# Adequacy of iron and zinc content and estimated bioavailability in commercially available complementary foods in Ethiopia

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## ABSTRACT

*Iron and zinc are the major micronutrients lacking in the diets of infants and children in many parts of the world particularly in developing countries who are living in resource poor settings. As a result complementary food formulated by many industries are geared towards fortifying their products with multimixes containing those nutrients. In our study we collected seven commercially available fortified and non fortified complementary foods (CFs) from supermarkets in Addis Ababa. Iron, zinc and phytate (IP6) contents were analyzed and the contents were in the range of 5.85-22.31, 0.80-12.07 and 235-893 mg/100g DM. One product which was claimed to be fortified had the least iron and zinc content. Highest amount of IP6 was obtained in products that are formulated form a mix of more than 10 cereals, legumes and pulses. The molar ratio of [IP]:[Fe] was found to be in the range of 0.89-7.07 and it is above the recommendation for almost all the analyzed products. While [IP6]:[Zn] was in the range of 1.93-30.63 and 3-out of the 7 CFs meet the recommendation. The iron content of all CFs analyzed were below the recommendation for 6-11 month-old children but 5 out-of 7 CFs contained adequate iron for 12-23 month-old children. The products are also poor in zinc and only 2 out-of 7 CFs could contribute to more than 80% of the requirement for both age groups. Therefore, manufacturers are strongly recommended to properly process the raw materials to achieve maximum dephytinization in combination with proper level of mineral fortification.*

## INTRODUCTION

Malnutrition in infants and young children is one of the most serious health problems in the developing world. Globally, 15% of under five children suffer from being underweight and 25% from stunting (UNICEF 2014). In Ethiopia 29% of under five children are underweight and 44% are stunted which is higher than the global average despite some improvements than the previous years (EDHS 2011). Although the causes for malnutrition are diverse, inadequate complementary feeding is the major contributing factor. Many of the complementary foods prepared in developing countries are plant-based that are frequently associated with micronutrient deficits, particularly of iron, zinc, and calcium. Moreover, the presence of high levels of phytic acid resulted in poor bioavailability of these nutrients, especially when the complementary foods are based on unrefined cereals and legumes. The deficiency of these micronutrients is associated with delays in motor and mental development, as well as increased morbidity and mortality. In recent years, attempt has been made to fortify commercial complementary foods with vitamin and mineral multimixes to meet the nutrient requirement of infants and children, despite achieving correct level of fortification is still a challenge and hamper the national and global effort to mitigate malnutrition.

## OBJECTIVES

Evaluate the adequacy of iron and zinc contents and estimated bioavailability of commercially available complementary foods (CFs) processed in Ethiopia.

## METHODOLOGY

Seven locally-produced fortified and non-fortified cereal-based CFs were purchased from supermarkets in Addis Ababa, Ethiopia in August 2013. Iron and zinc contents were determined by atomic absorption spectrometry and results were compared with recommendations for fortified CFs (Lutter and Dewey 2003). Phytate particularly *myo*-inositol hexaphosphate (IP6) was determined using high-performance anion-exchange chromatography. Iron and zinc bioavailability was estimated by calculating IP6-to-mineral molar ratios and comparison was made with the recommendations (Hurrell 2004; Brown et al., 2004).

**Table 1. Product description and level of fortification of commercially available complementary foods in Ethiopia**

| Sample | Major Ingredients | Mineral and vitamin premix added + or not - |
|---|---|---|
| CF1 | Barely flour, oats, soybean and iodized salt | + |
| CF2 | Wheat, soybean, chickpea, milk powder and sugar | + |
| CF3 | Wheat, carrot, spinach, pumpkin, skimmed milk powder, full cream milk powder, palm oil, sugar, iodized salt and enzyme* | + |
| CF4 | Corn and soy blend | + |
| CF5 | Corn, rice, soya, milk powder, sugar and fruits | + |
| CF6 | oats, barely, soybean, peanut, wheat, broad bean, lentil, pea, maize, sesame, bulla§, red sorghum, fenugreek, linseed and teff. | – |
| CF7 | soybean, barely, red teff, lentil, pea, millet, peanut, wheat, fenugreek, linseed, broad bean, maize, sorghum, sesame, bulla§, oats | – |

*Alpha amylase was added to facilitate starch hydrolysis  § Product of *Ensete Ventricosum*

## RESULTS & DISCUSSION

Among the seven complementary foods collected for the analysis, five of them were fortified with vitamin and mineral premixes (Table 1). Surprisingly the unfortified CFs constitute more than 10 cereal, legume and pulse mixes which shows the formulation was done with out any notion about nutrient contribution of the ingredients.

