



## Research report

## Cheese. What is its contribution to the sodium intake of Brazilians?



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## ABSTRACT

The heightened intake of sodium from processed foods is of great public health concern throughout the world. This study evaluated the sodium contents of cheeses available in Brazil and the contribution of cheese to the daily intake of this micronutrient. The labels of 156 commercial samples of various types of Brazilian cheese (*Minas*, *Prato*, *mozarella*, and *requeijão* cheese, as well as *padrão* cheese) were evaluated with respect to the reported sodium content. A high variability in the sodium contents of cheeses within each category was observed, although no significant difference was observed in the sodium content present in one serving (30 g) of cheese versus that present in 100 g of product ( $p > 0.05$ ). With the exception of *Minas* cheese, more than 70% of the other cheeses examined in this study could be classified as high-sodium cheeses, with sodium contents exceeding 400 mg Na/100 g of product. These results suggest that cheese manufacturers need to reformulate their products and that public health authorities need to take additional measures to curb sodium intake from cheese consumption, including demand-specific labeling and implementing educational campaigns to inform the public about the dangers associated with high sodium intake.

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## Introduction

Sodium participates in a number of essential metabolic functions in the human body and has an important role in maintaining a water balance within cells (Doyle & Glass, 2010). However, excess intake of this nutrient has been associated with high blood pressure and other chronic diseases. Sodium is currently the main focus of public health policies around the world that aim to prevent and control hypertension (He, Burnier, & MacGregor, 2011; McLean, Hoek, & Hedderley, 2012; Wyness, Buttriss, & Stanner, 2012). Such policies have become evident and diversified, including qualitative investigation of labels (Sarno, Claro, Levy, Bandoni, & Monteiro, 2009) and the creation of specific labels that highlight the sodium contents of high-sodium products (McLean et al., 2012).

Health authorities recommend that sodium intake should not exceed 2000 mg per day, which corresponds to 5 g of salt intake (World Health Organization, 2011). The main strategy adopted by government agencies is to create agreements with processed-food companies to gradually reduce the sodium content of their products. In Brazil, the Ministry of Health determined that 16 products,

including some dairy products, must show reduction in their sodium contents by 2020 (Brasil, 2011). However, prior to these agreements and in response to the requirements of the South American Common Market (Mercosul), Brazil had already created norms for the inclusion of nutrition information on food labels. The goal of this information was to facilitate consumer understanding and to help consumers to choose healthier foods. The inclusion of the nutrient sodium on these labels is compulsory (Brasil, 2003).

Although attention has been focused on reducing the sodium contents of meat products (Campagnol, Santos, Terra, & Pollonio, 2012; Campagnol, Santos, Wagner, Terra, & Pollonio, 2011; Horita, Morgano, Celeghini, & Pollonio, 2011), the development of low-sodium cheese is also relevant, as evidenced by the increasing number of studies in this area (Grummer, Bobowski, Karalus, Vickers, & Schoenfuss, 2013; Karimi, Mortazavian, & Karami, 2012; Ayyash, Sherkat, & Shah, 2012; Kamleh et al., 2012; Ayyash and Shah, 2011a, 2011b; Gomes et al., 2011; Van Dender et al., 2010; Černíková et al., 2010). Salt affects the structural and functional properties of cheese, with its exact effects also controlled by protein interactions and ionic strength, which is mediated by calcium (Pastorino, Hansen, & McMahon, 2003). The addition of sodium chloride (NaCl) to cheese also contributes to its safety; it has been reported that a 50% reduction in the NaCl content of cheese affects its

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microbiological stability and facilitates the survival of pathogens, such as *Salmonella* and *Listeria monocytogenes*, if good manufacturing practices are not followed strictly (Ilhak, Oksuztepe, Calicioglu, & Patir, 2011; Shrestha, Grieder, McMahon, & Nummer, 2011).

The consumption of the cheese by Brazilians has been growing, and increased by 30% between 2000 and 2008. Currently, the average person consumes 3.4 kg/year, as compared to 2.6 kg/year in 2000 (Lima Filho & Pombo, 2010). As a result of the need for a reduction in the sodium content of cheese, and considering the importance of cheese in many diets, the objective of the present study was to evaluate the sodium content information listed on the labels of commercially available cheeses in Brazil and to estimate the contribution of cheese to daily sodium intake.

