



WHO Recommendations on Wheat and Maize Flour Fortification with Zinc

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BACKGROUND

- Adequate zinc nutrition is necessary for optimal child health and physical growth and for normal pregnancy outcomes.
- Zinc deficiency is responsible for approximately 4% of deaths among children under 5 years of age in lower-income countries.
- Zinc supplementation decreases their rates of diarrhea and acute lower respiratory infections as well as the linear growth and weight gain of stunted or underweight children.

BACKGROUND



- Wheat and maize flour fortification with zinc worldwide
 - Mandatory: 4 countries
 - Voluntary: 13 countries
- Zinc absorption is influenced by:
 - Zinc intake
 - Amount of phytic acid in diet
 - Age: children up to 4 years old absorb 1/3 of that of adults

EQUATION TO PREDICT ZINC ABSORPTION

- Adults
- 15 studies, 209 subjects

$$\text{TAZ} = 0.5 * (\text{A}_{\text{max}} + \text{TDZ} + \text{K}_r (1 + \text{TDP} / \text{K}_p)) - \sqrt{(\text{A}_{\text{max}} + \text{TDZ} + \text{K}_r (1 + \text{TDP} / \text{K}_p))^2 - 4 * \text{A}_{\text{max}} * \text{TDZ}}$$

where

TAZ = total absorbed zinc (mmol/day),

A_{max} = the maximum possible amount of absorbed zinc = 0.11 mmol/day,

TDZ = total dietary zinc (mmol/day),

TDP = total dietary phytate (mmol/day),

K_r = the equilibrium dissociation constant for zinc-receptor binding = 0.065, and

K_p = the equilibrium dissociation constant for zinc-phytate binding = 0.77.

ESTIMATED MINIMUM LEVELS OF ZINC FORTIFICATION OF WHEAT FLOUR

Flour intake (g/day)	Minimum level of zinc fortification (mg zinc/kg flour)			
	80% extraction wheat flour		95% extraction wheat flour	
	Men	Women	Men	Women
50	94	48	136	78
75	69	37	112	68
100	57	30	99	59
200	38	21	81	50
300	32	18	75	46
400	29	16	72	45
500	27	15	70	44
600	26	14	68	43
700	25	14	67	43
800	24	13	67	42

STATEMENT DEVELOPMENT PROCESS

- Statement prepared by the core group led by:
 - WHO's Department of Nutrition for Health and Development in close collaboration with partners.
 - The core group evaluated the commissioned scientific reviews prepared by expert working groups for FFI Technical Meeting.
 - Approved by WHO Guideline Review Committee in interim period year 2008.
 - These recommendations remain valid until December 2010.
 - WHO headquarters in Geneva has initiated a review following formal *WHO Handbook for Guideline Development* procedures in 2010.

RECOMMENDATION

	Ranges of Daily Per Capita Availability of Wheat Flour (g/day)			
Percentile of Wheat Flour Availability	<75	75-149	150-300	>300
Low	95	55	40	30
High	100	100	80	70

Assumes 5 mg zinc intake and no additional phytate intake from other dietary sources

Recommendations on Wheat and Maize Flour Fortification

Meeting Report: Interim Consensus Statement

<http://www.who.int/nutrition/>

Available in UN languages

- *English*
- *Russian*
- *Chinese*
- *Spanish*
- *French*
- *Arabic*

Suggested citation

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World Health Organization

Recommendations on Wheat and Maize Flour Fortification
Meeting Report: Interim Consensus Statement

PURPOSE

This statement is based on scientific reviews prepared for a Flour Fortification Initiative (FFI) technical workshop held in Stone Mountain, GA, USA in 2008 where various organizations actively engaged in the prevention and control of vitamin and mineral deficiencies and various other relevant stakeholders met and discussed specific practical recommendations to guide flour fortification efforts being implemented in various countries by the public, private and civic sectors. This joint statement reflects the position of the World Health Organization (WHO), Food and Agriculture Organization of the United Nations (FAO), The United Nations Children's Fund (UNICEF), Global Alliance for Improved Nutrition (GAIN), The Micronutrient Initiative (MI) and FFI. It is intended for a wide audience including food industry, scientists and governments involved in the design and implementation of flour fortification programs as public health interventions.

