Quality of milk produced in small farms in Alagoas state and impact of application of good manufacturing practices to milking hygiene

Qualidade do leite produzido em pequenas fazendas no estado de Alagoas e impacto da aplicação de boas práticas de fabricação na higiene da ordenha

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Abstract

The purpose of this study was to monitor improvements in the hygiene and sanitation conditions of the milk after application of Good Manufacturing Practices (GMP) to milking. A total of 106 farms were assessed in four periods of six months in the regions named agreste, dairy region, mid-backlands and high backlands in State of Alagoas, Brazil. Two activities were executed in the project: monitoring of milk quality; and application of GMP to pre-milking and milking processes. Milk samples underwent determination of Somatic Cell Count (SCC), Total Bacterial Count (TBC) and composition. The results correspond to milk components, determination of mammary health indicative parameters - SCC and milking hygiene - TBC. Regarding SCC, 73% of producers complied with the standards established by normative instruction (IN) 62/2011. Results of SCC after application of GMP remained basically the same, showing the only significant difference in the group studied from 401 to 500 SCC (x 1,000) / mL. Regarding TBC, the use of GMP increased from 237 (46.75%) to 380 (59.94%), but this increase was significant only in the group of "up to 100 (x 1,000) / mL". The average of the other assessed samples was within the established parameters. Less than 4% of the samples presented one million or higher TBC/mL of milk.

Keywords: somatic cell count, total bacterial count, milking, milk production.

Resumo

O presente trabalho objetivou monitorar as melhorias das condições higiênico-sanitárias do leite no processo de ordenha após o uso das boas práticas de produção (BPP) aplicadas na ordenha. Foram trabalhadas 106 fazendas em quatro períodos de seis meses nas regiões denominadas agreste, bacia leiteira, médio sertão e alto sertão de Alagoas. A execução do projeto foi constituída por duas ações: 1. Monitoramento da qualidade do leite. 2. Aplicação das BPP na pré-ordenha e no processo de ordenha. As amostras de leite foram submetidas à determinação da Contagem de Células Somáticas (CCS), Contagem Bacteriana Total (CBT) e composição. Os resultados são apresentados para os componentes do leite, determinações de parâmetros indicativos de sanidade mamária - CCS e higiene da ordenha - CBT. Com relação à CCS, 73% das fazendas alcançaram os padrões estabelecidos pela IN 62/2011. Os resultados de CCS após a aplicação de BPP permaneceram praticamente inalterados, demonstrando apenas diferença significativa no grupo estudado de 401 a 500 CCS (x 1,000)/mL. Com relação à CBT observou-se que o uso das BPP elevou de 237 (46,75%) para 380 (59,94%) a média de todas as amostras estudadas que estavam dentro dos padrões estabelecidos, mas esse aumento foi significativo apenas no grupo de até 100 (x 1,000)/mL, não sendo significativas as mudanças ocorridas nos índices alcançados por ocasião da aplicação de BPP nos outros extratos estudados. Menos de 4% das amostras apresentaram um milhão ou mais CBT/mL de leite

Palavras-chave: contagem de células somáticas, contagem bacteriana total, ordenha, produção de leite.

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Introduction

Researchers from several regions of the Brazil and in the world have been directing their attention to the search for more suitable milk quality. Staphylococcal enterotoxins in dairy products cause food poisoning in humans, with symptoms including vomiting and diarrhea (De Buyser et al., 2001; Cousin et al., 2018). According to Huijps et al. (2008), the economic losses of a clinical case in a default situation were calculated as €210, varying from €164 to €235 depending on the month of lactation and is important to show the farmers the economic losses of mastitis on their farm. In another study on USA, Rollin et al. (2015) showed detailed costs of mastitis and the average case of clinical mastitis resulted in a total economic cost of $444, including direct costs ($128) and indirect costs ($316). Also, Rollin et al. (2015) showed the costs of therapeutics ($36), non-saleable milk ($25) and death loss ($32). Indirect costs included future milk production loss ($125) and premature culling and replacement loss ($182).

Such fact might be associated with its characteristics, which present excellent growth conditions for microorganisms, leading to microbiological and compositional changes and consequent yield loss and lower quality of dairy products. Low-quality milk is associated to the proceedings applied to milking, mammary gland health and herd management in addition to the inadequate use of milking equipment (Fagan et al., 2005; Nero et al., 2005; Zanela et al., 2006; Matsubara et al., 2011; Miguel et al., 2012). Nonetheless, according to Santana et al. (2001) and Nero et al. (2009), raw milk quality can be improved, in order to meet the standards established by the legislation and quality demanded by consumers, and consequently, comply with regulatory measures established for the production systems, only upon application of adequate solutions to those issues, use of qualified labor and cooling of the products, which in fact requires a set of appropriate measures.

