PESQUISA AGROPECUÁRIA GAÚCHA

REVIEW

Milk quality and characterization of different geographic regions of Brazil: a literature review

Sueli Fiorini Sommer[1] ID, Marc François Richter[1*] ID

Abstract - Milk is a rich source of nutrients that are important for human health. Due to its high nutritional value, it is considered an ideal substrate for the proliferation of pathogenic and deteriorating micro-organisms. Therefore, some control measures are necessary to guarantee the quality of milk and dairy products. The aim of this review is to present the main quality parameters in accordance with Brazilian legislation, as well as to provide data and studies on the characteristics and quality of milk in different regions of Brazil. For this purpose, besides consulting the legislation, articles were used located by the following keywords: "Milk quality", "Milk preservation" and "Milk storage", in the databases "Google Scholar", "SciELO" and "LILACs". It was found that even with control and regulation of dairy farming, failures can still occur in the various regions of the country, which can be minimised with technical assistance and rural extension.

Keywords: Production volume. Quality parameters. Microbiological control. Physico-chemical control.

**Qualidade do leite e caracterização das diversas regiões geográficas do Brasil:
uma revisão bibliográfica**

Resumo - O leite é um alimento rico em nutrientes importantes para a saúde humana. Devido ao seu alto valor nutritivo, é considerado um substrato ideal para proliferação de microrganismos patogênicos e deteriorantes. Desta forma, algumas medidas de controle são necessárias para garantir a qualidade do leite e derivados. O objetivo desta revisão é elencar os principais parâmetros de qualidade, conforme as normas da legislação brasileira, além de apresentar dados e estudos sobre as características e qualidade do leite nas diferentes regiões do Brasil. Para tal, além da consulta à legislação, foram utilizados artigos localizados pelas palavras-chave: "Qualidade leite", "Conservação leite" e "Armazenamento leite" e "Milk quality", nas bases de busca "Google Scholar", "SciELO" e "LILACs. Verificou-se que mesmo com controle e regulamentação da atividade leiteira, ainda podem ocorrer falhas nas diversas regiões do país, que podem ser minimizadas com assistência técnica e extensão rural.

Palavras-chave: Volume de produção. Parâmetros de qualidade. Controle microbiológico. Controle físico-químico.

[1] Programa de Pós-Graduação em Ciência e Tecnologia e Alimentos, Universidade Estadual do Rio Grande do Sul, Brasil. *Corresponding author: marc-richter@uergs.edu.br.

Introduction

Milk is a highly nutritious food and, in addition to lactose, it also contains protein, essential amino acids, fats, minerals and vitamins. Because of its high nutritional content, milk allows the growth of a large and heterogeneous number of micro-organisms (FUSCO *et al.*, 2020). In addition to its endogenous microbiota, numerous other microorganisms originating from the teat canal, udder skin, milking machines, tanks and containers used for storage can contaminate it (ADDIS *et al.*, 2016). The basic aim of hygiene and control is to ensure that milk and milk products are safe for the consumer. The presence of micro-organisms and/or their toxins, as well as other metabolites such as enzymes, result in alterations in the physico-chemical and microbiological characteristics of milk and its derivatives. These changes occur from the moment of milking until the processing of the milk by the industry (REIS *et al.*, 2013).

Brazil ranks as the 5th largest milk producer in the world. In 2019, national production reached 34.8 billion litres, the second highest volume ever recorded, with an increase of 2.7 % compared to 2018 (IBGE, 2020). Therefore, guaranteeing the quality of milk in Brazil is a primordial condition, both to preserve the nutritional and sensorial characteristics of the food, and to guarantee the confidence and health of consumers, often affected by the discovery of adulterations carried out by milk transportation companies in the country (HENRICHS; MACEDO; KARAM, 2014).

The aim of this study was to carry out a bibliographic review, listing the main milk quality parameters, according to the standards recommended by the Brazilian legislation, in addition to presenting studies on the characteristics and quality of milk in the different regions of Brazil.

