



## ORIGINAL ARTICLE

# Acceptance of salt reduction in bakery bread among Moroccan consumers

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## Abstract

**Background:** The use of cooking salt (sodium chloride) for bread preparation is due to several important sensory and technological properties. Even considered as an essential micronutrient and a salty taste stimulus, a significant dietary sodium intake is positively correlated with high blood pressure levels and some heart diseases. Recently, Morocco has adopted a plan to reduce salt consumption aiming to reinforce the prevention of Non-Communicable Diseases (NCDs) and to contribute to the achievement of 2025 global voluntary targets, set by the Second International Conference on Nutrition (ICN2). **Aims:** The aim of the present study was to determine the acceptance of bakery bread with a different percentage reduction of salt by the Moroccan population. **Subjects and Methods:** Various percentages of salt reduction in experimental bread; 7%, 10%, 16%, 23%, 30%, and 53%, were tasted and compared with standard market bread by 201 individuals. “Just About Right” (JAR) and purchase scales were utilized to score the different sample bread. **Results:** Bread with 10% and 16% salt reduction were highly accepted by 76% and 79% of tasters, respectively. Based on the JAR score, these types of bread were considered as “just about right” by 50% and 57% of the participants respectively. The best average score of purchase intent was obtained for salt content of 1.62g and 1.56g per 100g for a reduction of 10% and 16% respectively. **Conclusions:** The current adopted strategy allows a 16% sodium reduction while maintaining taste quality.

**Keywords:** Sodium chloride, bread, salt reduction, Moroccan population.

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## 1 Introduction

Sodium occurs naturally in most foods such as animals, plants, and water. However, this mineral is excessively added to processed foods by manufacturers and by consumers during cooking or on the table during meals. Cereals and their products, especially bread and breakfast cereals, provide about 40% of average intake [1]. Therefore, bad eating habits particularly westernized diet pattern characterized by overconsumption of salty foods, constitute a major risk factor for developing NCDs spreading in several developing countries [2].

In the 18<sup>th</sup> century, salt was widely utilized for food preservation purposes with an average of 10 g / kg [3]. However, in the 20<sup>th</sup> century, the average salt content in bread

doubled to reach 20 g / Kg. The most appropriate method to ameliorate taste, reduce the damage caused by mold spoilage, and preserving foods, rather than salting, is to consider further alternatives [3,4].

The main source of sodium depends on the population’s dietary habits [5]. Sodium is found in small quantities in a variety of natural products as well as processed foods (about 70 to 75% of daily intake) such as bread, crackers, and further manufactured products [6,7]. A food processed based diet, low in fresh fruits and a vegetable is considered as high in sodium [7]. Indeed, the diet pattern is related to the amount of salt and, therefore, the amount of sodium.

Bread, especially whole meal bread, constitutes an essential source of complex carbohydrates, proteins, minerals, fats, and B-group vitamins [8]. In Morocco, bread is a staple of the Moroccan diet constituting a potential source of sodium. The daily consumption of bread can reach 500 g per person [9]. According to Derouiche *et al.* [10], the average quantity of salt added, for the preparation of white bread, was  $17.42 \pm 1.28$  g/kg, being equivalent to a daily intake of 8 to 9 g of salt per bread. These amounts exceed the WHO's recommendations [9]. Thus, the high salt content of white bread could contribute to the increase of sodium intake within the population [11].

Sodium reduction in bakery products and processed foods would be beneficial for public health. Indeed, this nutrient, in its chloride form, should be moderately consumed according to dietary intake standards [12]. Sodium chloride can reduce microbial activity as a barrier to microbial growth and survival [13]. In addition to its unique taste, sodium chloride displays a strong effect on wheat gluten properties. Sodium chloride is an essential ingredient for the proper development of the bread dough structure. The interaction of salt with the flour components such as gluten is crucial to form high-quality breadcrumbs. Moreover, it guarantees satisfactory microbiological safety [14].

