Conference on Micronutrient Fortification of Foods: Science, Application & Management

Conference Report

ILSI-India

International Life Sciences Institute-India

Conference on Micronutrient Fortification of Foods: Science, Application & Management

January 7 - 8, 2011, New Delhi

CONFERENCE REPORT

Sponsored By
International Life Sciences Institute-India

Co-Sponsored By
Ministry of Food Processing Industries, GOI
National Institute of Nutrition, Hyderabad

ABOUT ILSI-INDIA

ILSI-India is a branch of International Life Sciences Institute (ILSI) with headquarters in Washington DC. ILSI is a non profit, worldwide foundation established in 1978 to advance understanding of scientific issues relating to nutrition, food and water safety, toxicology, risk assessment, and environment by bringing together scientists from academia, government, industry, and public sector. ILSI has 15 regional /country branches across the globe. ILSI has special consultative status with the Food and Agriculture Organization of United Nations and it is also affiliated to World Health Organization as a non-governmental organization.

ILSI-India works on issues relating to nutrition, food and water safety, risk assessment, biotechnology and environment. It works very closely with industry, R&D organizations, Government departments, and international organizations. ILSI-India has organized a number of activities on role of nutrition on health and wellness including nutrition for children, pregnant and lactating women, athletes, elderly, type 2 diabetes, food based dietary guidelines, bone health, micronutrient fortification of foods, role of Zinc and Vitamin D in health , micronutrient fortification of foods etc.

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PREFACE

ILSI-India had almost made its mission to create awareness about the benefits of food fortification considering the extensive prevalence of micronutrient malnutrition. It has so far organized 16 conferences all over India, apart from those in Sri Lanka, Nepal and Bangladesh. Fortified foods, however, is not as common as is desired and are not within the reach of the underprivileged sections of society with low purchasing power. In this perspective it was thought that we should to revive our mission to outreach the decision makers. The Conference on 'Micronutrient Fortification of Foods: Science, Application and Management' considered all dimensions of food fortification to evolve a practical action program.

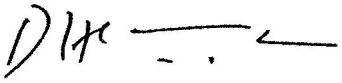
The most extensive and therefore obvious is the deficiency of iron. More than half the population is iron deficient and suffers health problems and has low productivity. This deficiency among children is of particular concern because it critically impairs mental development.

It is true that food fortification is not the only means to make up micronutrient deficiencies. But it is one strategy that has the widest reach and can show positive results in medium term. In target populations like children, pregnant women and adolescent girls whose intake of iron needs immediate attention, supplementation would the best option. A combination of supplementation and fortification with all essential micronutrients would be ideal.

Apart from iron, the other relevant micronutrients are folic acid, vitamin A, iodine, zinc and vitamin D. Iodized salt has been a success story and the incidence of goiter has been significantly reduced. It is important to ensure that the fortificant that is used is bioavailable, of proven effectiveness, of good quality and is safe, to ensure that fortification yields wholesome results.

To directly address the target populations the three official programs viz. Integrated Child Development Services (ICDS), Mid-day Meal for school children and Public Distribution System (PDS) can be excellent channels. The fortified foods will reach the sections of population that need these foods most.

ILSI-India is convinced that food fortification is the best strategy for the country. It has worked in other countries and there is no reason why it cannot deliver results here if it is vigorously pursued. The science is proven and the application is simple. What is absent is management. For that what is crucial is political will.



(**D. H. Pai Panandiker**)
Chairman, ILSI-India

CONFERENCE CONCLUSIONS AND RECOMMENDATIONS

A Conference on "Micronutrient Fortification of Foods: Science, Application and Management" was organized by ILSI-India on January 7-8, 2011 in New Delhi. The Conference was co-sponsored by Ministry of Food Processing Industries, Government of India and National Institute of Nutrition, Indian Council of Medical Research. It was attended by 145 participants representing industry, government, international organizations and academia from India and abroad. The Conference was addressed by 27 speakers from India and abroad.

CONCLUSIONS

- A large section of Indian population is exposed to micronutrient malnutrition resulting in severe health consequences like anemia, retardation and stunting in children, weakened immunity and so on. This has lowered labor productivity and consequently loss in national production which may amount to more than 4% of GDP.
- The reason for acute micronutrient deficiency in India is that poverty is high and food that the poor eat is deficient in calories, proteins and micronutrients. Even the better-to-do households suffer micronutrient deficiencies partly because the diet is not balanced and partly because the food products like cereals, oilseeds, pulses and vegetables are deficient in micronutrients due to soil erosion.
- Government has partly addressed this problem in respect of children and pregnant women through programs like ICDS, the results of which are yet to be assessed. But the dimensions of the problem are far too large and a sustained and focused effort needs to be made to improve the health status of the whole population.
- If a child is malnourished during the first 1000 days then it can never recover- mainly mentally.
- Studies have shown that chronic iron deficiency is responsible for persistence of goiter. In transition countries like India, current surge in overweight may impair efforts to control iron deficiency. *Interactions* of the 'double burden' of malnutrition may have adverse consequences. Overweight may increase risk for iron deficiency via low-grade inflammation that increases hepcidin and reduces systemic iron availability.
- A number of complementary strategies can be used to improve nutrition status in the population. These include: dietary diversification, supplementation, biofortification and food fortification. However, in the medium run food fortification has good results in both developed and developing countries. While supplementation is a good strategy for target groups like young children and pregnant women, it is food fortification that can deliver better results over longer time. Micronutrients are available through natural sources. Use of dietary diversification as a strategy for increasing consumption of micronutrient rich foods through natural sources though important is challenging. Bioavailability, combination of food being consumed and affordability by target groups makes it difficult to implement in practice.
- Food fortification becomes an important part of the public health strategy in disease control and improving quality of life.
- Food fortification has a long history of use in developed countries for the successful control

of deficiencies of vitamin A and D, several B vitamins (thiamine, riboflavin and niacin), iodine and iron. In the developing countries, fortification has become an increasingly attractive option in recent years., There are many success stories in different countries about how deficiencies have been rectified through fortification of commonly consumed products. Notable examples are iodine in salt in most countries; vitamin A in sugar in Central America; and folic acid in wheat flour in Canada, USA, Chile and South Africa.

Impact modulation studies carried out in Uganda suggest that vitamin A inadequacy can be corrected in almost the whole country by means of the combined fortification of vegetable oil and sugar, and that the nutrient gaps of vitamins B-2, niacin, folate, B-12, and zinc can be corrected for the population of Kampala (the capital city) through wheat flour fortification. Likewise, biomarker evidence from Palestinian school-age children suggests that status of folate and vitamin B-12 has increased due to the consumption of fortified wheat flour. Furthermore, in this population, wheat flour fortification appears to be very important to reduce inadequacies of vitamins A, D, B-1, B-2, niacin, and zinc. Effectiveness evaluation, which is rarely done in most countries, should confirm these inferences.

- Micronutrient fortification has its advantages. First no diet change is necessary; second, fortified food can deliver a significant part of the RDA; and third the intake of micronutrients can be on a continuous basis over long periods.
- Food fortification is a powerful intervention that when well designed and implemented could improve the nutritional status and health of large number of individuals, both in developed and developing countries. However, it requires the active and reliable participation of several stakeholders from many sectors of the society including Government, industry and academia.

In the Copenhagen Consensus 2008, a panel of economic experts were asked to address ten challenges areas to answer the question " What would be the best ways to advancing global welfare, and particularly the welfare of the developing countries" – Food fortification ranked second among all international development priorities and is viewed as highly cost effective.

- There are new opportunities in 2011 to correct micronutrient deficiencies using food fortification. There are new compounds, such as nano-structured iron and zinc. New target groups have identified, such as weaning infants at risk of iodine deficiency.
- The barriers to food fortification include;

  1. Changing consumer behavior/habit. There is lack of awareness in consumers about the nutritional needs, inability to correlate health problems with micronutrient malnutrition (hidden hunger), price sensitivity and no perceived need for prevention of health problems. Consumers do not see any immediate effect and find it difficult to grasp the benefits of long term "good health" or contribution to overall health *The most at risk choose the least expensive product.*
  2. Ambiguity in regulations relating to fortification. For example, if milk is to be called milk then no vitamin and minerals can be added and product name changes and there is 12% tax. Therefore, definition of milk under Income Tax should be changed to include fortified milk. Further there are contradictory provisions in law about certain micronutrients e.g. zinc: the RDA is 12 mg but under food law it is defined as poisonous metal beyond 5 mg for 100 gms. This discourages fortification.

- Unlike in the developed countries, developing country fortification experiences have relied extensively on mandatory legislation as key

to achieving sustainability of a food fortification program. Experience has shown that voluntary fortification in many developing countries have failed. Moreover, voluntary fortification of non-staple foods commonly initiated by the private industry does not reach the target population groups at risk for nutritional deficiencies. Against the above background several developing countries have set in place and enforced mandatory fortification laws.

- Legislation presupposes an effective monitoring and enforcement based on the partnership of relevant food industries and governmental agencies. In such a partnership, the government seeks improved public health, and the industry seeks value addition.
- Anemia is indicative not only of iron deficiency but many other nutrients are involved. Fortification with iron alone is not effective. The term iron deficiency anaemia should be eliminated –it should be replaced with nutrition deficiency anaemia.
- Toxicity will not be an issue in India since there are few fortified foods in India. Hence it is very unlikely that someone would consume fortified foods at toxic levels.
- Toxic levels are at least 5-10 times the RDA. Even if a person takes all fortified foods, the excessive minerals and iron will be excreted.
- Upper limit (UL) for fortification is different realm than RDA. RDA is meant to determine requirements whereas upper limit is determined for safety through risk assessment. In case UL is not available, highest observed intake (HOI) which is safe should be considered. It will be wrong to consider one RDA as the upper limit. Safety limits could be 2-3 times more than RDA.
- Strict quality control system and surveillance system are required to provide desired amount of micronutrient to consumers.
- The type of vitamins will determine the fortification level. For example, in Guatemala for sugar fortification, the level of vitamins required at mill level is different from the market level and at consumer level. Most vitamins which are adequately compounded can be used with no major problems on stability.

RECOMMENDATIONS

The Conference identified the following steps that are necessary to meet the challenge by using nutrition science to ensure that the food intake is closer to balanced diet

- Faster and more sustainable progress is needed to overcome hidden hunger and to achieve MDGs by 2015.
- Supplementation, fortification at the factory level or by households through sachets are complementary means of delivering micronutrients to the people exposed to malnutrition. There is consensus that fortification works best and can be sustained over long period.
- Multi-nutrient fortification of staple foods with proven effectiveness, assured quality, bioavailability and absolute safety would be a better option to correct micronutrient malnutrition since it is also the most cost effective, does not require diet change, delivers a significant part of RDAs with continuous intake
- At the first stage the micronutrients to be used in fortification should be iron, folic acid, vitamin A, iodine, zinc, vitamin D and calcium.
- The foods to be fortified to deliver the micronutrients should be those that are commonly consumed like wheat flour, rice, milk, bakery products, etc.
- The three major prevailing programs viz. Integrated Child Development Services

(ICDS), Public Distribution System (PDS) and Mid-Day Meal (MDM) scheme for school children should be effectively used to deliver micronutrients precisely to those sections of population that are most exposed to malnutrition. Some of the State Governments in the country are using these programs to deliver micronutrient fortified foods to target groups. Other State Governments need to be encouraged to adopt such initiatives to have impact at national level.

Centralized kitchen for Mid-Day Meal (MDM) is only in the urban areas and not in rural areas. Sachets should be used for rural areas with proper education.

In some of the states, Integrated Child Development Services (ICDS) and Mid-Day Meal (MDM) program are not effective because of lack of sufficient funds for these programs. There is a need to allocate more funds for these programs.

The quantity of food including prescribed protein and calories given under MDM should be given more than once to enable children to consume the quantities prescribed for them.

In ICDS and MDM programs, intensive public-private partnership is required. Government should be a catalyst in such programs.

- It is appreciated that the BPL families are price sensitive. While fortification can be market driven it can be expedited with support from government.
- Nutrition illiteracy is widespread. Hence it is important that media is used to educate consumers about the benefits of fortified foods. Popular TV serials can be used for imparting information on nutrition. There should be continuous dialogue between Government, private sectors and academia to attack micronutrient illiteracy problem. Private sector can provide good inputs to IEC programs due to their marketing skills. Certain set of standardized messages should be developed which will form a package of the total IEC that government functionary is supposed to administer. There is a need to get across clear messages about the adverse effects of under nutrition. The messages should be simple, clear and dramatic. For example messages conveying that iodine and brain development and cognition are linked to iodized salt have been successful.

  Scientists should reach out to the public and industry to explain the benefits of micronutrient fortification of foods.
- Management Information System (MIS) is part of the total program. It is important to know how the system is operating at the field level. Technical experts should help the government in finding a balance between good monitoring and too much monitoring.
- Effect of fortification program should be evaluated from time to time. Proper monitoring mechanisms for all fortification programs should be set up and impact studies should be undertaken from time to time. Monitoring and evaluation indicate whether the program is going in the right direction and whether there is a need for increasing the amount of fortificants to be added.
- There should be quality assurance about fortified products.
- Implementation of fortification program requires coordinated efforts of the central and state governments, food processing industry, regulatory authorities and the consuming public. With strong political will it will be easy to forge this cooperation to make micronutrient fortification of commonly consumed foods a success.
- In fortification programs, priorities will include choice of right technology, right vehicles, right micronutrients and right fortificants. Selection

of vehicles is very important with respect to target groups, its affordability, accessibility, technological know-how, availability and distribution system.

- Clear policy guidelines are required from Government to facilitate food fortification.
- Road map for eliminating micronutrient malnutrition should be prepared.
- Proposals for five year plan should be sent to Ministry of Food Processing Industries.
- Proper technical knowledge about fortification should be given to various stake holders.
- Micronutrient food fortification program should be complementary program with other nutrition program.
- Food fortification is not clinical nutrition or mathematics. Regulations have to account for high variability which is also found in natural products for example, micronutrients in potatoes will be different when harvested as compared to micronutrients at later stage. Programs could be designed for target population in mind but it should have generous variability which is technically attainable and sustainable.
- Intensive public-private partnership in drafting regulations is as important as in investment.
- FAO/ WHO recommendation on food fortification should be followed for addition of micronutrients.
- Pro-active role should be played by Food Safety and Standard Authority of India (FSSAI) to promote fortification.
- Despite the fact that a food fortification program can exist only if the process is adopted and controlled by the food industry, the functions of governmental and research institutions are indispensable for achieving the public health goals. Among those roles are establishing the nutritional population needs; coordinating the preparation of suitable standards; guaranteeing validity of the claims; enforcing standards for protecting the consumers and creating a level-playing field; and collecting the experimental evidence that the programs are indeed benefiting the at-risk populations and without causing undesirable effects to a few due to very rare, but still possible, excessive intakes.
- Industry should be conservative about over claims. Claims should be backed by bioavailability studies.
- Specialty and capacity building is required in micronutrient research and fortification.
- ILSI should undertake to create awareness in stakeholders about the importance of micronutrient fortification.
- Micronutrient fortification program should be well-managed. This should include proper documentation and self-regulation.
- Micronutrient fortification of foods should be considered as priority public health issue.
- Micronutrient fortification of foods should be safe and cost-effective. Variety of foods should be fortified.
- Special Purpose Vehicles (SPVs) are needed for better absorption and optimum bioavailability.
- Development of food processing industries should be accelerated to create opportunities for fortification.

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OPENING SESSION

Welcome Address

Mr. D.H. Pai Panandiker, Chairman, ILSI-India

Mr. Panandiker explained the importance of the conference. Mr. Panandiker said that ILSI-India has abiding interest in food fortification as a strategy to correct micronutrient malnutrition. In the last 15 years it organized more than 16 conferences in different parts of India as also Nepal, Bangladesh and Sri Lanka to create awareness among governments, industry and consumers, about micronutrient deficiencies, their perilous effects on human health and the ways these deficiencies could be made up. He pointed out that micronutrient deficiency is still very acute in India and other SAARC countries. The reason is that poverty is high and food that the poor eat is deficient in calories, proteins and micronutrients. Even the better-to-do households suffer micronutrient deficiencies partly because the diet is not balanced and partly because the food products like cereals, oilseeds, pulses and vegetables are deficient in micronutrients due to soil erosion.

The more important micronutrients are vitamin A, iodine, iron, zinc and folic acid. The deficiencies of these micronutrients are responsible for nearly half the deaths that occur in young children and pregnancy problems in mothers. The most pernicious deficiency is iron deficiency leading to a variety of diseases and slowing down of mental development in early childhood. The State Governments have addressed this problem and used supplementation to make up iron deficiency. But it does not appear that the results have been satisfactory.

Micronutrient fortification has its advantages. First no diet change is necessary; second, fortified food can deliver a significant part of the RDA; and third the intake of micronutrients can be on a continuous basis over long periods. There are many success stories in different countries about how deficiencies have been rectified through fortification of commonly consumed products, like iron in soy sauce or wheat flour, vitamin A in sugar and milk, iodine in salt, and so on.

The ICDS program and mid-day meal scheme for school children, could be used more effectively to reduce, if not eliminate, micronutrient deficiencies. Some states, particularly Gujarat, where the governments have been sensitive to the health needs of the people, have shown good results though there is not enough data to measure the extent of success.

While supplementation is a good strategy for target groups like young children and pregnant women, it is food fortification that can deliver better results over longer time. Since iron deficiency is critical, more particularly among the poorer sections of society, an easy and inexpensive way of delivering iron to these people would be to distribute fortified

wheat flour in place of wheat under public distribution system. That will deliver iron in required doses to more than 300 million people.

Until recently, the regulatory system was very restrictive and did not encourage fortification of a number of foods with the required micronutrients. The regulatory system has now undergone dramatic change with the establishment of Food Safety and Standards Authority of India. What is necessary is for the Authority to adopt a proactive approach and encourage industry to fortify processed foods.

The Ministry of Food Processing Industries encourages development of food industry by extending it support for purchase of capital goods. May be if a similar approach is adopted to motivate industry to fortify processed foods it will facilitate and speed up the progress of micronutrient fortification of foods. Some of the industries have discovered that there is a good market for fortified food and beverages products.

The burden of micronutrient deficiency is not only in respect of loss in public health but also loss in respect of national income. Broadly, about 4 per cent of India's GDP is lost due to drop in productivity, expenditure on medical treatment, absence from work, and so on. In absolute amount that loss is more than $ 40 billion a year. That loss can be avoided with food fortification which will primarily benefit the weaker sections of society.

Of course, benefit is not without cost. How much would it cost to remove micronutrient malnutrition? To earn back those $40 billion all that the country has to invest is less than $3 billion. That is the highest rate of return on any investment. What is more, it need not all be spent by governments. Most of it will be borne by beneficiaries themselves.

It has been the endeavor of ILSI-India to create the necessary awareness in government, industry and the consumers. But their implementation requires coordinated efforts from central and state governments, industry, regulatory authorities and consuming public. With that, public health in India will significantly improve.

Key Note Address

Mr. Ashok Sinha, Secretary, Ministry of Food Processing Industries

Mr. Ashok Sinha pointed toward the excellent relationship that Ministry of Food Processing Industries enjoyed with ILSI India and made the following observation.

- Post conference documentations should come out with specific programs. Ministry of Food Processing Industries (MFPI) would be happy to remain involved.
- Nutrition is attracting the attention of highest level of thinking in India. The Planning Commission held a meeting on "Prime Minister Council for Nutrition" to discuss all the issues relating to nutrition especially mother & child nutrition including using micronutrient fortification as a powerful weapon to fight malnutrition. All Ministries handling nutrition or in any way involved in nutrition will be brought together on a single platform. The meeting recommended that there should be an attack on lack of communication and nutrition awareness should be created .Some big personalities have agreed to be spokesmen to the Media. The outcomes of Conferences like the present conference by ILSI India needs to be supported by Government. Ministry of Food Processing Industries, Health Ministry and Ministry of women & Child Development are particularly involved.
- The current global debate on food security primarily focuses on availability, distribution and affordability of food and sometimes misses out on the vital issues faced with the hidden hunger arising out of deficiency of several essential vitamins and minerals.

Developing countries are facing deficiencies of iron, iodine and vitamin A. India is tackling problem of iodine deficiency through fortification of salt with iodine. Further, double fortified salt with iron and iodine will be useful.

- High incidence of Anemia in women and children can be traced to absence of proper education about nutrition requirements.
- Micronutrient deficiency is a matter of concern because it affects health and can lead to high morbidity and modality. Deficiency of iron and vitamin A are major causes for high global burden of disease.
- Fortification is not the only solution to reduce malnutrition. There is a need for supporting strategies to make any solution more effective.
- Food Industry should be an equal partner in food fortification strategy to reach large population.
- Following factors are important for a successful Food Fortification Program:
  - Quality of Micronutrient being used.
  - Identification of group suffering from deficiency.
  - Regional differentiation
  - Group differentiation.
  - Affordability.
  - Unambiguous regulatory frame work.
  - Awareness about benefits of fortifications in consumers.
  - Strong public private partnership.
  - Profit making company should be motivated by the income tax provisions relating to corporate social responsibilities.
  - Road map for eliminating micronutrient malnutrition.
  - Proposals for five year plan should be sent to Ministry of Food Processing Industries.
  - Imparting proper technical knowledge to various stake holders.

Vote of Thanks

Mr. N M Kejriwal, President, ILSI-India

Mr. Kejriwal, proposed vote of thanks to Mr. Ashok Sinha, speakers, Conference participants and others. He said that despite the fact that India is a leading producer of a number of agricultural and horticulture crops in the world including cereals, fruits and vegetables, and milk the country has been lagging in health status.

