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EVALUATION OF IODINE CONTENT IN COMMERCIAL TABLE SALT BRANDS IN NIGERIA

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Abstract: In Nigeria, the consumption of iodized salt plays a vital role in preventing iodine deficiency disorders, which are a significant public health concern. However, there is growing uncertainty about the actual iodine content in various salts produced and consumed across the country. This study analyzed the iodine concentrations in four salt samples (Uncle Palm Salt, Dangote Salt, Royal Salt and Sea Salt). The salt samples were collected from a commercial market in Enugu State, Nigeria. Accordingly, iodometric titration method was used to analyze the iodine content of the salt samples and from the result of the analysis, the salts showed varying concentrations of iodine ranging from Uncle Palm Salt (1.076 mg/g), Dangote Salt (1.633 mg/g), Royal Salt (1.473 mg/g), and Sea Salt (1.010 mg/g). This result reveals distinct variations crucial for public health. Dangote Salt met and slightly exceeded WHO's recommended iodine fortification range of 1.0– 1.5 mg/g, making it a reliable iodine source. Royal Salt also showed adequate levels, while Uncle Palm and Sea Salt had comparatively lower concentrations, potentially inadequate depending on intake. Variations are linked to environmental conditions, packaging quality and iodine formulation. The study underscores the need for stringent quality control and consistent iodine fortification practices to combat iodine deficiency disorders. Ongoing monitoring and further research into iodine stability during storage are recommended to enhance the effectiveness of iodized salt in public health strategies

Keywords: Concentrations, Fortification, Salt, Iodine

Introduction

around 10% when sufficient, but over 80% in deficiency [3]. Iodide is stored in thyroglobulin and converted to T3 and T4, with T3 being the active form. TSH, regulated by a negative feedback loop, controls T3/T4 production and iodine uptake. Elevated TSH suggests hypothyroidism; low TSH indicates hyperthyroidism. Urinary iodine concentration (UIC) is a key biomarker of iodine intake [7]. As the most common and effective method of iodine delivery, iodized salt has played a critical role in reducing iodine deficiency disorders globally, making it a major public health success of the 20th century [4, 7].

Iodine deficiency impairs thyroid hormone synthesis, affecting various organs and causing iodine deficiency disorders (IDDs). Severe deficiency leads to goiter and hypothyroidism, especially with intake below 50 µg/day [8]. In pregnancy, it can cause irreversible fetal brain damage, miscarriages, stillbirths, and cretinism. Children may experience developmental delays, while adults face apathy and reduced efficiency [9]. Iodine deficiency also

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raises thyroid cancer risk, particularly follicular carcinoma, due to elevated TSH and cell proliferation. Adequate iodine intake prevents these effects, while deficiency increases thyroid sensitivity to radiation, especially in children [8, 9, 10, 11]. In Nigeria, iodized salt is crucial for preventing iodine deficiency disorders, but concerns exist over inconsistent iodine levels in some salt brands, especially from unregulated markets [12]. Factors like poor storage and handling contribute to iodine loss. Due to limited data on regional iodine content, this study aims to assess iodine levels in various salt samples, evaluate compliance with standards, and identify potential health risks, ultimately guiding improved public health policies [13]. Since this iodine is essential to human health, the sole aim of this study is to determine the concentration of iodine in different table salts produced and consumed in Nigeria.

2. MATERIALS AND METHOD

2.1 Materials

The chemicals and reagents used for this analysis include: Salt sample, Distilled water, Sodium thiosulphate ($Na_2S_2O_3$), Potassium iodate (KIO_3), Potassium iodide (KI), Sulfuric acid (H_2SO_4), Starch indicator.

2.2 Sample Collection and Preparation

The various salt samples used for this analysis were purchased from a major Market in Enugu State (Ogbete Main Market) and were identified according to their different brands. The salt samples were then labeled; Uncle Palm salt (A), Dangote Salt (B), Royal Salt (C) and Sea Salt (D) respectively. Furthermore, the labeled salt samples were packaged with a clean sterile plastic container and were transported to the Laboratory in the Institute of Management of Technology (IMT), Enugu for further analysis. Accordingly, The salt samples were further weighed and stored in a clean container for further analysis.

