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Effect of storage on the iodine content of some table salts sold at a local and a super market in Port Harcourt, Nigeria

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One kilogram of five brands of commonly used iodized salts such as Dangote (DT), Mr Chef (MC), Magic Time (MT), Anapuna (AP) and Uncle Palm (UP) salt were procured from local market (LMT) and supermarket (SMT). They were stored at a temperature of 28±2°C for a period of six weeks and analysed to determine iodine loss over storage time. Iodine values at week 0 were used as the standard. The result showed that at week 0, salt samples had iodine content of 27.49 ppm, 39.65, 47.05, 47.60 and 92.55 ppm for UP, AP, MC, DT and MT, respectively for LMT salts with significantly lower (P < 0.05) value in AP and higher value in MT salts. Same LMT salts had moisture content of 1.72% UP, 1.09% AP, 0.71% DT, 0.53% MT and 0.46% for MC. SMT salts had significantly higher and lower iodine values of 94.15 and 31.15ppm (MT and UP), respectively. AP had 48.08 ppm, MC 49.70 ppm while DT had 51.25 ppm of iodine values. Moisture values recorded to be 2.07%, 1.13, 1.11, 0.61 and 0.46% for UP, DT, AP, MT and MC, respectively for SMT salts. During storage, iodine values of salt samples from the LMT were observed to decrease from 47.55 – 45.25 ppm with loss of 5.60% for DT salt, 47.05 – 41.05 ppm loss of 14.29% for MC, 92.55 – 84.65 ppm loss of 18.81% for MT, 39.65 – 38.08 ppm loss of 3.74% AP and 27.49 – 18.15ppm loss of 22.24% UP salt. Those from SMT equally decreased from 51.25 – 51.05 ppm loss of 0.48% (DT), 49.70 – 47.55 ppm loss of 5.12% (MC), 94.15 – 91.00ppm loss of 7.50% (MT), 48.05 – 42.50 ppm loss of 13.21% (AP) and 31.15 – 18.55 ppm loss of 30.00% for UP. Among all the salt samples, iodine values of those from SMT were better compare to those from LMT. It is then recommended to store salts away from direct sunlight.

Key words: Storage, iodine content, table salts, local and super markets, evaluation.

INTRODUCTION

Iodine is an essential trace element found in foods, needed for good function of the thyroid gland which is indispensable for optimal health (Dunn and Dunn, 2001; Horst et al., 2005), such as the production of thyroxin (T₄) and Triiodothyronine (T₃) hormones that regulates the metabolism of physiological processes in the body (WHO, 2007). It is essential for normal brain development, as well as important for foetus and young children to have adequate intake of iodine (Venturi and Cocchi 2000). Impaired production of thyroid hormones caused by iodine deficiency known as Iodine Deficiency Disorder (IDD) during pregnancy affects growth and brain development in the progeny, decreased fertility and increased infant mortality rate (Glinser, 2007; Zimmermann, 2007; Morreale de Escobar et al., 2007). Zimmermann et al., (2006) equally stated that IDD results in impaired somatic growth, cognitive performance and motor function. As a micronutrient, only small amount of iodine is required for human health (Rosenfeld, 2000). According to World Health Organisation, the Recommended Daily Allowance (RDA) of iodine for adults should be 150 μg per day and between 200 – 250 μg for pregnant women per day (WHO, ICCIDD, UNICEF, 2001). Delange (2000) recommended that more than 100 μg of iodine should be taken by children per day. Stang and Story (2005) stated that RDA means the average

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daily level of essential trace element intake sufficient to meet the nutrient requirement of nearly 97.5% healthy individuals. Seawater and seafood such as seaweed, shellfish, mollusks and fish are all primary natural sources of iodine (Pearce et al., 2004; Haldimann et al., 2005).

In many regions, leaching after erosion depletes the soil’s iodine content, thereby the crops grown on the soil are deficient of iodine. As nearly one-third of the earth population live in the areas of iodine deficiency, there is an effort to introduce iodine regularly into the daily diet to prevent iodine deficiency disorder which several foods have been considered as possible vehicles. These include water, milk, sugar, sweets, bread and salt. Among these, salt has become the most commonly accepted food commodity owing to the fact that it is one of the few commodities that is universally consumed by all individuals within a society irrespective of economic status (Diosady et al., 1998). It is consumed at approximately the same level throughout the year in a given region by all persons. Salt come in contact with foods on a daily basis as a clear brittle mineral, either as flavouring or preserving agent since ancient time (The World Book Encyclopedia, 2003). Recognizing the importance to prevent and control iodine deficiency disorders, World Health Organization taught of salt as a better option for external supply of iodine in the form of iodized salt (WHO, 2007). Iodine concentration of salt at the point of production has been recommended to be between 20 – 40 mg per 1 kg of iodized salt. This recommended level was estimated by World Health Organisation under the assumptions that 20% loss of iodine from production site to household, 20% loss when cooking and 10g of salt as average salt intake per capital (WHO, ICCIDD, UNICEF, 2001).

