



ORIGINAL ARTICLE

Residuals of Baking Soda and Sodium Dithionate in Bread and Environmental Health Status of Bakeries in Iran's Military Forces

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KEYWORDS

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ABSTRACT: In Iran, bakers use baking soda and sodium dithionate to lower baking costs, save time, and hide their product's imperfections. Because of the harmful effects of these additives on human's health, the Ministry of Health of Iran has banned their use for baking bread. The residuals of baking soda and sodium dithionate in bread, the relationship between these substances and bread type, baking time, and sanitary status of bakeries in military bases of one of Iran's military forces were examined. Out of 21 organizational dormitories, 15 were randomly selected, and 30 Iranian bread samples (Sangak, Lavash, Taftoon, and Barbari) were purchased. Baking soda and sodium dithionate content was investigated following the national standard methods. The sanitary status of bakeries was assessed by a checklist developed by the Ministry of Health. Based on the pH standard cut off point, 60% of the samples were considered positive in terms of using baking soda. Taftoon with 75% and Lavash with 66% had the highest frequencies of using baking soda. There was a statistically significant relationship between the type of bread and pH at the error level of 0.05 ($p=0.05$). All the samples were negative for using sodium dithionate. The sanitary status of bakeries was satisfactory; however, personal hygiene needed improvement. There is a need for constant monitoring to prevent bakeries from using the additives. Strict rules along with resolving deficiencies and educating sanitation guidelines will help to improve the sanitary status of bakeries.

INTRODUCTION

Bread, as the most important product of wheat, is the main food in many countries [1]. More than 35% of the people around the world consume it as a food [2].

Bread is the main ingredient in the food basket of Iranian households and provides most of the energy, protein, some minerals, and vitamins needed by the body. The average per capita bread consumption in Iranian households is 320 grams per day (286 grams in urban areas and 382 grams in

rural areas) which is almost twice European countries [3, 4]. Therefore, it is important to pay special attention to the production and consumption conditions of bread from hygienic, nutritional, and economical viewpoints [5].

One of the most important obstacles to improve the quality of bread is the poor quality of flour. Some important reasons for the poor-quality flour is low quality of domestic wheat, failure to observe proper storage time before

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sending to flour mills, lack of wheat sorting in factories, failure to observe hygienic principles of wheat storage, use of illegal additives, inadequate training and experience of bakers, and so on [4]. Consequently, bakers may use chemical substances such as baking soda and sodium dithionate to resolve the flavor deficiencies and save time, cost, and energy and also cover the poor quality of breads [1].

Although, baking soda is used as a substitute for the natural fermentation of bread, it can reduce the quality of bread. The improper fermentation interferes with the intestinal uptake of the divalent metals in bread such as iron and calcium [6]. Prolonged and continuous use of baking soda leads to the neutralization of the gastric acid, gastrointestinal disorders, and indigestion because of secretion of more acid [7].

Blanket (Dithionite ($\text{Na}_2\text{S}_2\text{O}_4$)) is a white sulfur-derived powder which is used as an inexpensive and easy way for bleaching various types of breads and sugar products in order to increase their transparency and desirability [8-10]. Studies have shown that excessive use of sulfur containing compounds causes gastrointestinal, respiratory [11], cutaneous [12], and visual [13] diseases. Sodium dithionite entering the gastrointestinal tract destroys gastric and intestinal villi [14], and in long-term, predisposes the user to gastrointestinal cancers by reducing antioxidant capacity [15]. The direct inhalation of sodium dithionite agitates the respiratory system of humans [16]. This compound also interferes with the function of hormones, especially insulin, so it can directly accelerate the development of diabetes [17]

The harmful effects of these additives (dithionite and baking soda) on human's health urged the national standard organization of Iran to prohibit the use of these agents by bakeries around the country (standard No. 2628) [18]. On the other hand, in 2001, the Health Ministry of Iran approved this prohibition, and in turn, the Ministry of Industrial Affairs instructed bakeries to use sourdough instead of dithionite and baking soda in 2006[6].

