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Milk quality in Brazil: an overview of official analysis of sanitary monitoring*

Qualidade do leite no Brasil: um panorama de análises oficiais de monitoramento sanitário

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Resumo

O leite beneficiado compõe uma parte importante dos alimentos mais consumidos e comercializados no mundo; no entanto, é reconhecido como um dos alimentos mais frequentemente fraudados, necessitando de monitoramento contínuo de qualidade. Objetivou-se no trabalho estudar a qualidade do leite beneficiado no Brasil, monitorado pelo Programa Oficial do Centro Integrado de Monitoramento da Qualidade de Alimentos (CQUALI-Leite), como subsídio para melhoria e aperfeiçoamento deste programa, direcionando ações corretivas para melhoria de produtos com foco em regiões de maior problemática. Para isso, foram avaliados os resultados de análises fiscais oficiais, totalizando 1556 amostras de leite beneficiado de diversas marcas comerciais disponibilizadas no comércio nacional. Os resultados obtidos evidenciaram que o leite pasteurizado foi a categoria com maior índice de irregularidades e o leite em pó a categoria de melhor qualidade, apesar de evidenciar a presença de *Bacillus cereus*, o que não pode ser negligenciado no controle sanitário. Concluiu-se que toda cadeia de processamento do leite beneficiado no Brasil ainda necessita de aprimoramento e monitoramento contínuos e que para aperfeiçoamento do CQUALI-Leite infere-se que o direcionamento de ações corretivas para melhoria de produtos deverá ter foco nas regiões Norte e Nordeste, principalmente quanto ao leite pasteurizado.

Palavras-chave: leite beneficiado, leite pasteurizado, programa de monitoramento, resultados oficiais.

Abstract

The processed milk makes up an important part of the food consumed and marketed in the world; however, it is acknowledged as one of the most frequently susceptible food to fraud practices, in need of continuous monitoring of quality and safety. This study aimed to assess the quality of milk processed in Brazil, monitored by the Official Program of the Integrated Center for Food Quality Monitoring (CQUALI-Milk), as a subsidy for improvement and enhancement of this program, focusing corrective actions to improve products with attention on problematic regions. For this, we evaluated the results of official analysis, totalizing 1556 samples of milk from several commercial brands available in the Brazilian retail market. The results show that pasteurized milk was the category with the highest rate of irregularities and the milk powder the category exhibiting the best quality, despite the evidence of *Bacillus cereus*, which cannot be overlooked in the sanitary control. Milk processing chain in Brazil still needs improvement and a continuous quality monitoring, and to enhance the CQUALI-milk we shall infer that the targeting of corrective actions to improve products should be focused in the North and Northeast regions, especially regarding the pasteurized milks.

Keywords: monitoring program, official results, pasteurized milk, processed milk

Introduction

The milk and dairy products make up an important part of the most consumed and traded food in the world. In Brazil, the amount of raw milk purchased by processors establishments was 5.64 billion liters only in the second quarter of 2015. The largest acquisition of raw milk was located in the Southeast of the country, about 41.3%. The South has acquired 35.2% of all milk and the Midwest 13.5%. With lower contribution the Northeast 5.5% followed by the North 4.5% (IBGE, 2015).

The average food intake for individuals over ten years of whole milk in Brazil is 34.7 g/day; semi-skimmed and skimmed milk 4.7 g/day; and milk powder 0.3 g/day. The whole fluid milk has a prevalence of food intake by 12.4%. The semi-skimmed and skimmed milk, although recommended as suitable options for healthy eating, represent less than 10% of the consumption of this food group and is directly linked to increased income. Compared by age group, the whole fluid milk is more consumed by the elderly with a prevalence of 15.8% in this age group. Average consumption also varies widely between regions, with whole milk being the most consumed in the Midwest Region and less consumed in the North. On the other hand, powdered milk has increased consumption in the Northeast and lower consumption in the South and Southwest of Brazil (IBGE, 2011).

