CONSUMER ACCEPTABILITY AND STORAGE STABILITY OF DOUBLE FORTIFIED SALT

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ABSTRACT

Double fortified salt (DFS) having iron and iodine, has been formulated for tackling the problems of iron deficiency anemia (IDA) and iodine deficiency disorders (IDD). The present research was designed to study the consumption pattern and storage practices of salt and determine the effect of household storage on the stability of iodine in DFS and Iodized salt (IS)/Common salt. The study also aimed at assessing the consumer acceptability of DFS. A survey in 39 markets and 135 shops in five zones of Delhi revealed the presence of 19 brands of IS. The iodine content of two brands was less than the prescribed limit of 15 ppm. All (N=90) families surveyed, used packaged IS. The different types of containers used to store salt at home were documented. Air tight containers showed minimum loss of iodine during storage. Sensory evaluation revealed overall acceptability of dishes prepared with DFS. All households were given a trial pack of DFS; about 70% reported that they liked the salt. The study highlights the need for an informative marketing strategy which would create awareness about benefits of DFS and also help consumers to use and store it in ways to minimize iodine losses.

Keywords – Double fortified salt (DFS), Iron deficiency anemia (IDA), Iodine deficiency disorders (IDD), and Iodized salt (IS).

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1. Introduction

In less developed countries Iodine deficiency disorders (IDDs) and Iron deficiency anemia (IDA) have serious health consequences, especially for women and young children (MI, 2004). In India, no state is free from IDD and studies have revealed its nationwide prevalence. Iodine deficiency in pregnant women across the world is causing almost 18 million babies per year to be born mentally impaired, an estimated 6.6 million of which are born in India (MI, 2004). Globally, Iron deficiency is also one of the most common nutritional deficiencies. It is estimated that 2 billion people worldwide suffer from anemia. In India, the average dietary intake of iron is only 50% of the recommended allowance. The gap is much wider for children and women of reproductive age **(**MI, 2004). National Family Health Survey (NFHS) – 3 revealed that 79.1% of India's children between the ages of 3 - 6 years and 56.2% of married women in the age group 15-49 years were anemic in 2006**.** In order to deliver a nutrient to a population, it is very important to select an appropriate vehicle. Salt is an attractive vehicle for the fortification of nutrients and has proved to be one of the low-cost strategies to tackle the problem of micronutrient deficiencies (World bank, 1993). The Government of India took a decision in 1984 for iodization of all edible salt in the country by 1992 (GOI, 1994). In India, Food Safety and Standards Act specifies the levels of fortification as 30ppm minimum at manufacturer's level and 15ppm minimum at the retail level (FSSAI, 2012). Strategically, it is not possible to provide two different types of fortified salts (iodine and iron separately) (Brahmam et al., 1994). Double Fortified Salt (DFS) is edible common salt to which small amounts of chemical forms of iodine as well as iron have been added. It was developed by the National Institute of Nutrition (NIN) Hyderabad, India for the first time and was designed to provide daily approximately 150 micrograms of iodine and 10 milligrams of iron through consumption of 8-10 grams of salt per day. This was shown to be enough to prevent anemia or reduce the prevalence of IDA through regular consumption of fortified salt over a period. The absorption was likely to be relatively higher in pregnant women (due to their higher requirement) and anemic subjects and thus consumption of DFS could lead to a rapid increase in the hemoglobin level in the community consuming DFS (Rao, 1991 & Sivakumar and Ranganathan, 2005). A significant reduction in the prevalence of anemic children from 83% to 57% in rural areas and from 42% to 29.5% in urban areas of Andhra Pradesh, India after 2 years of DFS intervention was observed along with DFS

acceptance as a cooking salt. None complained of any side effects on consumption of DFS with 100% compliance throughout the study period of 2 years (Brahmam et al., 1994). Nair et al (2000) demonstrated no adverse effects on Calcium and phosphorus homeostasis. Thus, the daily consumption of DFS was demonstrated to be safe. Brahmam et al., (2000) in a study on children in residential schools in Andhra Pradesh showed that DFS supplementation had a significant impact in preventing the decline and improving the hemoglobin levels. However, the data on the consumer acceptability of the DFS in Northern India and storage stability at the household level was lacking. Therefore, the present study was designed to assess the consumer acceptability in Delhi, India and storage stability of DFS at the household level. The study was also designed to study the consumption pattern and storage practices of salt in households to identify the best practices which would help minimize the loss of iodine. This would be a step towards ensuring that the populations at risk for iodine deficiency disorder receive effective amounts of iodine from salt whether fortified with iodine alone or double fortified.

