Chapter 14

Salt

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Chapter Outline

14.1 SALT AS A CARRIER OF NUTRIENTS

Fortifiable food products and condiments are frequently consumed in high-income countries. In industrialized countries micronutrient malnutrition has been largely controlled, at a very low cost. Investments made several decades back in fortification of staple foods have played a key role in improving intakes, and have been proven safe and economical.

Salt is universally consumed at a constant level independently of socioeconomic status. In most developing societies, a bulk of the salt intake is through its addition during cooking or at the table in the home. In contrast to most foods, salt consumption is very uniform—$\pm$10%−15%—within a specific region or country. In low-income countries fortified foods are less widely consumed or available. An exception is salt, which is widely consumed on a daily basis even in hard-to-reach regions of very poor populations. Salt is an excellent vehicle for a multiple nutrient fortification program due to its universal consumption by adults and children in small and regular quantities, even by the very poor and food insecure, and due to the relatively centralized production and processing of salt (as compared to other food commodities).

14.2 IODIZATION OF SALT

Iodine is an essential nutrient for humans and animals. A deficiency of this mineral has a wide range of negative consequences such as still-births, congenital abnormalities, and decreased cognitive capacity. The most successful global fortification experience has been the fortification of salt with iodine. In 1990, the United Nations World Summit for Children established the goal of eliminating iodine deficiency worldwide and universal salt iodization (USI), which intends that all edible salt (household, processed food, and animal salt) should be iodized thus ensuring adequate iodine nutrition, is the main global strategy to eliminate iodine deficiency.

Salt is an excellent carrier for iodine and other nutrients as it is safe, consumed at relatively constant, well-definable levels by all people within a society, independently of economic status. WHO provides guidelines as to the recommended prescribed levels of iodization as well as the recommended urinary iodine excretion levels for specific population groups. Adding iodine to salt is a simple manufacturing process costing no more than 4 cents per person annually. Iodine is added as potassium iodate to salt after refining and before drying and packing. Iodization can be easily integrated within existing

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production and/or refining lines. This can be done by adding a solution of potassium iodate to the salt (wet method) or by adding dry potassium iodate/iodide powder to the salt (dry method). In the wet method potassium iodate is first dissolved in water to prepare a concentrated solution. This solution can either be dripped or sprayed on the salt at a uniform rate as it travels on a belt or screw conveyor. In the dry method, potassium iodate is first mixed with either a filler such as calcium carbonate and/or dry salt and the powder is added to dry salt in a batch or continuous blender. In both methods, thorough mixing of the salt after the addition of potassium iodate is necessary to ensure even distribution of potassium iodate.

The past two decades have seen great progress in global awareness of the problem of iodine deficiency and its alleviation through the iodization of salt. A major multisectoral collaboration of national governments, salt companies and a range of partners in USI has led to significant advances in reducing iodine deficiency, making USI one of the most successful nutrition interventions of the past half-century. Salt iodization facilities have been installed in more than 140 countries. A public investment of only US$400 million during the 1990s has leveraged private investment of nearly US$3 billion over a 20-year period thereafter, resulting in access to iodized salt for more than 75% of the global population, or approximately 5 billion people. (UNICEF, 2015). Considerable progress has been made in reducing the number of countries whose populations suffer mild to severe iodine deficiency, from 54 countries in 2003 to 32 in 2011 and the number of countries with adequate iodine intake increased from 67 to 105. (Andersson et al., 2012). Several national surveys have confirmed the impact of expanded availability of iodized salt on iodine status of populations (Fig. 14.1).

In several countries salt iodization probably represents the first large-scale experience in national fortification of a commodity to eliminate a public health problem. It has taught valuable lessons on collaboration between government, industry, international organizations, the community at large, and other sectors. It has also offered insights into building and sustaining an intervention politically, technically, managerially, financially, and culturally. Strengthening salt iodization and expanding it to cover all edible salt in the country is the key requirement to eliminate iodine deficiency in a country. The infrastructure that has been created in recent years through national iodine fortification programs globally will serve well for the addition of other nutrients. However, the program context is changing with increasing consumption of salt through processed foods, a greater emphasis on assuring adequate iodine status of pregnant women, and more countries reaching program maturation and needing to adjust salt iodization standards and recognition of the need to reduce both deficiency as well as excess. (Timmer, 2012).

