

## **Guidelines and current international practices on the fortification of wheat flour with iron and folic acid**

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Fortification of wheat flour with deficit vitamins and minerals has been practiced since the late 1930s. It is now done by some 60 countries, listed in Table 1. Iron is included in all but Australian and New Zealand, who add only thiamin, and Sweden, who discontinued the use of iron some years ago. Folic acid is a recent addition to flour fortification, its inclusion starting some ten year ago with the recognition of its role in preventing neural tube birth defects. 49 countries have now included folic acid in their flour fortification programs.

Considerable effort with input from multiple sources was needed to compile the information in Table 1<sup>1</sup>. The data from each country may differ in the following respects:

1. The type and levels of vitamins and minerals used in flour fortification in each country.
2. Whether the levels shown are the minimum specified level in the fortified flour or the level being added.<sup>2</sup>
3. The source of iron used if specified.
4. Whether the fortification is actually in effect and practiced, only proposed and not yet practiced, or practiced despite there being no regulations, such as the case in Haiti.
5. The nature of the flour fortification regulations:
  - a. Voluntary, with the types and levels being specified.
  - b. Regulated, meaning the fortification is required for some regions of the countries or for specified consumers, but not for general use.
  - c. Universal, meaning they are intended that a large amount of the flour production will be fortified but with exceptions by type of flour or mill.
  - d. Mandatory for most types of flour.

Not shown in Table 1 is the situation regarding flour fortification in China, India and Pakistan, who together represent a third of the world's population. These countries are currently looking at different fortification possibilities. China is the closest to having a program, but they estimate it will take ten years to become national in scope.

Countries differ greatly in regard to the following aspects that impact the nature and impact of flour fortification:

1. Population
2. Wheat consumption
3. Number of mills
4. Distribution in size of mills
5. Distribution in type (extraction or ash content) of flour produced.
6. Type of baked products made from flour.

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<sup>1</sup> There well may be omissions and mistakes in Table 1 since countries are regularly adding or changing their flour fortification practices and standards. The information needs to be continually updated.

<sup>2</sup> Some countries have maximum levels, which are not given in this table.

To illustrate these differences, Indonesia with a large population has 6 very large and modern mills all fortifying flour, but the flour consumption is only 18 grams/person/day, so the impact is low. Central Asian countries have high flour consumptions, of 200 to 400 grams/person/day, but a large amount of that flour may be made in numerous small mills poorly suited to fortification. Much of the flour consumed in some countries, like India, is a high extraction flour (“atta” flour) made into non-fermented chapattis, resulting in very low iron absorption. Much of the flour in China goes into non fermented noodles, which has less iron absorption than from yeast leavened bread.

**Table 1**  
**Wheat Flour Fortification Standards and Practices in Different Countries<sup>3</sup>**

<i>Country</i>	<i>Type* of Program</i>	<i>Vitamin B<sub>1</sub> ppm</i>	<i>Vitamin B<sub>2</sub> ppm</i>	<i>Folic Acid ppm</i>	<i>Niacin ppm</i>	<i>Zinc ppm</i>	<i>Iron/ Type** ppm</i>	<i>Calcium g/kg</i>	<i>Vitamin B<sub>6</sub> ppm</i>	<i>Vitamin B<sub>12</sub> ppm</i>	<i>Vitamin A IU/kg</i>	<i>Notes</i>
Argentina	P	6.3	1.3	2.2	13		30 – FS					
Australia	V	6.4										
Azerbaijan	V	3.3	2.8	1.5	18	25	55 – E					
Bahrain	M			1.5			60	(2.1)				
Barbados	V	6.4	4.0	1.5	53		44					
Bangladesh	P	6.4	4.0	1.5	53	33	66 – E				10,000	<sup>4</sup>
Belize	M	4.0	2.5	1.5	45		60					
Bolivia	M	4.45	2.65	1.5	35.6		60					
Brazil	P,M			1.5			42					
Canada	M	6.4	4.0	1.5	53		44	(1.1) <sup>5</sup>				<sup>6</sup>
Chile	M	6.3	1.3	2.2	13		30					
China	P, V - LA	3.5	3.5	2	35	25	20 - SIE					<sup>7</sup>
Columbia	M	6.0	4.0	1.54	55		44					
Costa Rica	M	6.2	4.2	1.8	55		55 - FF <sup>8</sup>					
Cuba	M	7.0	7.0	2.5	70		45		6.0			
Dominican R.	V	6.0	4.0	1.5	55		60					
Ecuador	M	4.0	7.0	0.6	40		55					
El Salvador	M	6.2	4.2	1.8	55		55 – FF <sup>5</sup>					
Fiji	P	6.0	2.0	1.5	55	30	60					
Ghana	P	6.0	4.0	2.0	40	20	45 – FS			0.01	6,666	
Grenada	V	6.4	4.0	1.5	53		44					
Guyana	V	6.4	4.0	1.5	53		44					
Guatemala	M	6.2	4.2	1.8	55		55 – FF <sup>5</sup>					
Haiti	V	6.4	4.0	1.5	53		44					
Honduras	M	6.2	4.2	1.8	55		55 – FF <sup>5</sup>					
Indonesia	M - LA	2.5	4.0	2.0		30	50					