Hence, a significant decrease in salt will affect the functional and sensory properties of bread and may also reduce its acceptability by consumers. An adequate daily intake of salt (the equivalent of 180-230 mg of sodium) is essential for normal body functions [15]. However, a high dietary sodium intake is directly related to the development of NCDs such as hypertension, cardiovascular diseases, or coronary heart disease [16-18], representing the most significant pathologies causing global death [19]. In 2016, NCDs were responsible for 71% (41 million) of the 57 million deaths that occurred worldwide versus 60% of all deaths and 43% of disease burden in 2012 [18,20]. In this context, the most recent estimate on the daily intake of salt in Morocco was carried out by the Ministry of Health in 2008 prior to the addition of iodine to salt. This survey showed that salt intake among adults reached a daily consumption of 7-12 g/person [21]. This amount is exceeding the WHO's recommendations (<5g of salt a day eq. < 2 g of sodium per day) [18].

Concerning this high intake of salt, a well-studied plan has been established to increase awareness among the Moroccan population against overconsumption of salt and its harmful effects to prevent the emergence of NCDs. ICN2 projected a list of 60 recommendations, of which recommendation 14 encourages a gradual reduction in saturated fats, sugars and salt/sodium and trans fats in foods and beverages. This aims to avoid excessive consumption by consumers and improve

the nutrient content of the food as needed [22]. From this perspective, Morocco initiated a national multisectoral strategy for the prevention and control of NCDs 2019-2029 setting a target of reducing 10% of the population's salt/sodium intake [23].

The present study aimed to assess, on one hand, the effect of a salt reduction strategy in baked bread without affecting its textual and structural characteristics. On the other hand, we intended obtaining products of high sensory quality and assessing the effect of the reduction of the acceptability of Moroccan baked bread.

In sum, three primary objectives were fixed: (1) assess the overall appreciation of bread taste; (2) follow the intensity of salty taste of bread salt-reduced; and (3) evaluate the willingness to purchase salt reduced bread.

## 2 Subjects and Methods

### 2.1 Study design and subjects

#### 2.1.1 Study design and subjects

This is a cross-sectional and simple-blind experimental study that was conducted in the region of Rabat-Salé-Kénitra at households, at the level of Ibn Tofail University and the Joint unit of Nutrition and Food Research.

#### 2.1.2 Inclusion criteria

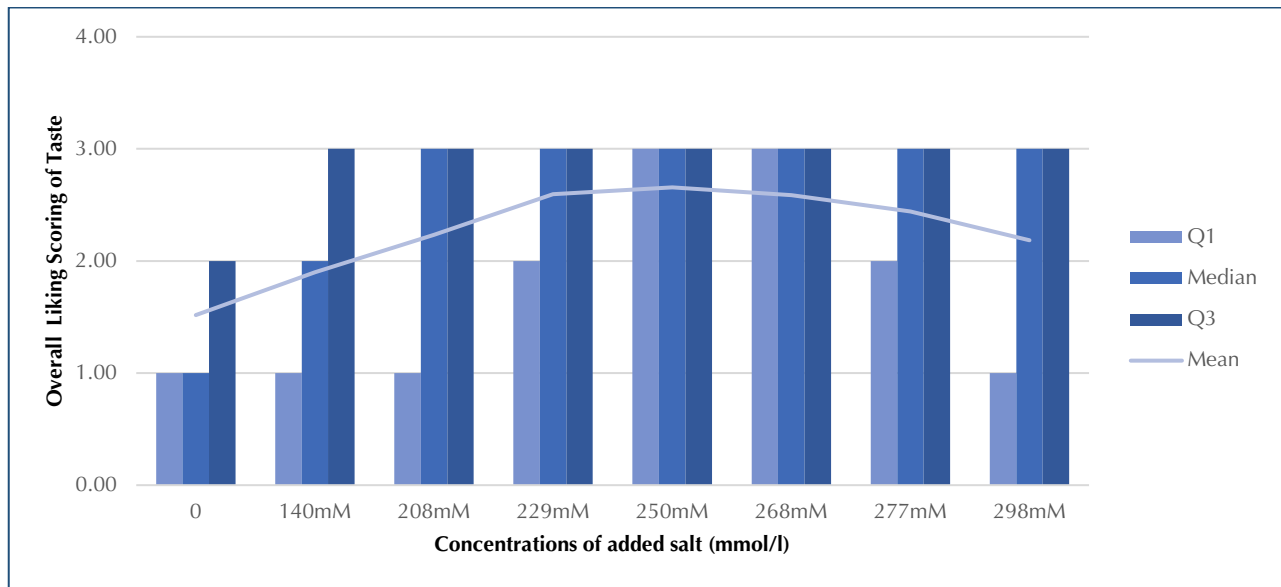
All the participants included in the study were aged 15 years and over, supposed to be healthy and regular bread consumers.