14.2.1 Consolidation and Modernization of the Salt Industry

The salt industry has been entrusted with the responsibility of dovetailing iodization into the prevailing salt production and distribution system, creating a standard of adequate iodization at minimum cost and disruption. Some countries derive their salt entirely through mining of underground rock salt deposits. Others extract salt from sea water or saline lakes or underground brines through solar drying. In large streamlined salt processing plants iodization is a relatively simple step. Over the past two decades there have been significant investments in salt refining capacity in

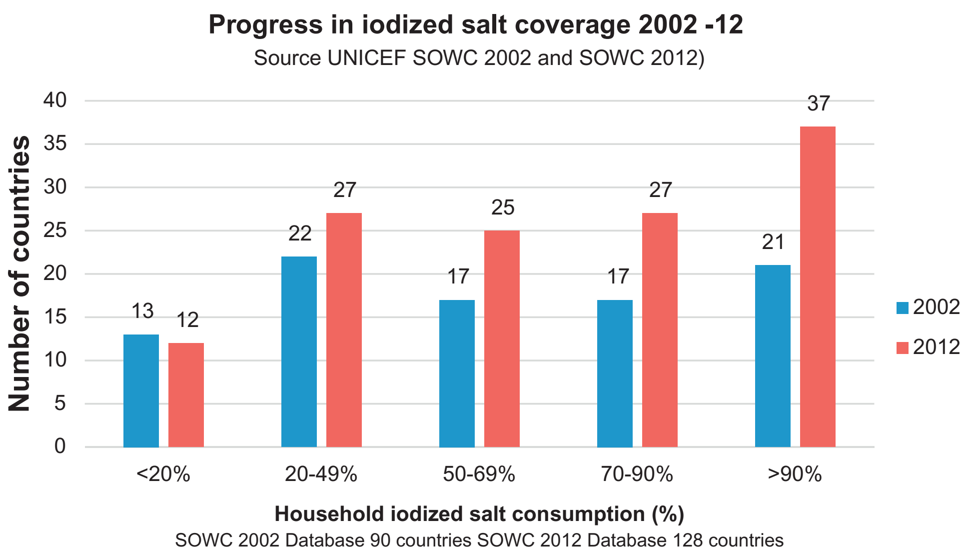

FIGURE 14.1 Progress in iodized salt coverage 2002–12. Source: *UNICEF SOWC 2002 and SOWC 2012.*

several countries coinciding with the expansion of salt iodization coverage. In India, salt refining capacity has increased from less than 5% to nearly 60% over the past 15 years. Over the same period, China has undergone a major modernization of salt refining, iodization and packaging facilities across nearly 2000 facilities in the country, involving an investment of over US$200 million (Proceedings of the International Workshop on IDD Elimination in China, 1998) (Fig. 14.2).

Iodization in medium/small operations poses more significant challenges in countries where salt manufacturing techniques and product quality vary over a wide spectrum of operations from cottage scale units producing a few hundred tons a year to very large fully automated plants producing several million tons. The strategies used to achieve the first 50%–60% coverage of iodized salt in several countries may not necessarily result in addressing the challenge to reach the remaining 40% of the population. Innovative approaches will need to systematically identify bottlenecks or constraints that impede universal iodization and should address them through a combination of advocacy, technical support, monitoring, and enforcement.

In some countries, multiple levels of iodization and packaging have posed problems in quality assurance. Raw salt producers, who often do not have the capacity to consistently produce superior quality iodized salt and to monitor its quality, supply their uniodized salt to multiple small repackagers who assume the task of iodization and packing the salt into consumer-sized bags. The result can be salt of inconsistent quality and iodine content.

