DOI: http://dx.doi.org/10.12957/demetra.2015.13481

Iodine's adequacy assessment in samples of refined salt and coarse salt marketed in Ouro Preto-MG, Brazil

Nara Nunes Lage[1]
Margarete Nimer[2]
Rúbia Aparecida Pereira[3]
Marcelo Eustáquio Silva[4]
Camilo Adalton Mariano da Silva[2]

[1] Universidade Federal de Ouro Preto, Programa de Pós-graduação em Ciências Biológicas. Ouro Preto-MG, Brasil.

[2] Universidade Federal de Ouro Preto, Departamento de Nutrição Clínica e Social, Escola de Nutrição. Ouro Preto-MG, Brasil.

[3] Prefeitura do Município de Mariana. Mariana-MG, Brasil.

[4] Universidade Federal de Ouro Preto, Departamento de Alimentos, Escola de Nutrição. Ouro Preto-MG, Brasil.

Corrrespondence
Margarete Nimer
Universidade Federal de Ouro Preto, Escola de Nutrição, Morro do Cruzeiro. Ouro Preto-MG, Brasil
CEP 35400-000
E-mail: mag _ nimer@hotmail.com e marnimer@enut.ufop.br

Abstract

Introduction: Salt iodization has been recommended as the primary public health measure for prevention and control of iodine deficiency disorders (IDD), due to its safe application and satisfactory cost-benefit ratio (ou results). Under Brazilian law, salt for human consumption should contain iodine in the proportion of 20mg to 60mg per kilogram of product. Thus, continuous monitoring and surveillance is needed to keep the level of iodine in salt within these limits. *Objective*: Iodization was assessed in samples of refined salt and rock salt in Ouro Preto-MG, Brazil. *Material and Methods:* Sixty-six samples from 16 different brands were collected; 40 of which were refined salt and 26, rock salt. As indicated in the Analytical Standards of the Adolfo Lutz Institute, iodine concentration was measured using a standard solution of sodium thiosulfate in triplicate samples. *Results:* Statistical analysis on the type of salt and on iodine concentration in the samples indicated that 7.5% of the refined salt samples, 53.85% of rock salt samples and 25.76% of all salt samples did not meet the Brazilian legislative requirements. *Conclusion:* Compared to previous studies, iodine levels in refined salt samples indicate improvement in the salt iodization monitoring, which is considered an effective public health action to prevent and control IDDs.

Key words: Salt. Iodine. Legislation. Ouro Preto city.

Introduction

Salt iodization has been recommended as the main public health measure for the prevention and control of iodine deficiency disorders (IDD) because of its safe application and satisfactory cost-benefit ratio.[1]

In Brazil, it was only in 1953 that the first law (no. 1.944, dated August 14, 1953) was enacted, making iodized salt mandatory for human consumption.[2] Since then, the iodization program has run a long way, and in 2003 the Brazilian Health Surveillance Agency (ANVISA), through a Collegiate Board Regulation, defined 20 and 60 mg/kg as the ideal concentration of iodine in salt for human consumption.

Iodine is an essential micronutrient for the normal function of the thyroid gland, human growth and adequate development and function of both the central nervous system and the body.[4]

Iodine deficiency may cause cretinism in children (severe and irreversible mental retardation), deaf-mutism, congenital anomalies, as well as the most visible clinical manifestation: goiter (thyroid hypertrophy). In addition, iodine deficiency is associated with high rates of stillbirths and low birth weight in babies, complications during pregnancy and an increased risk of miscarriage and maternal mortality.[4]

In 1994, a national survey conducted in 401 municipalities evaluated 16,803 schoolchildren, aiming to map areas of persistent lack of iodine in Brazil. Iodine deficiency was detected in 85 cities, being of moderate degree (≥ 25 and < 50 µg/l) in Cocos (Bahia), and Almas, Arraias and Paraná (Tocantins), and mild in the other cities (values ≥ 50 and < 100 µg/l). In other 35 cities, mean values were normal, but a significant part of the population (more than 10% of the children) presented iodine levels lower than 25 µg/l – occurrence that was due to samples with very heterogeneous contents of iodine in the same locality.[5]

Study conducted in Ouro Preto-MG reported iodine contents in the salt consumed by schoolchildren falling below the levels established in legislation and a significant level of urinary iodine deficiency in these children.[6,7] Another study showed that IDDs still remain a problem in some isolated regions of Brazil, probably due to non-iodized salt intake by rural populations. High prevalence rates are still reported in the states of Amazonas, Acre, Rondônia, Maranhão, Tocantins and Mato Grosso do Sul, and along the Northeast Region limits. The states of Minas Gerais, São Paulo and Bahia have no longer been considered areas of occurrence of endemic goiter, although in some locations iodine deficiency is still reported.[8]