This study is based on a bibliographic review of scientific articles on the main milk quality control parameters used in Brazil. The search bases consulted were "Google Scholar", "SciELO" and "LILACs", using the keywords: "Milk quality", "Milk preservation" and "Milk storage". For the description of the parameters the search selected articles starting in 2012, while for the study of cases of milk quality evaluation in the various regions of the country, publications from 2020 onwards were considered. In addition to consulting articles, Ordinance 370 and Normative Instructions 76 and 77 of the Ministry of Agriculture, Livestock and Supply (MAPA) were also consulted (BRAZIL, 1997; BRAZIL, 2018).

The search for the study of cases of milk quality in the various regions of the country resulted in 35 (thirty-five) scientific articles, ten of which effectively contributed to the achievement of the objectives of this work, and are cited and listed in Table 1.

Quality parameters of raw milk in Brazil

In order to guarantee the quality of raw chilled milk, the Brazilian legislation establishes some parameters, which are presented in Table 2.

For raw milk to meet the minimum quality parameters, it must have a minimum fat content of $3.0 \text{ g } 100 \text{ g}^{-1}$, a minimum protein content of $2.9 \text{ g } 100 \text{ g}^{-1}$ a minimum anhydrous lactose content of $4.3 \text{ g } 100 \text{ g}^{-1}$, a minimum non-fat solid content of $8.4 \text{ g } 100 \text{ g}^{-1}$, a minimum total solid content of $11.4 \text{ g } 100 \text{ g}^{-1}$, titratable acidity between 0.14 and 0.18 expressed in grams of lactic acid 100 ml^{-1}, alizarol

stability at a minimum concentration of 72 % v/v, and a relative density at 15 ℃ between 1.028 and 1.034 g ml^{-1}. In addition, it must have a cryoscopic index between -0.512 ℃ and -0.536 ℃ (BRAZIL, 2018).

Table 1. Different studies and approaches on milk quality control in different regions of Brazil.

Title/Approach	Region	Reference
Milk quality in small farms in Southern Region of Brazil	South	Candiotto *et al.* (2020)
Avaliação da qualidade do leite *in natura* de produtores rurais do Vale do Taquari em diferentes estações do ano [*Evaluation of the quality of raw milk from farmers in Vale do Taquari in different seasons of the year*]	South	Schmidt, Lawisch e Maciel (2020)
Production and composition of milk per Holstein and Jersey cow from two farms in northwest Rio Grande do Sul	South	Calgaro *et al.* (2020)
Chilled raw milk quality: a case study in Zona da Mata region, Minas Gerais State, Brazil	Southeast	Lima *et al.* (2020)
Influência do leite com elevada contagem de células somáticas sobre características físico-químicas e processo de fermentação de iogurte [*Influence of milk with a high somatic cell count on the physical characteristics and yogurt fermentation process*]	Southeast	Faria *et al.* (2020)
Efeito de diferentes níveis de contagem de células somáticas sobre a qualidade de leite fermentado e queijo minas frescal [*Effect of different levels of somatic cells counton the quality of fermented milk and Minas fresh chese*]	Southeast	De Lima *et al.* (2020)
Principal component and cluster analyses to evaluate production and milk quality traits	Northeast	Abreu *et al.* (2020)
Qualidade do leite *in natura* perante a instrução normativa IN 76 do Ministério da Agricultura, Pecuária e Abastecimento do Brasil [*Quality of fresh milk before normative instruction IN 76 of the Ministry of Agriculture, Livestock and Supply of Brazil*]	Center-West	Guimarães *et al.* (2020)
O impacto da extensão rural no controle da mastite em propriedades de agricultura familiar na região amazônica: Estudo de multicascos [*The impact of rural extension on mastitis control in family farms in the Amazon region: a multicase study*]	North	Mesquita *et al.* (2020)
Avaliação de métodos de detecção da fosfatase alcalina em leite bovino, bubalino e caprino [*Evaluation of alkaline phosphatase detection methods in bovine, buffalo and goat milk*]	North	Lima *et al.* (2021)

Besides these parameters, raw refrigerated milk must not contain substances harmful to its composition, such as microbial growth inhibitors, acidity neutralizers, density or cryoscopic index boosters, as well as residues of products for veterinary use and contaminants above the maximum limits established in complementary national rules. As to sensory characteristics, the milk should be a homogenous, opalescent white liquid with a characteristic odor (BRAZIL, 2018).

