the results of the mesophilic aerobes and psychrotrophics counts obtained from teat samples, milk cans and bulk tank, before and after applying the different cleaning practices. The data obtained indicated a greater efficiency in the new practices proposed by LIPOA compared with those previously performed by the farmer.

When the contamination points and each practice were analyzed separately, it was observed for teats that the practice usually carried out by the farmer using only running water to clean was not efficacious and there was little reduction in the microbial counts (Table 1). Considering a mean teat area of 50.8 cm^2 (FONSECA et al., 2000) and an expected incorporation of 86% of the mesophilic aerobes and 96% of the psychrotrophics (SANTANA, 2001), it could be estimated that the teats of each animal contributed 1.5x10^6 CFU/mL of mesophilic aerobes and 1.1x10^6 CFU/mL of psychrotrophics to milk contamination obtained with the farmers routine practices (Table 1).

Table 1. Mean counts of mesophilic aerobes and psychrotrophics obtained with different cleaning practices and antisepsis on the teats of 26 animals on a C type milk dairy farm in Londrina/PR region.

	Counts in CFU/cm^2		% microorganism reduction	
Practices performed by the farmer	MA	P	MA	P
Dirty teats	$5.5x10^4$	$5.0x10^3$	30.1%	57.1%
Teats cleaned in water	$3.8x10^4$	$2.1x10^3$		
Practices performed by LIPOA				
Dirty teats	$6.1x10^4$	$3.6x10^3$	94.8%	81.1%
Teats after direct immersion in sodium hypochlorine*	$3.1x10^3$	$6.7x10^2$		
Dirty teats	$2.1x10^5$	$2.9x10^4$	98.1%	98.2%
Teats cleaned with water and immersed in sodium hypochoride*	$3.9x10^3$	$5.1x10^2$		

MA: mesophilic aerobes, P: psychrotrophics
*Sodium hypochlorine at 750ppm active chlorine

LIPOA used two different practices to clean the teats, both with better results than those of the farmer. When pre-dipping was used with direct immersion of the teats in sodium hypochlorine solution, the mean initial mesophilic aerobes count was reduced from $6.1x10^4$ CFU/cm^2 to $3.1x10^3$ CFU/cm^2 and the mean counts of psychrotrophics decreased from $3.5x10^3$ CFU/cm^2 to $6.7x10^2$ CFU/ cm^2, representing a mean reduction of 94.8% and 81.1%, respectively.

When the teats were cleaned with water before applying the sodium hypochlorine solutions, the mean mesophilic aerobes and psychrotrophics counts were reduced from $2.1x10^5$ CFU/ cm^2 to $3.9x10^3$ CFU/cm^2 and from $2.9x10^4$ CFU/cm^2 to $5.1x10^2$ CFU/cm^2 respectively, corresponding to a 98.1% and 98.2% decrease (Table 1). Obtained similar results studying the efficiency of pre-dipping on an A type milk farm where, after the practice, there was a 99.5% reduction in the mesophilic aerobes and 99.0% reduction in the psychrotrophics (SANTANA, 2001). The practice of pre-dipping can determine a reduction of up to 80% in the milk microbial count (FONSECA et al., 2000).

The concentration of 750 ppm active chlorine best reconciled efficiency and residue absence. Concentrations below 750ppm were ineffective and those above left residues. Considering the efficiency and facility of execution of the practice of direct teat immersion in sodium hypochlorine with 750ppm active chlorine, it can be recommended that the teats be washed only when dirt is visible, as chlorine has little action when there is excessive organic matter.

Three milk can washing techniques were compared, one executed by the farmer and two executed by LIPOA. In the washing performed by the farmer, it was observed that the cleaning did not follow a sequence and a product without defined concentration and old sponge were used for cleaning. The cans were not inverted after washing and water accumulated inside them. Such procedures reduce the mean counts (bottom/ side) by only 51.5% and 81.0% for mesophilic aerobes and psychrotrophics, respectively.

In the first can cleaning practice performed by LIPOA, does not sufficiently eliminate contamination from can surfaces. Meanwhile, in the second practice, the cans were washed thoroughly using 2% chlorinated alkaline detergent and proper sponge, taking the means of the counts obtained between the can side and bottom, there was a reduction in the number of mesophilic aerobes from $3.2x10^6$ CFU/ cm^2 to $2.8x10^2$ CFU/ cm^2 and for psychrotrophics from $6.35x10^5$ CFU/cm^2 to 41 CFU/cm^2 corresponding to a 99% decrease in mesophilic aerobes and psychrotrophics (Table 2).

