

Cooking Effect, Storage Stability and Sensory Characteristics of Iodine in Salt

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ABSTRACT

A study was conducted to assess heat and storage stability of iodine in salt as well as sensory attributes of food products containing iodized salt. To determine storage stability, salt samples were iodized at 100 ppm and stored over a period of 12 months. Samples were analyzed for iodine at 0, 6 and 12 months respectively. To assess heat stability, iodized salt samples were boiled for 0, 15, 30, 45 and 60 minutes respectively and iodine content determined. Triangle test, paired comparison and descriptive profiling test were used to assess sensory qualities of food products containing iodized salt. Paired sample T-Test was used to determine statistical differences between the various samples at $p < 5\%$. There was a significant change in the level of iodine in salt stored for twelve months with the mean iodine content dropping steadily with time from 97.81 ± 18.50 ppm to 79.63 ± 18.24 ppm. The mean percentage drop was 18.6%. With regard to heat stability, boiling of samples of iodized salt in water for 60 minutes reduced the iodine concentration significantly with time ($p < 0.05$). The mean percentage decrease in iodine levels of the six samples was 13.5%. Sensory tests conducted on food products containing iodized salt showed that iodine fortification of salt does not affect sensory attributes of Ghanaian staple dishes like kenkey, boiled yam and plantain. Wheat flour products were also not affected. Storage and boiling of salt significantly decreased the iodine content of salt. (*J ARAHE 9:6-10, 2002*)

KEY WORDS : Heat and storage stability, iodization, sensory characteristics, iodized salt products.

INTRODUCTION

Ghana, like many other countries faced with problems of Iodine Deficiency Disorders (IDD), has selected salt iodization as a sustainable long-term solution. This strategy requires that any salt meant for human and animal consumption, be it from local or foreign source, should contain a specific amount of iodine.¹⁾ Iodine deficiency not only causes goitre, cretinism and deaf-mutism in all age groups, but may also result in irreversible brain damage in the fetus and infant, and retarded psychomotor development in a child. It also affects reproductive functions and impedes children learning ability.

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Sea fish, other seafood and seaweed are rich sources of iodine suitable for human consumption. Iodine is also found in vegetables grown in soils containing adequate amounts of this trace element, and in milk products, eggs, poultry, and meat from animals whose diets contain sufficient iodine. Not all these food products unfortunately are available to those who need the iodine most.

IDD is a public health problem in Ghana. The prevalence and severity of IDD in Ghana have been documented.²⁾ In 1995, 36 out of the 110 districts surveyed were found to have serious IDD problems. The results also revealed that the clinical effects of iodine deficiency on the mental and physical development of children living in the endemic areas were much more serious and required urgent attention. Based on the results of the survey, the Government of Ghana amended the Food and Drugs Law 1992 (PNDC Law 303B) to provide for the fortification of salts in Ghana to al-

leviate IDD problems.

Based on studies of energy balance and excretion over 24 hours, a safe daily intake of iodine has been estimated to be between a minimum of 50 μg and a maximum of 1000 μg .^{3,4)} A generally accepted desirable adult intake is 100–300 $\mu\text{g}/\text{day}$. The average daily salt intake varies from country to country. Usually consumption levels are within the 5–15 g/day range for children and adults. The average intake for Ghana has been estimated to be 10 g/day.⁵⁾ The Ghana salt iodization programme recommends that the highest level of salt iodization should be 100 $\mu\text{g}/\text{g}$ or 100 ppm. This was the level recommended by ICCIDD/UNICEF/WHO⁶⁾ for developing countries. The recommendation takes into consideration factors such as climate (warm and moist) and conditions affecting production, packaging and distribution.

Although iodized salt has been used in several countries for over fifty years or more, it is to most Ghanaians a new food product, introduced to the public in 1995. Since the introduction of the iodized salt, salt producers and consumers alike have posed several questions regarding sensory qualities, stability of the iodine in salt during cooking and as well as on storage. To provide answers to some of these questions, studies were conducted to assess heat and storage stability of iodine in salt and evaluate sensory qualities of food products containing iodized salt.