14.2.2 Monitoring and Evaluation

As a key component of any public health intervention, the monitoring of progress towards the goal and the evaluation of results—in this case the elimination of iodine deficiency—is critical. Improved monitoring and surveillance can also guide program adjustments as habits and diets change over time. While quality assurance of iodized salt occurs at the factory or production level, the testing of salt samples at the household level, done by Multiple Indicator Cluster Surveys (MICS) within the Demographic Health Surveys (DHS), are useful to assess whether that iodized salt is making its way into household use or, if there may be a leakage of noniodized salt into the household, the latter being especially important to countries with mandated salt iodization. (Sullivan et al., 2007). There has also been innovation in field test kits to allow for field testing of iodine levels in salt thereby enabling salt producers to monitor the quality of their product at source. Starting with dropper test kits the technology has evolved to electronic test kits that determine iodine content with reasonable accuracy. The instruments also enable the test readings to be transmitted from the field via mobile to central servers for monitoring and collation. Work continues to refine such tools.

14.2.3 International Support

Over the past two decades several agencies have played pivotal roles at the global, regional, and national levels to support the development and expansion of salt iodization programs in high burden countries—notably ICCIDD (International Council for Control of Iodine Deficiency Disorders—recently renamed the Iodine Global Network (IGN)), UNICEF (with support primarily from Kiwanis International), Micronutrient Initiative (with support from the Canadian Government), and GAIN (with support from the Bill and Melinda Gates Foundation). Global support over the last decade alone exceeds US$100 million and has been targeted to address key bottlenecks with support evolving from technical and financial assistance to building self-sustaining programs that will continue when external support is withdrawn.

14.3 KEY DETERMINANTS TO ACHIEVE UNIVERSAL SALT IODIZATION

14.3.1 Making Salt Iodization a Global Industry Norm

It is well established that the commitment to IDD elimination by a national government is essential to firmly root a USI program. Evidence of political commitment to USI and elimination of IDD usually comes in the form of legislation that mandates that all salt for human and animal consumption be iodized; a national coalition or oversight body responsible for the program that reports to the Minister of Health; and the appointment of a responsible executive officer for the IDD elimination program (WHO, UNICEF, ICCIDD, 2007, Third ed.). Experience has shown that legislation is a cornerstone to sustaining a USI program.

For USI to be realized, the salt industry should adopt and integrate iodization as part of it standard operating procedure for production of all varieties of salt for human and animal consumption. Salt industry associations at regional, national, or subnational levels should commit to compliance by all their members. Representatives of the salt industry also need to be active members of international networks such as the Iodine Global Network (IGN) and Scaling Up Nutrition (SUN) meetings to engage with other stakeholders in the global iodization and iodine deficiency elimination effort and understand the latest situation and trends in iodine nutrition and salt iodization coverage. They also need to present the salt industry viewpoint at such meetings. Over the past decade there

