



## **Determination of the pH, Salt, Sodium and Potassium Content in the Traditional Bread in Western Iran**

Fathollah Aalipour Hafshejani<sup>1\*</sup>, Farangis Mahdavi Hafshejani<sup>2</sup>, Mohammad Aalipour Hafshejani<sup>3</sup>, Reza Mohammadi<sup>1</sup>

1. Food and Drug Department, Shahrekord University of Medical Sciences, Shahrekord, Iran.

2. Hajar Hospital, Shahrekord University of Medical Sciences, Shahrekord, Iran.

3. Medical School, Isfahan University of Medical Sciences, Isfahan, Isfahan, Iran.

ARTICLE INFO	ABSTRACT
<i>Article type:</i> Research Paper	<b>Introduction:</b> Bread is frequently used worldwide and provides a significant portion of the energy, protein, minerals, and vitamins needed by the body. The present study aimed to determine the pH, salt, sodium, and potassium content in the traditional breads in Chaharmahal and Bakhtiari province, Iran.
<i>Article History:</i> Received: 20 Oct 2019 Accepted: 20 May 2020 Published: 30 Jun 2020	<b>Methods:</b> This study was conducted on 451 traditional bread samples of various types, which were randomly collected by the bakery health inspectors in Chaharmahal and Bakhtiari province in 2016. The pH, salt, sodium, and potassium content of the samples were measured using a pH metric and potentiometric and flame photometric methods at the Food Control Laboratory of Shahrekord University of Medical Sciences.
<i>Keywords:</i> Bread Salt pH Sodium Potassium	<b>Results:</b> The mean pH, salt, sodium, and potassium content of the bread samples were 5.85, 1.95%, 765, and 108 mg/100 g, respectively. At least 7.7% of the bread samples were positive for sodium bicarbonate use, and 54% had higher levels than the recommended maximum of salt content. In addition, the ratio of sodium to potassium was 12.07. <b>Conclusion:</b> According to the results, salt use was high in bread production, and a significant portion of the bread samples were positive for sodium bicarbonate use. This could be a major health threat to the community. Therefore, strong control and proper supervision are essential in bread production units.

► Please cite this paper as:

Aalipour Hafshejani F, Mahdavi Hafshejani F, Aalipour Hafshejani M, Mohammadi R. Determination of the pH, Salt, Sodium and Potassium Content in the Traditional Bread in Western Iran. *J Nutrition Fasting Health*. 2020; 8(2): 135-140. DOI: 10.22038/jnfh.2020.43911.1229

### **Introduction**

Bread is frequently used throughout the world as a major food and plays a key role in the provision of the energy, protein, minerals, and vitamins needed by the human body. Previous findings have indicated that in urban and rural communities, 42% and 47% of the daily energy is provided through bread consumption, respectively (1). Flour, water, yeast, and sodium chloride are the main ingredients of bread. The addition of sodium chloride to dough causes the gluten structure to become firm and strong, which improves the ability of the dough to retain the carbon dioxide that is produced during the fermentation process; as a result, bread gains proper volume.

Salt is a natural antioxidant (2). If sodium chloride is not added to bread dough, most of the

carotenoid pigments are eliminated, and the effective substances in the flavor reduce (2). Sodium chloride is a hygroscopic material that tends to absorb water from the surrounding environment, serving two main purposes; the first purpose is to slow the fermentation rate, and the second is to preserve the moisture and softness of bread.

Today, the maximum limit of salt use in bread production is  $2 \pm 0.2\%$  of the flour consumption (2). According to the National Standard No. 2628 of Iran, the maximum salt content in various types of traditional breads (Tafton, Barbari, Lavash, and Sangak) is 1.8% of the dry matter (3). In addition, the National Standard No. 2628 of Iran has introduced pH as an appropriate indicator for the quality assessment of the bread production process. This indicator could also

\* Corresponding author: Fathollah Aalipour Hafshejani, Food and Drug Department, Shahrekord University of Medical Sciences, Shahrekord, Iran. Tel: 00983833332810. Fax: 00983833339908. Email: Aalipour.f@skums.ac.ir.

