Storage Stability of Double Fortified Salt

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Abstract: ***The storage affects the stability of salt and reduces its effectiveness. The present study has been designed to evaluate the effectiveness of double fortified salt under different storage conditions. Two salt samples, iodized (control) and double fortified salt (experimental)) were chemically analyzed for their shelf life in different containers like glass, plastic, zip-lock, closed polythene and open polythene for a period of six months. The findings revealed that plastic containers have maximum storage stability for iron and iodine content in double fortifies salt.***

Keywords: double fortified salt, iodized salt, iron, moisture, iodine.

1. Introduction

Anaemia is a pervasive public health problem and affects 1.62 billion people globally. Iron deficiency is the principal cause of anaemia. Two billion people over 30 per cent of the world's population are anaemic (1). Food fortification is a sound approach to control micronutrient deficiency among the malnourished population. A wide variety of vehicles such as salt, sugar, cereal flours, and grain have been successfully utilized in the fortification programs because of its pervasive and plodding consumption. The preference for an appropriate medium is a key to the effectiveness of fortification programs. Salt iodization began in 1922 in Switzerland and has been implemented effectively in many countries as the major mechanism for combating IDD. So food-grade salt is a perfect vehicle for iodine fortification in many countries. Furthermore, it is safe, sustainable, and inexpensive. In the past decades, iodine-fortified salt has been successfully introduced across the globe in eradicating iodine deficiency disorder. However, since the problems of iron deficiency anemia and iodine deficiency disorders often coexist, it is preferred to control simultaneously by means of a single food fortification concept. Salt dual-fortified with iodine and iron is sound approach to control the micronutrient deficiency along with improving the nutritional status. The Micronutrient Initiative formulation uses physical separation of iodine by microencapsulation technique. (2,3). Iodized salt has been proven a healthy intervention in improving iodine deficiency disorders (4,5).Storage conditions effects the availability of iron and iodine content. Keeping this aspect in mind, the present study has been designed to evaluate the effectiveness of double fortified salt under different storage conditions.

2. Material and Methods

2.1 Experimental Protocol

To evaluate the effectiveness of double fortified salt under different storage conditions salt samples were procured from Tata chemicals Limited (Mumbai-400 001, India) in the packaging of one kg each. The salt samples were divided into two groups as iodized salt containing iodine 15 ppm at consumer level (control) and double fortified salt containing 85mg $FeSo_4$ and 15 ppm iodine at consumer level (experimental). The freshly packed salt (within 15 days of manufacturing date) were used for analysis.

2.2 Storage of Samples

An amount of 100g of iodized salt and double fortified salt samples were stored separately in different types of containers like glass containers, plastic containers, zip lock bag, open polythene and closed polythene for a period of six months.

2.3 Chemical Analysis

Stored salt samples were analyzed for moisture, total iron and iodine content at 0 month, 2 months, 4 months and after 6 months using standard methods as follows:

- Moisture (6)
- Total iron (Atomic Absorption Spectrophotometer)
- Total Iodine (7)

2.4 Statistical Analysis

All the samples were analyzed in triplicates and the results were given in mean ± standard deviation. The data obtained from the carried experiment were subjected to one-way analysis of variance (ANOVA) to determine the significant differences using Statistical Package for the Social Sciences (SPSS) version 16.0. The statistical difference was expressed at $p<0.05$. The significant differences ($p<0.05$) between the means were further analyzed Tukey's Post-Hoc test

3. Results and Discussion

The results revealed that (Table1) there was 0.14 percent moisture in the iodized salt at the baseline. There was gradual gain of moisture in the iodized salt samples (control) placed in glass container (0.22%), plastic containers (0.24%), zip-lock pouches (0.22%) and open polythene (0.36 %) at two months interval but there was no change in the moisture content of samples placed in closed polythene bag (0.14%). While in the double fortified salt (experimental) there was 0.02 percent moisture at the baseline but there was no gain in moisture for first two months in the glass container (0.02%), plastic container (0.02%) and closed polythene bag (0.02%). After six months of storage period, the maximum rate of moisture gain was analyzed in the open polythene bag that was 0.68 percent in iodized salt (control) and 0.54 percent in double fortified salt samples (experimental).

