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Sodium and salt content of Portuguese rolls produced in a city of southern Brazil: a comparison of laboratory analysis, food labelling and nutrition standards

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Abstract
Objective: To analyse the Na content of bread by comparing the amount of salt and Na among the label, laboratory analysis and international guidelines.
Design: Ten selected bakeries provided 3239 randomly selected samples of bread, which were weighed on-site. Triplicate samples were retrieved from each bakery (thirty samples) for analysis. Bread production was observed, and ingredient labels were queried to determine salt weights, which were used for comparison with the laboratory analysis. Flame photometry and the method for chlorides were utilised for analysing Na. Laboratory findings were compared to nine different international nutritional guidelines for Na consumption.
Setting: Florianopolis, south of Brazil.
Participants: Ninety independent bakeries locally producing Portuguese rolls were queried; rolls from ten conveniently selected bakeries were retrieved for further analysis.
Results: The average weight of the rolls was 50·2 ± 5·3 g. The average amount of salt (g) per roll, by laboratory and label analyses, was 0·69 ± 0·0 and 0·62 ± 0·1 g, respectively. The mean level of Na (mg) reported on nutrient labels (478·2 ± 93·4/100 g) was significantly lower than by laboratory analysis (618·2 ± 73·8/100 g), $P < 0·001$. There was a difference for Na in rolls produced in the bakeries considering the unit weight of rolls ($P \leq 0·001$) per 100 g ($P = 0·026$) and the mode of production. The consumption of two averaged units of rolls was equivalent to 51·7 % of the Brazilian guideline daily amount for Na for children and 31 % for adults.
Conclusions: The nutrient labels underreported Na values. This study strengthens the importance of monitoring Na of breads in Brazil.

Keywords
Bread rolls
Sodium chloride
Laboratory analysis
Salt reduction
Food labelling

The high consumption of foods with elevated Na content has been reported throughout the world[1]. Studies have shown that this excessive consumption of Na is associated with adverse health effects, such as a progressive elevation of blood pressure levels[2], cardiovascular and kidney[3] diseases and an increased incidence of stomach cancer[4]. A survey conducted by the Brazilian Institute of Geography and Statistics (2008–9) has found the average Brazilian daily intake of Na was 3190 mg[5,6]. This exceeded the tolerable upper intake level of 2000 mg/d recommended by the WHO[7] and by the dietary guidelines for the Brazilian population[8]. Findings in the literature indicate that 28 % of the average monthly expenses in Brazilian households are for food, with bakery products representing 10·4 % of this expenditure. Brazilians generally consume two units of bread rolls per day – usually at breakfast, for afternoon snacks or for dinner in units weighing approximately 53 g[9].

Bread is a food that fulfils an important energy requirement for the Brazilian population, but it is also one of the main sources of Na in their diets[10–12]. Studies have shown a positive association between the reduction of

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Na consumption and the commensurate reduction of associated morbidities[13]. Although salt contributes to maintaining the taste and the texture of bread[9], a gradual reduction of the Na content of bread has been shown not to affect consumer acceptability[11,14]. Thus, following global initiatives to reduce the Na content in food, in 2011 the Brazilian Ministry of Health signed an agreement with the Bakery Industry Association to reduce the content of Na in bread[15,16]. Targets were specifically set to reduce Na in wheat flour used in the preparation of bread dough from 2 to 1·8 %. This represented an overall reduction of 10 % by 2014[17].

According to the Brazilian National Dietary Survey (2008–9), bread is the fourth most consumed food in Brazil[6]. It is among the food groups with the highest densities of Na, including salty preserved meats, processed meats, cheeses, crackers, sandwiches, pizza and breads. In addition, the intake of Na among all ages and genders is highest for bread along with rice and beans. These food groups are considered prevalent sources of Na intake according to their frequency of consumption (despite the low Na density of rice and beans)[6]. While the provision of useful and reliable information on industry food labels has been mandated by the Brazilian Consumer Protection Code[18], data on the Na content in foods produced and marketed in Brazil are incomplete[19].

Considering that bread products consumed in Brazil are a prevalent source of daily Na intake along with other processed foods high in Na (such as sausages and cheeses), more research targeted at mitigating this phenomenon is necessary. Therefore, the primary objective of this study was to compare the composite Na values reported on food labels of Portuguese rolls that are commonly consumed in Florianopolis (a city in southern Brazil) and then compare these results to actual laboratory findings of Na content of the rolls. A secondary objective was to compare the actual Na laboratory findings with international and national recommendations for daily Na intake.