© 2020 mums.ac.ir All rights reserved.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

detect the illegal use of sodium bicarbonate (baking soda) in bread production. According to the same standard, the pH limit for Tafton, Barbari, and Lavash breads is 5-6, while it is 4.6-5.6 for Sangak bread (3). In the previous studies in this regard, the pH value has been considered the main criterion for the detection of sodium bicarbonate in bread; if the pH of bread is  $\geq 6.2$ , the bread is positive for sodium bicarbonate (4). Sodium and potassium are the major cations of the extracellular and intracellular fluids of the human body, respectively (5). These elements play a pivotal role in the osmotic balance, neuromuscular function, and balance of the acidic and alkaline fluids in the body. High sodium and low potassium intake are associated with the risk of hypertension, stroke, cardiovascular diseases, osteoporosis, obesity, and diabetes, while gastric cancer is also associated with long-term adherence to high-sodium diets (5). According to the World Health Organization (WHO) guidelines, these cations could have positive functions in the body when the sodium-to-potassium ratio of the daily diet is equal to one (6-8).

Studies have indicated that in the world's diet, more than 75% of the body's sodium intake is obtained through the consumption of processed food (e.g., bread), and only 10-15% of sodium is obtained by added salt during cooking and at the table (9, 10). The British Standard Food Agency has set the average sodium chloride content in various types of bread at 1% (range: 0.75-1.2%) (11).

Previous studies in different regions of Iran have shown that the sodium chloride content in various types of bread is approximately 1.2-2%. Since bread is an Iranian staple food, it could be the main source of sodium in the Iranian diet. The present study aimed to evaluate the quality of the bread used in Chaharmahal and Bakhtiari province, Iran based on pH, salt, and sodium and potassium content.

## Materials and Methods

This cross-sectional, descriptive-analytical study was extracted from the first part of an HSR study (code: 568), registered at Shahrekord University of Medical Sciences. Ethical criteria were implemented in accordance with the Code of Ethics No. 87-12-10, and the study protocol was approved by the Ethics Committee of Shahrekord University of Medical Sciences.

The study was conducted on 451 traditional bread samples, including Tafton, Barbari, Sangak, Lavash, and local breads. This sample size was equivalent to half of the total bread samples collected by the health inspectors of Shahrekord University of Medical Sciences from the bakeries in Chaharmahal and Bakhtiari province in 2016. The bread samples were randomly collected and sent to the Food Control Laboratory for health control.

The pH, salt, and sodium and potassium content of the bread samples were measured using valid methods. In addition, chemicals such as silver nitrate, nitric acid, and sodium chloride were measured using the laboratory-grade by Merck, Germany.

### **Determination the pH of the Bread**

The pH of the bread samples was measured in accordance with the Iranian National Standards No. 2628 and 37. In order to determine the pH of the bread samples, a pH meter was first adjusted using the buffer solutions 7 and 4, respectively. Afterwards, 10 grams of the samples was placed in a 100-milliliter container of distilled water, and the pH was measured after 30 minutes. Similar to previous studies, the criteria for the detection of sodium bicarbonate in bread was considered to be  $\text{pH} \geq 6.2$  in the current experiment (4).

### **Sample Preparation for the Determination of the Salt, Sodium, and Potassium Contents of the Bread**

To determine the salt, sodium, and potassium contents of the bread samples, 10 grams of each sample was placed in an electric oven at the temperature of 105°C for a minimum of three hours to remove moisture.

### **Determination of the Salt Content of the Bread**

The sodium chloride content of the bread samples was measured using the potentiometric method (model: Titrand 835 Metromh, made in Switzerland), with the device functioning based on the potentiometric method. The bread salt content was measured using the 0.1 M silver nitrate solution (16.98 grams of dry silver nitrate dissolved in 1 liter of distilled water). To determine the salt content of the bread samples, approximately 1.000 gram of the dried bread samples was placed in a container with 100 milliliters of distilled water, and one drop of nitric acid was added to acidify the reaction medium. Following that, the container was

attached to a Tetrando machine, and the salt content of the bread was calculated based on the amount of the consumed titrant in grams/percentage using the following equation.  $\text{Percentage of Bread Salt} = (0.585 \times \text{Consumed Titrant (ml)} / \text{Sample Weight (g)})$

### Determination of the Sodium and Potassium Contents of the Bread

#### Sample Preparation

The sodium and potassium contents of the bread samples were measured based on the amount of the released ions in the flame using a flame photometer (model: 405, made in USA) (12). To determine the levels of sodium and potassium in the bread samples, 1.000 gram of the dried powder was placed in a capsule and burned with a flame for conversion into black ash. In the next step, the black ash was converted into white ash in an electric furnace at the temperature of 600°C for one day. The obtained ash was dissolved in a 100-milliliter balloon containing distilled water and prepared for injection into the flame photometer apparatus (12).