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Despite the great commercial importance and high nutritional value, in the period between 1980 and 2010, milk was recognized as one of the world's defrauded food, requiring continuous quality monitoring (MOORE; SPINK; LIPP, 2012). In this context, government initiatives have been taken to integrate the actions of the agencies involved in the control of food and strengthen measures to prevent and combat the quality deviations, including irregularities and fraud.

Currently in Brazil, the "Programa Oficial do Centro Integrado de Monitoramento da Qualidade de Alimentos" (Official Program of the Integrated Center for Food Quality Monitoring - CQUALI-Milk) has the aim to monitor, in an inter-institutional way, the milk processing establishments and supervise compliance of pasteurized milk, UHT milk (Ultra High Temperature) and powdered milk in its several classifications and combat illegal trade as well as, characterized by gathering a large number of official quality analysis. The program was widely discussed and structured, with manual guiding of laboratory tests and large accession of Public Health Laboratories (BRASIL, 2008; MARSIGLIA et al., 2010).

The aim of this study was to evaluate and make public the quality of processed milk retailed in Brazil that is monitored by CQUALI-Milk. These results are potential input for suggestions to enhance the national quality program, focusing on preventive and corrective actions to improve products quality especially on the most problematic regions of the country. Ultimately, the data derived from the present study will foment the development and retail of milk products with improved overall quality.

Materials and methods

This study was conducted by the National Health Surveillance Agency (Anvisa), a government agency responsible for managing the information from official monitoring tests of milk marketed in Brazil. The official analytical results performed by Public Health Laboratories and monitored by CQUALI-Milk program, in the years 2013 and 2014, totalized 1556 randomly selected samples of milk from different commercial brands commercialized in Brazilian retail markets.

The milk samples were collected in its original packaging by local sanitary surveillance agents according to the classification of milk including whole, semi-skimmed and skimmed milk powder; whole, semi-skimmed and skimmed pasteurized milk; and whole, semi-skimmed and skimmed UHT milk. The number of samples collected reflected the average food consumption data *per capita* in Brazil. The largest number of analysis was in the categories of whole UHT milk n=698/45% and whole pasteurized milk n=366/23%. For fluid semi-skimmed and skimmed milk were evaluated n=278/8% and for powdered milk, in its various classifications n=214/14%. No semi-skimmed powdered milk analysis were performed in 2014 and skimmed pasteurized milk in 2013.

Samples were transported and stored in the same conditions as it is marketed in order to ensure the integrity of the product. The samples that are not temperature-stable, as pasteurized milk, were collected under strict hygienic conditions, then transported under refrigeration (at 4°C, packed on dry ice) from the collection until the analysis, not exceeding 24 hours.

The assessment of chemical and physical characteristics of the milk and microbiological analysis were carried out in accordance with national references and grouped in table 1 according to each milk sample category. The methodology used is described in Instruction N.68/2006, which formalizes the physical and

Table 1: Analysis performed according milk samples in 2013 and 2014

Milk Samples	Analysis
UHT/Pasteurized milk	Sensory characteristics (taste, odor and aspect)
	Chemical and physical analysis
	Acidity/ Acidity after incubation
	Alizarol stability at 72%
	Alkaline phosphatase content
	Alkalinity of the ashes
	Chlorine and hypochlorite content
	Cryoscopic index
	Density at 15°C
	Ethanol stability at 68%
	Ethanol stability at 68% after incubation
	Extraneous material content
	Fat content
	Formaldehyde content
	Hydrogen peroxide content
	Peroxidase test
	pH/ pH after incubation
	Reducing sugars
	Sodium
	Solids
	Solids-non-fat
	Starch content
	Microbiological analysis
	Counting and identification of coliforms at 35°C
	Counting and identification of coliforms at 45°C
	Escherichia coli
	Incubation test
	Listeria monocytogenes
	Salmonella spp.
	Standard plate count
Powdered milk	Sensory characteristics (taste, odor and aspect)
	Chemical and physical analysis
	Alkalinity of the ashes
	Extraneous material content
	Fat content
	Moisture and volatile
	Reconstitution
	Starch content
	Test of cooking
	Titratable acidity
	Titratable acidity after incubation
	Microbiological analysis
	Coagulase-positive staphylococci count
	Counting and identification of *Bacillus cereus*
	Counting and identification of coliforms at 35°C
	Counting and identification of coliforms at 45°C
	Escherichia coli
	Incubation test
	Salmonella spp.
	Standard plate count
	Sulfite-reducing *Clostridium* at 46°C