Iodized salt is undoubtedly the best strategy for countries to effectively distribute iodine to its population and most countries worldwide have implemented the universal salt iodization (UNICEF, 2008). Yet, iodine is not fully utilized by the people because of improper handling, usage and storage practices (Rashmi and Raghuvanshi, 2014). Countries like Australia, New Zealand, Nigeria and several others have been reporting reoccurring iodine deficiency (Skeaff et al., 2002; Anonymous, 2003; Delange, 2003; Vitti et al., 2003; Li et al., 2006; WHO, 2007). It is understood that the actual availability of iodine in salt depends on its form of fortification and environmental factors. On exposure to sunlight, wind, salts iodized with iodide loss a considerable amount of iodine while those iodized with iodate has shown no or less losses. When heating, salts containing potassium iodate retained a high percentage of their original iodine content while salts iodized with potassium iodide had lost a considerable amount of iodine (Laar and Pelig-Ba, 2013; Prodhan et al., 2014).

Salts sold in the local markets are left in the open space exposed to vagaries of weather such as sun, rain and varying temperatures. Salts in the supermarkets are kept in cool air conditioned environment. These conditions contribute to undesirable losses of iodine content of salt samples during storage. It is therefore critical to have an accurate estimate of the losses in iodine prior to consumption, so that the producers may compensate for the losses by the addition of excess iodine during production. Hence, the aim of this research is to evaluate the iodine content of different salt samples from a local and a super market in Port Harcourt, Rivers State, Nigeria and determine the actual percentage loss of iodine over 6 weeks of storage time.

MATERIALS AND METHODS

MATERIALS

One kilogram (1kg) of five different brands of commonly used edible iodized salts by the populace such as Dangote, Mr Chef, Magic Time, Anapuna and Uncle Palm’s salt were procured from Mile 3 market in Diobu and Next-Time supermarket in GRA and transferred to the laboratory at Department of Food Science and Technology, Rivers State University of Science and Technology, Port Harcourt, Nigeria for analysis. Other materials used for this analysis were obtained and preserved at room temperature (28 ± 2°C) in the same department.

Chemicals such as sodium thiosulphate (2N\textsubscript{2}S\textsubscript{2}O\textsubscript{3}), concentrated sulphuric acid (H\textsubscript{2}SO\textsubscript{4}), potassium iodide (KI), soluble chemical starch, hydrogen peroxide solution and white vinegar catalyst were equally obtained from the department and were of analytical grade.

Determination of iodine content

Iodine values were determined immediately on arrival of the salt samples in the laboratory and at different storage time for a period of six weeks using iodometric method of titration as reported by WHO (2007). Salt samples were thoroughly mixed separately to ensure that the iodine is homogeneously distributed in the salt. Ten grams (10 g) of iodized salt was weighed and dissolved in 50ml double distilled water. As the salt dissolved in the measured amount of water, sulphuric acid 2N (1 – 2 ml) and potassium iodide 10% (5 ml) was added to the salt solution, which turned yellow in the presence of iodine. The reaction mixture was kept in a dark place for 10min to reach the optimal reaction time before titrated with sodium thiosulfate using 2 ml starch as indirect indicator. The concentration of iodine in salt was calculated based on the titrated volume of sodium thiosulfate and percentage loss of iodine between the periods of storage was equally calculated according to the formula mentioned below:
The result showed that the salt samples such as Dangote salt, Mr Chef, Magic Time, Anapuna and Uncle Palm salts purchased from the local market had iodine content of 47.60, 47.05, 92.55, 39.65 and 27.49 ppm respectively as presented in Table 1. Those procured from the supermarket in GRA had iodine content of 51.25 ppm Dangote salt, 49.70 ppm Mr Chef, 94.15 ppm Magic Time, 48.05 ppm Anapuna and 31.15 ppm for uncle palm salt. Among all the salt samples from a local and supermarket, Magic Time salt was significantly higher (P < 0.05) while Uncle Palm was lower in iodine content compare to others. It was equally observed that supermarket salts had higher iodine content when compared with those from a local market. This could be attributed to exposure of local market salts to direct sunlight which causes loss of iodine in the salt samples through oxidation of the triiodide ions in the salt to form iodine which can be given off rapidly on exposure and storage. This is in agreement with the statement of Vithanage et al. (2016) who said that salt loss a considerable amount of its iodine content on exposure to sunlight and wind. Apart from the iodine content of magic time salt, other samples from local market agreed with the work of Adesina and Arinola (2014) who reported iodine content of salts with a range of 29.40 – 35.85 ppm.