#### 2.1.3 Exclusion criteria

Subjects under the age of 15 years, pregnant women, individuals with taste disorders, being sick or under medical treatment, were excluded. Only healthy subjects were recruited to determine the level of salt reduction in bakery bread.

#### 2.1.4 Study population

The sensory panel consisted on 201 volunteers classified on four age categories: 15-29, 30-44, 45-59 and over 60 [24]. Informed consent from participants was obtained before starting activities. After consent, participants respond to a short questionnaire about sociodemographic data (age and gender).



**Figure 1:** Participants distribution according to quartiles of their overall liking score of bread with varying salt concentration (n = 201) (Q1 = Quartile 1 and Q3 = Quartile 3)

The study population was divided into 104 males and 97 Females. General information on age, gender, height, and weight was requested from the participants [24] who were asked to complete a questionnaire and sign an agreement. Different measurements and tests were performed.

### 2.1.5 Anthropometric measurements

Anthropometric measurements were performed according to the standard WHO procedures [25].

#### Body Weight

Body Weight was measured at the nearest of 0.1 kg using a mechanical scale (Seca GmbH, Germany).

The body weight measurement was conducted by ensuring that the subject was wearing less clothing and without shoes. Every subject was placed in the middle of the scale, in the upright position, feet slightly apart and motionless until the body weight value was displayed.

#### Height

Height was measured at the nearest 0.1 cm using a stadiometer (formerly 130 Shorr Productions, LLC, USA). The participants were barefoot, in a standing position and lightly dressed. BMI was calculated as weight in kilograms by the square of the height in meter ( $\text{kg} / \text{m}^2$ ).

## 2.2 Bread-making procedure

### 2.2.1 Materials

Wheat flour, durum wheat flour, fresh yeast, NaCl sodium chloride, and water.

### 2.2.2 Preparation of standard bread

In a kneading machine, 500 g of wheat flour, 500 g of durum wheat flour, 10 g of fresh yeast, 17, 42 g of NaCl and 1000 ml of warm water were mixed for 10 min at 180 rpm and then for 5 min at 250 rpm. The dough was manually kneaded 5 min for an optimal development and then formed into small balls, each weighing 100g. After a rest period of 20 min at 37°C, the dough balls were pressed to a thickness of 3 cm, and left to rest for 20 min at 37°C then pricked and baked for 4 min at 270°C.

This standard recipe brought 1.74 g sodium/100 g final product (fresh weight).

### 2.2.3 Preparation of bread with reduced-sodium contents

The standard amount of 17.42 g NaCl was reduced to 7%, 10%, 16%, 23%, 30% and 53% [26] to yield 1.62; 1.56; 1.46; 1.34; 1.21 0.81 g of sodium /100g final product respectively. The same protocol was followed to prepare the different series of salt-reduced bread. The bread was cooled and frozen for later tests.

**Table 1:** Amount of salt added to bread

Salt contents (g)	0	8.19	12.19	13.41	14.63	15.68	16.20	17.42
Concentrations (mmol/L)	0	140	208	229	250	268	277	298
Percentage of salt reduction (%)	100%	53%	30%	23%	16%	10%	7%	0%

**Table 2:** Participants distribution according to their overall liking score of different bread salt reduction (n = 201)

Liking score	Percentage of reduction								p-value
	100%	53%	30%	23%	16%	10%	7%	0%	
I dislike	70.1	48.3	28.4	12.9	12.4	16.9	22.4	35.3	p<0,000
I neither like nor dislike	8.0	13.4	19.9	14.1	9.5	7.5	10.9	10.9	
I like	21.9	38.3	51.7	72.6	78.1	75.6	66.7	53.7	

Results are presented as percentages of the total population by each salt reduction. *p*-value was calculated using Freidman's Chi2test = 315,059, test significance was set at a *p*-value < 0.05

**Table 3:** Participants distribution according to their JAR score of different bread salt reduction (n = 201)

JAR scores	Percentage of reduction								p-value
	100%	53%	30%	23%	16%	10%	7%	0%	
A little salty	92.0	76.6	62.2	45.3	21.9	8.5	9.5	10.0	p<0,000
Just about right	7.0	22.9	32.8	74.8	56.2	50.2	35.3	14.4	
Too salty	1.0	0.5	5.0	7.0	21.9	41.3	55.2	75.6	