2. Materials and Methods

The study was divided into the following phases-

2.1 Phase I: Market Survey

A survey for the availability of different types and brands of salts in the markets of 5 zones (North, South, East, West and Central) of Delhi, India was done. Around 135 shops in 39 markets were covered. All the brands of iodized salt (IS)/ Common salt available were purchased from the retailers and tested for the iodine content by the modified method for iodine estimation (Ranganathan and Karmarkar, 2006).

2.2 Phase II: Consumer Survey

A consumer survey was conducted on a total number of 90 households who participated voluntarily and gave informed consent for participating in the study. Pre-tested interview schedules were used to study the storage practices and consumption pattern of salt and to assess the acceptability of DFS by the people from different economic strata of society (Slum, Village and Middle income group (MIG) locality). These localities were selected purposively from North and West Zones of Delhi. Packets of 100 grams of DFS (procured from M/S Prince International Pvt Ltd. by the name (Swasth Namak) were given to households consenting to try the salt. They

were provided information about the composition and benefits of DFS and encouraged to use the salt during the week. A follow up survey was conducted after a week to assess its acceptability

2.3 Phase III: Laboratory assessment of storage losses of iodine

Based on the results of Phase II of the study, in which storage practices of salt were identified an experiment was designed to assess the losses of iodine when the salt is stored in different types of household containers for a period of four weeks. The commonly used containers identified were plastic jar with screw on lid, Airtight plastic jar, Glass jar with screw on lid, Airtight glass jar, Stainless Steel Masala Box, Packet tightened with a rubber band on top, Packet kept in a polythene bag and loosely tied with its ends. Both the iodized and double fortified salt samples were stored in most commonly used containers in triplicate for a period of 4 weeks (as typically one kilogram salt packet lasted for 4 weeks in majority of the households) and were tested for their iodine content every week. The iodine content of IS and DFS was estimated by the "modified method" (Ranganathan and Karmarkar, 2006). The IS used was 'Tata Salt' as this was the most popular brand used by 70% of the households surveyed.

2.4 Phase IV: Sensory Evaluation

Preparation of food products with double fortified and iodized salt using different cooking procedures- pressure cooking, stir frying and pickling was done. The salt was also sprinkled on a cut vegetable salad. A selected panel of 25 collegiate women evaluated the four dishes for various sensory attributes including appearance, color, texture, taste, after-taste, flavor and overall acceptability using a 5 point hedonic scale. Four most commonly prepared recipes were selected. Vegetable salad was selected as a raw food preparation to find out if any difference in color between the two salts could be seen visibly when the salt is sprinkled along with lemon juice on a vegetable. A pulse preparation (Moong dal) was prepared in order to see if high heat treatment like pressure cooking would bring about change in appearance. Zeera aloo being one of the most common vegetable preparations was chosen to see the effect of salt on appearance of vegetable during stir frying. Lemon pickle was selected as in pickling a high concentration of salt is used and storage is for a long period. The preparations did not have a prominent color of their own so that discoloration caused by DFS could be easily seen. All the dishes are usually prepared with minimal use of other spices and hence the taste of salt is quite distinct and doesn't hinder in the sensory evaluation.

3. Results and Discussion

3.1 Market survey

It provided information on the different types and brands of salts available. A total of 39 markets and 135 shops were covered in all from 5 Zones of Delhi including the markets of slums and villages. Three different types of salt i.e. Common salt/Iodized salt (IS), black salt and rock salt were commonly available in the markets sold by different brand names. A total of 26 brands of all types of salt were found of which 19 brands of white/ table salt (IS), 3 brands of black salt and 4 brands of rock salt were available. Black salt and rock salt were also being sold loose. Tata brand of salt was the most commonly available brand in every shop of all the Zones. The label information provided on the salt packages was also analyzed. Out of the 19 different brands of table salts available, only 5 had a health message on their labels that use of iodized salt prevents iodine deficiency disorders and use of iodine is essential for mental development. One of the brands specified that lowering sodium in diet may help in management of high blood pressure. Only one brand had information regarding the storage of salt after opening the packet indicating that the salt be kept in an air tight container. The different common salt brands were also analyzed for their iodine content and it was found that in two of the brands, the iodine content was much lower than the prescribed limit. Double fortified salt was not found in any of the markets of Delhi. It was only being supplied to the food service providers of the Mid-Day Meal Programme and Supplementary feeding Program under Integrated Child Development Scheme (ICDS). Thus, from the analysis of label information on salt packages it was felt that the good label should have data on storage instructions and a health message besides the other mandatory information like net weight, MRP, ingredients, best before date and manufacturer's name. The concerned regulatory authorities need to be more vigilant with small manufacturing units producing iodized salt for the low socioeconomic group, as two lesser known brands of salt were found to have iodine content less than the mandatory 15 ppm. The major brands on the other hand were adding iodine in excess (around 30ppm-39ppm) probably to take care of any losses during transport and storage.