MATERIALS AND METHODS

Sample preparation

Crushed salt was purchased from Panbros Ghana Limited, a salt producing factory in Accra, Ghana, and iodized at 100 ppm (8.43 g of KIO₃ in 50 kg of salt) using the Imer mixer. Fifteen batches of 50 kg of iodized salt were prepared. Each batch was packed in one-kilogram high-density polyethylene bags, sealed, labeled and stored at room temperature of $30 \pm 4^\circ\text{C}$ until needed.

Determination of storage stability of iodine

The initial iodine content of each batch was determined using the iodometric method recommended by Programme Against Micronutrient Malnutrition.⁷⁾ At six and twelve months respectively, two sachets of each batch were pooled together and the concentration of

iodine determined in triplicate. The iodine retained in the salt after six and twelve months respectively were calculated and Paired sample T-Test was used to determine statistical significance of differences in the loss of iodine in salt over time.

Determination of heat stability of iodine in salt

Six different samples of iodized salt were purchased from the open market and analyzed for iodine concentration in triplicate. Ten grams of each sample was dissolved in 50ml of distilled water in conical flasks. Each flask was heated in a water bath for 15, 30, 45 and 60 minutes respectively and cooled to ambient temperature ($30 \pm 4^\circ\text{C}$). The iodine concentration of the samples were then determined using iodometric titration method.⁷⁾ Paired sample T-Test was used to analyze heat stability of iodine in salt.

Sensory evaluation of food products containing iodized and non-iodized salts

Using trained panelists, a combination of methods were used to assess sensory characteristics of food products containing iodized and non-iodized salts. The methods included Triangle test, Paired Comparison and Descriptive Profiling tests.

In the triangle test, twenty-four trained panelists were used to detect differences between pastry chips containing iodized salt and another with non-iodized salt (control). Each panelist was presented with three coded samples and instructed to identify the odd sample. Statistical analysis of the triangle test was based on the number of correct responses at P 5%.

Paired comparison test was used to determine whether iodized salt was saltier than non iodized. Iodized and non-iodized salt samples were used to prepare rock cakes. All samples were coded and served in a randomized manner to fifteen trained panelists. They were asked to indicate which sample was saltier and also to show their preference. Evaluation was performed by panelists in individual booths.

Descriptive profiling test was used to assess the overall impression of products containing iodized and non-iodized salts. The products evaluated were tuna pies, boiled yam and boiled plantain, with and without iodized salt. Fifteen panelists were asked to identify sensory attributes and their intensities on line scale with

anchored ends (1=none and 10=very intense). All evaluations were conducted in individual booths illuminated with white fluorescent light. A 9-point hedonic scale was used to test the overall acceptability of the products. In all the sensory assessments, 2% of either iodized or non iodized salt was used.

RESULTS AND DISCUSSION

Storage stability of iodine in salt

The initial mean iodine concentration of the 15 samples was $97.8 \pm 18.5 \mu\text{g/g}$. At the end of the sixth month in storage, the concentration of iodine had reduced to $95.6 \pm 17.3 \mu\text{g/g}$. The concentration decreased further to $79.6 \pm 18.2 \mu\text{g/g}$ after twelve months. The percentage mean change were 2.2% and 18.2% respectively for 6 months and 12 months in storage. The most drastic decrease in iodine concentration occurred during the second six months in storage (Fig. 1).

The stability of iodine in iodized salt depends on

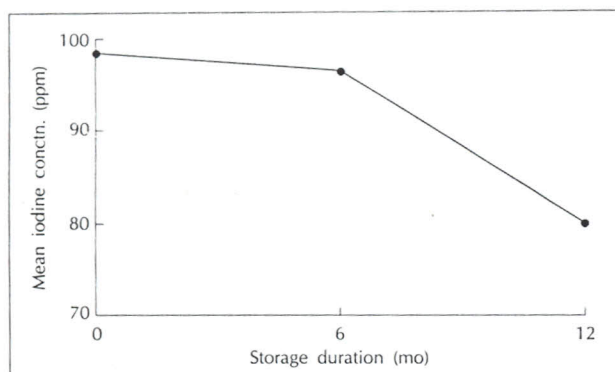


Fig. 1. Storage stability of iodine in salt.