The results (Table 2) findings reported that mean iodine content of iodized salt (control) was 40.87ug/g and 39.90ug/g for double fortified salt (experimental) at baseline. Iodine content during six months of storage period of iodized salt was analyzed maximum in the closed polythene (36.49ug/g) followed by plastic container (36.42ug/g) while in double fortified salt, maximum stability of iodine content was observed in plastic container (36.98ug/g) followed by closed polythene bag (36.25ug/g). In contrast to the present study, another research findings also reported that the mean iodine content at baseline in iodized salt was 39 ppm and 45 ppm found in double fortified salt. The level of iodine did not decrease below the mandatory 15ppm level in any of the containers during storage. The minimum iodine losses of about 16.9% in iodized salt and 19.8% in double fortified salt were found in salt stored in air - tight plastic containers (8). Another study also reported that iodine content was stable for duration of six months in different packaging containers like low density polyethylene (LDPE), high density polyethylene (HDPE) and woven high density polyethylene (WHDPE). The mean iodine content at baseline was 39.87ppm and the mean iodine content of LDPE after six months of storage was 30.88 ppm and for HDPE the mean iodine content was 33.84 ppm and 30.85ppm iodine content in WHDPE respectively (9).

Table 1: Effect of storage on total moisture content of double fortified salt

Parameters	Storage containers	0 months	2 months	4 months	6 months	% increase in moisture content during storage 2 months	4 months	6 months
Moisture (%)	Control							
1	Glass (Zera)	0.14 ± 0.00^{a}	0.22 ± 0.00^{c}	0.30 ± 0.01^{c}	0.46 ± 0.01^{d}	57.14	114.28	228.57
2	Plastic (pearl pet)	0.14 ± 0.00^{a}	0.24 ± 0.00^{b}	0.39 ± 0.01^{b}	0.60 ± 0.02^{b}	71.47	178.57	328.57
3	Zip-lock	0.14 ± 0.00^{a}	0.22 ± 0.00^{c}	0.40 ± 0.01^{b}	0.50 ± 0.01^{c}	57.14	185.71	257.14
4	Closed polythene	0.14 ± 0.00^{a}	0.14 ± 0.00^{d}	0.22 ± 0.00^{d}	0.34 ± 0.00^{e}	0	57.14	142.85
5	Open polythene	0.14 ± 0.00^{a}	0.36 ± 0.01^{a}	0.59 ± 0.02^{a}	0.68 ± 0.02^{a}	157.14	321.48	385.71
Moisture (%)	Experimental							
1	Glass (Zera)	0.02 ± 0.00^{a}	0.02 ± 0.00^{c}	0.16 ± 0.01^{c}	0.20 ± 0.01^{d}	0	700	900
2	Plastic (pearl pet)	0.02 ± 0.00^{a}	0.02 ± 0.00^{c}	0.20 ± 0.01^{b}	0.26 ± 0.02^{c}	0	900	1200
3	Zip-lock	0.02 ± 0.00^{a}	0.06 ± 0.01^{b}	0.20 ± 0.01^{b}	0.28 ± 0.02^{b}	66.67	900	1300
4	Closed polythene	0.02 ± 0.00^{a}	0.02 ± 0.00^{c}	0.08 ± 0.00^{d}	0.12 ± 0.00^{e}	0	300	500
5	Open polythene	0.02 ± 0.00^{a}	0.28 ± 0.02^{a}	0.45 ± 0.02^{a}	0.54 ± 0.03^{a}	1300	2150	2600

Values are presented as Mean±SD; *Tukey Post-Hoc test significance at 5% level; Superscript with different alphabets implies significant difference

Table: 2 Effect of storage on the total iodine content of double fortified salt

Parameters	Storage containers	0 months	2 months	4 months	6 months	Percent decrease in iodine content during storage 2 months	4 months	6 months
Iodine(ug/g)	Control							
1	Glass (Zera)	40.87 ± 0.03^{a}	39.72 ± 0.04^{b}	37.26 ± 0.04^{c}	35.81 ± 0.05^{c}	2.81	8.83	12.38
2	Plastic (pearl pet)	40.87 ± 0.03^{a}	39.83 ± 0.03^{a}	38.76 ± 0.03^{a}	36.42 ± 0.04^{b}	2.54	5.16	10.88
3	Zip-lock	40.87 ± 0.03^{a}	37.64 ± 0.04^{c}	36.51 ± 0.04^{d}	34.98 ± 0.05^{d}	7.90	10.66	14.41
4	Closed polythene	40.87 ± 0.03^{a}	39.82 ± 0.03^{a}	38.62 ± 0.03^{b}	36.49 ± 0.03^{a}	2.56	5.50	10.71
5	Open polythene	40.87 ± 0.03^{a}	34.72 ± 0.06^{d}	28.22 ± 0.07^{e}	22.92 ± 0.10^{e}	15.04	30.95	43.91
Iodine(ug/g)	Experimental							
1	Glass (Zera)	39.90 ± 0.02^{a}	37.05 ± 0.03^{c}	35.76 ± 0.04^{c}	34.18 ± 0.04^{c}	7.14	10.37	14.33
2	Plastic (pearl pet)	39.90 ± 0.02^{a}	38.92 ± 0.02^{a}	37.78 ± 0.03^{a}	36.98 ± 0.03^{a}	2.45	5.31	7.31
3	Zip-lock	39.90 ± 0.02^{a}	36.43 ± 0.03^{d}	35.42 ± 0.03^{d}	34.16 ± 0.03^{d}	8.67	11.22	14.38
4	Closed polythene	39.90 ± 0.02^{a}	38.80 ± 0.02^{b}	37.62 ± 0.03^{b}	36.25 ± 0.03^{b}	2.75	5.71	9.14
5	Open polythene	39.90 ± 0.02^{a}	33.42 ± 0.03^{e}	26.28 ± 0.05^{e}	20.12 ± 0.05^{e}	16.24	34.13	49.57