Methods

Selection of bakeries and data collection

Data for this investigation were collected between 2012 and 2014. A search was conducted of independent bakeries producing Portuguese rolls (the figure is available in Ref. [9]) in Florianopolis, Brazil, utilising the Yellow Pages[19] and the Hagah (food search) website (https://www.hagah.com.br). Inclusion criteria for further analysis were bakeries making Portuguese bread rolls (as defined below) that were willing to share their production methodology, ingredients and samples. In total, ninety bakeries were called (100 % of bakeries that met the inclusion criteria) in a telephone survey to ask whether they utilised processed dough or homemade dough. These bakeries produced Portuguese rolls (wheat flour, yeast, salt and water) as generally defined by the official recipe guidelines of the Brazilian Minister of Health[9,20]. Furthermore, ten sample bakeries were conveniently selected that met the inclusion criteria but were located in different areas (district zones) of Florianopolis. Among the ten bakeries selected, five purchased processed dough, and five used homemade dough from proprietary recipes. The ten bakeries ranged in productive daily output from 2000 rolls (in the smallest operation) to 200 000 rolls produced daily (in the largest operation).

Data were collected via production observation, ingredient label analysis and laboratory analysis of baked bread roll samples. A standardised form (developed in a pilot test of this study) was used to record the weights of all ingredients, the overall weight of raw dough, individual weights of the total bread produced by each dough, labelled nutritional data for the ingredients prepared in-house and the processed components. Twenty per cent of all bread rolls produced at the ten selected bakeries were weighed on-site. A combined total of 3239 breads were weighed at the bakeries using their production scales. This was to check if the average weight met the baking industry standard of approximately 50 g, as the size (weight) defined how much Na would be consumed per bread roll. Three Portuguese rolls (with a minimum weight of 50 g per sample) from each bakery (a total of thirty samples) were randomly collected in bags, identified with a code (A–J) and date of production, then delivered to the Food Science Laboratory at the Federal University of Santa Catarina for subsequent Na and salt content analysis.

Na determination

The determination of Na content of the rolls was carried out by comparing the nutritional information on ingredient labels and an actual laboratory analysis of the baked rolls. The labelling analysis entailed accessing the weights and nutritional information of Na in the individual ingredients included in the recipe for the dough made from proprietary recipes. This included the wheat flour, fresh or dry yeast labels, other dough starters and conditioners, added salt amounts[9] and, in one case, added margarine. The labels in processed dough bread were also accessed for information about Na content. The ingredients were entered into a spreadsheet by type, weight and Na content. Intrinsic Na content of the water used in dough was disregarded.

Laboratory analysis

The Na content of bread rolls was dissolved in doubly deionised water and quantified by the AOAC official flame photometric method 969.23[21] as follows:

Ash preparation

This procedure was performed for Na and Cl. Each was performed in triplicate. A total of three samples (from the three loaves from each of the ten bakeries) weighing 5 g each

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were prepared. The samples were ground in a food processor until homogenised; an aliquot of approximately 5 g was placed in a porcelain crucible and then weighed in triplicate. The crucible was transferred to a drying oven (Quimis® model Q318M24) for approximately 2 h and then to an electric plate where it remained until carbonisation. It was then transferred to a muffle oven at 550°C and held approximately for 6 h to obtain a clear ash.

Sodium

The ash was dissolved with 15 ml of nitric acid solution (1:4) and kept in a water bath for 15 min. The solution was completely cooled and filtered on black filter paper with the aid of deionised water; the filtrate was collected in a 100-ml volumetric flask. The contents of the flask were then homogenised. A 1-ml aliquot was removed and transferred to a 25-ml volumetric flask. The flask was filled with deionised water and homogenised. The flame photometer was calibrated with standard Na solution at concentrations of 2, 4, 6, 8 and 10 ppm. The concentration obtained in the 25-ml solution was read and expressed in mg/100 g.

Volumetric analysis of NaCl

The chlorides were precipitated in the form of silver chloride, at a slightly alkaline pH in the presence of potassium chromate, as indicator. The end-point of titration was visualised by the formation of a redbrick precipitate of silver chromate. Five grams of the sample was weighed (Shimadzu®, model AY220) on a porcelain dish and then carbonised on an electric sheet. The sample was then incinerated in a muffle oven at 550°C, then cooled. Thirty millilitres of hot water was then added and stirred with a glass stick. The solution was transferred with a funnel into a 100-ml volumetric flask. The capsule, glass stick and funnel were washed with another two 30-ml portions of hot water. The solution and wash water were then transferred to the volumetric flask, cooled, flushed, shaken and filtered. A 10-ml aliquot was transferred into a 125-ml Erlenmeyer flask with a pipette. Two drops of 10 % potassium chromate solution were added as an indicator, then titrated with 0·1 ml silver nitrate solution until a redbrick colour appeared.