## Methods

### Data collection

Data from 156 cheese samples representing several commercial brands were collected. The following cheeses were used in the study, with the number of samples collected listed in parentheses for each cheese: *Prato* (36), *mozzarella* (30), a typical Brazilian processed cheese (*Requeijão*, 30), *padrão* Minas (ripened cheese, 30) and *Minas* cheese (fresh cheese, 30). With the exception of mozzarella, all of the cheeses are typical Brazilian cheeses that have been described in previous studies (Barancelli et al., 2011; Gomes et al., 2011; Grummer, Karalus, Zhang, Vickers, & Schoenfuss, 2012; Merheb-Dini, Garcia, Penna, Gomes, & Da Silva, 2012; Iha, Barbosa, Okada, & Trucksess, 2011; Gomes & Penna, 2010). The sample of cheeses chosen can be considered a convenience sampling (Carrilo, Varela, & Fiszman, 2012), for which the main purpose was to obtain a representative sample of the cheeses commercially available in Brazil. In this particular case, the intention was to study a range of typical Brazilian cheeses available in several supermarkets in the city of Rio de Janeiro. Sodium data on the labels of the commercial cheeses were recorded, either in writing or by photography. Data were collected from August to October 2011. The collected data included the product name and the sodium content, which was recorded as content per 100 g and content per serving for each type of cheese. The serving size was established as 30 g, in accordance with Brazilian legislation (Brasil, 2003).

### Data analysis

The statistical analysis methods used in this study were similar to those used in a recent survey of Australian fast food chains (Dunford, Webster, Barzi, & Neal, 2010). Descriptive measures (mean sodium levels and ranges) were calculated for each type of cheese in addition to sodium content, both per serving and per 100 g. The sodium content per 100 g was classified according to Brazilian legislation (ANVISA). Products were classified as 'high-', 'moderate-' or 'low-sodium', and the sodium content range of each class was tabulated. This analysis was performed for each category of cheese (Brasil, 1998) (Fig. 1).

Data normalization was quantified using the Kolmogorov–Smirnov test (Bayarri, Carbonell, Barrios, & Costell, 2011). A one-way analysis of variance (ANOVA) was also performed, with the type of cheese being a fixed variable. The contribution of the cheeses to daily sodium intake (as a percentage) was also calculated. This calculation was based on a recent survey of the daily cheese intake of a majority of people (approximately 53%) in the city of Rio de Janeiro (Pflanzer et al., 2009). A daily intake of two 30-g slices of cheese was hypothesized, with one slice eaten during breakfast and one during a mid-morning or mid-afternoon snack. It is noteworthy that there are few studies exploring this topic, but a good

estimate can be made by taking into account the results obtained by Pflanzer et al. (2009).

All of the statistical analyses were performed using the software XLSTAT 2012.5 for Windows (Adinsoft, Paris, France); *p*-values smaller than 0.05 were considered to be statistically significant.

## Results

Table 1 shows the sodium contents reported on the labels of different commercial cheese brands per 100 g of product and per serving (30 g), a requirement established by the Brazilian legislation for cheeses (Brasil, 2003). *Padrão* cheese and *Requeijão* cheese exhibited the highest sodium contents per serving – 594 mg and 652 mg Na, respectively – but the difference was not significant ( $p = 0.65$  per serving and  $p = 0.67$  per 100 g) with respect to the other cheeses. The sodium contents of the *Minas*, *mozzarella* and *Prato* cheeses were 473.4, 574.5 and 588.8 mg Na, respectively. A similar variation was observed for the sodium contents of each type of cheese per serving (one cheese slice, 30 g), which were 195.6, 178.3, 176.7, 172.3 and 142.1 mg Na for *requeijão*, *padrão*, *prato*, *mozzarella* and *minas* cheese, respectively. Overall, the different cheese categories presented elevated variability with respect to their sodium contents, suggesting the considerable diversity of processing methods used by manufacturers, which can directly affect the amount of added sodium.

Figure 1 shows the classification of the sodium contents of the cheeses according to Brazilian legislation (National Agency of Sanitary Surveillance – ANVISA). This legislation defines high-sodium products as those with more than 400 mg of sodium per 100 g of product; moderate-sodium products as those with sodium contents ranging from 120 to 400 mg per 100 g of product; and low-sodium products as those with less than 120 mg of sodium per 100 g of product. None of the cheeses could be classified in the low-sodium category, as all contained more than 120 mg of sodium per 100 g cheese.

According to Brazilian legislation (Fig. 1), approximately 90% of the *requeijão* and *padrão* cheeses sampled and approximately 75% of the *mozzarella* and *Prato* cheeses sampled are classified as high-sodium. The *Minas* cheeses had the lowest sodium contents, with 40% of these cheeses being classified as moderate-sodium.

