ADVANCES IN FOOD TECHNOLOGY AND NUTRITIONAL SCIENCES

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Commentary

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Commentary: Food Fortification: African Countries Can Make More Progress

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ABSTRACT

Micronutrient malnutrition (MNM) is a major public health issue in the developed world, but it is even more important in low-income, developing countries. The main forms of MNM include vitamin A, iron or iodine deficiency, but folic acid, vitamin D, selenium and zinc deficiencies, although less recognized, are important as well. A lack of those micronutrients represents a major threat to the health and development of populations, particularly children and pregnant women. They account for 7.3 percent of the global burden of disease.

In Sub-Saharan Africa where the prevalence of malaria, HIV, diarrhoea diseases and other infectious conditions is high, MNM increases their severity and has a high health impact on children and pregnant women. In Africa, the prevalence of anaemia in pregnant women is 52% percent and is a major factor that contributes to high maternal mortality rates. Vitamin D deficiency, rickets, osteomalacia and thyroid deficiency are highly prevalent chronic conditions in low income developing countries.

For many years, food fortification has proven to be the most cost effective means to prevent MNM. In recent years, many African countries have adopted mandatory fortification schemes. In 2002, Nigeria successfully mandated a salt iodization program and the fortification of maize and cooking oil with vitamin A, and sugar and flour with iron. The Tanzanian government passed mandatory food fortification legislation in July 2011, and it provides a tax exemption for imported premix for its national fortification program. Such efforts by African countries are playing a vital role in addressing MNM in Africa. More effort and support are needed to ensure that these programs are implemented successfully to effectively reduce MNM.

KEYWORDS: Food fortification; Micronutrient malnutrition (MNM); Folic acid; Vitamin D; Vitamin B12; Deficiency.

ABBREVIATIONS: MNM: Micronutrient malnutrition; DALYs: Disability-adjusted life years; VAD: Vitamin A Deficiency.

INTRODUCTION

This paper is written from the perspective of an African doctor with experience working in clinical and public health care and from that of a long experienced public health professional. The following commentary is, thus, addressed to policy makers and international donors interested in advancing the health of the African population. In Africa, malnutrition affects all age groups, but young children, women of reproductive age and the elderly tend to be among those most at risk of developing micronutrient deficiencies. For decades, considerable effort has been made to curb this "silent hunger". In recent years, a number of African countries have initiated food fortification programs, which have proven to be cost effective in addressing

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the issue of food security. For example, in 2002, Nigeria successfully instituted a mandatory salt iodisation program, and it also began to fortify maize and cooking oil with vitamin A, and sugar and flour with iron.[1-3] This established it as one of the first countries in Africa to embrace food fortification. A situational analysis two decades later showed that regulatory monitoring is requisite to ensure that fortification reaches it maximum potential.[4]

Micronutrient malnutrition (MNM) is widespread in industrialized nations, but more so in low income, developing regions of the world.[5,6] Fortification is a means to increase the content of essential micronutrients in basic foods; i.e., vitamins and minerals (including trace elements), so as to improve the nutritional quality of the food supply. Food fortification has advanced considerably in Africa,[5] and along with providing needed supplements to high risk groups, it provides public health benefits at a minimal cost and risk to the public.[5]

In Africa, the three most common forms of MNM are iron, vitamin A, and iodine deficiency but other forms of MNM, including deficiencies of folic acid, vitamin D, selenium and zinc, are also important. Together, these affect at least one-third of the world's population, the majority of which resides in developing countries.[5] MNM, being a risk factor for many diseases, can contribute to high rates of morbidity and case fatality rates.[5] It has been estimated that micronutrient deficiencies account for ~7.3 percent of the global burden of disease, with iron and vitamin A deficiency ranking among the fifteen leading causes of the global disease burden.[5]