Considering the above-mentioned and also the high per capita consumption of bread in Iran (about 140-160 kg per year), the present study is aimed at determining the

presence of residuals of baking soda and sodium dithionate in bread and the relationship between the presence of these substances with bread type and baking time in the government-leased houses of Iran's military forces. The adherence of the bakeries to sanitation guidelines was also assessed.

MATERIALS AND METHODS

A cross-sectional study was conducted to detect the residuals of baking soda and sodium dithionate (sodium dithionite) in the breads baked in military neighborhood of a military force of Iran over a period of three months in 2019. The statistical population included the bakeries of 21 residential areas in Tehran, of which 15 were randomly selected. Two breads, one in the morning (i.e., baking onset) and one in the afternoon (end of baking) were collected from each bakery.

After placing in plastic containers and recording the date and specifications of the sampling location, the samples were transferred to the laboratory. The samples were stored in the refrigerator until use. Measuring baking soda and sodium dithionate was performed in accordance with the standard No. 2628 of the Iranian standard organization. The sanitary status of the bakeries was evaluated using the surveillance checklist developed by the Iran Ministry of Health to inspect traditional bakeries (the form code 920318/111).

Measuring baking soda

In accordance with the standard No. 2628 of the Iranian National Organization for Standardization, a pH meter, buffers No. 4 and 7, and distilled water were used in the test. Briefly, bread was initially air-dried and powdered in the laboratory. Then, 10 g of the bread was mixed with 100 mL distilled water in a 250 mL Erlenmeyer flask. The mixture was stirred for 20 minutes for homogenization. After that, the solution was allowed to rest for 20 minutes to allow the pellet to precipitate. Finally, pH was determined using a pH meter, and a value higher than 6 (for Sangak bread higher than 5.6) was considered as the

evidence for the presence of baking soda in the product [18]

Sodium dithionate measurement

The instruments and materials used in this assay included a 1000-mL volumetric balloon, a 1000-mL Erlenmeyer, a digital scale, Williams' set, nitrogen gas with 99% purity, 0.9-1 mg l⁻¹ hydrogen peroxide solution, Bromophenol Blue detector solution, 0.01 N sodium hydroxide, and distilled water. All the materials used had standard laboratory grades and were sulfate free.

Having the bread samples air-dried and ground in the laboratory, 50 grams of the sample was placed into a 500 mL Williams' set balloon containing 250 mL of distilled water. The mixture was thoroughly shaken for 20 minutes, and a number of glass pearls were also added to the mixture.

For distillation, 50 mL of hydrochloric acid was poured into a tapped funnel. In each of the bubbles, 3 mL of hydrogen peroxide and 0.1 mL of the detector reagent were added. Hydrogen peroxide was then neutralized by sodium hydroxide to change its color from yellow to purple. Then the cooler and the bubbles were connected to the device, and nitrogen flow was slowly established to drive out air. The balloon-coolant connection was covered with paraffin to avoid leakage. [18]

The sanitary status of bakeries

A checklist developed by the Ministry of Health for inspecting the adherence of traditional bakeries to sanitation guidelines was used. The checklist consisted of four sections: personal hygiene (14 questions), food hygiene (10 questions), instruments/equipment hygiene (16 questions), and building hygiene (16 questions).

Statistical analysis

SPSS version 16 was used to analyze the data. To assess the relationship of baking time and the type of bread with the amount of used baking soda and sodium dithionite, analysis of variance and t-test were used.

RESULTS

Overall, 30 samples were obtained from a total of 15 bakeries, including four Sangak, four Taftoon, four Barbari, and three Lavash breads. Half of the samples (15, 50%) were collected in the morning, and the other half in the afternoon.

Out of 30 samples tested, 60% rendered positive results for using baking soda, and 56.7% had a pH higher than 6. Taftoon breads with a mean pH above 9 showed the highest pH among the tested samples. Out of 30 samples, all (100%) delivered negative results as to sodium dithionite. Table 1

Table 1. pH of bread samples

pH	Frequency	Percent%
Over standard (6 for Barbari, Taftoon and Lavash, 5.6 for Sangak)	18	60
Lower than standard	12	40

There was no significant relationship between the type of bread and using baking soda Table 2. However, there was a statistically significant relationship between the types of bread in terms of pH Table 3. According to the Scheffe post hoc test, the mean pH differences between Taftoon and both Sangak ($p = 0.02$) and Barbari ($p = 0.01$) were

statistically significant. Out of 15 samples of the morning and afternoon, 73.3% and 47% were positive for baking soda test respectively. Nevertheless, there was no statistically significant relationship between baking time and presence of baking soda Table 4.