Table 2 shows the contribution of the different types of cheeses examined in this study to the daily sodium intake of the Brazilian population. The World Health Organization maximum recommendation of 2000 mg of sodium per day was used, as the Brazilian legislation does not provide a maximum recommended intake. *Requeijão* cheese contributed significantly to daily sodium intake, providing almost 20% of the maximum daily recommendation, followed by *padrão*, *Prato*, *mozzarella*, and *Minas* cheeses, which provided 17.8%, 17.6%, 17.2%, and 14.2%, respectively. However, it is important to highlight the fact that these values are based on hypothetical values, and that an analytical determination of the sodium content would be important for providing a more precise measurement of this parameter in future studies.

## Discussion

Our findings indicate that Brazilian cheeses have high sodium contents, which is a public health problem. Similar results were found for cheeses sold in Australia (Grimes, Nowson, & Lawrence, 2008), England (Mhurchu et al., 2010), France (Chekri et al., 2012; Huybrechts et al., 2011), Canada (Tanase, Griffin, Koski, Cooper, & Cockell, 2011) and the USA (Agarwal, McCoy, Graves, Gerard & Clark, 2011; Moshfegh et al., 2012), showing that reduction of the sodium content of cheeses is a global challenge in countries of all levels of development.

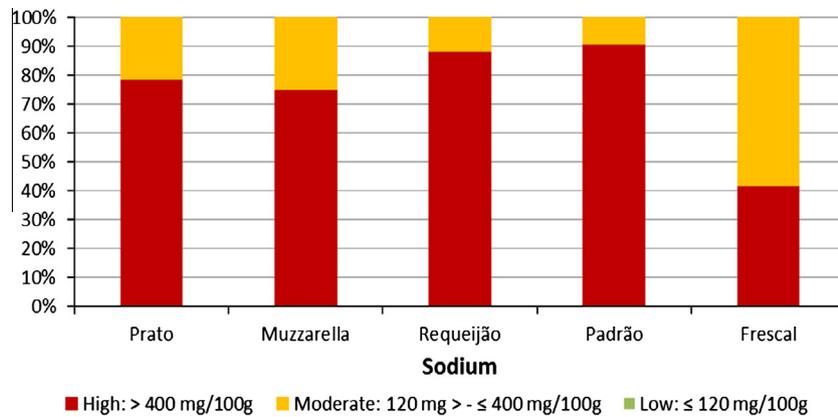


Fig. 1. Proportions of cheeses categories meeting 'low', 'moderate' and 'high' benchmarks for sodium according to the Brazilian Legislation (ANVISA).

**Table 1**  
Sodium content (mean and range) of cheeses per 100 g and per serve (30 g).<sup>a</sup>

Cheese	Products (n)	Mean per 100 g (range)	Mean per serve (range)
Minas fresh	30	473.7 <sup>a</sup> (243–967)	142.1 <sup>a</sup> (73–290)
Mozarella Prato	30	574.5 <sup>a</sup> (300–1267)	172.3 <sup>a</sup> (90–380)
Padrão	30	588.8 <sup>a</sup> (303–703)	176.7 <sup>a</sup> (91–220)
Requeijão	30	594.4 <sup>a</sup> (150–967)	178.3 <sup>a</sup> (45–290)
<i>p</i> Value		0.65	0.67

<sup>a</sup> *p* Values for comparisons of mean sodium content between cheeses were calculated through ANOVA.

**Table 2**  
Contribution of cheese at the daily ingestion of sodium.<sup>a</sup>

Cheeses	Ingestion (g)	Ingestion (%)
Minas fresh	284.2	14.2
Muçarela	344.7	17.2
Prato	353.5	17.6
Minas padrão	356.7	17.8
Requeijão	391.3	19.5

<sup>a</sup> Considering daily consumption of two cheeses slices (30 each one) and maximum value of 2000 mg Na/person/day (WHO, 2011).

The use of *Prato*, *mozzarella* and *requeijão* cheeses as ingredients in sandwiches and for other culinary applications has increased, which has resulted in a natural tendency for these products to contain increased sodium contents (Cruz, Antunes, Celeghini, & Faria, 2011a). Cheeses enhance the taste of preparations to which they are added, including pies, stuffings and pasta sauces. Recently, the high sodium contents of several hot takeaway meals in the United Kingdom have been reported, with sodium contents varying from 1.32 to 1.65 g salt per 100 g across several pizzas, for which the main ingredient is mozzarella cheese (Jaworowska, Blackham, Stevenson, & Davies, 2012).