<sup>3</sup> As of November, 2004.

<sup>4</sup> Project for atta flour.

<sup>5</sup> Calcium (1.4 g/kg) required in Newfoundland.

<sup>6</sup> Optional standards on pyridoxine (3.1 ppm) pantothenic acid (13 ppm) and magnesium (1.9 ppm).

<sup>7</sup> China has another set of voluntary flour fortification levels. The ones shown here are proposed under the GAIN project where Ca and Vitamin A are optional.

<sup>8</sup> 45 ppm iron to be added as ferrous fumarate and 10 ppm from intrinsic (natural) iron.

<i>Country</i>	<i>Type* of Program</i>	<i>Vitamin B<sub>1</sub> ppm</i>	<i>Vitamin B<sub>2</sub> ppm</i>	<i>Folic Acid ppm</i>	<i>Niacin ppm</i>	<i>Zinc ppm</i>	<i>Iron/Type** ppm</i>	<i>Calcium g/kg</i>	<i>Vitamin B<sub>6</sub> ppm</i>	<i>Vitamin B<sub>12</sub> ppm</i>	<i>Vitamin A IU/kg</i>	<i>Notes</i>
Iran	P			1.5			30 – FS					
Israel	P - LA	5.8	4.0	1.5	46		37.5			0.01		
Jamaica	V	6.4	4.0	1.5	53		44					
Jordan	M			1.5			30 – FS					
Kazakhstan	V <sup>9</sup>	3.3	2.8	1.5	18	25	55 – E					
Kuwait	M - LA	6.38	3.96	1.5	52.91		60					
Kyrgyz Rep.	V	3.3	2.8	1.5	18	25	55 – E					
Mexico	M, V <sup>10</sup>	4.0	2.4	1.6	28	16	24					
Mongolia	V	3.3	2.8	1.5	18	25	55 – E					
Morocco	P - LA	4.5	2.8	1.5	36		45					
New Zealand	V <sup>11</sup>	6.4										
Nicaragua	M	6.2	4.2	1.8	55		55 – FF <sup>5</sup>					
Nigeria	M	6.2	3.7		49.5		40.7	(1.1)			30,000	
Oman	M			1.5			30					
Panama	M	6.0	4.0	1.5	55		60					
Paraguay	M	4.5	2.5	3.0	35		45					
Peru	M	5.0	4.0	1.2	48		55					
Qatar	M			1.5			60					
Russia	P, R	4.5	2.0	0.4	40		30					
Saudi Arabia	M	6.38	3.96	1.5	52.9		36.3	(2.1)				
South Africa	M -LA <sup>12</sup>	1.94	1.78	1.43	23.7	15	35 – E		2.63		5,947 <sup>13</sup>	
St. Vincent	V	6.4	4.0	1.5	53		44					
Sweden		4.0	1.5		40				3.50			
Switzerland	V	4.4			50		29					
Tajikistan	V	3.3	2.8	1.5	18	25	55 – E					
Trinidad Tobago	M						30					
Turkmenistan	R						25 - FS					
UAE	M			1.5			30					
UK	M	2.4			16		16.5	(2.35)				
United States	R	6.4	4.0	1.5	53		44	(2.1)				
Uganda	P, V	6.0	4.0	2.0	40	20	45 – FS			0.01	6,666	
Uzbekistan	V	3.3	2.8	1.5	18	25	55 – E					

<sup>9</sup> A national scale “Universal” program has been proposed.

