1) A review of phytate, iron, zinc, and calcium concentrations in plant-based complementary foods used in low-income countries and implications for bioavailability. Gibson RS, Bailey KB, Gibbs M, Ferguson EL. Food Nutr Bull 31: S134-S146, 2010.

2) The adequacy of micronutrient concentrations in manufactured complementary foods from low-income countries. Gibbs M, Bailey KB, Lander RD, Fahmida U, perlas L, Hess SY, Loechl CU, Winichagoon P, Gibson RS. J Food Comp Analysis 24: 418-426, 2011.

Introduction

Previously published reviews have concluded that home-prepared complementary foods available in low-income countries frequently lack sufficient quantities of selected essential nutrients, which have been designated by the World Health Organization as "problem nutrients" (Brown, 1998; Gibson, 1998). The most commonly identified problem minerals are iron, zinc, and calcium; and deficiencies of these minerals can lead to adverse health consequences and restricted child growth and development. Inadequate intakes of these nutrients occur most commonly when the local complementary foods are based primarily or exclusively on plant-derived products. This is because plant-based complementary foods usually have low mineral contents relative to young children's physiological requirements, and these foods often have high levels of inhibitors of mineral absorption, such as phytic acid (also known as phytate). In theory, commercially processed, fortified complementary foods could overcome these nutrient shortfalls, but little information has been published on the nutrient content of processed complementary foods that are available in lower-income countries.

The two papers selected for this month's edition of NNA present information on the mineral content and estimated mineral bioavailability of locally available complementary foods. The first paper also provides background information on related technical and conceptual issues, such as methods of laboratory analysis and techniques for estimating mineral bioavailability (or mineral absorption and utilization from these foods), by using the ratios of phytate and each mineral. The papers then summarize specific information on the iron, zinc, calcium, and inositol penta-phosphate and hexa-phosphate (IP-5 and IP-6) contents of both home-prepared and industrially produced complementary foods consumed in lower-income countries, including several African countries. (IP-5 and IP-6 are the chemical forms of phytate that reduce mineral absorption.) Strategies that can be applied at the household level to reduce the phytate content of complementary foods, and thereby enhance mineral absorption, are also discussed.

Methods

The first paper by Gibson et al is organized into several sections, including the background items described briefly above and the results of the authors' analyses and estimates of the mineral and contents of local complementary foods. The nutrient contents of the home-prepared complementary foods were calculated from traditional recipes, using values obtained from analysis of the major staple foods in each mixture and from food composition tables. For the manufactured foods, the concentrations were determined by direct chemical analysis. The second paper by Gibbs et al focuses specifically on the measured mineral and phytate contents of industrially processed complementary foods purchased in the capital cities of five African and five Asian countries, and compares the measured mineral contents and phytate:mineral molar ratios with recommended intakes for 9-11 month old infants. For these latter sets of analyses, the authors assumed that the targeted infants would consume an average amount of breast milk and the recommended amount of energy from the complementary foods.

Results and conclusions

As expected, the indigenous complementary food recipes based on starchy roots and tubers or rice contained very low amounts of iron, zinc and calcium unless they also included animal source foods. By contrast, the recipes prepared from maize and legumes or other cereal mixtures and legumes had higher iron and zinc contents, but they also had considerably greater phytate contents. In both types of recipes, the low mineral content and/or predicted bioavailability indicated that almost all the recipes would not meet the theoretical mineral requirements of young children. Only those recipes that were enriched with liver, eggs, powdered fish (with bones) or milk powder had adequate (or near adequate) mineral contents.

The concentrations of iron and calcium varied markedly in the African processed complementary foods, depending mainly on whether or not they were fortified or (in the case of calcium) contained added milk powder. On the other hand, zinc concentrations were less variable and generally low, except for the three preparations that were fortified with zinc. Most preparations had unfavorable phytate:mineral ratios. Of the 25 African processed complementary foods that were analyzed, only two met the theoretical requirements for iron, one for zinc, and two for calcium. The foods that came closest to satisfying requirements were stated to be fortified, but even some that claimed to be fortified had inadequate mineral contents and/or estimated bioavailability.

Program and Policy Implications

The analyses of indigenous, home-prepared complementary food recipes are consistent with the concerns previously raised that these preparations are inadequate with regard to mineral content and/or bioavailability. Possible intervention strategies to improve the nutritional quality of these recipes include the addition of animal source foods; reduction of phytate (in those few instances where the mineral contents are adequate, but the phytate:mineral ratio suggests poor mineral bioavailability); point-of-use fortification with micronutrient powders or lipid-based nutrient supplements; or mineral supplementation.

It is somewhat alarming that most of the commercially distributed, processed complementary foods had inadequate mineral contents, even though these are often marketed specifically for young children and many claim to be fortified. Although a few of the preparations that were stated to be fortified had adequate contents of selected minerals, most did not. Moreover, the chemical form of the fortificants was generally not stated, so their bioavailability is uncertain.

NNA Editors' comments*

These papers highlight a critical issue for young children's nutrition during the period of complementary feeding. Although concerns have been raised for a number of years regarding problem nutrients in general, and the dietary adequacy of key minerals in particular, little information has been published on the specific mineral and phytate contents of the foods that are currently available and consumed in lower income countries. Thus, the articles fill an important information gap and reemphasize the need for targeted nutrient interventions for this age group. Nutritionists in these settings should seek opportunities to improve the food components and/or home processing of complementary food mixtures and work with the local food industry to enhance the nutritional quality of their products. National public health agencies should develop specifications for processed foods targeted to young children, and should require product labels to reflect what is actually present in the foods and their nutritional adequacy for the target population.

References

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