He recommended that more attention should be paid to nutrition. Investment should be made to improve the nutrition status of women and children particularly. It is imperative to look at where the programs and policies need to be strengthened, and implementation expedited and made more effective. Nutrition security along with food security should be part of the programs to improve public health. Many smaller countries have gone much ahead of us.

There is a need for public private partnership in food fortification programs. Industry should develop low cost fortified products with the help of R&D institutions and prove their effectiveness scientifically for eliminating micronutrient malnutrition. Government should act as facilitator to enable industry to produce such products. At times industry is not able to go ahead because of lack of clarify about the regulations. Since fortification is a “win win situation” for all there should not be any hesitation on part of Government to facilitate the process and allow industry to take initiatives for public health.

ILSI brings science to everyone’s notice and also information on how it has been used in other countries. However, how such information can be used has to be judged by the concerned organizations. ILSI-India will always be available for any further assistance. You may like to know that ILSI works with more than 4000 scientists and it is unique in its approach to issues. It works with scientists from Government, R&D institutions and industry from around the world to seek solutions to public health issues particularly those relating to food safety, nutrition and biotechnology.

SESSION I: MICRONUTRIENTS AND HEALTH

Chair: Major General Dr. Raman K Marwaha, Head-Dept. of Endocrinology & Thyroid Research Centre, Indian Institute of Nuclear Medicine and Allied Sciences

Micronutrient Nutrition And Food Fortification Activities In China

Professor Chunming Chen, Chinese Center for Disease Prevention and Control, ILSI Focal Point in China, Beijing, China

Along with the rapid economic development of China, in the past 10 years, the nutritional status of Chinese population has dramatically improved in food security and the percentage of people exposed to Protein Energy Malnutrition (PEM) (including underweight and stunting) has continuously reduced. The general dietary pattern has been improved too. But in China, micronutrient deficiency is still a public health problem to be addressed:

(1) Iodine deficiency disorder (IDD) prevalence was high in early 1990's, the goiter rate in children aged 8-10 years was 20.4% in 1995. After the implementation of the national universal salt iodization program, the household iodized salt coverage reached 90.2% and the goiter rate of the same age group reduced to 5% since 2005.

(2) Dietary iron intake of Chinese people was 23-25mg/day in 2002, iron from meat and fish was13.3% in big cities and below 9% in less-developed rural areas. Applying the iron absorption of Chinese diet (4%), the estimated daily absorbed iron of adult men was 0.92mg. Anemia prevalence of children aged 6-11 months, 12-24 months, pregnant women and elderly was 38.3%, 29%, 28.9% and 28.8% respectively. According to the surveillance data since 2000 to 2008, there was minor reduction of anemia prevalence in children under 5.

(3) Sub-clinical vitamin A deficiency exists in China. Children aged 3-12 years with plasma retinol <20ug/dl in less-developed rural area was 13-14%.

(4) Folic acid deficiency defined by red blood cell folate <140ug/L in child bearing age women in the northern part of China was 54.9%.

(5) The daily dietary intake of vitamin B_1 and B_2 are inadequate as usual, which is 1mg and 0.8mg on average respectively, but no clinical deficiencies were found.

To address the issue, food fortification becomes an important part of the public health strategy in disease control. The proposed framework of the national food fortification program is: staple food/ condiment fortification for general population, nutrient-dense food supplements for complementary feeding for children under 2 and nutrient supplementation for pregnant women. The priority nutrients are iron, iodine and folic acid, and vitamin A and B vitamins fortification are encouraged. A set of public health targets for fortified foods is described as (1) Available in rural market, (2) Accessible to the rural households, (3) Acceptable to the consumers and (4) Affordable to the general rural families. To approach the targets, relevant legislation, production, marketing, distribution mechanism, pricing, packaging as well as public nutrition education to enhance the demand for mass fortification and target fortification etc. should be adopted. To create a sustainable food fortification chain is a complicated issue. A sound public-private-partnership is needed, which is in the process of development in China.

The activities combating micronutrient deficiencies in china is now in the state of pilot programs and project basis, which is beyond a comprehensive policy implementation. The major ones are:

(1) Iron fortified soy sauce – Since 1997, research has been undertaken on the fortificant, technology, legislation, food safety control system, and the efficacy study and effectiveness study. Later on trials were undertaken in 9 provinces. Under the leadership of Ministry of Health (MOH) and with the support of Global Alliance for Improved Nutrition (GAIN) and partnership with scientists, soy sauce producers and the retailers, including the people and companies, rural market is developing. The stakeholders are working together to make the mass food fortification scaled up and beneficial to the population.

(2) Nutrient-dense food supplements for complementary feeding (In-home fortification for children 6-24 months of age –YingYang Bao) – After the promulgation of the national standard for such fortified food, various brands of such product have been manufactured. Several activities under social equity and support programs to the earthquake areas since 2009 have been initiated to explore policy development for the nutrition security for early childhood in the future. The Government of China has increased investment on such programs since 2010.

(3) Multi nutrient fortified wheat flour in Shanxi Province – a program in the counties with high prevalence of neural tube defect (NTD) was carried out under the leadership of the Provincial Population Planning Bureau and with the support of Micronutrient Initiative. Multi-nutrients including folic acid, vitamin B_1 $B_{2,}$ iron and zinc fortified wheat flour coupons were provided to 7654 households with childbearing females in Zhongyang County. There were 836 live births in 2 years, among them, NTD case in the households with average fortified wheat flour consumption more than 234g per day was 1 per 376; and in the household with less than 116g per day, the NTD cases were 8 per 319 live births. Wheat flour fortification program for specific provinces is now under consideration.

China is on the way towards policy formulation of food fortification.

Figure 1: Reduction of Anemia Prevalence

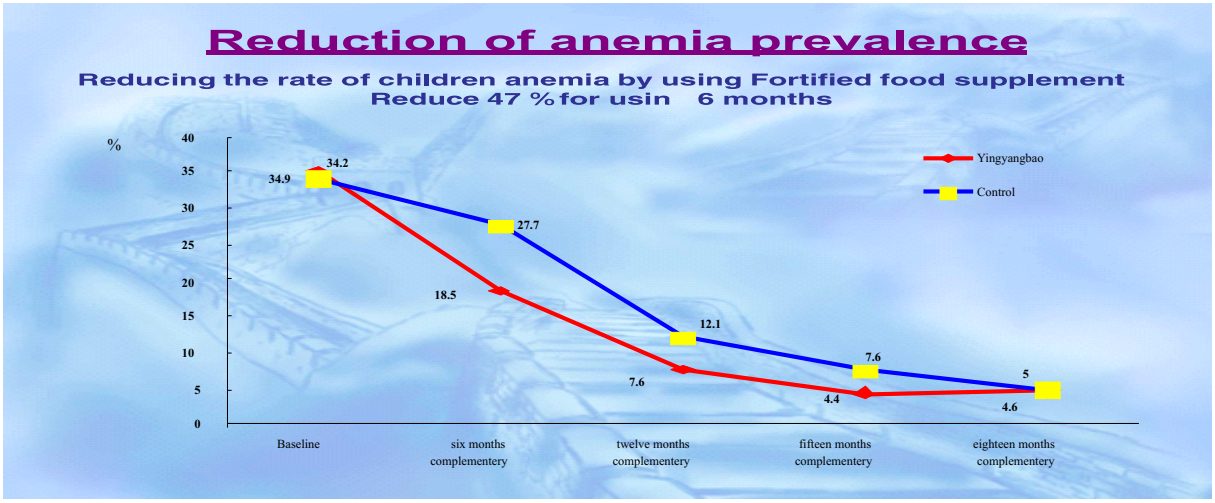


Figure 2: Sustained Intelligence Development of Children Supplemented with Fortified Food Supplement

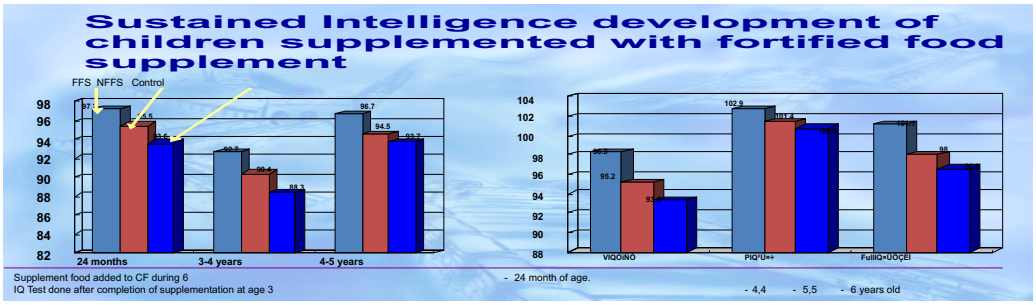


Figure 3: Anemia Prevalence in the at-risk Population Reduced

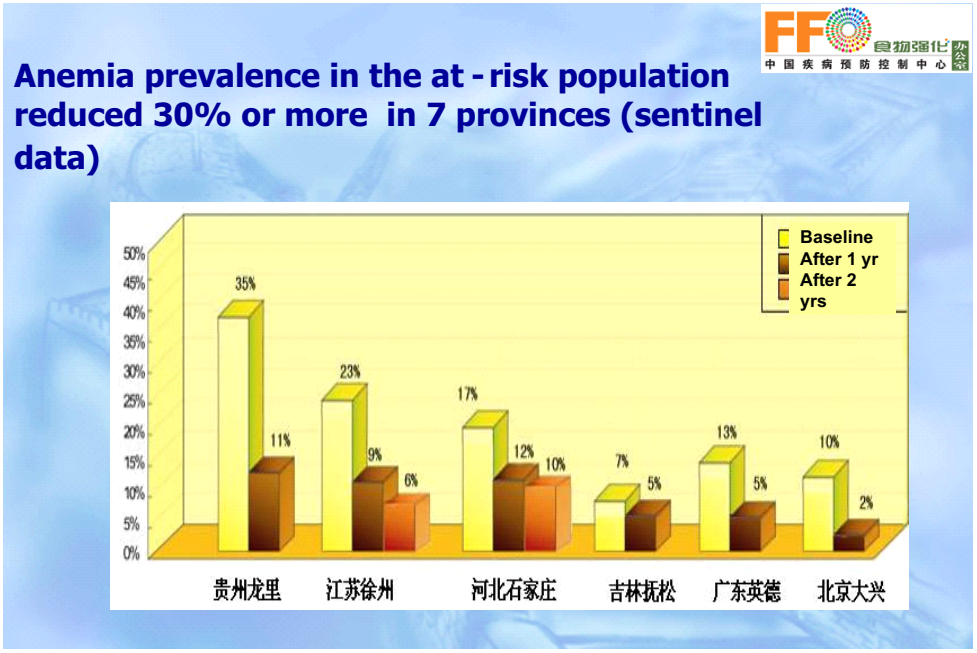


Figure 4: Environment for Sustainable Food Fortification Program

Environment for sustainable food fortification program

- Integrated social marketing and public education -Ensure supply and enhance demand
- Policy and legislation encouragement -- Incentives and food quality and safety assurance
- Social responsibility of industry (manufacturer, retailers, super markets, village shops…….).
- Public -private partnership

National Perspective On Micronutrient Deficiencies And Their Impact On Health And Productivity

Dr. Chandrakant S Pandav, Professor & Head, Centre for Community Medicine, All India Institute of Medical Sciences, New Delhi, India

The magnitude of under nutrition in the world remains unacceptably high with close to one billion in year 2010 suffering from under nutrition. Developing countries suffer a disproportionately higher burden (prevalence of under nutrition is 16 percent in developing countries) accounting for 98 percent of the world's undernourished people. Along with the more visible under nutrition (defined by low weight for age) co-exists the chronic lack of vitamins and minerals affecting mental and physical well being of individuals. An estimated two billion people globally live below their physical and mental potential because of micronutrient deficiencies. These essential vitamins and minerals known as "Micronutrients" are needed in small amounts for various physiological functions. Micronutrient deficiencies often have no visible warning signs and are also known as "hidden hunger". Deficiencies of several micronutrients are known to exist including deficiencies of iron, vitamin A, iodine and zinc which are of significant public health importance.

As regards the existing burden of vitamin and micronutrient deficiencies in India the prevalence of anemia has increased in ever-married women from 52 percent in National Family Health Survey - 2 (NFHS - 2) (1998-88) to 56 percent in NFHS-3 (2005-06). Among pregnant women, anemia has increased from 50% to 59%. As per NFHS-3 (2005-06), 79 percent of under five children in India are anemic.

The prevalence of Bitot's Spots, night blindness and conjunctival xerosis in preschool children is 0.7 %, 0.3% and 1.7% respectively as per NFHS-3 (2005-06). As per the survey by National Nutrition Monitoring Bureau, 62% of children have serum vitamin A levels <20 mcg/dl, indicating sub-clinical VAD. In India 200 million people are living in iodine deficient areas, another 71 million people suffer from goiter, and other Iodine Deficiency Disorders (IDDs). Adequately iodised salt consumption at household level increased only marginally from 49 % in 1998-99 (NFHS 2) to 51% (NFHS 3) in 2006-06. There is a lack of adequate and reliable data on the current burden of zinc deficiency in children and general population in India. It is estimated that about 71.2% of the total population in Southeast Asia is at risk of developing zinc deficiency. In opinion of experts, nearly 40 percent of Indian children suffer from zinc deficiency.

The factors leading to micronutrient deficiency can be largely grouped as direct and indirect. The factors directly related include inadequate production and improper storage and distribution of food grains along with difficulty in accessibility and affordability of food. The micronutrient deficiencies are also affected by age, sex, genetics, socioeconomic status and environmental conditions. The important indirect causes comprise of weak governance or public administration, unsustainable livelihoods systems and breakdown of local institutions and poor coverage nutrition improvement initiatives. The high burden of micronutrient deficiency could also be attributed to, which in turn is fall out of lack of motivation of functionaries, absence of nutrition education and non-participation of community.

Iron deficiency, the major cause of nutritional anemia impairs the fetal growth, cognitive development and immune system. Vitamin A deficiency leads to night blindness, conjunctival and corneal xerosis, keratomalcia, anorexia, hyperkeratosis respiratory and gastrointestinal infections and growth failure and has a direct link with childhood and maternal mortality. Iodine deficiency causes a wide spectrum of disorders ranging from mental retardation and impaired physical development, goiter, cretinism to neonatal deaths and stillbirths. Severe maternal zinc deficiency is linked with spontaneous abortions and congenital malformations. Minor forms of zinc deficiency have been associated with low birth weight, Intra Uterine Growth Retardation (IUGR) and preterm deliveries.

Though sizeable literature on impact of micronutrient deficiencies on productivity exists at global level, the information at country level on this is scanty. In a study done by Administrative Staff College in 1997, three scenarios were taken to carry out the cost analysis of malnutrition. The three scenarios – low, moderate and high based on the assumptions made on three indicators: productive life expectancy, average annual wage for an adult and average rate of employment were considered. The baseline values for the year 1997 were extrapolated to the year 2010 using the Consumer Price Index inflators. In case of low scenario, the estimated annual productivity losses due to Iron deficiency, vitamin A deficiency and IDD were Rs.305.8 billion, Rs.16.4 billion and Rs.69.2 billion respectively. It was Rs.750.0 billion, Rs.63.6 billion and Rs.156.8 billion for iron deficiency, vitamin A and IDD respectively in high scenario.

Figure 5: Productivity Loss due to Different Deficiency Disorders- Assumptions

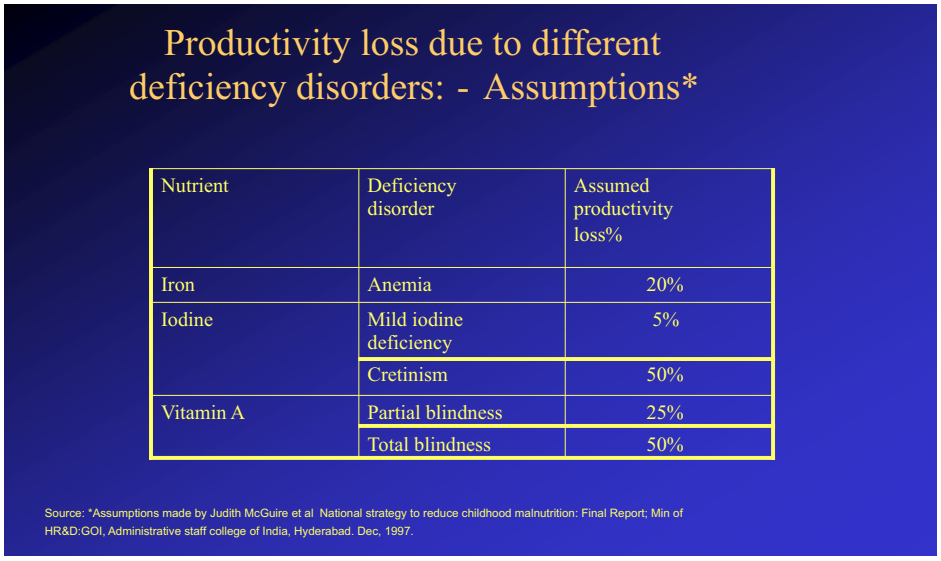
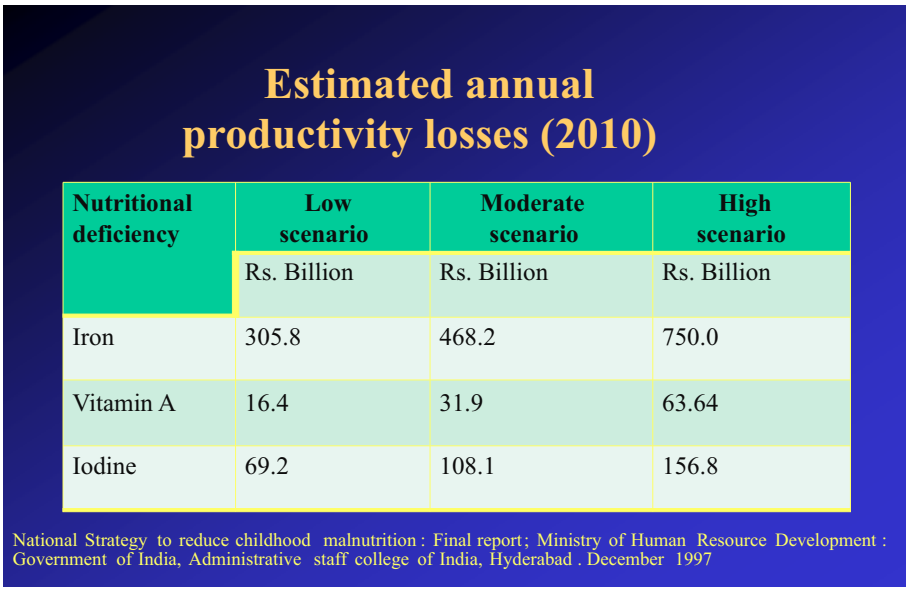


Figure 6: Estimated Annual Productivity Losses (2010)



The Way Forward

Short term interventions

The short term approach for could be supplementation and fortification. The National Health programs providing supplementation to vulnerable groups like children, adolescent, pregnant and lactating women needs to be strengthened to increase coverage. With increasing urbanization, commercially fortified foods are likely to reach increasing number of people at risk of deficiency, at a decreasing marginal cost. Public-private partnership can accelerate the uptake of fortification in developing countries providing low–cost staple foods with essential micronutrients.

Medium term interventions

Community education on key family health and nutrition practices using participatory and planned communication methodologies is essential to address micronutrient deficiencies. Family counseling and follow up by community volunteers and government health and nutrition staff for all families with pregnant women and children under three years should be made essential component of Maternal and Child Health care. Further, incorporating health and nutrition education into formal school curriculum for girls and adult literacy programs could greatly improve women's health and nutrition.

Long term interventions

A multi-sectoral approach is needed bringing together professionals from the fields of nutrition, health and medicine, health economics, agriculture, environmental sciences and social sciences. Community based nutrition programs (CBNP) which enhances community participation should be the key feature of all nutrition related interventions.

The government policy needs to focus on holistic nutrition policy ensuring up-scaling and mainstreaming of nutrition improvement initiatives. High priority should be given to increasing agriculture production. Indirect determinants of nutrition like education, sanitation, health services, etc should also be integrated with Nutrition policy making process. Schemes like Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) which **aims at enhancing the livelihood security of people in rural areas should be promoted.** Poverty alleviation programs need to be re-oriented and revived to make a positive impact on the purchasing power of the lowest economic segments of the population. Nutritional objectives should be an integral part of all the poverty alleviation programs.

Conclusion

Up-scaling and mainstreaming of Nutrition into national policy making process is essential to address the issue of malnutrition and micronutrient deficiency. What is required is paradigm shift from combating malnutrition and micronutrient deficiencies to ensuring Nutrition Security.

During the discussions, the following points were emphasized:

- Below poverty line population should be included in calculations to make it more comprehensive.
- It needs to be seen as to how contaminants in water affect the nutrition status. Water is contaminated with arsenic, fluoride and heavy metals in a number of places in India.
- Nutrition education is very important for people to take balanced diet including fortified foods.
- Quality control of iodized salt is still an issue.This has resulted in inadequate coverage of population using iodized salt. Iodized salt is produced only in three States in India i.e. Gujarat, Tamil Nadu and Rajasthan.

- There should be continuous dialogue between Government, private sectors and academia to attack micronutrient illiteracy problem. Private sector can provide good inputs to IEC Programs due to their marketing skills.
- Bad quality of soil in the country is also responsible for micronutrient malnutrition and many non-communicable diseases. Quality of soil should be improved to increase micronutrient contents.
- Studies have shown that chronic iron deficiency is responsible for persistence of goiter.
- There should be quality assurance about fortified products.

