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Influence of bulk transportation, storage and milking system on the quality of refrigerated milk

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Dairy farmers strive to meet industry quality standards, the industry focuses on the quality of the raw material for higher yield and quality of dairy product. The aim of this study was to evaluate the influence of bulk transportation, storage and milking system on the quality of refrigerated milk. Overall, 548 samples of refrigerated milk were collected, 312 from bulk tanks (individual and collective) and (manual and mechanical milking), 143 from tank cars and 93 from industrial silos. Mean values of proximate composition, somatic cell count (SCC) and total bacterial count (TBC), were compared in relation to different milking systems (manual and mechanical), type of producer (individual and collective) for these comparisons and for physicochemical analyses, total bacterial count and somatic cell count in different collections, the Tukey test at 5% significance level was used. It was observed that 40% of milk samples from bulk tanks, 69.93% of samples from tank cars and 62.36% of samples from industrial silos had SCC over 500,000 SC / ml. There was an increase of TBC from the bulk collection of milk on the farm up to the arrival of milk in the processing industry. Refrigerated milk stored in individual or collective bulk tanks obtained by manual or mechanical milking had to be adjusted to standards required by Normative Instruction number 62 of December 2011. Education and training measures such as hygienic milk collection, cleaning of milking equipment, proper implementation of mastitis control programs and refrigeration of the post-milking raw material must be adopted aiming at improving the quality of refrigerated milk.

Key words: Somatic cell count (SCC), total bacterial count (TBC), protein, fat, non fat solids.

INTRODUCTION

The effort to improve the quality of milk includes the milk chain, dairy industries and consumers. Thus, dairy farmers strive to meet industry quality standards, the industry focuses on the quality of the raw material for higher yield and quality of dairy products, and consumers increasingly search for safe and healthy products of easy

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consumption. For the quality of milk in general (producers, industries and consumers) to be achieved, legislative measures have been taken by government agencies. Normative Instruction number 62 of December 29, 2011 establishes quality standards for refrigerated milk from July 1, 2014 of maximum of 500,000 SC / ml and 300,000 CFU / ml, for somatic cell count (SCC) and total bacterial count (TBC), respectively (Brazil, 2011).

The monitoring of SCC is a measure to be taken so that milk quality standards meet the Normative Instruction 62, and SCC is related to changes in milk constituents (Bueno et al., 2005), due to the increase of the initial milk microbiota after milking. There are losses in the production of milk components with SCC from 17,000 SC / ml (Coldebella et al., 2004).

Another determining factor in milk quality is the transport logistics (farm, tank car and industry), and TBC increases during logistics, making TBC monitoring a fundamental step (De Jonghe et al., 2011) to verify if milk quality fits standards established by Normative Instruction 62 of December 2011.

Meeting the standards of legislation is a major challenge for the dairy sector, which searches for constant quality improvement, given that good-quality raw material results in higher yields and quality of milk products, bringing benefits to industry and consumers (Borges et al., 2009). However, dairy farmers from the state of Goiás are struggling to meet the quality standards established by Normative Instruction 62. Martins et al. (2008) reported that only 23% of the 30 samples taken from bulk tanks were in accordance with legislation.

Given the above, the aim of this study was to evaluate the influence of bulk transportation, storage and milking system on the quality of refrigerated milk.

MATERIALS AND METHODS

Refrigerated milk samples were collected and stored in bulk tanks (individual and collective) of farms (manual and mechanical milking), isothermal tank cars and industrial silos in southwestern state of Goiás. In the period from April to July 2014, 312 refrigerated milk samples were collected from bulk tanks, 143 samples from isothermal tank cars and 93 samples from industrial silos, totaling 548 refrigerated milk samples.

Sampling

Bulk tank

Bulk tanks of rural properties had storage capacity from 500 to 4000 L of milk / day. Refrigerated milk samples were aseptically collected after mechanical stirring for five minutes set in own bulk tank. Milk samples were collected in vials containing preservative Bronopol® for SCC analysis and chemical composition and Azidiol® for TBC analysis.

Isothermal tank car

Refrigerated milk samples stored in isothermal tank cars were collected after collection of milk from bulk tanks in farms immediately upon arrival to the industry. Tank cars that performed bulk collection had isothermal tanks of 9000 liters capacity. With the help of previously sanitized stainless steel collector, milk samples were collected in vials containing preservative Bronopol® for SCC analysis and chemical composition and Azidiol® for TBC analysis.

