



# Evaluation of Salt, Sodium, and Potassium Intake Through Bread Consumption in Chaharmahal and Bakhtiari Province

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## Abstract

**Background and aims:** Bread is considered as one of the important sources of sodium in the Iranian diet and salt is the main source of sodium, which is used to produce bread. The assessment of dietary intake is a reliable method that shows nutritional problems in the community. Therefore, the purpose of this study was to evaluate the intake of salt, sodium, and potassium through bread consumption.

**Methods:** In the present study, 451 samples of different types of bread were tested, sent to the Food Control Laboratory for health control, and the amount of salt, sodium, and potassium was determined by potentiometric and flame-photometric methods, respectively. In addition, the amounts of salt, sodium, and potassium intake were evaluated based on their average concentration in different types of bread and per capita consumption of bread. Finally, the status of salt, sodium, and potassium intake was investigated by comparing their recommended daily allowance (RDA) and sodium/potassium ratio and sodium to caloric intake.

**Results:** Based on the results, the concentrations of salt, sodium, and potassium were 1.95%, 769%, and 108% (mg per 100 g of bread), respectively. Furthermore, per capita consumption of bread was 320 g/d and the average intake of salt, sodium, and potassium through bread consumption was 4.03 g, 1588 mg, and 223 mg/d, respectively. Moreover, 79% of sodium RDA was received through bread consumption. In these breads, the ratio of sodium to potassium, as well as that of sodium to calorie was 12.07 (mmol/mmol) and 2 mg/calories, respectively.

**Conclusion:** In general, the results showed that the intake of sodium and salt by using bread is more than that of their RDA. Accordingly, the ratio of sodium to potassium and sodium to caloric intake is higher than the permitted limit in these conditions, which provides the basis for the incidence of cardiovascular diseases. Therefore, strong monitoring of bread producing units is necessary.

**Keywords:** Estimation of intake, Salt, Sodium, Potassium, Bread

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## Introduction

Accordingly to several studies, there is a positive association between sodium intake with hypertension and cardiovascular diseases.<sup>1,2</sup> The World Health Organization (WHO) recommends the public to reduce the daily intake of sodium to 2000 mg/d, which is equal to 5 grams of salt per day.<sup>3</sup> Nowadays, only a few countries are able to reduce the average daily intake of sodium for adults to below the WHO recommendation.<sup>4</sup> The high intake of sodium is a global problem so that the sodium intake of 86.2% of Americans, 89.1% of the French, 81% of Koreans, 83.4% of British, and 44% of Mexicans is more than the WHO recommendation.<sup>5</sup> Based on the results of a previous study, the average sodium intake in the world is 3.95 g/d.<sup>6</sup>

The origin of about 90% of our daily sodium intake comes from the salt that is used to make food delicious and prevent food spoilage. More than 75% of the daily

sodium intake of Americans is through the processed food while about 10% belongs to sodium, which is naturally found in food and the remaining percentage comes from the salt that is used to cook or is consumed in the table.<sup>7,8</sup> According to the American diet guidelines issued in 2010, the maximum sodium intake for the whole population and the groups at high-risk like diabetic patients was estimated 2300 mg and 1500 mg/d, respectively.<sup>9</sup>

In addition, sodium and potassium are the main cations of extracellular and intracellular fluids and have an important role in the osmotic balance, the function of neuromuscular, and the maintenance of the acid balance of body fluids. High sodium intake and low potassium intake increase high blood pressure and the occurrence of stroke and cardiovascular diseases. Further, the increased urinary excretion of calcium, followed by osteoporosis, obesity, diabetes, and stomach cancer are the result of

excessive salt intake in the diet. Furthermore, excessive salt intake increases the person's desire for consuming sweet and high-calorie foods, which can lead to obesity, diabetes, and related complications.<sup>10</sup> The recommended maximum limit of the sodium and potassium intake in the diet is 2300 mg and 4700 mg/d, respectively. In accordance with the WHO guidelines, the best ratio of sodium to potassium intake in a normal daily diet is equal to 1 so that these cations can have optimal functions in the body.<sup>11,12</sup>