Cost-benefit analysis should be included in all programs for nutrition improvement.

SESSION II: FOOD FORTIFICATION AS A STRATEGY FOR A NUTRITION DELIVERY: DOES IT WORK?

Chair: Mr. D H Pai Panandiker, Chairman, ILSI-India

A Personal Evolution: From An Unbeliever To An Advocator

Dr. Omar Dary, Food Fortification Specialist, A2Z/ The USAID Micronutrient And Child Blindness Project, Academy For Educational Development (AED), Washington DC, U.S.A.

Introduction

Twenty years of work in food fortification programs in more than 40 countries around the globe have changed my appreciation of addition of vitamins and minerals (micronutrients) to foods from an unbeliever to an advocator. At the beginning I doubted if indeed the vitamins could remain in the fortified vehicle until the consumer table. After I confirmed that it was the case –if the fortificants come from a reliable supplier-, I initiated a permanent experience of learning in an area that now I call as the "Science of Food Fortification".

Why Food Fortification Works?

Because it delivers needed vitamins and minerals in the adequate amounts to correct nutrient inadequacies in vulnerable individuals. The solution depends on the additional intake of micronutrients that are low in the usual diets and not simply in the consumption of the fortified food. However, the epidemiological impact depends on the penetration (coverage) of the fortified vehicle in the population if it delivers the appropriate solution to the at-risk individuals.

An Efficacious Product Does Not Necessary Mean An Effective Program

As the solution is contingent to the adequate supply of micronutrients through the fortified vehicle, program effectivity is limited to the feasible fortification levels that are allowed for technological compatibility and affordable cost, and the habitual amounts of the fortified food that the vulnerable population consumes. Only very few cases using a single fortification vehicle combine the requirements of sufficient micronutrient intake and the adequate population coverage. Notable examples are iodine in salt in most countries; vitamin A in sugar in Central America; and folic acid in wheat flour in Canada, USA, Chile and South Africa. Nevertheless, a fortified food will always increase the micronutrient intake of the individuals that consume it and therefore food fortification reduces micronutrient inadequacies -if those are present. Therefore, this is generally a nutritional intervention in the right direction, whose magnitude of impact depends on the local conditions.

Measuring Of The Additional Intake Is Basic To Explain Impact

Assessment of the additional micronutrient intake and evaluation of the proportion of the micronutrient gap correction are very useful, but little appreciated and used to measure the importance of food fortification programs in public health nutrition. Impact modulation studies carried out in Uganda suggest that vitamin A inadequacy can be corrected in almost the whole country by means of the combined fortification of vegetable oil and sugar, and that the nutrient gaps of vitamins B-2, niacin, folate, B-12, and zinc can be corrected for the population of Kampala (the capital city) through wheat flour fortification. Likewise, biomarker evidence from Palestinian school-age children suggests that status of folate and vitamin B-12 has increased due to the consumption of fortified wheat flour. Furthermore, in this population, wheat flour fortification appears to be very important to reduce inadequacies of vitamins A, D, B-1, B-2, niacin, and zinc. Effectiveness evaluation, which is rarely done in most countries, should confirm these inferences.

Functions Of The Private And Academic Sectors Are Essential For The Program Success

Despite that a food fortification program can exist only if the process is adopted and controlled by the food industry, the functions of governmental and research institutions are indispensable for achieving the public health goals. Among those roles are establishing the nutritional population needs; coordinating the preparation of suitable standards; guaranteeing validity of the claims; enforcing standards for protecting the consumers and creating a level-playing field; and collecting the experimental evidence that the programs are indeed benefiting the at-risk populations and without causing undesirable effects to a few due to very rare, but still possible, excessive intakes. Although all these functions are of low cost as compared with the total investment that the industry transfers to the consumers into the price of the fortified product, their strengthening and budgetary allocation are frequently neglected.

Conclusion

Food fortification is a powerful intervention that when well designed and implemented could improve the nutritional status and health of large number of individuals, both in developed and developing countries. However, it requires the active and reliable participation of several stakeholders from many sectors of the society; this is not a simple intervention. Nevertheless, the potential positive individual and population impacts make it very worthy to implement.

Figure 7: Potential Impact of Fortified Wheat Flour in Kampala

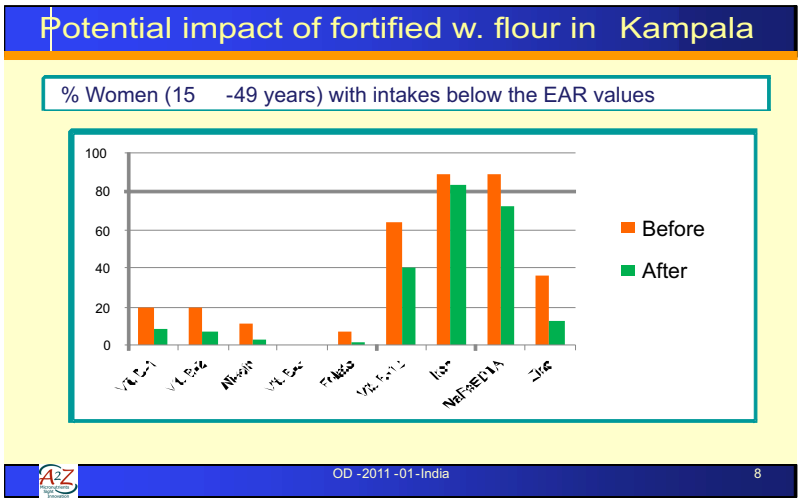
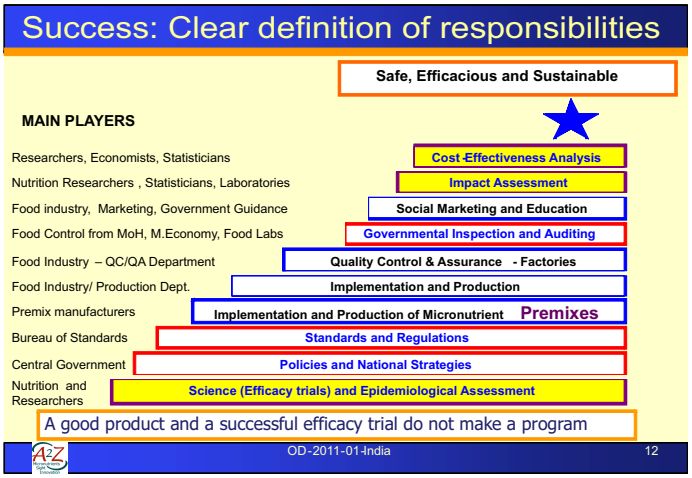


Figure 8: Success- Clear Definition of Responsibilities



The Gujarat Food Fortification Program

Mrs. Sangeeta Singh, Managing Director, & Mr. S N Rao, General Manager, The Gujarat Civil Supplies Corporation (GSCSC)

Article 47 And Food Security

- Article 47 (Directive Principles) - "State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties…"
- FAO - Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.

Food Fortification - Gujarat Model

- Based on Public-Private Participation Model with involvement of society.
- Stakeholders: State Government and its agencies, the Private Sector oil producers, refineries and packers, Roller Flour Millers' Association and its member mills.
- The fortification began in open market with private public partnership.
- In the first phase, Government decided that about 2.5 lakh tons of wheat, which is sold in open market shall be made into wheat flour and the same may be fortified with pre-mixed iron and folic acid.
- Initially Micronutrient Initiative (MI) – NGO of Canada also supported this program technically and financially. World Food Programme also provided free premix to the small atta chakkies of Surendranagar and Surat districts.
- Based on the experience, fortification of items of daily food intake like wheat, edible oil and salt was undertaken through basic Government programs – Public Distribution System (PDS), Integrated Child Development Scheme (ICDS) and Mid-day Meal (MDM) scheme.
- Role of the Government is as catalyst to the project.
- The program is based on partnership, not legislation.
- Success in markets leads to internalize this program to PDS, MDM, and ICDS with fortified flour and oil to remove deficiencies of iron/folic acid and vitamin –A and D.
- Most of the population being vegetarian, to fight against protein deficiency, model was further adapted to include defatted soya flour fortification – food to food fortification.

Steps To Improve Program Implementation

After roll out and implementation of food fortification program in welfare schemes, GSCSC took following steps to improve the program implementation:

- Organised National Seminar on Nutrition and Food Fortification in March, 2007.
- Assignment to CFTRI, Mysore to suggest steps to maintain quality and enhance shelf life of fortified atta. These included:
- Kept maximum moisture level to 10%.
- Distributed of atta in laminated HDPE bags.
- Used E-Tendering to award work of grinding and fortification to millers (to have competition, to reduce cost and to emphasize on responsibility and accountability through penalty clauses).
- Posted responsible officer from GSCSC at participating mills to monitor the whole fortification assignment and record keeping.
- Disallowed mills to carry out private work while working on welfare schemes.
- Appointmented qualified third party agency for sampling and testing.
- Appointed qualified third party agency for base line survey and evaluation of the program.

Monitoring of Nutritional Security Initiatives

The Department has taken two pronged approach to monitor and evaluate the impact of the various nutritional security initiatives:

- Firstly, the GSCSC carries out in-house sampling and primary testing of the fortified flour, i.e. moisture sieve and spot test indicative presence of iron (Fe).
- Secondly, independent third party quality testing agencies are also appointed to test the quality of the fortified products.

Overall schematic evaluation/ impact assessment has also started through third party agencies on both concurrent basis and also periodical basis. Further, IT Solution is under development for overall monitoring of various schemes.

Hon. Js. Wadhwa Committee Report

Introduction of Fortified Atta (Wheat Flour) In The Public Distribution System:

"The Committee is of the considered view that fortified atta along with wheat should be made available through PDS outlets which would immensely benefit the vulnerable sections of society and increases take off by consumers of PDS food grains. Even today, persons without BPL ration cards, despite being eligible for the same and other persons with BPL ration cards are purchasing wheat flour from the open market as a matter of convenience and to save on the time and cost involved in grinding of wheat into flour. The system of distribution of wheat flour is in vogue in the district of Darjeeling where enriched wheat flour is given @Rs. 6.80 per kg costs anything up to Rs. 150 and therefore, it should be possible to price a packet of fortified 5kg or 10kg wheat flour at a much lower price which may be any price between Rs.7 and Rs.8 per kg. This will definitely be much less than what may be available through the open market. The advantage would far outweigh a somewhat increased price that may have to be paid. At least, providing this option to the vulnerable section of the society though the PDS network will be a step in the right direction.

The Committee has also suggested modalities for operationalising this innovative step in the main chapter dealing with this subject.

Fortified atta would also improve the general health of the vulnerable sections and reduce instances of vitamin A deficiency and iron deficiency anemia. It has also been suggested that general instructions may be given to sell only fortified atta both under the PDS as well as the open market as this will make implementation easier and prevent diversion"

Factors For Success

- Dedicated and clear leadership of the program.
- Part of the Golden Goals (Swarnim Siddhi) of the State.
- Public Private Partnership (PPP) which is now being extended to Public Private Community Partnership (PPCP) mode.
- Regular interaction and consultations with stake holders at all levels.
- Integrating program delivery to all other delivery systems.
- Striving for constant improvement with planned stage wise progression.

Conclusion

It was experienced that legislative sanction was not crucial but administrative /stake holder's involvement and commitments made the project successful. People's participation, motivation and awareness are continuously needed. Costs are marginal and incidental. Integration of logistics, training of people, motivation, monitoring etc. are equally important.

Figure 9: TPDS- Norms of Distribution and Price

TPDS - NORMS OF DISTRIBUTION & PRICE

Category	Item	Distribution in KG Per		Central Issue Price	Cost Price	Distribution Price
				Rs./Kg	Rs./Kg	Rs./Kg
		Person	Card			
AAY	Wheat		#19.000	2.00	3.00	2.00
	Rice		16.000	3.00	4.06	3.00
	Levy Sugar	0.500				13.50
	Palmolien*		1.000		42.25	32.00
BPL	Wheat		#13.000	4.15	5.34	2.00
	Wheat (Sp.BPL)		4.000	4.15	5.34	5.40
	Wheat (APL to BPL)		10.000	6.10	7.50	7.50
	Rice	1.000	3.500	5.65	6.97	3.00
	Rice (Sp.BPL)		4.500	5.65	6.97	7.00
	Levy Sugar	0.500				13.50
	Palmolien*		1.000		42.25	32.00
APL	Wheat	0.000	10.000	6.10	7.50	7.50
	Rice		1.000	8.30	10.00	10.00

* in 1 Ltr. & Quantum and Distribution Price are decided on month to month basis.

In lieu of 19 Kgs. AAY wheat, 19 Kgs. Fortified Paustik atta (18 Kgs Wheat flour + 1 Kg Tosted Defatted Soya flour) & in lieu of 13 Kgs BPL Wheat, 13 Kgs Fortified Paustik atta (12.500 Kgs Wheat flour + 0.500 Gms Tosted Defated Soya flour) is being distributed.

GAIN'S Experiences Around The World In Fortification

Dr Rajan Sankar, Special Adviser & Regional Manager- South Asia, Global Alliance For Improved Nutrition (GAIN), New Delhi, India

Critical Factors For Success (Primary Foundational Blocks)

A. ***Choosing a Vehicle***

One of the key processes in developing a food fortification program is choosing a suitable food vehicle. This can be a challenge, especially in countries with large rural populations, a small food industry with limited technology, and limited access and low consumption of processed foods. A food fortification vehicle should be chosen based on key factors, including consumption patterns, marketing and distribution data, and economic and technical feasibility.

B. ***Food Industry And Market Analysis***

One of the features that distinguish food fortification from many other public health initiatives is the high level of involvement and motivation required of the food industry. Successful achievement of food fortification has a complex relationship to the level of economic development.

The situational analysis should include a review of the industrial capacity. What is the installed capacity and what is the capacity that is utilized. Share of the public and private industry should be examined.

In many developing countries there are subsidies and price controls of staple food. In such a scenario the food companies operate on thin profit margins and are not willing to take on the additional cost of

fortification unless assured of consumer demand.

C. ***Food Laws And Regulation***

Unlike in the developed countries, developing country fortification experiences have relied extensively on mandatory legislation as key to achieving sustainability of a food fortification program. Experience has shown that voluntary fortification in many developing countries has failed. Moreover, voluntary fortification of non-staple foods commonly initiated by the private industry does not reach the target population groups at risk for nutritional deficiencies.

Against the above background several developing countries have set in place and enforced mandatory fortification laws.

Legislation presupposes an effective monitoring and enforcement based on the partnership of relevant food industries and governmental agencies. In such a partnership, the government seeks improved public health, and the industry seeks protection against competition with unfortified products.

Barriers

Consumers

- Nutrition has Low Purchase Priority.
- Price sensitivity.
- No perceived need. *Hidden hunger.*
- Prevention and future benefits.

The most at risk choose the least expensive product.

Producers

- Little price or volume increase
- Competition and price pressure
- Low profit margins
- Low capacity utilization.

It is not the Cost, it is the Competition.

National Fortification Program- India

- Wheat flour fortification in Bihar and MP.
- All wheat processed through the RFMs in these two states will be fortified with iron and folic acid.
- Fortified flour will be sold through market channel and PDS.
- At scale the project is expected to reach 50 million persons.

Evidence from Completed Projects

Vehicle: ***Soya Sauce***

Fortificant: ***Iron***

Grant: ***US $3 million***

1. Effectiveness Trial (Chen, 2005)

   Data showed approximately a one third decrease in the prevalence of anemia for women of reproductive age and children 3-6 years old.

2. Similar trends reported by the Chinese CDC via their sentinel site monitoring system

Vehicle: ***Wheat Flour and Maize Meal***

Fortificants: ***Iron, vitamin A, zinc, thiamin, riboflavin, niacin, folic acid***

Grant: ***$2.8 Million***

1. Birth Defects Surveillance System
   - Established in 2002 in 12 public hospitals in 4 provinces.
   - Since 2002, 53,000 births/ year have been monitored.

2. Perinatal Mortality Surveillance System
   - Causes of death up to seven days of age are recorded through 164 sentinel health care facilities.

World Food Programme' Experiences

Ms. Rita Bhatia, Senior Regional Programme Advisor, The United Nations World Food Programme, Bangkok, Thailand

Worldwide, the three most common forms of MNM of public health concerns are iron, vitamin A and iodine deficiency. Together these affect at least one third of the world's population, the majority of whom are in developing countries. Of the three, iron deficiency is the most prevalent.

(1) It has been estimated that micronutrient deficiencies account for about 7% of the global burden of disease, with iron and vitamin A deficiency ranking among the 15 leading causes of the global disease burden.

(2) The scale and impact of deficiencies in other micronutrients is much more difficult to quantify, although it is likely that some forms of MNM, including zinc, folate and vitamin D deficiency, make a substantial contribution to the global burden of disease.

Strategies For The Control Of Micronutrient Malnutrition

The control of vitamin and mineral deficiencies is an essential part of the overall effort to fight hunger and under nutrition. Policy and program responses aimed at increasing the intake of micronutrients include dietary diversification, food fortification and supplementation.

Increasing The Diversity Of Foods Consumed: means increasing both the quantity and the range of micronutrient foods consumed. It is the preferred way of improving the nutrition of a population. This requires the implementation of programs that improve the availability and consumption of, and access to, different types of micronutrient rich foods in adequate quantities, especially among those who are at risk of or vulnerable to MNM. However, as a strategy for combating MNM, increasing dietary diversity is not without limitations, the main one being the need for behavior change and for education about how certain foods provide essential micronutrients and other nutritive substances.

Supplementation: It has the advantage of being capable of supplying an optimal amount of a specific nutrient or nutrients, in a highly absorbable form, and is often the fastest way to control deficiency in individuals or population groups.

Food Fortification In Practice

Food fortification has a long history of use in industrialized countries for the successful control of deficiencies of vitamin A and D, several B vitamins (thiamine, riboflavin and niacin), iodine and iron. Salt iodization was introduced in the early 1920's in both Switzerland (3) and the United States of America (U.S.A)(4) and has since expanded progressively all over the world to the extent that iodized salt is now used in most countries. From the early 1940's onwards, the fortification of cereal products with thiamine, riboflavin, iron and niacin became common practice. Margarine was fortified with vitamin A in Denmark and milk with vitamin D in the U.S.A. Foods for the young children were fortified with iron, a practice which has substantially reduced the risk of iron deficiency in this age group. In more recent years, folic acid fortification of wheat flour has become wide spread in the America's, a strategy adopted by Canada and the US and several other Latin American Countries, resulting in a steep decline in the incidence of neural tube defects. In the less industrialized countries, fortification has become an increasingly attractive option in recent years, so much so that planned programs have moved forward to the implementation phase more rapidly than previously thought possible.

In the Copenhagen Consensus 2008, a panel of economic experts were asked to address ten challenges areas to answer the question " What would be the best ways to advancing global welfare, and particularly the welfare of the developing countries" – Food fortification ranked second among all international development priorities and is viewed as highly cost effective.

Fortification of food with micronutrients is a valid technology for reducing micronutrient malnutrition as part of a food based approach when and where existing food supplies and limited access fail to provide adequate levels of the respective nutrients in the diet. In such cases, food fortification reinforces and supports ongoing nutrition improvement programs and should be regarded as part of broader, integrated approach to prevent MNM, thereby complementing other approaches to improve micronutrient status.

World Food Programme: Experience With Food Fortification

Given the magnitude of the problem, MNM is an area of importance for WFP. As a matter of policy WFP provides fortified foods in various programs. These are fortified blended foods, fortified cereals flour (maize and wheat) and oil. Currently WFP is undertaking efficacy trials on fortified rice in some Asian countries. The WFP also includes more nuanced and robust tools for different groups such as ready to use foods for children, fortified high energy biscuits and compressed bars, all of which are fortified. Multi Micronutrient powders are also used in many countries as an option for home fortification when households already have access to food but the food is deficient in micronutrients.

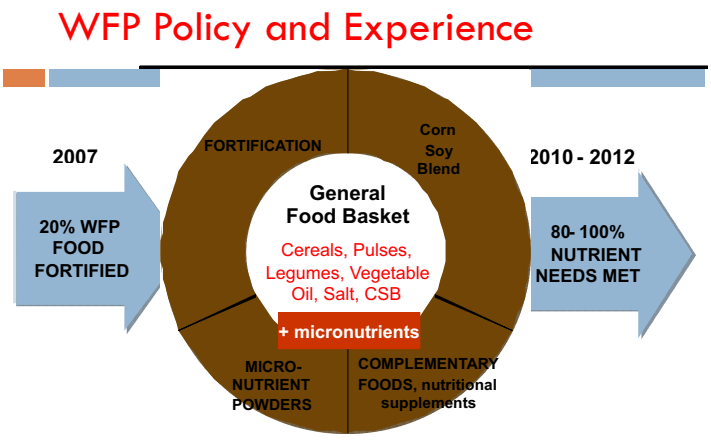
Important activities in local processing and fortification have taken place in Angola, Zambia, Bangladesh, India, Pakistan, Afghanistan, Nepal, Myanmar, Timor Lester and DPR Korea and in the context of the southern Africa regional drought emergency. Each case demonstrates that when micronutrient deficiencies are an operational concern, local fortification is possible but challenging. The challenges remain in terms of technical and management capacity constraint, the need for systematic compliance with specification and quality control and clear policies on micronutrient content labeling and packaging.

WFP is also encouraging local farmers to produce nutritious foods and through its progress for purchase initiatives supports the local farmers. Through its cash vouchers program, WFP is supporting program to enhance diet diversity to address MNP.

Additionally, the WFP based on its extensive experience/programmatic evidence in the use of fortificants both at the community level as well as the production level, also advocates with Governments for fortification policies. WFP has worldwide supported local production of fortified foods both at small scale and central level.