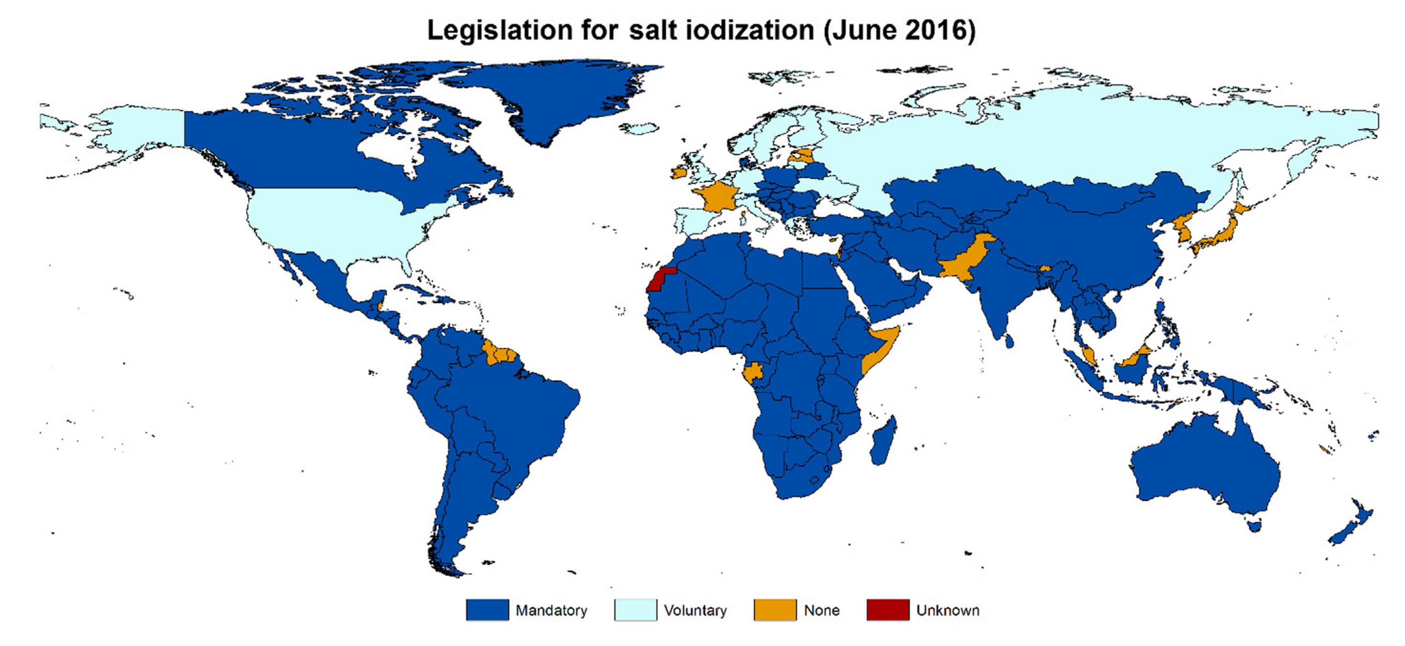

FIGURE 14.2 Legislation for salt iodization (June 2016). Source: *IDD Newsletter*.

have been significant investments in salt refining capacity in several countries.

Once a national program is established and universal coverage of iodized salt is achieved the cost of the intervention is virtually transferred to the consumer. Public costs are limited to advocacy and public endorsement, monitoring and adjustment to intervention (where warranted), and periodic evaluation of progress in ensuring optimal iodine nutrition. While iodine nutrition cannot be sustained as a vertical intervention and will need to be part of a basket of nutrition interventions the focus and attention to its key determinants should not be lost.

With the requirement for quality assurance of the product, the salt industry has been instrumental in addressing many technical issues. For example, one strategy has been to encourage the raw salt producers to iodize at source while another strategy has seen large processors buy up the salt produced by cottage scale producers and either iodize it in their facilities or apply it to nonfood grade use (Akunyili, 2007).

The stability of iodine in salt and levels of iodization and packaging are also related to issues of quality assurance. Conditions of high humidity result in rapid loss of iodine from iodized salt, with iodine loss ranging anywhere from 30% to 98% of the original iodine content (Diosady, Alberti et al., 1998). By refining and packaging salt in a good moisture barrier, such as low density polyethylene bags, iodine losses can be significantly reduced, during storage periods of over 6 months. The salt industry has also been at the vanguard of innovation in testing equipment to allow for field testing of iodine levels in salt thereby enabling salt producers to monitor the quality of their product at source.

Nigeria provides an example of how the division of labor and building a strong working relationship between Government regulatory bodies and salt industry can be managed. Salt iodization laws are enforced through two key regulatory agencies: The Standards Organization of Nigeria (which sets the standards) and the National Agency for Food & Drug Administration and Control (which enforces the standards). In turn, the salt manufacturers have established an umbrella association for effective self-regulation and to ensure distribution of adequately iodized salt (Akunyili, 2007; Untoro, 2006).

14.3.2 Sustained Public Education and Social Mobilization

Goiter and cretinism provided the visual picture of iodine deficiency that gave it easily identifiable reference. As IDD elimination progressed, these physical manifestations became fewer and far between, giving the impression that IDD had been solved. Yet iodine deficiency persists, in its more generic form—brain damage, to which the unborn fetus is especially vulnerable. In effect, IDD elimination programs are threatened to be victims of their own success since a deficiency must be continuously addressed or it will reemerge. Thus, ongoing communication efforts through multiple channels (including the media, health systems, and schools) are critical.