BACKGROUND

WHO and FAO published in 2006 the *Guidelines on Food Fortification with Micronutrients* (WHO/FAO, 2006). These general guidelines, written from a nutrition and public health perspective are a resource for governments and agencies implementing or considering food fortification and a source of information for scientists, technologists and the food industry. Some basic principles for effective fortification programs along with fortificants physical characteristics, selection and use with specific food vehicles are described. Fortification of widely distributed and consumed foods has the potential to improve the nutritional status of a large proportion of the population, and neither requires changes in dietary patterns nor individual decision for compliance. Technological issues to food fortification need to be fully resolved especially with regards to appropriate levels of nutrients, stability of fortificant, nutrient interactions, physical properties and acceptability by consumers (WHO/FAO, 2006). Worldwide, more than 600 million metric tons of wheat and maize flours are milled annually by commercial roller mills and consumed as noodles, breads, pasta, and other flour products by people in many countries. Fortification of industrially processed wheat and maize flour, when appropriately implemented, is an effective, simple, and inexpensive strategy for supplying vitamins and minerals to the diets of large segments of the world's population. It is estimated that the proportion of industrial-scale wheat flour being fortified is 97% in the Americas, 37% in Africa, 48% in Eastern Mediterranean, 27% in South-East Asia, 6% in Europe, and 4% in the Western Pacific regions in 2007 (FFI, 2008).

THE FFI SECOND TECHNICAL WORKSHOP ON WHEAT FLOUR FORTIFICATION

Nearly 100 leading nutrition, pharmaceutical and cereal scientists and milling experts from the public and private sectors from around the world met on March 28 to April 3, 2008 in Stone Mountain, GA, USA to provide advice for countries considering national wheat and/or maize flour fortification. This *Second Technical Workshop on Wheat Flour Fortification: Practical Recommendations for National Application* was a follow up to a FFI, the US Centers for Disease Control and Prevention (CDC) and the Mexican Institute of Public Health, first technical workshop entitled "Wheat Flour Fortification: Current Knowledge and Practical Applications," held in Guanajuato, Mexico in December 2004 (FFI, 2004). The purpose of this second workshop was to provide guidance on national fortification of wheat and maize flours, milled in industrial roller mills (i.e. >20 metric tons/day milling capacity), with iron, zinc, folic acid, vitamin B₆ and vitamin A and to develop guidelines on formulations of premix based on common ranges of flour consumption. A secondary aim was to agree on the best practices guidelines for premix manufacturers and millers. Expert work groups prepared technical documents reviewing published efficacy and effectiveness studies as well as the form and levels of fortificants currently being added to flour in different countries. The full reviews will be published in a supplement of *Food and Nutrition Bulletin* in 2009 and the summary recommendations of this meeting can be found in http://www.who.int/nutrition/publications/micronutrients/wheat_maize_fort.pdf (FFI, 2008).

RECOMMENDATIONS FOR WHEAT AND MAIZE FLOUR FORTIFICATION

Wheat and maize flour fortification is a preventive food-based approach to improve micronutrient status of populations over time that can be integrated with other interventions in the efforts to reduce vitamin and mineral deficiencies when identified as public health problems. However, fortification of other appropriate food vehicles with the same and/or other nutrients should also be considered where feasible. Wheat and maize flour fortification should be considered when industrially produced flour is regularly consumed by large population groups in a country. Wheat and maize flour fortification programmes could be expected to be most effective in achieving a public health impact if mandated at the national level and coordinated with international public health goals. Decisions about which nutrients to add and the appropriate amounts to add to fortify flour should be based on a series of factors including the nutritional needs and deficiencies of the population, the usual consumption profile of "fortifiable" flour (i.e. the total estimated amount of flour milled by

ADDITIONAL CONSIDERATIONS

- There is not enough information to model the data in children.
- Zinc oxide:
 - Similar bioavailability to zinc sulfate
 - Zinc losses during storage are expected to be minimal
 - Fortification levels >100 mg zinc/kg may have adverse effects on sensory properties
 - Evidence of any possible effects of zinc fortification on other minerals still lacks.
 - Cheap
- The impact of zinc fortification as public health fortification is still unknown.
- More research on efficacy and effectiveness of large scale zinc fortification programmes is needed.

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