In conclusion, importance of fortification is increasingly apparent as evidence accumulates on the role of micronutrient deficiencies not only to address mortality and morbidity and malnutrition but also in national economic development potential. Food fortification along with other strategies will continue to be an important vehicle.

Figure 10: WFP Policy and Experience



Experiences With Food Fortification From Asia

Dr. Deepika Nayar Chaudhery, Deputy Regional Director, The Micronutrient Initiative, New Delhi, India

Food Fortification Programs

MI offers its knowledge and technology to add nutrients, such as iodine, iron and folic acid, to food cost effectively without affecting its quality or taste, helping to improve the quality of life of women and their children.

MI has been increasingly involved at the country level in revitalizing, or encouraging and facilitating the development of national Universal Salt Iodization strategies and is working on providing technical and operational support and creating tools specific for small scale processors to use to improve their own quality assurance and thus adhere to iodization standards. As a result of MI efforts, production capacity has been increased in several countries such that 1.3M MT of adequately iodized salt was produced over a calendar year and additional equipment was installed with a processing capacity of over 0.9M MT per year globally. MI has ongoing successful salt iodization programs in Bangladesh, India, Indonesia and Pakistan. In Bangladesh, India and Pakistan increases in 92,154 MT, 649,343MT and 355,253 MT of iodized salt were achieved during 2010, reaching 23, 89 and 162 million people, respectively.

Double fortified salt (DFS) is an innovative approach - delivering small but crucial amounts of iodine and iron to populations through their diet. In 1994, MI actively participated in an experiment to fortify iodized salt with iron and a technological breakthrough was achieved in 1998. After a series of field trials, efficacy tests and consumer acceptability surveys the viability of DFS was demonstrated and the premix technology is now available.

Another strategy to combat iron deficiency anemia among vulnerable populations especially women of child bearing age is the fortification of staple foods such as cereal flours with iron and folic acid. MI has been providing technical and financial support to Governments for wheat flour fortification (WFF). MI has active wheat flour fortification programs in India, Pakistan and Nepal. In India, MI hosts the secretariat for the India Flour Fortification Network (IFFN) in New Delhi, with the support of the Flour Fortification Initiative and the CDC Foundation. The network partners constitute flour miller associations, development partners such GAIN, UNICEF, WFP, WHO and academic institutions. The current focus of the network partners is to pilot introduction of wheat flour fortification in the public distribution systems in three wheat consuming states, namely Rajasthan, Madhya Pradesh and Bihar; training of mill owners and government officials on flour fortification and assisting in finalizing the flour fortification standards. The voluntary fortification of wheat flour at roller mills was launched by Nepal Flour Mills Association in 2008 with support from the MI. In 2010, MI continued its support by way of monitoring, supervision and quality assurance support. The Government of Nepal has decided to make the flour fortification at roller mills mandatory and the Government notice is expected by March 2011. In Pakistan approximately 67,000 MT of wheat flour fortified with iron and folic acid was produced during the year 2010 reaching a population of approximately 800,000 in earthquake affected areas of Khyber Pakhtoonkhwa and Azad Jammu and Kashmir.

Success Factors And Challenges

Developing and nurturing champions and leaders at the country level and within Governments, continuous investments in advocacy, and focused capacity building at all levels, a well developed "Behavior Change Communication (BCC)" strategy, developing monitoring and evaluation frameworks are factors that have made some these fortification programs successful.

The major challenges involving food fortification are; poor technical knowledge, lack of political commitment and funding support and an inappropriate BCC strategy. While food fortification has been recognized as one of the strategies to reduce micronutrient deficiencies and has contributed in bridging micronutrient gaps, its full potential is expected to be realized in years to come.

Global Experiences Of Food Fortification

Mr. Bruno Kistner, Director, Nutrition Improvement Program (NIP), DSM Nutritional Products, Switzerland

Several countries who have introduced mandated fortification laws have experienced that if done in the right way food fortification is the cheapest way to bring low cost food as close to a balanced diet as possible, or in the words of the World Bank *"there is probably no other technology available today that offers as large an opportunity to improve lives and accelerate development at such low cost and in such a short time".*

Following micronutrients can be added to food:

- Vitamin A- Important for eye sight and immune response, especially in small children.
- Vitamin D3- Important for bone health
- Vitamin E- Important for heart health.
- B-vitamins- Some are related to single disease prevention like pellagra or beriberi – a child can die from B1 deficiency for example but in general it can be said that he B vitamins regulate all the messaging in the body – so if they are absent all the electric signals do not work.
- Vitamin C- Important for immune response but also connected to bone health.
- Minerals, carotenoid and amino acids make food better digestible and enzymes which make the body take up minerals such as iron from the available food better which result in lesser requirements for iron for example.

A trial was conducted in Dandelion migrant workers in China. A multitude of food vehicles to deliver micronutrients as close to a balanced diet as possible were used. The newly developed fortified rice kernels was used to deliver B-vitamins, vitamin A, iron and zinc, soy sauce was fortified with iron and cooking oil was fortified with vitamin A. The trial showed good results. Results were presented by Chinese Centre for Disease Control (CDC). Results after children consumed fortified rice for 8 months showed that:

- Reduction in clinical deficiency by half.
- Reduction in vitamin B deficiencies.
- Reduction in vitamin A deficiency of 51%.
- Reduction in iron deficiency anemia of 82%.
- Reduction in zinc deficiency of 58%.

It was also it was shown, through scientific methods that the intervention caused:

- Increase in (classroom) concentration.
- Improvement in memory.
- Better grades.
- Faster reflex response.
- Superior athletic ability.

The results will be published in a scientific paper.

If food is brought as close to a balanced diet as possible it clearly shows the desired results. A trial in India with the St. Johns University showed exactly the same results: improved performance and behaviour for schoolchildren.

If a child is malnourished during the first 1000 days then it can never recover- mainly mentally. It is well-known that if people have to be brought

out of poverty, population growth is to be decreased then the first thing to do is to give them the mental capabilities to do so and that is via good nutrition – else the deadly spiral of growing population and the immense pressure on the world resources will continue.

All nutrients a person requires cost as little as US$ 0.40 per person per year – to fortify a ton of flour costs as little as US$ 3 and that with a balanced nutrient portfolio – this is almost nothing for a loaf of bread.

Policy makers cannot use science anymore as a reason for non-action – fortification with iron alone is non-action because it helps no one and is a waste of money – there is not one case globally where iron/folic acid fortification has improved public health – the term iron deficiency anaemia should be eliminated – it is wrong – it should be replaced with nutrition deficiency anaemia this is the correct term and gives no excuse for alibi fortification.

Vitamin A delivered in food is safe – even a pregnant woman where the upper safety intake level is the lowest could not stomach enough fortified food to get to that level unless she would swallow many supplements at the same time. Thousands of children who have so little vitamin A that they die or go blind. This is something completely avoidable in today's age.

During the discussions, the following points were made:

- Correcting micronutrient deficiency is important and then efforts should be made for maintenance level.
- In theory micronutrient fortification of foods is most successful intervention. However, to make it successful in practice it is necessary that government should invest in program. It is also imperative that effective monitoring and evaluation system are in place.
- Monitoring and evaluation indicate whether the program is going in the right direction and whether there is a need for increasing the amount of fortificants to be added.
- Fortification of food should be considered as complementary strategy with other nutrition programs.
- Baseline survey has been conducted in Gujarat for impact evaluation. It will be continued.
- World Food Program is supporting fortification of ICDS foods. An impact evaluation of the program by National Institute of Medical Statistics of Indian Council of Medical Research in Uttarakhand, Uttar Pradesh and Madhya Pradesh has shown that anemia level has reduced and Serum, retinol levels have improved in ICDS children. Similar study was undertaken in Uttarakhand on mid- day -meal program which showed improved serum retinol level.
- Impact of a fortification program can be seen in six months in general. However, change in anemia can be seen in one year.
- It should be noted that anemia is indicative not only of iron deficiency but many other nutrients are involved.
- FAO/ WHO recommendation on food fortification should be followed for addition of micronutrients.
- In the fortification program in Gujarat many challengers were faced .The milling capacity was only 50 thousand tons of wheat. People were encouraged to set up mills. The number of mills went up from 50 to 80 mills. Another challenge was to lift wheat from FCI, take it to mills, fortify them and take it to shopkeepers. End users should have minimum of 30 days of shelf life. Principle of "JIT" was applied. One person each was posted in mills for quality control. Controlling moisture was very important. PFA allows 14 % moisture. But in Gujarat it was reduced to 10 %. Lack of awareness, transportation issue, and storage issue were other challenges. Millers were given contracts through E - tendering.

- When supplementation is given to correct anemia initially children are given 25 mg daily and when its corrected then for prophylaxes 12.5 MG is given .Similar recommendations are required for fortification.

While summing up the discussions Mr. Panandiker mentioned the following points:

- There is consensus that food fortification works under certain conditions: Product must be with proven efficiency Vehicle choice must be consistent with consumptions pattern, Public / private partnership will give better result, and clear leadership is important from Government with Government being the catalyst.
- Fortification has succeeded in Gujarat only because of Government commitment.
- The ICDS and MDM programs are good avenues for delivering micronutrient.
- Development of food industry is very important.
- Monitoring and evaluation are necessary.
- Consumer is price sensitive and this should not act as barrier. In initial stages Government may give subsidy so that prices do not increase.
- Micronutrient food fortification program should be complementary program with other nutrition program.
- There should be micronutrient literacy or consumer awareness.

SESSION III: VEHICLES FOR FORTIFICATION, SINGLE VS. MULTIPLE FORTIFICATION, TECHNOLOGY & COST

Chair: Dr. A S Bawa Director, Defense Food Research Laboratory

Fortification Of Cereals, Rice, Oil And Sugar

Dr. Hector Cori, NIP Scientific & Technical Director, DSM Nutritional Products, Chile

Introduction

Food fortification is generally recognized as one of the most cost effective strategies to improve nutrition. Proper micronutrient intake can diminish child and maternal mortality dramatically, increase working capacity and increase a populations IQ by 10 to 15 points. An important amount of capacity and resources are being employed globally to implement and sustain programs that will alleviate the burden of malnutrition in developing nations. Proper fortification technology and quality of micronutrients and premixes have a critical influence on the outcome of programs.

Issues And Solutions

Staple foods are easy and economical to fortify, do not change due to fortification, require no changes in dietary habits and have proven to be an effective vehicle for micronutrients.

Cereal flours have been fortified since early in the 20th century through the simple addition of a micronutrient premix by means of a gravimetric feeder placed in the flour conveyor screw that will provide the necessary mixing.

Rice fortification offers a more difficult challenge, yet recent technological developments –by means of the extrusion of kernels identical to rice with a high concentration of micronutrients– have enabled rice to become an excellent fortification vehicle with no perceptible sensory changes.

Vegetable oils can be fortified with fat soluble vitamins by a simple addition by batch or through a volumetric pump, and minimal mixing.

Sugar fortification technology was developed and deployed in Central America –using oil to "glue" vitamin A beadlets to sugar crystals– averting blindness, child and maternal mortality and enhancing iron nutrition. Improvements in this technology have made it recently simpler and less demanding in infrastructure.

Fortification of staple foods is present worldwide today. Wheat flour is fortified in practically all countries in the Americas and is expanding rapidly in Asia and Africa. The same holds true in countries where maize is more abundant at the household. Rice fortification is mandated only in the Philippines and in Costa Rica, but several countries are considering or implementing rice fortification in a mandatory fashion.

The fortification of margarines began ever since a similar nutritional value to butter was intended when its consumption became more popular. Then vegetable oils have been fortified as part of food aid programs and as part of national fortification programs in Africa and South America. Sugar fortification is mandated in most Central American Countries, in Zambia, Nigeria and in the Philippines (not enforced in the last one).

Yet the true success indicator for the fortification of staple foods is the health outcome in the

targeted population. Lower anemia rates, higher serum micronutrient levels, increasing population IQs or reduced need for medical treatment are true measures of a successful fortification program, as opposed to coverage, tons of food that are fortified, or any other surrogate indicator such as the number of countries with fortification in place.

The success or effectiveness of food fortification programs depend on many quality components. From the design point of view the palette of micronutrients considered is critical, since micronutrient deficiencies do not occur in isolation and the metabolism of some critical nutrients is dependent on the adequacy of others. For example, proper iron nutrition depends on adequate intake of vitamins A, E, B2, Folate, B12, C, and B6. Thus, eliminating iron deficiency anemia is not only a matter of adding iron to the food chain, sufficiency in the other mentioned micronutrients will maximize chances for success in improving iron nutrition.

The quality of micronutrient forms and premixes will have a critical influence on how much of these will actually reach the population in need and how bioavailable they will be to exert their intended biological effect. In order to have the exact intended amount of micronutrients in every portion of food, a homogeneous premix is needed and this is achieved using the right equipment with standardized operation procedures. Plant quality will guarantee hygiene and overall quality, ingredients designed for the specific purpose they are used on guarantee stability and homogeneity, quality is preserved through optimal packaging and storage and guaranteed through quality control, quality certificates and external audits, certifications and standards.

Some fortification programs implemented in the developing world have shown little impact in expected outcomes such as iron deficiency anemia and serum micronutrient levels. Concomitantly, the analysis of several micronutrient premixes employed for the fortification of staple foods show unsatisfactory results in terms of micronutrient content, stability and composition details that influence the earlier mentioned parameters, as well as the bioavailability of the micronutrient in the fortified food.

This implies that poorly fortified foods with unstable, heterogeneous and non-bioavailable micronutrients are not making any contribution to public health nutrition, yet they are consuming resources and discrediting food fortification as a nutrition improvement strategy.

A lack of regulations and standards that guarantee the use of stable, traceable, compatible, bioavailable and safe ingredients, as well as hygienic, efficient and certified mixing facilities is evident. Even though international guidelines on the quality of food fortification premixes exist, these are not adopted at a country level nor are they incorporated in regulations that will protect public health.

Conclusions

The fortification of staple foods is simple, effective and economical, yet micronutrient quality and variety is a critical driver for the effectiveness of nutrition improvement programs. The maximization of quality will maximize the chances for better nutrition, health and quality of life for millions of people in need. The implementation of fortification of basic foods and a global dialogue on micronutrient quality, international standards, and quality assurance and certification systems are urgently needed for public health improvement.

Figures on next page

Figure 11: Vitamin A Fortification of Sugar improves Serum Iron in Preschool Children (Guatemala)

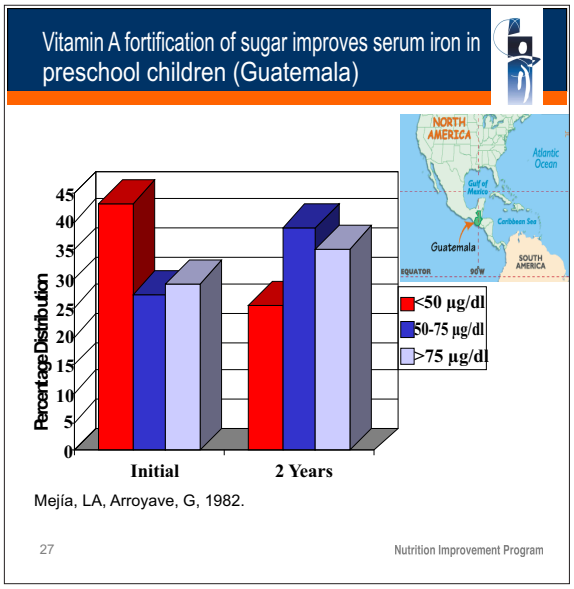


Figure 12: Fortificants' Cost

How much do fortificants cost?

Nutrient	Male RDA		Cost/RDA
Vit. A (250 CWS)	3000 IU	$	0.00079
Vit. D (100 CWS)	200 IU	$	0.00011
Vit. E (50% CWS)	22.35 IU	$	0.00250
Thiamin	1.2 mg	$	0.00004
Riboflavin	1.3 mg	$	0.00005
Pyridoxine	1.3 mg	$	0.00005
Niacin	16 mg	$	0.00026
Folic Acid	400 µg	$	0.00008
Vitamin B12	2.4 µg	$	0.00010
Vitamin C	90 mg	$	0.00257
Fe ($FeSO_4 \times 1H_2O$)	8 mg	$	0.00008
Total		**$**	**0.00662**

Figure 13: Estimated Fortificant Costs to Reach Nutritional Goals through Food Fortification

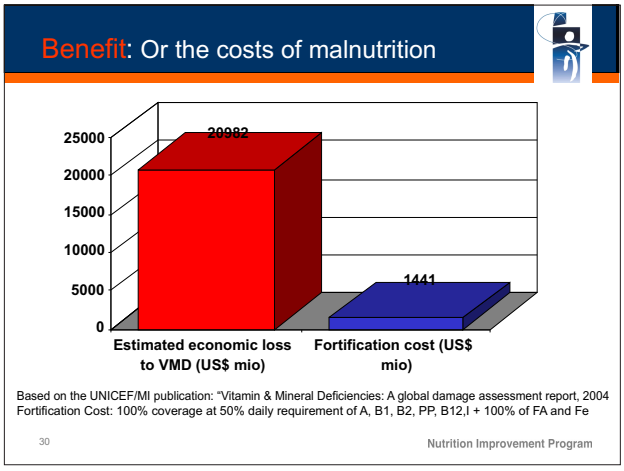
Estimated Fortificant Costs to Reach Nutritional Goals Through Food Fortification

Micronutrients	Vehicle	Women EAR (mg/day)	Nutritional Goal (% EAR)	Cost per person [1] (US$/year)
Calcium	Solid-Food	833.333	60	0.584
Iron-NaFeEDTA	Flour	13.243	80	0.193
Vitamin E	Dry Food	6.250	60	0.162
Vit. C	Beverage	34.615	40	0.142
Vit. A	Flour or sugar	0.357	80	0.087
Iron-electrolytic	Flour	40.524	80	0.045
Vit. A	Oil	0.357	80	0.031
Vitamin D	Dry Food	0.005	80	0.028
Vit. B-3 (Niacin)	Flour	10.769	40	0.021
Zinc	Flour	8.167	80	0.020
Vit. B-12	Flour	0.001	80	0.014
Vit. B-9 (Folate)	Flour	0.188	80	0.015
Vit. B-2	Flour	0.917	60	0.009
Vit. B-6	Flour	1.083	40	0.008
Vit. B-1	Flour	0.917	40	0.005
Iodine	Salt	0.107	100	0.002

1: Includes processing and storage overages.

Source: Modified from Omar Dary A2Z - 18 Sept. 2007

Figure 14: Benefit Or Costs of Malnutrition



Fortification Of Dairy Products

Dr. A.K. Srivastava, Director & Vice-Chancellor, National Dairy Research Institute, Karnal, India

Widespread malnutrition among children and women is a serious threat to the growing economy. In India, approximately 47% children are malnourished that results in 22% of country's disease burden and 50% of 2.3 million child mortality annually. The major reason of malnutrition is lack of diversity in diet which often leads to deficiencies in micronutrients such as iron, calcium iodine and vitamins. Fortification of staple foods could be one of the most effective strategies to tackle the problem among the population. Fortification ensures a safest method by which manufacturers can deliver health promoting, nutritionally dense food products. The risks associated with fortification are minimal except if good manufacturing practices are not practiced.

Milk in its natural form is considered as a balanced source of man's dietary need. Minor bioactive components present in milk and milk products such as lactoferrin and certain peptides enhance the bioavailability of micronutrients. Milk and other dairy products are a part of the daily diet in almost all countries. However, various unit operations during processing and storage have a measurable impact on certain specific nutrients. Milk and milk products also offer a convenient and useful medium for addition of certain nutrients to deliver in the diet.

There are certain inherent advantages associated with fortification of milk and milk products such as they are widely consumed regularly in predictable amount by people of all ages and available at affordable cost. Moreover it is centrally processed hence quality control can be effectively implemented and regulated. Diet-related micronutrient deficiencies rarely occur in isolation; deficiencies of iodine and vitamin A or of iron and vitamin A or zinc are often reported in the same populations. In addition, widespread deficiencies of some micronutrients, for example, calcium and zinc, may often go undiagnosed because of the lack of specific and sensitive status indicators. Multiple micronutrient supplementations can be more effective in improving nutritional status than supplementation with single key micronutrients; therefore, the multiple fortifications of appropriate food vectors, including milk is of interest from the nutritional standpoint.

The technology of milk fortification is relatively simple and mineral/vitamin fortification can be practiced at several stages in the production. But liquid milk is usually fortified prior to pasteurization or ultra-heat treatment. As per the requirement of processing unit fortification process can be made as batch or continuous. Water soluble minerals and vitamins are generally added in powdered form while fat soluble vitamins are delivered in the form of emulsion or liquid pre-mix. However, many technological problems may occur upon addition of minerals to milk and milk products due to the interaction of minerals with other milk constituents. These problems may be reflected in changes in texture, color, sedimentation, flavor and/or the functional properties of the product.