14.3.3 Supporting Small Salt Producers

While large producers account for nearly 75% of all salt for edible consumption in salt producing countries, a small but sizable proportion of the salt is produced by many small producers, often along coastlines or lake shores as a semi-agricultural operation. The salt produced in these units is often of mediocre quality. Nevertheless, these small salt producers are often the main salt source to the communities that are not reached by the conventional iodized salt suppliers and therefore most at risk of IDD. Small producers need help—some would say protection – to compete and stay viable. Associations of small producers/processors are often able to improve market access and sustain sales of the product. They may also assist in improving cleaning and packing. While small-scale processors are responsible for "last mile" of coverage, they need sustained and secure markets. Equally important is a sustainable and secure procurement chain for raw materials and consumables like potassium iodate (in convenient size packages and prices), salt packaging material, equipment, and supplies.

In recognition of the role of these small salt producers pilot initiatives have been undertaken in several countries. Two projects undertaken to integrate small producers into the overall USI strategy of their respective countries of note in Senegal and India deserve special mention. In Senegal, which has more than 10,000 operating small producers, it was not the ban on noniodized salt as much as the prospect of financial returns that motivated those involved in the pilot project to join into associations of producers with financial and technical support and training to enable them to produce a quality of iodized salt that complied with national standards while increasing their overall productivity (Ndao et al., 2009).

In Rajasthan, India, where small salt producers account for 88% (1.3 million metric tons) of the state's total production for human consumption, the pilot project aimed not only to build the iodization capacity of small salt producers through the provision of technical inputs, teaching good business as well as quality assurance practices, but by establishing a revolving fund operated through their newly formed cooperatives to provide the salt producers with the financial support to upgrade their facilities, leverage other loans, and expand their capacity (Gulati and Jain, 2009). In both cases, the support has been intensive in the initial phases with equipment and technical assistance provided, but built into the projects is a scheme to first, promote the economies of scale (sharing of equipment and facilities) and second, to support the sustainability of the operation and transfer the ownership of the production of iodized salt to the small producers.

14.3.4 Engaging the Processed Food Industry

USI intends that all salt for human and animal consumption is iodized. In practice, however, USI efforts do not always include salt used in processed foods. Even when legislation permits the voluntary use of iodized salt in processed foods, this does not necessarily translate into practical application. Second, USI program guidelines often do not specify measures (such as advocacy, monitoring) directed at the use of iodized salt in processed foods. Third, food processors are reluctant to use iodized salt stating concerns about its effects on their food products and trade barriers due to legislation variations (Bohac et al., 2009). However, consumption patterns are changing, particularly in industrialized countries, resulting in a shift in the source of iodine intake. For example, in the United States approximately 70% of the total salt intake comes from processed foods, while discretionary use of table salt contributes only about 15% of salt consumed and the remaining 15% is found naturally in foods. As a result, national programs relying upon on the fortification of table salt alone may not be adequate. Also, there are several instances where sodium intake is primarily through condiments used in the daily diet (fish sauce, soy sauce).

There are examples of successful national strategies (e.g., Netherlands) which specifically utilize iodized salt in processed foods to achieve adequate iodine nutrition in the population. As other countries take on such a strategy (e.g., New Zealand) and some countries (e.g., United Kingdom) take on a strategy of sodium intake reduction, iodine nutrition should be carefully monitored so that the impact of such strategies upon population iodine status can be assessed and guidance can be developed.

