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SODIUM AND POTASSIUM CONTENTS IN LOCALLY BAKED NAANS AND ROTTIS BY FLAME PHOTOMETRY AND ITS AWARENESS AMONG LOCAL POPULATION

Original Research

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ABSTRACT

Background: An optimal balance of dietary sodium and potassium is essential for cardiovascular health. The World Health Organization (WHO) recommends less than 2300 mg of sodium and at least 3500 mg of potassium per day for adults. However, in many South Asian countries, excessive sodium intake and inadequate potassium consumption remain prevalent due to unregulated food sources. Commonly consumed items like naan and roti, prepared in tandoors, may contribute significantly to this imbalance, yet remain under-investigated.

Objective: To estimate the dietary sodium and potassium content in locally prepared naan and roti and assess the baseline awareness of the general public regarding their nutritional implications in the tandoors of Iqbal Town, Lahore.

Methods: A cross-sectional study was conducted from September to December 2022 across 40 tandoors in Iqbal Town, Lahore. A total of 400 participants aged 18 to 76 years were selected using a convenience sampling technique. Laboratory analysis using flame photometry was performed to measure sodium and potassium content in 40 samples each of naan (100 g) and roti (80 g). A structured 14-item questionnaire was administered to evaluate public awareness. Data were analyzed using IBM SPSS version 23.0. Independent sample t-tests and chi-square tests were applied; a p-value <0.05 was considered statistically significant.

Results: The mean sodium content in naan was 413.54 ± 22.84 mg/100 g, and in roti was 221.02 ± 24.96 mg/80 g. Potassium values averaged 134.53 ± 52.51 mg in naan and 132.14 ± 19.73 mg in roti. Only 21.8% of the population demonstrated good knowledge of sodium and potassium. A significant difference was found in knowledge based on education level ($p = 0.00$) and gender ($p = 0.002$), while hypertension status showed no significant association ($p = 0.761$).

Conclusion: Naan and roti from local tandoors contain high sodium and low potassium levels, contributing to a dietary imbalance that may increase the risk of hypertension and cardiovascular diseases. Public knowledge remains limited, with education emerging as a significant predictor of awareness. Targeted health education and salt-reduction strategies are warranted.

Keywords: Cardiovascular Diseases, Cross-Sectional Studies, Diet, Dietary Sodium, Hypertension, Potassium, Public Awareness.

INTRODUCTION

The regulation of bodily fluid balance is intricately dependent on the interplay between sodium and potassium, two essential electrolytes that influence numerous physiological processes. Sodium chloride (NaCl), commonly known as table salt, is the primary source of dietary sodium and is required in moderate amounts to maintain fluid homeostasis, nerve transmission, and muscle function. However, the average salt intake often exceeds the recommended threshold, with an estimated daily intake of 3200 mg of sodium chloride being commonplace in many populations. Excessive sodium intake disrupts the body's natural balance, increasing extracellular fluid volume, elevating blood pressure, and contributing to cardiovascular morbidity through direct effects on target organs (1,2). This relationship has led to the identification of salt-sensitive blood pressure, a condition in which an individual's blood pressure varies significantly with changes in sodium intake. While sodium is essential, its overconsumption has been consistently associated with the onset and progression of hypertension. Salt-sensitive hypertension not only poses risks for the development of chronic diseases such as ischemic heart disease and heart failure but also creates challenges in managing cardiovascular health on a population level (3,4). Sodium also plays a functional role in food processing by influencing flavor, pH stability, and texture, and by limiting microbial growth, thus extending the shelf life of various food products (5). Despite these benefits, the excessive use of salt in daily food consumption, especially in baked and tandoor-based goods, has raised significant public health concerns.