3.2 Consumer survey

Survey at the household level was conducted to study the storage practices and consumption pattern of salt and to assess the acceptability of double fortified salt. Thirty households each from three different communities - a slum, a village and an MIG locality were selected from North and West Zones of Delhi for conducting the survey. The survey was conducted using a pre-tested interview schedule. Most of the respondents were in the age group 21-40 years with majority 56.6% and 53.3% having attended only up to primary school in the Village and Slum surveyed. Majority (60%) of respondents from the MIG locality were graduates. About 30% and 37% of the respondents in village and slum were illiterates. Three different types of salt i.e. Common salt/IS, Black salt and Rock salt were being used by the people in all the three communities. Black salt was added to special dishes only while Rock salt was used more during religious fasts. All the families in all the three communities used packaged and powdered iodized common salt for their regular cooking. Lesser quantity of salt was being purchased and consumed by the MIG families in comparison to the families in the village and slum due to the smaller family size in MIG community (average family size of 5) and village and slum with a family size of 6-8 members. Average monthly per capita consumption of salt was 0.40 kilograms (in slum and village) and 0.20 kilograms in MIG families. 'Tata' salt was found to be the most popular brand of salt being used by 70% of the households in all the three communities. Around 20% of the families each in slum and village did not ask for any specific brand of the salt while purchasing, this may be due to the problem of illiteracy or lack of awareness. However, a majority (86.6%) of the families' in the slum preferred packaged salt due to the cleanliness factor. Cost factor as a determinant of brand selection was important for 6.6% of the families in village, 13.3% in slum and 3.3% in MIG locality. Only about 10.0% of the MIG families also considered whiteness of salt together with iodization as criteria while buying salt. Loose black salt and rock salt was still purchased by 13.3% of all families and used along with IS. Only 13.3% considered iodization alone as the criteria. None of the families gave importance to labeling of the salt package.

Majority (65.5%) of the families in all the three communities used plastic containers followed by glass (17.7%) and steel (5.5%) for storing salt [Table 1]. Few other families used a combination of the containers for storing salt like air tight jars and jars with screw on lid, or salt stored in jar and in the same packet etc. Families also used a combination of containers made from different

materials like plastic and steel, steel and glass or plastic and glass. So, these families stored some quantity of salt in one container and the rest in another container. Only one family each in the village and slum used a plastic jar with a hole or a slit on the lid to facilitate easy pouring or sprinkling of salt. This exposure of salt to the atmosphere is undesirable and would result in greater losses of iodine from the salt. Plastic jars with screw on lid were most commonly used for storing salt. While conducting the survey the respondents were also asked for how long the container was left open during cooking. The respondents reported that the large containers were opened only when the salt was to be added to the dish and then the lid was closed. Steel 'masala boxes' with small cups containing different spices remained loosely covered for most of the cooking time. It was also seen that all the families added salt at the beginning of cooking a dish. Studies have been conducted to assess the losses of iodine during different cooking procedures. Goindi et al (1995) in a study on effect of cooking on iodine found that the loss of iodine ranges between 28% to 66% and losses increase as the temperature and duration of cooking increases.