chemical Analytical and Officials Methods for Milk and Milk Products in Brazil. Likewise, analysis of sensory characteristics of the fluid milk and powdered milk were performed as described in the official rules parameters, including taste, odor and aspect of the samples (BRASIL, 2006). Adding, macroscopic and microscopic extraneous material analysis was carried out according to AOAC (BOESE; BANDLER, 1990) and the microbiological methodology used is described in Instruction N.62/2003 (BRASIL, 2003). All methodologies have been validated by Public Health Laboratories, establishing reproducibility in order to minimize disparities among laboratories.

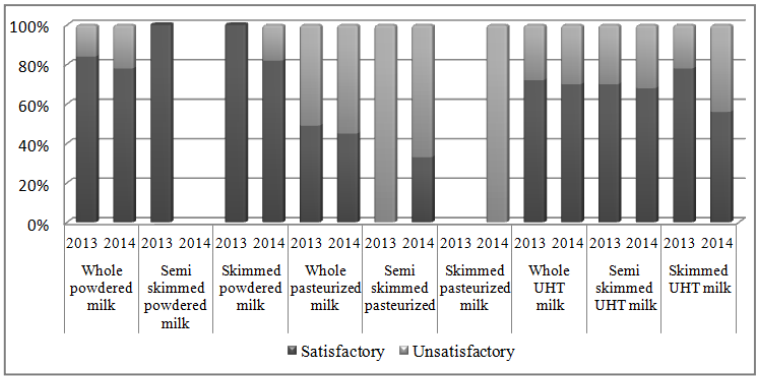

Figure 1: Percentages of satisfactory and unsatisfactory results in milk samples in 2013 and 2014

The verification of the conformity of processed milk followed labeling requirements of Brazilian legislation for packaged foods (BRASIL, 2002; BRASIL, 2003; BRASIL, 2005).

Results were considered unsatisfactory when any of the parameters evaluated showed up nonstandard for the assessed milk category or when resulting in non-compliance with parameters established in Brazilian legislation (BRASIL, 2002; BRASIL, 2003; BRASIL, 2005; BRASIL.2006).

Results and discussion

Among all milk samples analyzed, 571 samples (37%) had unsatisfactory results. In a more detailed and comparative analyze, it seems that the major problem of unsatisfactory results is found in pasteurized milk. In view of all sorts of irregularities, powdered milk has a superior quality, followed by the UHT milk when compared to pasteurized milk (Figure 1).

It is clear that pasteurized milk is the milk category more critical, since its manufacturing process uses milder temperatures for processing and needs refrigeration during distribution and marketing. The classification of pasteurization as Critical Control Point is justified by the fact that at this point, if there is a fault in the binomial time x temperature may occur persistence of pathogenic and spoilage microorganisms. Microorganisms can develop during storage reducing the quality of the product and determining its unsatisfactoriness in analysis (VARNAM; SUTHERLAND, 1994).

As regards packaging, it is also considered a Critical Control Point as when performed incorrectly will determine the low quality in the storage step. An alternative is the implementation of hazard analysis and critical control points in the raw milk processing, an efficient tool for controlling hazards, allowing the establishment comply with Brazilian law and ensuring the safety of the product offered to the population (TOBIAS; PONSANO; PINTO, 2014). Moreover, maintaining the product at the correct temperature during the distribution and marketing is essential to keep product quality.