Selection of an appropriate mineral fortificant is based on its organoleptic considerations, bioavailability, cost and safety. Addition of calcium cause decrease in thermal stability of milk and affect the starter culture activity in fermented milks. Iron compounds lead to the oxidation of milk fat resulting in development of off-flavor and discoloration. Organic salts of calcium were found more suitable for fortification of milk because of their higher bio-availability and better organolpetic quality. Milk and milk products can also be fortified with a range of other mineral salts such as Mg, P, Zn, Cu and Mn. Prudent selection of mineral compounds is based largely on consideration of mineral reactivity and solubility

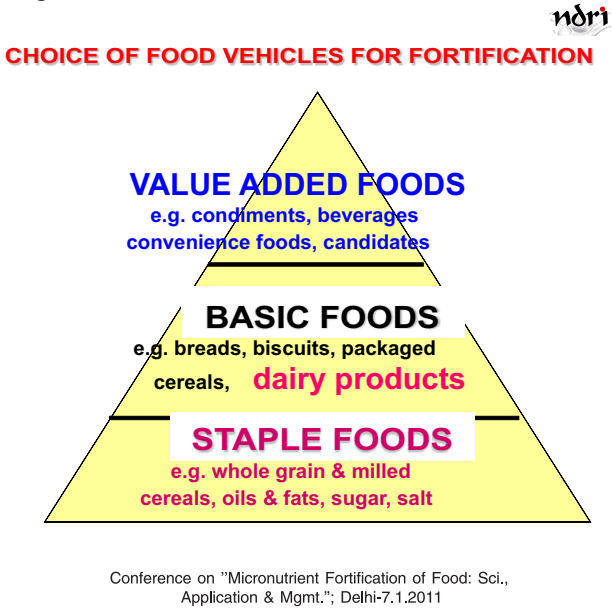
of the salt. To overcome problems of flavor, texture and color deterioration due to addition of minerals, certain commercial designer fortificant preparations have been developed, which generally involve the use of stabilizers and emulsifiers to maintain the mineral in solution.

Fortification of liquid milk with vitamin A and D is mandatory in certain countries. The limited stability of vitamins in presence of heat, humidity and oxygen is the major obstacle. Among the water soluble vitamins, vitamin C, folic acid, vitamin B_6 and vitamin B_{12} are the less stable, while among the fat soluble vitamins vitamin A, D and E are least stable. In order to improve the stability of these vitamins microencapsulation with suitable coating material has been attempted by certain researchers, however it needs refinement for commercialization. Fortification of processed dairy foods like cheese, butter, ice cream, is quite challenging task as many unit operations involved in their manufacture have detrimental effect on added vitamins.

Micronutrient supplementation of infant formulae has also been recommended by most national and international agencies. UHT milk, milk beverages, weaning foods and dried skim milk can also serve as a promising vehicle for fortification both technologically and nutritionally. Use of vitamin producing microbial strains for the bio-fortification of fermented dairy products could be an attractive option. High folate producing *Streptococcus thermophilus* strains have been successfully employed for the production of folate-rich dahi. The folate content of *dahi* increased to 70 ppb level from the initial level of 24 ppb. Similarly vitamin B_{12} producing *Propinibacterium freudenerichii* was utilized to develop enriched yoghurt.

Any fortification technique should be based on certain important criterion like bioavailability, nutrient-nutrient interaction; nutrient-food component interaction, effect on shelf-life, adoption of appropriate processing technology, packaging material; cost of fortification and finally the safety of added nutrient. Analysis of potency of fortificants constitutes an important component of the overall analytical requirements in quality assurance programs for fortification processes.

Figure 15: Choice of Food Vehicles for Fortification



Conference on "Micronutrient Fortification of Food: Sci., Application & Mgmt."; Delhi-7.1.2011

Figure 16: Recent Work on Fortification of Milk and its Products with Micronutrients

Recent Work on Fortification of Milk and its Products with Micronutrients

Product	Micronutrient	Reference (s)
Liquid Milk	Folic acid	Verwei *et al., 2003*
	Calcium	Vyas and Tong, 2004; Arora *et al.*,2007
	Iron	Allen *et al.*, 2006; Kwak*et al.*, 2003; Xu and Xia 2005
	Iron and Zinc	Villalpando*et al.*, 2006
Infant Formula	Iron	Bermejo*et al.*, 2004
Powdered Milk	Calcium	Williams*et al.*,2005
	Iron, Ascorbic acid, Zinc & Copper	Torrejo'n*et al.*, 2004
Dahi	Calcium	Arora *et al.*,2007
Ice-cream	Calcium	Costa*et al.*, 2008
Cheese	Calcium	Mora-Guiterrez*et al.*, 2005
	Vitamin D	Mistry*et al.*, 2002

Conference on "Micronutrient Fortificatgion of Food: Sci., Application & Mgmt."; Delhi-7.1.2011

Fortification Of Bakery Products

Dr. K. Madhavan Nair, Scientist E, Micronutrient Research, Department Of Biophysics, National Institute Of Nutrition, Indian Council Of Medical Research, Hyderabad, India

There is quantitative increase in the presence of baked products claiming micronutrient fortification. With changing food consumption patterns and increasing dependence on ready to eat foods, at least in urban areas, this holds much potential for improving micronutrient intake of the population. In most cases such fortification is industry driven and poorly planned thus unable to achieve nutritional goal. Bakery products like bread, cookies, biscuits, crackers etc are increasingly being fortified with micronutrients calcium, iron, vitamin D, and folic acid. However the purpose is not always achieved due to poor product acceptance or ineffective fortification. Fortification of bakery product faces several challenges at production level as well as utilization level. There is a need for proper technical planning for fortifying bakery products.

Using bakery products as vehicle for fortification has several merits and demerits. Mass fortification using bakery products may not be a feasible idea in country like India where baked products are not consumed by large proportion of population and they are not consumed on a regular basis, inadequate and consistent amounts. But it can be good vehicle for targeting special population groups because of several advantages such as:

- Easy reach to specific target group, for example children and adolescents.
- They can be centrally processed.
- Allow a nutrient premix to be added relatively easily using low cost technology, and in such a way so as to ensure an even distribution within batches of the product.
- Are used relatively soon after production and purchase, thus having better vitamin retention and lesser sensory changes due to the need for only a small overage.

Figure 17: Role of Micronutrients

Role of Micronutrients

Hematopoiesis	Iron, vitamin B12, folic acid, vitamin A, vitamin E, vitamin C, riboflavin, Pantothenic acid, vitamin B6, zinc,	Nutrients like Vitamin C and A enhance dietary iron absorption.
Bone Health	Zinc, Vitamin D, boron, Cu	calcium absorption. Zinc, iron , boron, copper helps certain enzymes
Immune Functions	vitamin A , vitamin E , vitamin B6, vitamin C, Zn.	functioning of immune cells. particularly T helper cell
Cognitive Functions	Iron, zinc, vitamin E, C and B and Omega-3 fatty acids Like DHA	neurotransmitter, synaptic transmission, membrane fluidity and signal transduction, protect membranes from lipid peroxidation and affect synaptic plasticity.
Cardiovascular Health	Vitamins B6, B12, folic acid	Folic acid , Vitamins B6 and B12 reduce homocysteine levels
Insulin Action	Chromium , zinc, vitamin C and E.	required for the synthesis of chromodulin, a molecule that also potentiates the action of insulin .Antioxidant vitamins C and E diminish protein glycoxidations.

Bakery Fortification As Target Fortification Or Market Driven Fortification

Target Fortification: In targeted fortification, foods aimed at specific subgroups of the population are fortified, thereby increasing the intake of that particular group rather than that of the population as whole. Examples: Baked foods like biscuits, pretzels can be used in school feeding programs to target children; fortified bread can be used for displaced people (refugees).

Market Driven Fortification: Food manufacturers add micronutrients to their products not just to

increase their nutritional value but also to increase their appeal to the health conscious consumer. This business oriented initiative has potential to play positive role in public health by improving micronutrient intake. Until recently the public health impact of fortification of market driven processed foods has been very modest in developing countries but this impact is expected to profound in near future, largely as a natural consequence of increasing urbanization and availability of such foods.

Setting Limit of Fortification : It is important to set limit of fortification such as it is high enough to exhibit nutritional benefits but low enough to ensure safe consumption. Therefore it is prudent to collect information regarding prevalence of deficiency in the target population and consumption pattern of the chosen baked product by this group. Based on this information, the reduction in prevalence of inadequate intake (the proportion below EAR) and the risk of excessive intakes (the proportion above UL) that would be expected at different levels of fortification should be calculated. Having determined the level of nutrient, determine bioavailability in baked product from the selected fortificant. Other factors to consider when deciding fortification level are:

Safety limits: The safety of fortification can be assessed by comparing predicted (higher) micronutrient intakes with the UL. Care should be taken to consider intake from all sources, especially other fortified products. In case of absence of UL, level of addition should be kept logical, especially if there is no evidence of derived benefits from intakes in excess of RDA.

Technological limits: The fortification limit should be selected such that it causes no adverse organoleptic changes in the food vehicle as well as no inhibitory associations in case of multiple fortifications.

Cost limits: Fortification should not result in high proportionate increase in product cost. Cost should be acceptable to producers as well as consumers so as not to make it a constraint.

Setting Level of Fortification for Targeted Fortification:

In case of targeted fortification, level of fortification can be set at higher level, as the product is usually in final form and serving sizes are pre-defined. Also price of the product is usually not borne by the beneficiary but by the financial supporters of the program and so compliance is not cost dependent.

Setting Level of Fortification for Market Driven Fortification:

Market driven baked foods are usually marketed to all family members and the serving size is common for all. This may lead to unnecessarily large amounts of micronutrients (MN) being delivered to children. Market driven fortification has to be therefore, planned carefully. Based on the serving size and number of servings of the product that are consumed the limit of fortification can be set as given below:

Maximum micronutrient content per serving size = [UL - (amount of MN in diet + amount of MN provided by fortified foods as part of an ongoing mass fortification program)] ¸ Number of servings

Fortifying bakery products faces several technical challenges with respect to the baked product (vehicle) as well as fortification.

Challenges

Premix Stage: The challenge in blending ingredients with different particle sizes is that bulk density and variable particle sizes can lead to segregation. For fat soluble nutrient like vitamin D, it is necessary to have some fat and/or hydrocolloids to suspend it properly into a finished product's matrix

Baking Process: Several fortificants like calcium pose rising challenges in products like bread and muffins by disrupting bubble formation stage.

Product Quality: Incorporating fortificant may lead to alteration in taste, texture, shelf life and thus over all product acceptability.

Fortificant

Processing losses: Though mineral salts are relatively stable to heat treatments, vitamins are heat labile. According to a recent study heat degradation of folic acid during baking is between 21.9 % and 32.1 %. Baking temperatures may create issues with some heat-labile vitamins. Percentage loss of different vitamins during processing and storage may be significant, especially for vitamins C, A, folic acid, and niacin. Addition of antioxidants may minimize destruction. Other options to increase availability are encapsulation or adding heat-sensitive ingredients at a lower temperature point, such as in a coating or by spraying on top.

Bioavailability: Bioavailability means the percent of added nutrient that is available for utilization. It is important to ensure the overall quality of the product in terms of the bioavailability of the fortifying agent. Bioavailability, typically in mineral salts, is related to the solubility of the fortifying agent. In general, as solubility of the compound increases, the nutrient is more bioavailable, but at the same time is more reactive with the fortified food, making it less stable and susceptible to changes.

Factors Affecting Bioavailability

Role Of Processing: In the process of bread making phytic acid decreases due to action of phytases in the dough. Reduction in phytic acid content in different bread types varies between 13-100%, with the lowest decrease being in unleavened bread. Processing of foods rich in protein and carbohydrates and/or fat favors the development of Maillard reaction and the formation of browning products, which can improve food palatability. The final products of the reaction are high molecular weight colored compounds, melanoidins. These melanoidins have ability to complex iron. Maillard reaction products from model system have also been shown to possess iron chelating properties.

Inhibitory Ligands: Apart from phytates present in bakery flour, certain other ingredients used in bakery products such as vanilla and chocolate may be inhibitory to mineral absorption .Vanilla extracts contain appreciable amounts of iron binding polyphenols thus it may be a potential inhibitor. Chocolate contains alkaloids such as theobromine and phenethylamine .Binding of theobromine onto transferrin could probably inhibit or block the receptor site for iron

Innovations To Overcome Challenges

Microencapsulation: A microencapsulation separates a mineral salt from its environment. Single particles are covered with a protective layer of hydrogenated vegetable fat or crystals are agglomerated and covered with cellulose or other suitable coatings.

Advantages of microencapsulated mineral salts

- Prevention of interactions with content substances of the foodstuff matrix.
- Avoidance of discoloring.
- masking of taste and smells
- Controlled release of the mineral compound.
- Protection against the influences of moisture.
- Protection during production.
- Improvement of the physical product properties.
- To improve nutrient availability

Beadlet Technology: For vitamins highly susceptible to oxidation this technology cross-links the vitamin inside a gelatin-based matrix, protecting it from oxidation.

Newer Fortificants To Combat Inhibitors-Sodium Iron Chlorophyllin: The use of heme

analogues from vegetable origin could provide an alternative iron source of potentially high bioavailability. Sodium iron chlorophyllin is a water-soluble semisynthetic chlorophyll derivative where the magnesium in the porphyrin ring has been substituted by iron. Miret et al, 2010 demonstrated that sodium iron chlorophyllin is stable under simulated gastrointestinal conditions and is able to deliver bioavailable iron to enterocyte cell line such as Caco-2 cells.

Improved Absorption Promoters -Ascorbyl Palmitate: One of the recommended strategies to improve the bioavailability of iron is to add an absorption promoter such as ascorbic acid (AA). However, because AA is thermolabile, it is destroyed during the process of baking. In contrast, ascorbyl palmitate (AP), a synthetic ester composed of palmitic acid and L-ascorbic acid, is thermostable, and its reductive and vitamin properties are maintained even when exposed to baking temperatures.

Conclusions

There is scope for bakery products as a means of providing micronutrients to the target population. Hidden hunger caused by deficiency of micronutrients like iron, zinc, vitamin B12 folic acid can be reduced at village level by taking advantage of their food habits, resources and the new technologies. The challenge is to create evidence for the implementation of such new initiative which are cost effective and complement the existing strategies in the region.

The following points were made during discussions:

- Quality Assurance Program is required at consumer level to ensure that there are minimum losses of micronutrients during storage.
- Strict quality control system and surveillance system are required to provide desired amount of micronutrient to consumers. The type of vitamins will determine the fortification level. For example, in Guatemala for sugar fortification, the level of vitamins required at mill level is different from the market level and at consumer level. Most vitamins which are adequately compounded can be used with no major problems on stability.
- Food fortification is not clinical nutrition. Regulations have to account for high variability which is also found in natural products for example, micronutrients in potatoes will be different when harvested as compared to micronutrients at later stage. Programs could be designed for target population in mind but it should have generous variability which is technically attainable and sustainable.
- Milk is an important vehicle for fortification. However, the food laws do not allow for fortification of milk as when milk is fortified, it is called beverage/ drink. Food laws need to be changed to encourage industry to fortify. This issue should be taken up by National Dairy Research Institute.
- Upper limit (UL) for fortification is different realm than RDA. RDA is meant to determine requirements whereas upper limit is determined for safety through risk assessment. In case UL is not available, highest observed intake (HOI) which is safe should be considered. Ii will be wrong to consider one RDA as the upper limit. Safety limits could be 2-3 times more than RDA. The issue requires further discussions.

Dr. A.S. Bawa summed up the discussions and stressed that selection of vehicles is very important with respect to target groups, its affordability, accessibility, technological know-how, availability and distribution system.

SESSION IV-A: OPTIONS FOR DELIVERING FORTIFIED PRODUCTS TO PUBLIC

Chair: Dr. Omar Dary Food Fortification Specialist,
Academy for Educational Development (AED)

Options For Delivering Fortified Products To Public

Dr. Manfred Eggersdorfer, Senior Vice President, DSM Nutritional Products, Head, Nutrition Science & Advocacy, Basel, Switzerland

Sufficient intake of vitamins and minerals is essential to achieve maximum health benefit. However, it is well established that in many countries and regions of the world billions of people still suffer from insufficient intake of micronutrients or even on deficiencies. Insufficient intake of essential micronutrients (vitamins and minerals) by individuals or populations has a negative impact on health, cognition, function, survival, and economic development. Mandatory or voluntary fortification of foods offers a large opportunity to improve lives and accelerate development at such low cost and in a short time.

Addition of one or more essential nutrients to a food whether or not it is normally contained in the food, **for the purpose of preventing or correcting a demonstrated deficiency** of one or more nutrients in the population or specific population groups. Any fortification program should be based on a demonstrated need for increasing the intake of an essential nutrient in one or more population groups, e.g.:

- Clinical or subclinical evidence of deficiency.
- Estimates indicating low levels of intake of nutrients or.
- Possible deficiencies likely to develop because of changes taking place in food habits.

Conventional Fortification

- Staple foods (flour, sugar, milk, oil, rice).
- Dairy (milk, yoghurt).
- Spreads (margarine).
- Condiments (salt).

Home Fortification

- Crushable/soluble tablets
- Powder.
- Spreads.

Bio-fortification

- Agricultural products (rice, maize, sweet potato,…).

Nutririce®: Nutririce is made of natural rice with micro-encapsulated vitamins in reconstituted rice kernels via extrusion. It

- Looks, tastes and cooks exactly like ordinary rice.
- Fortified kernels deliver the added micronutrients to the consumer.
- Kernels can be customized in shape, color and micronutrient composition.

Nutrients

- Vitamin A (Retinyl- palmitate)
- Vitamin B1 (Thiamine chloride HCl)
- Vitamin B2 (Riboflavin)
- Vitamin B12 (Cyanocobalamine)
- Niacin
- Iron

  … And others

- **Mass/Universal Fortification**
  Wide consumption by general population; often mandatory.

- **Targeted Fortification**
  Consumption by specific population subgroup, e.g. for children or displaced populations; mandatory or voluntary depending on public health problem.

- **Market-driven Fortification**
  Food manufacturers voluntarily fortify foods; always voluntary, but governed by regulatory limits.

Summary and Outlook

- Faster and more sustainable progress is needed to overcome Hidden Hunger and to achieve Millennium Development Goals (MDGs) by 2015.
- Food Fortification can be the most sustainable and cost-effective option to enhance micronutrient consumption in a population.
- Technologies for mandatory and voluntary food fortification are available.
- A joint approach by policy makers, regulatory bodies, nutrition scientists and private companies is required.

Conventional Fortification Has A Strong Track Record

- There is long history in industrialized countries for successful control of deficiencies of:
- Vitamins A and D.
- Several B vitamins (thiamine, riboflavin and niacin)
- Iodine.
- Iron.
- Salt iodization was introduced in early 1920s in both Switzerland and USA and is now available in most countries.
- From early 1940s, fortification of cereal products with thiamine, riboflavin and niacin became common practice.
- Margarine is fortified with vitamin A in Denmark.
- Milk is fortified with vitamin D in USA.
- Foods for young children are fortified with iron and this has substantially reduced risk of iron-deficiency anemia in this age group
- Folic acid fortification of wheat is adopted by Canada, USA and Latin America.
- In the less industrialized countries, fortification is an increasingly attractive option. Fortification of sugar with vitamin A in Central America reduced vitamin A deficiency considerably. Similar initiative has been taken in sub-Saharan Africa.

A Number of Technical and Societal Pre-Requisites have to be Fulfilled for Successful Bio-fortification

- Increased micronutrient content of food staples through plant breeding (GM and non-GM).
- Growing bio-fortified plants must be a financially attractive for the farmer compared to traditional plants.
- Consumption of bio-fortified foods has to result in measurable and significant improvement of nutritional status.
- Bioavailability of extra micronutrients bred into the food staples has to be established.
- Bio-fortified crops have to be culturally and sensory acceptable to target population.
- Poor malnourished people have to eat bio-fortified foods in sufficient quantities.

Both, Mandatory and Voluntary Fortification Require Regulatory Guidance

- There is diversity in national public health goals with different approaches to regulation of food fortification.
- In most industrialized countries, food fortification parameters are established by law.
- At other end of spectrum, fortified foods are produced without any form of governmental guidance or control at all.
- Generally it is recommended that all forms of food fortification are appropriately regulated to ensure safety and health benefit to target groups.

By providing a higher level of certainty, mandatory fortification is more likely to deliver a sustained source of fortified food for the relevant population group and, in turn, a public health benefit

Summary and Outlook

- Faster and more sustainable progress is needed to overcome hidden hunger and to achieve MDGs by 2015.
- Food fortification can be the most sustainable and cost-effective option to enhance micronutrient consumption in a population.
- Technologies for mandatory and voluntary food fortification are available.
- A joint approach by policy makers, regulatory bodies, nutrition scientists and private companies is required.

