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# IMPORTANCE OF THE QUANTIZATION OF MACROELEMENTS AND MICROELEMENTS IN MILK COLLECTED AND DISTRIBUTED BY THE BRAZILIAN NATIONAL NETWORK OF HUMAN MILK BANK

***Cleodete Candida Gomes and Débora Gomes Pimenta**

Universidade Federal de Mato Grosso do Sul/UFMS, Faculdade de Medina, Campo Grande/MS. Cidade Universitária, Caixa Postal 549. CEP 79070-900, Campo Grande – MS, Brazil

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**ABSTRACT**

This study is descriptive, involving analyzes based on data from Brazilian milk banks. The objective of this study was to evaluate if there is data obtained by atomic absorption spectrometry (AAS), atomic absorption spectrophotometry with electrothermal atomization (ICP-MS) and inductively coupled plasma optical emission spectrometry (ICP OES) in the quantification of macroelements and microelements in milk collected and distributed by the Brazilian National Network of Human Milk Bank. Such analyzes can assure the quality of this milk, and it is essential to know its mineral profile or nutritional toxicity. It was verified that there is no information or results involving heavy metals or non-metals obtained from the quantification of milk donated or distributed by the Brazilian milk banks.



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## INTRODUCTION

Breast milk is the most appropriate food to be fed to the newborn and is recommended for exclusive use up to six months of age and as a complement until two years of age (WHO, 1989a; American Academy of Pediatrics, 2012). Because of their increased need for nutrients from their rapid growth, and the metabolic immaturity of body, newborns, especially preterm or low birth weight and those afflicted with diseases are more likely to develop nutritional deficiencies that will affect their growth and development. The composition of human milk is varied and is influenced by several factors such as genetic individuality, maternal nutrition and lactation period. In addition, potentially toxic metals, can also be transferred to the infant through human milk (Klein *et al*., 2017). The need for macro- and microelements for the newborn is greater than other children and adults due to rapid body growth and also the high level of activity of the metabolic routes involved in growth. Thus, care for this need is supplied by breast milk (Bates and Prentice, 1994).

***Corresponding author: Cleodete Candida Gomes***
Universidade Federal de Mato Grosso do Sul/UFMS, Faculdade de Medina, Campo Grande/MS. Cidade Universitária, Caixa Postal 549. CEP 79070-900, Campo Grande – MS, Brazil.

Human milk has a balanced nutritional composition and has approximately 45 types of bioactive factors. Many of these factors can contribute to the growth and development of the newborn as well as to the maturation of your gastrointestinal tract. Among them, we highlight antimicrobial factors, anti-inflammatory agents, digestive enzymes, various types of hormones and growth factors (Kunz *et al*., 1999). In Brazil, from the 1970s, with the encouragement of breastfeeding, there was a significant increase in research on human milk. From that period, the nursing mothers were encouraged to donate the excess milk produced, with the human milk banks being responsible for the collection, processing and quality control of colostrum and milk for later distribution to newborns. Due to its composition and low cost, human milk stored in milk banks is the safest in the dietary treatment of low birth weight infants, premature or not, unable to breastfeed (MAIA *et al*., 2006). The nutritional needs are not precisely established, and they change with the gestational age and clinical condition of the newborn (BRASIL, 2011a). In addition, the nutritional status of a child at birth varies according to the conditions experienced in intrauterine life. The nutritional adequacy of the fetus can significantly influence the morbidity and mortality rates of newborns (FALCÃO, 2003). Human bank milk is widespread worldwide, but in some countries this interest has not remained active or renewed. There is an urgent need to collect data and reports that have results referring to the newborns receiving the donated milk, as well as high quality research that makes it possible to evaluate the nutritional needs of this vulnerable population. The macroelements and microelements composition of human milk stored in milk banks varies widely, according to studies conducted in several countries, as well as Brazilian studies. According to Guo (2014), geographic and environmental influences seem to be the main reasons for these variations. Thus, to ensure the quality of milk processed in milk banks, it is therefore essential to know its nutritional profile of macro- and microelements. The main techniques for the quantification of macro and micro elements in biological systems are Atomic Absorption Spectrometry (AAS - Atomic absorption spectrometry) (Robert Bunsen and Gustav Kirchhoff, 2018), Atomic absorption spectrophotometry with electro thermal atomization (ICP-MS - Inductively Coupled Plasma Mass Spectrometry) (Howard Taylor., 2001), and Inductively Coupled Plasma Optical Emission Spectrometry (ICP OES) (Charles *et al.,* 2004). This study aimed to highlight the use of advanced techniques such as atomic absorption and/or atomic emission spectroscopy in the quantification of macro- and microelements in the milk human donated at posts or places authorized by the Ministry of Health and distributed to the child population of the Brazil.