Chlorides

The chlorides in rolls were quantified using the IAL (2015)[22] method as follows. The ashes were dissolved with three drops of nitric acid solution (1:9) and filtered on a black filter paper to a 500-ml Erlenmeyer flask. Approximately 300 ml of the filtrate was obtained. One millilitre of 5 % potassium chromate indicator solution was added and titrated with 0·1 N standard silver nitrate solution until the turning point was visualised. The concentration in g/100 g was calculated by the spent volume of the titrant. The concentration of Na was obtained by a calibration curve with a standard solution at points 2, 4, 6, 8 and 10 ppm.

Classification of rolls based on the recommendation of Na content

The potential dietary contribution of Na in the analysed rolls was compared to Brazil's daily dietary reference values, nutrition parameters established by the WHO[7], dietary guidelines for the Brazilian population[8] (2000 mg Na for adults), the Brazilian dietary reference intakes for children aged 4–8 years (1200 mg Na) and children and adolescents aged 9–18 years (1500 mg Na)[23]. The recommendations and national guidelines for the production of breads in Brazil[9], as well as international guidelines from Portugal[24], Argentina[25], Canada[26], United Kingdom[27], Ireland[28] Finland[29], South Africa[30], Australia[31] and New Zealand[31] were consulted for comparison. Also, the rolls were classified as having high (>600 mg), medium (>120 and ≤600 mg) and low (≤120 mg) Na content, according to the UK Food Standards Agency (FSA)[27].

Statistical analysis

The mean Na content was calculated for 100 g of product and for a unit of commercialised bread. The normality of variables was tested by the Shapiro–Wilk test. ANOVA followed by Bonferroni test were utilised for comparisons of Na content in bread rolls among the bakeries. The Na content in breads prepared with proprietary recipes was compared with those made with processed dough by Student's *t* test.

Laboratory and label comparison

Paired *t* tests compared the differences in Na values obtained by laboratory analysis and from ingredient labels. Reproducibility among the methods was analysed by coefficients of correlations of concordance[32]. Mean differences between the methods were estimated using the method proposed by Bland and Altman[33]. The percentage difference in Na content per 100 g of bread was estimated by the formula: (difference in Na content between laboratory and label analyses (mg) × 100)/Na content (mg) by laboratory analysis per 100 g). Stata® (version 14.0) was used, with $P < 0.05$ indicative of statistical significance.

Results

Of the ninety bakeries that participated in the telephonic survey, 67 % (*n* 60) used processed dough in the production of Portuguese rolls, while 33 % (*n* 30) prepared the rolls from recipes utilising individual ingredients. A total of 3239 rolls were weighed from the ten bakeries that met the criteria for a further examination of their production methodologies. Fifty per cent of these bakeries used their own recipes and individual ingredients to make dough, while the other 50 % utilised processed dough. The average unit weight of the bread was 50·2 ± 5·3 g (41·8 – 57·3 g)

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Table 1 Na (mg) content and average weight of Portuguese rolls (laboratory analysis and labelling) produced by bakeries in Florianopolis, Santa Catarina, Brazil

	Weight of baked bread per bread unit (g)		Na content by laboratory analysis				Na content by label analysis				Difference in Na content between laboratory analysis v. food label analysis for 100 g of bread
			100 g		Bread unit		100 g		Bread unit		
Bakeries	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Na (%)†
Own bread recipe											
A	47·6	1·5	734·2	31·8	348·9	7·8	624·9	68·8	297·1	33·7	14·9
B	48·4	4·3	583·3	42·6	282·8	40·9	449·2	9·8	216·9	14·9	23·0
C	41·8	2·2	597·8	47·5	249·5	16·8	480·5	20·2	201·1	18·0	19·6
D	54·0	0·8	564·6	42·5	304·9	18·4	592·6	98·5	319·8	49·7	–5·0
E	45·2	5·2	590·3	88·1	269·3	69·3	454·4	23·6	206·2	34·1	23·0
Subtotal	47·4*	5·0	614·0	78·0	291·0*	47·6	520·3*	89·6	248·2	58·6	15·3
Processed dough											
F	52·1	1·3	585·7	93·9	306·0	55·9	310·8	21·8	161·8	7·3	46·9
G†	57·3	0·8	644·1	69·7	368·6	36·6	471·3	5·8	269·9	6·7	26·8
H†	57·1	0·6	559·9	64·7	319·4	24·8	433·0	0·6	247·1	2·5	22·7
I†	51·5	2·2	690·9	30·9	355·4	1·6	436·4	1·0	224·7	9·0	36·8
J†	47·3	1·6	631·6	58·4	298·2	19·3	529·6	68·7	251·2	40·7	16·1
Subtotal	53·1*	4·1	622·4	71·9	329·5*	40·0	436·2*	79·1	231·0	42·0	29·9
Total	50·2	5·3	618·2	73·8	310·3	47·4	478·2	93·4	239·6	50·9	22·6

†Percentage difference in Na content per 100 g of bread = (difference in Na content between laboratory and label analyses (mg) × 100)/Na content (mg) by laboratory analysis per 100 g)
*$P < 0·05$ by Student's t test, comparison between types of production.