Table 2. Relation between types of bread and presence of baking soda.

Kind of bread	Baking soda				Sum		Sig.
	Positive	Percent	Negative	Percent	Frequency	Percent	
Sangak	5	62.5	3	37.5	8	100	0.39
Lavash	4	66	2	34	6	100	
Taftoon	6	75	2	25	8	100	
Barbari	3	17	5	83	8	100	

Table 3. ANOVA between types of bread and pH of bread samples.

Kind of bread	Test parameters			F	Sig.
	Mean	SD			
Sangak	6.04	0.34		5.38	0.005
Lavash	6.51	1.21			
Taftoon	7.95	1.84			
Barbari	5.91	0.46			
Total	6.61	1.36			

Table 4. Time of baking and presence of baking soda (pH of bread samples).

Time of baking bread	Baking soda				Sum		Sig.
	Positive	Percent	Negative	Percent	Frequency	Percent	
Morning	11	73.3	4	26.7	15	100	0.14
Afternoon	7	47	8	53	15	100	

Sanitary status of bakeries based on the Health Ministry's checklist

Regarding the personal hygiene in the studied bakeries, washing hands with soap and water, smoking ban, using suitable and clean clothes, and designating a place to keep personal belongings acquired the highest compliance rate (100%). On the other hand, proper informing about the ban on smoking (73.3%) and the entry of unauthorized people (60%) had the lowest compliance with the standard.

Overall, personal hygiene was at moderate level in 60% of cases Table 5.

The least compliance rates were also related to self-monitoring and self-reporting of sanitary status. The overall rate of food hygiene was at a satisfactory level in 73.3% of cases Table 6.

Table 5. Personal health of bakeries

Level	Frequency	Percent%
Good	4	26.7
Moderate	9	60
Poor	2	13.3
Total	15	100

Table 6. food safety of bakeries

Level	Frequency	Percent%
Good	11	73.3
Moderate	4	26.7
Total	15	100

Regarding the hygiene of instruments and equipment, a standard sink with both warm and cold taps, sewage system, and using a colorless and stainless dough mixer equipped with warm and cold water attained the highest rates of compliance with the standard (100%). Appropriate packaging and using intact and clean cooking utensils had the lowest compliance rates. Overall, the hygiene of instruments/equipment was the highest and satisfactory in 86.7% of studied bakeries.

Regarding the hygiene of the building, the lighting, temperature, and humidity of the place had the lowest compatibility with the standard. The overall building hygiene was acceptable in 60% of cases.

DISCUSSION

This study was conducted to detect baking soda and sodium dithionate in four types of Iranian breads (Sangak, Lavash, Taftoon, and Barbari) and to evaluate the compliance with sanitation guidelines in the bakeries of the military neighborhoods of Iran's military forces. According to the national standard of Iran, a pH higher than 6 is considered as positive for baking soda (except for Sangak).

Our results showed that 17 of the samples (60%) had a pH higher than the allowable standard. The highest pH was related to Taftoon and Lavash. Regarding the cooking time, 73% of the samples collected in the morning were positive for baking soda.

There was a statistically significant relationship between the type of bread and pH ($P = 0.005$), and there were significant pH differences comparing Taftoon with Sangak and Barbari. Nevertheless, no statistically significant relationship was detected between the baking time and the presence or absence of baking soda in bread ($P > 0.05$).

The results indicated that none of the bread samples contained no sodium dithionate, which meant 100% of the samples were negative in terms of this substance.

Regarding sanitary status, personal hygiene was at moderate level in 60% of the bakeries, and the hygienic conditions of food, instruments/equipment, and building were satisfactory in 73.3%, 86.7%, and 60% of cases respectively.