Table 1- Storage containers used by the households for storing salt

Storage of salt at home	**Total Households N=90 f (%)**	**Village (n = 30) f (%)**	**Slum (n = 30) f (%)**	**MIG (n = 30) f (%)**
Open Container	4 (4.4)	2 (6.6)	2 (6.6)	-
Container with screw- on lid	58(64.4)	19 (63.3)	19 (63.3)	20 (66.6)
Air tight container	7 (7.7)	2 (6.6)	1 (3.3)	4 (13.3)
Same packet tightened at the top	1 (1.1)	-	1 (3.3)	-
Packet in a polythene and loosely tied	2 (2.2)	-	2 (6.6)	-
Container with screw- on lid and Air tight container	3 (3.3)	-	-	3 (10.0)
Container with screwed lid and Same packet tightened at the top	9 (10)	5 (16.6)	3 (10.0)	1 (3.3)
Container with screwed lid and Packet in a polythene and tied	6 (6.6)	2 (6.6)	2 (6.6)	2 (6.6)

Material of container				
Steel	5(5.5)	1 (3.3)	3 (10.0)	1 (3.3)
Plastic	59(65.5)	21 (70.0)	20 (66.6)	18 (60.0)
Glass	16(17.7)	6 (20.0)	4 (13.3)	6 (20.0)
Plastic and steel	6 (6.6)	2 (6.6)	-	3 (10.0)
Steel and glass	1 (1.1)	-	-	1 (3.3)
Plastic and glass	1 (1.1)	-	-	1 (3.3)

Note :- Figure in parenthesis are percent values. f is number of respondents.

The respondents from all the three communities had not heard about double fortified salt or its benefits. Only two MIG respondents were clear about the importance of iodine and iron in the diet. The other respondents knew that it is important to have iodized salt but were not clear about the function of iron and iodine. Table 2 shows the acceptability of double fortified salt distributed as trial packets to 90 households.

Table 2- Acceptability of DFS by the community

Parameters	**Total Households N=90**	**Village (n=30)**	**Slum (n=30)**	**MIG (n=30)**
	f (%)	**f (%)**	**f (%)**	**f (%)**
Used full packet	69 (76.6)	20 (66.6)	22 (70.0)	27 (90.0)
Liked the salt	63 (70.0)	16 (53.3)	21 (73.3)	26 (86.6)
Added salt to all the dishes	74 (82.2)	21 (70.0)	25 (83.3)	28 (93.3)
Detected difference in salt from the salt they were using	78 (86.6)	25 (83.3)	27 (90.0)	26 (86.6)

Note :- Figures in parentheses are percent values and f is the number of respondents.

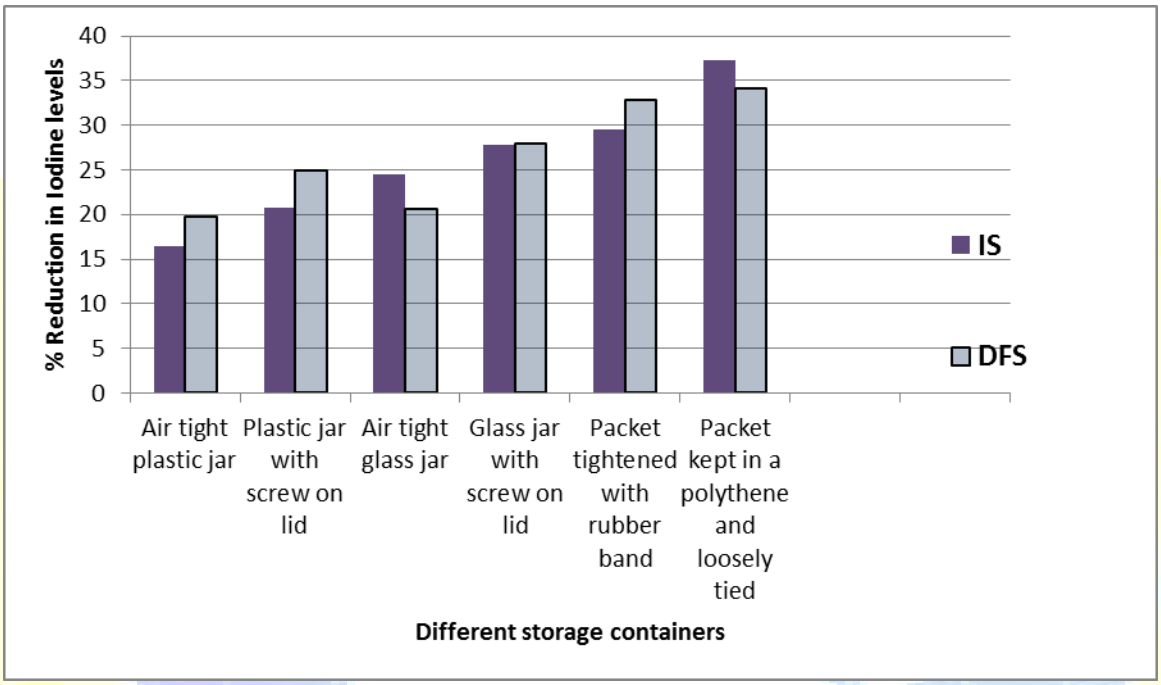
The respondents were asked to rate the DFS on scale of 1- 5 in terms of taste, color and appearance Where, 1= Very poor, 2 = Poor, 3=Satisfactory, 4=Good and 5=Excellent. Majority (88%) of the respondents from all the three communities rated the salt satisfactory in terms of taste. Almost 87% of the respondents said that the salt looked different from the regular one they used, and 47.7% of the respondents actually rated the salt poor in terms of appearance. They