(Table 1) without variability between production types ($P = 0·073$). However, there was a significant difference in the average unit weight of loaves among seven bakeries ($P < 0·001$) (Table 1).

The mean amount of Na content in bread rolls per 100 g varied between food labels (478·2 ± 93·4 mg) and laboratory analysis (618·2 ± 73·8 mg) with a statistical significance ($P = 0·005$). The mean difference in Na content (mg) per 100 g of bread rolls was 140 mg in laboratory-analysed samples compared to label-analysed samples, ranging from +274·9 to –28·0 mg. The findings indicated that the labels underreported actual laboratory Na values by 22·6 %, with the exception of one bakery (D). Among the ten selected bakeries, only one (bakery D) produced rolls with (5·0 %) lower actual Na values compared to the label analysis (Table 1). For rolls from other bakeries, the actual Na content was 14·9–46·9 % higher than the label analysis revealed. Furthermore, analytical differences were found (labelling and laboratorial) in the types of bread production (processed dough bread or proprietary bread recipes) between the bakeries compared. The mean variance of Na content per unit of bread was higher for bakeries using processed dough than those utilising proprietary bread recipes. The amount of Na found by label analysis was higher for proprietary bread recipes compared to processed dough bread, which could represent a higher rate of underreported Na in processed dough bread. This was confirmed by the percentage difference in Na content per 100 g of bread between both methods, which was higher for processed dough-based breads in most bakeries.

The difference in Na content when comparing laboratory and label analyses for proprietary bread recipes ranged from –5 to 23·0 %, while for processed dough breads, it varied from 16·1 to 46·9 % (Table 1). The correlation coefficient between the methods was 0·122 ($P = 0·275$).

Based on the label analysis, Na content varied significantly ($P < 0·001$) among the units of bread rolls produced at bakeries A and B ($P = 0·006$) and A and C ($P = 0·042$). This is of importance as there are no standards for bread production in Brazil. The laboratory analysis uncovered a statistically significant difference in average Na (per 100 g of roll) among all bakeries ($P = 0·026$). However, this difference was non-significant by the Bonferroni multiple comparison method.

Based on the laboratory analysis, the consumption of two units of average-sized (50·2 g) rolls (without fillings) is equivalent to 31·0 % of the guideline daily amount (GDA) of Na for Brazilian adults[7,8] (Table 2). Considering the recommendation for children and adolescents, the same amount represents 51·7 % of GDA for Na for children aged 4–8 years[23], and 41·4 % for children and adolescents aged 9–18 years[23].

Based on the present study, all bakeries produced rolls with Na limit exceeding 578 mg/100 g as established by nine international guidelines[24–31], and eight exceeded the Na limit between 400 and 560 mg/100 g proposed by the Brazilian government[9] (Fig. 1).

Based on FSA classifications[27], 40 % of surveyed bakeries produced rolls with a high Na content (>600 mg/100 g), 60 % produced rolls with intermediate

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Table 2 Comparison of mean salt (g) content between laboratory analysis and labelling of Portuguese rolls produced at bakeries in Florianopolis, Santa Catarina, Brazil

	Salt content by laboratory analysis per 100 g		Salt content by laboratory analysis per bread unit			Salt content by label analysis per 100 g		Salt content by label analysis per bread unit		
Bakeries	Mean	SD	Mean	SD	GDA* (% of salt per 100 g)	Mean	SD	Mean	SD	GDA* (% of salt per 100 g)
A†	1·40	0·1	0·67	0·0	28·0	1·22	0·2	0·58	0·1	24·4
B†	1·30	0·4	0·63	0·2	26·0	1·12	0·0	0·54	0·0	22·4
C†	1·30	0·0	0·54	0·0	26·0	1·19	0·1	0·50	0·1	23·8
D†	1·10	0·0	0·59	0·0	22·0	1·15	0·1	0·62	0·1	23·0
E†	1·20	0·2	0·54	0·1	24·0	1·14	0·1	0·52	0·1	22·8
F‡	1·30	0·1	0·68	0·0	26·0	1·32	0·2	0·69	0·1	26·4
G‡	1·20	0·1	0·69	0·0	24·0	1·86	0·1	1·07	0·0	37·2
H‡	1·70	0·2	0·97	0·1	34·0	1·18	0·0	0·67	0·0	23·6
I‡	1·60	0·1	0·82	0·0	32·0	1·08	0·0	0·56	0·0	21·6
J‡	1·70	0·1	0·80	0·0	34·0	1·09	0·0	0·52	0·0	21·8
Total (mean)	1·38	0·1	0·69	0·0	27·6	1·23	0·1	0·62	0·1	24·6

*GDA, guideline daily amount of salt contribution (by laboratory analysis) by consumption of 100 g of Portuguese bread roll in an adult's diet with 8368 kJ (2·000 kcal) or 5 g of salt[7,8].
†Own bread recipe.
‡Bread produced with processed dough.