According to WHO mortality data, ~0.8 million deaths (1.5 percent of the total) can be attributed to the annual level of world iron deficiency, and a similar percentage of the world's vitamin A deficiency.[5] In terms of the effect on overall health, as expressed by the term "Disability-adjusted life years (DALYs)", iron-deficiency anaemia results in 25 million DALYs lost (or 2.4 percent of the global total), vitamin A deficiency in 18 million DALYs lost (or 1.8 percent of the global total), and iodine deficiency in 2.5 million DALYs lost (or 0.2 percent of the global total).[5] In Africa, vitamin A deficiency significantly increases the under-five years of age mortality and morbidity levels, while iron deficiency anaemia is responsible for an estimated 20 percent of all maternal mortality while also contributing to poor physical and mental development in children.[2] Such deficiencies increase the mortality rate from diseases such as measles, diarrhoea diseases, malaria, tuberculosis, HIV/AIDS and others.[7]

Food fortification can lead to relatively rapid improvement in the micronutrient status of a population, and at a very reasonable cost, especially if advantage is taken of existing technology and local distribution networks.[5] This strategy has a long historical background. Iodised Salt has been used in the United States since the 1920's, and just prior to the US entering World War II, the fortification of milk with vitamin D, salt with iodine, flour with iron, niacin and other B vitamins were entrenched in the US based on the country's experience in combating pellagra.[5] Niacin has been added to bread in the US since 1938, vitamin D began to be added to margarine in Denmark in the early 1950's, and vitamins A and D were first added to Vanaspati (hydrogenated vegetable oil) in India in 1954.[5] Folic acid is added to flour on a mandatory basis in over 60 countries to prevent neural tube birth defects.[8]

The most widely used vehicles for fortification are among the most commonly consumed foods in Africa, including oils and fats, milk, sugar, rice, wheat flour and maize flour, with all of these reaching the vast majority of the population. The micronutrients that must be fortified and consumed daily are vitamins and minerals, in the form of trace elements, which means that they required in only small quantities for growth and development purposes (macronutrients are proteins, carbohydrates and fats).[9] Food fortification is the most cost effective and affordable way to reduce micronutrient deficiency in Africa.[5]

TYPES OF FORTIFICATION

Food fortification can take several forms. When we fortify foods that are widely consumed by the general population, it is called mass fortification.[9,10] To fortify foods designed for specific population subgroups, such as complementary foods for young children or rations for displaced populations, it is referred to as targeted fortification; permitting food manufacturers to voluntarily fortify foods available in the market place, is termed market-driven fortification. An example of this type of fortification is breakfast cereal, however, these cereals are not commonly accessed by the low income majority that is most in need of essential trace elements.[9]

IMPORTANCE OF FOOD FORTIFICATION

In 1981, Sir Nicholas Wald and colleagues at the United Kingdom's Medical Research Council demonstrated in a randomized control trial that spina bifida and anencephaly (neural tube defects) were folate deficiency disorders.[8] Many years later, we are aware that folic acid fortification has proven to be a huge success in preventing these conditions[8] and that more than sixty countries had started flour folic acid fortification programs by 2013.[5] However, there is still resistance to mandatory fortification, and relatively few European countries have adopted this practice, while all countries in the Americas and many others have done so. Birth defects are a major contributor to infant mortality and morbidity, requiring costly life-long medical care. The benefits of birth defect prevention through food fortification are potentially large, and food fortification can be a very cost-effective public health intervention.[2]

Fortification has nearly a century long record of success and safety, and it has proven effective in the prevention of specific diseases, including birth defects.[5] Understanding the pathophysiology and epidemiology of micronutrient deficiencies, and implementing successful methods of prevention, are

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both vital for nutritional security in setting contemporary public health standards for folic acid, vitamin A, vitamin B complex, including vitamin B12,[8] and vitamin D intake.[11] If a food fortification delivery system is in place, it is feasible to fortify it with several micronutrients, making safe intervention relatively easy to implement, regulate and monitor. In this case, food fortification is a more cost effective and sustainable strategy than are others.[9]