The World Health Organization (WHO) has acknowledged the global overconsumption of sodium—primarily in the form of salt—and has set a target to reduce average salt intake by 30% by the year 2025, compared to levels observed in 2010. WHO further recommends that adults limit sodium intake to less than 2000 mg per day and increase potassium intake to more than 3500 mg per day to reduce the risk of cardiovascular disease (6,7). Diets with a high sodium-to-potassium ratio, often seen in urbanized and processed dietary patterns, are particularly harmful, contributing to elevated blood pressure and increasing the risk of premature cardiovascular mortality. In contrast to sodium, dietary potassium offers protective cardiovascular benefits. A deficiency in potassium has been linked to the pathogenesis of hypertension and other cardiovascular diseases. Adequate potassium intake has been shown to mitigate the adverse effects of sodium, highlighting the critical importance of maintaining a balanced sodium-to-potassium ratio in the diet (8,9). Despite this, public awareness of potassium's health role remains limited, especially in developing regions.

Within the South Asian context, particularly in Pakistan, the frequent consumption of naan and roti—staples prepared in tandoors—has emerged as a significant yet overlooked source of excessive dietary sodium. These products are widely consumed across socio-economic groups, often without standardized preparation methods or quantified salt content. Consumers typically remain unaware of their daily sodium and potassium intake, inadvertently contributing to the early development of primary hypertension and other chronic diseases (10,11). Addressing this issue through public health strategies aimed at reducing salt content in commonly consumed baked goods may offer a practical solution to mitigate long-term cardiovascular risks. Given the widespread consumption of tandoor-baked products and the lack of regulation or awareness regarding their sodium content, this study aims to quantify the sodium levels in locally prepared naan and roti and evaluate their potential impact on public health. The objective is to rationalize the need for sodium reduction strategies and provide evidence-based recommendations for preventing salt-induced hypertension in the general population.

METHODS

A cross-sectional study was carried out in Iqbal Town, District Lahore, over a four-month period from September to December 2022. The primary objective was to quantify the sodium and potassium content in commonly consumed tandoor products—namely naan and roti—and to evaluate public awareness regarding dietary intake of these electrolytes. A convenience sampling technique was used to select both food samples and participants from the general population residing in the area. This design allowed for simultaneous collection of data related to food composition and population awareness in a community-based setting. Inclusion criteria for the food analysis included freshly prepared naan and roti obtained directly from local tandoors within Iqbal Town. Packaged or commercially branded variants were excluded to ensure focus on traditionally prepared tandoor products. For the awareness component, residents aged 18 years and above were eligible to participate, while individuals who refused verbal consent or provided incomplete responses were excluded from the final analysis (12,13). The sampling framework consisted of 40 individual samples each of naan (weighing 100

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grams) and roti (80 grams), procured from diverse tandoors to represent local preparation variability. In parallel, a total of 400 adult participants from the same community were enrolled for the awareness survey. The food samples underwent laboratory analysis to quantify sodium and potassium levels using flame photometry—a validated method for determining alkali metal concentrations in food matrices.

Prior to analysis, each naan and roti sample was oven-dried at 105°C to eliminate moisture content, followed by homogenization using a laboratory-grade grinder. A wet digestion protocol was applied using a 3:1 mixture of concentrated nitric acid (HNO_3) and perchloric acid ($HClO_4$) under controlled heating until a clear solution was achieved. The final digest was diluted to 100 mL with deionized distilled water and filtered using Whatman No. 42 filter paper. Quantitative assessment was performed using a digital flame photometer (e.g., Jenway PFP7 or equivalent) at specific wavelengths: 589 nm for sodium and 766.5 nm for potassium, utilizing an air-acetylene flame as the fuel mixture. The instrument was calibrated using freshly prepared standard solutions at concentrations of 50, 100, 200, 400, and 600 mg/L for sodium and 50, 100, 200, and 400 mg/L for potassium. A blank solution of deionized water was used for zeroing the instrument, and calibration curves were generated to interpolate sample concentrations. All samples were analyzed in triplicate to enhance precision, and mean values were recorded. Quality control measures included the use of reagent blanks, recalibration of the instrument after every 10 samples, and inclusion of quality control standards to monitor instrument drift and analytical consistency.