Table 2. Mean counts of mesophilic aerobes and psychrotrophics obtained in different cleaning practices in 20 milk cans on a dairy farm producing C type milk in Londrina/PR.

*Farmer: Quick superficial washing with water and semi-solid detergent

	Counts CFU/cm² or CFU/mL		% microorganisms reduction	
*Farmer practices**	MA	P	MA	P
Residual water after washing	$4.5x10^6$	$1.0x10^6$	-	-
Swab from dirty can sided (before cleaning)	$9.4x10^5$	$3.5x10^5$	24.3%	79.5%
Swab from clean can side taken by the farmer	$7.1x10^5$	$7.1x10^4$		
Swab from can bottom (before cleaning)	$1.5x10^6$	$3.5x10^5$	78.7%	82.5%
Swab from can bottom cleaned by farmer	$3.2x10^5$	$6.2x10^4$		
*LIPOA practices***				
Swab from the dirty can side (before cleaning)	$3.1x10^7$	$5.2x10^6$	68.0%	50.2%
Swab from can side cleaned with pressurized water	$1.0x10^6$	$2.6.10^6$		
Swab from dirty can bottom (before cleaning)	$4.6x10^7$	$5.4x10^6$	92.3%	85.9%
Swab from the can bottom cleaned with pressurized water	$3.5x10^6$	$7.6x10^5$		
*LIPOA practices****				
Swab from the dirty can side (before	$2.6x10^6$	$6.6x10^5$	99.99%	99.99%
Swab from clean can side	$1.8x10^1$	$4.0x10^0$		
Swab from the dirty can bottom (before cleaning)	$3.9x10^6$	$6.1x10^5$	99.98%	99.98%
Swab from clean can bottom	$5.4x10^2$	$7.9x10^1$		

** LIPOA: Superficial washing with only pressurized water
*** LIPOA: Thorough manual scrubbing with pressurized water and 2% chlorinated alkaline detergent
MA : mesophilic aerobes, P: psychrotrophics

Regarding residual water in the cans, a mean of $4.5x10^6$ CFU/mL of mesophilic aerobes and $1.0x10^6$ CFU/mL of psychrotrophics were found. Thus each can with a mean of 80mL residual water would represent an incorporation of $3.6x10^8$ CFU mesophilic aerobes and $8.0x10^7$ CFU psychrotrophics in the milk and counts up to $5.1x10^7$ CFU/mL of mesophilic aerobes and $9.6x10^5$ CFU/mL psychrotrophics in final milk (SANTANA et al., 2001).

The results showed the importance of careful and through washing, emphasizing manual scrubbing with detergent at a suitable concentration and inverting the cans after washing.

The bulk tank was washed quickly and superficially by the farmers and the residual water was not drained out of the tank. As result, the mesophilic aerobes and psychrotrophics counts obtained before and after the practice presented a mean reduction, considering both the sides and bottom of the tank, of only 8.3% and 42.5%, respectively (Table 3).

Table 3. Mean counts of mesophilic aerobes and psychrotrophics obtained in different cleaning practices in the expansion tank (5 repetitions), on a dairy farm producing C type milk dairy farm in the Londrina/PR region.

	Counts CFU/cm^2 or CFU/mL		% microorganisms reduction	
*Farmer practices and samples**	MA	P	MA	P
Residual water	$1.1x10^7$	$7.5x10^6$	-	-
Swab from dirty can side	$4.1x10^6$	$1.0x10^7$	11.6%	37.0%
Swab from tank side cleaned by farmer	$3.6x10^6$	$6.4x10^6$		
Swab from dirty tank bottom	$8.5x10^6$	$1.4x10^7$	5.0%	48.0%
Swab from tank bottom cleaned by farmer	$8.0x10^6$	$7.4.10^6$		
*LIPOA practices and samples***				
Swab from dirty tank side	$1.2x10^7$	$4.6x10^6$	99.99%	99.99%
Swab from clean tank side	$8.0x10^0$	0.0		
Swab from dirty tank bottom	$1.9x10^7$	$1.6x10^7$	99.99%	99.99%
Swab from clean tank bottom	$3.0x10^0$	0.0		

