

EVALUATING FOOD-BASED APPROACHES TO PREVENT MICRONUTRIENT MALNUTRITION USING ISOTOPE TECHNIQUES



Fruit and vegetables are one of our main sources of vitamins and minerals – market in Cotonou, Benin.

(Photo: C. U. Loechl, IAEA)

Good nutrition needs more than just carbohydrates, protein and fat. Humans may eat enough calories to live, but may have a diet that fails to provide sufficient levels of crucial vitamins and minerals that allow them to be mentally and physically healthy. A lack of these essential vitamins and minerals often results in what is termed as ‘hidden hunger’, where the signs of undernutrition are less visible and people may not even be aware of it. Hidden hunger has been estimated to affect as many as 2 billion people globally. Vitamin and mineral deficiencies account for an estimated 7.3% of the global disease burden, with iron and vitamin A deficiencies ranking among the top 15 leading causes of the global disease burden. Hidden hunger impairs the mental and physical development of children and adolescents and can result in lower IQ, stunting, and blindness; women and children in low-income countries are especially vulnerable. Hidden hunger also reduces the productivity of adult men and

women due to increased risk of illness and reduced work capacity.

Micronutrients are substances needed in amounts of less than 100 mg (less than the weight of two grains of salt!) per day for good health, growth and development. They include all vitamins, as well as some minerals such as zinc, iron, chromium, copper, manganese and iodine. Micronutrients play important roles in nutrition, including ensuring healthy growth and development, resistance to infection, and specific functions such as good vision, bone strength, or oxygen-carrying in red blood cells. Many micronutrients are limited in human diets, largely due to high intakes of energy-dense, nutrient-poor staple foods. In developing countries, many individuals do not have the resources to purchase or cannot access a wide range of nutritious foods such as meat, eggs and fish, as well as fruit and vegetables in order to meet their nutritional requirements.

Current strategies to address hidden hunger include individual supplementation, staple food fortification, biofortification of crops and improved dietary diversification.

Micronutrient supplementation provides one or more micronutrients daily or periodically in liquid, tablet or capsule form. For example, high dose vitamin A supplements are given every 6 months to children between 6 and 59 months to prevent mortality in areas where vitamin A deficiency is prevalent.

Food fortification can be achieved by adding micronutrients to staple foods that are regularly eaten by the population, so that the micronutrient is consumed frequently in amounts chosen to prevent deficiencies, while avoiding the likelihood that excessive amounts, which are also unhealthy, will be consumed. This provides an efficient distribution system for staple foods that are processed at just a few sites and distributed widely, for example large grain mills or the principal producers of cooking oils.

Biofortification is the process by which the nutritional quality of staple crops is enhanced. Biofortified crops accumulate higher levels of minerals and vitamins in their seeds and roots during growth. Biofortification is intended to be a self-sustaining agricultural approach to food fortification that involves the breeding, selection and promotion of staple food crops based on their nutrient content to meet human nutritional requirements, in addition to other agricultural attributes such as crop yield and disease resistance.

Another essential strategy is the promotion of dietary diversification or consumption of a wide variety of foods across nutritionally distinct food groups. Dietary diversification or modification strategies at the community or household level aim to enhance the availability, access, and utilization of foods with a high content and bioavailability of micronutrients throughout the year. This approach involves changes in food production practices, food selection patterns, and traditional household methods for preparing and processing indigenous foods.

The IAEA provides support for the use of stable isotope techniques to investigate absorption and retention of iron or zinc from fortified or biofortified foods fed to adults or children, from mixed diets that contain enhancers and inhibitors of absorption or from modified dietary practices, for example using traditional

IAEA SUPPORTS RESEARCH ON NUTRITION-SENSITIVE AGRI-FOOD SYSTEMS

As a continuation of its biofortification research, the IAEA is starting a new five-year coordinated research project on the use of nuclear techniques to assess the role of nutrition-sensitive agri-food systems in improving the diet, health and nutritional status of vulnerable populations. This research project will generate important information about the role of body composition in understanding the link between agriculture and nutrition and in strengthening the evidence in support of nutrition-sensitive agricultural policies and practices. Compared to total body weight, body composition provides a more sensitive means of assessing changes in nutritional status in response to nutrition-sensitive agricultural interventions and changes in consumption.