Industrial silos

After the arrival of the isothermal tank car in the dairy industry, milk was transferred through the flexible hose with sanitary pump for the industrial silo. Refrigerated milk samples were aseptically collected through the valve coupled to the industrial silo in vials containing preservative Bronopol® for SCC analysis and chemical composition and Azidiol® for TBC analysis.

After collection, refrigerated milk samples from bulk tanks, isothermal tank cars and industrial silos were placed in isothermal box containing ice and sent to the Laboratory of Milk Quality - Research Center of Food of the Animal Science and Veterinary School, Federal University of Goiás, Goiânia, GO, for carrying out electronic analyses.

Chemical analysis

Fat, protein, and non fat dry extract (NDE) were evaluated through the analytical principle based on the differential absorption of infrared waves by the milk components using MilkoScan 4000 equipment (Foss Electric A / S. Hillerod Denmark). Samples were previously heated in water bath at temperature of 40°C for 15 min to dissolve fat. Results were expressed in percentage (International Dairy Federation, 2000).

Somatic cell count

SCC analysis was performed according to the analytical principle based on flow cytometry using Fossomatic 5000 Basic equipment (Foss Electric A / S. Hillerod, Denmark). Before analysis, samples were previously heated in water bath at a temperature of 40°C for 15 min to dissolve fat. Results were expressed in SC / mL (ISO, 2006).

Total bacterial count

TBC was performed using BactoScan FC equipment (Foss Electric A / S. Hillerod, Denmark), which was based on flow cytometry by measuring cell characteristics when they are suspended in a fluid medium. Results were expressed as CFU / ml (ISO, 2004).

Statistical analyses

Overall, 548 milk quality results were assessed, 312 samples from bulk tanks, 143 from isothermal tank cars and 93 results from industrial silos. Descriptive statistics was performed for SCC, TBC and chemical composition through Excel software version 2007 and data were presented in graphs. To compare the mean values found for chemical composition, SCC and TBC, regarding the TBC evolution (bulk tank, tank cars and industrial silos), the different milking systems (manual and mechanical), type of producer (individual and collective) and physicochemical analyses and somatic cells in different samples, ANOVA variance analysis was carried out, then realized the Tukey test at 5% significance level was used. Statistical analysis was performed using the SISVAR

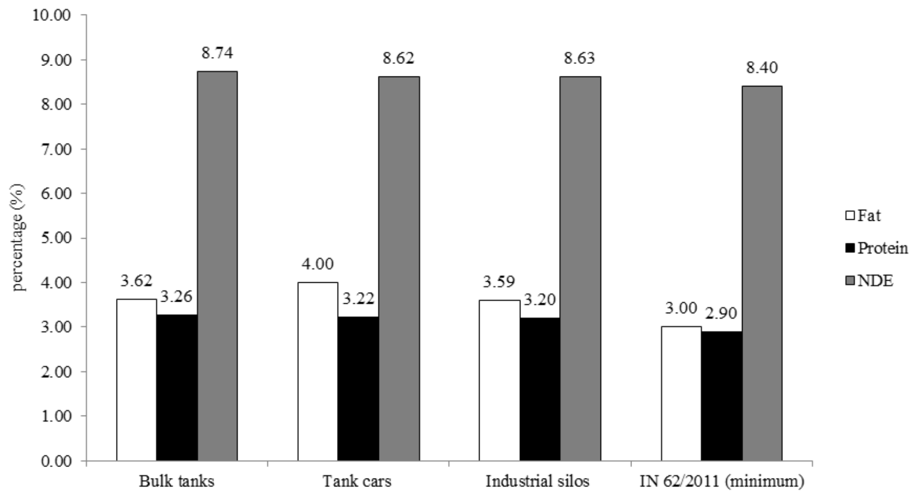

Figure 1. Mean fat, protein and non fat dry extract (NDE) values of refrigerated milk from bulk tanks, tank cars and industrial silos in southwestern Goiás.

software (Ferreira, 2003).

RESULTS AND DISCUSSION

Mean fat, protein and non fat dry extract (NDE) values of refrigerated milk samples collected from bulk tanks, tank cars and industrial silos in southwestern Goiás are consistent with minimum requirements established by Normative Instruction 62/2011 (Figure 1).

Although new milk quality requirements entered into force from July 2014, the minimum requirements for physicochemical parameters have not changed and remain at 3.0; 2.9 and 8.4%; for fat, protein and non fat solids, respectively.