*Farmer practices: Quick superficial washing with water and semi-solid detergent. ** LIPOA practices: Thorough manual scrubbing with pressurized water and 2% chlorinated alkaline detergent. MA: mesophilic aerobes, P: psychrotrophics

The cleaning practice proposed by LIPOA to wash the bulk tank used vigorous manual scrubbing, suitable fiber and detergent and draining of the residual water. There was a reduction in the mean counts considering both the tank bottom and sides of $1.5x10^7$ CFU/cm^2 of mesophilic aerobes to 5 CFU/cm^2 and of $1.0x10^7$ CFU/mL of psychrotrophics to <10 CFU/mL representing, respectively, 99.99% and 99.99% efficiency (Table 3).

A mean was found in 300mL of residual water in the expansion tank that represented incorporation in the refrigerated milk of $3.4x10^9$ CFU of mesophilic aerobes and $2.2x10^9$ CFU of psychrotrophics. Therefore ascertained, counts of up to $1.7x10^8$ CFU/mL of mesophilic aerobes and $2.6x10^7$ CFU/mL of psychrotrophics in the residual water of bulk tank were found (SANTANA et al., 2001).

Thus similarly to the milk cans, the recommended practice for the bulk tank was careful and through manual washing with suitable fiber, product and concentration, and total draining of the residual water.

The water on the farm studied used in the cowshed and to clean equipment and utensils, although it was not chlorinated, presented absence of coliforms and psychrotrophics and a low count of mesophilic aerobes (3 CFU/mL) and did not affect the milk quality. However, chlorination should always be recommended, since contamination can happen at any moment, representing an important risk to production. Water contaminated with psychrotrophics used to clean milking utensils and equipment can be the main responsible for damaging the quality of refrigerated milk (THOMAS, 1966).

Analyzing together the practices used, in the farmer cleaning flowchart deficiencies are observed in the teat, can and bulk tank cleaning, worn teat cup rubber, unclean vacuum system and permanence of the milk in the can at ambient temperature for 1.5h on average, leading to a high contamination of the product after 48h refrigeration (Table 4).

Table 4. Comparison between mesophilic aerobes and psychrotrophic counts obtained with the flowchart of routine practices of the farmer and those implanted by LIPOA, during 4 consecutive milking on a dairy farm producing C type milk in the Londrina PR region.

Collection points	Microorganisms count CFU/mL*			
	Farmer Practices		LIPOA	
	MA	P	MA	P
1. Mean of milk from 8 cans after milking	$4.5x10^6$	$2.2x10^5$	-	-
2. Mean of milk from cans before chilling	$8.5x10^6$	$5.5x10^5$	$5.4x10^3$	$4.1x10^3$
3. Milk in the refrigeration tank mixture	$1.7x10^7$	$1.2x10^6$	$6.5x10^3$	$4.1x10^3$
4. Milk after 12 hours refrigeration	$1.2x10^7$	$1.6x10^6$	$5.5x10^3$	$6.6x10^3$
5. Mean of milk from 11 cans before chilling	$5.9x10^6$	$1.1x10^6$	$6.6x10^3$	$5.9x10^3$
6. Milk from the refrigeration tank mixture	$1.3x10^7$	$2.1x10^6$	$5.6x10^3$	$5.6x10^3$
7. Milk after 24 hours refrigeration	$1.5x10^6$	$5.3x10^6$	$7.0x10^3$	$4.6x10^3$
8. Mean of milk from 8 cans before chilling	$1.6x10^6$	$1.4x10^6$	$7.1x10^3$	$4.6x10^3$
9. Milk from the refrigeration tank mixture	$2.6x10^6$	$6.0x10^6$	$9.0x10^3$	$4.3x10^3$
10. Milk after 36 hours refrigeration	$6.7x10^6$	$1.2x10^7$	$1.1x10^4$	$4.7x10^3$
11. Mean of milk from 11 cans before chilling	$5.3x10^5$	$1.1x10^6$	$7.1x10^3$	$3.8x10^3$
12. Milk from the refrigeration tank mixture	$6.9x10^6$	$1.3x10^7$	$8.9x10^3$	$4.9x10^3$
13. Milk after 48 hours refrigeration	$1.2x10^7$	$1.8x10^7$	$1.2x10^4$	$5.4x10^3$

