Research Article

Determination of Iodine Content and Quality Evaluation of Different Brands of Table Salt Available in Peshawar

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Abstract | Iodine deficiency (ID) is a significant global public health problem, particularly affecting developing countries. Salt iodization is mandatory to reduce iodine deficiency disorders (IDD). However, environmental factors like moisture, heat and light can reduce iodine content of iodized salt. This study aimed to assess iodine content and quality of different brands of salt available in local market. Salt samples were collected from different shops based in District Peshawar, Khyber Pakhtunkhwa, Pakistan and transferred to Provincial Food Testing Laboratory of KP Food Safety and Halal Food Authority, Hayatabad for analysis. All the samples were analyzed for iodine content, pH and moisture content. Iodine was analyzed using standard titration procedure. Results showed that (33.3%) salt samples were sufficiently iodized with iodine content greater than (15 ppm) recommended by Pakistan Standards and Quality Control Authority, (8%) were insufficiently iodized, while (58.3%) of samples had no iodine. Moisture content was high in local salt samples than branded salts (0.01% to 0.03%). All salt samples were found to have neutral pH (6.4 to 6.1). On heating, high iodine loss was observed in local salt samples than branded salts. Samples containing iodine were selected and stored at room temperature under light for two months and subsequent analysis was performed with the same methodology. Results revealed that throughout 60-day study period; iodine content of all salt samples decreased. Moisture content of all samples increased during storage This study suggests that there should be mandatory iodine fortification in table salt at production level and setting up of monitoring system to evaluate iodine content at production and retailer level. While, further study should be carried out in order to study different types of salt extracted from different areas for iodine retention and quality.

Received | July 08, 2025; **Accepted** | December 24, 2025; **Published** | May 01, 2026
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Citation | Afzal, M., M. Suhail and M. Ali. 2026. Determination of iodine content and quality evaluation of different brands of table salt available in Peshawar. *Sarhad Journal of Agriculture,* 42(2): 769-774.
DOI | https://dx.doi.org/10.17582/journal.sja/2026/42.2.769.774
Keywords | Iodine content, Iodization, Monitoring, Quality evaluation, Table salt

Introduction

Iodine plays an important role in production of thyroid hormones and is found in trace levels in the body, mostly in the thyroid gland. 10–20 milligrams of iodine is present in the human body, more than 90% is used in the production of thyroid hormones (Leung *et al.*, 2012). Iodine is mostly obtained from diet, with the largest concentration found in foods derived from the sea, such as seafood and algae. Seaweed and shellfish have the highest concentration of iodine (Lee *et al.*, 2016).

An iodine deficiency is when the amount of iodine in your body is lower than the recommended amount. The daily intake of iodine recommended by World Health Organization is 90 micrograms for children of 0 to 59 months, 120 micrograms for children of 6 to 12 years, 150 micrograms for teenagers and adults of above 12 years, 250 micrograms for pregnant and lactating mothers (Fallah *et al*., 2020).

Universal salt iodization is the fortification of table salt with iodine for human consumption (Knowles *et al*., 2023). There has been significant increase towards the use of iodized salt in the last 20 to 25 years. In most of the developed countries, salt iodization has remained an effective tool to counter iodine deficiency. These countries were reportedly facing iodine deficiency but reduced it through salt iodization with the passage of time (Zmitek and Pravst, 2016).

Universal salt iodization is the best approach in reducing deficiency of iodine, which can cause enlargement of the thyroid hypothyroidism and mental retardation in infants and children whose mothers were iodine deficient during pregnancy. Rate of goiter (enlarged thyroid) and levels of TSH in blood are generally recommended to examine iodine deficiencies in the body (Zimmermann, 2021).

According to WHO, 20 to 40 mg of iodine must be added to per kg of salt to satisfy iodine needs (WHO, 2007). The stability of iodine in iodized salt depends on its moisture content, which must be in good control in the process of salt iodization, its packaging and storage. Salt producers must monitor the content of iodine in salt at the salt iodizing units and government health agencies to ensure the availability of iodized salt in local markets (WHO, UNICEF, ICCIDD, 2007).

Nutrient fortification in staple diets can help to prevent deficiency disorders. Majority of people in northern regions of KPK and people of some areas of Punjab are suffering from iodine deficiency illnesses. Pakistan has undertaken numerous programs to treat nutritional problems, such as iodine nutrition program, world food program, national wheat flour fortification program, global alliance for improved nutrition and the USI program (Rehman *et al*., 2013).