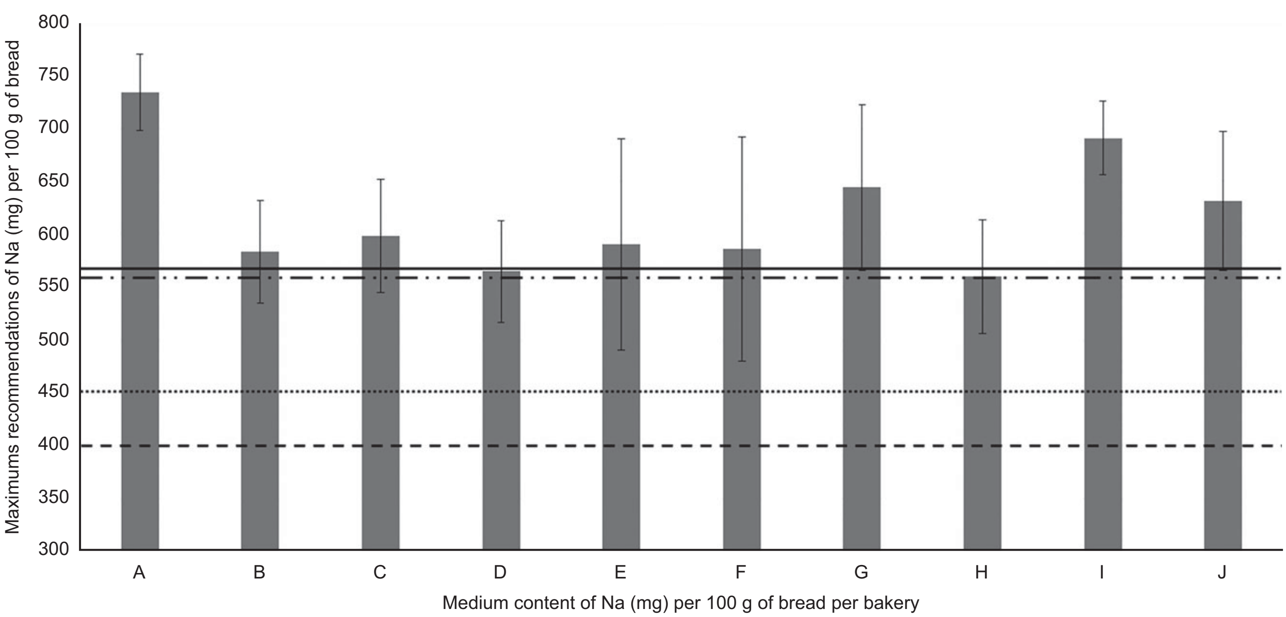

Fig. 1 Comparison between the mean Na content of bread rolls (by laboratory analysis) produced in Florianopolis, Brazil, and international recommendations for maximum Na content in breads. ——, Brazil (578 mg/Na); — · ·, Portugal (560 mg/Na); ·······, Argentina, Finland, Ireland, New Zealand (450 mg/Na); – – -, South Africa, Australia, Canada, United Kingdom (400 mg/Na)

Na content (>120 and ≤600 mg/100 g) and none produced rolls with a low Na content (≤120 mg/100 g).

Discussion

The present study assessed the Na content in breads by label and laboratory analyses. Most of the bakeries queried during the telephonic survey (67 %, *n* 60) used processed dough for the production of rolls with the exception of one bakery. The analysed laboratory samples had higher Na content (22·6 %) compared to the label analysis. These findings coincide with a study that assessed the reliability of nutritional facts stated on the labels of processed foods (*n* 153) marketed in Brazil[34]. All the products analysed were not compliant with dietary fibre, Na and saturated fat content standards. In this context, the lack of reliability of food labels contravenes national regulations and the protection guaranteed by the Nutritional and Food Safety Law and Consumer Protection Code.

The Na content of breads was higher than the guideline values recommended around the world. The mean Na

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content per 100 g of bread observed by laboratory analysis (618·2 ± 73·8 mg) exceeded the limit established by nine international recommendations, and 80 % of bakeries exceeded the limit proposed by the Brazilian government. In addition, the laboratory analysis found the mean Na content per 100 g of bread was higher than reported by international studies from Mozambique[35] (+27·2 %), Australia[31] (+31 %) and New Zealand[31] (+25 %).

