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Food system strategies for preventing micronutrient malnutrition

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ABSTRACT

Micronutrients are defined as substances in foods that are essential for human health and are required in small amounts. They include all of the known vitamins and essential trace minerals. Micronutrient malnutrition affects ⅓–½ of the global population. It causes untold human suffering and levies huge costs on society in terms of unrealized human potential and lost economic productivity. The goal of this paper is to identify deficiencies in the food system that lead to micronutrient malnutrition and explore and evaluate strategies for its prevention. We examine the impact of agricultural practices on micronutrients in the food supply, including cropping systems, soil fertility and animal agriculture. We then discuss the potential of biofortification – i.e. increasing the concentration of micronutrients in staple food crops through conventional plant breeding or genetic engineering– as a means to reduce micronutrient deficiency. In addition, we discuss the impact of food losses and food waste on micronutrients in the food supply, and we explore successful strategies to preserve micronutrients from farm to plate, including food fortification. Our review of the literature sheds light on the advantages and limitations of alternative interventions to reduce micronutrient deficiencies along the supply chain. We end with recommendations for actions that will reduce the prevalence of micronutrient malnutrition.

Introduction

Micronutrients are substances in foods that are essential for human health and are required in small amounts. They include all of the known vitamins and essential trace minerals. Micronutrient malnutrition develops when intakes of bioavailable micronutrients are too low to meet requirements. It affects ⅓–½ of the world population. The 3 most prevalent forms of micronutrient malnutrition are iron, iodine, and vitamin A deficiencies (Allen et al., 2006). Zinc and vitamin B-12 deficiencies are also widespread. Consequences of micronutrient malnutrition include increased mortality rates, especially in women and children; poor pregnancy outcomes; increased morbidity; impaired mental and physical development in children; and reduced work productivity in adults (Black et al., 2008).

Both the density and bioavailability of micronutrients in the diet are important for achieving optimal micronutrient status. Nutrient density is the amount of a nutrient in a food per calorie or unit weight. Bioavailability is the proportion of an ingested nutrient that is absorbed and utilized for some essential metabolic function.

Food systems are linked to the nutritional wellbeing and heath of individuals and populations through the nutrients and other bioactive components contained in the foods they supply. Agriculture is the foundation of all food systems in that agricultural products are the primary source of most nutrients. If agriculture cannot supply all the essential nutrients in amounts required for good health and productive lives, malnutrition develops. To date, the primary focus of agricultural research, policy, and practice has been on increasing yields with little attention paid to improving the nutrient output of farming systems. Increasing yields is important but the nutritional quality of crops produced must also be a priority if sustainable progress toward reducing the prevalence of malnutrition is to be realized.

A basic tenet of a nutritionally adequate diet is the principle that it must contain a variety of foods from several different food groups. Therefore, strategies for improving the nutritional status of populations should include efforts to increase dietary diversity. However, while agricultural production is a necessary component of an adequate food supply, it is not sufficient. A well-functioning food value chain is also necessary to deliver food to the consumer. The food processing sector is an important component of the food value chain. Food processing can reduce food waste, prevent nutrient losses, increase nutrient content through fortification, enhance the acceptability of foods to consumers, reduce risk of foodborne illness, provide jobs and economic development, and reduce the time and energy required for home food preparation. Conversely, food processing can be detrimental to nutritional quality when it manufactures foods that are high in added sugar, fat, and sodium or when it removes nutrient dense fractions from whole foods as is often the case in cereal milling operations.

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A major cause of micronutrient malnutrition in low income populations is lack of access to a variety of foods. When incomes are low, people rely on inexpensive sources of calories, such as cereals and tubers, to meet energy needs (Bouis et al., 2011a). These foods tend to be poor sources of many micronutrients. More nutrient dense foods such as fruits, vegetables, and animal products are more expensive and, as a result, are often beyond the reach of the poor (Bouis et al., 2011a).

Aim of this review

The aim of this review is to identify deficiencies in the food system that lead to micronutrient malnutrition and explore and evaluate strategies for its prevention. We examine the impact of agricultural and food processing practices on micronutrients in the food supply. We then discuss the potential of fertilization, plant breeding, food processing, and food fortification for enhancing the availability of micronutrients to consumers in both developing and developed countries. We conclude with key lessons to guide intervention policies.