Advantages of Food Fortification

Food fortification has many benefits, since it utilizes staple foods consumed by a large segment of the population, it does not change the original product, it is technologically feasible, and fortification can easily be implemented in developing countries.[9]

Life styles have changed considerably around the world over the last several years. There is inadequate exposure to sunlight among children,[12] primarily because children spend less time outdoors than they did in previous decades. The widespread prevalence of vitamin D deficiency, even in sunny countries, is especially high among breast fed, dark skinned children and obese children and adults.[13,14] Vitamin D deficiency is also widely prevalent in countries at low latitudes, where it was generally assumed that UV-B radiation was adequate enough to prevent vitamin D deficiency, and in industrialized countries, where vitamin D fortification of milk and margarine has been implemented for many years.[15] Supplements for pregnant women and infants, along with milk or other commonly used manufactured foods, fortified with vitamin D, are the most effective and affordable way to prevent vitamin D deficiencies, including rickets and osteomalacia. Food fortification does not require people to alter their diet, thus, it is socially acceptable. The effect of fortification is rapid and covers a large part of the population without deleterious effects on taste, shelf life or the nutritional value of the food.[5,9,16] Fortification is the most cost effective approach to prevent nutrient deficiencies.[9,16] It can be introduced quickly through existing marketing and distribution channels, and the benefits are readily apparent.[9] Apart from that, fortification will reach other high risk groups, such as the elderly. Through basic food fortification, we may be able to prevent neuro-tube defects due to folic acid deficiency,[17] Vitamin A deficiency (vitamin A), rickets and osteomalacia (vitamin D),[14] dental caries (fluoridation of drinking water in endemic areas), goitre and growth delays (Iodization of salt)[17] and ID anaemia (iron in salt or flour).[9] All these conditions can be prevented in the most at risk groups of children and pregnant women.[10,18]

Requirements for a Successful Food Fortification Program

In order to have a successful food fortification program, political leadership and support from the health professions, industry and the general public are vital. Political will is needed to legislate mandatory food fortification and to regulate the food industry, with adequate legislation to ensure adherence to agreed upon practices and to set standards for other voluntary fortification schemes. Recognizing that anti-fortification lobbyists and misinformation is widely distributed on the internet, well planned public information campaigns by the government and NGOs will be required to lobby for improved maternal and child health through fortification. Consumer acceptance is very important, and there should be no cultural objection to fortification.[3,9] The key players should ensure availability of micronutrients in a sustainable way.[5]

Key Players

The following key players needed to succeed in facilitating a functioning and sustained fortification program include: government policy makers, the food industry, public health officials, regulatory bodies, NGOs and international donors, and quality monitors, such as nutrition bodies and community involvement groups. Policy forums and community focus groups can help to promote public understanding of the importance of fortification and to participate in reporting progress. Public health professionals and policymakers in state and local governments, with the support of international agencies, have a moral responsibility to promote aggressive and well-supported national nutrition policies.[3]

Criteria for Fortification

An obvious requirement is that the fortified food(s) need to be consumed in adequate amounts by a large proportion of the target individuals in a population,[16] and it should not adversely affect the balance of other nutrients.[17] It is also necessary to have access to, and to use, fortifiers that are well absorbed yet do not affect the taste and appearance properties of foods. In most cases, it is preferable to use food vehicles that are centrally processed, and to have the support of the food industry.[5] Vehicles selected must be a part of the regular daily diet of the relevant segment of the population, the amount of nutrient added must provide an effective supplement for low consumers of the vehicle, and it should not be harmful to the consumer or cause any noticeable change in the taste, smell, appearance or consistency of the product.[16]

SUPPLEMENTATION

Supplementation is another vital approach used to provide additional nutrients, as a key component of public health programs, such as maternal and child health. This requires a long-term commitment and excellent outreach programs.[17] Supplementation is the term used to describe the provision of internationally recognized doses of micronutrients, usually in the form of pills, capsules or syrups.[5] It has the advantage of being a viable means to supply an optimal amount of a specific nutrient or nutrients, in a highly absorbable form, and is often the fastest way to control deficiencies in individuals or population groups that have been identified as being deficient.[5]