Table 2. Minimum parameters established to guarantee the quality of raw milk, according to standards in Brazil.

Items/parameters	Values
Fat content (g 100 g^{-1})	Minimum 3.0 g
Total protein content (g 100 g^{-1})	Minimum 2.9 g
Anhydrous lactose content (g 100 g^{-1})	Minimum 4.3 g
Solids-non-fat content (g 100 g^{-1})	Minimum 8.4 g
Total solids content (g 100 g^{-1})	Minimum 11.4 g
Titratable acidity in g of lactic acid 100 ml^{-1}	Between 0.14 and 0.18 g
Stability to alizarol 72 % (v/v)	Stable
Relative density at 15ºC (g ml^{-1})	Between 1.028 and 1.034 g
Cryoscopic index (ºC)	Between -0.512 and -0.536 ºC

Source: Adapted from BRAZIL (2018).

To illustrate the characteristics of the various regions of Brazil, Figure 1 shows the percentage share of each in the total amount of milk produced in 2019.
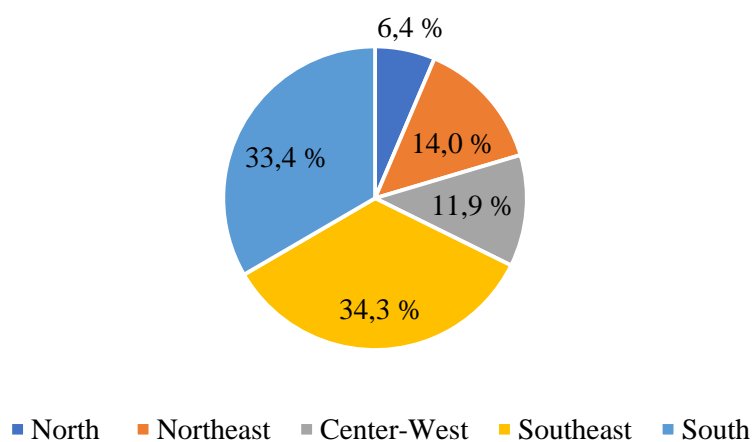

Figure 1. Participation of the five regions in milk production in Brazil (%). Source: Adapted from IBGE, 2020.

Milk quality in Southern Brazil

Candiotto *et al*. (2020) carried out a study on Brazilian small farms in the cities of Mariópolis, Pato Branco and Clevelândia in the State of Paraná, and São Domingos in the State of Santa Catarina. Some physicochemical standards of raw chilled milk were evaluated regarding its compliance with the quality standards imposed by the Brazilian legislation. The fat content, crude protein (CP) and total suspended solids (TSS) of chilled raw milk from 78 small farms were analysed monthly between October 2014 and February 2017. The results of the composition of the analysed milk can be seen in Table 3.

Table 3. Frequency of the number of samples that complied with Brazilian legislation for Crude Protein (CP), Fat and Total Suspended Solids (TSS) of raw milk.

Item	--------- October 2014 to February 2017---------		
	CP (g 100 g^{-1})	Fat content (g 100 g^{-1})	TSS (g 100 g^{-1})
Mean	3.20	3.80	12.20
Standard Deviation	0.20	0.40	0.50
Samples in conformity (nº)	2,162	1,960	2,049
Compliance percentage (%)	96	87	91

Brazilian legislation: CP $\geq$ 2.9 g 100 g^{-1}, fat $\geq$ 3.0 g 100 g^{-1} e TSS $\geq$ 11.4 g 100 g^{-1}.