Mohammad Beigi et al. (2018) examined the prevalence of using baking soda in 234 bakeries in Qom City and showed that 29.9% of the bakeries used the substance, with the highest rates belonging to Taftoon (38.7%) and Lavash (31.5%) bakeries [19]. Their findings is consistent with our results (Taftoon 75% , Lavash 66%).

A survey of the consumption of baking soda by 95 bakeries in Zabol City showed that 67.3% of the samples were positive. In a recent study, Taftoon bread had the highest positive rate with 73.9%, and a statistically significant relationship was found between the type of bread and the rate of baking soda utilization ($P=0.03$) [1]. This result is consistent with our study.

Another study evaluated the status of traditional breads in the bakeries of Gonabad City and reported that 71% of the bread fulfilled the standard range, and Taftoon bread with 28.6% had the highest amount of baking soda, which is consistent with current study [20].

The results of a study in Bandar Abbas City revealed that 21% of Lavash and 16% of Taftoon breads had pH values higher than the standard [21]. The results of a study by Rostami et al. (2011) on the sanitary status of 14 bakeries belonging to Iran's army and 14 regular bakeries across the city showed that 42.9% of Lavash bread baked by the army bakeries and 14.3% of the bread of other bakeries were positive for baking soda [5].

The usage of baking soda and salt in the bakeries of Najafabad in Isfahan was assessed. Overall, 91.5% of the samples in the study were positive for baking soda. Among various types of bread, Brabari and Sangak each with 100% and Taftoon with 93.4% had the highest positive rates respectively; however, no statistically significant relationship was found between the type of breads in terms of baking soda use [6]. Regarding the high amount of baking soda in Taftoon bread, their results are consistent with those of the present study. In contrast, we noticed a significant relationship between the type of breads in terms of using baking soda, and this inconsistency can be due to the different number of samples in the two studies.

Although, the use of baking soda has been banned by the Iran's Ministry of Health since 2001[22] and selling this product to bakeries has also been prohibited since 2006 [23], the results of studies showed that this substance is still used by bakeries across the country. Among the reasons for using this compound, one can mention the low quality of flour due to variations in the breed of wheat or improper storage and grinding conditions, low knowledge of manufacturers and bakers about available instructions, time shortage, and shortening the time of dough preparation [9]. By educating bakers and others involved in bread preparation to improve their attitudes, regularly inspecting bakeries, and establishing punishments and rewards, it is possible to resolve these shortcomings and help to improve bread quality and reduce baking soda utilization.

The statistically significant relationship observed between the type of bread and pH can be due to the relatively higher pH values of Taftoon and Lavash in comparison with other types of bread. The reasons of higher pH of Taftoon bread compared with other types of bread, which has been observed in many studies, are not clear. However, it seems that factors such as the type of flour, the method and duration of heating (heat breaks baking soda down to sodium carbonate, water, and carbon dioxide), baking instructions, bakers' experience, knowledge, and attitude, as well as the number of samples tested can affect this outcome. Nevertheless, confirming the effects of these parameters needs more studies with a higher number of samples.

As mentioned 100% of the samples were negative for sodium dithionate. Another study investigated the use of sodium dithionate by the bakeries of Hamedan City in three types of bread (Sangak, Lavash, and Barbari) by spectrophotometry. The results showed that 97% of the samples were negative, and only 3% (Lavash) were positive for extremely low levels of this substance ($0.0041 < 1$ as the standard cut off) [24]. This finding is consistent with that of our study.

Consistent with our findings, the residuals of sodium dithionate in the industrial breads produced in Tehran was investigated and none of the samples were positive for this substance [25]. We found no report investigating the residuals of sodium dithionate in breads overseas. This can be explained by the fact that this substance is allowed to be used as an additive in industries such as sugar and food production, as well as textile, paper production, and cellulose fibers while it is not allowed to be used in bakeries, therefore no studies have been conducted to investigate its residuals in bread in other countries.

Regarding the sanitary status of bakeries, although the results of this study showed that the general status of the bakeries' environment was satisfactory, there was a need to improve individuals' adherence to personal hygiene and educate them.

A study on the sanitary status of bakeries in Bandar Abbas City showed that 65.7% and 27.9% had poor and moderate sanitary parameters [21]. Consistent with our study, the lowest score reported for personal hygiene.