Figure 18: Need for Fortification- Worldwide 2 Billion People Affected by Hidden Hunger

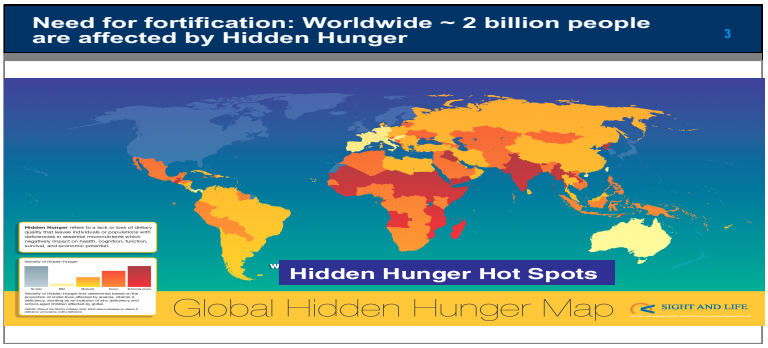


Figure 19: Impact of Hidden Hunger

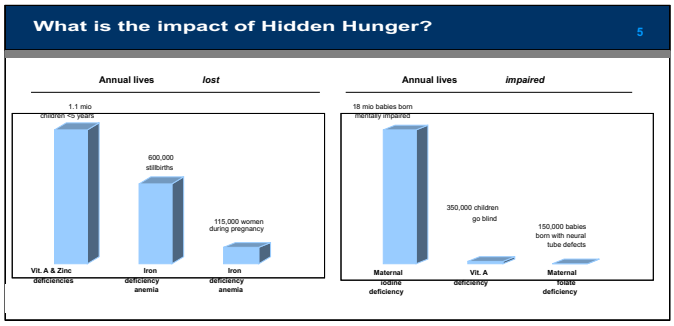


Figure 20: Micronutrients (vitamins and minerals) Essential for Many Functions and Health

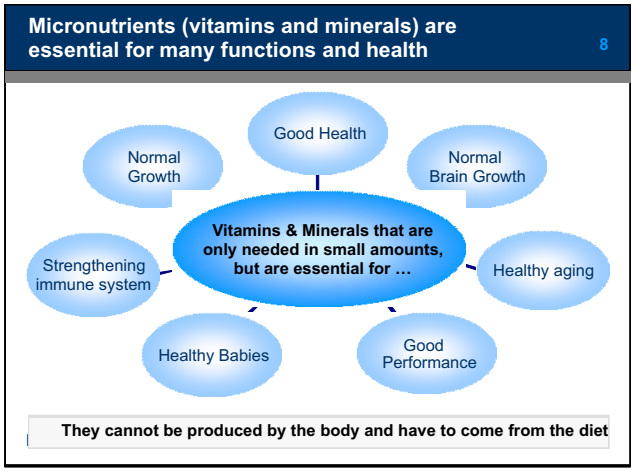


Figure 21: Three Types of Food Fortification

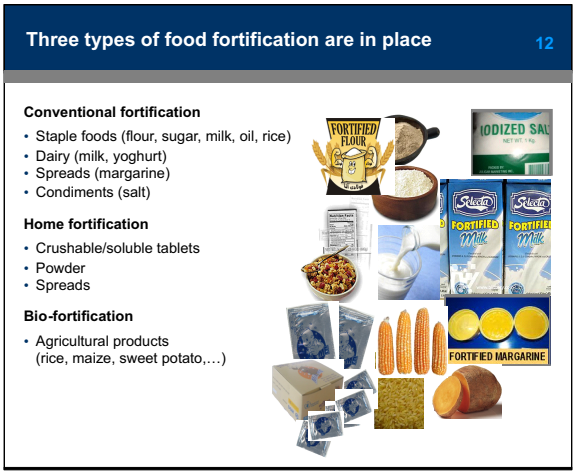


Figure 22: Successful Track Record of Food Fortification in Several Countries

Food fortification has a successful track record an many countries

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Long history in many countries for successful control of deficiencies of vitamins A, D, several B vitamins, iodine and iron.

1923: **Mandatory iodization of salt in Switzerland and USA** ; now available in most countries.

1933: **Mandatory fortification of flour with** Vitamin B1 **in Canada** and virtual elimination of Beriberi.

1941: **Mandatory fortification of flour with** Vitamin B3 **in the USA** and virtual elimination of pellagra

early 40ies: **Fortification of cereal products** with Vitamin B1, B2 and B3 became common practice **in many countries.**

1954: **Flour fortified in Chile with** B-vitamins and iron. Country has now very low prevalence for anaemia.

1974: **Beginning of sugar fortification with** Vitamin A **in Guatemala** . Vitamin deficiency diminished to one third.

1992: **Wheat and maize flour fortification in Venezuela** . Vitamin A sufficiency in general population and important reduction in anemia in children.

1998: Folic Acid **fortification mandated in the USA** . Now implemented in 60 countries.

2000: Vitamin D **fortification of milk and dairy products in US and Canada started**

Figure 24: Criteria Governing the Selection of Mandatory or Voluntary Fortification

Criteria governing the selection of mandatory or voluntary fortification

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Six key factors determine whether mandatory or voluntary fortification is the most appropriate option

Factor	Mandatory	Voluntary
Public health risk	Higher / more affected	Lower / fewer affected
Food industry	Centralized, well organized	Smaller, more diverse
Consumer awareness/ demand	Not necessary	Essential
Political environment (choice)	Not necessary	Essential
Food consumption patterns	Fortified food widely consumed	Variety and accessibility essential
Fortification approach	Mass/universal	Market -driven

Proactive communication and advocacy on role of fortification is a joint task of policy makers, regulatory bodies, food industry and nutrition scientists

Figure 26: Different Dynamics and Solutions from Three Market Channels

Three market channels offer different dynamics and solutions

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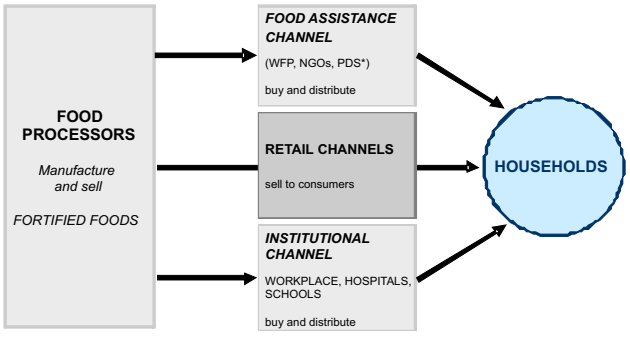

PDS: Public Distribution System, in India = Integrated Childhood Development Service (ICDS) delivered in Anganwadi Centers

Figure 27: Fortification Costs Low Relative to Achievable Benefits

Costs for fortification are low relative to achievable benefit

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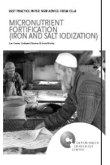
Table 1. Orders of magnitude for fortification costs with different vehicles/different methods

Type of fortification	Estimated cost /person/year	Approximate potential % population covered
Salt iodization, large producers	$0.05	70%
Salt iodization, small plants	$0.10	Up to 80% (S Asia, SE Asia) Up to 90% (SS Africa)
Double-fortified salt	$0.20-0.25	Up to 70%*
Wheat/maize flour fortification (with ferrous fumarate or sulphate in roller mills)	$0.12	20% (India); 50% (Pakistan) 80-90% (mid-East, N Africa) 10-50% (Sub-Saharan Africa)
Soy or fish sauce (with NaFeEDTA)	$0.18	Possibly up to 70% in Southeast Asia and China
Rice (using synthetic grains)	$0.53	Not known (only pilot tests)
Sprinkles (home fortification)	$0.90 plus distribution	Not known (early phases)

*Double-fortified salt would likely only be used instead of iodized salt, if no suitable local alternative for iron fortification were available.



PDS- Role In Food Fortification

Dr. Prakash V. Kotecha, Country Representative, Academy for Education Development, New Delhi, India

Public Distribution System (PDS)

PDS means distribution of essential commodities to a large number of people through a network of fair price shops on a recurring basis. The commodities are as follows: wheat, rice, sugar and kerosene. When started in 1960s PDS covered the entire population. In 1992 when it was tried for tribal blocks of far and difficult areas to improve the reach. In 1997 it was made targeted to poor people only (TPDS). It is State Government's responsibility to identify poor and ensure that they get the benefit. When started it aimed for 6 crore (60 million) people with 72 lakh tones of grains.

With a network of large number of fair price shops (FPS), PDS is perhaps the largest distribution network of its type in the world. It is operated under the joint responsibility of the Central Government and the State Governments. The Central Government is responsible for procurement, storage, transportation and bulk allocation of food grains. The State Governments are responsible for distributing the products to the consumers through the network of FPSs. They also have the operational responsibilities including allocation within the State, identification of families below poverty line, issue of ration cards, supervising and monitoring the functioning of FPSs.

Antyodaya Anna Yojana (AAY) was launched in December, 2000 to make TPDS more focused and targeted for poorest of the poor families. It initially covered one crore families and was extended to 2.5 crore people in 2009. The scheme provides food grains at a highly subsidized rate of Rs.2/ per kg for wheat and Rs. 3/ per kg for rice.

Role of PDS in Fortification

PDS is a good system to supply fortified atta in place of grains to reach poor. It is most practical to fortify wheat flour with iron, folic acid, vitamin A, (iodine), in that priority. Rice fortification and sugar fortification are also promising

Flour Fortification Success Story

- One state (Tamil Nadu) with mandatory fortification
- The projected quantity of fortified flour distribution by end of 2010 would be approx.3,20,344 MT/ month.
- Approximately 75 million population in India will have the access of fortified wheat flour by the end of 2010.

Flour Fortification Progress

Since 2000

- 44.5 million people now have access to fortified flour from 1 million in 2000.
- Larger proportion of market flour is now fortified than before.
- The number of states with wheat flour fortification increased from 4 (2008) to 10 (2010).

Challenges of Fortification in PDS

- Is PDS for really poor people?
- Fight corruption and ensure that the real targeted population gets it is. Ensure that it is not re-circulated in the open market.
- Who would bear the cost?
- How shall the quality be maintained?
- Technology transfer to appropriate authority
- Accountability between Civil Supply, Health, Social Welfare, whose jurisdiction?
- Should it be mandatory?

Challenges of Fortification- Technical Aspects

- What foods to fortify?
- What nutrient to use for fortification?

- Most of the wheat atta is not produced centrally and so small chakkis will have to be involved extensively.
- The amount of nutrient elements depends upon the available dietary source that is so variable in Indian population.

Landing Fortified Foods In Indian Market – Few Observations And Challenges

Dr. Kalyan Srinivasan, Former Head of Nutrition Research, Hindustan Unilever Ltd., Bangalore, India

Factors determining successful launch of a fortified product in the market are:

Choice Of Vehicle

This will vary depending on rural vs urban market. In rural the choices are still restricted to staples (dal, flour) and beverages which is part of daily habit for example tea. Tea is consumed by even children in rural India. In urban India, considering nutrition transition and the diet diversification that has happened, the choice is wider and more options like milk additives, and snacks, can be explored.

Awareness on Nutrients/Fortification

- Urban consumer: Fortified foods are becoming common in an average Indian household, but the focus still remains on children. The need to give a better life to children is seen across socio economic classes in urban India – be it food or education. Urban consumer (woman) is aware and is able to recall nutrients vitamin A, C, calcium, iron and iodine and even associate it to sources and functions.
- Rural consumer: (bottom of pyramid): The approach is curative than preventive and there is less focus on children, it is more about existence. The only nutrient recalled is iron and the credible source of information is the anganwadi worker.

Both in rural and urban India signs of good health are mainly seen in terms of ability to do work like "remain active the whole day", "do things faster". Other common health concerns spoken about are digestion, fatigue.

Challenges Due To Consumer Perception

In both markets the women feel they are doing the best for the family and are unaware of possible nutrient gaps or deficiency that may exist. In urban India fortified foods is always linked to better performance in children. There is an urgent need to educate consumers on intake gaps and deficiencies and effects on health.

Communication Models

In urban India television commercials still are the main source of information, In rural India, especially villages with less than 5000 people communication is a challenge because of lack of awareness and on ground activations other communication models like puppet shows, door to door canvassing, and skits work better.

Common Challenges

- Technology, shelf life and bioavailability continue to be a challenge.
- Changing consumer behavior/habit.
- Pricing: premium has to be lower if it has to be consumed as part of daily diet. The difference in purchasing power and accessibility between urban and rural populations needs to be considered while marketing fortified products.
- Costs involved in sustained communication and education – repeated messaging to consumers to reiterate the benefits need to be considered.
- The biggest challenge is consumers do not see any immediate effect and find it difficult to grasp the benefits of long term "good health" or contribution to overall health. Consumer education on nutrient benefits is key to the success of a product.

Some of the challenges can be overcome, through partnerships –public-private partnerships. For example partnering with the government is critical in rural India as it will provide the reach and credibility to the program.

ICDS As An Option Of Delivering Fortified Products To Public

Dr. R V P Singh, Planning Commission, Government of India, New Delhi, India

- ICDS is the world's largest early-child development program run by Ministry of Women and Child Development since 1975.
- This scheme is India's response to the challenges of providing pre-school education and breaking the vicious cycle of malnutrition.
- Presently 6615 projects are in operation in 11, 95,256 anganwadi centers benefitting 9 crore women and children.
- It is expected that 7,676 projects will be in operation in 14 lakh anganwadi centers in the next financial year.
- The objective of ICDS is being achieved through a package of services comprising of supplementary nutrition, immunization, health check-up, referral services, pre-school informal education and nutrition and health education.
- The concept of providing a package of services is based on the consideration that the overall impact will be much larger.
- Services as far as supplementary nutrition is concerned, the target group is children below 6 years and pregnant and lactating mothers. It is the same for immunization, health services and referral services. For pre-school education, children between 3-6 years are the target group and as regards health and nutrition education, the target group is women between the age of 15-45 years.
- All the services are directly provided by anganwadi workers and nurses.
- Supplementary nutrition component include supplementary feeding and growth monitoring and prophylaxis against vitamin A deficiency and control of nutritional anemia.
- All families in a community are surveyed to identify children below the age of 6 years and pregnant and nursing mothers.
- They can avail supplementary feeding support for 300 days in a year by providing supplementary feeding by anganwadi workers. They attempt to decrease the caloric gap between the recommended and average intake of children and women in low income and disadvantageous community.
- Growth monitoring and nutrition surveillance are two important activities that are undertaken.
- Children below the age of 3 years are weighed. Age growth cards are maintained for children below 6 years which helps to detect growth problems and help in assessing nutritional status.
- Severely malnutrition children are given special supplementary feeding and referred to medical services.
- Funding pattern of this scheme is 90:10 for north-eastern States and 50:50 for the other States.
- Community development is the criteria for setting up of a project. Similarly, 400-800 population is the criteria for setting up of one anganwadi centre in the rural and urban projects.
- For a mini anganwadi centre, the criterion is 150-400 population.
- Financial cost for the supplementary nutrition is Rs.4 for children between 6-12 months, Rs. 6 for severely malnourished children between the age of 6-72 months and Rs. 5 for pregnant and lactating mothers.
- The nutrition norm is 500 calories and protein 12-15 gms for children between 6-72 months.

- It is 800 calories and 20-25 gms protein for severely malnourished children between the age of 6-72 months.
- For pregnant and nursing mothers, the nutrition norm is 600 calories and 18-20 gms protein.
- Children from 0-6 months, early initiation within one hour of birth and first 6 months there should be exclusive breast feeding.
- Children between 6 months to 3 years are provided with dry and raw ration to take home.
- Children between 3-6 years are served hot-cooked meals in anganwadi centers. State and U.T. governments have been requested to serve more than one meal since the children cannot consume 500 calories in one sitting.
- Accordingly, morning snacks are served which include milk, bananas, eggs, seasonal fruits and micronutrient fortified food.
- There is a significant increase in the budgetary allocation from Rs. 10,391.75 crores in the 7th five-year plan to Rs. 44,400 crores in the 11th five-year plan.

Options Of Delivering Fortified Products To Children Through Mid Day Meal Program

Dr. Santosh Jain Passi, Associate Professor in Nutrition, Institute of Home Economics, New Delhi, India

Mid- Day Meal Program (MDMP) Also known as "National Program of Nutritional Support to Primary Education (NP-NSPE)" is one of the largest nutrition support schemes in the world. It was launched on 15th August, 1995 to boost the universal education (UEE) by increasing enrollment and attendance coupled with a reduction in absenteeism; and simultaneously to improve the nutritional status of children in primary classes. Its coverage increased from 3.4 crore in 1995-96 to over 15 crore children in rural/ urban areas in 2010. In view of the Government's commitment to UEE, the program has been extended to the children in Upper Primary classes (VI – VIII).

Fortification Of MDM

Options for Food Fortification

- Premix/ Sachet Approach
- Fortified Flour/ Ultra Rice
- Ready to Eat Foods (RTEs)
- Food - Food Fortification

- ***Premix/ Sachet Approach***

Benefits of adding the vitamin/ mineral premix

- Economical.
- Require little infrastructural mechanism
- Quality control mechanism can be simple.
- Nutrient losses during mixing/ food preparation can be minimised.

a) Addition of the Premix before Cooking

- Require no special measuring skills/ literacy on the part of users.
- Pre-weighed/ pre-portioned sachets can be used.
- Once the premix is blended with the ready to use staple cereal like flour, it can be used as and when necessary for the preparation of MDM.
  Ultra Rice premix can be blended with local rice (~1:100) to meet 1/2 to 1/3rd of the RDA of the micronutrients.

b) Addition of Premixes During Cooking

- Premix sachets can be added to the food during cooking or nearing preparation.
  Vita Shakti is available in sachets containing 1.25 g of the premix (sufficient for 5 persons). One serving provides 14mg iron, 150 mcg vitamin A, 50 mcg folic acid.

c) Addition of Premixes after Cooking

- For instant fortification, the premix can be sprinkled on the cooked food and thoroughly mixed to ensure proper distribution. Single-dose sachets of a

weighed amount containing a blend of micronutrients in a powder form can be easily sprinkled on any food.

Anuka – A multiple micronutrient containing single serving sachet provides 12 mg iron, 5 mg zinc, 300 mcg vitamin A, 40 mg vitamin C, 50 mcg folic acid.

Figure 28: Some Cooked MDM Menus

Some of the Cooked MDM Menus

States	Cooked Foods Served in MDMP
• Andhra Pradesh	*Rice -Sambar, Rasam, Tamarind / Tomato rice, Pongal*
• Delhi	*Mixed Veg. Pulao, Dal /Sambar Rice, Rajmah Rice, Choley Rice, Aloo -Poori, Choley -Poori, Black Channa Pulao*
• Gujarat	*Dal Dhokli, Khichidi, Veg. Pulao, Handvo, Upma*
• Haryana	*Dalia, Khichdi*
• Karnataka	*Sweet -Pongal, Rice - Sambar, Roti - Sabzi, Bisibele Bhath, Upma, Chitaraana (lemon rice)*
• Rajasthan	*Ghooghri, Dalia, Sattu, Lapsi*
• Tamil Nadu	*Tamarind rice, Sambar rice, Dadhojjanam, Pongal, Coconut rice, Halwa/ Shira*

Source: NPNSPE, 2005

Commercially Manufactured Low-Cost Fortified Ready To Eat Foods

Fortified RTEs such as biscuits, m*athris*, n*amakparas*, l*addos* and extruded foods can be given to the children as morning snack in addition to the hot cooked meal served later. Some examples of snacks that can be served are:

- *Iron Fortified Biscuits*: Children studying in primary classes were given Iron Fortified Biscuits two each (providing 10 mg iron) per day for 84 school days. Another group of Children were given four biscuits (providing 20 mg iron) per day for 50 school days. The study indicated an improvement in their Hb status.
- *Sweet ready mix* consists of roasted wheat flour, full fat soya flour, and sugar; and the extruded snack food consists of wheat, full fat soya flour, maize, bengal gram, spices, salt, edible oil. Both the products are fortified with vitamins and minerals.
- *Indiamix* is a ready to eat precooked blended food containing wheat (75%), full-fat soya (25%) suitably fortified with the required micronutrients; provides about 20% protein, 6% fat and 390 Kcal/100 g.
- *Fortified Mamri* - an extruded ready to eat snack (made of Bengal gram powder, wheat flour, oil, salt and sugar.

Food to Food Fortification

This can be achieved through the use of red palm oil, dehydrated GLV powder and defatted soy flour.

â-carotene Enriched Biscuits

- In a Defence Research Development Organization (DRDO) funded research project, the children (classes I – III) were given six biscuits each for on-the-spot consumption for 50 school days.

a) Experiment group: was given â-carotene enriched biscuits prepared using red palm oil (provided 353 kcal, 4g protein and ~2152 mcg of â-carotene)
b) Placebo group: was given non-enriched biscuits similar in appearance and composition except the â-carotene.
c) Serum retinol concentration of the experimental group increased significantly (170.9%) as against a nominal increase in the placebo group (37.5%).

Conclusion

A combination of these approaches can, thus, be adopted for delivering fortified products to children through mid-day meal program.

Morning Snacks

- Fortified ready to eat foods as a morning snack.

Hot Cooked Meal:

- Micronutrient premix sachets can be added during the final stages of preparation in *rice /pulao* /khichri / pulse preparations and curries.
- Fortified flour can be used for the preparation of *poories /shira.*
- Red palm oil can be used in 1:1 blend with other edible oils for food preparation, particularly the bakery items to keep the TFA content at low levels.
- Dehydrated green leafy vegetables powder can be added to MDM menus to further improve their micronutrient content.

During discussions it was recommended that centralized kitchen for Mid-Day Meal (MDM) is only in the urban areas and not in rural areas. Sachets can be used for rural areas with proper education.

SESSION IV-B: MICRONUTRIENT RICH NATURAL PRODUCTS FOR HEALTH

Chair: Dr V Prakash, Director, Central Food Technological Research Institute

Natural Sources Of Micronutrients

Dr. K. Madhavan Nair, Scientist E, Micronutrient Research, Department of Biophysics, National Institute of Nutrition, Indian Council of Medical Research, Hyderabad, India

There is general consensus that the most desirable, sustainable, and safest strategy for the control of micronutrient deficiency is the regular ingestion of bioavailable micronutrients in foods in adequate amounts and reducing their losses throughout the life cycle. Three main approaches recognized are:

i) dietary improvement,
ii) supplementation, and
iii) prevention of loss due to parasites.

Dietary diversification to include micronutrient rich foods appears to be a promising strategy to alleviate their deficiencies. Often this is considered as mere inclusion of adequate amounts of green leafy vegetables without due consideration to other essential foods such as fruits and vegetable oils essential for availability of iron and carotenes respectively. Unfortunately, green leafy vegetables are generally poor sources of certain minerals because of its low bioavailability (iron) in these sources, although some are rich in this mineral. There are many vegetables that are good sources of iron and vitamins, and their identification and promotion of their use in combinations that favor absorption of other micronutrients should be ensured. This should be undertaken by agriculture extension agencies, nutrition personnel, and community groups. A balanced diet that can maintain adequate micronutrient status to be healthy should be considered.