Values similar to those of this study for fat, protein and NDE were reported by Machado et al. (2000) studying 4784 milk samples from bulk tanks. The average chemical composition of milk from healthy and properly nourished animals is in line with standards set by law for fat, protein and NDE (Pedrico et al., 2009).

The study results demonstrated that actions aimed to improve milk quality with a view to increase fat and protein content, either through the use of milk producing breeds of inclusion of protein concentrate in the diet of lactating cows, can benefit producers receiving payment according to milk quality, and industries would increase cheese manufacture yield through receiving milk with higher levels of non fat solids.

It was found that the average SCC value of milk collected from bulk tanks, tank cars and industrial silos are outside the limit set by Normative Instruction 62 in the current period (Figure 2). The noncompliance of results of milk samples with standards established by legislation was also reported by Ribeiro Neto et al. (2012), who evaluated the quality of refrigerated milk under federal inspection in Northeastern Brazil and pointed out that the states of Alagoas, Ceará, Maranhão, Pernambuco, Piauí and Rio Grande do Norte presented SCC values over 1 million SC / mL and attributed high SCC levels found to widespread failures in milking procedures and milk refrigeration in dairy farms.

The implementation of payment systems according to milk quality, greater demand from industries and milk quality surveillance by government agencies are tools that could improve the quality of milk produced in southwestern Goiás. Over 90% of milk samples were within standards required by law with respect to fat, protein and NDE; however, most samples were outside standards regarding SCC and TBC (Figure 3).

Most of the samples analyzed in this study were outside standards required by Normative Instruction 62 in relation to SCC and TBC and within standards regarding chemical composition. Similar results were obtained by Lacerda et al. (2010), who evaluated the quality of milk from dairy farms in the municipalities of Miranda do Norte and by Paiva et al. (2012), evaluating the quality of milk in an industry of Minas Gerais.

Of a total of 548 milk samples from expansion tanks, tank cars and industrial silos analyzed, only few samples were outside standards established by law for fat, protein and NDE. However, most of the milk samples were outside standards for SCC and TBC. Higher fat and protein and lower SCC and TBC values were found by Borges et al. (2009), who evaluated the quality of milk from dairy farms in the region of Vale do Taquari, state of Rio Grande do Sul and reported that of the 143 milk samples analyzed, all were outside standards established by the Brazilian legislation for fat, protein, SCC and TBC, respectively 9.79; 7.69; 14.69 to 29.37%.

Values above those of this study for TBC were reported by Martins et al. (2008), who evaluated the

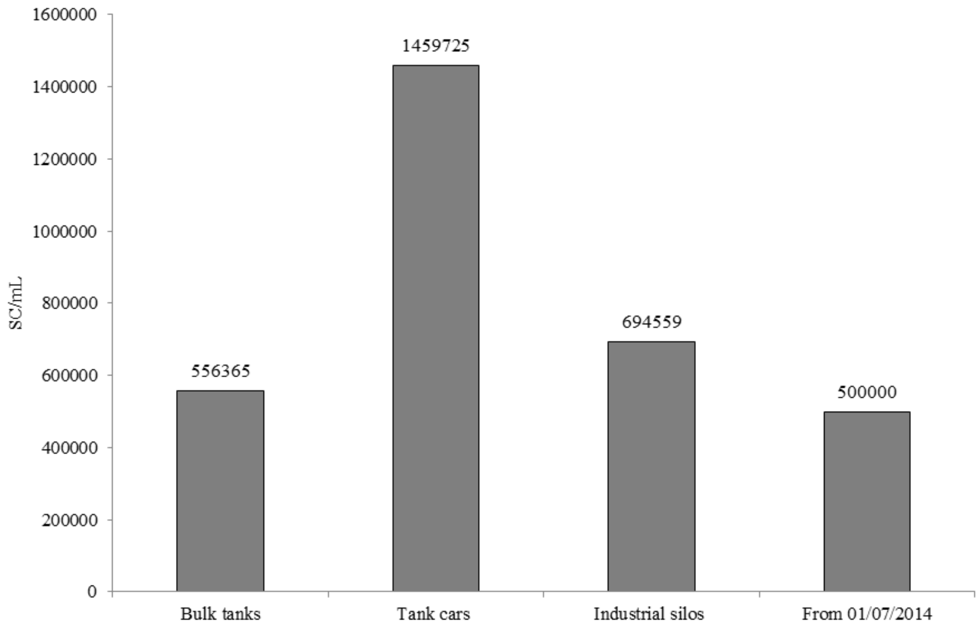

Figure 2. Mean somatic cell count (SCC) values of refrigerated milk from bulk tanks, tank cars and industrial silos in southwestern Goiás.