For the public awareness assessment, a 14-item pre-structured questionnaire was administered in Urdu or English based on participant preference. The tool gathered demographic information (age, sex, education), self-reported awareness regarding sodium and potassium, perceived dietary sources, and knowledge about health risks associated with electrolyte imbalances. The questionnaire was designed to be accessible and culturally appropriate for the target population. Ethical approval for the study was granted by the Institutional Review Board of the Institute of Public Health, Lahore. All participants were provided with a verbal explanation of the study objectives, and verbal informed consent was obtained in accordance with ethical research guidelines. Data entry and analysis were performed using IBM SPSS Statistics version 23.0. Descriptive statistics, including means, medians, standard deviations, and ranges, were calculated for sodium and potassium concentrations in food samples. Frequencies and percentages were used to summarize awareness responses. To determine statistical associations, an independent samples t-test was applied to compare awareness scores with measured sodium and potassium levels in consumed products. The chi-square test was used to examine the relationship between hypertension status and awareness levels. A p-value of less than 0.05 was considered statistically significant for all inferential analyses.

RESULTS

Out of 400 participants surveyed, 315 (78.8%) were male and 85 (21.3%) were female. The educational breakdown revealed that 215 (53.8%) were under matric, 73 (18.3%) had matriculated, 52 (13.0%) had completed intermediate, 40 (10.0%) were graduates, and 20 (5.0%) held master's degrees. A majority of the population, 336 individuals (84%), reported being non-hypertensive, while 64 (16%) identified as hypertensive. Regarding awareness of sodium presence in daily food items, 308 respondents (77%) correctly stated that naan and roti contain salt, 39 (9.8%) disagreed, and 53 (13.3%) were unsure. When asked about potassium sources, 234 participants (58.5%) correctly identified bananas as a good source, while 48 (12%) reported no knowledge. With respect to sodium sources, 128 individuals attributed high sodium to factory-made foods. Additionally, 125 participants (31.3%) identified fermented roti, 156 (39%) pointed to cheese, 38 (9.5%) mentioned tomato ketchup, and 81 (20.3%) believed that all such products contributed sodium to the diet. In terms of health awareness, 304 individuals (76%) recognized that excess sodium leads to hypertension, whereas 3.5% linked it to jaundice, 2.8% to liver cancer, 4.8% to multiple diseases, and 13% had no knowledge. For potassium, 268 participants (67%) correctly associated its deficiency with heart problems, 4.5% believed it did not cause any heart issues, and 28.8% were unaware of its role. As for the perceived daily sodium requirement, 122 participants (30.5%) estimated it as 2/3 spoon, 17.8% said 1 tablespoon, 10.3% claimed half a cup, 8.8% said 1 full cup, and 32.8% were unaware of the requirement.

When questioned about potassium function, 15.5% associated it with nerve cells, 28.5% with the heart, 24% with the circulatory system, 7.3% believed it was required for all organs, and 24.8% had no knowledge. Overall, 87 participants (21.8%) demonstrated good knowledge of sodium and potassium, while 313 (78.3%) showed poor knowledge. Among non-hypertensive individuals, 22% had good knowledge compared to 20.3% among hypertensives; however, this difference was not statistically significant ($p = 0.761$). Laboratory analysis of 40 food samples showed that 100 grams of naan contained a mean sodium concentration of 413.54 ± 22.84 mg and potassium of 134.53 ± 52.51 mg. In 80 grams of roti, sodium averaged 221.02 ± 24.96 mg and potassium was 132.14 ± 19.73 mg. The maximum sodium in naan was 448 mg, the minimum was 340 mg, with a range of 108 mg. For roti, sodium ranged from 186.24 mg to 294.40 mg.