Results are presented as percentages of the total population by each salt reduction. *p*-value was calculated using Freidman's Chi2 test = 853,789, test significance was set at a *p*-value < 0.05

### 2.2.4 Sensory analysis

Participants were requested to taste the bread and to evaluate their overall liking based on the taste scale that consisted of 9 hedonic scale points (From 1 = I extremely dislike to 9 = I extremely like). The 9 points were grouped into 3 categories: 1 = I dislike, 2 = I neither like or dislike and 3 = I like. Saltiness intensity was assessed using the JAR (Just About Right) on a 9-points scale (1-4 = not salty enough, 5 = just about right, 6-9 = too much salty). Purchase intent was scored on a 5-point scale (1=would definitely not buy, 5 = would definitely buy) [27].

### 2.2.5 Two-AFC Alternative Forced Choice tests

The evaluation of saltiness perception in bread was performed as described for bread by Pflaum *et al.* [28]. The frozen bread was thawed, brought to room temperature (22°C) and cut into pieces of 3 g. Two three-digit random number encrypted sensory flasks containing different bread samples (3 g each) were presented to each participant in an AB or BA presentation design randomized over the subjects (2 alternative forced-choice). The participants were instructed to rinse their mouths with mineral water during the break (one minute), between tasting the eight bread samples, to eliminate interference carryover effects. Two sensory flasks with different bread samples were presented to each panelist in a randomized order [26].

## 2.3 Statistical analysis

The statistical analysis was performed using SPSS (version 21). Data were analyzed using ANOVA at *p*-value ≤0.05. Mean values were compared using the FISHER test. Scores' distribution frequency was calculated for the three used scales (taste scale, JAR scale, and purchase intent scale). The percentage (%) of scores in each category was calculated and Freidman's Chi<sup>2</sup> test was applied to assess the significance between the different categories.

## 3 Results

### 3.1 Overall Liking

Table 1 displays the added amounts of salt to the experimental bread and Table 2 summarizes the taste scale results. 78.1% of the participants presented the highest liking taste score for bread with 250 mM corresponding to -16% decrease of added salt with a significant difference (*p*<0.000) between different reduction regarding perception. The taste of bread with 268 mM, corresponding to -10% of the added salt, was liked by 75.6% of the participants. These findings were confirmed by the first quartile evolution (Q1) of hedonic test scores by participants presented on figure 1. The highest Q1 taste score was obtained for the concentration of 250 mM (Q1=3). Q3 for 250 mmol/L was equal to that for 268mM, 277 mmol/L, and 298 mmol/L indicating that liking bread with salt reduction at 16% was equal to 0%.

**Table 4:** Participants distribution according to their purchase intent scoring of different bread salt reduction (n = 201)

Purchase intent scale	Percentage of reduction								p-value
	100%	53%	30%	23%	16%	10%	7%	0%	
1. I would definitely not buy	50.2	22.9	5.5	2.0	6.5	7.0	10.0	19.4	p<0,000
2. I would probably not buy	15.9	26.4	13.4	2.5	5.0	7.0	10.0	16.4	
3. I don't know	9.0	12.4	33.8	22.4	10.4	10.4	17.9	16.4	
4. I would probably buy	16.9	22.9	26.9	41.3	36.3	27.9	28.9	25.4	
5. I would definitely buy	8.0	15.4	20.4	31.8	41.8	47.8	33.3	22.4	

Results are presented as percentages of the total population by each salt reduction. *p*-value was calculated using Freidman's Chi2test = 361,213, test significance was set at a *p*-value < 0.05