Brazil is classified as a country in which iodine consumption is more than enough and sometimes excessive, with average urinary iodine concentrations over 200 μg iodine/l.[9]

This indicates that the most sensitive population groups are exposed to the risks of excessive iodine ingestion, increasing the prevalence of chronic lymphocytic thyroiditis (Hashimoto's thyroiditis). Overconsumption of iodine is likely due to the higher salt intake by Brazilians, providing an additional condition for the introduction of this nutrient into the body.[10]

The World Health Organization (WHO) recommends that sodium intake should not exceed the daily limit of 2g, equivalent to 5g of salt per person. Study based on data from the Household Budget Survey (HBS) conducted in Brazil from July 2002 to June 2003 showed that the daily amount of sodium available for consumption in Brazilian households was 4.5g per person, twice the consumption limit recommended for this micronutrient. The study also reported that most of the sodium available for consumption in all household income classes came from table salt and salt-based condiments (76.2%).[11]

In view of such transition in iodine consumption, possibly linked to an increase of salt intake, the Ministry of Health created the Committee for the Prevention and Control of IDDs. The committee suggested a national survey conducted in 2008-2009 to verify current iodine intake by the Brazilian population. The completion of this study, called National Survey on the Impact of Salt Iodization (PNAISAL), will represent a step forward in the efforts for determining the most appropriate iodine concentration in salt for human consumption.[12]

Strategies aiming to control iodine deficiency or excess should be continuing and essentially preventive to ensure a safe and strictly controlled salt iodization throughout the country and prevent occurrences such as those reported in previous studies. Thus, the present study aimed to examine the effective iodization of refined salt and coarse salt marketed in Ouro Preto-MG.

Methodology

Study site

From October to November 2008, salt samples were collected in 16 different retail establishments in Ouro Preto-MG. This city was chosen because it did not participate in the national surveys for the monitoring of salt iodization for human consumption and to proceed with the studies previously conducted in this city. The establishments were chosen according to their popularity in each neighborhood, selecting those that were more frequented by the local population. Selection of the neighborhoods was based on the principle of encompassing all regions of Ouro Preto (north, south, east and west). Therefore, the neighborhoods chosen were: Água Limpa, Alto da Cruz, Antônio Dias, Barra, Bauxita, Cabeças, Centro, Nossa Senhora do Carmo, Padre Faria, Pilar, São Cristóvão and Saramenha.

Sample collection

Sixty-six samples from different brands were collected, 40 of them of refined salt (table salt) (lots: 040/08; 90808; 08/08/9006; 04/08/9002; 08/08/9007; 06/08/9002; 801CB; M394; M408; M370; M369; M371; M373; 804-DG; 807-BK; SPR0508; 15H07; 15C08; 15F08; 07/08-BD; 08/08-BD; 02/08-BD) and 26 of unrefined (coarse) salt (lots: 15/02/2008; 02/jul; 15B08; 15107; 15M07; 3; 801-CB; S029; S027; M031; 001/08; 07/07/9012; 20C070). The samples were sent to the laboratory of chemical analysis of the Food Department of the School of Nutrition, in Ouro Preto, for identification and determination of iodine contents.

Analysis of iodine content in salt to detect potassium iodate

Analysis of iodine content in table salt is based on the reaction between potassium iodate (KIO) and potassium iodide, which, in acid medium, liberates iodine. Then it is immediately titrated with sodium thiosulfate, using a starch solution as indicator, as described by the Analytical Standards of the Adolfo Lutz Institute.[13]

Determination of iodine concentration in the samples of refined salt and coarse salt was performed in triplicate. The iodine content found in each salt sample was classified as to its compliance with the RDC no.130, of May 26, 2003, legislation that was in force when the study was conducted, which establishes that salt for human consumption must contain 20mg to 60mg of iodine per kilogram of the product.[3]

Statistical analysis

The statistical software *Stata* was used for the analyses. To determine the iodine content in the different salts (table salt and coarse salt) and in the samples price range, the Pearson's chi-square test was used. To evaluate the distribution of iodine content according to the type of salt, the Kruskal-Wallis test was used.[14] The data were considered statistically significant at $p < 0.05$ level.

Results

The data of Table 1 show that of the 66 samples of salt collected in food stores in Ouro Preto-MG, 40 (60.6%) were table salt (60.6 %), and 26 (39.4 %) coarse salt.