The potassium content in naan ranged from 108 mg to 456 mg (range 348 mg), while roti ranged from 90.24 mg to 166.72 mg (range 76.48 mg). Extrapolating intake based on 3 to 6 naan per day indicated that individuals could be ingesting 1240.62 to 2481.24 mg of sodium daily from naan alone, surpassing WHO's recommended upper limit of 2300 mg/day. Potassium intake from naan in the same range was estimated at 403.59 to 1326.12 mg/day, which falls significantly below the WHO's recommended minimum of 3500 mg/day, underscoring the need for alternative potassium sources. Post hoc statistical analysis revealed that participants with good knowledge had a slightly lower mean sodium intake in naan (409.43 ± 19.37 mg) compared to those with poor knowledge (414 ± 23.61 mg), though the difference was not statistically significant (p = 0.235). However, potassium levels in naan were significantly lower among the well-informed group (124.80 ± 10.56 mg) compared to their less informed counterparts (137.23 ± 58.83 mg), with a significant p-value of 0.020. Sodium and potassium levels in roti did not show significant variation between knowledge groups. A scatter plot of sodium content in naan and roti revealed a negative correlation, suggesting that as sodium concentration increased in naan, it tended to decrease in roti.

Table 1: Sodium & Potassium in 100g *Naan* & 80g of *Rotti*

Variable	Mean	Median	Standard Deviation	Minimum Value	Maximum Value	Range
Sodium (Naan)	413.54	415	22.84	340	448	108
Potassium (Naan)	134.53	126.80	52.51	108	456	348
Sodium (Roti)	221.022	217.60	24.96	186.24	294.40	108.16
Potassium (Roti)	**132.144**	**135.36**	**19.73**	**90.24**	**166.72**	**76.48**

Table 2: HTN and Non HTN Vs Knowledge of Sodium and Potassium

	Good knowledge	Poor knowledge	Total
NON- HTN	74 (22.0) %	262 (78.0) %	336 (100) %
HTN	13 (20.) 3%	51 (79.7) %	64 (100) %
TOTAL	**87 (21.8) %**	**313 (78.3) %**	**400 (100) %**

Table 3: T-Test of Good Knowledge & Poor Knowledge Vs Sodium Potassium Values

Variable	Good knowledge Mean ±SD	Poor knowledge Mean ±SD	t-Test Value	P- Value	Remarks
Age	36.98 ± 11.25	39.13 ±12.134	-1.485	0.383	Not Significant
Sodium in *Naan*	409.43± 19.37	414 ±23.61	-1.899	0.235	Not Significant
Potassium in *Naan*	124.80 ± 10.56	137.23 ± 58.83	-1.960	0.020	Significant
Sodium in *Roti*	227.28 ± 25.27	219.28 ±24.62	-2.668	0.485	Not Significant
Potassium in *Roti*	**131.47 ± 19.99**	**132.32 ±19.69**	**-0.357**	**0.538**	**Not Significant**