MA: mesophilic aerobes, P: psychrotrophics
* Results refer to the means obtained in three replications of the experiment

The practices proposed by LIPOA when implanted together were quite efficient. The mean of the counts of the milk in the cans were reduced from $9.0x10^5$ CFU/mL of mesophilic aerobes and $1.0x10^6$ CFU/mL of psychrotrophics to $6.5x10^3$ CFU/mL and $4.6x10^3$ CFU/mL, corresponding to a decrease of 99.2% and 99.5%, respectively. The practices of pre-dipping and can washing proposed by LIPOA allow the milk to arrive at the refrigerator with a 150-fold lower microbial load (Table 4).

Milk after 48h refrigeration, when produced according to the farmer routine, presented counts of $11.95x10^6$ CFU/mL mesophilic aerobes and 18.10 x 10^6 CFU/mL psychrotrophics, while after the practices proposed by LIPOA the counts were reduced, respectively, to $12.4x10^6$ CFU/mL and $5.4x10^6$ CFU/mL (Table 4), values 950 and 3,370 times lower, respectively. The product obtained passed to correspond, by the Brazilian legislation, to B type milk of excellent quality.

Teat cup cleaning by the farmer was efficient permitting counts of 230 CFU/mL mesophilic aerobes and 20 CFU/mL psychrotrophics to be obtained. Thus LIPOA only proposed the regular replacement of the rubbers of the cups. However, the effect of heat was not assessed on the durability of the cups of milking.

Concerning the cost of the practices, the only one that depended on new expenses was the pre-dipping. Farmers can properly achieve a bottle of sodium hypochlorine tablets, once it is not too expensive, and it would be useful for a long time, according the number of the animals in lactation. Plus, this additional expense can be compensated in the payment of quality, so that the farmer accepted all the suggestions and continues to perform the practices. The other procedures are being used products already on the farm, without additional expense.

The results obtained, as the recommended practices, are important for a future structuring of the system of analysis of Hazards and Critical Control Points on the farm. Practically one year after the experiment finished, the cooperative confirmed the results obtained, following the quality of the milk of this producer that has presented mean counts of 30 x 10^3 CFU/mL of mesophilic aerobes.

The obtained results in this study, applied to Brazilian milk production reality, allows the conclusion that the microbial quality of milk depends basically on the implantation of Good Practices in production, even when the farm have poor conditions of infra-structure and technology. A supposed technology, as bulk tank, will provide high quality milk only if the initial milk contamination is low. Regarding the procedures, pre-dipping was shown to be a very important practice to obtain milk with microbial quality, and for can and bulk tanks the removal of dirt by vigorous manual scrubbing, with suitable detergent, is the most efficient cleaning technique. In conclusion, the procedures proposed by LIPOA are efficient and viable, and can be implanted on other dairy farms.

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References

AMERICAN PUBLIC HEALTH ASSOCIATION. Milk and milk products. In: ______. *Compendium of methods for the microbiological examination of foods*. Washington, 1992.

AZEVEDO, P. R. Coleta a granel diminui custos para laticínios. *Engenharia de alimentos,* São Paulo, v. 15, n. 4, p. 27, 1996.

BELOTI, V.; BARROS, M. A. F.; NERO, L. A.; SOUZA, J. A.; SANTANA, E. H. W.; BALARIN, O.; CURIAKI, Y. Avaliação da qualidade do leite cru comercializado em Cornélio Procópio, Paraná: Controle do consumo e da comercialização. *Semina*, Londrina, v. 20, n. 1, p. 12-15, 1999.

BRAMLEY, A. J.; MCKINNON, C. H. *The microbiology of raw milk*. In: ROBINSON, R. K. (Ed.). *Dairy Microbiology:* the microbiology of milk. London: Elsevier Science, 1990. p. 163-207.

BRASIL. Ministério da Agricultura, do Abastecimento e da Reforma Agrária. *Laboratório Nacional de Referência Animal*. Brasília, 1981.

BRASIL. Ministério da Agricultura, do Abastecimento e da Reforma Agrária. *Métodos de Análises Microbiológicas para alimentos*. Brasília, 1991-1992

BRASIL. Ministério da Agricultura, do Abastecimento e da Reforma Agrária. *Instrução Normativa nº51*, de 18 de setembro de 2002. Regulamento técnico de produção, identidade e qualidade de leite. Brasília, 2002.