Bread is widely consumed in many parts of the world and has a significant contribution to the supply of the required energy, protein, vitamins, sodium, and other minerals of the body.<sup>13</sup> According to the Iranian National Standard (No.2628), the maximum limit of salt in different types of bread such as Taftoon, Barbari, Lavash, and Sangak is 1.8% of dry matter.<sup>14</sup>

Iranians are the second largest consumers of bread in the world with a per capita 117 kilograms per person, which is 4.5 times higher than the global average.<sup>15</sup> Turks consume the most bread with a per capita of 150 kg annually. Additionally, Germans, French, and British consume bread with a per capita of 70 kg, 56 kg, and 37 kg, respectively.<sup>8</sup> In 2010, the per capita consumption of bread in the United States and Australia was 50 and 46 kg, respectively.<sup>8,15</sup>

Similarly, 30% of daily sodium intake in the Western diet is due to the consumption of bread and cereal products.<sup>16</sup> British and American standard food agencies set the maximum amount of sodium in white bread at 400 and 490 mg per 100 grams of bread, respectively.<sup>17</sup> The evaluation of dietary intake is regarded as a reliable method that demonstrates nutritional problems in the community. Therefore, the present study aimed to evaluate the intake of salt, sodium, and potassium through bread consumption.

## Materials and Methods

This study is a result of a research project registered with code 568 at the Research and Technology Deputy of Shahrekord University of Medical Sciences. In the first part of this research, the values of pH, salt and sodium, and potassium ions were determined in different kinds of traditional bread consumed in Chaharmahal and Bakhtiari province. The amount of salt, sodium, and potassium obtained through bread was evaluated in this section.

This study was conducted on 451 samples of different types of traditional bread including Taftoon, Barbari, Sangak, Lavash, and Local Bread that were sent to the Laboratory of Food Control of Shahrekord University of Medical Sciences by health inspectors. These samples were collected from the bakeries of Chaharmahal and Bakhtiari province by the health inspectors of the health centers during 2016 and were sent to the Food and Beverage Control Laboratory of Shahrekord University of Medical Sciences under cool conditions using the cool box. In addition, the amount of salt, sodium, and potassium of the

bread samples was determined according to valid methods.

The amount of salt of the bread samples was measured according to Iranian National Standard No. 2600 by a potentiometric method using a Titrator device model (835 Metrohm, Switzerland). In this method, 0.1 molar silver nitrate solution and concentrated nitric acid were used in accordance with the manufacturer's manual.

The amount of sodium and potassium in the bread samples was measured based on the amount of released ions in the flame photometer device.<sup>18</sup>

## Estimated Daily Intake of Sodium and Potassium by Traditional Bread Consumption

In order to estimate the daily intake of salt and sodium, the net per capita daily consumption of bread was calculated according to equation (1):

$$B_{(g/day)} = A_{(g/day)} - [(A_{(g/day)} \times M_{(g/100g)} + A_{(g/day)} \times W_{(g/100g)})] \quad (2)$$

where, A and B demonstrate per capita daily consumption of bread (in g/d) and net daily consumption of bread (in g/d), respectively. Further, M and W denote the average moisture content of bread in percentage and the percentage of bread waste, respectively.

Similarly, the amount of bread waste was considered based on 10% of the per capita consumption of bread.

Furthermore, the amount of salt intake by bread consumption was computed based on equation 2:

$$C_{(g/day)} = B_{(g/day)} \times S_{(g/100)} \quad (2)$$

where, C and B indicate the amount of salt intake (in g/d) and per net capita daily consumption of bread (in g/d), respectively, and S is the average percentage of bread salt.