In Pakistan, Universal Salt Iodization (USI) program is currently applied in more than 102 districts. The prevalence of IDD among women and school children has dropped due to consuming iodized salt at household level, which has been increased from 17 to 69% in the year 2011. The USI Pakistan program is driven by the monitoring and control of government officials, quality control procedures, severe regulation and implementation systems, availability of fortificants in the local market, and consumer need are all required for sustainable USI program (Masuood and Janjua, 2013).

A research was conducted to evaluate iodine content and quality of different brands of salt with the objectives to determine mandatory fortification, iodine content and quality assessment of different salt brands available in the market. This research will help to assess the current status of salt iodization and iodine fortification in table salt at production and retailer level.

Materials and Methods

Sample collection

Research was carried out at provincial food analysis laboratory of Khyber Pakhtunkhwa Food Safety and Halal Food Authority, Peshawar, during the year 2024. Seventeen samples of commercially available iodized salt (local and branded) were collected from various shops of District Peshawar Khyber-Pakhtunkhwa, Pakistan. The branded salts were National, Shan, and Marhaba, while the local salts included Lahori Namak, Shafaf, White Gold, Pak National Salt, Lahori Tohfa, Daster Khwan, Special Punjabi Salt, Hania Table Salt, and Zaika.

Samples weighing 500 to 1000 g were bought and transferred to laboratory for analysis. All the samples were labelled as iodized. Samples were evaluated for iodine content, pH and moisture content. Iodine was analyzed with the help of standard titration method (Diosady *et al*., 1998). Moisture content was determined according to the method of AOAC (2012). pH meter was used to measure the pH of salt samples. On the basis of results, another experiment was designed. Samples containing iodine were stored at room temperature for two months and analyzed for iodine content at interval of 60 days. Three control samples were prepared from National salt due to its high iodine content for comparative analysis of iodine in table salt over a storage period of 60 days.

Statistical analysis

All the parameters were determined in triplicates. The data was analyzed using statistix 8.1 2- factorial design (CRD). ANOVA and LSD tests were performed at $p < 0.05$. A p-value of less than 0.05 considered significant and means were separated by LSD test (Jan *et al.*, 2009).

Table 1: *Effect of storage days on iodine content and quality of salt brands*

Treatment	Iodine content (ppm)	Moisture content	pH
Brand A	24.01 ±0.6	0.01 ± 0.005	6.3 ± 0.015
Brand B	17.62 ± 0.6	0.03 ± 0.005	6.3 ± 0.015
Brand C	15.58 ± 0.6	0.02 ± 0.005	6.2 ± 0.02
Brand D	21.46 ± 0.6	0.04 ± 0.005	6.2 ± 0.02
Brand E	9.52 ± 0.6	0.16 ± 0.01	6.2 ± 0.02
Probability	0.000	0.000	0.000
Storage Days (SD)			
Control	24.01 ± 0.6	0.01 ± 0.005	6.3 ± 0.015
1	20.39 ± 0.63	0.03 ± 0.0054	6.27 ± 0.0081
14	18.3 ± 0.48	0.08 ± 0.05	6.19 ± 0.0057
30	13.04 ± 0.07	0.3 ± 0.05	6.18 ± 0.0057
60	10.8 ± 0.5	0.4 ± 0.05	6.20 ± 0.0057
Significance	0.000	0.000	0.000
TXSD	Figure 1 2	Figure 3	Figure 4

Results and Discussion

Iodine content

According to Table 1, out of 12 samples, 4 samples (National, Shan, Marhaba and Lahori namak) met the Pakistan Standards and Quality Control Authority standard of iodine fortification in edible salt (20 to 30ppm) per kg. All the branded salt samples had the iodine content according to PSQCA requirement. Salt of brand A (National) had high iodine content than other salt samples. Results indicated that iodine content of salt samples were significantly different ($p<0.05$).

In this study, iodine content (24 ppm) were significantly higher in national salt followed by lahori namak (21.46 ppm), shan (17.62 ppm), marhaba (15.58 ppm) and then shafaf (9.52 ppm). The initial iodine concentration was as high as (24.01 ppm) which gradually decreased with increase of storage days. The lowest (10.8 ppm) value was observed on day 60 (Figure 1 and Figure 2). Iodine value in all salt samples decreased with respect to storage days. Results obtained from the current study are in accordance with the results previously reported by (Habib *et al.*, 2023; Fallah *et al.*, 2020) for different salt brands. External factors like light, moisture and heat can cause iodized salt to decrease its iodine content. Iodine in iodized salt is unstable to heat and storage conditions. When salt is exposed to light and heat, iodizing compounds like potassium iodide and potassium iodate present in salt break down to free iodine leading to iodine loss from salt (Deresa *et al.*, 2023).