In Brazil, the Portuguese roll is the widely consumed bakery good. A study in 2010 evaluating the food patterns of adolescent meals in São Paulo, Brazil, found that 30·8 % of consumers replace lunch or supper with a snack. Among the most common replacements for a meal were milk, chocolate milk, bread rolls, margarine and soft drinks[36]. In the present study, the consumption of only two units of the analysed Portuguese rolls equalled 51·7 % of GDA for Na for children aged 4–8 years[23], 41·4 % for children and adolescents aged 9–18 years[23] and 31·0 % for adults[7,8]. These Na values may be likely underestimated as the rolls are most often consumed with processed ingredients such as cheeses and sausages containing high amounts of Na. For example, one Portuguese roll (weighing 50·2 g) with one portion of mozzarella cheese (20 g Na)[37], one portion of mortadella (15 g Na)[37] and salted butter (two tablespoons, 6 g Na) would contain 643 mg Na[37]. Daily consumption of just two of these sandwiches would correspond to 107·2 % of GDA for Na for children aged 4–8 years [23], 85·7 % for children and adolescents aged 9–18 years[23] and 64·3 % for adults[7,8].

Comparatively, an analysis conducted in Brazil[38] with 1411 processed food labels verified that 58·8 % of the products were having a high Na content according to the FSA guidelines[27]. In Canada, 17 % of the 364 processed food products were found to be high in Na[39]; and in Australia[40], 63 % of 7221 processed foods, fifty-one of which were white breads, exceeded the Na content recommendation[27].

The present study found no significant difference in Na content between these two production methodologies (processed dough or homemade dough). There was also no significant association relating to unit weight and Na content. These findings validate a study conducted in Porto, Portugal, which did not find a significant association between weight and Na content of breads ($P > 0·05$)[41].

A gradual reduction of salt and Na content in breads can be an accessible and effective way to reduce Na intake by consumers without affecting the acceptability of the food consumed[14,42]. A recent systematic review about reduced-salt foods indicated that the Na content of food products could be lowered by 40 % without a detrimental effect on consumer acceptability[42]. In addition, several countries are implementing strategies for a significant reduction of salt and Na content in breads[11,14,15]. For example, the United Kingdom has set a voluntary goal of reducing Na to 400 mg/100 g of breads[43], while New Zealand has set a target of 450 mg/100 g of breads; and Australia, 400 mg/100 g[30]. A study in Lima, Peru, gradually reduced salt content in breads by 20 %. This reduction occurred in 6 weeks, while there was no perceptible change to taste as noticed by consumers[11]. Another study carried out with 120 students and staff aged 18–35 from a university in the Netherlands also demonstrated that a reduction of salt by 52 % in breads did not decrease its consumption[44]. In addition, a reduction of up to 67 % of salt did not affect consumer acceptability for added PCl bread[44]. A study has found that reducing Na content by up to 30 % in sandwich bread in the United States did not affect taste and purchase intent[42]. The aforementioned investigations indicate that salt reduction is possible and perhaps imperceptible. Therefore, we suggest that bakeries in this investigation can reduce Na content in their products gradually without a perceptible difference to product acceptability and without a risk of sales reduction.

The baking industry produces processed dough to facilitate and standardise bread production in bakeries. Nevertheless, the baking industry uses high amounts of Na and preservatives in their processed products. We reported a high amount of Na in bread rolls from bakeries using these processed dough. Then, we compared the findings with bakeries preparing the rolls using proprietary recipes. The Brazilian population consumes high amounts of Na daily, more than national and international recommendations. Therefore, joint efforts by the government, the civic society and the health agency are needed to demand that the baking industry implement a gradual and effective target to reduce Na content in processed and ultra-processed foods. Reducing the salt intake is one of the WHO strategies for the prevention of non-communicable diseases. Furthermore, awareness campaigns are expressly needed addressing the proprietors and baking staff about the harmful properties of Na and on strategies for its reduction. Educating the public is a way to rethink about using food for health promotion and disease prevention.

The present study has some limitations. The findings cannot be extrapolated to other locations because the collected data were localised and specifically targeted traditional Portuguese rolls, the bread most consumed by the Brazilian population. This study also does not represent daily Na intake through other bread varieties. Although this study focused on Florianopolis, bread rolls are consumed daily in most regions of Brazil. As these are produced by large enterprises, they have a national reach. Therefore, studies about other types of bread across different parts of the country are needed to further understand the magnitude of Na content in bread products and labelling deficiencies.

The present study shows the importance of reducing Na in breads in Brazil. However, the lack of reliable label information confounds efforts to reduce Na content. This issue confronts Brazilian national regulations and the rights guaranteed by the Nutritional and Food Safety Law and

Consumer Protection Code. Public health strategies should be adopted to reduce Na intake and associated diseases through Na reduction agreements with the food industry, public awareness campaigns and stricter compliance of nutrient labels.