**Table 5:** Participants distribution of their overall liking score of each salt reduction according to sex

Salt reduction (%)	Liking score	Total	Women (n=104)	Men (n=97)	p-value
100	I dislike	141	66 (46.8%)	75 (53.2%)	0.634
	I neither like nor dislike	16	9 (56.3%)	7 (43.8%)	
	I like	44	22 (50.0%)	22 (50.0%)	
53	I dislike	97	22 (43.3%)	55 (56.7%)	0.391
	I neither like nor dislike	27	17 (63.0%)	10 (37.0%)	
	I like	77	38 (49.4%)	39 (50.6%)	
30	I dislike	57	20 (35.1%)	37 (64.9%)	0.019
	I neither like nor dislike	40	20 (50.0%)	20 (50.0%)	
	I like	104	57 (54.8%)	47 (45.2%)	
23	I dislike	26	10 (38.5%)	16 (61.5%)	0.070
	I neither like nor dislike	29	10 (34.5%)	19 (65.5%)	
	I like	146	77 (52.7%)	69 (47.3%)	
16	I dislike	25	11 (44.0%)	14 (56.0%)	0.381
	I neither like nor dislike	19	7 (36.8%)	12 (63.2%)	
	I like	157	79 (50.3%)	78 (49.7%)	
10	I dislike	34	15 (44.1%)	19 (55.9%)	0.846
	I neither like nor dislike	15	9 (60.0%)	6 (40.0%)	
	I like	152	73 (48.0%)	79 (52.0%)	
7	I dislike	45	24 (53.3%)	21 (46.7%)	0.241
	I neither like nor dislike	22	13 (59.1%)	9 (40.9%)	
	I like	134	60 (44.8%)	74 (55.2%)	
0	I dislike	71	34 (47.9%)	37 (52.1%)	0.897
	I neither like nor dislike	22	12 (54.5%)	10 (45.5%)	
	I like	108	51 (47.2%)	57 (52.8%)	

Results are presented as effective (percentage). *p*-values were calculated by one-way ANOVA for means

### 3.2 Saltiness Liking

Participants' distribution, according to their JAR score of bread with varying salt concentration, is reported in table 3. Results show that 76.6% of participants confirmed that bread with a concentration of 298 mmol/L salt/l (0%

reduction) was too salty, while 92% declared that 0 mmol/L (100% reduction) was not salty enough. Reductions of 16% (250 mmol/L) and of 10% (268mmol/L) were considered as “Just About Right” by 56.2% and 50.2% respectively. A significant (*p*<0.000) difference was reported between different reduction according to JAR.

**Table 6:** Participants distribution of their overall liking score of each salt reduction according to age groups

Salt reduction (%)	Liking score	Total	Age groups (year)				p-value
			15-29 (140)	29-43 (31)	43-58 (19)	>58 (11)	
100	I dislike	141	107 (75,9%)	22 (15,6%)	8 (5,7%)	4 (2,8%)	0.001
	I neither like nor dislike	16	9 (56,3%)	3 (18,8%)	3 (18,8%)	1 (6,3%)	
	I like	44	24 (54,5%)	6 (13,6%)	8 (18,2%)	6 (13,6%)	
53	I dislike	97	79 (81,4%)	14 (14,4%)	3 (3,1%)	1 (1,0%)	0.000
	I neither like nor dislike	27	17 (63,0%)	6 (22,2%)	3 (11,1%)	1 (3,7%)	
	I like	77	44 (57,1%)	11 (14,3%)	13 (16,9%)	9 (11,7%)	
30	I dislike	57	48 (84,2%)	7 (12,3%)	2 (3,5%)	0 (0,0%)	0.002
	I neither like nor dislike	40	29 (72,5%)	8 (20,0%)	2 (5,0%)	1 (2,5%)	
	I like	104	63 (60,6%)	16 (15,4%)	15 (14,4%)	10 (9,6%)	
23	I dislike	26	25 (96,2%)	0 (0,0%)	1 (3,8%)	0 (0,0%)	0.036
	I neither like nor dislike	29	19 (65,5%)	7 (24,1%)	3 (10,3%)	0 (0,0%)	
	I like	146	96 (65,8%)	24 (16,4%)	15 (10,3%)	11 (7,5%)	
16	I dislike	25	21 (84,0%)	2 (8,0%)	1 (4,0%)	1 (4,0%)	0.255
	I neither like nor dislike	19	15 (78,9%)	3 (15,8%)	1 (5,3%)	0 (0,0%)	
	I like	157	104 (66,2%)	26 (16,6%)	17 (10,8%)	10 (6,4%)	
10	I dislike	34	30 (88,2%)	1 (2,9%)	2 (5,9%)	1 (2,9%)	0.162
	I neither like nor dislike	15	9 (60,0%)	5 (33,3%)	1 (6,7%)	0 (0,0%)	
	I like	152	101 (66,4%)	25 (16,4%)	16 (10,5%)	10 (6,6%)	
7	I dislike	45	32 (71,1%)	7 (15,6%)	4 (8,9%)	2 (4,4%)	0.737
	I neither like nor dislike	22	20 (90,9%)	1 (4,5%)	0 (0,0%)	1 (4,5%)	
	I like	134	88 (65,7%)	23 (17,2%)	15 (11,2%)	8 (6,0%)	
0	I dislike	71	48 (67,6%)	9 (12,7%)	7 (9,9%)	7 (9,9%)	0.221
	I neither like nor dislike	22	11 (50,0%)	7 (31,8%)	3 (13,6%)	1 (4,5%)	
	I like	108	81 (75,0%)	15 (13,9%)	9 (8,3%)	3 (2,8%)	

