Fortification of flour to control iron deficiencies in the Middle East and North Africa

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Iron-deficiency anemia is a serious public health problem in all countries of the Eastern Mediterranean Region of the World Health Organization and the Middle East and North Africa Region of the United Nation's Children's Funds. This nutritional disorder, which is the most common in the world, has profound effects on psychological and physical development, behaviour, and work performance and eventually on productivity. It affects women of childbearing age, young children, school-age children and adolescents. A consultation organized by WHO and UNICEF was held in Teheran, Islamic Republic of Iran, in October 1995 to develop effective strategies for the control of iron deficiency which would be suitable for the Region. Agreed upon strategies included supplementation with iron, food fortification, dietary measures such as changing eating behaviour, and public health measures. The consultation recommended that countries of the Region explore the feasibility of flour fortification as a long-term strategy given that it had proven to be the most effective means of improving iron intake in industrialized countries. This consultation lead to further work and research on fortification possibilities in countries of the Region and materialized in a workshop held in Oman in 1996, where countries present pledged to explore the feasibility of flour fortification. It was decided to hold a follow-up workshop in 1998, to review progress since 1996 and to encourage more countries to commit themselves to flour fortification.

There are many strategies for increasing intake of iron. When iron-deficiency anaemia is population-wide and results from a combination of low iron intake and low bioavailability, fortification of flour with iron offers a number of strategic advantages.

i. Wide consumption: all population segments and socioeconomics strata consume bread and other flour products. Bread is taken daily and in relatively constant amounts.
ii. Low cost: per person costs usually range 1 US cent per year and usually represent less than 1% of retail cost.

iii. Consistent delivery maximizes benefits: providing iron in bread, a food that is consumed daily and in constant amounts, would fulfil the body's physiological needs.
iv. Safe. Low levels of iron in food minimize the potential for accidental overdose.
v. Centralized processing: flour is increasingly processed in large roller mills.
vi. Stability: chemical interaction with appropriate iron compounds is minimal.
vii. No organoleptic change: addition of iron to flour, when done properly, does not alter in any way the taste, colour, appearance, or baking properties.
viii. Consistency: Wheat flour is a relatively dry and free-flowing powder making it easy to blend small quantities of micronutrients with little segregation or separation.
ix. Minimal reliance on behaviour change: while consumers must be educated to purchase fortified products, flour products are already part of the diet, and no individual compliance is necessary.
x. Sustainability: fortification is market-based strategy.

Flour fortification works

Based on over 50 years of experience, flour fortification has proven effective in the control and prevention of numerous micronutrient deficiencies. In the United States, after the introduction of flour fortified with niacin, deaths from this deficiency (pellagra), dropped to marginal levels in about a decade. About one-quarter of the iron intake in the US comes from fortified sources.

All corn and wheat flours in Venezuela were fortified with iron, vitamin A, and B vitamins. Fortified with iron to a level of 20-30 ppm, flour products currently contribute about 48% of the Recommended Dietary Allowance (RDA) for iron to the average Venzuelan. The impact has been both swift and dramatic. Studies of anemia in children living in Caracas slum areas during the years immediately before and after fortification began indicate anaemia rates cut by more than half. This improvement occurred during the period when no other nutrition interventions took place and when economic pressures were causing an overall decline in the quality of diet among the poor. Today many countries are capitalizing on flour as a vehicle to deliver iron and other micronutrients to their population.

Based on FAO per capita wheat consumption reports, consumption of wheat products is high throughout the Region. Countries are divided into three groups according to consumption, high-, moderate- or low-consumption. Even with the lowest consumption group, participant

countries have seen positive impact from flour fortification. An iron fortification level of 30 ppm (1ppm ≡ mg/kg), iron isn't absorbed by the body as readily as vitamin A. Requirements for absorbed iron are in facts less than 15 mg/day, ranging from about 0.56 mg/day for children to 1.25 mg/day for adult women. Whole wheat, while a natural source of iron, is also high in phytates, which act as powerful inhibitors of iron absorption. The more highly refined the wheat flour, sometimes called low-extraction flour, the lower are both the iron and the phytate content.

Firstly, flour fortification is a preventive measure for iron-deficiency anaemia. The goal is not to provide 100% daily iron but rather "fill the gap" between intake from other sources and daily iron needs. *Secondly*, most research indicates that there is an inverse relationship between the amount of iron absorbed and total iron stored of the individual. Deficient individuals more readily absorb iron. Costs of fortification with iron and folate are clearly negligible on a per person per year basis. Success requires active collaboration among several sectors: the scientific community, the government, private industry, consumer groups and international agencies.

Ten steps for developing a flour fortification programme

i. Determine the prevalence of iron deficiency.
ii. Conduct dietary survey to establish iron intake and bioavailability.
iii. Obtain consumption data for flour.
iv. Inform and advocate to key decision-markers.
v. Assess the milling industry processing and distribution chain to establish technical feasibility of flour fortification.
vi. Select the type and amount of iron fortificant or premix.
vii. Develop technical recommendations for in-plant technology and quality control as well as external programme quality assurance and monitoring.
viii. Develop standards for flour packaging and labeling.
ix. Develop legislation and regulation for monitoring and compliance.
x. Develop promotional campaigns to educate the public and improve consumer awareness.

A cost-benefit analysis

Dietary deficiencies of vitamins and minerals in many regions of the world, particularly in developing countries, are responsible for significant levels of disease, low work capacity, learning disabilities, mental retardation and premature death. The consequences of such deficiencies are both a significant public health problem and a major economic drain on

country's financial resources. A study by the World Bank provides a good basis for such an analysis. The Bank estimated that for a developing nation with a population of 50 million, vitamin A, iron and iodine deficiencies result in an annual loss to gross domestic product of US$ 1000 million or US$ 20.00 per capita. The Bank also projects the annual cost of eliminating all micronutrient malnutrition approximately US $25 million or US $0.50 per capita. Therefore, in general terms, the economic losses due to micronutrient deficiencies minus the cost of elimination yield an annual benefit to the nation of US $975 million or US $19.50 per capita.

The milling or refining process extracts flour from the whole grain. Mainly the outer bran layers, is removed during milling. The outer layers contain the highest concentrations of vitamins and minerals. So this reduces the micronutrient content of resultant flour from what was present in the whole wheat. Wheat grains contain high levels of phytates, which inhibit the absorption of iron. During milling both iron and phytates are lost in roughly equal proportions. As a result, more refined flour offers less iron but also contains fewer phytates and added iron will be readily absorbed.

Since iron is mineral, it won't diminish during production, storage or backing. However, over time interactions between ferrous sulfate and the fat naturally contained in flour will cause rancidity. Reduced or elemental iron and iron EDTA does not react with fat in flour and will not promote rancidity.

The amount of iron to be added depends on two factors: how much flour is consumed and the severity of the iron deficiency. It has been recommended that countries of the Region fortify flour with 30 ppm iron as ferrous sulfate or 60 ppm iron as elemental iron along with adding 1.5 ppm folic acid. The interplay of stability and bioavailability governs the choice of iron fortificant.