Deficiency in hygiene and sanitary measures starting since before milking, begins with the health of cows from the milking process until the processing plant constitutes an urgent risk to public health due to the presence of microorganisms or toxins and residues of antibiotics and chemicals (Catão & Ceballos, 2001; Padilha et al., 2001; Fagan et al., 2010), considering also that, due to its nutritional quality and digestibility, milk and dairy products are consumed by all age groups of the population. According to Assis et al. (2007), the problems are also related to the small-scale production, in addition to unsatisfactory technical standards, whereas raw milk quality is emphasized, and such factors, if looked at, will contribute to the stability of milk agribusiness.

In Brazil, the National Program for Milk Quality Improvement (PNMQL), provided by Ordinance no. 51/2002 of the Ministry of Agriculture, Livestock and Food Supply, and amended by normative instruction IN 62/2011, provided for SCC reduction, milk cooling at the dairy farms, total microbial count reduction, absence of chemical waste, payment for quality and/or punishment to stimulate mastitis control (Brasil, 2002, 2011).

Since milk produced in the country is required to comply with the current legislation, researchers from certain regions have been trying to establish actions toward assessment and improvement of product quality, adopting, especially, objectives that assess more rationally the problems related to contagious mastitis, the environment and hygiene, which interfere in prophylactic herd management. Among the suggested improvement actions, the following have been exemplified: a) to determine the intensity of the contamination by total and fecal coliforms at each point of the milking allows to determine the main points and origin of the contamination, that is, environmental, fecal origin, improper manipulation or from the animal, and what is the effect of the cooling temperatures on their multiplication; b) regulate the collection of raw refrigerated milk and its transportation in bulk; c) application of simple practices such as contempt for the first three milk jets, washing of milking utensils (brass, pails, wipes) with chlorinated alkaline detergent 2%, pre-dipping with chlorinated solution 750 ppm in a non-refluxed mug and elimination of the residual water of the milking utensils were sufficient for the adequacy of the fluid milk to the current regulations, among others (Machado et al., 2000a; Fagan et al., 2005; Pinto et al., 2006; Nero et al., 2009; Vallin et al., 2009; Silva et al., 2011).

The determination of milk quality in the production systems of Alagoas, especially for the family agriculture production segment, was conducted in pursuance of having its performance suitable in the new milk production scenarios of the country and according to the current legislation (Oliveira et al., 2009, 2015), contributing to a paradigm shift through quality improvement and increase in the productivity of the milk produced in such sector.

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Therefore, the present study aimed to determine the quality of the raw milk used for the production of dairy products and informal sales in the State of Alagoas.

Materials and methods

Prior to starting the study, four scholarship holders were trained on how to apply Good Manufacturing Practices (GMP) before, during and after milking and they were subsequently designated to follow the execution of activities in the dairy farms of each dairy region. Farming procedures studied included health and feed management, pre-milking, milking, storage and distribution of milk (Oliveira et al., 2015).

During the course of two years, 106 small dairy farms were assessed in the State of Alagoas. The scholarship holders followed up on each of the farms for six months. Family agricultural farms were selected randomly, with two manually-performed milking sessions a day and with an average of 15 females in a milking session, with a variation of four to 60. A mixed-breed of Holstein Friesian livestock was predominant in the genetic characteristic of the herds, in addition to animals with elevated blood degree of such breed. To obtain such information, three questionnaires were applied to each one of the farms: 1. General questions about mastitis and milk quality considering the current legislation - assessed before and after application of GMP. They concerned the data about production and general management of each herd and were used to understand the production system, obtain information related to production, consumption and processing of milk, in addition to specific information about prophylaxis and hygienic measures applied to milking, transportation and milk conservation. 2. Checklist - aimed to assess structural and functional issues that might affect milk quality. 3. Standard Operating Procedure (SOP) - step-by-step description for animals to be milked always the same way.

Before application of GMP, milkers received on-the-job training, during the year 2007. GMP tools comprising procedures related to sanitary management, pre-milking and milking were used. In the milking phase, GMP was based on the use of the "Embrapa kit for manual milking" from Empresa Brasileira de Pesquisa Agropecuária (2008).