Table 1. Number and percentage of analyzed samples of refined salt and coarse salt. Ouro Preto-MG, Brazil, 2008.

Type of salt	Number	%
Refined salt	40	60.6
Coarse salt	26	39.4
Total	66	100

The iodine concentrations in the analyzed samples are described in Table 2. It was found that 92.5% of the table salt samples, 46.15% of coarse salt samples and 74.24% of the total samples meet the requirements of current legislation, whereas the percentage of noncompliance with the legislation for table salt, coarse salt and total salt was of 7.5%, 53.85% and 25.76%, respectively. In this analysis, a statistically significant difference was found for the iodine content and type of salt, with $p = 0.000$.

Table 2. Adequate and inadequate iodine content in refined salt and coarse salt samples. Ouro Preto-MG, Brazil 2008.

	Iodine content					
Type of salt	Number of adequate samples	%	Number of inadequate samples	%	Total	%
Refined salt	37	92.5	3	7.5	40	100
Coarse salt	12	46.15	14	53.85	26	100
Total	49	74.24	17	25.76	66	100

$p = 0.000$; according to Pearson's chi-square test.

Figure 1 indicates the distribution of iodine contents in the samples, according to the type of salt. One can see that the average quantities of iodine in the samples of table salt and coarse salt were, respectively, of 29.97mg and 19.75mg of I_2/Kg of salt. One can also see that, within the recommended limits of iodine in salt for human consumption (20 to 60 mg), there is a greater number of adequate samples of table salt, showing the higher percentage of conformity of this product.

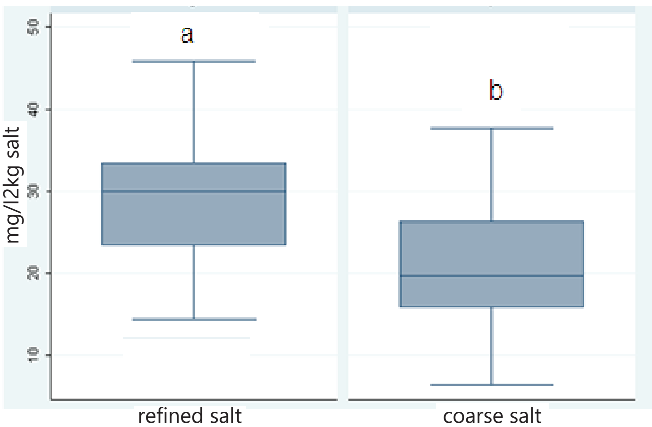

Figure 1. Distribution of the adequacy of iodine concentrations according to the type of salt. p = 0.0002, according to the Kruskal-Wallis test. Ouro Preto-MG, Brazil, 2008

The statistical analysis of the correlation between different prices and iodine contents in the samples of table salt and coarse salt (Table 3) showed that there was no significant difference, with p-value equal to 0.257. This result shows that price has no influence on the iodine concentrations present in the different products.

Table 3. Evaluation of the relationship between retail prices and conformity of iodine contents in the samples of refined salt and coarse salt. Ouro Preto-MG, Brazil, 2008.

	Iodine content					
Price range (R$)	Number of adequate samples	%	Number of inadequate samples	%	Total	%
0.0 < 0.80	36	78.26	10	21.74	46	100
≥ 0.80	13	65.00	7	35.00	20	100
Total	49	74.24	17	25.76	66	100

$p = 0.257$; according to Pearson's chi-square test.

Figure 2 shows the distribution, in Ouro Preto-MG, of the table salt and coarse salt samples that had iodine contents below the recommended levels, i.e., values below 20mg per kilo of the product. Such samples were prevalent in the eastern neighborhoods Ouro Preto.