Strategies for preventing micronutrient malnutrition

Numerous factors throughout the food system impact the concentrations and bioavailabilities of micronutrients in food supplies and in the diets of individuals and families. Fig. 1 provides an overview of the factors that influence the nutritional quality of diets that are ultimately consumed by people. Clearly, the task of designing interventions for preventing micronutrient malnutrition is complex given the multifactorial nature of the problem. We will organize our discussion of strategies into three categories: (1) Agricultural production strategies, (2) food processing strategies, and (3) economic and consumer education strategies.

Agricultural production strategies

Background

There is growing support for the notion that agricultural interventions have an important role to play in efforts aimed at improving the nutritional status of populations (Welch, 2001; Masset et al., 2012). Since most human foods are products of agricultural enterprises, it should be obvious that agricultural policies designed to increase the production of a wide variety of nutrient-dense foods and make them available at affordable prices will increase intakes of deficient micronutrients and, ultimately, reduce prevalences of micronutrient malnutrition. Unfortunately there have been only a very limited number of studies designed to assess the effectiveness of agricultural interventions on nutritional status. Given that so many factors influence micronutrients in foods, a holistic food systems approach to combating micronutrient malnutrition is the only way to achieve sustainable solutions to micronutrient malnutrition (Graham et al., 2007; Combs et al., 1996; Welch and Graham, 2005). Such an approach requires trans-disciplinary collaborations that include the agricultural sector. Various agricultural strategies including the use of fertilizers, improvements in cropping systems, and plant breeding for enhanced nutritional

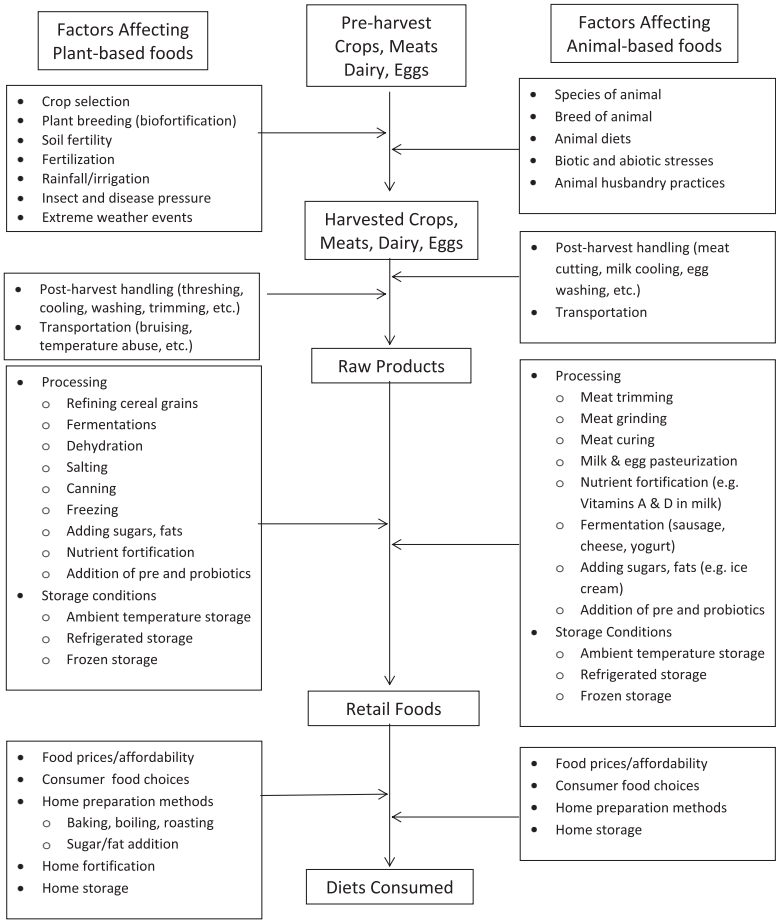

Fig. 1. Factors affecting concentrations and bioavailabilities of micronutrients in human diets.

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