CERQUEIRA, M. M. O. P.; SOUZA, M. R.; RODRIGUES, R.; FONSECA, L. M.; RUBINICH, J.; QUINTAES, I. A. S. Características microbiológicas de leite cru e beneficiado em Belo Horizonte - MG. *Arquivo Brasileiro de Medicina Veterinária e Zootecnia,* Belo Horizonte, v. 46, n. 6, p. 713-721, 1994.

COUSIN, M. A.; BRAMLEY, A. J. The microbiology of raw milk. In: ROBINSON, R. K. *Dairy Microbiology* –1 The Microbiology of Milk. London: Applied Science Publishers, 1981. p. 119-163.

COUSIN, M. A. Presence and activity of psychrotrophic microorganisms in milk and dairy products: a review. *Journal of Food Protection*, Des Moines, v. 45, n. 2, p. 172-207, 1982.

DOMMETT, T. W. Spoilage of aseptically packaged pasteurized liquid dairy products by thermoduric psychrotrophs. *Food Australia*, North Sydney, v. 10, n. 44, p. 459-461, 1992.

FONSECA, L. F. L.; SANTOS, M. V. Importância e efeito das bactérias psicrotróficas sobre a qualidade do leite. *Higiene Alimentar*, São Paulo, v. 15, n. 82, p. 13-19, 2001.

FONSECA, L. F. L; SANTOS, M. V. *Qualidade do Leite e Controle de Mastite.* São Paulo: Lemos, 2000.

FURTADO, M. F. *Principais problemas dos queijos:* Causas e prevenção. São Paulo: Fonte, 1999.

MORAIS, M. M.; SEHLING, R. N.; MAGALHÃES, F. A. R. Limpeza e sanitização do vasilhame de transporte de leite. *Revista Boletim do Leite e Seus Derivados*, Rio de Janeiro, v. 6, p. 20-36, 1992.

MUIR, D. D. The shelf-life of Dairy Products: 1. Factors influencing raw milk and fresh products. *Journal of the Society of Dairy Technology*, Wembley, v. 49, n. 1, p. 24-32, 1996.

OLIVERIA, J. S.; PARMELEE, C. E. Rapid enumeration of psychrotrophic bacteria in raw and pasteurized milk. *Journal of Milk and Food Technology*, Ames, Iowa, v. 39, n. 1, p. 269-272, 1976.

SAKATE, R. I.; SANTOS, F. L.; CARDOSO, R. C. V.; BRANDÃO, S. C. C. Elaboração e Planejamento do Sistema HACCP para Estábulo Leiteiro. *Higiene Alimentar*, São Paulo, v. 13, n. 65, p. 30-37, 1999.

SANTANA, E. H. W.; BELOTI, V.; BARROS, M. A. F. Microrganismos Psicrotróficos em Leite**.** *Higiene Alimentar*, São Paulo, v. 15, n. 88, p. 27-33, 2001.

SANTANA, E. H. W; BELOTI, V.; MULLER, E. E.; BARROS, M. A. F.; MORAES, L. B.; GUSMÃO, V. V.; PEREIRA, M. S. Milk Contamination in different points of the dairy process. II -Psychotrophics and proteolytics microorganisms, *Semina Ciências Agrárias*, Londrina. v. 25, n. 4, p. 349-358, 2004.

SILVEIRA, N. V. V.; SAKUMA, H.; DUARTE, E. L. Avaliação das condições físico-químicas e microbiológicas do leite pasteurizado consumido na cidade de São Paulo. *Revista do Instituto Adolfo Lutz,* São Paulo, v. 49, n. 1, p. 19-25, 1989.

SOLER, A.; PONSELL, C.; DEPAZ, M.; NUÑEZ, M. The microbiological quality of milk produced in the Balearic-Islands. *International Dairy Journal*, Oxford, v. 5, n.1, p. 69-74, 1995.

SORHAUNG, T.; STEPANIAK, L. Psychrotrophics and their enzymes in milk and dairy products: Quality aspects. *Trends in Food Science & Technology*, Cambridge, v. 8, n. 2, p. 35-41, 1997.

THOMAS, S. B. Source, incidence and significance of psychrotrophic bacteria in milk. *Milchwissenschaft*, Munchen, v. 21, n. 5, p. 270-275, 1966.