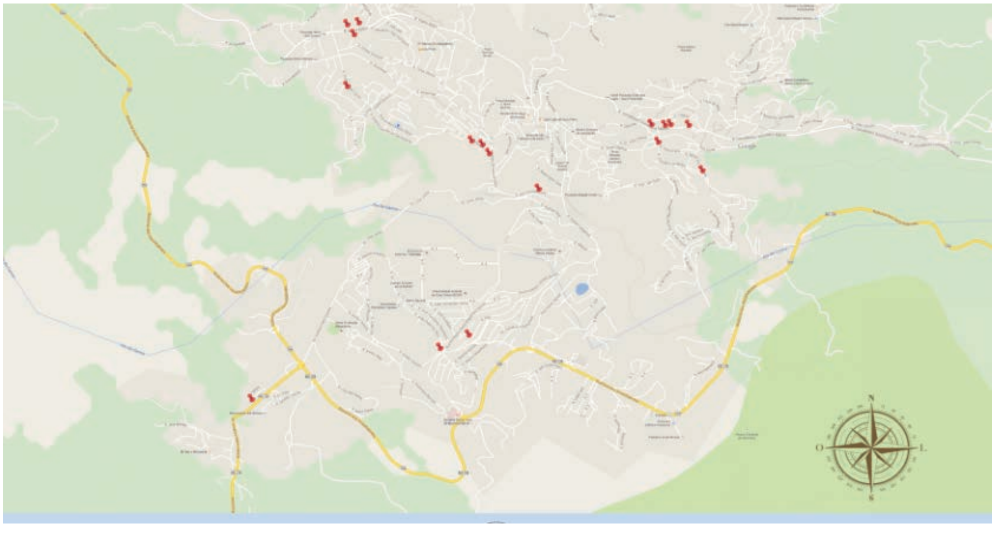

Figure 2. Regional distribution of the refined salt and coarse salt samples that presented iodine contents below the recommended levels in Ouro Preto, MG, Brazil.

Legend:


Samples of refined salt and coarse salt with iodine contents below the recommended values.

Discussion

IDDs are natural and permanent phenomena largely distributed in various regions worldwide. Populations living in iodine deficient regions are exposed to the risk of developing disorders caused by such deficiency.[1] Conversely, the amount of iodine in salt, as observed in some countries, added to other possible nutritional iodine sources (asthma expectorant syrups, water purification tablets, radiocontrast agents, iodine-containing creams, among others), likely contribute to the excess of this element in the body. [10]

The national survey conducted from 1994 to 1996 indicated that the salt consumed in households (458 samples were collected) presented insufficient supplementary iodine, 50% below the recommended level of 20 mg/kg or 20 ppm. In 7% of the samples, iodine concentrations were lower than 10 mg/kg of salt, even in the salt-producing states, such as Rio Grande do Norte.[15]

Two previous studies carried out in Ouro Preto, using the same methodology of the present survey, showed that 62.1% and 32.73% of the samples did not meet current legal requirements.[16,17] In the present study, the percentage of noncompliance with legislation was of 25.76%, prevalent in the eastern region of the city, as illustrated in Figure 2. It is assumed that such prevalence can be influenced, for example, by how salts are stored in the supermarkets. Moreover, such region had a greater number of stores that sold salt and, consequently, more samples of this product were collected.

According to the report on the monitoring of iodine content in salt in Brazil, published in 2011 by the National Health Surveillance Agency (ANVISA), there is a trend of increasing compliance with legislation. In 1999, 73% of a total of 396 samples that were analyzed were satisfactory, compared to 97.4% of 1,148 samples of salt sold in the retail market and from the industries analyzed in 2011.[18]

The adequacy of the iodine contents found in the samples of this study depends on refining, i.e., the conformity of iodization to the legal parameters may be associated with the type of salt, with higher noncompliance found in coarse salts. For this reason, table salt should not be replaced by coarse salt in daily diets.

Comparing the findings of this work with the results found in previous studies, one can see an improved adequacy of salt for human consumption regarding the iodization recommended by the RDC no.130, of May 26, 2003.[3] Such improvement may be related either with the systematization of the technical and operational aspects developed by the National Program for the Prevention and Control of Iodine Deficiency Disorders (Pro-iodine) or the changes of the iodization levels established by law.

The latest Household Budget Survey conducted by the Ministry of Health from 2008 to 2009 showed that the average salt intake by 10-year old Brazilians is around 8.2g/person/day. Considering that WHO recommends that countries with average salt consumption of about 10g/day should establish an iodization rate of 20 to 40ppm, ANVISA[19] approved new optimal levels of iodine in salt. Thus, the salts sold in the retail market in in Brazil should have 15 to 45 mg of iodine per kilo of product, as established by the Resolution RDC no. 23, of April 24, 2013.

Therefore, continuing monitoring of salt iodization is vital, because it is a major strategy for an adequate intake of this micronutrient by children and the population in general. The amount of iodine additions should be revised over the years, based on changes of Brazilians' eating patterns, taking into account that overconsumption of this nutrient may also cause health damages.

Conclusion

The satisfactory analytical results of table salt found in this study indicate improved monitoring of salt iodization, an effective public health policy for the prevention and control of IDDs, besides preventing iodine concentrations above the levels recommended by the Ministry of Health.