The deuterium dilution stable isotope technique, one of the most accurate techniques for assessing body composition, will be used in this research project. Studies, which have been accepted so far from Bangladesh, Cuba, Haiti, Myanmar, Peru, Senegal and Tanzania, will evaluate different nutrition-sensitive agricultural interventions, such as household or community level gardens with nutritious crops, diversification of crops and dairy promotion in combination with nutrition education.

household methods, such as fermentation, germination and soaking to reduce phytic acid. In addition, stable isotope techniques can be used to quantify how much human milk is consumed by infants. When this information is combined with the micronutrient content (e.g. vitamin A) of human milk, the infants' micronutrient intake can be estimated.

The IAEA is currently concluding a coordinated research project on food fortification and biofortification to improve micronutrient status during early life. Three examples from this research project show the importance of stable isotope techniques in the evaluation of the bioavailability of iron or zinc from biofortified crops. In Rwanda, investigators used iron stable isotopes to study iron absorption from beans to determine which chemicals in beans should be the focus of crop breeding programmes to improve the absorption of iron from beans. Beans have two components known to reduce iron absorption, phytic acid and polyphenols. Phytic acid (which also occurs in whole grains and seeds) binds minerals such as iron, calcium and zinc, thereby substantially



Market in Burkina Faso.
(Photo: N. Mokhtar, IAEA)

reducing mineral absorption. Polyphenols, compounds associated with the pigments of coloured beans, also reduce iron absorption. The study in Rwanda found that the phytic acid in beans inhibited iron absorption by women so substantially that there would be little or no benefit in increasing iron or decreasing the polyphenol content of beans without also decreasing the phytic acid content. These findings, published in 2012, provide information to agricultural scientists about the best strategies for developing iron-biofortified bean crops.

A zinc absorption study in Bangladesh showed that, zinc-biofortified rice contained more zinc, but it was less efficiently absorbed, so did not substantially improve the total amount of zinc retained by children compared with control rice. This 2013 study indicated that the zinc content of the biofortified rice needed to be further increased to have a meaningful effect on the children's zinc nutrition. In India, iron and zinc from biofortified pearl millet, a staple food, were well absorbed in amounts that meet the requirements for young children. Children under the age of three could meet their full daily iron needs from just 100 grams of the biofortified pearl millet flour. This 2013 finding that biofortified pearl millet could improve children's nutrition demonstrates that it would be useful to further disseminate this crop,

which is now being cultivated by more than 30 000 farmers in Maharashtra, India, and that it will also be useful to do so in arid and semi-arid regions of Africa.

Another study in Morocco is investigating the impact of the daily consumption of vitamin A fortified oil and vitamin A supplementation on the vitamin A content in human milk in lactating women during the first 6 months postpartum. Vitamin A in human milk and human milk intake is measured in infants at 3 and 6 months of age.

The IAEA is also sponsoring ongoing research on dietary modifications that enhance the nutrient intake from plant-based local complementary foods and human milk to prevent micronutrient deficiencies in infants and young children in developing countries. Examples include:

- Addition of phytase (an enzyme that splits phytic acid, which reduces iron and zinc absorption) and fish to plant-based traditional complementary foods in Bangladesh to enhance zinc absorption;
- Addition of amaranth grain (a pseudo-cereal) (20%) to traditional white maize tortillas to enhance zinc absorption in young Guatemalan children;
- Addition of a whey-protein based nutritional supplement to a plant-based diet in young children in Mexico to improve iron and zinc absorption;
- Food supplementation (leaf powder) for pregnant women until one month postpartum to increase infants' vitamin A intake from human milk.

The results of the IAEA supported research will help to establish effective and sustainable strategies and interventions based on locally available foods to prevent and combat micronutrient deficiencies.

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