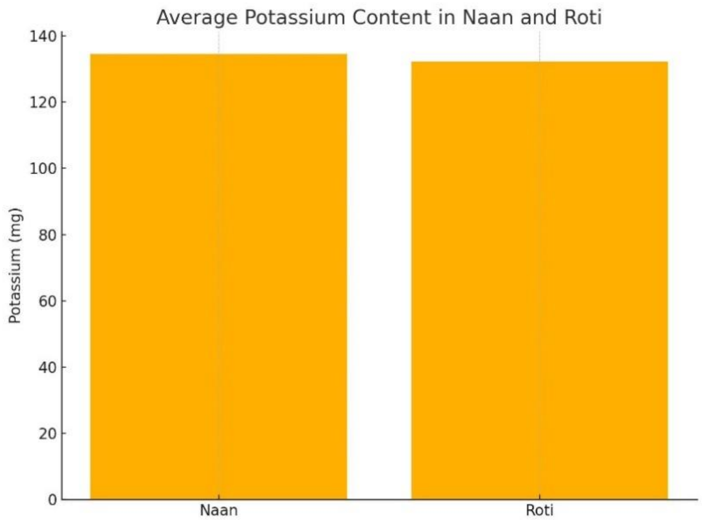

Figure 1 Average Potassium Content in Naan and Roti

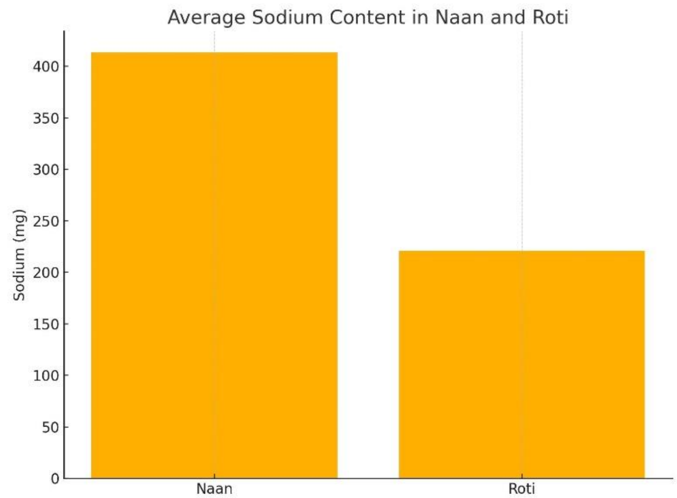

Figure 2 Average Sodium Content in Naan and Roti

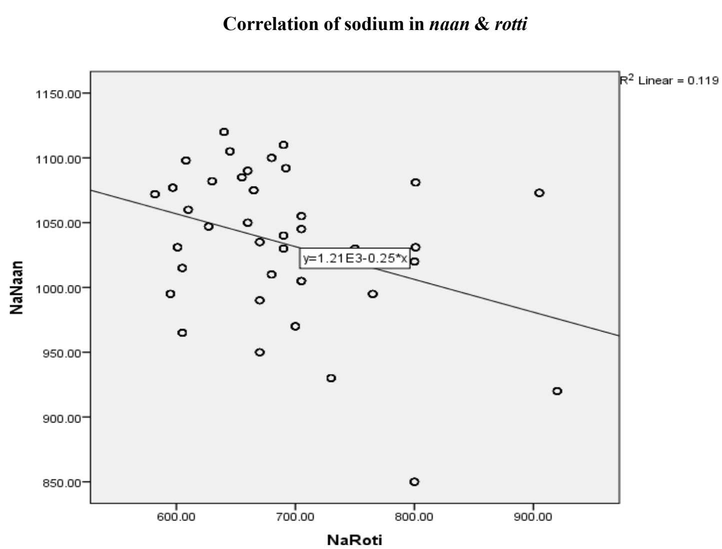

Figure 3 Correlation of Sodium in Naan & Roti

DISCUSSION

The present study provided important insights into the dietary sodium and potassium content of commonly consumed tandoor items—naan and roti—in an urban population of Lahore, Pakistan, and evaluated the community's awareness regarding these key nutrients. It was revealed that both naan and roti contained sodium concentrations that, when consumed in routine quantities, could alone exceed or closely approach the WHO's recommended daily intake of less than 2300 mg/day. Specifically, consuming 3 to 6 naan per day would result in an intake ranging from approximately 1240.62 mg to 2481.24 mg of sodium, while the same quantity of roti would provide 663.06 mg to 1326.12 mg. These values highlight the significant contribution of tandoor products to total daily sodium intake. In contrast, the corresponding potassium intake from these items was far below the WHO's recommendation of 3500 mg/day, which underscores an alarming nutritional imbalance that is associated with increased risk for hypertension and other non-communicable diseases (14-16). The nutritional imbalance observed in this study aligns with global trends where high sodium-to-potassium dietary ratios have been linked to increased cardiovascular morbidity and mortality. A deficit of potassium in particular has been associated with endothelial dysfunction, arrhythmias, and progression of hypertensive heart disease. The lack of naturally rich potassium sources in the diet, particularly when staple foods like naan and roti offer minimal potassium content, can aggravate this imbalance, especially when combined with the high salt load from both home-cooked and processed foods (17,18).