Iron and zinc contents of CFs varied widely in the range of 5.85-22.31 and 0.80-12.07 mg/100g DM, respectively (Table 2). CF5 had the least iron and zinc contents although it was declared as fortified complementary food. The IP6 content was in the range of 235-893 mg/100g DM with the highest IP6 content in complementary foods formulated from many cereals, legumes and pulse mixes showing that the ingredients were not properly processed targeting to lower the level of mineral absorption inhibitors. The molar ratios [IP6]:[Fe](0.89-7.07) was above the recommendation for 6-out of 7 CFs. While the molar ratios of [IP6]:[Zn](1.93-30.63) was met by 4 of the CFs (Table 2).

**Table 2: Iron, zinc and IP6 contents and molar ratios of IP6 to minerals in commercially available complementary foods in Ethiopia**

| Sample | Mineral contents | | IP6 | IP6:Fe | IP6:Zn |
|---|---|---|---|---|---|
| | Fe | Zn | | | |
| CF1 | 15.15 | 7.64 | 676.88 | 3.78 | 8.78 |
| CF2 | 13.85 | 4.74 | 326.43 | 1.99 | 6.82 |
| CF3 | 22.31 | 12.07 | 235.31 | 0.89 | 1.93 |
| CF4 | 17.55 | 10.50 | 723.04 | 3.49 | 6.82 |
| CF5 | 5.85 | 0.80 | 247.23 | 3.58 | 30.63 |
| CF6 | 10.68 | 2.97 | 892.48 | 7.07 | 29.78 |
| CF7 | 11.89 | 2.57 | 753.95 | 5.37 | 29.07 |

Assuming breast fed infants 6–11 months and children 12-23 months consume the recommended daily ration size of CF (i.e., 40 and 60 g/day, respectively), the percentage contribution of the complementary foods to the estimated need of iron and zinc was 21-81% and 6-97% for 6-11 months and 50-100% and 10-100% for 12-23 month-old children respectively (Fig. 1). The result indicates that none of the CFs could meet the iron requirement for 6-11 month old children but 5 out-of 7 CFs contained adequate iron for 12-23 month-old children. Regarding zinc, only 2 out-of 7 CFs could contribute to more than 80% of the requirement for 6-11 month old children and 3 out-of 7 CFs could contribute to more than 90% of the requirement for 12-23 month old children.

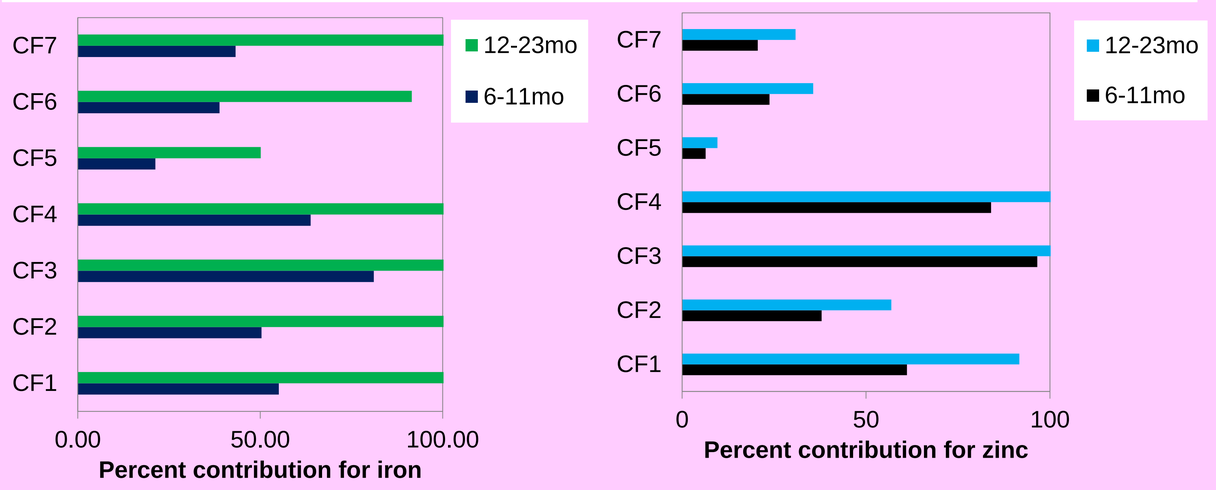


**Fig. 1: Percentage contribution of the CFs to the estimated needs of iron and zinc**

## CONCLUSIONS

The iron and zinc contents of many of the CFs is below the requirement in complementary foods for infants and children. Mineral-to-phytate molar ratios also predicted low bioavailability. Therefore, manufacturers need to consult nutritionists to define proper fortification of processed CFs and for further modification of their processing methods to improve mineral bioavailability, so that children could meet their daily nutrient requirement that consequently contributed to the improvement in their nutritional status.

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