Evidence suggests that for common food commodities, the use of iodized salt in processing does not affect organoleptic properties. However, concerns about trade barriers pose a bigger problem as legislation varies greatly from country to country. In a world of interrelated geopolitics and trade, harmonization becomes increasingly important. Efforts such as those by EURRECA Network, which works in the context of the EU to address the problem of national variations in micronutrient recommendations, may offer a way to overcome this stumbling block (EURRECA, 2009). Finally, not only are consumption patterns changing but so are the sources of iodine in the diet. In several European countries as well as the United States, iodophors were used by the dairy industry, thereby delivering iodine to the population through milk. This practice has decreased or been eliminated and, in addition, the consumption of milk has also declined in some countries and/or among certain population groups. These trends need to be monitored and impact assessed through the analysis of the population iodine status.

14.3.5 Monitoring and Adjusting Iodine Intakes

Solid monitoring of iodine status reveals not only an insufficiency of iodine intake but also an excess intake. WHO data shows that 34 countries have more than adequate or excessive iodine intake. Investigations of these instances have resulted in identifying numerous factors including cases of salt being iodized at elevated levels (such as in Kenya and Uganda, which imports salt from Kenya); cases of iodine supplementation overlapping with the introduction of iodized salt (such as occurred in some regions of China) as well as iodine-induced hyperthyroidism occurring on the introduction of salt iodization. Although there is consensus that the risks involved in iodine intake excess are smaller than those of iodine deficiency, they underscore the importance of good monitoring of the population iodine status (Zimmermann et al., 2008).

14.3.6 Double Fortified Salt

The promise of salt to carry multiple nutrients was first proposed in 1969 (Levinson and Berg, 1969). The second micronutrient that has been considered most extensively for addition is iron. The main challenge here is the interaction between iron and iodine which leads to loss of iodine. The use of stabilizers, and encapsulation of iron and/or iodine have been investigated as the feasible way of solving this problem. Other research on adding iron and iodine to salt includes a formulation using ferrous sulfate by the Indian National Institute of Nutrition (Nair et al., 1998) and a study in Morocco using micronized ferric pyrophosphate (Zimmermann et al., 2004).

A recent technology has been developed by the University of Toronto using an encapsulated ferrous fumarate (EFF) DFS formulation, which uses cold extrusion, color masking, and microencapsulation of the iron particles to provide stability and create a barrier that prevents iron−iodine interaction. (Li et al., 2011). The process starts with raw ferrous fumarate and processes it through a series of steps to agglomerate and coat the iron particles until a uniform white particle comparable in size with salt particles is obtained. It is then mixed with binding agent, and extruded. The extrudates are cut into shape and the required size, dried and color masked. The colored masked extrudates are subsequently coated with

Hydroxy Propyl Methyl Cellulose (HPMC). Encapsulated iron premix contains 18%–20% iron. The encapsulated iron is then transported to the salt refinery for blending with iodized salt (Fig. 14.3).

The process of double fortification of salt requires just one additional step to current salt refineries producing refined/crushed dried iodized salt. This step involves the preparation of a rich mix of the encapsulated iron premix with a small quantity of salt followed by mixing this rich mix with the bulk of the salt in the required proportion in a ribbon blender. The proportion of encapsulated iron premix to salt is approximately 5.5 kg/Ton of salt. DFS is essentially organoleptically indistinguishable from iodized salt in appearance, taste, or smell. This formulation can only work well with salt of the same particle size, 300–700 μm, without the problem of segregation. Iron premix with relatively smaller size would adhere to the surface of salt particles. The layer has an optimal thickness (of only a few microns) that protects the iron until it is ingested, and passes through the stomach, and reaches an optimal point in the gastrointestinal tract where the encapsulant disintegrates, enabling the absorption of iron.

An efficacy study conducted by ETH Zurich and St. Johns' Research Institute in Bangalore on DFS–EFF in 2008 showed a 66% reduction in anemia prevalence, and improvement in other iron indicators, over 10 months (Andersson et al., 2008). Consumer acceptance studies were conducted in Bangladesh and Sri Lanka in 2012 and found good acceptance (Lanka Market Research Bureau, 2012). A randomized controlled trial conducted in 2014 found significant improvements in all biomarkers of iron status in women tea pickers in Darjeeling, India (Haas et al., 2014). In addition, the Darjeeling study has demonstrated significant improvement in cognitive skills and energy efficiency among recipients of DFS (Murray-Kolb, 2014). These improvements depended on the extent of the anemia and on the concurrent causes of anemia. DFS provides approximately 30%–50% of the Recommended Daily Intake (RDI) of iron for women of reproductive age. The importance of the new formulation of DFS lies essentially in the fact that it is indistinguishable in taste, color, and smell from regular salt (speck like particles of encapsulated ferrous fumarate may be faintly visible but do not deteriorate with time) and in addition, unlike micronized ferric pyrophosphate, which has a similar bioavailability to the encapsulated ferrous fumarate, it causes no additional loss of iodine in moist salt during storage.