<sup>10</sup> Only iron and folic acid are mandatory, the other micronutrients shown are voluntary.

<sup>11</sup> Bread flour only.

<sup>12</sup> South Africa (RSA) has separate standards for the final level of micronutrients in wheat flour and brown flour.

<sup>13</sup> RSA previously had voluntary standard of 2.5 ppm riboflavin and 25 ppm niacin in flour.

	<i>Type* of Program</i>	<i>Vitamin B<sub>1</sub> ppm</i>	<i>Vitamin B<sub>2</sub> ppm</i>	<i>Folic Acid ppm</i>	<i>Niacin ppm</i>	<i>Zinc ppm</i>	<i>Iron/Type** ppm</i>	<i>Calcium g/kg</i>	<i>Vitamin B<sub>6</sub> ppm</i>	<i>Vitamin B<sub>12</sub> ppm</i>	<i>Vitamin A IU/kg</i>	<i>Notes</i>
Venezuela	M	1.5	2.0		20		20					
Zambia	V		3.3		35.5		28.9					

**CODE:**

\* Type of program:

P = Proposed,

V = Voluntary,

M = Mandatory,

R = Required for specific situations or regions (states or provinces),

LA = Level Added, otherwise value gives minimum level standard required in fortified flour.

\*\* Iron types specified under regulations if any:

FS = Ferrous Sulfate,

E = Electrolytic iron,

FF = Ferrous Fumarate,

SIE = Sodium Iron EDTA

Levels in parentheses are optional.

## **Guidelines on iron and folic acid fortification of wheat flour**

The following table summarizes six existing guidelines on iron and folic acid fortification of wheat flour. There is good agreement on the following points.

1. Ferrous sulfate and ferrous fumarate are the preferred iron sources in low extraction flour and where they can be used without adversely affecting flour properties.
2. Electrolytic iron is a preferred type of elemental iron powder.
3. The level of elemental iron powder when used should be added at twice the level used for iron salts.
4. Sodium iron EDTA is a preferred source of iron for high extraction flour.
5. Folic acid should be included.

Code of abbreviations used:

FG – Folic Acid Expert Group convened under the Micronutrient Initiative. Guidelines on folic acid submitted to the Birth Defects Research J., part A.

FFI – Flour Fortification Initiative of the Micronutrient Initiative.

WHO – World Health Organization of the United Nations.

WHO-EMRO – Eastern Mediterranean Region Office of the WHO.

FS – Ferrous Sulfate

FF – Ferrous Fumarate

RNI – Recommended Nutrient Intake defined by WHO.

### References

SUSTAIN (2001). Guidelines for Iron Fortification of Cereal Food Staples,  
[http://www.micronutrient.org/frame\\_HTML/resource\\_text/publications/fe\\_guide.pdf](http://www.micronutrient.org/frame_HTML/resource_text/publications/fe_guide.pdf)

Allen, L., De Benoist, B., Dary, O. & Hurrell, R. (2003). Guidelines on food fortification with micronutrients for the control of micronutrient malnutrition. Geneva, Department of Nutrition for Health and Development, World Health Organization.

PAHO (2002). "Iron compounds for food fortification: Guidelines for Latin America and the Caribbean." *Nutr Rev* 60(7): S50 - S61