Conclusion

The present study showed that food labels on bread rolls underreported Na values compared to laboratory analysis. Depending on how it is produced and how it is included in daily meals, bread can be a part of healthy diet. However, the present study reinforces the importance of reducing the Na content in breads. The Brazilian National Dietary Survey (2008–9) has found that Na in breads contributed to half of the daily dietary recommendation. This finding should direct public health policies towards reducing total Na intake by consumers. The present study strengthens the importance of monitoring the Na content of breads in Brazil.

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References

1. Powles J, Fahimi S, Micha R *et al.* (2013) Global, regional and national sodium intakes in 1990 and 2010: a systematic analysis of 24 h urinary sodium excretion and dietary surveys worldwide. *BMJ Open* **3**, 1–18.
2. He FJ, Li J & Macgregor GA (2013) Effect of longer-term modest salt reduction on blood pressure: Cochrane systematic review and meta-analysis of randomized trials. *BMJ* **346**, f1325.
3. He FJ & MacGregor GA (2011) Salt reduction lowers cardiovascular risk: meta-analysis of outcome trials. *Lancet* **378**, 380–382.
4. D'Elia L, Rossi G, Ippolito R *et al.* (2012) Habitual salt intake and risk of gastric cancer: a meta-analysis of prospective studies. *Clin Nutr* **31**, 489–498.
5. The Brazilian Institute of Geography and Statistics – IBGE, Brazil (2010) *POF – Dietary Assessment of Household Food Supply – Consumer Expenditure Survey – 2017–2018*. Rio de Janeiro: IBGE.
6. Souza AM, Bezerra IN, Pereira RA *et al.* (2013) Dietary sources of sodium intake in Brazil in 2008–2009. *J Acad Nutr Diet* **113**, 1359–1365.
7. World Health Organization (2012) *Guideline: Sodium Intake for Adults and Children*. Geneva: WHO.
8. Ministry of Health, Brazil (2008) Dietary Guidelines for the Brazilian population. Secretariat of Health Care, Primary Health Care Department; translated by Carlos Augusto Monteiro. Brasília: Ministry of Health of Brazil. http://bvsms.saude.gov.br/bvs/publicacoes/dietary_guidelines_brazilian_population.pdf (accessed June 2020).
9. Ministry of Health, Brazil (2012) Brazilian Health Surveillance Agency. Guidelines for the Good nutrional practices for Portuguese rolls. Brasília: MS. http://portal.anvisa.gov.br/documents/33916/389979/Guia+de+Boas+Pr%C3%A1ticas+Nutricionais+para+P%C3%A3o+Franc%C3%AAs/a389f51c-7e4c-4496-a1dd-33de55a48ae1 (accessed July 2019).
10. Drewnowski A & Rehm C (2013) Sodium intakes of US children and adults from foods and beverages by location of origin and by specific food source. *Nutrients* **5**, 1840–1855.
11. Saavedra-Garcia L, Sosa-Zevallos V, Diez-Canseco F *et al.* (2016) Reducing salt in bread: a quasi-experimental feasibility study in a bakery in Lima, Peru. *Public Health Nutr* **19**, 976–982.
12. Coyne KJ, Baldridge AS, Huffman MD *et al.* (2017) Differences in the sodium content of bread products in the USA and UK: implications for policy. *Public Health Nutr* **21**, 632–636.
13. Hendriksen M, Verkaik-Kloosterman J, Noort W *et al.* (2015) Nutritional impact of sodium reduction strategies on sodium intake from processed foods. *Eur J Clin Nutr* **69**, 805–810.
14. Webster J, Trieu K, Dunford E *et al.* (2014) Target salt 2025: a global overview of National Programs to encourage the food industry to reduce salt in foods. *Nutrients* **6**, 3274–3287.
15. Webster J, Dunford E, Hawkes C *et al.* (2011) Salt reduction initiatives around the world. *J Hypertens* **29**, 1043–1050.
16. Vyth E, Steenhuis I, Roodenburg A *et al.* (2010) Front-of-pack nutrition label stimulates healthier product development: a quantitative analysis. *Int J Behav Nutr Phys Act* **7**, 1–7.
17. Ministry of Health, Brazil (2011) Agreement beetwen the Ministry of health and the Brazilian Association of food industry (*Associação Brasileira das Indústrias de Alimentação* – ABIA). Brasília: MS. http://189.28.128.100/dab/docs/portaldab/documentos/termo_abia_abip_abima_abitrigo_2011.pdf (accessed July 2018).
18. Law nº 18.18 of September 18, B18 Brazil (1990) Code of Consumer defense and protection. http://www.planalto.gov.br/ccivil_03/leis/l8078.htm (accessed July 2018).
19. Telephone directory central for Brazil. Yellow pages phone book (2013). Bakeries in Florianopolis, Santa Catarina, Brazil.
20. Ministry of Health, Brazil & Brazilian Health Surveillance Agency (2000) Resolution-RDC nº 90, of October 18, 2000 (*Aproves the Technical Rules for Bread Identity and Quality*). http://www.anvisa.gov.br/anvisalegis/resol/2000/90_00rdc.htm (accessed July 2018).