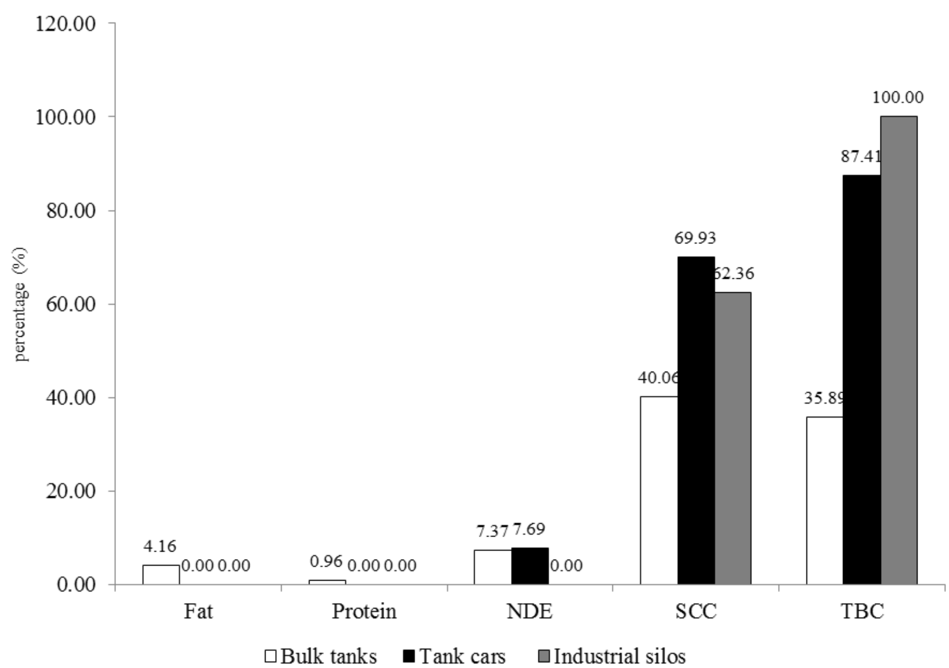

Figure 3. Percentage of refrigerated milk samples outside Normative Instruction 62 from July 1, 2014.

quality of milk produced and stored in bulk tanks in the state of Goiás, and 46% of samples had TBC over 300,000 CFU / ml. For the milk to be received by milk processing industries and producers to adapt to current Brazilian legislation regarding milk quality, aspects such as milking hygiene, milk refrigeration below 7°C and mastitis control must be constantly monitored. Table 1 shows the mean values and standard deviation of TBC of refrigerated milk from bulk tanks, tank cars and industrial silos in southwestern Goiás.

Table 1. Mean values and standard deviation of total bacterial count (TBC) of refrigerated milk from bulk tanks, tank cars and industrial silos in southwestern Goiás.

Type of storage Estocagem	n	TBC (UFC/ml)
Bulk tank	312	531.202 ±938.331 [a]
Tank car	143	2.101.098 ±2.225.183 [b]
Industrial silo	93	2.965.215 ±1.503.730 [c]

n = number of samples. Different lowercase letters in line significantly differ at 5% significance level.

According to Table 1, it was observed that the TBC of refrigerated milk significantly differed ($p < 0.05$) in relation to the type of storage, that is, milk stored in bulk tanks showed lower TBC when compared to refrigerated milk transported by tank cars, also differing from milk stored in industrial silos of the processing industry, which results were 531,202 ± 938 331 CFU / mL, 2,101,098 ± 2,225,183 CFU / mL and 2,965,215 ± 1,503,730, respectively.

The Brazilian legislation through NI 62/2011 (Brazil, 2011), recommends maximum TBC values of 300,000 CFU / ml, before that, the values described in this study would be higher than allowed, that is, milk processing with high TBC values decrease the yield of dairy products, promote unpleasant taste and odor and endanger the health of consumers. It was observed in this study that there is an increase of TBC during milk transport and storage in the industry. The same result for TBC was reported by De Jonghe et al. (2011), who assessed milk quality and reported that milk stored in the farm, during transport and in industry had TBC of 1×10^5 CFU / ml, 1×10^6 CFU ml and 1×10^8 CFU / ml respectively. There is an increase in TBC of milk during transport and storage in industrial silos by the action by psychrotrophic bacteria that grow at refrigeration temperature (Bishop and White, 1998).