Natural Sources of Micronutrients

For the purpose of dietary diversification, sources of micronutrients can be classified as primary and secondary. Primary sources are those that are rich in nutrient content and their consumption will lead to increased intake of nutrient, thereby directly influencing nutrient availability at physiological level. Secondary sources are those that do not increase nutrient intake but improve its utilization at physiological level. Such food sources contribute the micronutrient indirectly by reducing its intake requirement.

Food sources can be sub classified as those originating from plant source or animal source. Sources which are not conventionally used as food are discussed as non food sources.

Primary Natural Food Source Of Micronutrient: Plant source

Staple foods such as rice and wheat contain low amounts of minerals such as iron, but because of higher intake they contribute substantially in meeting mineral requirements. Underutilized food sources, such as coarse millets, leafy vegetables, can be used at household level as a dietary diversification strategy to improve nutrient intake. Refined rice and wheat as staple can be partially replaced with iron and calcium rich millets like bajra and ragi. Poppy seeds, omum, gingelly seeds, niger seeds, garden cress seeds, etc are items from traditional kitchen that are good in micronutrient mineral content but have been getting decreased attention in daily meal over the time. Red palm oil obtained from the mesocarp of the oil palm (Elaeis guineensis), is rich source of bioavailable â-carotene. Leafy vegetables like cauliflower greens, onion leaves, drumstick leaves, amaranth leaves have easy availability and are good source of minerals.

Increasing intake of nutrients from plant sources alone may not be a successful strategy as nutrients may not be in 'available form'. Bioavailability, the ratio of nutrient that is absorbed at physiological level, is a complex issue modulated by several factors. For certain nutrients like iron, bioavailability is not always good. Iron present in plant foods is in non heam form, and has poor bioavailability at physiological level. Several components of food matrix, termed anti-nutrients (phytates, tannins, goitrogens etc) interfere with mineral absorption; whereas other components such as ascorbic acid, meat improve mineral absorption.

Strategies To Increase The Non-Heam Iron Bioavailability Through Processing

During processing such as germination, fermentation malting endogenous enzyme phytase hydrolyses phytates which are absorption inhibitors. Non enzymatic processes like thermal treatment, soaking, milling can also reduce phytic acid content of certain plant based staples.

Food-to-food fortification strategies to improve iron nutrition implies dietary modifications to either include in a meal foods that can promote the absorption of nonheme iron or to exclude foods that inhibit nonheme iron absorption. For example: studies have shown that improving ascorbic acid intake with meal result in improved mineral absorption, thereby reducing the need to increase mineral intake.

Improving Mineral Density Of Plant Foods

Mineral concentrations in many plant foods are low, relative to human requirements; this has elicited efforts to enhance plant mineral content by using the tools of plant biotechnology. For seed crops, transgene expression designed to increase mineral loading into the phloem pathway is envisioned as a primary strategy to effectively enhance seed mineral content.

Primary Natural Food Source Of Micronutrient: Animal Source

Food from animal source such as meat , eggs are not only good source of vitamin A, zinc ; they may improve utilization of non heam iron .Bovine hemoglobin , in the form of dry red blood cells , is used as food additive and demonstrated to improved iron status in children fed iron fortified cookies in Chilean School Lunch Program.

Primary Non-Food Source of Micronutrients

Primary non food sources are those that are high in nutrient content (eg spirulina, iron herbs) but not commonly considered as part of diet. Once identified, such sources can be included in regular diet to improve nutrient density of diet.

Spirulina : The Edible Microorganism

Spirulina is a microscopic blue-green algae (*Arthrospira platensis* and *Arthrospira maxima*) in the shape of a spiral coil, living both in sea and fresh water. It has 62% amino acid content, is the world's richest natural source of vitamin B-12 and contains a whole spectrum of natural mixed carotene and xanthophyll phytopigments.

Secondary Sources Of Micronutrients

Functional foods such as prebiotics and probiotics and other components of diet such as ascorbic acid, which improve bioavailability of minerals at physiological level, are secondary sources of micronutrients. Prebiotics provide substrate for the intestinal microflora resulting in increased short chain fatty acids production leading to increased solubility of minerals. Maintenance of healthy absorptive surface, gut health, stabilization of the intestinal flora, and increased expression of calcium binding proteins, stimulation of immune defense and release of bone modulating factors are other mechanisms improving micronutrient utilization. Probiotics alone or in combination with prebiotics (symbiotic) degrades mineral chelating phytic acid and stimulates calcium uptake by entrecytes. Additionally, intestinal microflora are also responsible for production of several vitamins such as vitamin K, niacin, pantothenic acid, folic acid, biotin and vitamin B12 in humans.

Conclusions

Not all the micronutrients present in diet are completely absorbed by our body. Dietary diversification with natural sources of micronutrients is an essential component of a long

term sustainable holistic approach to control micronutrient deficiency. Therefore, there is a need to identify natural sources of vegetables and fruits and flesh foods which are made available regionally at affordable cost to derive the long term benefits of controlling micronutrient deficiency.

Biofortification- Engineering The Metabolic Pathways

Dr Swapan Kumar Datta, DDG (Crop Sciences), Indian Council of Agricultural Research, New Delhi, India

About 1.1 billion persons are malnourished globally. Plenty of natural foods provide nutrients even then there is a great deal of micronutrient malnutrition in India. Poorer people are mainly malnourished and they do not have access to diversified foods which can give them required nutrition. They depend on cereal grains mainly. Nutrition from cereals is inadequate. This is the main reason why micronutrient remains a difficult task.

There are many new developments – improved protein potatoes, carotenoid enriched potatoes, insulin promoting rice (Japan), Canola with â carotene and vitamin C enriched food crops. Biofortified vegetables are being developed with much higher level of vitamin C as it is required for absorption of nutrients; vitamin E and â carotene maize have been developed. Our food diversification is restricted; people eat least vegetables in India in spite of majority of population being vegetarian.

Nutritional genomics provide new opportunities. All metabolic pathways lead to different compounds – nutraceutical compounds. There is a gene regulating pathways and those genes are now being characterized and their pathways being worked out. Crops can be re-engineered to enrich them with nutrition. Pathway can be altered. An enzyme can be over expressed or a pathway can be blocked to reduce expression of certain enzyme and end up with more desirable compounds. Vitamin E maize is developed which is used in US for animal feed. Vitamin E maize is developed taking a gene from barley and that has been over expressed in maize.

Medicinal Rice Kerala is rich in nutrients. Some germ-plasms have carotenoid but they disappear after polishing. Cost of brown rice (containing â carotene) in Italy is $ 5 a Kg. Poor cannot afford.

People are used to milled rice. Rice should be fortified. By genetic engineering a gene of interest can be included and other genes which are not required for expression in the plant can be removed.

As regards golden rice, there is no change in control and transgenic except that latter would produce â carotene in seeds and others not. Cooking reduces â carotene in golden rice by 15-20% which is acceptable. Golden rice cannot have shelf life of more than 3 months – after which â carotene degrades.

Everything can be done on designer system and it can be incorporated. It is not only one gene but more genes can be added as required. Further, phytate content in rice can be reduced to make iron and zinc more bio available. Transgenic ferritin rice. Vitamin A rice and high iron rice – conventional breeding can also change it. Vitamin A, Zinc and Iron help each other absorption. Lysine can also be enriched in a plant.

Government policies and urge of country to solve the problem of micronutrient is not working synergistically. Current GMO regulation needs to be changed. Otherwise there is no point in working on new technologies if they are put on shelves and cannot be utilized for the country when country needs so much these technologies to be utilized. Further staple crops should have iron, zinc and other micronutrients. Success of green revolution was in freedom to operate, freedom to move, freedom to disseminate which

is not there for many other technologies. Everything is known but implementation has not happened. All options should be available with people so they can choose what they want.

Figure 29: Global Food Security and Malnutrition

Figure 30: Biofortified Food Crops for India?

Observations made by following participants:

Dr Umesh Kapil, All India Institute of Medical Sciences – Testing of 3.5 lakhs sample by Indian Soil Institute, Bhopal found that 40-70% of soil is deficient in zinc and 12-20% is deficient in iron. Take specific measures to see that soil is enriched with micronutrient so that plants have more micronutrient.

Dr R Shankar, Global Alliance for Improved Nutrition – No one can deny that if you can get all minerals and vitamins through natural sources that will be the ideal situation. However, it is not possible/affordable by vast majority.

Dr A S Bawa, Director, Defence Food Research Laboratory: Micronutrients are available through natural sources. However, bioavailability, combination of food being consumed and affordability by target groups. From armed forces side, food for high altitude need to be developed which address issues of comfort, sleep, stress, depression during war time etc. DFRL is trying to find micronutrient for incorporation in foods as also trying to find natural sources which can give the desired micronutrients.

Dr K Srinivasan- Enhancement of bioavailability through natural resources needs to be examined. For example it is well known that in certain parts of India Betel leaves are given during pregnancy since time immemorial. Research has now revealed that certain fibre enhance bioavailability of calcium. Lot more work on natural sources need to be done.

The following observations were made during discussions:

- There is opposition in West Bengal for experimental field testing of iron fortified rice. Opposition is not scientific. Scientific studies should continue. Work to find out best possible option. Let all options be available and people can choose the option, however, denying option is not correct.
- In PFA, zinc is considered as poisonous metal. RDA for zinc is 12 mg whereas PFA stipulation is 5 mg for 100 gms. Both stipulations are contradictory. It is difficult to fortify foods to provide the RDA. It is necessary to remove this anomaly.
- All legislations including PFA needs to be reviewed from time to time as they make functioning difficult.
- For growing GM Crops – any institute or farmers can do the field testing. They have to follow DBT protocol. It takes 3 years.
- Nutrition is included in Food Security Act. This should be examined
- Micronutrient malnutrition should be look as disease and food should be fortified with whatever way it can be done.

- Micronutrients in traditional Indian foods should be studied. ILSI-India can take up a project.

While summing up the discussions Dr Prakash made the following points:

- Biofortification is very important in long term and we should work on that.
- Fortification with micronutrient for processed food through some staples is a major way to reach out This is not an alternate but it is along with natural sources biofortification
- Spices have lot of micronutrients.
- Look at specialty foods like red rice – spot things which are culturally available.
- Look at gut health. Do work on prebiotic, probiotic and iron absorption.
- Look at bio availability in human and animals.
- Look at food as diet.
- Nutrigenomic is important.
- Industry should be conservative about over claims. Claims should be backed by bioavailability studies.
- We need a balance all approaches to improve nutrition status.

SESSION V: CRITICAL ISSUES IN MICRONUTRIENT FORTIFICATION PROGRAM

Chair: Dr Michael Bruce Zimmermann, Laboratory for Human Nutrition, Institute of Food Science and Nutrition, Swiss Federal Institute of Technology

Enhancing Impact Of Food Fortification Program: Program Design, Monitoring And Evaluation

Dr. Shubhada Kanani, Professor, Department of Foods and Nutrition, (A WHO Collaborating Center for Research and Training in Promoting Nutrition In health and Development), M S University of Baroda, Vadodara, India

The basic objective expected to drive decisions in food fortification programs is that of bridging the gap between micronutrient requirements and current intakes among the recipient groups. Thus, how to best minimize or eliminate micronutrient deficits is also the basic issue governing the elements of program design, quality of implementation, monitoring and evaluation (I-M &E) of fortified food interventions. Successful food fortification programs meant for vulnerable and economically deprived communities need to go beyond the technology of fortifying foods and making them available to beneficiaries. A quality-assured and system-wide approach is required which takes care of the many threats to the long and delicate quality chain from production stage to the sustained consumption of the food supplement by the intended beneficiary in the required amounts.

Realizing that a 'result oriented' monitoring system is the need of the hour, the Results frameworks (or "strategic framework,") was presented which depicts the direct causal relationships between intermediate results (IR) of key activities all the way up to the overall objective and goal of the program. It clarifies the points in the program at which results can be monitored and evaluated. Before achieving the SO, a set of "lower level" intermediate results must first be reached; which in turn are dependent on subordinate intermediate results, or sub-IRs (MEASURE Evaluation and USAID, 2007). Like other programs, Food Fortification programs in government systems also need to look results at each step of implementation till the eventual goal of the program is reached.

Based on this framework, examples of recent initiatives in Government fortified food supplementation programs in Gujarat were presented such as ICDS and MDM. Some positive features, the field level challenges and corrective measures needed as regards I-M&E of these programs were highlighted. For example, public private partnership (PPP) in Gujarat's MDM program has resulted in a vastly improved quality assurance system compared to the Government run MDM. Similarly, in ICDS, tremendous inputs are visible in the monitoring system that has been put in place for the distribution of the fortified premixes for children 0-3y, pregnant women and adolescent girls. However, several field challenges are evident. For example, the time and labor intensive records to be maintained; inadequate administrative support, poor outreach and counseling to ensure the desired consumption by the intended beneficiary. In particular, the need to view I-M&E in the context of the totality of overall service delivery package was highlighted; especially how services influence each other
Illustrative data from the department on research and training experiences in these programs suggest, for example, that when series of trainings for better implementation, or M&E exercises, become 'ends in themselves' (often taking away

precious time from community contacts and home level visits); or when M&E data is inadequately used at field level from where it is generated; then significant positive impact at scale is unlikely. Action is needed towards 'result oriented' rather than merely 'activity oriented' implementation, monitoring and evaluation; drawing on the 'results framework' for M&E. To support a much needed change in orientation where the eventual result and achievement of the desired objective is the focus, the need for taking a fresh look at program design elements -where required is necessary.

In sum, the hope and the aim underlying these measures is to help examine the desired impact on enhancing micronutrient intakes in vulnerable groups.

Recommendations

- View I-ME of FFS in context of the total program and total MIS for all activities.
- Focus only on the critical tasks – essential for achieving objectives.
- Rationalize workload and provide administrative support.
- Adopt result oriented MIS.
- Keep community contacts and home visits as one of the non-negotiable activities.
- Encourage PPP judiciously.

re 31: Time Activity Pattern of ICDS Supervisors

TIME ACTIVITY PATTERN OF ICDS SUPERVISORS: Sample Feedback From 36 Supervisors (11 Of 17 Blocks In Vadodara District)*

Activities	Average days spent in Oct, 2010	Percent days (out of 24)
A. Office work (compilation of records, Stat. asst work, stock checking	4	17
Meetings (cluster, block, others);trainings	6	25
Other events –attendance, admin work ; eg Balika Smruddhi yojana , school health, Gunotsav and other schemes	4	17
Monitoring at field level (mostly AWC visit, Home visit -rare)	10	41
Total	24	100

* Kanani and Gandhi, 2010 Note: Community contacts are negligible

KANANI 2011

Figure 32: Nature of Admin and Field Work

Nature of Admin and field work – Sample feedback *

ACTIVITY IN OCTOBER '10	DESRIPTION - SOME EXAMPLES
MEETINGS:	Seja (Cluster) meeting, Meeting with CDPO, Meeting for school health microplan , gunotsav , Helper meeting, with adolescent girls... VHSC of NRHM, with health dept (mamta day)
OFFICE WORK:	Compilation of AWC records, statistical assistant work, distribution of THR/BB records, correcting mistakes of AWWs, bank and account work related to sakhi mandals ; accounts related to expenses for fruit, milk, Annaprasan diwas , overseeing transport of THR/BB stock from block to AWC
TRAINING	HIV/AIDS Related, for Stat assist work
ANGANWADI VISITS:	Includes in about 3 hours... •Observation of AWC activities. Distribution of FFS, checking stock and distribution registers, correcting AWW mistakes,
OTHER SCHEMES:	Balika Samrudhi Yojana , Khel Mahakumbh , school health, Rural dev dept (AWC repair, baby toilets), total sanitation campaign
* Kanani and Gandhi, 2010	

Critical Issues In Micronutrient Fortification Program

Dr. Kalyan Srinivasan, Former Head of Nutrition Research, Hindustan Unilever Ltd., Bangalore, India

Successful implementation of any fortification program requires a careful design and execution in the several stages. The following critical factors have already been discussed in detail and so there is no need to discuss them further: the right fortificant and the food vehicle through which it is delivered, bioavailability (including cross interactions of fortificants in case of multiple additions), levels of addition and safety, taste and acceptability, stability under different cooking conditions and temperatures, quality control, cost, communication and so on.

There are three challenges in the fortification programs: bioavailability, cost and communication.

Of the two fortificants – iodine and iron – that have been widely used and studied, a lot of data have been generated with regard to the availability of iodine in different vehicles and stability under different cooking conditions. People in different parts of the country with various temperatures and ambient humidity adopt different cooking conditions. The fortificant should be stable during under these conditions. It is also critical that the taste of the food does not change. This is particularly true for iodine.

Different forms of iron have been studied – ferrous iron, ferric iron, different forms of iron in these two oxidation states, chelated iron etc., Similarly, the common form of iodine is the iodate form though some work has been reported about a compound with sodium iodide in the silica matrix. While stability is not a major issue with respect to iron, bioavailability is.

Next is the cost benefit analysis and establishing the efficacy. The proper assessment of cost-benefit analysis is very crucial for the sustainability of the program. The Government and the industry may have different perspectives of doing this study. They must therefore jointly evolve a reliable measurement to assess the efficacy of the program.

Without appropriate communication, any fortification program is bound to face problems. Herein arises the need for some coordinated efforts of the Government, industry, media, self-help groups and the NGOs. More particularly there is a need to assess in quantitative terms the advantages of fortification for the consumer, to enable the Government and the industry to be interested in the program. Towards this end, Government should give special tax incentives to research institutes and industries which are working on the enhancement of the bioavailability of various products.

Government has done excellent job in creating awareness about iodine requirement and particularly enhancement of cognition in school children. There is a need for commitment from the government in propagating and educating people of the prevalence of malnutrition. The message should reach the poorest of the poor in the villages. Media and TV serials have a great impact on the viewers and hence they can help the government in spreading these messages.

Consumers have the following reservations on their minds which need to be addressed:

- Fortified foods are medicines.
- Fortified foods may lead to excess intake and toxicity.
- Fortified foods are expensive.
- Fortification leads to change of taste.
- People have belief that they are not suffering from malnutrition.

Effect of fortified program should be evaluated from time to time. Government has good intention, however clear policy guidelines are required to facilitate food fortification.

IEC As A Tool For Success Of Fortification Programs

Dr. Deepti Gulati, Senior Program Associate for South Asia, GAIN: Global Alliance for Improved Nutrition, New Delhi, India

While macronutrients (fats, carbohydrates and proteins) constitute majority of an individual's diet and are primarily needed for energy and growth, micronutrients are life-sustaining nutrients that are needed only in small quantities for effective functioning of brain, the immune system and energy metabolism.

Globally it is considered that micronutrient malnutrition cannot be eliminated but can be reduced to acceptable public health levels, using a mix of effective policies, control strategies, well-designed programs; the efforts put in for efficient program implementation, and the prevailing social and economic levels of development. These programs however can only make a difference if these are continued for the foreseeable future.

One of the most cost-effective and efficient strategies for reduction and management of micronutrient malnutrition is fortification of various food vehicles. However, successful initiation and sustaining of fortification programs largely depends upon the "Political will', 'Commitment of the food industry' and the

'Awareness created' amongst the general population about the need and importance of consuming fortified foods, leading to 'Demand creation'. However, for leveraging "Political will' and 'Commitment of the food industry' and for 'Creating awareness' and 'Demand generation', it is important to develop and implement a well-defined advocacy / communication strategy, focusing at educating the political leaders, food industry, key opinion leaders, scientific community and at the different population groups. In addition, it is also critical to create alliances with NGOs and politically powerful groups who can help to promote food fortification. Also, it is equally important to engage with groups / organizations / influential individuals who are potential opponents of fortification, so that their opposition and perspective on food fortification can be understood and this can be countered by providing them with relevant scientific rationale on the advantages of fortification. In fact this should be an effective element of the advocacy strategy.

For reducing micronutrient malnutrition, it is important to strengthen information dissemination about the need and importance of fortified foods and food fortification programs amongst masses and amongst the key opinion leaders. To ensure effective communication, it is important to strategically use print, radio, electronic and folk media; organize special advocacy events; disseminate regular press releases, organize briefings workshops for journalists, writers and healthcare professionals; develop special communication materials and use digital media effectively by developing and uploading specific blogs, web-articles etc. These help to highlight the importance of food fortification in reducing micronutrient malnutrition. Furthermore, these help to provide a high visibility to the existing fortification programs, and these also help to showcase the impact and benefits of the programmatic interventions, relative to costs.

Lastly, consumer demand for fortified products is a potentially important force in maintaining interest of the food industry and for garnering the quintessential political support. Creating and sustaining consumer demand requires high and visible promotion of fortified products and their nutritional merits. Consumers do not automatically demand micronutrient-rich foods, even when there is no financial constraint. Where consumers have a choice they must be convinced that the fortified products bring them health benefits. However educating consumers and creating a demand for fortified foods for improved nutrition would require understanding the factors that constrain or prevent people from purchasing and consuming fortified foods. Finding practical and acceptable solutions that overcome these "resistance points" are critical to the success of a communication program.

Nutrition-focused information, education and communication programs for the consumers should convey right and adequate information and should use a social marketing or social mobilization approach, including a well-defined process and an effective communication strategy that would help people to understand the food fortification issues from their perspective, and motivate them to make the right choices. An effective and a good audience-centered nutrition communication program will make a positive impact on nutritional status, even among those from the low-income groups.

Therefore, for the success of any food fortification program, or for making available a variety of fortified foods available to the consumers, close collaboration between the public and private sector, as well as civil society, is essential. The consumers, the industry and the politicians must continually be reminded of the benefits — political, economic and health — of effective programs and their continuation.

Consumer groups should be formed and their capacities built over a period of time so that they should serve as watchdogs, helping to monitor the quality and price of the fortified food products. It's only a sustained working with people and organizations that would make a difference. It's only when many specific, short-term activities are continued over a period of time that a long-term vision of change can be achieved.