the iodine compound used, the quality of salt, the type of packaging and the exposure of the package to the prevailing ambient temperature as well as the period of time between iodization and consumption. Preliminary results of a study conducted by Alnwick⁸⁾ and sponsored by UNICEF showed that crude salt from Ghana iodized at 50 ppm and stored at 40°C and 100% humidity for 3 months in low-density polyethylene bags did not lose more than 10% of the iodine content. Odoom *et al.*⁹⁾ in their study on iodine shelf life recorded that iodine content of iodized salt in polyethylene sachets from 2 manufacturers reduced by 21.6 – 45.2% from factory to household consumption within 8 weeks. The quality of the salt was blamed for the losses. On the contrary, although Diosady *et al.*¹⁰⁾ recorded no losses of iodine in Ghanaian salt after 3 months, they reported losses of 27% and 82% over six months and 12 months respectively at the same temperature and humidity. Silveira *et al.*¹¹⁾ did not find any significant change in iodine content 2 years after manufacture in Brazil. The reason could be because their samples were white, refined and well packaged.

In this study, the mean loss of iodine over the 12 month period at $30 \pm 4^\circ\text{C}$ was 18.2%. This percentage loss is within the limits of 50% losses assumed to occur between iodization and consumption made by the ICCIDD/UNICEF/WHO⁶⁾ in recommending salt iodization levels for developing countries. The percentage losses are also lower compared to results of similar studies conducted in Ghana discussed above.

Stability of iodine with boiling

Table 1 shows the percentage change in iodine concentration after boiling six different samples of iodized

Table 1. Effect of boiling on iodine content of salt¹⁾

| Iodized salt sample | Initial iodine content ($\mu\text{g/g}$) ¹⁾ | % iodine loss during boiling | | | |
|---------------------|--|------------------------------|----------------|----------------|----------------|
| | | 15 min. | 30 min. | 45 min. | 60 min. |
| A | 131.2 ± 2.5 | 10.9 ± 1.3 | 13.7 ± 1.7 | 14.3 ± 1.5 | 21.8 ± 2.1 |
| B | 85.7 ± 0.8 | 0.5 ± 0.3 | 0.9 ± 0.4 | 0.9 ± 0.2 | 6.4 ± 1.3 |
| C | 107.9 ± 1.4 | 1.2 ± 0.6 | 1.2 ± 0.4 | 3.5 ± 0.9 | 3.9 ± 1.0 |
| D | 38.1 ± 1.8 | 13.9 ± 0.8 | 15.0 ± 1.1 | 15.0 ± 0.9 | 20.7 ± 1.8 |
| E | 61.4 ± 2.2 | 10.4 ± 1.2 | 11.4 ± 1.4 | 18.4 ± 2.3 | 18.4 ± 1.9 |
| F | 42.3 ± 0.9 | 0.2 ± 0.1 | 0.2 ± 0.1 | 5.0 ± 1.5 | 9.9 ± 1.8 |
| Mean | 77.8 | 6.2 | 7.1 | 9.5 | 13.5 |

1) Values are means \pm standard deviation of three replicates

Table 2. Mean score for intensity of sensory attributes of yam, plantain and tuna pies prepared with or without iodized salt¹⁾