## MATERIALS AND METHODS

The results of this study were collected from data from the Ministry of Health, as part of a research on the quantification of the concentration of macro and microelements in human milk banks in the city of Campo Grande, state of Mato Grosso do Sul, Midwest regions of Brazil (Portal, 2018). A standardized collection procedure and Software (Origin 9.0) was used to facilitate the comparison between results from different regions of Brazil.

## RESULTS

Table 1 shows the data reported by the Ministry of Health from January to December 2017. The differences between the total number of milk donors, total number of newborns attended, total volume collected for the Northeast region of Brazil, the Northern Region of Brazil, the Southeastern Region of Brazil, the South Region of Brazil and the Midwest Region of Brazil. For a better visualization of the data we can interpret them through Figure 1. From Figure 1, it is observed that some regions present a higher volume of milk collected, this is justified due to the greater number of donors. The human milk banks in Brazil follow norms established by the Resolution of the Collegiate Board of the National Agency of Sanitary Surveillance, Resolution RDC No. 171, of September 4, 2006 (BRASIL, 2006). This resolution provides for the technical regulation for the installation and operation of human milk banks and collection points throughout the national territory for the purpose of ensuring the sanitary safety of milked human milk. Every collection point must be technically linked to a bank and administratively to a health service or to the milk bank itself. Both must have an operating license, sanitary permit or health certificate in force issued by the competent health surveillance authority. Banks of milk are responsible for actions to promote, protect and support breastfeeding, as well as collecting, selecting, classifying, processing, quality control and distribution activities, prohibiting the marketing of products collected, processed and distributed (Britto *et al*., 2002; Hinrichsen, 2004). Samples of milk that do not meet specifications for sensory, physicochemical and microbiological aspects should be discarded. The evaluation of sensory aspects covers the absence of dirt or foreign bodies such as hair, hair, insects, fragments of paper, glass, skin, nails and other materials. As for color, red-brick and dark brown stains may indicate blood presence, while greenish may indicate infection by Pseudomonas.

**Table 1. Data reported by the Ministry of Health, from January to December, 2017. (PortalMS, 2018)**

| | Northeast Region of Brazil | Northern Region of Brazil | Southeast Region of Brazil | South region of Brazil | Midwest Region of Brazil |
|---|---|---|---|---|---|
| Total number of milk donors | 36.487 | 17.801 | 57.831 | 32.402 | *15.598* |
| Total number of newborns seen. | 44.482 | 36.721 | 43.285 | 30.294 | *21.925* |
| Total volume collected (L). | 48.929,2 | 13.936,4 | 67.602,1 | 33.127,8 | *26.409* |
| Total volume distributed (L). | 34.109,4 | 10.893,4 | 48.269,0 | 24.349,6 | 18.622,6 |