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FORTIFICATION TECHNOLOGY

Fortification technology includes the dry mixing of foods, such as wheat and maize flour and their products, and the supplementation of liquid and powdered milk, beverage powders, breakfast cereals, cooking oils, rice and other widely used processed foods.[19] As well, nutrients can be dissolved or added in liquid milk, drinks, fruit juices, bread, pastas, cookies, or sprayed on corn flakes and other processed foods that require cooking or extrusion steps that could destroy vitamin activity. They can also be dissolved in oil for oily products, such as margarine, or added for sugar fortification. Vitamin A in powder form is absorbed onto the surface of sugar crystals when used with a vegetable oil or coated for foods like rice, where the vitamins sprayed over the grains must adhere to the food product to avoid losses when the grains are washed before cooking.[16]

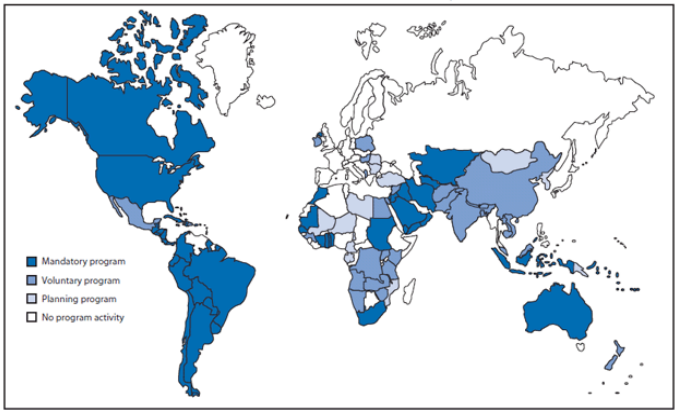
Monitoring Fortification for Quality and Impact

In order for fortification to have maximum health impact, quality measures must be monitored routinely, with results analyzed, and technical problems corrected.[17] It is essential that the process include food control and program monitoring.[20] Food control can be internal (industrial), external (regulatory) or commercial (households).[20,21] Internal control is when public or commercial flour millers use procedures such as recording the use of premix and conducting spot tests to provide quality checks, while external control is when government authorities (such as food safety inspectors) test products at mills periodically to ensure that fortification meets the country's specifications. Commercial control is when food safety inspectors check retail stores to be sure that the fortified product is in the marketplace.[21] Monitoring involves intake using household and market surveys to confirm that fortified rice or food made with fortified flour is purchased, that people are consuming it, and that enough is eaten to have the desired effect.[20] Impact monitoring checks if products are fortified at recommended nutrient levels and at least 80 percent of the population is consuming the products, so that countries may assess the impact of biological and clinical outcomes.[21] Measures such as child growth patterns, anaemia rates and iodine levels in the urine of pregnant women and schoolchildren are examples of vital biological monitoring. Data from routine demographic and health surveys or birth defect surveillance programs may be a valid indication of a fortification program's impact.[20]

CURRENT SITUATION

Sub-Saharan Africa

Significant progress in food fortification is being achieved throughout Africa.[2] In Sub-Saharan Africa, 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.[5] New low-cost tools are being developed to increase the ease of assessing micronutrient levels in fortified foods, thereby improving program monitoring and effectiveness in an ongoing and sustainable manner.[2] More than 70 percent of the population of African countries with mandatory fortification and legislation is now estimated to be regularly consume at least one fortified food staple daily.[2,19] Zambia began a successful program of fortifying sugar with vitamin A in 1998. Continued support for food fortification is required to ensure scale-up throughout Africa.[2] In South Africa, a significant decline in the prevalence of NTDs of 30.5 percent was observed, from 1.41 to 0.98 per 1,000 births (RR 5 0.69; 95 percent CI: 0.49-0.98; p 5 .0379) following folic acid fortification.[22]



Source: Flour Fortification Initiative.[20]

Figure 1: Countries (N=53) with regulations for fortification of wheat flour with folic acid, by program status -worldwide, June 2010.