Concerning the descriptive evaluation of irregularities, despite powdered milk presented lower level of irregularities when compared to the others categories, 66% of unsatisfactory results were due to labeling analysis, considered lower risk (Figure 2). Federal intervention in food labeling is often proposed with the aim of achieving a social goal such as improving human health and safety, mitigating environmental hazards, averting international trade disputes or supporting domestic agricultural and food manufacturing industries. Economic theory suggests, however, that mandatory food-labeling requirements are best suited to alleviating problems of asymmetric information and are rarely effective in redressing environmental or other issues associated with food production and consumption (GOLAN et al, 2001).

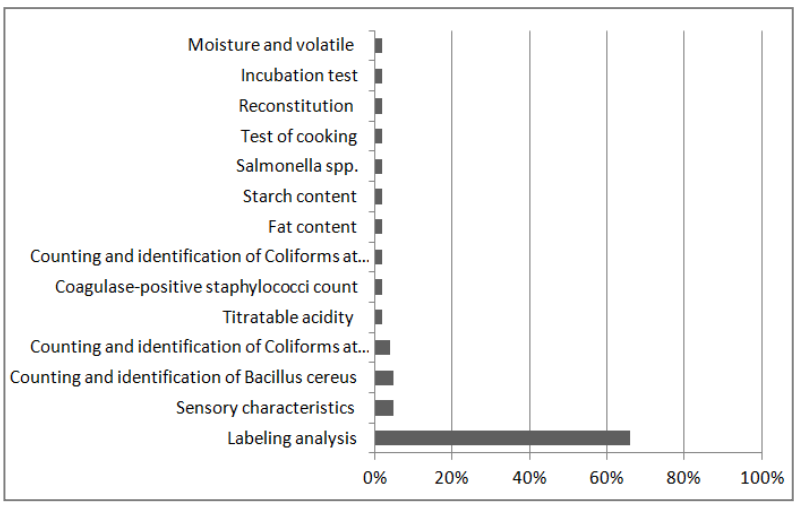

Figure 2: Distribution of unsatisfactory results in powdered milk in 2013 and 2014

Besides the labelling results, 5% of the unsatisfactory results were about sensory analysis and 5% of counting and identification of *Bacillus cereus*. This is a concern in view of that organism may be a deteriorating the milk and can resist the main treatments used in the food industry, representing a health risk due the presence of the emetic and/or diarrheic toxins. This microorganism may be present in the milk exposed to drastic heat treatment, due to the presence of bacteria spores that have heat resistance during processing; and improper packaging of milk after its treatment, which allows the post-processing recontamination (SALUSTIANO et al., 2009). Nevertheless, *Bacillus cereus* spores are able to produce biofilms on equipment and contaminate other raw materials which may characterize failure in

cleaning and disinfection procedures (PAGEDAR, SINGH, 2012). These results work as a warning, since it detected the presence of pathogenic microorganism capable of producing toxin and develop food poisoning, especially in immunocompromised individuals, the elderly and children, more susceptible population groups that consume large amounts of milk.

Less frequently, but not least, 2% of the irregularities occurred by the presence of *Salmonella* spp. in powdered milk, which raises a concern since the ingestion of contaminated milk can cause gastroenteritis from mild to severe complications, such as in the case of typhoid and paratyphoid fever (WHO, 2005).

In contrast, the major problems found in pasteurized milk were counting and identification of coliforms at 45°C (23%) and physical and chemical analysis of cryoscopic index (15%) and acidity (11%) (Figure 3).