The study was conducted in the so-called regions of Agreste, dairy region, mid-backlands and high backlands of Alagoas and subdivided into four periods of six months, whereas assessment of milking management was conducted for three months and GMP was applied to milking for three months. For the first period, 40 farms of the municipalities of Craíbas, Minador do Negrão, Maravilha and Canapi were selected, all of them located, respectively, in the mentioned regions of Agreste, dairy region, mid-backlands and high backlands. The second period of the project was performed in 24 farms, located in the same regions, whereas the municipality of Minador do Negrão was replaced by Cacimbinhas. The third and fourth periods were conducted in the municipalities of Giral do Ponciano, Agreste; Cacimbinhas, dairy region; Ouro Branco, mid-backlands and Mata Grande, high backlands. In the last period, the municipality of Cacimbinhas was replaced by Batalha. Twenty-four farms were also assessed. Project execution in these regions was composed of two actions, as follows: 1. Monitoring of milk quality. 2. Application of Good Manufacturing Practices (GMP) to pre-milking, milking and post-milking processes.

Collected milk samples were placed in specific 40 mL bottles that contained a bronopol lozenge to determine SCC and milk composition and in 40 mL specific bottles containing an azidiol lozenge to determine TBC. They were packed in thermal boxes with recyclable ice and sent to the milk quality laboratory of Embrapa Gado de Leite, in Juiz de Fora, Minas Gerais. Such determinations were performed in processor BENTLEY 2000®, coupled with SOMACOUNT 300®, by means of the infrared absorption technique (Bentley Instruments Incorporated, Minnesota, USA).

Statistical analysis was performed according to Sampaio (2010), and the Chi-Square test was used ($p < 0.05$).

Results and discussion

The presented results were based on the standard values defined by normative instruction (IN) 62/2011 for the Northeastern region. The general results of the periods in the four assessed regions of Alagoas are presented below in Tables 1 and 2 for determination of the parameters that indicate mammary health - SCC and milking hygiene - TBC.

Regarding SCC (Table 1), results refer to the average of all periods of study in all farms in the four groups. Slightly over 86% of producers reached the standard established by normative instruction IN 62 with up to 600 thousand cells per mL of milk, whereas, before application of GMP this was the case for 82.91%. In the group of up to 400 thousand cells per mL of milk, where more than 70% of samples are found, there were no significant (P<0.05) changes in the quantitative of farms with and without application of GMP in milking. In the intermediary group of 401 to 500 thousand cells per mL of milk, a significant difference (P<0.05) was demonstrated, but the number of samples was not relevant in the study. In the range starting from 501 thousand cells per mL of milk the use of GMP in milking had no adequate repercussion (P<0.05), whereas mastitis infection was more predominant.

The fact that the SCC averages presented approximate results before and after application of GMP might be related to the index presented before application of GMP, which can be associated to the types of herds used, which are, in general, more resistant to mastitis for detaining a certain degree of zebu blood. Furthermore, sample collection was performed during the dry period of the year, so the possibility of disease evolution was reduced.

Initially, results of SCC can be considered satisfactory since approximately 73% of the herds are within the established regulation standard of 400 thousand cells per mL of milk. Notwithstanding, the average of 10.7 and 12.3 liters of daily milk production per cow and daily production of 148 and 150 liters per farm, respectively, before and after application of GMP, could be much higher if practices applied to nourishment and sanity of the herds, in general, were improved, associated to the blood degree of the dairy cows. With more specialization, the production indexes will probably increase and sanitary problems, especially mastitis, might then stimulate the growth of SCC. However, the differences were significant only in the group studied from 401 to 500 thousand cells per mL of milk (Table 1).

Such results can also be considered important when compared to the findings of different authors. Using secondary data obtained from 7941 tanks, Machado et al. (2000b) found an

Table 1. Somatic Cell Count (SCC) of total amount of milk of 106 herds in Alagoas, before and after application of Good Manufacturing Practices to milking from November, 2010 to May, 2012.

SCC (x 1,000)/mL	Before (% and number of samples)	After (% and number of samples)
Up to 400	73.01 (487)a	73.07 (472)a
From 401 to 500	4.65 (31)a	8.36 (54)b
From 501 to 600	5.25 (35)a	4.64 (30)a
Over 601	17.09 (114)a	13.93 (90)a

Means followed by different letters in the same line are significantly different using Chi-square (P<0.05) (Sampaio, 2010).

Table 2. Total bacterial Count (TBC) of milk of 106 herds in Alagoas before and after application of Good Manufacturing Practices to milking from November, 2010 to May, 2012.

TBC (x 1,000)/mL	Before (%) (no. of samples)	After (%) (no. of samples)
Up to 100	46.75 (237)a	59.94 (380)b
From 101 to 300	33.33 (169)a	25.39 (161)a
From 301 to 600	12.62 (64)a	8.68 (55)a
Over 601	7.30 (37)a	5.99 (38)a

Means followed by different letters in the same line are significantly different using Chi-square (P<0.05) (Sampaio, 2010).