**Table 2 Summary of Guidelines on Iron and Folic Acid Fortification of Flour**

	<i>SUSTAIN</i>	<i>WHO</i>	<i>MI Manual</i>	<i>PAHO</i>	<i>Other</i>
<b>IRON FORTIFICATION</b>					
General statement on efficacy and advisability of iron fortification of wheat flour.		To date no efficacy studies have been made to demonstrate the nutritional usefulness of iron fortification. Based on current evidence, and assuming sufficient flour intake, iron fortification of flour would be expected to improve iron status provided (these) guidelines on iron fortification are followed.	Despite lingering questions on its effectiveness, it would not be wise to exclude iron from cereal fortification programs in countries with high levels of IDA.		
When iron should be included in flour fortification programs.	In countries where IDA is prevalent.		All flour fortification programs in developing countries on refined (white) flour with ash content < 0.8%		
Types of iron recommended for general flour fortification.	Ferrous sulfate (dried, small particle size) or ferrous fumarate	Low extraction flour: Ferrous sulfate, dried (bakery flour only), Ferrous fumarate, Electrolytic iron (2X amount of FS), Encapsulated ferrous sulfate.	Follow SUSTAIN, WHO and PAHO guidelines	FS or FF, can be encapsulate, or The iron compound that provides the highest proportion of the RNI without causing unacceptable sensory changes and has the lowest cost.	WHO-EMRO: Ferrous sulfate or elemental iron powder

	<b>SUSTAIN</b>	<b>WHO</b>	<b>MI Manual</b>	<b>PAHO</b>	<b>Other</b>
Types of iron <b>not</b> recommended	Large particle size elemental iron powders, hydrated ferrous sulfate	100 mesh (> 100 µm) elemental iron powders. Atomized iron, CO reduced iron		Ferric pyrophosphate, Ferric orthophosphate	
Minimum level of iron to be in final fortified product.	35 ppm		Restoration or levels needed to meet those present in whole grain.		
Maximum level of iron				60 ppm for FS and FF, or 80 ppm for elemental iron.	
<b>Recommendations on use of iron salts (ferrous sulfate [FS] and ferrous fumarate [FF])</b>					
Types of flour that can be fortified with iron salts.	Best in low extraction, white flour, bakery flour, semolina or flour used to make pasta or flour used within two months after milling.	Low extraction flour, pasta or semolina	Flour with ash content < 0.8% that has < 3 month shelf life requirement.	FS recommended on low extraction flour stored under low to moderate temp. (20 to 30° C) and low relative humidity (<50%) for less than 3 months.	
Not recommended for	Flour used in mixes with added fat, home-use flour with > 3 month shelf life, flour used in Japanese noodles.		Flour with ash content >0.8%.		
Recommended level of iron to be added.	25 to 40 ppm			To achieve target RNI	WHO-EMRO: 30 ppm

	<i>SUSTAIN</i>	<i>WHO</i>	<i>MI Manual</i>	<i>PAHO</i>	<i>Other</i>
<b>Recommendations on use of elemental iron powders (reduced iron)</b>					
When should they be used?	If unacceptable changes in color, flavor or storage properties result from FS or FF.		Flour with ash content < 1.0%.		
Recommended types.	Electrolytic iron	Electrolytic or carbonyl iron	Electrolytic iron or products that research shows has a RBV equivalent to that (i.e. around 50% that of FS)	Electrolytic iron (<45 µm, 325 mesh)	
Level of iron to add.	Twice that of FS or FF with 60 ppm maximum added.	Twice that of FS.	Twice that of FS.	Twice that of FS or FF.	WHO-EMRO: 60 ppm
<b>Recommendations on use of chelated iron (iron-EDTA and iron glycinates)</b>					
When should they be used?	Consider using iron EDTA when high phytic acid levels significantly reduce iron absorption and where use is permitted.	High extraction flour.	Consider for high extraction flour with ash content > 1.0% when there is no other way to meet nutritional objectives.	Corn flour (not mentioned for wheat flour)	
Level of iron to add.			~ 15 ppm or quantity sufficient to achieve nutritional objective.	Test starting at 20 ppm iron	
<b>Recommendations on fortification of high extraction flour.</b>					
Suitable iron sources	NaFeEDTA	NaFeEDTA Ferrous fumarate (2X amount) Encapsulated ferrous sulfate (2X amount) Encapsulated ferrous fumarate (2X amount)	NaFeEDTA		

	<b>SUSTAIN</b>	<b>WHO</b>	<b>MI Manual</b>	<b>PAHO</b>	<b>Other</b>
<b>FOLIC ACID FORTIFICATION</b>					
When folic acid should be added to flour.			Include in all flour fortification programs.		FG: all countries should implement mandatory fortification with folic acid for most types of flours
Level of folic acid to add.		To avoid any possible risk of adverse effects, folic acid fortification should be designed to limit regular daily intakes to a maximum of 1000 µg.	1.5 ppm minimum		FG: 2.4 ppm minimum