Source: Candiotto *et al*. (2020)

The study showed satisfactory results for physical-chemical indicators, since 96 % of the samples met the Brazilian regulations for CP, 87 % for fat content and 91 % for TSS. On the other hand, the average values of 806,500 CFU ml^{-1} and 775,000 CS ml^{-1} for total plate count (TPC) and somatic cell count (SCC) respectively, found in the study, were significantly higher than the maximum limits established by Brazilian regulations. For these indicators, the maximum allowed by legislation is 300,000 CFU ml^{-1} (three hundred thousand colony forming units per ml) and 500,000 CFU ml^{-1} (five hundred thousand cells per ml) for TPC and SCC, respectively. The result of the analysis showed that the hygienic-sanitary management was deficient. It was concluded that small properties in the Southern Region of Brazil produce milk with adequate standards for the main physical and chemical indicators. However, there is an important gap in compliance with hygienic-sanitary practices, leading to high levels of raw chilled milk that do not meet the limits of the Brazilian regulations (CANDIOTTO *et al*., 2020).

In the Taquari Valley region, state of Rio Grande do Sul (RS), Brazil, where there are marked temperature changes between the different seasons of the year, a study was conducted based on the assumption that the seasons of the year could affect milk quality. Sudden changes in temperature could cause hormonal changes in the animals, in a way that affects the quality of the milk. Thus, samples were collected in August and October 2018, a period of lower temperatures, and another, of warmer temperatures, respectively. Collections were taken from milk cooling tanks belonging to rural producers in the Taquari Valley (RS), in a total of eight properties. The quality of raw milk was evaluated through physico-chemical and microbiological analyses such as cryoscopy, acidity, pH, alizarol test, mesophilic aerobic, psychrotrophic, thermotolerant and total coliform counts (SCHMIDT; LAWISCH; MACIEL, 2020). In the testing performed, some samples were found to be in accordance with the legislation and others not, except for mesophiles, psychrotrophs and alizarol, in which all samples were in conformity. When comparing the rainiest and coldest month (first collection - August) with the month with mild temperatures (second collection - October), the microbiological analyses showed an improvement, that is, the microbiological growth in the results of total coliforms and thermotolerant coliforms decreased. It was deduced that these results could be associated to the dirt in which

the animals enter the stables, in the rainy season, having a greater initial contamination of the milk, when the udders are not properly cleaned. However, no difference was observed between the results obtained in the analyses carried out in different seasons, indicating that temperature changes had no interference in the quality of the raw milk in this study (SCHMIDT; LAWISCH; MACIEL, 2020).

In the mesoregion of the Northwestern part of Rio Grande do Sul, located in the municipalities of Palmeira das Missões and Pinhal - RS, Calgaro *et al*. (2020) carried out the monitoring per lactating cow regarding the quality and composition of milk from two rural properties. Both herds were mixed, with Holstein (70 %) and Jersey (30 %) cows. The following parameters were evaluated: body condition score (BCS), udder dirt, calving order and milk composition: total dry matter (TDE), defatted dry extract (DDE), lactose, fat, protein, casein, milk urea nitrogen (MUN) and somatic cell count (SCC). Despite the care taken in the management of the herds, the tests showed some undesirable results, demonstrating that individual control needs to be carried out effectively for decision making, adjustments and bioeconomic responses (CALGARO *et al*., 2020).
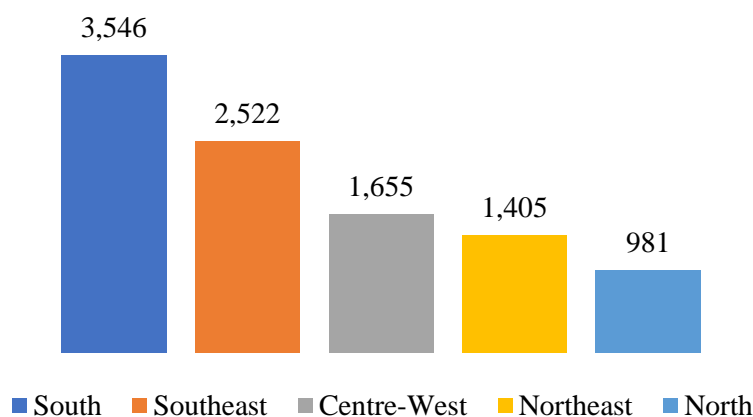

Figure 2. Milk productivity rankings in Brazil by region (average litres/cow/year). Source: Adapted from IBGE (2020).