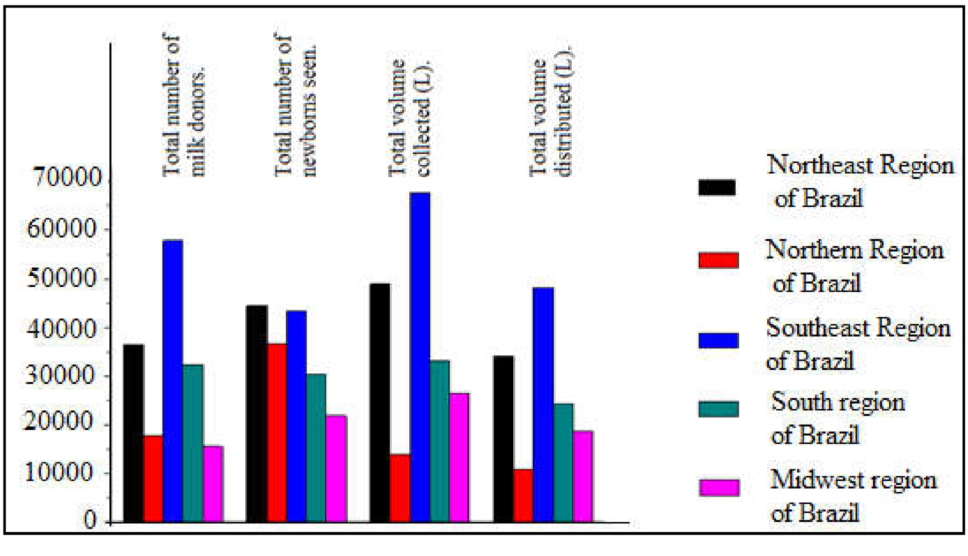


**Figure 1. Data reported by the Ministry of Health, from January to December, 2017.**

The presence of off-flavor characteristic of rancification and the smell of coconut soap may indicate the presence of lipolytic microorganisms. The smell of decomposing fish or egg stems from the presence of proteolytic microorganisms, while that smell of chlorine, plastic, rubber and medicine come from the sorption capacity of lactose, that is, from absorbing and adsorbing volatile substances. In the physical-chemical aspects, the energy content (estimated by the crematocrit analytical technique) and the acidity, expressed in degrees Dornic (°D, with acceptable values in the range of 1 to 8 °D), which can be derived from constituents such as micelles of casein and mineral salts, mainly citrates and phosphates, and the presence of bacteria producing lactic acid. In the microbiological aspects the absence of fecal coliforms at 35 ° C is evaluated (Sousa and Silva, 2010; Almeida, 1999). Human milk is classified as colostrum (less than seven days postpartum), transitional milk (7-14 days postpartum), mature milk (more than 14 days postpartum) and preterm mother (gestational age less than 37 weeks) (ALMEIDA, 1999). After approval of the respective evaluation steps, the bottling and pasteurization takes place. However, a complete quantification of macro (Na, K, Ca, P, S, Mg, Fe) and microelements (Zn, Mn, B, Cu, Mo, Cr, Se, As, Cd, Pb, is not performed to ascertain its potential nutritional or toxic value in children. The nutritional needs are not precisely established, and they change with the gestational age and clinical condition of the newborn (Brasil, 2011a).

In addition, the nutritional status of a child at birth varies according to the conditions experienced in intrauterine life. The nutritional adequacy of the fetus can significantly influence the morbidity and mortality rates of newborns (FALCÃO, 2003). Nutrition of the neonate requires adequate supply of nutrients such as proteins, carbohydrates, fats, vitamins and minerals. In particular the minerals calcium and iron and vitamins D and C should be considered. The needs for calcium and vitamin D in this age group are due to the rapid ossification that occurs after birth. Iron is essential for the formation of blood cells, which accelerates at this stage. From the nutritional point of view, the birth of a preterm or underweight child represents an emergency because its energy reserve can last for a few days. The premature newborn loses energy through basal metabolism (at rest) and as a result of activity through thermal regulation, tissue synthesis and water loss through evaporation; the energy is stored in tissues of recent synthesis and lost in feces and urine (AKRÉ, 1994). In fact, hours and not days, constitute the time it is assumed that the preterm newborn can remain without nutritional support (BRASIL, 2011a). To compensate for these losses, a daily intake of 95 to 160 kcal/kg/day is necessary. Human milk has a density of 65 to 70 kcal/100 ml, and the energy requirement is reached with volumes of 150 to 200 ml/kg/day (AKRÉ, 1994).