Results are presented as effective (percentage). *p*-values were calculated by one-way ANOVA for means

### 3.3 Purchase Intent

Table 4 shows that the best average score of purchase intent was obtained for salt concentration of 268mM. Less than one third of participants (22.4%) confirmed their intention to purchase bread with 298mM salt concentration (0% reduction) besides 47.8% and 41.8% for bread with salt concentration of 268 mM and 250mM respectively. A significant difference ( $p < 0.000$ ) between salt reductions based on purchase intent score was recorded.

In table 5, are presented, the results of participant's distribution of their overall liking score of each salt reduction according to gender. The chi-square test shows a significant difference ( $p \leq 0.05$ ) between overall appreciation of bread taste and gender for the 30% salt reduction with  $p = 0.019$ . Women appreciated the taste of bread, reduced to this salt content, much more than men with a percentage of 54.8% *versus* 45.2%.

Data about the distribution of participants according to different age categories, for their overall liking, is reported in table 6. For all concentrations, the large size was found in the age category of subjects between 15 and 29. A significant ( $p < 0.05$ ) difference was recorded between different age categories from 100% to 23% reductions. Results showed that young subjects presenting the age category between 15 and 29 years old appreciate low-salt bread without affecting their acceptability.

## 4 Discussion

In terms of ensuring food safety and improving nutritional practices, the WHO has set a global plan of action for the control of NCDs considering a reduction of 30 % of salt intake by 2025 [28]. It should be reminded that the current study constitutes a part of the national multi-sectoral strategy 2019-2029 [23] for the prevention and the control of NCDs. The primary emphasis is to study the feasibility of salt

reduction in bakery bread and acceptability among Moroccan subjects aged from 15 to over 60 years old.

Our results showed that 70.1% of the tasters disliked the taste of bread with 0 mmol/L (corresponding to 0% of added salt), while the taste of bread at a concentration of 250 mmol/L (16% of salt reduction) was appreciated. 78.1% of the population answered by "I like it a lot" against 12.4% who answered "I hate". 75.6%, 72.6% of participants liked the taste of bread at 10% and 23% respectively.

Compared with other studies, these findings were also reported by Miller & Hosney [29], who showed that salt-free baked bread possesses a tasteless taste. Indeed, in the absence of salt, bread was described as "yeasty," "sour," or "acidic" and having "sourdough" type characteristics [30]. In terms of reduction, it can be judged that around 23%, salt reduction is undetectable by consumers which has been well reported by Girgis *et al.* who demonstrated that the salt content of bread can be reduced by 25% with no detection [31]. Another study showed that a salt reduction of 10 to 20% in whole bread does not affect the taste of the bread and could not be detected by tasters [32]. In Germany, an identical study was performed by Mueller *et al.* [26] who adopted the same strategy of salt reduction with the same levels (from 7% to 53%) in pizza crust showed that 7% and 10% sodium reduction were not significantly discriminable from the standard amount, while 16% and 23% reduction tasted significantly less salty. Moreover, Pasqualone *et al.* [33], showed that would be possible to decrease the salt amount of bread formulation to 15 g/kg without significantly affecting consumer's appreciation. 15g/kg corresponds to 10% of salt reduction in our study that agrees with our results.

According to gender, our results underlined a significant difference between overall appreciation of bread taste and this parameter for 30% salt reduction. Women appreciated the taste of bread reduced salt content much more than men. This disagrees with Weiffenbach *et al.* [34], who found no differences in flavors perceptions according to gender.