#### Preparation of the Standard Curves

To determine the standard curve of sodium and potassium, a stock solution and standard working solutions were prepared using the AOAC 969.23 method and laboratory-grade sodium chloride and potassium chloride (12). The sodium and potassium contents of the bread samples were measured using the atomic absorption method with a flame photometer (model: 405, USA) (12).

In accordance with the Instructions of the manufacturer of the device, the device was switched on, and the flame was set to the blue

color by adjusting the amount of gas and air entering the device. Afterwards, pure water was injected into the device as a blank solution, and the device was set to zero in millivolts. In the next step, the working standards of the sodium and potassium solutions were injected into the device from the highest to the lowest concentration. Data were obtained based on the ions released into the flame (mV).

#### Statistical Analyses

The general equation  $y=ax+b$  was obtained after the regression analysis of the obtained data from the injection of the standard sodium and potassium working solutions into the flame photometer using the IBM SPSS version 19. In the equation,  $y$  shows the output data of the flame photometer (mV),  $x$  is the concentration of the substance in the sample solution (mg/ml),  $a$  represents the standard curve slope, and  $b$  is the constant value of the standard curve. In addition, the following equation was applied to calculate the sodium and potassium concentrations in the bread samples:

$$\text{Sodium and Potassium Contents of Bread (mg/100 g)} = 100 \times x / \text{Sample Weight}$$

### Results

In total, 451 samples of various traditional breads were assessed, including 297 samples of Tafton bread (65.9%), 66 samples of local bread (14.4%), 35 samples of Barbari bread (7.7%), 29 samples of Lavash bread (6.4%), and 25 samples of Sangak bread (5.5%). The pH, salt, and sodium and potassium contents of the samples were measured, and the results of the experiments are presented in Table 1.

**Table 1.** Values of pH, Salt, and Sodium and Potassium Ions in Bread Samples

Types of Bread	Number of Tested Samples	Mean Moisture	Mean pH	Salt (g/100)			Sodium Content (mg/100 g)	Potassium Content (mg/100 g)
				Mean	Maximum	Minimum		
Tafton	297	27.77±2.51	5.66±0.42	1.98±0.65	3.81	0.38	787±287	106±18
Lavash	29	26.39±3.58	6.08±0.21	1.52±0.21	4.17	0.29	608±441	103±11
Local	65	26.72±1.79	5.79±0.24	2.06±0.64	3.22	1.01	801±323	109±15
Barbari	35	27.41±1.94	5.90±0.28	1.36±0.66	2.22	0.41	550±588	112±14
Sangak	25	29.12±1.93	5.50±0.11	1.67±0.85	2.82	0.9	663±338	110±10
Total	451	28.27±2.27	5.85±0.4	1.95±0.63	6.30	0.29	769±248	108±13

$\alpha$ : standard deviation

According to the results, the mean pH of various types of bread was 5.84±0.44, and the pH of 51.9% of the samples was within the permissible range of 5-6. In addition, the mean pH of all types

of traditional bread (other than Lavash bread) was within the permissible range.

According to the information in Table 2, the pH of 41.9% of the bread samples was above the maximum permissible limit, while the pH of 5.8%

of the samples was below the minimum permissible limit (5). Based on the pH of  $\geq 6.2$  as the diagnostic criterion of baking soda in bread,

only 7.3% of the bread samples were positive for baking soda.