The following points were made during discussions:

- Toxicity will not be an issue since there are few fortified foods in India. Hence it is very unlikely that someone would consume fortified foods at toxic levels.
- Toxic levels are at least 5-10 times the RDA. Even if a person takes all fortified foods, the excessive minerals including iron will be excreted.
- There needs to be a certain set of standardized messages which will form a package of the total IEC that government functionary is supposed to administer. As scientists and people from the technical side, there is a need to devise a set of messages and materials that can form a package in the overall IEC campaign of the government because they do not want to focus exclusively on any X, Y, Z topic.
- There are plenty of effective materials for communication available.
- Knowledge on fortification should be converted into doable things.
- Management Information System (MIS) is part of the total program. It is important to know how the system is operating at the field level. As technical experts, there is a need to help the Government in finding a balance between good monitoring and too much monitoring.

Dr. Michael Zimmermann made the following points while summing up the discussions:

- There is a need to get across clear messages about the adverse effects of under-nutrition.
- The messages should be simple, clear and dramatic.
- Setting up of a good quality monitoring and evaluation is just as important as rolling out programs and their implementation.
- Concept of bioavailability; It is a very generic term. It is different for different micronutrients.
- Messages conveying that iodine and brain development and cognition are linked to iodized salt are successful.

SESSION VI: SETTING PRIORITIES IN FORTIFICATION

PANEL DISCUSSION WITH NUTRITION & FOOD SAFETY LUMINARIES

Chair: Mr. D H Pai Panandiker, Chairman, ILSI-India

Micronutrient Deficiencies And Their Impact On Health And Productivity

Prof. Michael Bruce Zimmermann, Senior Scientist, Laboratory for Human Nutrition, Institute of Food Science and Nutrition, Swiss Federal Institute of Technology, Zurich

There are new opportunities in 2011to correct micronutrient deficiencies using food fortification. There are new compounds, such as nanostructured iron and zinc. New target groups have identified, such as weaning infants at risk of iodine deficiency. But with these new opportunities come new challenges. Now it is know that increasing obesity in industrialized and transition countries impairs iron metabolism. And we also have new safety concerns, including the modification of the gut microflora by iron. Micronutrient programs are extremely cost effective.

The 2004 World Bank Report on correcting micronutrient deficiencies stated "Probably no other technology today offers as large an opportunity to improve lives and accelerate development at such low cost and in such a short time". In addition, the 2004/2008 Copenhagen Consensus ranked "Providing micronutrients" as the second (2004) and first (2008) best global welfare investment. But as move is made into program implementation, investment in micronutrient research remains important, as emphasized by U.S. Secretary of State Hillary Clinton, accepting the 2010 WFP Leadership Award for fighting global hunger, who said: "Its important we focus on science and research again…to look for ways to bring about the widespread distribution of micronutrients and develop hardier, micronutrient-rich crops."

Iron Fortification

Iron Fortification Common In S Africa

- Iron fortification being widely introduced in developing countries.
- Flour fortification in place or planned in H"80 countries; including ¼ of population of SS Africa.
- Most common fortificants are elemental Fe powders despite low bioavailability.
- Absorption of these poorly-soluble forms of iron is often as low as <2-3%.

Colonic Iron And The Gut Microflora

- Low absorption of Fe fortificants results in >90% passing into the colon.
- Most body Fe tightly bound to proteins limiting supply to potential pathogens.
- But no system for sequestration of dietary Fe in gut.

Intense Competition For Unabsorbed Dietary Iron Among The Gut Microflora

- Fe a **growth-limiting nutrient** for many gut bacteria.
- Colonization depends on ability to acquire iron and other essential growth nutrients.

Iron Is Essential For Most, But Not All, Gut Microflora

- Enteric gram-negative bacteria (e.g. *Salmonella*, *Shigella*, *E. coli*) **effectively compete for Fe and acquisition plays essential role in virulence** and colonization
- Many dominant fibrinolytic strains (e.g. Bacteroides) **require Fe for growth, H_2 and SCFA production.**

- Lactobacilli, beneficial 'barrier' bacteria, help prevent colonization by enteric pathogens, **do not require Fe.**

Colonic Fe Supply May Influence Balance Of Gut Microbiota

- Increase in unabsorbed dietary Fe through fortificants or supplements **could modify the colonic microbiota equilibrium and favor growth of pathogenic strains over 'barrier' strains**

  If true, would be an important adverse effect; diarrhea the cause of death of 1 in 6 <5 y-olds in SS Africa.

Perspectives

New methods of characterizing the gut microbiome will provide new insights into the links between micronutrients and health.

Iron Defeciency in Obese Population

Obesity Increases Risk For Iron Deficiency In Vulnerable Groups

- In NHANES III, overweight toddlers and children (n=9000) had double the risk of ID (Tsat, FEPP, SF)
  (Nead et al., Pediatrics, 2004)
- Increased ID (TfR) in obese women in Mexico, Spain and the USA (Lecube et al., Obesity, 2006; Menzie et al JADA 2008; Yanoff et al IJO, 2007; Cepeda et al AJCN 2010)

Why The Link?

- Lower dietary intake from poor dietary choices?
  Maybe, but:
  - Low serum iron in obese U.S. adults not predicted by lower iron intake or iron bioavailability (Menzie et al., 2008)
- Higher requirements, larger blood volume?
- Reduced absorption/increased iron sequestration due to low-grade adiposity-related inflammation?

Hepcidin

- Key regulator of body iron metabolism.
- Reduces intestinal iron absorption and iron release from macrophages and liver.
- Produced mainly by liver, but also small amounts by the stromal fraction of adipose tissue.

In Mexico, sharply higher rates of ID in obese women and children are correlated with inflammation rather than iron intakes

- National nutrition survey (1999).
- Overweight young women and SA children had **odds ratios for iron deficiency of 1.92 and 3.81** compared to normal weight population.
- Correlated with CRP but not with dietary iron intakes or bioavailability.

Iron fortification in overweight children

- 4 efficacy trials of iron fortification in children (5-16 y) from Morocco and India (n=1688)
- Iron fortification with encapsulated ferrous sulfate/fumarate or micronized FePP
- Hb, SF, sTfR, ZPP measured at baseline and after 7–9 months
- prevalence of overweight was 6%; prevalence of iron deficiency 42%: anemia 33%

Perspectives

In transition countries, current surge in overweight may impair efforts to control iron deficiency.

***Interactions* of the 'double burden' of malnutrition may have adverse consequences.**

<u>Investments in food fortification and micronutrient research need to move forward in a parallel and complementary fashion</u>

- Identification of new compounds and new vulnerable groups.
- Effectiveness in transition countries with high rates of obesity; Safety of iron and gut microflora.
- Enhanced effectiveness and safety of fortification.

Conclusions

- Adiposity in women and children predicts decreased iron absorption, iron deficiency and a reduced response to iron fortification.
- Overweight may increase risk for iron deficiency via low-grade inflammation that increases hepcidin and reduces systemic iron availability.

Figure 33: Enhanced Effectiveness and Safety of Fortification

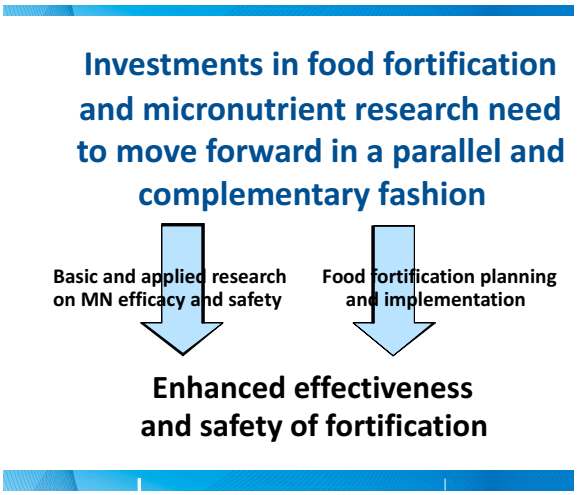
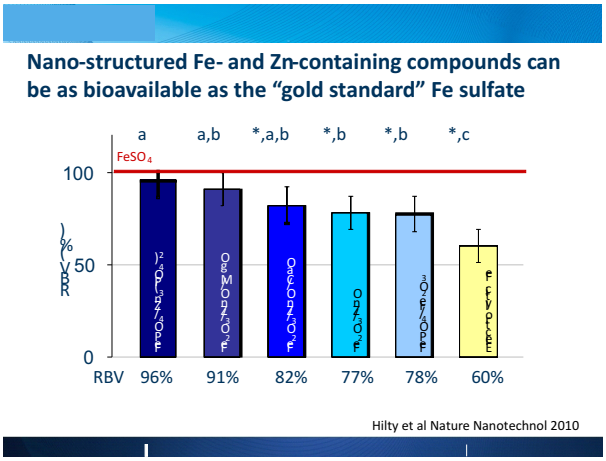


Figure 34: Nano-structured Fe and Zn-containing Compounds as Bioavailable as the "Gold Standard" Fe Sulphate



Observations by Food Safety and Nutrition Luminaries

Dr. Amarinder S Bawa, Director, Defence Food Research Laboratory (DFRL), Mysore

- Fortification is important and it can be effective in tackling micronutrient malnutrition and should be taken up.
- Many factors are important for effectiveness including carriers, fortificants and target population (community/ public).
- Carriers should be staples consumed by the masses.
- Iron fortification is important, however bioavailability should be considered.
- Cost of fortification should be brought down through research.
- There is a need to create awareness about fortification.
- Sensory attributes of fortified products should be studied.
- Feasibility of fortified milk with iron and vitamin C should be looked into since milk is a staple and important.
- Cost of fortified products should include processing, handling, transportation and packaging and should be affordable by target population.
- In some of the states, Integrated Child Development Services (ICDS) and Mid-Day Meal (MDM) program are not effective because of lack of sufficient funds for these programs.
- It needs to be examined whether the quantity of food including prescribed protein and calories given under MDM should be given only at one go or should be given more than once to enable children to consume the quantities prescribed for them.
- Biofortification is important.
- All programs should be evaluated from time to time to assess effectiveness and carry out modifications from time to time.

Dr. B.K. Tiwari, Nutrition Advisor, Ministry Of Health And Family Welfare, Government Of India

- There has not been much success in fortification programs except salt iodization program.
- Since then, life expectancy has increased and visible goiter is below 3-4 %. But palpable goiter still continues to be at 40%.
- There was a pivotal project in 9 Districts of 9 States for more than 15 years on Zinc.

- More than 100 Districts had Zinc deficiency. However, no district has Zinc as a public health problem. The RDA for Zinc in India is 12 mg. It was 15 mg when the project started.
- There is no zinc deficiency in plants and humans (zinc serum level).
- Vitamin D and calcium deficiencies are emerging as problem areas.
- Milk is good vehicle for vitamin A but not iron and vitamin C
- Some fortificant must be there to take care of the deficiency of iron, B6, B12, vitamin C.
- Micronutrient in processed foods should be accessible, affordable, absorbable and should assimilate in the system.
- Around 37.5% of the Indian population is below poverty line. They are deprived of the basic 2 square meals. Hence, macronutrient (i.e. protein & energy) deficiency problem must be tackled first.
- Children do not consume sufficient fruits and vegetables which is a problem of dietary diversification. Obesity is a problem in school children which needs to be focused.
- Wheat flour is a good vehicle for micronutrient fortification but there is less impact due to transfer of government officials who are implementing such fortification programs. Hence, the impact gets diluted.
- Immediate attention is to be given to diet-related chronic diseases like obesity, diabetes, cardiovascular problems and various stress related problems that are visible even in children and affluent families.

Dr. V. Prakash, Director,
Central Food Technological Research Institute, Mysore

- Micronutrient fortification of food is necessary.
- It should be processed-food based application.
- Vitamin C should not be added to milk in India. The common practice is to boil the milk before consumption and addition of vitamin C may spoil the milk.
- Nutraceutical Vehicularized Foods (NVFs) are important source for fortification.
- Innovative processes may be introduced to minimize micronutrient losses while processing.
- "Just-in-time" approach should be used.
- Industry should be a partner in nutrition program.
- Food fortification should be science-based. Statements made by scientists should be reliable and factual without any conflict of reports.
- Speciality and capacity building is required in micronutrient research and fortification.
- ILSI should undertake to create awareness in policy-makers about the importance of micronutrient fortification.
- Micronutrient fortification program should be well-managed. This should include proper documentation and self-regulation.
- Intensive public-private partnership in drafting regulations is as important as in investment.
- Micronutrient fortification of foods should be considered as social issue.
- Micronutrient fortification of foods should be safe, cost-effective and promote health. Variety of foods should be fortified.
- Special Purpose Vehicles (SPVs) are needed for better absorption and optimum bioavailability.
- Scientists should reach out to the public and industry to explain the benefits of micronutrient fortification of foods.
- Global approach for food fortifications should be studied for applicability in India.

Dr. Omar Dary, Food Fortification Specialist,
Academy For Educational Development (AED), Washington D.C

Objective of food fortification is to increase intake.

- We should measure how much food is consumed that is fortified. The additional intake of micronutrient units is the indicator of success of fortification programs.
- The solution is in the units of micronutrients consumed and not in the food consumed.
- We need bioefficacy which is a combination of bioavailability, bioconversion and the intake. Our requirement is linked to bioavailability.
- There might be sufficient intake of iron but there is insufficient absorption of iron.
- Food fortification is only one of the strategies. There should be many other ways to increase intake of micronutrients such as supplementation and micronutrient powder for home fortification.
- There is a nutritional gap which is not just in terms of intake but also in terms of absorption and how much is working.
- There must be interventions to provide additional intake i.e. whether there is sufficient absorption.
- Interventions must be separated from solutions. We must measure how much of this solution is provided by the intervention. We should necessarily measure how much is the additional intake of the nutrient that is going into the fortified foods.
- We do not evaluate and monitor each intervention individually. We evaluate outcomes which is associated with many things.
- We need to evaluate the coverage of population, but it is again insufficient because we need to look at the awareness of the people, change the practices followed and educate them.
- We need to have a supervision system whether it is being complied with. It must be proved.
- We need to have monitoring of the standards, projections and quality of the inputs in factories, retail stores up to the home level to test the quality of the food, its content and consumption.
- We need to look at the resources of micronutrients deficiency as well. For an example, if we do not eat sufficient marine fish, we will be deficient in iodine. No matter how much iron or zinc we have, its absorption will be impaired. It is not the intake but the bioavailability.
- Iron is difficult to add because it may result in the problem of excessive iron in the large intestine. Calcium is not a micronutrient and hence cannot be fortified.
- In Chile, anemia was corrected in one year by fortifying milk not only with iron but also with zinc, vitamin C and vitamin A.
- The three main priorities in food fortification are:
  1. Establish a simple, reliable and permanent monitoring and evaluation system for assessing the intervention outputs and program outcomes.
  2. Promote consumption of fortified milk (including in adults).

Use fermentation or phytases in cereal processing (for increasing mineral bioavailability).

Figure 35: Goal of Micronutrient Programs= Outcomes

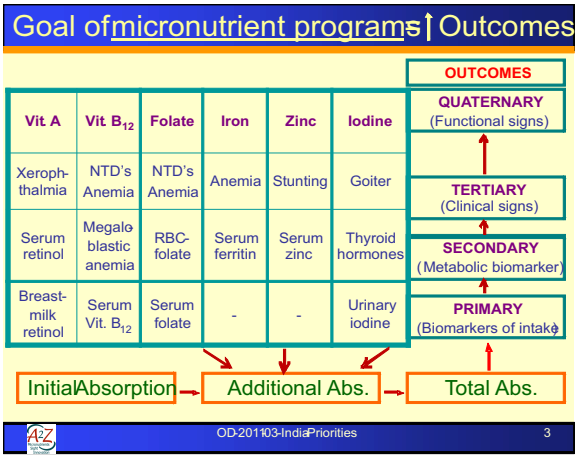
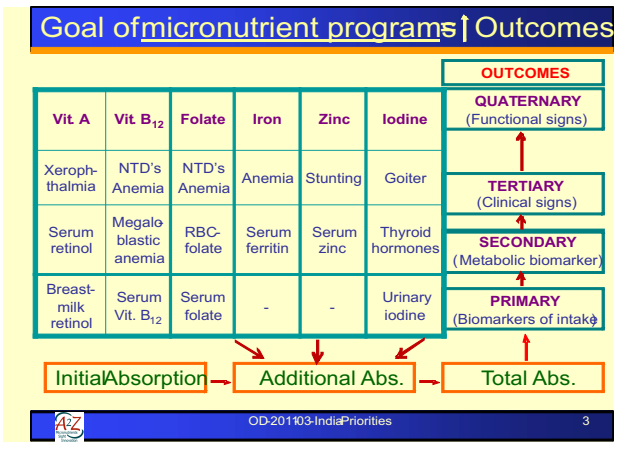


Figure 36: Impact of Fortified Milk in Chile



Discussions

- There are regulatory barriers to fortification. For example, if milk is to be called milk then no vitamin and minerals can be added and product name changes and there is 12% tax. Therefore, definition of milk under Income Tax should be changed to include fortified milk.
- Pro-active role should be played by Food Safety and Standard Authority of India (FSSAI) to promote fortification.
- Computerization of beneficiaries under PDS is important to reach out to target population under PDS.
- Movement of materials should also be computerized.
- Low cost complementary foods should be developed by government and industry.
- Zinc should not be considered as toxic under PFA Acts and Rules.

Concluding Remarks by Chair: Mr. D.H. Pai Panandiker, Chairman, ILSI-India

- Micronutrient malnutrition is a concern because of health consequences and economic consequences.
- Problem is more acute in below poverty line (BPL) population. There should be greater focus on mitigating micronutrient malnutrition in this section of society.
- Pre-requisite of success for fortification programs are-
  1. Proven effectiveness of the product.
  2. Synergy with complementary programs of supplementation and balanced diet.
  3. Utilization of ICDS, MDM and PDS.
- Barriers to fortification include price sensitivity, nutrition illiteracy and political-will.
- Development of food industry is important for successful fortification program.
- In fortification programs, priorities will include choice of right technology, right vehicles, right micronutrients and right fortificants.
- Foods distributed under Public Distribution System (PDS) should be fortified.
- Consumers should be educated.
- In ICDS and MDM programs, intensive public-private partnership is required. Government should be a catalyst in such programs.
- Since consumer is price sensitive, government should support food fortification by giving tax incentives.
- Development of food processing industries should be accelerated for greater scope for fortification.
- Proper monitoring mechanisms for all fortification programs should be set up and impact studies should be undertaken from time to time.

ANNEXURE

LIST OF ABBREVIATIONS

1. AA- Ascorbic Acid
2. AAY- Antyodaya Anna Yojana
3. APL- Above Poverty Line
4. AP- Ascorbyl Palmitate
5. BCC- Behavior Change Communication
6. BPL- Below Poverty Line
7. CBNP- Community Based Nutrition Programs
8. CDC- Chinese Centre for Disease Control
9. DFS- Double Fortified Salt
10. DRDO- Defence Research Development Organization
11. FAO- Food and Agriculture Organization
12. FCI- Food Corporation of India
13. FFS- Fortified Food Supplements
14. FPS- Fair Price Shops
15. FSSAI- Food Safety and Standard Authority of India
16. GAIN- Global Alliance for Improved Nutrition
17. GDP- Gross Domestic Product
18. GLV- Green Leafy Vegetables
19. GMO- Genetically Modified Organism
20. GM- Genetically Modified
21. Gms- Grams
22. GSCSC- Gujarat Civil Supplies Corporation
23. HDPE- High Density Polyethylene
24. HOI- Highest Observed Intake
25. ICDS- Integrated Child Development Services
26. ID- Iron Deficiency
27. IDD- Iodine Deficiency Disorder
28. IEC- Information, Education and Communication
29. IFFN- India Flour Fortification Network
30. I-M & E- Implementation, Monitoring and Evaluation
31. IR- Intermediate Results
32. IUGR- Intra Uterine Growth Retardation
33. JIT-Just in time
34. Mcg- Micrograms
35. MDMP- Mid-Day Meal Program
36. MDG- Millennium Development Goals
37. MFPI- Ministry of Food Processing Industries
38. Mg- milligram
39. MGNREGA- Mahatma Gandhi National Rural Employment Guarantee Act

40. MI- Micronutrient Initiative
41. MIS- Management Information System
42. MN- Micronutrient
43. MNM- Micronutrient Malnutrition
44. MOH- Ministry of Health
45. MT- Million Tones
46. NFHS- National Family Health Survey
47. NGO- Non-Government Organization
48. NHANES- The National Health and Nutrition Examination Survey in the United States
49. NIN- National Institute for Nutrition
50. NPNSPE- National Program of Nutritional Support to Primary Education
51. NTD- Neural Tube Defect
52. NVF- Nutraceutical Vehicularized Food
53. PDS- Public Distribution System
54. PEM- Protein Energy Malnutrition
55. PFA- Prevention of Food Adulteration Act
56. PPP- Public Private Partnership
57. PPCP- Public Private Community Partnership
58. RDA- Recommended Daily Allowance
59. RFM- Roller Flour Mills
60. RTE- Ready to Eat
61. SO- Strategic Objective
62. SPV- Special Purpose Vehicles
63. TFA- Trans fatty *Acid*
64. TPDS- Targeted Public Distribution System
65. UEE- Universal Education
66. UHT- Ultra Heat Treatment
67. UL- Upper Limit
68. UNICEF- United Nations International Children's Education Fund
69 U.T.- Union Territories
70 VAD- Vitamin A Deficiency
71 WFP- World Food Programme
72 WFF- Wheat Flour Fortification
73. WHO- World Health Organization

ILSI-India

International Life Sciences Institute-India

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