An investigation stated that 57.1% of army bakeries and 71.4% of regular bakeries had moderate and poor levels of compliance with sanitation guidelines respectively ($P > 0.05$) [5]. In terms of personal hygiene, they also reported a poor condition, which is consistent with the results of the present study. Absence of a valid certificate of passing a public health course, lack of soap and washing liquid, and inappropriate clothing were the main reasons for the low hygiene scores. In comparison, we noticed that a lack of information about the prohibition of smoking and the entry of unauthorized people, as well as not installing a hand washing guide attained the highest rates of deviation from the standard.

Another study found that 23% and 63.7% of the bakeries of Shahroud City had satisfactory and poor sanitary conditions respectively, and also 36% of their employees had passed a public health course [26].

A survey on the health, safety, and performance of bakeries in Bangladesh (Tangil district) found that building infrastructure and wearing aprons and hats were at poor levels, and only 33% of participants were satisfied with bathroom services. In addition, none of the bakeries had regular programs for monitoring sanitation performance [27].

Our research showed that the bakeries needed to improve their condition in terms of personal hygiene. Cleaning baking tools, preventing the entry of insects, controlling light, temperature, and humidity are among the issues that can be improved by continuous monitoring, unexpected inspections, implanting strict rules, resolving defects, and holding educational courses focusing on personal hygiene.

CONCLUSIONS

Identifying and removing obstacles of improving bread and flour quality and enhancing the quality of flour for baking bread can definitely prevent use of additives. It is clear that training those who involved in these industries can be helpful.

The overall sanitary status of the bakeries was satisfactory; nevertheless, some areas, particularly personal hygiene, needed improvement. Continuous monitoring, enacting strict rules and deterrent punishments, as well as proper implementation of rules can help establishing sanitation guidelines and improve the status quo.

CONFLICT OF INTERESTS

The authors declare that there is no conflict of interests.

REFERENCES

1. Ahamadabadi M.S.M., Rahdar S., Narooie M.R., Salimi A., Alipour V., Khaksefidi R., Baneshi M., Biglari H., 2016. Amount of Baking Soda and Salt in the Bread Baked in City of Zabol. *Iioab J.* 7(2), 518-522.

2. Mohammadpour Karizaki V., 2017. Ethnic and traditional Iranian breads: different types, and historical and cultural aspects. *J of Ethn Foods.* 4, 8-14.
3. Loloei S P.H., Majdzadeh R., Takian A., Goshtaei M., Djazayeri A., 2019. Policy analysis of salt reduction in bread in Iran. *AIMS Public Health.* 6(4), 534–545.
4. Bazhan M., Naseri E., Shafiei Sabet F., 2019. Challenges and Barriers to Improve Quality of Traditional Flat Breads in Iran. *Iran J Nutr Sci Food Technol.* 16(1), 47-60.
5. Rostami H.F.D., Haratian P., Masuombeigi H., Ebadi A., Delkhosh M., 2013. Studying the environmental health status and consumption of baking soda in military and urban Lavash bakeries of Tehran in 2012. *Iran J Health Sci.* 1(1), 19-24.
6. Rezaee Mofrad M.R.F., Mosavi G.H.A., 2011. Studying of baking soda and salt in breads of Mehrdasht bakeries in 2009. *Feyz J.* 15(3), 267-273.
7. Roohani N.H.R., Wegmuelle R., Schulin R., 2012. Zinc and phytic acid in major food consumed by rural and suburban population in central Iran. *J Food Compos Anal.* 7(5), 1-31.
8. Pourbakhtyaran E.S.M., Rashidian A., Pasalar P., Rastkari N., Yunesian M., 2013. Current evidence on the adverse effects of sodium bicarbonate used in bread processing on human health: A systematic review. *Iran J Epidemiol.* 8, 31-39.
9. Chamandoost S.N.M., Afshar H., Kamali K., 2015. Amount of baking soda and salt in bakeries of Zanjan city in 2011. *J Hum Environ Health Promot.* 1, 56-62.
10. Kamali K.C.S., Naderi M., Afshar H., 2015. Amount of baking soda and salt in bakeries of Zanjan city in 2011-2012. *J Hum Environ Health Promot.* 1, 56-62.
11. Riedel F., Naujokat S.R.J., Petzoldt S., Rieger C.H., 1992. SO₂-induced enhancement of inhalative allergic sensitization: inhibition by anti-inflammatory treatment. *Int Arch Allergy Immunol.* 98(4), 386-391.
12. Eckardt R.E., 1973. Recent developments in industrial carcinogens. *J Occup Med.* 15(11), 904-907.
13. Johnson J.L., Rajagopalan K.V., 1979. The oxidation of sulphite in animals systems. *Ciba Found Symp.* 72, 119-133.