Despite the non-conformities raised by the studies, and after a joint effort by rural producers, authorities and sector entities, recently the States of Rio Grande do Sul, Acre, Paraná, Rondônia and some regions of the States of Amazonas and Mato Grosso, were recognised as zones free of foot-and-mouth disease without vaccination (BRAZIL, 2020). This achievement represents a step forward for dairy farming and opens up the possibility of new export markets for both meat and dairy products, since in terms of milk production volume, the South and Southeast regions account for almost 70 % of national production, alternating the leadership between them (IBGE, 2020). The South region also recorded the highest national productivity in 2019, as can be seen in Figure 2.

Productivity in the South region averaged 3,546 litres per cow in 2019, a ranking led by Santa Catarina, which reached 3,816 litres of milk/cow/year, followed by Rio Grande do Sul with 3,609 litres of

milk/cow/year and Paraná with 3,324 litres of milk/cow/year (IBGE, 2020). The Southeast region ranked second in productivity, with an average of 2,522 litres per cow per year, followed by the Centre-West region, with 1,655 litres/cow per year, the Northeast with 1,405 litres/cow per year and the North with 981 litres/cow per year.

Milk quality in the Southeast region

According to IBGE (2020) the state of Minas Gerais, besides being the largest milk producer in the Southeast region, is also the largest producer in the country with 27.1 % of the overall production, followed by Paraná and Rio Grande do Sul; and occupies the fourth place in the productivity ranking, with 3,011 litres of milk per cow in the year 2019.

In the same state, Lima *et al*. (2020) analysed the evolution of the quality of raw refined milk from producers in the Zona da Mata region, between the 2012 and 2018. To this end, a linear mixed-effects model was used to analyse the monthly evolution of the results of milk composition indicators: fat, protein and DDE, SCC and TBC (Total Bacterial Count), obtained from monthly official analyses of 94 milk producers, suppliers of a dairy plant in the region (LIMA *et al*., 2020).

The results indicated a continuous reduction in milk composition indicators between the years 2014 and 2018. For the SCC and TBC indicators, only occasional reductions were observed. Average values for fat, protein and DDE were in accordance with legal standards applicable for the region, while average values for SCC and TBC were above standards for most of the period. However, minimum values observed for fat, protein and DDE, as well as maximum values observed for SCC and TBC, indicated the existence of cases in non-compliance with the legislation. It was concluded that, despite the actions implemented by the National Programme for Improving the Quality of Milk - PNMQL, the quality of raw chilled milk from the producers evaluated decreased throughout the period under analysis (LIMA *et al*., 2020).

In Montes Claros, Minas Gerais, Faria *et al.* (2020) conducted an experiment with milk from the Fazenda Experimental Professor Hamilton de Abreu Navarro (FEHAN), based on mechanical milking of Holstein cows kept under an intensive breeding system. In six separate weeks, four litres of high SCC milk ($> 250,000$ cells ml^{-1}) and four litres of low SCC milk ($< 250,000$ cells ml^{-1}) were obtained once a week and sent to yoghurt production. The fermentation profile and acidity, pH and syneresis of yoghurts made with milk containing high and low SCC, and added or not of milk solids, was studied. The raw milk collected on six different days was tested for fat, lactose, protein, total solids, defatted dry matter, SCC and TBC. After fermentation, the pH and acidity expressed as lactic acid were checked. In the yoghurt, pH, acidity expressed as lactic acid and syneresis were measured (FARIA *et al*., 2020).

It was concluded that the use of high SCC milk did not interfere in the fermentation time or in the growth of the lactic culture used to prepare the yogurts during the six hours of fermentation or in the acidity, pH and syneresis characteristics of the yoghurts. The addition of milk powder in the manufacture of yoghurt added solids was not enough to promote changes in the index of syneresis between the two product types, just as the SCC of raw milk also did not affect this response (FARIA *et al.*, 2020).

In principle, these results may justify the use of milk outside microbiological standards for the production of by-products. However, De Lima et al. (2020) studied the effects of different SCC levels in milk on the physico-chemical characteristics and sensory quality of fermented milk and Minas Frescal cheese during different storage periods. It was found that the pH of the fermented milk was influenced by the storage time and the different SCC levels did not alter the sensory acceptance of the product. However, the physico-chemical parameters evaluated during the shelf life of the *Minas Frescal* cheese and the overall acceptance were negatively influenced by the high SCC level (> 600,000 cells ml^{-1}) of the milk, presenting lower pH and higher acidity (DE LIMA *et al.,* 2020).