Likewise, the daily intake of sodium and potassium were calculated according to the following equation:

$$D_{(mg/day)} = B_{(g/day)} \times E_{(mg/100)} \quad (3)$$

where, D is the amount of sodium or potassium intake, B demonstrates per net capita daily consumption of bread (in g/d), and E represents the sodium or potassium concentration of the sample in mg per 100 g.

## Results

Table 1 demonstrates the results of the tests performed on 451 samples of different types of bread in order to determine the amount of salt, sodium, and potassium. Moreover, Table 2 shows the comparative results of per capita consumption of bread, the permissible percentage of salt in bread, and the percentage of recommended daily allowance (RDA) for sodium and potassium, obtained through the consumption of bread between the current study and several developed countries. As shown in Table 3, Turkey is the largest consumer in the world with 411 g/d for consumption per capita, followed by Iran with 320 g/d

**Table 1.** The Values of pH, Salt, Sodium, and Potassium in the Tested Bread Samples

| Kind of Bread | Number & Percentage of Samples |       | Average Percent of Moisture (Mean $\pm$ SD) | Average pH      | Salt Percentage (g/100) |         |         | Sodium Content of Bread (mg/100 g) | Potassium Content of Bread (mg/100 g) |
|---------------|--------------------------------|-------|---|-----------------|-------------------------|---------|---------|------------------------------------|---------------------------------------|
|               |                                |       |   |                 | Average                 | Maximum | Minimum |                                    |                                       |
| Taftoon       | 297                            | 65.9% | 27.77 $\pm$ 2.51                            | 5.66 $\pm$ 0.42 | 1.98 $\pm$ 0.65         | 3.81    | 0.38    | 787 $\pm$ 287                      | 106 $\pm$ 18                          |
| Lavash        | 29                             | 14.4% | 26.39 $\pm$ 3.58                            | 6.08 $\pm$ 0.21 | 1.52 $\pm$ 0.21         | 4.17    | 0.29    | 608 $\pm$ 441                      | 103 $\pm$ 11                          |
| Local         | 65                             | 7.7%  | 26.72 $\pm$ 1.79                            | 5.79 $\pm$ 0.24 | 2.06 $\pm$ 0.64         | 3.22    | 1.01    | 801 $\pm$ 323                      | 109 $\pm$ 15                          |
| Barbari       | 35                             | 6.4%  | 27.41 $\pm$ 1.94                            | 5.90 $\pm$ 0.28 | 1.36 $\pm$ 0.66         | 2.22    | 0.41    | 550 $\pm$ 588                      | 112 $\pm$ 14                          |
| Sangak        | 25                             | 5.5%  | 29.12 $\pm$ 1.93                            | 5.50 $\pm$ 0.11 | 1.67 $\pm$ 0.85         | 2.82    | 0.9     | 663 $\pm$ 338                      | 110 $\pm$ 10                          |
| Total         | 451                            | 100%  | 28.27 $\pm$ 2.27                            | 5.85 $\pm$ 0.4  | 1.95 $\pm$ 0.63         | 6.30    | 0.29    | 769 $\pm$ 248                      | 108 $\pm$ 13                          |