Case Report -Tanzania

In Tanzania, vitamin and mineral deficiency pose a severe health problem, contributing to the heavy burden of disease and disability as well as exacting a heavy economic toll.[23] In April 1994, the national salt iodization program was officially inaugurated, which led to the availability of iodized salt in households. Availability of iodized salt subsequently increased from nearly zero in the 1980's to a sufficiency level of more than 90 percent.[24] Total goitre prevalence decreased from 25 percent in the 1980's to 7 percent in 2004. In addition, iodized oil capsules have been distributed to ~5 million persons 1-45 years of age in severely endemic areas. The WHO classifies Vitamin A Deficiency (VAD) in Tanzania as a clinical and public health problem.[25] Countrywide, an estimated 10,000 children are likely to suffer from VAD-related blindness at any given time.[7]

The success of Tanzania in improving food fortification is partly due to improved community based programs with strong community participation.[7,26] But the government has also been a contributing factor, with an announcement of mandatory food-fortification legislation in July 2011, and enforcement beginning in May 2013. The government provides a tax exemption for imported premix for the national fortification program.[27]

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CHALLENGES AND THE WAY FORWARD

Apart from these successes, food fortification faces a number of challenges which must be addressed. Among these are the cost of fortification, a lack of dietary diversification, the presence of natural anti-nutrient (i.e., phytates and tannins), disease and poor health due to AIDS, malaria and intestinal parasites, low utilization rates in large mills and a general lack of education.[7]

The benefits, safety and cost effectiveness of food fortification have been demonstrated globally, hence, more effort needs to be expended to ensure that all countries adopt mandatory food fortification programs to reduce the burden of various diseases that especially effect children and pregnant women.[28] To achieve this in Africa, a number of priority activities are required, including harmonized fortification standards, strengthened quality management systems and capacities, dedicated and coordinated leadership and oversight of fortification programs, fortification coverage assessments, fortification labelling, and continued advocacy and monitoring.[2,29] Home fortification has some advantages, and evidence in support of the efficacy of home fortification is building, as countries like South Africa and Malawi have shown certain degrees of success with this approach.[30,31] One review demonstrated that home fortification with MNP reduced anaemia rates by 31 percent (six trials, RR 0.69; 95 percent CI 0.60 to 0.78) and iron deficiency by 51 percent (four trials, RR 0.49; 95 percent CI 0.35 to 0.67) in infants and young children when compared with no intervention or a placebo.[32]

RECOMMENDATIONS

The following recommendations are important for the success of food fortification, especially in developing countries:

- Food fortification should be recognized as a public health priority, no less important than universal vaccination programs.
- Government and NGO leadership are needed to enact legislation, funding and technical support for the mandatory and regulated voluntary fortification of basic foods to promote community awareness about the benefits of food fortification.[5,33]
- A multi-sectoral approach must be adopted in the establishment of any food fortification programme, encompassing participation of relevant governmental organizations, food industry, trade organizations, consumers, academic and research facilities, marketing specialists and any involved international organizations and agencies.[34,35]
- Ensure increased availability of fortified foods to the vulnerable groups of populations.[26,36,37]
- There should be appropriate fortification of foods used in food aid programmes, with donors being required to provide relevant nutritional information, particularly through adequate labeling.[35]

CONCLUSION

Food fortification is vital to national, community and individual health, therefore, we should adopt guidelines and regulations to ensure its proper implementation, to use processes that cause minimal losses, and to choose packaging materials that give maximum protection.[16] Fortification by government mandate and regulation is essential, with cooperation from the private sector, food manufacturers, and in the context of broader policies for poverty reduction, education and agricultural reform.[1,34] It should be part of priority public health nutrition vital to the development of the nation, along with supplementation, for high risk groups and nutrition monitoring.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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