The Food Standards and Safety Authority of India (FSSAI) issued a Gazette Notification approving the revision of the standards for DFS that will encompass the current team's EFF–DFS formulation to come into effect immediately (The Gazette of India, 2014). Double Fortified Salt is now being produced in India on a commercial scale and has the potential to be distributed through commercial channels and public programs to reach economically weaker sections of the population in many countries. A phased approach to introduce DFS first through targeted public and market-channel programs, and ultimately to extend it to the entire population and making it mandatory, is considered the most optimal strategy.

14.4 MULTIPLE FORTIFICATION OF SALT

Several attempts have been made to add other nutrients to salt. The stability of triple fortified salt containing iron, iodine, and vitamin A was investigated by Rutkowski and Diosady. Several sources of iron, iodine, and vitamin A were investigated. Coencapsulation of all the three micronutrients and encapsulation of individual micronutrient was also investigated. The type of iron and vitamin A sources used had significant effect on the stability of vitamin A in the TFS. Encapsulation of individual micronutrients, using ferric sodium iron EDTA (FeNaEDTA) and vitamin A palmitate as source of iron and vitamin A, gave optimal vitamin A retention after storage for 3 months.

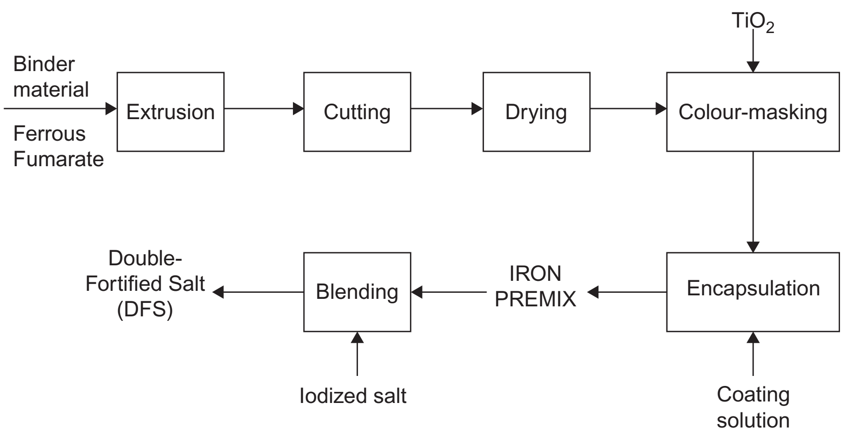

FIGURE 14.3 Production of double fortified salt using encapsulated ferrous fumarate.

The prevalence of anemia, mental impairment, and birth defects can be substantially reduced by food fortification with iron, iodine, vitamin B12, and folic acid. Efforts are currently in progress to fortify salt with iron, iodine, vitamin B12, folic acid, and zinc. Multiple fortified salt (MFS) will provide these at levels that should result in a substantial improvement in micronutrient status of women and children, leading to large decreases in maternal, neonatal, and infant mortality. The principal challenge with adding the five micronutrients to a single vehicle (salt) is that they interact, reducing their effectiveness. Iron reacts with iodine, reducing the added iodate to elemental iodine, which sublimes and is lost. Similarly, iron can destroy folic acid, and accelerate the loss of B12. Research is ongoing on the use of microencapsulation to physically separate the reactive components and stabilize all four micronutrients. The vitamins may either be (1) incorporated into the iodate spray solution directly or (2) added to the microencapsulated iron premix particle in the core or the coating, or (3) encapsulated separately.