Dangote salt purchased from a local market was observed to have moisture content of 0.71%, Mr Chef 0.46%, Magic Time 0.53%, Anapuna 1.09% and Uncle Palm 1.72% with significantly higher value while Mr Chef with significantly lower (P < 0.05) moisture content compare to other samples. These values are in close agreement with the report of Adesina and Arinola (2014) who reported that moisture content of salts in Ado-Ekiti was in the range of 0.099 – 0.495%. The slight difference in these values could be as a result of different locations where the salt samples were obtained as Port Harcourt is located in a relatively humid area of Nigeria compare to Ado-Ekiti. Supermarket salts had the moisture contents of 1.13%, 0.46, 0.61, 1.11 and 2.07% for Dangote, Mr Chef, Magic Time, Anapuna and Uncle Palm salt respectively. It was equally observed that Mr Chef and Uncle Palm salt obtained from the supermarket recorded significantly lower and higher (P < 0.05) moisture values, respectively compare to other salt samples. The moisture content of supermarket salts was a bit higher than those from a local market which could be attributed to the cool place they were stored away from sunlight which may cause the salt samples to gain more moisture. Kelly (1953) stated that relative humidity and temperature play a significant role in the preservation and storage of salts.

### RESULTS AND DISCUSSION

#### Iodine and moisture content of local and supermarket salts

The result showed that the salt samples such as Dangote salt, Mr Chef, Magic Time, Anapuna and Uncle Palm salts purchased from the local market had iodine content of 47.60, 47.05, 92.55, 39.65 and 27.49 ppm respectively as presented in Table 1. Those procured from the supermarket in GRA had iodine content of 51.25 ppm Dangote salt, 49.70 ppm Mr Chef, 94.15 ppm Magic Time, 48.05 ppm Anapuna and 31.15 ppm for uncle palm salt. Among all the salt samples from a local and super markets, Magic Time salt was significantly higher (P < 0.05) while Uncle Palm was lower in iodine content compare to others. It was equally observed that supermarket salts had higher iodine content when compared with those from a local market. This could be attributed to exposure of local market salts to direct sunlight which causes loss of iodine in the salt samples through oxidation of the triiodide ions in the salt to form iodine which can be given off rapidly on exposure and storage. This is in agreement with the statement of Vithanage et al. (2016) who said that salt loss a considerable amount of its iodine content on exposure to sunlight and wind. Apart from the iodine content of magic time salt, other samples from local market agreed with the work of Adesina and Arinola (2014) who reported iodine content of salts with a range of 29.40 – 35.85 ppm.

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### Table 1. Iodine and moisture content of local and supermarket salt samples.

<table>
<thead>
<tr>
<th>Types of Salt</th>
<th>Local Market Salts</th>
<th>Supermarket Salts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Iodine (ppm)</td>
<td>Moisture (%)</td>
</tr>
<tr>
<td>Dangote</td>
<td>47.60 ± 3.74</td>
<td>0.71 ± 0.02</td>
</tr>
<tr>
<td>Mr Chef</td>
<td>47.05 ± 2.19</td>
<td>0.46 ± 0.04</td>
</tr>
<tr>
<td>Magic Time</td>
<td>92.55 ± 0.77</td>
<td>0.53 ± 0.02</td>
</tr>
<tr>
<td>Anapuna</td>
<td>39.65 ±2.19</td>
<td>1.09 ± 0.14</td>
</tr>
<tr>
<td>Uncle Palm</td>
<td>27.49 ± 1.48</td>
<td>1.72 ± 0.17</td>
</tr>
</tbody>
</table>

**Note:** Values with the same superscript within the row are not significantly different at 5% level of probability (P<0.05).
Table 2. Effect of storage time on iodine content (ppm) of local market salts.