Concerning age, young participants responded positively to 16% and 10% of salt reduction. However, further age categories responded to the concentration of 208 mM (30% salt reduction). In this context, some authors showed that cultural influences, age, gender and taste phenotype present an effect on taste appreciation [35,36]. Another study, conducted in Australia, demonstrated this interaction between age and salt perception too. 79% of middle-aged women, especially the age category (22-62 years), consumed an average of 25 bread slices a week up to six consecutive weeks of bread with a 5% discount. Women aged 45-60 enjoyed the taste of bread just in the fourth week of testing. The study concludes that 25%

of sodium reduction can be delivered over a short period of time while maintaining consumer acceptance [31].

For the salt intensity in bread, 56.2% of our study population responded by "just about right", while 21.9% of them consider it less salty at the concentration of 16%. Compared to their purchase willingness to each bread type, 21.8% of the population agree to purchase bread corresponding to the concentration of 268 mM (23% salt reduction), and 41.8% agree purchasing bread at 16% of salt reduction, whereas, 20.4% at 30% of salt reduction. La Croix *et al.* [37] found that reducing sodium levels in bread up to 30% did not affect consumer liking or purchase intent of the products.

Additionally, it was shown that a 50% reduction in bread salt did not reduce bread consumption or affect the choice of sandwich fillings [38]. Bertino *et al.* [39] reported that, when subjects ingest solid or liquid foods with salt reduction by 25%, they appreciate the taste foods just after 2 months against the original ones that become too salty in the long term.

In summary, our results highlight the long-term feasibility of a substantial reduction in daily salt intake. In addition, other studies showed that when the reduction in salt content of food is performed gradually, the intervention goes unnoticed for the majority of people. A study, carried out by the health monitoring institute, showed that people consuming large amounts of salt have a caloric intake increase, appetite and thirst [40]. High salt consumption is frequently accompanied by an increase in food consumption, snacking and sweet drinks primarily among young consumers who may become addicted to and, as a consequence, could develop obesity. Indeed, several epidemiological studies have found that high salt intake is correlated with a marked increase in the risk of developing NCDs such as hypertension, cardiovascular diseases, cancer, diabetes and other pathologies which are the leading cause of worldwide mortality [20].

In Morocco, there has been a rapid increase in the prevalence of obesity within the population [9,41]. According to STEPS, a recent survey conducted in Morocco, the prevalence of obesity among adults aged more than 18 years old was 20%. Like other countries in the world, this prevalence has increased compared to that of 2000 (13.2%) [42]. Obesity does not concern solely the adult population, however, adolescents aged between 10 and 19 were also considered obese (9%) [20]. Overweight/obesity and high sodium intake are considered as a risk for developing hypertension among adults and children [43]. High blood pressure is affecting 29.3% of Moroccan adults, this fact has been decreasing slightly between the years 2000 (33.6%) and 2017 (29.3%)[42].

It must be underlined that a healthy diet is a crucial approach for preventing and controlling NCDs. Thus, our study on salt reduction in bread, based on the principle of setting objectives, allows the Moroccan population consuming fewer salt amounts, especially in processed foods and as a result avoiding developing chronic diseases.

Our investigation is comparable to other studies carried out in 19 global countries where salt amounts were reduced in processed foods at 25% depending on the function of the product concerned. Therefore, our study leads to the conclusion that 16% of salt reduction (eq. 14.63 g of salt/kg of flour) in Moroccan bread is a possible target without affecting the taste and the quality of bread consumed by the general population.

## 5 Conclusion

Modest restrictions in salt intake could potentially reduce the risk of morbidity and mortality of cardiovascular diseases. Our results highlight that producing bread containing lower salt levels is technologically feasible. Overall, a 16% reduction of salt did not affect the acceptance of consumers and their willingness to purchase bread. The current study reflects one of the potential strategies for achieving the objective of reducing salt consumption at the level of our population and to decrease the burden of cardiovascular diseases, high blood pressure by reducing its prevalence to 10% by the year 2029.

Some of the potential limitations of this study were that our population presented an unequal distribution according to different age groups with a high effective for participants aged from 15 to 29 years. This may be owing to the encountered difficulty in convincing elderly persons to participate in this survey. While, the final included sample was valid. Nevertheless, further studies will be conducted with the aim of overcoming the present limitations.

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