21. Association of Official Analytical Chemists (1990) *Official Method 969.23 Flame Photometric Method*. Washington: AOAC.
22. Zenebon O, Pascuet NS & Tiglea P (editors) (2008) *Physical–Chemical Methods for Food Analysis*, 4th ed. Sao Paulo: Adolfo Lutz Institute.
23. Padovani RM, Amaya-Farfán J, Basile FA *et al.* (2006) Dietary reference intakes: application of tables in nutritional studies. *Rev Nutr* **19**, 741–760.
24. Diário da República de Portugal (2009) Lei n. 75/2009 155, 5225–5226. Porto: DRP.
25. Ministry of Health, Argentina (2009) Iniciative Less salt, more life. http://www.msal.gob.ar/images/stories/bes/graficos/0000001643cnt-2013-09_presentacion-iniciativa-menos-sal-mas-vida.pdf (accessed June 2020).
26. Health Canada, Canada Minister of Health (2010) *Sodium Reduction Strategy for Canada*. Ottawa: HC.
27. UK, Food Standards Agency (2009) *The Little Book of Salt*. London: FSA.
28. Food Safety Authority of Ireland (2010) *Salt Reduction Programme (SRP) – 2010 to 2011: Written Achievements and Undertakings Submitted by the Food Industry to the Food Safety Authority of Ireland*. Dublin: FSAI.
29. National Institute for Health and Welfare (2009) *Finland's Experience in Salt Reduction*. Brussels: NIHW.
30. South African Government, Department of Health (2013) *Foodstuffs, Cosmetics and Disinfectants Act, 1972 (ACT 54 OF 1972): Regulations Relating to the Reduction of Sodium in Certain Foodstuffs and Related Matters*. Johannesburg: SAG.
31. Dunford E, Eyles H, Mhurchu C *et al.* (2011) Changes in the sodium content of bread in Australia and New Zealand between 2007 and 2010: implications for policy. *Med J Aust* **195**, 346–349.
32. Lin L (1989) A concordance correlation coefficient to evaluate reproducibility. *Biometrics* **45**, 255–268.
33. Bland J & Altman D (1986) Statistical methods for assessing agreement between two methods of clinical measurement. *Lancet* **1**, 307–310.
34. Lobanco CM, Vedovato GM, Cano CB *et al.* (2009) Reliability of food labels from products marketed in the city of São Paulo, southeastern Brazil. *Rev Saúde Pública* **43**, 499–505.
35. Silva V, Padrão P, Novela C *et al.* (2014) Sodium content of bread from bakeries and traditional markets in Maputo, Mozambique. *Public Health Nutr* **18**, 610–614.
36. Leal GV, Philippi ST, Matsudo SM *et al.* (2010) Food intake and meal patterns of adolescents, São Paulo, Brazil. *Rev Bras Epidemiol* **13**, 457–467.
37. Table Brazilian Food Composition: TACO. Center for Food Studies and Research – NEPA. State University of Campinas – UNICAMP, Brazil. ed. 2011.
38. Martins C, Sousa A, Veiros M *et al.* (2014) Sodium content and labelling of processed and ultra-processed food products marketed in Brazil. *Public Health Nutr* **18**, 1206–1214.
39. Elliott C (2008) Assessing 'fun foods': nutritional content and analysis of supermarket foods targeted at children. *Obes Rev* **9**, 368–377.
40. Webster JL, Dunford JK & Neal BC (2010) A systematic survey of the sodium contents of processed foods. *Am J Clin Nutr* **91**, 413–420.
41. Vieira E, Oliveira B, Soares M *et al.* (2007) Study of sodium content in bread consumed in Oporto. *SPCNA* **13**, 97–103.
42. Croix KWL, Fiala SC, Colonna AE *et al.* (2014) Consumer detection and acceptability of reduced-sodium bread. *Public Health Nutr* **18**, 1412–1418.
43. FSA (2017) Salt reduction targets. https://www.food.gov.uk/business-guidance/salt (accessed September 2018).
44. Bolhuis DP, Temme EH, Koeman FT *et al.* (2011) A salt reduction of 50 % in bread does not decrease bread consumption or increase sodium intake by the choice of sandwich fillings. *J Nutr* **141**, 2249–2255.

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