<table>
<thead>
<tr>
<th>Storage Period/Weeks</th>
<th>Dangote</th>
<th>Mr Chef</th>
<th>Magic Time</th>
<th>Anapuna</th>
<th>Uncle Palm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 0</td>
<td>47.60a</td>
<td>47.05b</td>
<td>92.55b</td>
<td>39.65a</td>
<td>27.49a</td>
</tr>
<tr>
<td>Week 1</td>
<td>47.55a</td>
<td>44.65b</td>
<td>91.51b</td>
<td>38.35b</td>
<td>24.15b</td>
</tr>
<tr>
<td>Week 2</td>
<td>47.55a</td>
<td>44.45b</td>
<td>89.65c</td>
<td>38.25b</td>
<td>24.15b</td>
</tr>
<tr>
<td>Week 3</td>
<td>47.35a</td>
<td>44.45b</td>
<td>89.60c</td>
<td>38.10b</td>
<td>20.12c</td>
</tr>
<tr>
<td>Week 4</td>
<td>47.25a</td>
<td>44.40b</td>
<td>88.60d</td>
<td>38.10b</td>
<td>18.65d</td>
</tr>
<tr>
<td>Week 5</td>
<td>45.65b</td>
<td>44.25b</td>
<td>84.83a</td>
<td>38.08b</td>
<td>18.15d</td>
</tr>
<tr>
<td>Week 6</td>
<td>45.25b</td>
<td>41.05c</td>
<td>84.65e</td>
<td>38.08b</td>
<td>18.15d</td>
</tr>
</tbody>
</table>

*a, b, c, d, e* ± Standard deviation of duplicate readings. Values with the same superscript within the row are not significantly different at 5% level of probability (P < 0.05).

Effect of storage time on iodine content of local market salts

The analyses showed that there was a significantly gradual decrease in iodine concentration of the salt samples stored for a period of six (6) weeks. Laar and Pelig-Ba (2013) observed similar decreased in iodine content of different salts after exposure to several storage temperatures. Chauhan et al. (1992) studied the stability of iodine over 300 days in common salt iodized with iodate and equally reported a decreased in their iodine concentration. Among the five salt samples procured from a local market, there was no significant difference (P < 0.05) in iodine retention of Dangote salt sample up to the fourth week of storage compare to its iodine value at week 0 as presented in Table 2. There was a significant drop of iodine content of Dangote salt at week 5 and 6 compared to other weeks. Apart from iodine value of Mr Chef and Anapuna salt at week 0 which was significantly higher compare to those of other weeks, week 1 – 5 was observed to have significantly stable values and slightly dropped at week 6 for Mr Chef while Anapuna salt was observed to be stable up to the sixth week. Magic Time and Uncle Palm salt had significantly the least stability iodine values from first to sixth weeks of storage. Comparing the iodine loss of the salt samples during storage, Uncle Palm’s salt had the highest iodine loss of 33.98%, followed by Mr Chef and Magic Time with iodine loss of 12.75% and 8.54%, consecutively. Although, Anapuna salt had the lowest iodine value but it was observed to be highly susceptible during storage with values ranging from 39.65 – 38.08ppm from week 0 to the sixth week which resulted to the lowest iodine loss of 3.96% compared to all other samples. Another sample that was observed to strive over time is Dangote with iodine loss of 4.94%. The iodine losses in this study are within the ranges of that reported by Vithanage et al. (2016) for commercial edible iodized salts in Sri Lanka. This could be attributed to the type of iodine added to these salt samples during production and exportation that is lacking in other samples such as uncle palm, magic time and Mr Chef salts. Laar and Pelig-Ba (2013); Prodhan et al. (2014) stated that salts iodized with potassium iodate retained a high percentage of their original iodine content while those iodized with potassium iodide had lost a considerable amount of its iodine during heating and storage.

Effect of storage time on iodine content of supermarket salts

Analyses showed that Dangote salt purchased from the supermarket had the highest stability during storage compare to other salt samples and there was no significant difference (P < 0.05) in its iodine values from 0 – 6 weeks of storage as shown in Table 3. In terms of Mr Chef Salt, there was no significant difference (P < 0.05) between week 0 – week 3 and 4 – 6 weeks of storage. Iodine value of Magic Time and Anapuna salt samples was observed to be stable from week 4 – 6 while stability was not recorded in Uncle Palm salt in all the storage weeks with the highest iodine loss of 40.45% followed by Anapuna with iodine loss of 11.55%. Dangote salt had the least iodine loss of 0.39%, followed by Magic Time and Mr Chef salt with iodine loss of 3.30% and 4.32% respectively. The difference in the loss of iodine can be associated with the suitability of stabilizers used in the concentration of these salt samples. This is in agreement with the statement of Rashmi and Raghuvanshi (2014) who reported that the difference in iodine loss of brands of salt may be due to variation in the use of suitable...
Table 3. Effect of storage time on iodine content (ppm) of some supermarket salts.