Further Brazilian regions (Northeast, Centre-West and North)

According to the estimates, in 2019, the Northeast region saw its production grow by 8.4 % over the previous year, which represented the largest proportional increase at the regional level. In that same year, the region accounted for 14 % of national production, followed by the Centre-West and North (IBGE, 2020).

In Agreste of Pernambuco, a semi-arid region of Northeast of Brazil, a study carried out by Abreu *et al*. (2020) analysed the quality of milk from Holstein cows on three co-market farms, located in the cities of Gravatá and São Bento do Una. Monthly milk control data obtained from the period 2007 to 2017 were used. A total of 5,872 samples of production information, milk components and SCC data were analysed. The average daily production observed was 32.50 kg. The results regarding milk components were found to have average values of 3.33 % fat, 3.21 % protein, 4.58 % lactose and 12.12 % TSS. The average SCC was 3.89, corresponding to approximately 185,000 cells ml^{-1}. The data collected were submitted to multivariate cluster analysis using Principal Components Analyses (PCA), which indicated the variables TSS, lactose and fat as the most important in the selection of animals to improve the quality of herd milk. The high average daily production was attributed to the genetic quality of the animals, in addition to the good adaptive characteristics of the herd and the adequate management used on the properties that were studied. It was concluded that the type of analysis used can help producers to interpret the relationships between variables and provide support in decisions for the selection of animals, according to the characteristics of the main variables and the relationships between them (ABREU *et al*., 2020).

In the municipality of Rio Verde in the State of Goiás, Guimarães *et al.* (2020) conducted a study in four rural properties in the period from May to September 2018. The samples were collected monthly, 40 samples were collected at each visit, and analysed for the presence of psychrotrophic and psychrotrophic proteolytic microorganisms, together with analyses of TBC, SCC and proximate composition of the milk, comparing the results with the levels required by legislation (GUIMARÃES *et al*., 2020).

It was observed that the values found were fully in compliance with the legislation. Likewise, no antibiotics were identified in any of the samples. The results obtained for the analysis of TBC and SCC showed that only the milk from one of the producers had a bacterial load above the established standard set by the legislation. In the standard plate count, results of the study were within the established limit, which according to the authors, indicated that farmers are concerned with good hygiene practices, management and

animal health (GUIMARÃES *et al.*, 2020).

Results from this study are relevant because Goiás is the Midwestern state that quarterly produces around 690 million litres of milk, a volume four times greater than the sum of the production of the other states in the region (SIDRA, 2021). And according to IBGE (2019), although the region has a lower volume production than the Northeast, it had an average productivity of 1,655 litres of milk/cow/year, while the Northeast had an average productivity of 1,405 liters/cow/year.

In the state of Rondônia, in the most southern region of the state, Mesquita *et al.* (2020) carried out a study to assess the impact of rural extension, through technical assistance, on mastitis control, and consequently on the improvement of milk quality, in family farm properties. A multiple case study was carried out on five family farmer properties located in the Amazon region. The rural extension was through technical visits and training, initially evaluating the risk factors for mastitis, jointly, a SCC and TBC survey, California Mastitis Test (CMT) and by the black-bottomed mug test.

After the initial survey, a specific training session was held in each farm, showing the main points to be improved, and 60 days after the training session the milk quality indices were measured again. The results indicated a high prevalence of subclinical mastitis, with an average of 57 %, and the risk factors observed were the absence of pre-dipping, post-dipping, drying of teats with disposable paper, black-bottomed cup test, CMT and milking line. After the technical assistance the TBC decreased by 75.98 % and SCC by 19.69 %. In view of this result, we conclude that the impact of rural extension, through technical assistance to improve milk quality, has proved to be efficient in family farms, through the reduction of TBC and SCC values. In addition, it has improved the income of the assisted milk producers (MESQUITA *et al.*, 2020). It is worth emphasising that Rondônia is the northern state with the highest milk production volume in the region, around 176 million litres per quarter, representing more than three times the production volume of the state of Pará, which is the second largest producer in the region (SIDRA, 2021).