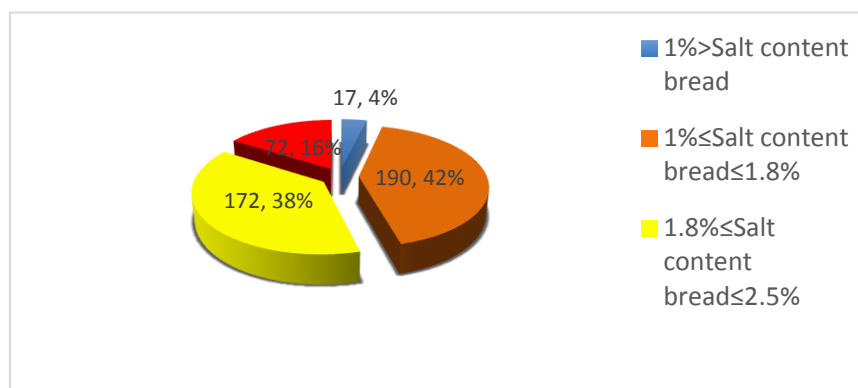
**Table 2.** pH Status of Bread Samples

Sample Number	pH<5		pH: 5-6		6<pH≤6.2		pH>6.2	
	N	%	N	%	N	%	N	%
Total	26	5.8	234	51.9	157	34.8	33	7.3

The mean sodium chloride in various types of bread was  $1.95 \pm 0.63\%$ , which was above the maximum permissible limit (1.8%). However, the salt content of all types of the traditional bread (except the local bread) was within the permissible range. As can be seen in Figure 1, the salt content of 54% of the samples was above the maximum permissible limit.

The mean potassium in various bread samples was  $108 \pm 13$  mg/100 g of bread, and since the

potassium source of bread was quite natural, no significant difference was observed in the potassium content of various types of bread. The mean sodium in various types of bread was  $769 \pm 248$  mg/100 g, with the lowest value observed in Sangak bread and the highest value observed in local bread. Since bread formula salt content is the main source of sodium in bread, a significant difference was observed in the sodium content of various bread types.



**Figure 1-** The frequency of salt content in bread samples tested

## Discussion

Excess sodium chloride used in bread production leads to high sodium intake, which is a major cause of several diseases. The results of the present study showed that only 52% of the bread samples had proper fermentation since the pH of the samples was within the permissible range of 5-6. A study conducted in Sabzevar (Iran) indicated that 76% of the bread samples were within the permissible range, and the fermentation status of the samples in the mentioned study was better than the samples in the present study (4).

Bread pH indicates the fermentation status, and fermentation rate has a significant effect on the micronutrient availability of bread (6). In the current research, 42% of the bread samples with higher pH than the maximum permissible limit

was insufficiently fermented. As a result, the bioavailability of micronutrients such as iron and zinc in these samples was low (5, 6). When dough is not fermented sufficiently, yeast cannot produce the phytase enzyme, and the phytic acid in the dough is not degraded sufficiently, which in turn disrupts the absorption of these cations (5, 6).

Similar to previous studies, we considered the pH of  $\geq 6.2$  in the current research as the criterion for the detection of sodium bicarbonate in bread. Since the pH of 7.3% in the bread samples was higher than 6.2, these samples were considered positive for sodium bicarbonate. The use of sodium bicarbonate in bread production in Chaharmahal and Bakhtiari province has been on the rise as it has been reported that 5% of the bread samples in the area had higher pH than 6.2

in a study (14). However, the use of sodium bicarbonate in this province is less common than the average level of the country (9.1%), as well as the reported values in Najafabad (8.5%) and Isfahan (8%) (15, 16). Bread iron could be absorbed in the intestine when it is first released from the insoluble complexes in bread, reducing from the trivalent form (ferric) to the bivalent form (ferrous) in the presence of gastric acid. This process is disrupted in the presence of sodium bicarbonate and decreases the iron absorption in the gut and lead to the loss of iron-enriched flour costs and gastric inflammation. These events occur due to the inadequate supervision over bread production units (5).

According to the results of the present study, the salt content in various types of bread exceeded the maximum permissible limit (1.8%) (3). Previous studies in different regions of Iran have also shown that bread salt content is within the range of 1.31-2.19% (17-19). In the current research, the salt content of 54% of the bread samples was above the maximum permissible limit, while the studies in Najafabad, Isfahan, and Shiraz (Iran) have indicated that the bread salt content was higher than the maximum permissible limit in 64.5%, 13%, and 9% of bread samples, respectively (15, 16, 19). The Ministry of Health of the Islamic Republic of Iran has recently set the maximum salt level of 1% for different types of bread. Accordingly, the mean salt content of bread in the present study was almost twice higher than the permissible limit.