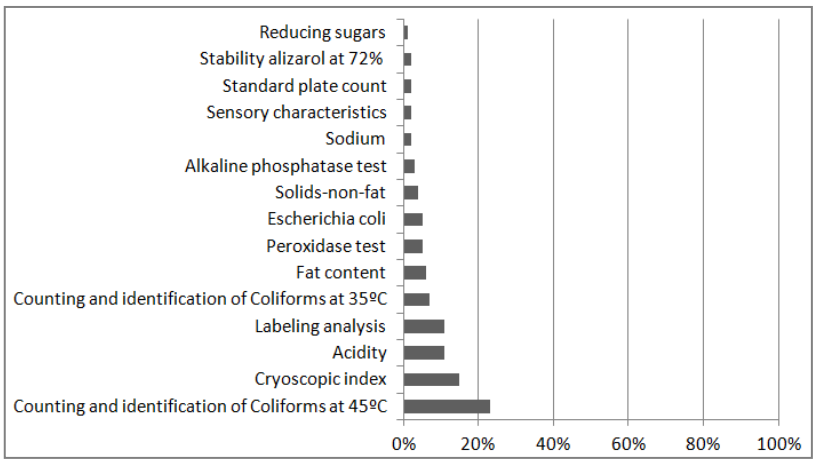

Figure 3: Distribution of unsatisfactory results in pasteurized milk in 2013 and 2014

The thermotolerant coliform is a subgroup of the total coliform able to ferment lactose with production of acid and gas at 45°C, confirming the results of unsatisfactory analysis of pasteurized milk containing this microorganism that also showed acidity over the limit. Although these organisms are indicators of fecal contamination, we should not conclude on the safety. In fact, it can be suggested that thermotolerant coliforms are indicative of inadequate hygiene practices in the process of obtaining, processing and post processing, which may also be related to the contamination after heat treatment (SILVA et al., 2010).

These results demonstrate the poor hygienic quality of pasteurized milk in Brazil, as indicating the occurrence of fecal contamination. It is assumed that the milk processing chain in this country still needs improvement. Tobias, Ponsano and Pinto (2014) concluded that the implementation of Good Manufacturing Practices together with the hazards control and critical control points in the pasteurized milk processing in Brazil is the key to significant reduction of microorganisms, achieving a 20% reduction in the values found before implementation, being the main tool used currently to ensure safety, quality and integrity of the pasteurized milk.

Concerning the unsatisfactoriness in cryoscopic index analysis, although individual parameters of dairy cows were not evaluated in this study, we must consider the effect of race, solids and stage of lactation on the freezing point. It can be seen that the rise in urea levels in milk and milk protein concentration decrease the freezing point. In contrast, studies have shown that the cryoscopic index can reflect the occurrence of water added in milk, made in order to defraud the volume of milk delivered to industry. However, before suppose a diagnosis of fraud, factors related to race, solids content, protein content, lactation stage, management of drinking fountains, diet quality and urea levels in milk should be investigated, so that the real reasons that may affect the freezing point can be elucidated (KĘDZIERSKA-MATYSEK et al., 2011).

Regarding the most frequent irregularities in UHT milk, there have been changes in sensory characteristics (16%), followed by determination of pH (15%), acidity (11%), labeling analysis (9%) and stability to ethanol at 68% (9%) (Figure 4). Corroborating the data of this study, Machado et al. (2014) demonstrated that the acidity determines sensory defects contributing to the rejection of milk, because the salt balance of the milk affects its thermal stability, especially between their main components as the concentrations of calcium, phosphate and citrate. Given the important role of calcium phosphate in the stability of casein micelles, changes in calcium balance between soluble and colloidal affect the stability of milk. These results confirm the poor quality of raw milk used and/or thermal processing fails, resulting in irregularities.

Supplementing the data of unsatisfactoriness in official analysis of processed milk, this study carried out an assessment of irregular results by Brazilian Regions in order to allow an improvement of the monitoring program targeting control for most problematic regions. Thus, it is observed in Figure 5 that the Northeast and North regions of Brazil have the highest rates of irregularities.