<table>
<thead>
<tr>
<th>Storage Period/Weeks</th>
<th>Dangote</th>
<th>Mr Chef</th>
<th>Magic Time</th>
<th>Anapuna</th>
<th>Uncle Palm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 0</td>
<td>51.25(^a)</td>
<td>49.70(^a)</td>
<td>94.15(^a)</td>
<td>48.05(^a)</td>
<td>31.15(^a)</td>
</tr>
<tr>
<td>Week 1</td>
<td>51.25(^a)</td>
<td>49.25(^a)</td>
<td>92.51(^b)</td>
<td>48.00(^a)</td>
<td>30.00(^b)</td>
</tr>
<tr>
<td>Week 2</td>
<td>51.25(^b)</td>
<td>49.15(^b)</td>
<td>92.22(^b)</td>
<td>46.25(^b)</td>
<td>25.15(^b)</td>
</tr>
<tr>
<td>Week 3</td>
<td>51.23(^b)</td>
<td>49.10(^b)</td>
<td>92.15(^b)</td>
<td>44.00(^c)</td>
<td>24.35(^d)</td>
</tr>
<tr>
<td>Week 4</td>
<td>51.15(^d)</td>
<td>48.00(^d)</td>
<td>91.00(^c)</td>
<td>42.56(^d)</td>
<td>21.00(^e)</td>
</tr>
<tr>
<td>Week 5</td>
<td>51.05(^e)</td>
<td>47.55(^e)</td>
<td>91.00(^c)</td>
<td>42.56(^d)</td>
<td>21.00(^f)</td>
</tr>
<tr>
<td>Week 6</td>
<td>51.05(^f)</td>
<td>47.55(^f)</td>
<td>91.00(^c)</td>
<td>42.50(^d)</td>
<td>18.55(^e)</td>
</tr>
</tbody>
</table>

\(^a,b,c,d,e\) ± Standard deviation of duplicate readings. Values with the same superscript within the row are not significantly different at 5% level of probability (P<0.05).

Figures are not provided in this text, but they would typically include a graph showing the percentage loss of iodine content over 6 weeks of storage for both local market and supermarket salt samples. A bar chart could illustrate the data from Table 3, with bars for each salt type showing the percentage loss at each week.

stabilizer to improve the stability of iodine in common salt. Apart from Uncle Palm salt which lost a high percentage of iodine, other salt samples from a local and supermarket showed iodine loss below 20% assumed to occur from production site to household (WHO, ICCIDD, UNICEF, 2001), which is a good indication of the fortification of these salt samples.

Percentage of iodine loss

Among the local market and supermarket salt samples, Dangote salt had the highest stability; lowest iodine loss in supermarket salt, Anapuna salt had the lowest iodine loss while Dangote is second to the lowest iodine loss in local market salts. The stability and low iodine loss of these salt samples could be as a result of the iodate compound and stabilizers which could be present in them thereby helped to retain more iodine than iodide compound. Another point may be due to the good manufacturing practices observed by these companies but neglected by the other companies. The good part is that Dangote, Mr Chef and Anapuna salt samples met the SON and CODEX standards of iodine value of 30 – 50 ppm (CODEX, 2006). Magic Time salt had an exceeding value of 92.55 ppm and 94.15 ppm for local market salt and supermarket salt, respectively while Uncle Palm salt had values that fall below the SON and CODEX iodine standard (Figure 1).
Conclusion

The storage time of 6 weeks did not have much effect on the iodine loss especially Anapuna and Dangote salts from a local market. As well as Dangote, Mr Chef and Magic Time salt procured from supermarket due to the iodate chemical that might have been used for their fortification. The analyses showed that most salt samples sold at supermarket and local market contain iodine in recommended levels but it is advisable to store them in an impurity free environment away from sunlight to avoid rapid loss of iodine. Since iodide stimulates on direct sunlight and heat, supermarket salts are preferable to local market salts because of their storage conditions.

REFERENCES