Values are presented as Mean±SD; *Tukey Post-Hoc test significance at 5% level; Superscript with different alphabets implies significant difference

The results findings revealed that (Table 3 and fig 1) the total iron content was stable for a duration of six months in glass container (97.17mg/100g), plastic container (97.16mg/100g), zip-lock pouches (97.15mg/100g) and also in closed container (97.14mg/100g). There was gradual loss of total iron content in open polythene(85.09mg/100g) up to 12.44 percent.

Table 3: Effect of storage on the total iron content of double fortified salt

Parameters	Storage containers	0 months	2 months	4 months	6 months	Percent decrease in iron content during storage 2 months 4 months6 months		
Iron(mg/100g)								
1	Glass (Zera)	97.18±0.01 ^{a}	97.18±0.03^{a}	97.17±0.02^{a}	97.17±0.01^{a}	0	0.01	0.01
2	Plastic (pearl pet)	97.18±0.01 ^{a}	97.17±0.02^{a}	97.16±0.03^{b}	97.16±0.03^{a}	0.01	0.02	0.02
3	Zip-lock	97.18±0.01 ^{a}	97.17±0.01^{a}	97.16±0.02^{b}	97.15±0.03^{b}	0.01	0.02	0.03
4	Closed polythene	97.18±0.01 ^{a}	97.16±0.02^{b}	97.16±0.02^{b}	97.14±0.03^{b}	0.03	0.03	0.04
5	Open polythene	97.18±0.01 ^{a}	92.01±0.16^{c}	89.12±0.11^{c}	85.09±0.12^{c}	5.32	8.29	12.44

Values are presented as Mean±SD; *Tukey Post-Hoc test significance at 5% level; Superscript with different alphabets implies significant difference

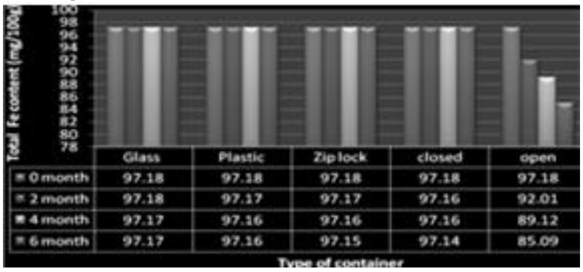

Figure 1: Effect of storage on the total iron content of double fortified salt

The results (Table 4) also revealed that the iodine content was slightly higher in iodized salt that was 40.87 ug/g (DFS 39.90 ug/g) when compared the labeled information at consumer level (15ppm or ug/g). The present experiment investigated that moisture and iodine content was stable in iodized salt and double fortified salt in comparison with the recommended values. The iron content was also stable in double fortified salt as compared with the recommended values labeled on the salt packet at consumer level

Table 4: Percentage content of iron and iodine as compared with the labeled information at consumer level

Parameters	Experimental value	Recommended value	% change
Control			
Moisture(%)	0.14±0.00	<6	2.33
Iron(mg/100g)	-	-	-
Iodine(ug/g)	40.87±0.03	15	272.46
Experimental			
Moisture(%)	0.02±0.00	<6	0.33
Iron(mg/100g)	97.18±0.01	85	114.32
Iodine(ug/g)	39.90±0.02	15	266.0

Values are presented as Mean±SD

4. Conclusion

It may be concluded from the research findings that the both the salt, iodized salt and double fortified salt has maximum stability for iodine content in plastic containers (38.76ug/g and 36.98ug/g) and iron content of double fortified salt has also analyzed maximum stability in plastic container (97.16mg/100g) during the storage period of six months. Therefore it may be concluded from the present findings that plastic containers are best for keeping the maximum retention of iron and iodine content for a period of six months.

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