14. Luo L., Chen S.J.H., Tang C.Du. J., 2011 Endogenous generation of sulfur dioxide in rat tissues. *Biochem Biophys Res Commun.* 415(1), 61-67.
15. Meng Z., 2003. Oxidative damage of sulfur dioxide on various organs of mice: sulfur dioxide is a systemic oxidative damage agent. *Inhalation Toxicol.* 15(2), 181-195.
16. Schlottmann U., 2004. Sodium dithionite, CAS N°: 7775-14-6. Advisory Committee on Existing Chemicals of the Association of German Chemists (GDCh). 19-22. BASF AG, Germany.
17. Kucukatay V.A.A., Gumuslu S., Yargicoglu P., 2007. Effect of sulfur dioxide on active and passive avoidance in experimental diabetes mellitus: relation to oxidant stress and antioxidant enzymes. *Int J Neurosci.* 117(8), 1091-1107.
18. Iran ISIRI. 2014. Specifications and test methods for traditional breads. Iran: Institute of Standards and Industrial Research of Iran.1-9.
19. Mohammadbeigi A.S.A., Izanloo H., Ghorbani Z., Vanaki V., Ramazani R., AsadiGhalhari M., 2018. Prevalence of Using Baking Soda in Different Types of Most Commonly Consumed Breads by Iranian People. *Adv Hum Biol.* 8, 24-27.
20. Alami A.B.S., Rostamiyan T., Asadzadeh SN., Mohammadzadeh Moghaddam M., 2014. Quality assessment of traditional breads in Gonabad bakeries, Iran. *ISO: jrh JCR: JRH.* 4(3), 835-841.
21. Goodarzi B.M.A., Soleimani-Ahmadi M., Dindarlo K., Dindarlo V., 2014. Hygiene status in urban bakeries of Bandar Abbas in 2012. *Prev Med.* 1(1), 10-15.
22. Jahed Khaniki G., Yunesian M., Vaezi F., Nabizadeh R., Paseban Gh.A., 2006. A Survey on Baking Soda Elimination from Iranian Flat Breads in Bakeries of Islamshahr City in 2005. *Toloo e Behdasht.* 5, 24-34.
23. Special health, medicine, food and drug rules; from Governmental ratification; Iranian Minister of Health, (Accessed August 13, 2011) approval No36083/96170; 13/8/85.
24. Asgari G.S.M.A., Faradmal J., Moradi M.J., Yari K., 2018. The Study of Blankit Concentration as an Unauthorized Additive in Hamadan Bakeries and Risk Assessment of Food Consumption. *Pajouhan Scientific Journal (PSJ).* 16(4), 21-27.
25. Seidmohammadi A.A.G., Sharifi Z., Faradmal J., Yari K., Pirmoghani A., 2017. Evaluation of the Residual Sodium Hydrosulfite (Dithionite) Levels in Produced Industrial Breads: A Case Study in Hamadan. *Pajouhan Science Journal (PSJ).* 15(3), 23-28.
26. Sharifi Arab Gh.A.A.M., Abbasi M., Nazarian A., 2009. Studying about Health status and quality of breads in Shahroud bakeries in 2008. Twelfth National Conference on Environmental Health, Shahid Beheshti University of medical sciences, Health Faculty. [In Persian].
27. Obidul Huq A.K., Jafar Uddin Md., Formuzul Haque K.M., Provat Roy., Bellal Hossain M., 2013. Health, Hygiene Practices and Safety Measures of Selected Baking Factories in Tangail Region, Bangladesh. *Int J Curr Microbiol.* 2(10), 68-75.