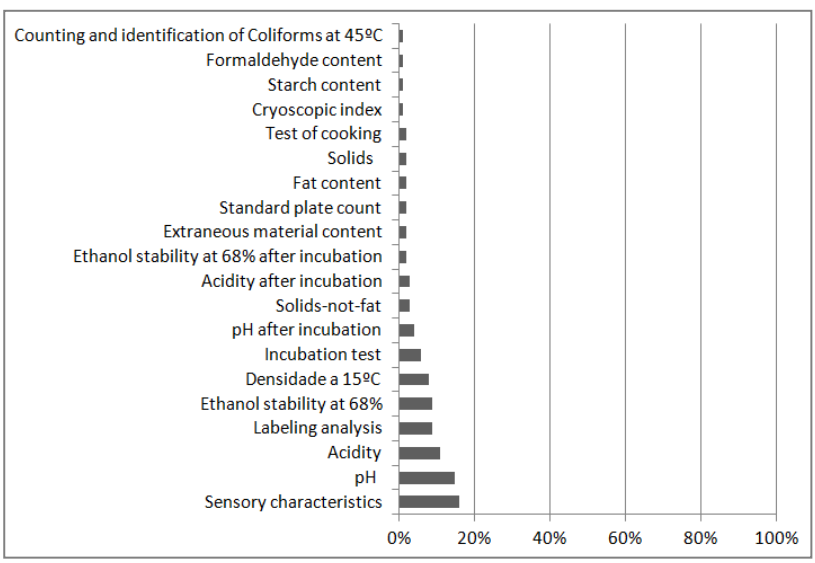

Figure 4: Distribution of unsatisfactory results in UHT milk in 2013 and 2014

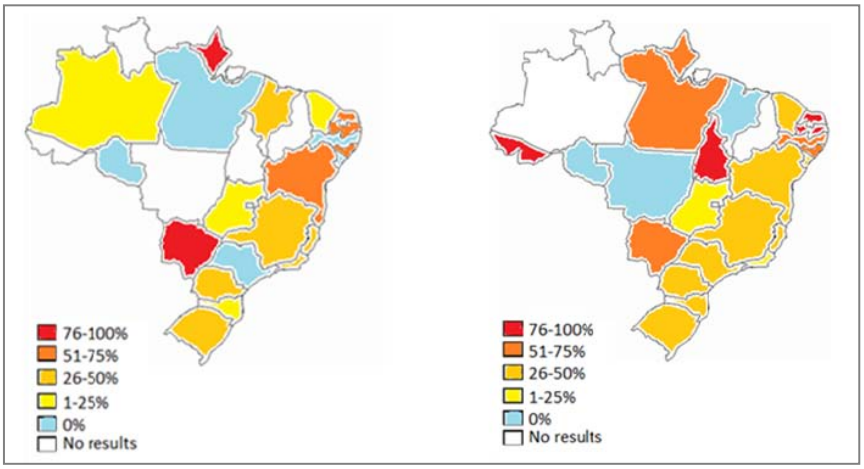

Figure 5: Map of distribution of unsatisfactory results of milk samples by Brazilian states. Left map for the year 2013 and right for 2014

Data from the Brazilian Institute of Geography and Statistics (IBGE, 2015) point out that the Northeast and North regions of Brazil have low involvement in obtaining milk for processing representing 5.5 % and 4.5 % respectively. Due to the low supply of raw milk in the Northeast and North of the country (Associação de Indústria de Leite Longa Vida, 2011), it can be suggested that the transportation of raw milk from other regions for processing can represent a problem in sanitary control, negatively impacting the product quality. Areas of greater dairy production and acquisition, such as the South and Southeast, are the ones with lesser irregularities, demonstrating a higher level of hygiene and sanitary control.

Conclusion

Considering the data provide by this study, pasteurized milk is the processed milk category with the highest rate of irregularities, being a major target of unsatisfactory official analysis in monitoring realized by CQUALI-Milk in Brazil. On the other hand, the powdered milk presents as the better category, despite the evidence of presence of *Bacillus cereus*, a pathogenic microorganism able to produce toxin and develop food intoxications especially in individuals in risk group, requiring greater sanitary control.

The unsatisfactory results for pasteurized milk and UHT milk have shown a low hygienic quality of milk used or failure in the processing. Thus, it is concluded that milk processing chain in Brazil still needs improvement and continuous monitoring.

For enhancement of the Official Program of the Integrated Center for Food Quality Monitoring it appears that the targeting of corrective actions for improve products must be focused in more problematic regions as North and Northeast of the country, mainly as regards the pasteurized milk.

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