The current research and previous studies conducted in Iran have shown that the sodium chloride content in bread is higher compared to developed countries, such as the United States and United Kingdom. In a study in this regard, the sodium chloride content of bread in the United States was reported to be 1.28% (20), while in the other studies in the United Kingdom, Spain, France, and Turkey, this value has been estimated at 0.98%, 1.28%, 1.80%, and 1.8%, respectively (10). The issue of reducing sodium chloride consumption in developed countries has received more attention as the United Kingdom managed to reduce the salt content of bread from 1.23% in 2001 to 0.98% in 2011 by 20% (21).

Considering that bread is the staple food of Iranians, it could be a major source of dietary sodium. A study performed in Isfahan showed that the sodium content in more than 53% of bread samples was higher than 800 mg/100 g,

which is in line with the present study (17). While the main source of sodium in bread is sodium chloride added during the production process, the origin of potassium in bread is quite natural. The results of the present study indicated that the mean sodium content of bread was 769 mg/100 g (33.4 millimoles), and the potassium content of bread was 108 mg/100 g (2.7 millimoles). According to the findings in Sweden, Finland, and Norway, the sodium content of bread was 420, 455, and 467 mg/100 g, respectively, while in the present study, the sodium content was almost twice higher (22). Salt plays a key role in the strengthening the gluten network of bread dough, and low-gluten flour needs more salt for good strength in the gluten network (2).

Since sodium is the main extracellular fluid cation and potassium is the intracellular fluid cation, the sodium-to-potassium ratio (molar) of these fluids indicates the state of function of the cell; optimally, this ratio is equal to one (23). Since no additives containing potassium are added to bread during the production process, the potassium content of bread is approximately equal to the potassium content of the flour. If the potassium content of British bread is considered to be 108 mg/100 g, the ratio of sodium to potassium is 1.6, while the ratio in the present study was 12.07. Therefore, British breads are healthier compared to the traditional breads in Chaharmahal and Bakhtiari province.

## Conclusion

Based on chemical indicators (pH, salt, and sodium bicarbonate), the bread consumed in Chaharmahal and Bakhtiari province is not nutritionally appropriate. For the most part, the consumed bread in this region is made of dough with insufficient fermentation. The excessive use of sodium chloride and illegal use of sodium bicarbonate in the bread production process significantly increases the sodium content in bread. Consequently, the consumption of such breads causes numerous health problems. To address this issue, proper Training and continuous monitoring of bread production units are recommended for the reduction of the salt used in bread production. Furthermore, the provision of infrastructures for industrial bread production could be an effective and safe approach to the production of healthy bread. The use of herbs such as fenugreek and fennel could also be effective in reducing salt use in bread

production; herbs and spices are often recommended for salt reduction as they could improve the flavor of bread while exerting healthful effects (24). Therefore, the policies for the reduction of salt consumption should be updated by the authorities.

### Acknowledgements

This article was extracted from a research on a health system (code: 568), approved in 2010 by the Research and Technology Department of Shahrekord University of Medical Sciences, Iran. Hereby, we extend our gratitude to all the collaborators, especially the former head of the Food Control Laboratory and the environmental health inspectors of the university's subsidiary departments for assisting us in this research project.