References

1. Brasil. Ministério da Saúde. Manual técnico e operacional do pró-iodo: Programa Nacional para a Prevenção e Controle dos Distúrbios por Deficiência de Iodo. Brasília: Ministério da Saúde; 2007.
2. Knobel M, Medeiros NG. Moléstias associadas à carência crônica de iodo. Arq. Bras. Endocrinol. Metab. 2004; 48(1):53-61.
3. Brasil. Resolução. RDC n. 130, 26 de maio de 2003. Dispõe sobre o teor de iodo no sal destinado ao consumo humano e dá outras providências. Diário da União, 28 mai. 2003.
4. Delange F, Benoist B, PretellE, Dunn JT. Iodine deficiency in the world: do we stand at the turn of the century? Thyroid. 2001; 11(5):437-47.
5. Esteves RZ, Kasamatsu TS, Kunii IS, Furuzawa GK, Vieira JGH, et al. Desenvolvimento de um método para a determinação da iodúria e sua aplicação na excreção urinária de iodo em escolares brasileiros. Arq. Bras. Endocrinol. Metab. 2007; 51(9):1477-1484.
6. Nimer M, Silva ME, Oliveira JED. Associações entre iodo no sal e iodúria em escolares, Ouro Preto, MG. Rev. Saúde Pública 2002; 36(4):500-504.
7. Nimer M. Estudo das associações entre as determinações de iodo no sal de consumo humano, iodúria e estado nutricional de alunos de duas escolas do ensino fundamental em Ouro Preto, Minas Gerais [Dissertação]. Araraquara: Departamento de Alimentos e Nutrição, Faculdade de Ciências Farmacêuticas da Universidade Estadual Paulista; 1997.

8. NimerM, AnsaloniJA, Silva ME. Iodization of salt: the control of iodine deficiency disorders in Brazil. In: Preeddy VR, Burrow GN, Watson PR, organizadores. Comprehensive handbook of iodine nutritional, biochemical, pathological and therapeutic aspects. London: Elsevier; 2009. p. 1205-1214.

9. Hetzel BS. Eliminating iodine deficiency disorders-the role of the International Council in the Global Partnership. Bull. WHO 2002; 80(5):4100-7.

10. Duarte GC, Tominori EK, Boriolli RA, Ferreira JE, Catarino RM, et al. Avaliação ultra-sonográfica da tireóide e determinação da iodúria em escolares de diferentes regiões do Estado de São Paulo. Arq. Bras. Endocrinol. Metab. 2004; 48(6):842-848.

11. Sarno F, Claro RM, Levy RB, Bandoni DH, Ferreira SRG, Monteiro CA. Estimativa de consumo de sódio pela população brasileira, 2002-2003. Rev. Saúde Pública. 2009; 43(2):219-225.

12. Medeiros GN. Iodine nutrition in Brazil: where do we stand? Arq. Bras. Endocrinol. Metab. 2009; 53(4):470-474.

13. Instituto Adolfo Lutz. Normas analíticas do Instituto Adolfo Lutz: métodos químicos e físicos para análise de alimentos. 4. ed. São Paulo: Editora IAL; 2005.

14. StataCorp LP. Statistical software. College Station, TX: StataCorp LP; 2009.

15. Correa Filho HR, Vieira JBF, Silva YSP, Coelho GE, Cavalcante FAC, Pereira MPL. Inquérito sobre a prevalência de bócio endêmico no Brasil em escolares de 6 a 14 anos: 1994 a 1996. Rev. Panam. Salud Publica 2002; 12(5):317-326.

16. Nimer M, Ansaloni JA, Pereira TT, Gomide AFF, Silva ME. Teor de Iodo do Sal Consumido na Sede do Município de Ouro Preto. XVI Congresso Brasileiro de Ciência e Tecnologia de Alimentos; 1998. Rio de Janeiro: SBCTA; 1998. p. 704-706.

17. Nimer M, Chaves CRC, Ansaloni JA, Silva ME. Teor de iodo do sal consumido no município de Ouro Preto. XVI Congresso Brasileiro de Ciência e Tecnologia de Alimentos; 2000. Fortaleza.

18. Agência Nacional de Vigilância Sanitária. Resultado do monitoramento do teor de iodo no sal - Ano 2011. [acesso em: 30 ago. 2012]. Disponível em: http://portal.anvisa.gov.br/wps/wcm/connect/7d7bb4804be9dbf18c50ddbc0f9d5b29/Relat%C3%B3rio+Pro.Iodo+2011.pdf?MOD=AJPERES

19. Brasil. Resolução. RDC n. 23, 24 de abril de 2013. Dispõe sobre o teor de iodo no sal destinado ao consumo humano e dá outras providências. Diário Oficial da União 24 abril 2013.

Received: October 30, 2014
Reviewed: December 22, 2014
Accepted: January 14, 2015