TBC values lower than those found in this study for bulk tank were found by Gargouri et al. (2013), with 12.87 thousand CFU / ml. Ribeiro Neto et al. (2012) evaluated the quality of refrigerated milk under federal inspection in Northeastern Brazil and reported that the states of Alagoas, Ceará, Maranhão, Pernambuco, Piauí and Rio Grande do Norte showed mean TBC values over 1 million CFU / ml. Ribeiro Neto et al. (2012) attributed the high elevation of TBC levels to widespread failures in milking procedures and milk refrigeration in dairy farms. It could be inferred that the delay in bulk milk collection in dairy farms and the delay of delivering milk to dairy industries are directly related to the increase in microbial load of milk.

The number of microorganisms present in milk may be influenced by factors such as milking hygiene, season, refrigeration temperature, time on the farm and distance from farm to milk processing plant (Silveira et al ., 2000).

Pinto et al. (2006) reported that milk refrigeration for long periods, both in the dairy farm as in the dairy industry, directly affects the microbiological quality of refrigerated raw milk, allowing the development of psychrotrophic bacteria that grow at refrigeration temperature. The high TBC value reported in this study demonstrates the deficiency in production processes from the raw material on the farm, delay in the collection and transport of milk held by tank car and the milk storage time in processing industries.

Therefore, a high microbial load in milk directly influences the processing of dairy products, reducing yield, shelf-life and providing unpleasant tastes and odors, endangering the health of consumers. The mean results and standard deviation of chemical composition, SCC and TBC of refrigerated milk collected from bulk tanks of collective and individual producers are shown in Table 2.

As described in Table 2, there was no significant difference ($p > 0.05$) in the fat content of refrigerated milk from bulk tanks of collective and individual producers. The fat content of samples was 3.56 ± 0.383% for refrigerated milk from bulk tanks of collective producers and 3.63 ± 0.402% for refrigerated milk from bulk tank of individual producers. The results were above the limit established by Brazilian legislation, which recommends minimum fat content of 3.0% for refrigerated milk (Brazil, 2011).

Fat values below those obtained in this study were described by Souza et al. (2006), who evaluated raw milk samples from dairy farms that delivered milk in bulk tank in Sacramento-MG from April to July 2005, and showed that 13.9% (10) of samples did not meet the minimum requirements stipulated by NI 62/2011 for fat content.

Results higher than those obtained in this study were described by Mendes et al. (2010), who obtained fat content of up to 3.8% when assessing the quality of milk marketed in the city of Mossoró, RN. Variations in fat content are determinants of industrial yield (Lindmark-mansson et al., 2003). According to Reis et al. (2004), environmental, handling, and nutrition factors and genetic variations are closely related to the milk fat content. For the dairy industry, fat, protein, lactose, total dry extract (TDE) and NDE are criteria used for the payment of milk producers (Neves et al., 2004).

There was no significant difference ($p > 0.05$) in protein content of refrigerated milk from bulk tanks of collective and individual producers, and the average protein values

Table 2. Mean values and standard deviation of fat, protein, Non fat dry extract (NDE), lactose, somatic cell count (SCC) and total bacterial count (TBC) of refrigerated milk from bulk tanks of collective and individual producers.

Parameter	Type of producer	
	Collective	Individual
Fat (%)	3.56 ± 0.383[a]	3.63 ± 0.402[a]
Protein (%)	3.25 ± 0.164[a]	3.27 ± 0.177[a]
NDE (%)	8.72 ± 0.197[a]	8.75 ± 0.256[a]
Lactose (%)	4.48 ± 0.135[a]	4.48 ± 0.172[a]
SCC (x1000 SC/mL)	507.136 ± 431.342[a]	575.086 ± 626.532[a]
Log SCC	6.59 ± 0.326[a]	6.61 ± 0.345[a]
TBC (x1000 CFU/mL)	578.346 ± 761.927[a]	516.283 ± 994.760[a]
Log TBC	6.33 ± 0.691[a]	6.08 ± 0.766[b]

Different lowercase letters in line significantly differ at 5% significance level.

ranged from 3.25 ± 0164% to 3.27 ± 0.177%, respectively. These results were higher than values established by Normative Instruction 62/2011, which minimum value is 2.9% for crude protein.

Results similar to those obtained in this study were described by Ribeiro Neto et al. (2012), who evaluated the quality of refrigerated raw milk under federal inspection in northeastern Brazil and obtained average values of 3.2% crude protein.