SCC average of 641 thousand cells. By assessing a daily production extract in the range between 19 and up to above 1000 liters, Olival et al. (2004) observed a variation ranging from 17.9% to 100% of producers with a variation of SCC of above 400 thousand cells, whereas specialized farms demonstrated a higher rate.

Prior to the application of GMP, Vallin et al. (2009) found an average of 611,913 cells/mL in 46 assessed farms, whereas six (13.04%) farms demonstrated results above the standard allowed a limit of one million cells per mL of milk. By considering only the farms where manual milking is performed, the average consisted of 607,844 cells/mL, whereas 5 (15.63%) of the 13 samples were above one million. The farms with mechanical milking averaged 621,224 cells/mL and one of the samples (3.13%), obtained from the immersion tank, presented a result of over one million.

After application of the proposed practices in the 46 farms, the average reduction of SCC consisted of 55.65% - except for the expansion tank where the count increased to 27.12% - in farms with manual milking and 51.85% in farms with mechanical milking. Two (6.25%) farms with manual milking and no farms with mechanical milking presented values above one million cells/mL. The greatest impact of the practices was observed in farms with manual milking and expansion tank cooling, where reduction reached 63.73%.

By assessing herds of 13 farms in the Agreste region of Pernambuco, Lima et al. (2006), found an average of 402,126 cells/mL. By analyzing dairy herds of Rio Grande do Sul with manual milking and bucket set on the floor, Zanela et al. (2006) found averages of 803,000 cells/mL. Machado et al. (2000a) assessed 4,785 milk samples from expansion tanks for SCC of herds located in the State of São Paulo and in the southern area of Minas Gerais and registered an average of 505,000 cells/mL. Studies conducted by Miguel et al. (2012) certified the efficiency of teat disinfection before milking compared to milking without sanitization or cleaned only with water for *Staphylococcus aureus* and Gram-positive bacteria in general with an average of above 50%.

Langoni et al. (2011) observed a positive correlation between SCC and TBC in the milk of two farms among the six statistically analyzed farms. They concluded that mastitis is one of the factors that keep producers from reaching the quality level required by the government. Management and hygiene errors exist and they must be corrected by training producers on the application of GMP. Finally, monitoring of mastitis and milk quality of herds must be performed, and accessible techniques such as compound SCC can be applied. Furthermore, mastitis is a multifactorial disease, and in order to measure it, somatic cell count (CCS) in milk is an important tool in the diagnosis of subclinical mastitis, accepted internationally as a standard measure to determine the quality of raw milk and to monitor the mastitis (Langoni et al., 2011). Also, the Total Bacterial Count (TBC) measures parameters related to the hygienic quality of milk (Lima et al., 2006). Regarding TBC, presented in Table 2, application of GMP in the assessed farms reduced contamination by 13.19% (P<0.05) in the group of 100 thousand cells per mL of milk, which may be a reflection of the lack of understanding about the application of GMPs in the farms of this group, or indicates the need for a better adjustment in the application of these measures, mainly in this group. However, in the groups of 101 to 300, 301 to 600 and above 601 thousand cells per mL of milk, no significative reduction was observed (P<0.05). Despite the application of GMP, 40.06% of the farms did not reach the level of 100 thousand cells per mL of milk established by the legislation. Such results can be considered important when compared to the results of other regions of the country.

In another study, performed in Santa Maria (RS), Viana et al. (2002) observed that only 17.8% of raw milk presented results below the limit of one million. The highest averages were found in milk cooled in expansion tanks and immersion tanks, with results of 3,657,000 and 2,712,429 TBC/mL, respectively. In the farms with mechanical milking, seven (50%) out of 14 milk samples presented results above one million TBC/mL. In our work, only the farms with manual milking, 14 (43.75%) of them presented a TBC of over one million/mL of milk, therefore, lower results than the ones found in the present work. The highest averages found by the author's concerned milk samples cooled in expansion tanks and immersion tanks, with counts of 3,657,000 and 2,712,429 TBC/mL, respectively. We also observed that in the farms with mechanical milking, seven (50%) out of the 14 milk samples presented TBC of over one million per milliliter of milk. Changes in the proceedings of milk storage and transportation must also be considered, since, associated with the other actions, they might imply substantial quality improvement.

Conclusion

The application of GMP demonstrated a significant difference in the SCC only in the intermediary group of 401 to 500 thousand cells per mL of milk, but the number of samples was not relevant in this group. In the other groups, the use of GMP had no adequate repercussion. Considering the TBC, the application of GMP show difference only in the group of up to 100 (x 1,000)/mL. Therefore, the culture of good manufacturing practices (GMP) must be improved in the studied regions of the state of Alagoas

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