| Sensory attribute | Yam | | Plantain | | Tuna pie | |
|-------------------------------------|---------|-------------|----------|-------------|----------|-------------|
| | Iodized | Non-iodized | Iodized | Non-iodized | Iodized | Non-iodized |
| Colour | 3.5±1.0 | 4.4±1.2 | 4.3±1.8 | 4.7±1.2 | 3.3±0.5 | 4.2±1.2 |
| Taste | 6.1±1.8 | 5.8±1.7 | 4.6±1.2 | 5.6±1.6 | 6.2±1.7 | 5.8±1.4 |
| Hardness | 4.2±2.1 | 5.8±2.4 | 5.6±1.6 | 5.3±1.6 | 3.4±1.2 | 4.4±1.2 |
| Chewiness | 3.0±1.6 | 3.2±1.3 | 4.6±1.7 | 5.0±1.1 | 3.7±1.8 | 3.6±1.8 |
| Moistness | 6.0±2.0 | 4.4±2.3 | 5.3±1.0 | 4.3±1.9 | 4.2±1.3 | 4.0±1.5 |
| Fibrousness | 2.7±1.3 | 3.9±2.3 | 3.6±1.3 | 4.9±1.9 | 3.6±1.3 | 3.5±0.8 |
| Saltiness | 4.0±1.6 | 4.1±1.6 | 4.7±1.4 | 4.2±0.8 | 5.4±0.9 | 5.5±0.9 |
| Overall acceptability ²⁾ | 7.1±1.0 | 7.0±1.2 | 7.5±0.7 | 7.2±1.2 | 8.0±0.9 | 7.5±1.3 |

1) Interpretation of scores : 1=not intense and 10=very intense

2) Based on a 9-point hedonic scale with 1=dislike extremely, 5=neither like nor dislike and 9=like extremely

salt (A-F) over some time. Significant changes were observed after boiling the samples for different duration of time, although the percentage reduction of iodine concentration in the samples was not uniform. For samples A, D, and E, the percentage losses were quite high even at 15minutes of boiling. By one hour of boiling, the mean percentage losses of iodine were 21.8%, 20.7% and 18.4% respectively. The percentage loss of iodine in samples B, C, and F were quite low. Changes observed at one hour of boiling in these samples were 6.4, 3.9 and 9.9 respectively. The mean percentage change at one hour of heating was 11.6%.

Oppey *et al.*¹²⁾ reported losses of 31.0 to 60.9% of iodine during cooking of some local Ghanaian dishes. The differences therefore may be attributed in part to the methods of cooking. There was no frying and grilling in the present study, as was the case in the previous reports. In addition, specific foods or dishes may affect iodine content differently because of differences in the chemical and physical characteristics of the food. Iodine liberation is enormous in the presence of most food additives and spices. The losses might be lower in our work because of the absence of other food ingredients. The cooking losses of 31 – 60.9%, reported by Oppey *et al.*¹²⁾ could also reflect the different levels of purity or percentage moisture of the iodized salt used. Clean, dry salt with equal or less than 4% moisture content is recommended for iodization.

Sensory characteristics of products containing iodated and non-iodated salts

Salt is a flavour enhancer and a preservative. It reduces off flavors and helps to improve texture. It also

helps in colour development and in fermentation. All these properties might be affected by the fortification of salt with the iodine. In the triangle test conducted on pastry chips, only 6 out of the 24 panelists could correctly identify picked the odd sample. From standard tables, at least 13 correct judgements were required for significant differences at $p < 0.05$, therefore there were no significant difference between iodized and non-iodized salt. In terms of saltiness using rock cakes as the food base however, the paired comparison test indicated that differences existed between food products containing iodized and non-iodized salt. In the paired comparison test, eight out of the 15 panelist indicated that non-iodized salt rock cakes were saltier than iodized salt rock cakes. Seven panelists preferred iodized salt rock cakes while eight panelists showed preference for non-iodized rock cakes. This shows that the food product may play an important role in the ability to detect differences between iodized and non-iodized salt.

Results of the descriptive profiling test are shown in Table 2. The panelists did not find any significant difference between iodized and non-iodized salt using yam, plantain and tuna pies as the food base. Iodized salt did not therefore affect the sensory attributes of these foods.

The sensory data indicated that when used in most foods, there was no significant difference between iodized and non-iodized salt. It has been reported that potassium iodate does not change either the appearance or the taste of salt.¹³⁾ This has been confirmed to a large extent by the results of the present study. What might change some of the properties of salt would be the moisture content, the presence of impurities and the general quality of the salt. The drier the salt, the more intense is the taste.

CONCLUSION

Storage and boiling of salt significantly decreases the iodine content of salt, especially over a long period of time. The sensory data indicated that the use of iodized salt does not affect the sensory attributes of yam, plantain, tuna pies, rock cakes and pastry chips.

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