Among the chemical parameters of milk, protein is the component that shows less seasonal variation (Alves, 2006). An important factor that can influence milk protein content is the phase of lactating cows. Research indicated that the protein levels increase during lactation (Aganga et al., 2002). Lactating cows older than seven years tend to produce milk with higher protein content and first delivery animals produce milk with lower protein content (Noro et al., 2006).

NDE did not differ significantly ($p > 0.05$) between milk collection systems evaluated. The values were 8.72 ± 0.197% for milk collected from bulk tanks of collective producers and 8.75 ± 0.256% for milk collected from bulk tanks of individual producers. These results were consistent with values set by NI 62/2011, which establishes minimum NDE value of 8.40%.

NDE values similar to those obtained in this study were described by Cerdótes et al. (2004), with mean values ranging from 8.55 to 8.75%. These researchers investigated the production and composition of milk from cows of four genetic groups submitted to two feeding systems. Lactose results did not differ significantly ($p > 0.05$), with mean value of 4.48 ± 0.135% for milk collected from bulk tanks of collective producers and 4.48% ± 0.172 for milk collected from bulk tanks of individual producers. It is noteworthy that lactose is the milk constituent that suffers less oscillation and has high osmotic capacity. Reduced lactose levels can result in decreased milk production and therefore, in healthy mammary gland, the more lactose is secreted, the more milk is produced.

Statistical analyses for SCC and TBC shown in Table 1 were performed as $\log^{10}$, however the discussion will be based on the unit recommended by NI 62/2011, which establishes maximum of 500,000 SC / ml for SCC and 300,000 CFU / ml for TBC, taking into account that the region comprised in this study is southwestern Goiás, located in central Brazil.

The somatic cell count (SCC) results did not differ significantly from each other, with values of 507 136 ± 431 342 SC / ml and 575 086 ± 626 532 SC / ml obtained from bulk tanks of collective and individual producers, respectively. These values are above maximum limits established by Brazilian legislation. The SCC of milk should not exceed the limit of 500,000 SC / ml, as described in NI 62/2011 (Brazil, 2011).

The somatic cell count of cow milk is used as a measure to check the health of the mammary gland and milk quality, as high somatic cell counts affect the shelf-life of dairy products and inhibit the growth of starters for the production of dairy products, causing great losses in the dairy industry (Tronco, 2008). Increase in SCC causes decline in productivity and affects milk composition, enzyme activity, clotting time, yield and quality of dairy products (Arashiro, 2006).

As data shown in Table 2, the TBC results of refrigerated milk significantly differ ($p < 0.05$), with values of 578,346 ± 761,927 CFU / ml and 516,283 ± 994,760 CFU / ml for milk obtained from bulk tanks of collective and individual producers, respectively. TBC in treatments was higher than recommended by NI 62/2011, which establishes maximum count of 300,000 CFU / ml, indicating that the milking sanitary conditions in both systems were not effective.

According to Bueno et al. (2004), the poor quality of milk stored in tanks for collective use, compared to milk stored in tanks for individual use, is due to the accumulation of individual failures from the milking procedure and the difficulty of reducing the temperature

Table 3. Mean values and standard deviation of fat, protein, non fat dry extract (NDE), lactose, somatic cell count (SCC) and total bacterial count (TBC) of refrigerated milk from bulk tanks obtained by manual and mechanical milking.

Parameter	Milking system	
	Manual	Mechanical
Fat (%)	3.61 ± 0.380[a]	3.63 ± 0.443[a]
Protein (%)	3.28 ± 0.174[a]	3.22 ± 0.165[b]
NDE (%)	8.78 ± 0.233[a]	8.66 ± 0.245[b]
Lactose (%)	4.50 ± 0.152[a]	4.43 ± 0.180[b]
SCC (x1000S C/ml)	456.549 ± 358.091[b]	825.505 ± 896.063[a]
SCC Log	6.55 ± 0.313[b]	6.76 ± 0.363[a]
TBC (x1000 CFU/ml)	519.805 ± 889.804[a]	566.059 ± 1060.377[a]
TBC Log	6.15 ± 0.751[a]	6.14 ± 0.764[a]

Different lowercase letters in line significantly differ at 5% significance level.

inside the tanks. This difficulty is mainly due to the fact that hot milk coming from the various producers are transported in drums, arriving at different times to the collective tank and added to the refrigerated volume. This practice increases the temperature of the stored milk, remaining a long time at high temperature. Table 3 shows the average results and standard deviation of chemical composition, SCC and TBC of refrigerated raw milk obtained by manual and mechanical milking in dairy farms of southwestern Goiás.