The best milk to be offered is that of the mother, milk from milk banks is the second option to be considered (BRAZIL, 2011b). In order to provide nutrition that guarantees adequate growth and psychomotor development, it has been emphasized the importance of macroelements and microelements and their functions in the body. It is noteworthy that in premature newborns, the needs for calcium and phosphorus are markedly higher for other children and adults (Trindade, 2005). Despite the high bioavailability of nutrients, human milk may be insufficient to meet the nutritional needs of the extremely low birth weight infants weighing less than 1000 grams (Camelo junior and Martinez, 2008). In preterm infants, the major challenge is to provide enough nutrients to allow tissue deposition at the same rate as that occurring in the fetus in the third trimester of pregnancy (Brasil, 2011a). To assist this process, in addition to proteins, lipids and vitamins, there is a group of inorganic components that are macroelements and microelements that perform various functions and are as useful as vitamins for the growth and development of the human body. There are recommendations for minerals for premature babies weighing between 1,000 and 2,500 g, according to nutrition committees (ESPGHAN, AAPCON and Canadian Pediatric Society). However, data from those committees, according to Klein and Heird (2005), reflect the lack of evidence of concentrations and a range of recommendations for some minerals such as chromium and molybdenum. In addition, there is an obligation to define the nutritional needs of premature babies weighing less than 1,000 g, ie those weighing less than 750 g. Such obligations aim to better assess optimal dietary practices and thus provide more adequate support for the development and growth of the short- and long-term child of this low-weight and weakened population. Low-weight children are vulnerable and more susceptible, as they have greater nutritional need and are also more sensitive to excess, besides being a more heterogeneous population in terms of their clinical state in relation to other newborns (Tsang *et al*., 2005; Tangehope *et al*., 2013). Most of the time, the assignment of establishing these needs are transferred to the medical professional responsible for the child. It should be emphasized that the establishment of nutritional needs should be performed in an individualized manner and according to the gestational age of the infant, stage of physiological development and clinical condition. The scarcity of research in this vulnerable population regarding nutritional needs and the short- and long-term effects of ingestion of these nutrients on neurodevelopment are troubling.

Higher premature survival is reflected in increased concern about adequate nutrition both in the period of hospitalization and in the post-discharge period, since fetal and postnatal malnutrition can lead to comorbidities when these children become adults, such as hypertension, diabetes and heart disease (Trindade, 2005). In relation to preterm and low birth weight infants, breastfeeding with human milk from a milk bank has generated concern, especially when mature milk is used, since these newborns present greater nutritional requirements in relation to newborns, nutritional deficiencies of calcium, phosphorus, iron, copper, zinc and vitamin A are common in preterm and low birth weight infants (Nutrition committee, Canadian paediatric society, 1995). In addition, data on the composition of human milk provided by milk banks in developing countries are scarce, particularly with regard to macroelements and microelements.

According to Vieira *et al.,* (2004), nutritional support is one of the main pillars in the treatment of the newborn. Ensuring the quality of milk delivered to these babies is critical to their normal growth and development. Required in specific amounts at each stage of development of the human organism, minerals may, when in excess, compete with other elements and cause toxicity (Bianchi *et al*., 2000). In Brazil as in other countries, collected milk does not undergo an analysis using advanced equipment such as ICP Ms, ICP OES or AAS to ascertain the concentration of potentially toxic metals for children or adults. In fact, the mineral composition of human milk is not completely known. In particular for some elements such as: nickel, silicon and aluminum. In view of the above, the studies should be developed and aimed at elucidating the concentration of macro and microelements in the composition of donated breast milk.

**Conclusion**

According to the Ministry of Health, Brazil has a larger and more complex network of milk banks. Despite the structure and mobilizations in various regions, the number of operations is still low. There is no information available from the Ministry of Health on the analysis of heavy metals in the composition of donated breast milk. Analyzes of heavy metals and other elements in the composition of breast milk should be performed to avoid possible intoxication.

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