Acceptability of the fortified salt poses enormous challenges in developing appropriate technology for multiple nutrient fortification. The challenges include, but are not limited to, interaction of micronutrients, nutrient homogeneity, and organoleptic changes. Thus, the effect of interaction of folic acid and vitamin B12 with other constituents of the salt needs to be evaluated. Extrusion based encapsulation technology, developed (Li et al., 2011) to prevent interaction between iron and iodine for double fortification of salt, can be potentially explored as a conceivable way to minimize interaction between these micronutrients.

14.5 SCALE UP OF DFS

As prerequisites for scale-up, analyses that have been completed for DFS include: efficacy, organoleptic (taste/color/smell) properties, design and fabrication of process equipment, and other technical support. What still needs to be done is to evaluate the effectiveness of the intervention at scale through a targeted public distribution program, to lay the groundwork for launch through commercial channels, and to facilitate state and nationwide scale-up.

Based on the experience with salt production and marketing, two distribution arms hold promise: (1) a mid-tier market-based channel, targeting income quintiles C and D, where salt is currently unbranded or locally branded, but is relatively moisture-free and thus suitable for fortification; and (2) public distribution channels, to reach those in the bottom income quintile. A phased approach to introduce DFS first through targeted public and market-channel programs, and ultimately to extend it to the entire population is therefore recommended. If double fortified salt (with iron) is mandatory, then the impact of salt in addition to other iron fortified wheat and rice on overall iron intake would need to be monitored.

14.6 COST OF MULTIPLE FORTIFICATION

The incremental cost of adding iodine to salt is approximately 2 cents per person per year; and for iron about 20 cents. The cost of folic acid addition would be another ~1 cent. The cost of B12 is expected to be of similar magnitude. This additional cost could be affordable even by people in the lowest income quintile, but more likely, it could be financed by aid agencies and governments. Overall the multiple fortification of salt with these four micronutrients would add between 10% and 20% to the retail price of salt. With appropriate education, this cost could be absorbed by consumers for its health benefits.

14.7 CONCLUSIONS

While tremendous progress has been made in making salt iodization indeed universal and global, 2 billion people worldwide are still at risk of iodine deficiency. Although universal iodization has stabilized and generally been sustained as a major public health intervention, 25% of households are not using iodized salt.

The foundation of a USI program requires mandatory iodization and this can be achieved only when there is strong government commitment. Recent reports by the Copenhagen Consensus, which rate salt iodization as one of the top investments with a benefit cost ratio of 30:1, provide a compelling argument to be directed at national policy makers in countries where a national commitment has not been made (Horton et al., 2008) In addition, in those countries which have existing USI programs, a reaffirmation—in the form of commitment of both human and financial resources for salt iodization programs—would not only assure sustainability but also mark the national ownership of the program and the goal.

There is no other activity that draws together the productive sector of society, the government sector, civic society, and the public such as does iodine deficiency elimination. Success with salt iodization has given governments, industry, consumer groups, and other stakeholders a new confidence to address other more complex micronutrient problems using salt as well as other food carriers to deliver essential vitamins and minerals to the population.

The populations not yet reached with adequately iodized salt are often the more marginalized section of the population and in greatest need for protection. They are not reached by the mainstream of iodized salt supply but rather by the more informal sector of the small salt producers. This underlines the importance of integrating small salt producers into national USI programs. Several working models, demonstrating initial success exist. These models should be documented, reviewed, and the lessons learned shared to provide program guidance in areas where small salt producers have a significant role in the marketplace. Just as the economics of the salt industry need to be understood to integrate salt iodization into the supply chain, active engagement of the processing food industry is necessary to include iodized salt in processed foods, especially in countries where processed foods dominate the household table.

Building on the success with iodization, double fortification of salt with iodine and iron is gaining ground and can be integrated with established iodization processes. The iodization infrastructure can be readily expanded to add premixes containing other micronutrients such as folic acid, vitamin B12, and zinc with minimal investments in processing.

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FURTHER READING

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