According to data shown in Table 3, it could be observed that the fat content of milk obtained by manual (3.61 ± 0.380%) and mechanical milking (3.63 ± 0.443%) did not differ significantly (p> 0.05). The results were above limits established by Brazilian legislation (Brazil, 2011). These results were higher than values shown by Saran Netto et al. (2009), who carried out a comparative study of milk quality in manual and mechanical milking systems and found average fat values of 3.02% for milk obtained by mechanical milking and 3.10% for milk obtained by manual milking.

Lima et al. (2006) evaluated the physical, chemical and microbiological parameters of raw milk produced in the wild region of the state of Pernambuco and obtained fat content of 3.54 and 3.21% for manual and mechanical milking, respectively, which are far below those found in this study.

According to Harding (1995), due to its lower density compared to protein, milk fat shows percentage variations during milking, increasing at the end of the milking process. Diets with high fiber contents induce the production of milk with high fat content, so animal feeding directly influences milk production and quality, thus explaining the high fat levels found in this study, where animals were kept in pasture and submitted to manual milking.

Mastitis decreases milk production of dairy herds, which occurs due to epithelial cell injury, reducing the capacity of synthesis and secretion of the mammary gland (Auldist and Hubble, 1998). The high SCC of refrigerated milk obtained by mechanical milking of this work points to the high incidence of mastitis in the herd, promoting a decrease in milk production and an increase in fat content, taking into account that if the drop in production is sharper than the fat content, milk becomes more concentrated.

The crude protein content significantly differed (p <0.05) between the different milking systems. Milk obtained by manual milking showed averaged protein content of 3.28 ± 0.174%, which is higher than values found for milk obtained by mechanical milking of 3.22 ± 0.165%. The average protein contents of refrigerated milk from bulk tanks obtained by manual and mechanical milking were higher than values recommended by legislation.

In evaluating collection procedures of individual raw milk and its relationship with the physicochemical composition and somatic cell count, Reis et al. (2007) found protein content of 3.01% for milk obtained by manual milking and 2.92% for milk obtained by mechanical milking, which are lower than values obtained in this study.

Changes in protein content are less significant than changes in fat due to diet (Auldist and Hubble, 1998). An important factor that can influence the milk protein content is the phase of lactating cows. Studies have indicated that the protein levels increase during lactation (Aganga et al., 2002).

Non fat dry extract (ESD) values statistically differed (p <0.05) between treatments (manual and mechanical milking), with mean values of 8.78 and 8.66%, respectively. These results were consistent with values established by Brazil (2011).

While researching fraud in informal milk marketed in the city of Mossoró, RN, Mendes et al. (2010) obtained non fat dry extract values higher than those obtained in the present study, with mean values ranging from 8.82 to 8.84%. Lima et al. (2006) observed NDE values lower than those found in this study, corresponding to 8.29% for NDE for milk samples obtained by mechanical and manual milking.

The lactose content found in this study significantly differed (p <0.05) in the different milking systems. Milk obtained by manual milking showed mean lactose contents higher than milk obtained by mechanical milking, which values were 4.50 ± 4.43% and 0.152 ± 0.180, respectively. Mean lactose content smaller than values found in this study were described by Alves (2006), which varied from 4.34 to 4.40%. Saran Netto et al. (2009) conducted a comparative study on the quality of milk obtained by mechanical and manual milking and obtained mean lactose values greater than those described in this study, with mean values of 4.57 and 4.68% for milk obtained by manual and mechanical milking, respectively.

The association of pathogens with external factors results in a wide range of injury to the animal, but milk production may decrease and the secretory tissue can be damaged, as well as variations in milk components such as reduced lactose content, which can occur due to increased SCC related to the desquamation of the secretory tissue (Silva et al., 2000).

SCC in milk obtained by manual milking significantly differed (p <0.05) from milk obtained by mechanical milking, with values of 456,549 ± 358,091 SC / ml and 825,505 ± 896,063 SC / ml, respectively.

The Brazilian legislation through the NI / 62 (2011) establishes that milk should present no more than 500,000 SC / ml; however, milk obtained by mechanical milking showed values higher than those allowed by legislation and should not be received and processed by the dairy industry. The somatic cell count is a key indicative of milk quality, detecting mainly affected animals with subclinical mastitis. The number of somatic cells in milk can also vary depending on factors such as animal age, stage of lactation, stress, time of year and nutrition.