The study further uncovered that the awareness level among the general population regarding the health consequences of excessive sodium and insufficient potassium intake was suboptimal. Only 21.8% of participants demonstrated good knowledge, while 78.3% exhibited poor understanding. Stratified analysis revealed that males had statistically significantly better knowledge (25.1%) than females (9.4%), with a p-value of 0.002, indicating a true difference rather than a chance occurrence (19). Similarly, participants with formal education had better knowledge scores, and this association was also statistically significant ($p = 0.00$). These findings underscore the influence of gender and educational background on health literacy related to nutrition. Interestingly, despite better knowledge, those with higher awareness were not necessarily consuming less sodium, particularly in roti. This paradox may reflect limited control over food preparation methods in commercial tandoors, where raw materials are processed in bulk and ingredients are added by estimation rather than standardized measurement (20,21). The use of the "fist method" for salt addition, as reported anecdotally, supports the lack of regulation or portioning practices at local tandoors, further complicating efforts to reduce population-wide salt intake.

The correlation analysis presented a weak negative relationship between sodium content in naan and roti, suggesting inconsistent salt use practices between different batches or products. While roti appeared to be the more frequently consumed item, its sodium variability was still concerning and suggested a need for standardized formulations (22). The study holds several strengths. It is among the first to quantify sodium and potassium concentrations in local tandoor products using validated laboratory methods and relate these findings to population knowledge levels. The dual approach—laboratory analysis and community survey—provided a comprehensive view of both exposure and awareness, enriching the study's relevance for public health planning. However, several limitations must be acknowledged. The use of convenience sampling may limit the generalizability of findings to other regions or populations. The dietary recall of naan and roti intake was based on assumptions rather than direct observation or food frequency questionnaires, which could result in over- or under-estimation of actual consumption. Additionally, factors such as overall dietary habits, co-morbidities, and socioeconomic status were not analyzed in depth, which may also influence knowledge and intake patterns.

Future studies should consider larger, randomly selected samples and incorporate dietary assessment tools to accurately estimate total sodium and potassium intake. Interventional studies involving tandoor vendors to regulate salt use and public awareness campaigns targeting high-risk groups, such as hypertensive individuals and women, would be valuable. Moreover, engagement with policy-makers to draft guidelines for salt use in commercial food production, particularly in widely consumed items such as naan and roti, is critical in curbing the growing burden of diet-related non-communicable diseases. This study reinforces the urgent need for nutritional education, regulatory action, and dietary modifications at both individual and community levels. Without these changes, the continued high intake of sodium through traditional dietary staples may significantly undermine cardiovascular health across populations.

CONCLUSION

This study concluded that locally prepared tandoori naan and roti contribute substantially to excessive dietary sodium intake while offering insufficient potassium, diverging markedly from global nutritional recommendations. These staple items play a dominant role in elevating daily sodium consumption within the community, posing a potential risk for hypertension and other chronic diseases. Furthermore, public awareness regarding the nutritional content and health implications of sodium and potassium remains limited, particularly among less educated individuals. Even those with relatively better knowledge were found to consume excessive sodium, highlighting a gap between awareness and practice. These findings emphasize the urgent need for public health interventions, nutritional education, and regulatory oversight to address the rising burden of diet-related health issues in the local population.

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AUTHOR CONTRIBUTION

Author	Contribution
Mehwish Nawaz	Substantial Contribution to study design, analysis, acquisition of Data Manuscript Writing Has given Final Approval of the version to be published
Muhammad Shahzad	Substantial Contribution to study design, acquisition and interpretation of Data Critical Review and Manuscript Writing Has given Final Approval of the version to be published
Muhammad Atif	Substantial Contribution to acquisition and interpretation of Data Has given Final Approval of the version to be published
Saqlain Ghazanfar*	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Sikandar Rafique	Contributed to Data Collection and Analysis Has given Final Approval of the version to be published
Khadija Ashfaq	Substantial Contribution to study design and Data Analysis Has given Final Approval of the version to be published
Mehtab Ahmed Khan	Contributed to study concept and Data collection Has given Final Approval of the version to be published

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