reported that the salt was not as white in appearance as the normal iodized salt. But, they also said that this criterion would not affect the usage of this salt if the salt was good for their health. Majority (94.4%) of the total respondents found no change in the food cooked with DFS while two of the respondents in the village and one in the slum did report a change in the taste of the food. They reported that the food had a slight metallic aftertaste. One of the respondents in the village and one in MIG reported darkening of color of the dishes prepared with DFS. The dishes prepared were dry cauliflower sabzi, dry paneer sabzi and moong dal. This darkening of the color was not acceptable as it was viewed with suspicion by the people and they did not use the salt further. About 55.5% of the total respondents were willing to buy the salt while 36.6%, 43.3% and 33.3% of the respondents from village, slum and MIG families respectively were unsure. They wondered whether a small quantity of salt would bring about any major beneficial effect and they were also hesitant to change the brand they were using presently. Also, few (6.6%) of the respondents in the village were apprehensive about its cost and were also concerned about the safety and said that they would not want to take any risk.

3.3 Storage stability of iodine in DFS

Stability of iodine in DFS and IS during household storage was assessed. Both the iodized and double fortified salt samples were stored in triplicate in most commonly used containers for a period of 4 weeks (approximate time for which a 1 kg packet of salt lasts according to the consumer survey). Weekly analysis of the iodine content was done for both IS and DFS. The initial content of iodine in both types of salts was tested and was taken as the baseline value. The iodized salt brand most commonly consumed was selected and its iodine level was found to be 39 ppm and that of DFS to be 45ppm. The percentage reduction in iodine in case of plastic jar with a screw on lid was found to be 20.7% in IS and 24.9% in DFS at the end of 4 weeks. However, in case of Air tight plastic jar the losses were less 16.5% and 19.8% in IS and DFS after a 4 week period. Iodine losses were almost same from both types of salts in the glass jar with a screw on lid. The iodine losses for DFS were more than IS except in Air tight glass jar and packet kept in polythene bag and loosely tied in which the losses were less from DFS (Fig. 1).

Figure 1: Percentage reduction in iodine levels in IS and DFS from different storage containers



The losses of iodine from salt stored in Air-tight glass jar were found to be lesser (around 20.6% from DFS and 24.5% from IS) than the losses from glass jar with a screw on lid (27.8% from DFS and 27.9% from IS). A total reduction of 29.5% and 32.8% was observed when the salt was stored in packet tightened at the top with a rubber band. Likewise, a greater reduction was seen when the salt packet was kept in a polythene bag and loosely tied. In case of masala box, the initial levels of iodine and the levels at the end of one week (as the amount of salt in masala box lasts for one week on an average) were noted for IS and DFS. About 8.8% (IS) and 7.8% (DFS) reduction was observed in iodine content after one week. It was also observed that if the salt is left in the steel masala box for one month, the metal starts corroding and the salt gets yellowish orange in color. Hence, steel is not recommended as a storage container for salt. On the whole, the results of the study showed that the highest percentage loss in iodine (about 34% from DFS) was when the salt was stored in its original packet kept in polythene and tied loosely. The percentage difference in the iodine content of DFS when stored in a container with a screw on lid

and Air tight lid was found to be ranging from 5 -7%. And the percentage difference between the iodine contents of salt when stored in plastic and glass air tight and screw-on lid containers were found to be only about 1% which is negligible. Glass and plastic containers showed similar amount of reduction in iodine. The percentage reduction was highest in the 4th week in all the containers (ranging between 10-15%). This may be due to the increased head space. It is therefore recommended that the salt be transferred to a smaller container to decrease the iodine loss. The level of iodine did not decrease below the mandatory 15ppm level in any of the containers as the initial level of iodine of the salt taken for the experiment was high. The minimum iodine losses of about 16.9% (in IS) and 19.8% (in DFS) were found in salt stored in Air - tight plastic jar.