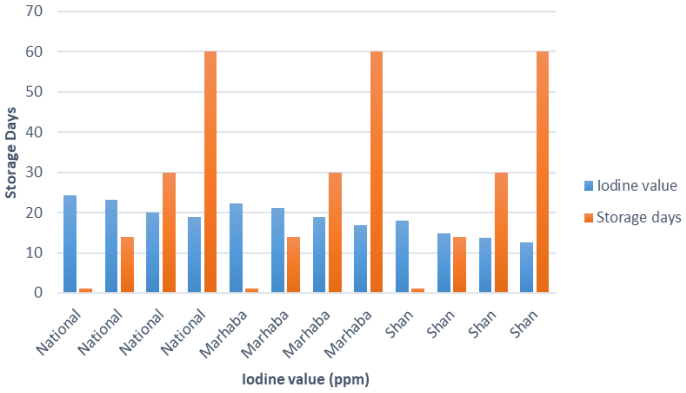

Figure 1: *Iodine content of branded salt samples as effected by storage days*

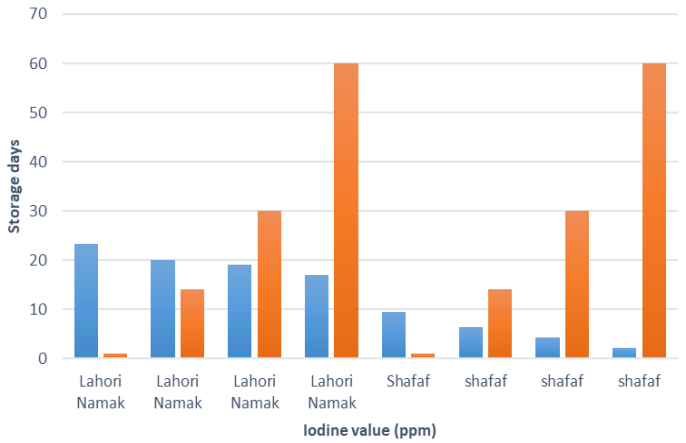

Figure 2: *Iodine content of local salt samples as effected by storage days*

Moisture content

According to Table 1, high moisture content was found in local salt sample of brand E (shafaf). Moisture content was high in local salt samples than branded salts (0.01% to 0.02%). High moisture content in local salt may be due to improper packaging and hygroscopic nature of salt (Prodhan *et al.*, 2019). The highest moisture content was found in Brand D (0.17%) and Brand E (0.15%), while the lowest moisture content was 0.06% in Brand A. Moisture content was low initially, which gradually increased with storage days (Figure 2). Moisture content was

low initially, which gradually increased with storage days (Figure 3).

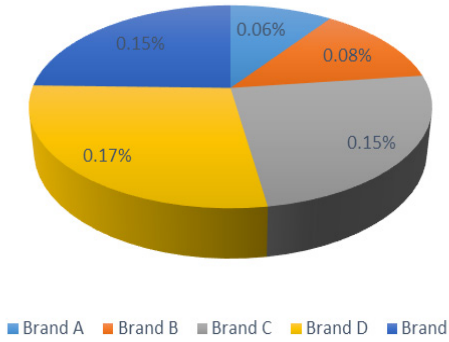

Figure 3: *Moisture content of salt samples affected by storage days*

According to Jabin, (2009) raw salt has no iodine and iodized salt is dropping its iodine content frequently, due to impurities and moisture present in it. Moisture that is either naturally present in table salt or hygroscopic impurities like magnesium chloride in salt absorb it from air. Moisture break down iodizing compounds into elemental or free iodine. High temperature accelerates the production of elemental iodine and speed up the process of iodine evaporation.

pH

Table 1 showed that all salt samples were found to have neutral pH values between 6.4 and 6.1. Findings are in accordance with the results previously reported by Halligudi *et al*., (2022) for pH of iodized salt. Minimum pH value 6.11 was observed in Brand A (national), while maximum pH was 6.23 in Brand E (shafaf). pH of salt samples exhibited a decline from 6.39 to 6.18 over the entire 60-day storage period (Figure 4).