2.3 Determination of Iodine in Salt Sample Using Titration Method

An iodometric titration method was used to analyze the iodine content of the salt samples according to AOAC, (1984). 10g of each salt sample was weighed and dissolved in 100ml of distilled water. The solution was stirred to ensure complete dissolution and 25ml of the salt solution was transferred into a 250ml conical flask. 10ml of 10% potassium iodide (KI) solution was added to the salt solution with the addition of 5ml of 1M sulfuric acid (H_2SO_4) which helps to acidify the solution. The reaction was allowed to stand in the dark for 10 minutes to ensure complete liberation of iodine. On the other hand, the burette was filled with 0.1M sodium thiosulphate ($Na_2S_2O_3$) solution and the liberated iodine was titrated by adding $Na_2S_2O_3$ dropwise while swirling until the brown color fades to pale yellow. 2ml of freshly prepared starch indicator was added to the pale yellow solution and the titration continued until the blue-black color disappears completely, indicating the end point. The volume of $Na_2S_2O_3$ used was recorded. This reaction was carried out in triplicate and the concentration of iodine in each of the salt sample was calculated.

Calculation:

The iodine concentration in the salt sample was determined using the formula: Iodine (mg/kg) = V x M x 126.9 x 1000/W Where:

V = Volume of $Na_2S_2O_3$ used (mL)

M = Molarity of $Na_2S_2O_3$

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126.9 = Atomic mass of iodine

W= Weight of salt sample (g)

3. RESULT

Table 1 showed the result of the analysis. From the analysis, sample B showed the highest concentration of iodine (1.633±0.047 mg/g) while sample D has the lowest iodine concentration (1.010±0.01 mg/g). Sample A (1.076±0.014mg/g) and C (1.473±0.027mg/g) showed moderate concentration of iodine, though sample C showed higher concentration than sample A (1.076±0.014mg/g).

Table 1: Concentration of Iodine in Salt Samples

S	T1 (mg/g)	T2 (mg/g)	T3 (mg/g)	AT (mg/g)
A	1.09	1.04	1.10	1.076±0.014
B	1.64	1.58	1.68	1.633±0.047
C	1.47	1.45	1.50	1.473±0.027
D	1.01	1.00	1.02	1.010±0.01

Key:

(*A Represent Uncle Palm Salt; B Represent Dangote Salt; C represent Royal Salt; D represent Sea Salt; T1 represent Test 1; T2 represent Test 2; T3 represent Test 3; AT represent Average Test; S represent salt sample*)

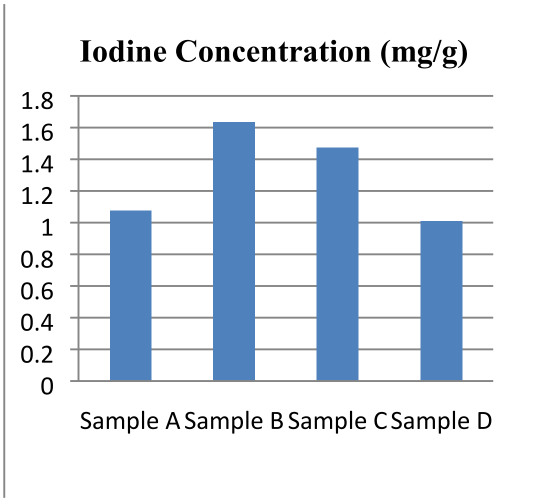

Fig 1: showing the various concentration of iodine in each salt sample from the analysis and from the figure, sample B showed the highest concentration of iodine with sample D showing the least concentration of iodine.