3.4 Sensory Evaluation

Food products were prepared with IS and DFS to judge the acceptability of DFS and see if the panelists could differentiate between the dishes cooked with the two different salts. All the food products were evaluated for different sensory attributes including appearance, color, flavor, taste, after-taste and overall acceptability. The sensory evaluation was carried out by a panel of 25 postgraduate collegiate women. The panelists were asked to rank the various attributes of food products on a five point hedonic scale from 1-5 with 1 = very poor, 2 = poor, 3 = satisfactory, 4 = good, 5 = excellent. They were also asked to identify which of the dishes were cooked with DFS. Mean scores on all the attributes were obtained and t-test was used to compare the means of the scores of the two different salts. The mean scores obtained by the food products cooked with both iodized and double fortified salt for all the sensory attributes were 3 and above (satisfactory to good) and were higher for the iodized salt than the double fortified salt. There was a statistically significant difference between scores given for appearance and color of the Moong dal prepared with DFS and iodized salt ($p< 0.05$). No statistically significant difference was seen between scores of the other food products prepared with both the salts for all the sensory attributes appearance, color, flavor, taste, after taste ($p>0.05$). However, DFS received a higher mean score for color of pickle which was acceptable, as people preferred a darker colored pickle. On the contrary, the darker color obtained in dal cooked with DFS was not preferred by some of the panelists but most of them could not make out any difference in color of the dal

cooked with the two salts. The flavor of the DFS cooked food products was also liked by all, although, the mean scores obtained for DFS were slightly less than the IS. They reported that DFS had a rounded flavor which is not sharp as that of IS. Thus, DFS was well accepted by the panelists. Only 8 of the panelists out of 25 could correctly identify which of the products had DFS. The food products in which they were able to identify were Moong dal and pickle on the basis of color, taste and after taste.

The results obtained in the present study were in accordance with the organoleptic acceptability trials being reported in other studies. Ranganathan et al., (1996) in a study on the acceptability of DFS in 30 different food items, reported no change in the organoleptic properties of foods prepared with DFS. Its use was not associated with any change in the sensory features of the food items. Another study by Brahmam et al., (2000) revealed that DFS was well accepted as a cooking salt, which was compatible with the local food preparations of Southern India. The results obtained in the present study showed that a slight difference in the color and taste could be detected between the foods prepared with IS and DFS, though it may not lead to the rejection of the salt. It is however, important that information about the benefits of the salt be communicated effectively to the community for better acceptance.

4. Conclusion

From the study, it was found that 19 brands of common salt/IS, along with 7 brands of black and rock salt were available. Black salt and Rock salt were also being sold loose. Consumer survey revealed that all the families used packaged IS and most of them (65%) used plastic containers for storing salt. Black salt and Rock salt was used by about 13% of the families alongside IS. None of the respondents were aware about the existence of DFS. About 70% liked the salt given as a trial pack but only about 55% expressed their willingness to buy DFS. The results of the storage stability of iodine in DFS showed losses were least from airtight containers. Glass and Plastic containers gave similar amount of reduction in iodine. But, the level did not reduce below 15 ppm in any of the containers as the initial level of iodine was high. Food products with DFS were found to be satisfactory and well accepted by the panelists. Minor color changes do occur in the foods prepared with DFS. Due to the time and financial constraints, the sample size of this

study was small. However, it gives important insights about storage practices and factors influencing choice of cooking salt, consumption pattern of salt, the stability of iodine in the salt during household storage and also most importantly the acceptability of DFS at the household level.

Recommendations- It is recommended that in order to promote the use of DFS, the package be designed with catchy messages to inform the consumers about the health benefits of DFS. Also, an awareness campaign would be needed for the illiterate, poor socio-economic group consumers. The consumers also need to be informed about possible darkening of dishes prepared with DFS allaying their fears about the safety of the salt formulation. It must be remembered that communities tend to resist even the slightest change in their food habits. In order to make DFS as a "felt need" of the community, it is very important to explain to people the importance of DFS. To encourage people to use DFS would involve convincing them to overlook minor differences in appearance over the added health benefit of the new salt formulation. It is also important to make people aware that iodine is best retained when salt is stored in air tight containers.

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