In the state of Pará, Lima et al. (2021) carried out a study to verify the applicability and sensitivity of procedures to detect alkaline phosphatase in bovine, bubaline and caprine milk, experimentally pasteurized and defrauded with aliquots of raw milk. Tests were carried out in the Food Hygiene and Quality Laboratory of the Veterinary Medicine Institute of the Federal University of Pará - Castanhal Campus. For this purpose, samples of bovine, bubaline and caprine milk were experimentally pasteurised, separated into aliquots and blended with raw milk. The milk was pasteurized and raw milk was added in the following percentages: 0.1 %; 0.25 %; 0.5 %; 075 %; 1 %; 3 %; 5 % and 7 %; 10 %; 50 %, and control samples were used: "negative" (pasteurized milk) and "positive" (raw milk). The following methods were used: the official methodology of the Brazilian legislation, colorimetric strips and a kit of reagents (LIMA *et al.*, 2021).

The results demonstrated that in the tests carried out on buffalo milk a slight reaction occurred when the reagent kit and the colorimetric strips were used, while the methodology according to the legislation was not very efficient. For goat milk the enzyme was not detected in the milk samples tested by either of the methodologies adopted. For bovine milk, the most sensitive procedure for detecting minimum portions of raw milk was the methodology based on the Brazilian legislation. The conclusion of the authors is that the

methodology of the Brazilian legislation is the most sensitive to detect the presence of alkaline phosphatase in bovine milk, and the procedures for the control of pasteurization in bovine milk do not have the same efficacy for bubaline and caprine milk, which, in this case, need to be optimized (LIMA *et al*., 2021).

Conclusions

The search for excellence in milk quality goes through standardization, activity control, genetic improvement, herd health and the adoption of good hygienic-sanitary handling practices. In Brazil, despite the regulation and control of dairy farming, there are still problems in the various regions of the country, which can be minimised with technical assistance and rural extension. It was found that tools such as multivariate statistical analysis can also assist producers in making the right decisions.

In a general overview, the study shows the contribution and importance of the Southern Region in the activity that places Brazil in the ranking of the world's largest milk producers. The region stands out both for the volume produced and for its productivity. It was observed that there is still a deficiency in the compliance with hygiene and sanitary practices, which explains the occurrence of raw refrigerated milk outside the limits of Brazilian regulations. However, despite the deficiencies, common to all regions, it was found that small properties produce milk of adequate standards regarding the main physical and chemical indicators. It is deduced that the favourable conditions to advance in quality, in search of excellence, are mainly due to the joint commitment of rural producers, authorities and entities of this economic sector. According to the studies, temperature oscillations, due to climatic variations, do not interfere in the quality of raw milk.

In any case, the search for the reduction of somatic cell count levels should be continuous, since the use of milk outside microbiological standards, although not directly affecting the production of by-products, negatively affects the overall acceptance of the products throughout their shelf life. Among the procedures for the control of pasteurisation in bovine milk, the methodology established by Brazilian legislation proved to be the most efficient to detect the presence of alkaline phosphatase. However, the same efficacy did not apply to bubaline and caprine milks which still need to be optimised.

The conclusion, therefore, is that Brazil has already evolved with its regulations, but as a continental country, there is still room for improvement in all aspects, from milking to the final consumer. The subject is complex and involves economic activity with great potential for growth. It is important that new scientific studies continue to be conducted in order to provide more information, test new methods and clear up the remaining doubts.

Conflict of interest

The authors declare that the research was conducted in the absence of any potential conflicts of interest.

Ethical statements

The authors confirm that the ethical guidelines adopted by the journal were followed by this work, and all authors agree with the submission, content and transfer of the publication rights of the article to the journal. They also declare that the work has not been previously published nor is it being considered for publication in another journal.

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ORCID

Sueli Fiorini Sommer: https://orcid.org/0000-0002-9212-0151

Marc François Richter: https://orcid.org/0000-0002-0868-9127

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