### References

1. Abdollahi M, Doust-Mohammadian A, Abtahi M, Esmaili M, Houshiarrad A. Validity of Telephone versus Face-to-Face Interviews in the Assessment of Bread Consumption Pattern. *J Community Health* 2014;1(1):45-53.
2. DiMuzio DT. *Bread Baking: An Artisan's Perspective*. John Wiley & Sons; 2009 Feb 24.
3. Iranian National Standardization Organization (INSO). *Traditional breads Specifications and test methods*. (3rd. Revisio). Theran: Iranian National Standardization Organization; 2014.
4. Khmyrchy R, Tavana, Esmaili, Akbari, Arash. Baking soda and salt content of bread in a bakery in Sabzevar. *J Sabzevar Univ Med Sci*. 2010;17(2):135-42.
5. Kathleen M, Escott-Stump, Sylvia. *Krause's Food & Nutrition Therapy*. Mandy L. Corrigan. Water, Electrolytes, and Acid-Balance balance. Elsevier Inc. 2017;85-96.
6. World Health Organization (WHO). *Guideline: Potassium intake for adults and children*. Geneva, World Health Organization (WHO), 2012.
7. Aalipour F. Determine the prevalence contamination foods to synthetic colors with thin layer chromatography in Shahrekord. *J Shahrekord Univ Med Sci*. 2016 Feb 15;17(6):103-12.
8. Aalipour HF, Mahdavi HF, Aalipour HE. Determination of Peroxide Number of Oils Extracted from Zolbia and Okra in the holy month of Ramadan. *JKUMS*. 2015;17(5):74-82.
9. Fulgoni VL, Agarwal S, Spence L, Samuel P. Sodium intake in US ethnic subgroups and potential impact of a new sodium reduction technology: NHANES Dietary Modeling. *Nutr J*. 2014 Dec 1;13(1):120.
10. Quilez J, Salas-Salvado J. Salt in bread in Europe: potential benefits of reduction. *Nutr Rev*. 2012 Nov 1;70(11):666-78.
11. Public Health England (PHE). *Salt Reduction Targets for 2017*. Public Health England; March 2017.
12. Association of Official Analytical Chemists (AOAC). *Monitoring of Sodium and Potassium in Processed Foods*. Association of Official Analytical Chemists (AOAC) method 969.23. 18th Edition 2005.
13. Castanheira I, Figueiredo C, André C, Coelho I, Silva AT, Santiago S, et al. Sampling of bread for added sodium as determined by flame photometry. *Springer-Verlag Berlin Heidelberg* 2009; 621-28.
14. Moshtagi Mogadam M, Amini F, Mardani J. Research of the quality of bread and removing of bicarbonate of soda and reduction of wastage of bread in Charmahal & BaKhtiari 2003-2004. In 7th national congress of environmental health 2004.
15. Rezaei-Mofrad MR, Rangraz-Jeddi F, Moosavi GA. Amount of baking soda and salt in bakeries of Mehrdasht city (Najafabad) during 2009-10. *Feyz Journal of Kashan University of Medical Sciences*. 2011;15(3):267-73.
16. Rezaei-Mofrad M. R, Jeddi F. R, Kashani H, Azarbad Z, Assarian A. Study of Sodium bicarbonate and Sodium chloride in Bakeries of Isfahan-Iran. *Rep Opinion* 2016;8(9):1-6.
17. Maghroun M, Sajjadi F, Sarhanghpour MR, Nouri F, Shriatifar M, Mohammadifard N, et al. Salt and Sodium Content in Iranian Breads. *Hakim*. 2015;18(3):209-16.
18. Zabihollahi T, Goftari S, Garibi F, Naderi K, Korani A, Danesh O, et al. Investigation of the amount of sodium bicarbonate and salt in different types of bread in the bakeries of Kurdistan Province from 2008 to 2010. *Sci J Kurdistan Univ Med Sci*. 2013;18(3):39-46.
19. Zibaenezhad M, Hooshangi M, Abtahi A, Heydari S. A Study of Salt Content in Different Bread Consumed in Shiraz City in Spring/Summer 2009. *Iran Cardiovasc Res J*. 2010;4(1):17-21.
20. Maalouf J, Cogswell ME, Yuan K, Martin C, Gillespie C, Ahuja JK, Pehrsson P, Merritt R. Sodium content of foods contributing to sodium intake: comparison between selected foods from the CDC Packaged Food Database and the USDA National Nutrient Database for Standard Reference. *Procedia food science*. 2015;4:114.
21. Brinsden HC, He FJ, Jenner KH, MacGregor GA. Surveys of the salt content in UK bread: progress made and further reductions possible. *BMJ open*. 2013 Jun 1;3(6).
22. Pastell H, Jöeleht A, Kielland E, Reykdal O, Ohrvik V, sterholt Dalane J. Levels of iodine, sodium and dietary fibre in selected Nordic and Estonian foods. *Food & Nutrition Research* 2016, 60:30961, P 422.
23. Mirzaei M SM, Namayandeh M, Gharahi Ghehi N. Sodium and Potassium Intake of Urban Dwellers: Nothing Changed in Yazd, Iran. *J Health Popul Nutr*. 2014;32(1):111-7.
24. Hoppu U, Hopia A, Pohjanheimo T, Rotola-Pukkila M, Mäkinen S, Pihlanto A, Sandell M. Effect of salt reduction on consumer acceptance and sensory quality of food. *Foods*. 2017 Dec;6(12):103.