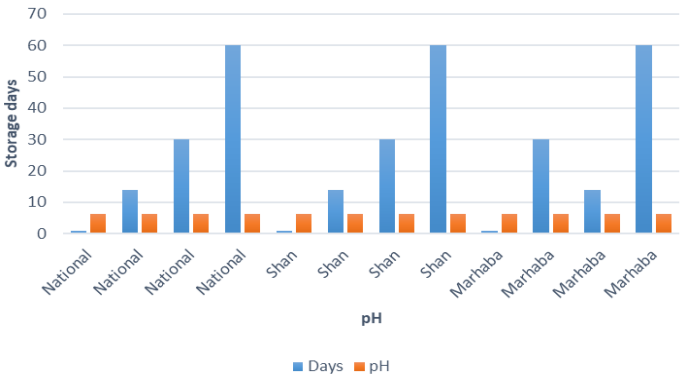

Figure 4: *PH of salt samples affected by storage days*

pH range of 6.5 and 7.5 is recommended by World Food Program for table salt. pH of human blood is around 7.4. it is crucial that pH of table salt must be neutral. Thus, the acidity and alkalinity found in table salt can imbalance the blood pH, that poses a risk to human health (Fatah *et al*., 2018).

Effect of heat on iodine content of salts

Iodine content was affected by boiling, results are presented in Table 2. The results showed that in all salt samples, iodine content was significantly affected with heating up to boiling temperature. High iodine loss (66%) was observed in salt sample brand E, while lowest loss in iodine content (17.3%) was observed in brand A (national). Iodine loss of 29%, 35% and 19% was observed in salt brands brand B, brand C and brand D salt samples, respectively (Figure 5). On heating, iodizing compounds breaks down into free iodine, which undergo sublimation changes from solid to gas, that can easily evaporate and diffuses into atmosphere (Deresa *et al*., 2023).

Table 2: *Percent loss in iodine content after heating*

Brand name	Iodine loss (%)
A	17.38
B	29.42
C	35.26
D	19.0
E	66.70

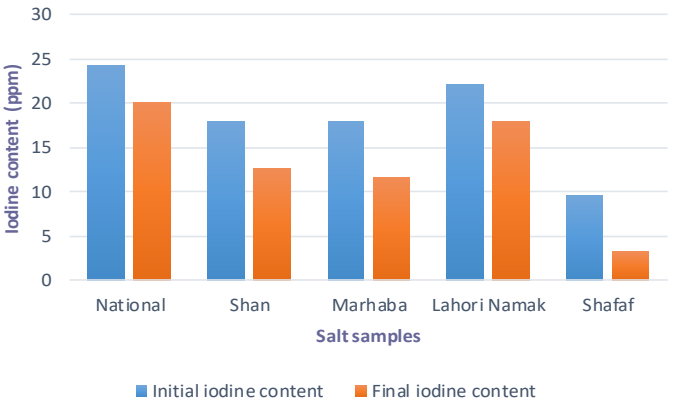

Figure 5: *Initial and final iodine content of salt samples after heating*

Conclusions and Recommendations

Results derived from analysis showed that 33.3% salt samples were fortified with iodine according to PSQCA standards, while majority were not fortified. Iodine content of salt decreases when salt is exposed to heat and light, which break down potassium iodate to free iodine, which evaporates from salt. Iodine loss was more in local salt samples than branded salt samples during storage days.

It is recommended to use airtight containers, low density polyethylene bags or opaque packaging materials to reduce iodine loss from salt.

Further study should be carried out to study different types of salt extracted from different areas for iodine retention and quality.

It is recommended to monitor iodine content of salt at production and retailer level to ensure iodine fortification. The role of Food Authorities and the Food department is pivotal in this case. The Khyber Pakhtunkhwa food fortification act (2022) abide them to ensure salt iodization. The inspection teams can work with the USI program together, collect samples, generate laboratory reports and take strict action according to the law.

Acknowledgements

Authors acknowledge Khyber Pakhtunkhwa Food Safety & Halal Food Authority, especially the Provincial Food Testing Laboratory and Research & Development wing, for providing necessary research facilities and write-up.

Novelty Statement

This research study itself is novel; there is no significant data available about the iodine content and quality of current branded and local salts in Peshawar. The previous data was insufficient and not up to date.

Author's Contribution

Muazma Afzal: M.Sc scholar, who did research, collected data, analyzed and wrote draft of the manuscript.
Majid Suhail: Major Supervisor, who provided guidelines in the study throughout.
Murad Ali: Research Supervisor, who provided technical support throughout research work.

Generative AI or AI assisted technology statement
The authors declare that no generative AI was used in the creation of this manuscript.

Conflict of interest
The authors have declared no conflict of interest.

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