The milking system, when presenting different results among investigations concerning the occurrence of clinical or subclinical mastitis, may be influenced by infection with pathogens from the environment such as pasture, stable, bed of animals, milking parlor and food wastes of troughs, provided they are dirty, humid and at high temperature (fermented) (Smith and Hogan, 1993). Results similar to those obtained in this study were described by Barbosa et al. (2009), who investigated the incidence of mastitis in cows submitted to different milking systems of dairy farms in the “Triângulo Mineiro” region, and obtained mean SCC values for mechanical milking of 886,396 thousand SC / ml and 352,670 thousand SC / ml for manual milking.

Machado et al. (2000) evaluated the quality of milk stored in bulk tanks in some regions of the country and obtained 641,000 SC / ml. SCC results obtained by Martins et al. (2006) evaluating milk production and quality in the dairy region of Pelotas in different months of the year were 334,000 SC / ml and 332,000 SC / ml, respectively, which are lower than those described in the present study. Milk obtained by mechanical milking showed TBC of 566,059 ± 1060,377 CFU / mL, which was higher than value obtained milk obtained by manual milking of 519,805 ± 889,804 CFU / mL; however, the mean TBC values did not differ significantly (p> 0.05) between milking systems. Regardless of type of milking studied, the results were below limit set by NI 62 (2011), which establishes maximum values of 300,000 CFU / ml of milk, indicating good milk storage conditions in dairy farms.

When analyzing dairy cattle located in regions of the states of Espirito Santo, Minas Gerais and Rio de Janeiro from January 2007 to June 2008, Souza et al. (2008) found that 58.3% of dairy farms obtained total bacterial count greater than 600,000.

Guerreiro et al. (2005) reported that the milking system does not necessarily imply in milk with better microbiological quality but is rather another item to be considered as a possible agent of bacterial contamination, as they observed cows submitted to mechanical milking showing 11.6 times more contamination than animals manually milked.

Regardless of milking system adopted on a dairy farm, the hygiene conditions directly influence the occurrence of clinical or subclinical mastitis, for providing environmental pathogens of high colonization at the end of the teat; however, when failures occur in the milking mechanism, which provide injuries in the teat canal and the udder, the incidence of mastitis increases. This risk is thus more pronounced when milking is mechanical (Barbosa et al., 2009). Table 4 shows the mean values and standard deviation of fat, protein and NDE as a function of the SCC of refrigerated raw milk.

According to data shown in Table 4, the milk fat content did not differ significantly (p> 0.05) as a function of SCC of refrigerated milk. Values obtained were equal to 0.322 ± 3.63% of fat for milk with SCC less than or equal to 500,000 SC / ml and 3.69% ± 0.514 of fat for milk with SCC greater than or equal to 501,000 SC / ml. Protein and NDE significantly differed (p <0.05) as a function of SCC of refrigerated raw milk. Milk samples showing SCC below 500,000 SC / ml had protein and NDE levels corresponding to 3.27 ± 0.148% and 8.75 ± 0.221%, respectively. Milk samples with SCC more than 501,000 SC / ml had protein and ESD values of 3.23 ± 0.134% and 8.66 ± 0.190%, respectively.

Ventura et al. (2006) evaluating the somatic cell count and the effects on milk constituents found that minimal addition for protein led to an increase in SCC values. This increase can be explained by infection in the mammary gland, reducing milk production and the dilution of components (protein and fat) (Barreto et al., 2010). Similar results were described by Rangel et al. (2009), who reported a positive linear correlation between levels

Table 4. Mean values and standard deviation of fat, protein and NDE as a function of the SCC of refrigerated raw milk.

Parameter	SCC up to 500 thousand SC/ml	SCC above 501 thousand SC/ml
Fat (%)	3.63 ± 0.322[a]	3.69 ± 0.514[a]
Protein (%)	3.27 ± 0.148[a]	3.23 ± 0.134[b]
NDE (%)	8.75 ± 0.221[a]	8.66 ± 0.190[b]

Different lowercase letters in line significantly differ at 5% significance level.

of somatic cells and fat and protein percentages of bovine milk.

Conclusion

The mean fat, protein and NDE of milk in southwestern Goiás met the requirements established by Normative Instructions 62 of December 2011; but SCC and TBC are out of the new standards established by the legislation in force since July 01, 2014. Education and training measurements regarding milking hygiene procedures, hygiene of milking equipment, proper implementation of mastitis control programs and refrigeration of the post-milking raw material must be adopted aiming at improving the quality of refrigerated milk.

Conflict of Interests

The authors have not declared any conflict of interests.

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