**Table 2.** Comparison of Salt, Sodium, and Potassium Intake by Bread between Iran and Several other Countries

| Country              | Per capita Consumption of Bread |     | Salt Content of Bread (g/100) | Amount of Salt Intake by Food Consumption (g/d) | Amount of Sodium Intake by Bread Consumption (mg/d) | RDA Percent of Sodium Intake by Bread Consumption | Potassium Content in the Bread (mg/d0) | Ratio of Sodium to Potassium in the Consumed Bread (mmol) | Year of Survey |
|----------------------|---------------------------------|-----|-------------------------------|---|---|---|--|---|----------------|
|                      | kg/y                            | g/d |                               |   |   |   |  |   |                |
| Iran (present study) | 116.8                           | 320 | 1.95                          | 4.03 <sup>a</sup>                               | 1588 <sup>a</sup>                                   | 79.4%   | 223 <sup>a</sup>                       | 12.1  | 2016           |
| The US <sup>19</sup> | 60                              | 165 | 1.28                          | 2.11  | 844   | 42.2%   | 178                                    | 8.04  | 2015           |
| France <sup>8</sup>  | 50                              | 137 | 1.8                           | 2.47  | 970   | 48.5%   | 148                                    | 11.1  | 2007           |
| The UK <sup>8</sup>  | 37                              | 101 | 0.98                          | 0.99  | 396   | 19.8%   | 109                                    | 6.2   | 2011           |
| Turkey <sup>8</sup>  | 150                             | 411 | 1.82                          | 7.48  | 2947  | 147.3%  | 444                                    | 11.3  | 2009           |
| Spain <sup>8</sup>   | 46                              | 126 | 1.28                          | 1.61  | 644   | 32.2%   | 136                                    | 8.02  | 2008           |

<sup>a</sup> indicated that the average intake of salt, sodium, and potassium by bread was calculated based on 10% for bread waste and 28.3% for bread moisture content according to the following equations:

The average intake of salt, sodium, and potassium through bread consumption = net per capita consumption of bread  $\times$  Dry matter content of bread

Net per capita consumption of bread = per capita consumption of bread - 10%  $\times$  per capita consumption of bread (320 - 10% $\times$ 320=288 g/d)

Dry matter content of bread = 100 - moisture content of bread (100-28.3=71.7)

**Table 3.** Comparison of Sodium to Calorie Intake by Bread Between Iran and Some Other Countries

| Country              | Daily Consumption of Bread (g/d) | Number of Serving Bread (1 Serving bread=30 g) | Amount of Calories by Bread Consumption (cal) | Percentage of Received Calories to Energy RDA | Received Sodium Content by Bread Consumption (mg/d) | Ratio of Sodium Intake to Sodium RDA | Sodium to Calorie Intake by Bread Consumption (mg/cal) |
|----------------------|----------------------------------|--|---|---|---|--------------------------------------|--|
| Iran (present study) | 288                              | 9.6  | 768   | 38.4%   | 1588  | 79.4%                                | 2.06   |
| The US <sup>19</sup> | 165                              | 5.5  | 440   | 22%   | 844   | 42.2%                                | 1.87   |
| France <sup>8</sup>  | 137                              | 4.5  | 360   | 18%   | 970   | 48.5%                                | 2.69   |
| The UK <sup>8</sup>  | 101                              | 3.4  | 272   | 13.6%   | 396   | 19.8%                                | 1.45   |
| Turkey <sup>8</sup>  | 411                              | 13.7   | 1096  | 55%   | 2947  | 147.3%                               | 2.69   |
| Spain <sup>8</sup>   | 126                              | 4  | 320   | 16%   | 644   | 32.2%                                | 2.01   |

Cal: Calorie; RDA: Recommended daily allowance.

while the United kingdom is the smallest bread consumer with 101 g a day per person. The results indicate that Iran, with the consumption rate of 1.95 g of salt, has the highest rank while Britain, with the consumption of 0.98 g of salt, has the lowest rank in terms of producing 100 g of bread. Additionally, Turkey and Iran have the highest levels of salt and sodium intake through bread consumption whereas Britain has the lowest level of receiving these elements. In addition, the British receive 19.8% of sodium RDA through bread consumption while Turks and Iranians receive more than 147% and 79% of sodium RDA by

bread, respectively.