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4. Discussion

The results of iodine concentration analysis in various salt samples show distinct variations in iodine content, which is a crucial factor for public health due to iodine's role in preventing iodine deficiency disorders. The average iodine concentrations across the four salt samples tested were as follows: Uncle Palm Salt (Sample A) with 1.076 mg/g, Dangote Salt (Sample B) with 1.633 mg/g, Royal Salt (Sample C) with 1.473 mg/g, and Sea Salt (Sample D) with 1.010 mg/g. This study is contrary to the study of Abughoush *et al*. [14] who reported that the majority of samples, iodine levels were below the recommended amount of 15 ppm. On average, 76.5% of the 152 samples they analyzed contained less than 15 ppm of iodine, falling short of the World Health Organization (WHO) recommended range of 15–40 ppm.

Dangote Salt, with the highest average iodine concentration of 1.633 mg/g, meets the recommended iodine fortification levels for table salt, which are typically between 1.0 to 1.5 mg/g, as per the World Health Organization (WHO) guidelines. This suggests that Dangote Salt could be an effective source of iodine supplementation for the population, aligning with national public health strategies to combat iodine deficiency. Royal Salt (Sample C) also shows a significant iodine concentration of 1.473 mg/g, indicating that it may be another reliable source of iodine for consumers. However, Uncle Palm Salt (Sample A) and Sea Salt (Sample D) show lower iodine concentrations (1.076 mg/g and 1.010 mg/g, respectively), which may fall short of optimal iodine levels for combating iodine deficiency, depending on consumption patterns.

Similar to the study of Usoro *et al*. [15], sea salt had the lowest mean iodine content of 15.90 mg/kg ± 1.05 mg/kg while Abakaliki refined salt had the highest mean iodine content of 37.00 mg/kg ± 2.07 mg/kg. Comparing the results of the iodine contents determined in the present study, only raw sea salt had a mean iodine content of 15.19 mg/kg less than permissible iodine limit of 20 mg/kg – 30 mg/kg recommended by World Health Organization (WHO). However, the general low values of the iodine content below the minimum requirement of 50 mg/kg – 60 mg/kg at the production packaging stage may be attributed to poor stability of iodine in salt due to moisture content of the salt, humidity of the atmosphere, bad packaging, impurities in the salt, alkalinity and acidity of the salt and the form in which the iodine is present [15].

The present result is also similar to the study of Sani *et al*. [16]. From their result, the concentration of iodine falls within the range of 25.40-26.80ppm with a mean iodine value of 26.10ppm. It is therefore evident that the salt contains iodine content that is within the recommended range provided by World Health Organization (WHO) (20-30ppm). The result obtained is lower compared to the result of Dangote (Open Bag) in table 4 of 33.50-35.60ppm and similar to the findings of Usoro *et al.* [15] with a value of 24.30-25.40mg/kg for Dangote salt (Blue sachet) and 22.10-23.10mg/kg for Dangote salt (Red sachet) [16].

In Belgrade, it was found that the contents of iodine in the table salt samples were according to standard (16-24 mg/kg), except one. Also, another study in North Western Ethiopia showed that 61.54 % of the collected samples were insufficiently iodized. It also showed that the iodine distribution in these samples is not uniform [17]. A study in the United States found that the iodine content varied in five samples taken from the same container of different depths [17].

These results indicated that there are significant variations in the iodine content in the salt that reach consumers in different countries. Several factors influence the stability of the iodine component in iodized salt, including moisture content, atmospheric humidity, light, heat, impurities in the salt, acidity or alkalinity, and the form in which iodine is present. The variation in iodine concentration among these samples could be attributed to differences in manufacturing processes, iodine fortification practices, and the salt's exposure to environmental conditions. Therefore, regular monitoring and enforcement of iodine fortification standards are essential to ensure public health safety and to minimize the risks associated with iodine deficiency. Further research could investigate the stability of iodine in these salts over time, especially under different storage conditions.

5. Conclusion

In conclusion, the iodine concentrations in the salt samples analyzed vary significantly, with Dangote Salt meeting the recommended iodine fortification levels. While Dangote and Royal salts provide sufficient iodine, Uncle Palm and Locally Processed salts may fall short of optimal levels, posing potential health risks. Regular monitoring and adherence to fortification standards are crucial to ensure iodine deficiency prevention. Further studies on iodine stability in salt over time are recommended for better public health management.