Studies describing the reduction of sodium in *Prato* cheese are still scarce, despite the importance of this cheese to the Brazilian diet. Those studies that exist simulate the diffusion process of the compounds sodium chloride and potassium chloride during the salting step, with the goal of optimizing the concentration of these two compounds and producing a good-quality cheese with a lower sodium content (Bona, Silva, Borsato, Silva & Fidelis, 2010). Other studies involve the addition of other compounds that can function in ways similar to sodium chloride, such as potassium lactate (Cichoski, Cunico, Di Luccio, Zitkoski, & De Carvalho, 2008).

The manufacturing process for processed cheeses, faces a more challenging situation as emulsifying salts, which contain sodium, are necessary to prevent the separation of fat and water after melting (Kappor & Metzger, 2008). Thus, these cheeses contain another source of sodium in addition to the sodium chloride added to the cheese as a raw material (Cruz et al., 2011b). Only one study describing the manufacture of low-sodium *requeijão* cheese was found in the literature (Van Dender et al., 2010). Similarly, only one study exists in the literature describing a manufacturing process for low-sodium *Minas* cheese (Gomes et al., 2011). No such studies were found for *padrão* cheese.

It is common knowledge that sodium, from added sodium chloride, plays an important role in the processing of cheese – it cannot simply be removed from the formulation (Cruz et al., 2011b). However, our findings suggest that there is a clear need for reformulation of Brazilian cheeses. New sodium contents, specific to each type of cheese, are necessary, and should be tested in advance by manufacturers to ensure successful sales.

The reduction of sodium in cheeses is a multifactorial problem that goes beyond the simple quantitative reduction of sodium in the food matrix, and deals also with its technological and sensory influences. Appropriate and efficient listing of the sodium content on product packaging is indispensable, as it allows consumers to more easily purchase products that are adequate to their needs (Chand, Eyles, & Mhurchu, 2012; Kim, Lopetcharat, Gerard, & Drake, 2012; Drake, Lopetcharat, & Drake, 2011; McLean et al., 2012; Sanz-Valero, Sebastian-Ponce, & Wanden-Berghe, 2012; Dunbar, 2010). However, consumers have a limited understanding of food labels (Grunert, Wills, & Fernández-Celemim, 2010; Sharf et al., 2010); therefore, such messages should be delivered with caution (Drake et al., 2011; Kim et al., 2012; Liem, Aydin, & Zandstra, 2012), because consumers generally do not understand the relationship between salt and sodium contents (Grimes, Riddell, & Nowson, 2009). This phenomenon suggests a need for educational campaigns to clarify this misunderstanding. Another important strategy worthy of consideration is repeated exposure (Methven, Langreny, & Prescott, 2012), which has been proven to be useful for improving the acceptance of low-sodium foods. Repeated exposure allows continuous contact with an unfamiliar flavor for a specific period, thereby helping to familiarize the consumer with the new taste and decreasing rejection of the food.

The daily sodium intake resulting from cheese consumption is of concern from a public health point of view. The amount of cheese consumed varies between consumers; therefore, some consumers may be consuming too much sodium from cheese. Thus, the contribution of cheese to the sodium intake of some individuals may be worrisome.

## Limitations of this study

Several limitations are present in this study. Some other types of Brazilian cheeses were not considered, including rennet (*coalho*) cheese (Queiroga et al., 2013), which is barbecued and sold by vendors on beaches and on the street. Its consumption throughout the Brazilian territory is irregular, but it is highly appreciated and widely consumed in the Brazilian northeast. This study has also not considered *Marajoara* cheese (Hotta et al., 2005), a soft cheese manufactured from raw buffalo milk in the Amazonian regions. Nevertheless, the results of this study are relevant and serve to document the sodium content of some Brazilian cheeses, providing a foundation for future studies and providing information for programs that could potentially move toward the reformulation of these products.

Another limitation is the numbers of cheeses studied; only 30 brands of each type of cheese were investigated. In consideration of this limitation, only products with a national outreach, which could be consumed by Brazilians in any part of the country, were examined.

Finally, another important and relevant limitation is that the data collected in this survey are based upon the sodium contents from the nutrition labels presented on cheese packaging. Further study should cover sodium contents determined through laboratory analysis to achieve a better understanding of the true sodium contents of Brazilian cheese products.

## Conclusion

Cheeses available in Brazil have high sodium contents, suggesting a need for reformulation by manufacturers. Considering that the portion size and intake frequency for cheeses varies between consumers, these results are somewhat alarming from a public health point of view, as cheese contributes significantly to the sodium intake of the population.

Relevant governmental agencies need to take actions to better inform consumers about the health hazards associated with the consumption of high-sodium foods, create specific labels for these products and provide educational campaigns containing straightforward and comprehensible language.

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