## Discussion

The findings of the study revealed that the average amount of salt in different types of bread was higher than the maximum permitted rate (1.8%) of National Standard of Iran. Some previous studies discussed that the salt content of bread varies from 1.31% to 2.19% in different regions of Iran.<sup>20-22</sup> According to such studies, the amount of salt consumed for bread production is high in Iran. Meanwhile, the average salt concentration in Iranian bread

is higher compared to the bread produced in developed countries such as the United States, Britain, and Spain. This is due to that issue that the maximum allowed salt in the bread standard of Iran with 1.8% is higher than that of the US standard (1.22%) and the UK (1%). The nutritional quality of the bakery flour, especially in terms of protein content is lower in Iran compared to that of the developed countries. Further, the main bread is produced in the traditional way in Iran, while in developed countries it is produced more by industrial methods. Therefore, all the above-mentioned factors increase the amount of salt in Iranian bread.<sup>17</sup>

Based on the results of this study, there was about 769 mg of sodium in 100 g of bread. In other words, each Iranian receives about 1588 mg of sodium per day with consumption of 320 g of bread. Similarly, the amount of sodium was equal to 79.4% of the RDA of every Iranian while the results of a study in the United States showed that every 100 g of bread contains 512 mg of sodium, therefore, each American receives 42% of sodium RDA by consuming 165 g of bread per day.<sup>19</sup> Thus, Iranians receive about 2 and 4 times more sodium than Americans and Britons due to higher per capita consumption of bread and higher salt concentration in their bread.

In developed countries, the bakery industry pays more attention to the issue of limiting salt intake for bread production. For example, a study showed that Britain was able to reduce the amount of bread salt by about 20% from 1.23% in 2001 to 0.98% in 2011.<sup>23</sup> Furthermore, salt intake through bread consumption was reduced up to 26% and 20% in New Zealand and Australia, respectively.<sup>23</sup>

Sodium and potassium are the most important extracellular and intracellular cations and the physiological concentration of both cations in molar should be within the normal range with a ratio of one for the cells to function properly. Moreover, the physiological concentration of these cations in body fluids is heavily influenced by the diet. The risk of diseases associated with high blood pressure increases if the molecular ratio of sodium to potassium in our diet exceeds 1. According to the results of this study, the molar ratio of sodium to potassium intake through bread consumption in Chaharmahal and Bakhtiari province was 12.1, which was double that of Britain and 1.5 times the United States, therefore, the situation of the Iranian diet is not healthy.

According to the WHO dietary guidelines, sodium/caloric intake, which is equal to one in a healthy diet, is considered as one of the criteria for a healthy diet.<sup>12</sup> This means that it is received 1 calorie of energy per 1 mg of sodium. Considering that in this province, about 80% of sodium RDA and 38% of the energy RDA were received through the consumption of bread, the ratio of sodium to caloric intake was twice the WHO recommended limit. This situation indicates that the sodium intake in Iran, in

particular, in Chaharmahal and Bakhtiari province is about twice the WHO rate. According to the current guidelines of the Ministry of Health of the Islamic Republic of Iran, the amounts of salt in bread production reduces to less than 1%, if sodium intake significantly reduces while sodium/calorie ratio improves with a decreasing trend.

### Conclusion

Overall, sodium and potassium are essential elements that the human body needs, which cause health problems if their received amount is more or less than the RDA. The assessment of their daily intake helps to identify the causes of the involved health problems. The methods for evaluating daily sodium and potassium intake at the community level include determining their urinary excretion over a 24-hour period and estimating their nutritional intake. Salt is the main source of sodium in the diet that is used as an additive in food and bread is regarded as the main food of Iranians. Therefore, bread plays an important role in receiving daily sodium in Iranian diets and assessing the amount of sodium and potassium intake through bread can help us identify the health problems associated with their intake. The findings further show that about 80% of RDA sodium is received through bread due to high salt consumption in the production of bread and this condition plays an essential role in the occurrence of hypertension and mortality. Accordingly, the maximum allowed salt in bread production should be reduced in the relevant standard to the level determined by the Ministry of Health of the Islamic Republic of Iran. In addition, this study should be undertaken in other parts of the country in order to generalize the results to further contexts. Finally, more vigorous monitoring units are required to control bread production units.

### Ethical Approval

The protocol of this study was in accordance with the ethic committee of Shahrekourd University of Medical Sciences (code: IR.skums.REC 87-12-10).

### Conflict of Interest Disclosures

None.

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