Author Contributions

All authors contributed equally in preparing, writing and revising this manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

Ethical Approval

This article does not contain any studies with human participants or animals performed by any of the authors.

6. REFERENCES

Abughoush, M., Olaimat, A. N., Al-Holy, M., Al-Awwad, N. J., Al-Dalali, S., Al-Hourani, H., Daseh, L., Abazeed, B., Al-Dabbas, M., Abuawad, B., Abu-Ghoush, L., & Al-Jawaldeh, A. (2024). Quantitative determination of iodine content in iodized table salt marketed in Jordan as an indicator of compliance with national salt iodization standards: A cross-sectional study. Italian Journal of Food Science, 36(4), 72–81.

Bediye, M. T., & Berihe, G. K. (2015). Iodometric titration and spectrophotometric method for the determination of iodine in salt samples commercially available in Bahir Dar, North Western Ethiopia. Chemical and Materials Research, 7(4), 59–66.

Brough, L. (2021). Iodine intake for pregnant and breastfeeding women and their infants remains a global concern. Journal of Nutrition, 151, 3604–3605.

Graudal, N., Albert, H., & Thorbjorn, J. G. (2017). Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride. The Cochrane Database of Systematic Reviews, 4(4), 4022.

Hatch-McChesney, A., & Lieberman, H. R. (2022). Iodine and iodine deficiency: A comprehensive review of a re-emerging issue. Nutrients, 14, 3474.

Koukkou, E. G., Roupas, N. D., & Markou, K. B. (2017). Effect of excess iodine intake on thyroid on human health. Minerva Medica, 108, 136–146.

Mente, A., O'Donnell, M., Rangarajan, S., Dagenais, G., & Lear, S. (2016). Associations of urinary sodium excretion with cardiovascular events in individuals with and without hypertension: A pooled analysis of data from four studies. The Lancet, 388(10043), 465–475.

Monaghan, A. M., Mulhern, M. S., McSorley, E. M., Strain, J. J., Dyer, M., van Wijngaarden, E., & Yeates, A. J. (2021). Associations between maternal urinary iodine assessment, dietary iodine intakes and neurodevelopmental outcomes in the child: A systematic review. Thyroid Research, 14, 14.

Sani, B. Y., Abdullahi, J., Sani, Z. T., & Sulaiman, R. (2023). Determination of the composition of iodine in selected brands of table salts sold in different Sokoto State markets. International Journal of Advanced Academic Research, 9(2), 41–48.

Strom, B. L., Yaktine, A. L., & Oria, M. (2013). Sodium intake in populations: Assessment of evidence. Institute of Medicine of the National Academies, 1–14.

Usoro, M., Etesin, A. E., Ite, E. J., Ukpong, E. E., Ikpe, U. U., Ubong, T., & Ifikairom, G. I. (2017). Comparative assessment of iodine content of commercial table salt brands available in Nigerian market. American Journal of Hypertension Research, 4(1), 9–14.

Winder, M., Kosztyła, Z., Boral, A., Kocełak, P., & Chudek, J. (2022). The impact of iodine concentration disorders on health and cancer. Nutrients, 14(2209), 2–17.

World Health Organization. (2023). Iodization of salt for the prevention and control of iodine deficiency disorders. World Health Organization.

Wulandari, N. R., & Rosyida, N. (2017). Analysis of iodine content in table salt. Journal of Vokasi Indonesia, 5(1), 35–37.

Zimmerman, M. B. (2020). Iodine and the iodine deficiency disorders. In Present Knowledge in Nutrition (pp. 1). Elsevier.

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Zimmermann, M. B., & Galetti, V. (2015). Iodine intake as a risk factor for thyroid cancer: A comprehensive review of animal and human studies. Thyroid Research, 8, 8.

Zou, Y., Ding, G., Lou, X., Mo, Z., Zhu, W., Mao, G., & Zhou, J. (2015). A study on the influencing factors of urinary iodine concentration and the relationship between iodised salt concentration and urinary iodine concentration. British Journal of Nutrition, 113, 142–146.