

17.3 Flour Fortification Standards

C. Buhmann

This chapter summarizes all the public standards for flour fortification in 70 countries, with the latest entries dating from September 2006. The adoption of flour fortification as a national standard and its modification is an ongoing process, and therefore the following information can only reflect the current situation.

Tab. 85 lists the nutrient standards of countries with mandatory or voluntary flour fortification. Whereas in North and Latin America the fortification of flour is implemented in nearly every state, there are still a lot of countries where fortification is not practised and people suffer from malnutrition. In South-East Asia and Africa, especially, more and more states are determined to start flour fortification and work on projects and plans to put guidelines into practice.

New legislation is coming into force in the Philippines (since November 2004), Peru (December 2004), Uruguay (February 2005), Yemen and Iran (March 2006). Vietnam will implement flour fortification in 2007 and the following countries are also at the planning stage: Bangladesh, Cambodia, China, Côte d'Ivoire, Ghana, India, Turkey and Ukraine.

Standards for iron may differ from one country to another because there are various forms of iron which can be used for flour fortification. The most common are ferrous sulphate, ferrous fumarate and elemental iron powders. They differ in respect of bioavailability²⁶, iron content, price and strength of reaction to other flour ingredients. Ferrous sulphate and ferrous fumarate have good bioavailability and are added to flour in the same proportions. The bioavailability of elemental iron powders (electrolytic²⁷ and reduced²⁸ iron)

²⁶ bioavailability is the degree to which the body can utilize or absorb a particular mineral source

²⁷ electrolytic iron powder: elemental iron powder produced in an electrolytic process (next page)

²⁸ reduced iron powder: elemental iron produced in a hydrogen reduction process (next page)

varies between 5 and 148 % (Nalubola and Nestel, 2000) compared to ferrous sulphate as the standard, depending on particle size and shape. It is therefore often recommended to add larger amounts of elemental iron powders. Electrolytic iron has a more constant and better investigated bioavailability of approximately 50% of that of ferrous sulphate and is therefore

said to be of better quality. Nevertheless reduced iron is the cheapest iron form and the least reactive. It has no influence on the shelf life of flour, whereas ferrous sulphate and ferrous fumarate can accelerate rancidity. All elemental iron powders are pure forms, whereas ferrous sulphate and ferrous fumarate contain only about 32% iron.

Tab. 85: Flour fortification standards of September 2006^a

Region Country	Type of programme	Vit A IU/kg	Vit B ₁ ppm	Vit B ₂ ppm	Vit B ₆ ppm	Vit B ₁₂ µg/kg	FA ppm	Niacin ppm	PA ppm	Vit C ppm	Iron ppm	Zinc ppm	Ca g/kg	Mg g/kg
North America														
Canada	M		6.4	4.0			1.5	53.0	1.3		44		1.1	1.9
USA	S		6.4	4.0			1.5	53.0			44		2.1	
Latin America														
Argentina	M, LA		6.3	1.3			2.2	13.0			30 FS			
Belize	M		4.0	2.5			1.5	45.0			60 R			
Bolivia	M		4.5	2.7			1.5	35.6			60 R			
Brazil	M						1.5				42 R			
Chile	M		6.3	1.3			2.2	13.0			30 FS			
Colombia	M		6.0	4.0			1.5	55.0			44			
Costa Rica ^b	M		6.2	4.2			1.8	55.0			55			
Ecuador	M		4.0	7.0			0.6	40.0			55 R			
El Salvador	M		4.0	2.5			1.5	45.0			55 R			
Guatemala ^b	M		6.2	4.2			1.5	45.0			55 R			
											FF allowed			
Honduras	M		4.4	2.6			1.5	35.6			55 R			
											FF allowed			
Mexico ^{b,c}	M/V		5.0	3.0			2.0	35.0			40	40		
Nicaragua	M		6.0	3.5			1.5	40.0			55 R			
Panama	M		6.0	4.0			1.5	55.0			60 R			
Paraguay	M		4.5	2.5			3.0	35.0			45 FS			
Peru	M, LA		5.0	4.0			1.2	48.0			55			
Uruguay	M, LA					6.0	2.4				30 FS/FF			
Venezuela	M		1.5	2.0				20.0			20 FS			
Caribbean														
Barbados	V		6.4	4.0			1.5	53.0			44			
Cuba	M		7.0	7.0	6.0		2.5	70.0			45			
Curacao	M										not defined			
Dominican Rep.	M		6.0	4.0			1.5	55.0			60			
Grenada	V		6.4	4.0			1.5	53.0			44			
Guadeloupe	M										not defined			
Guyana	V		6.4	4.0			1.5	53.0			44			
Haiti	V		6.4	4.0			1.5	53.0			44			
Jamaica	V		6.4	4.0			1.5	53.0			44 R			
Puerto Rico	M													
St. Vincent	V		6.4	4.0			1.5	53.0			44			
Trinidad & Tobago	M										30			

^a Abbreviations, see box on page 219

^b Minimum level in flour

^c Iron and folic acid are mandatory, the other nutrients are voluntary, but proposed as mandatory

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Tab. 85: Flour fortification standards of September 2006 (continued)^a

Region Country	Type of programme	Vit A IU/kg	Vit B ₁ ppm	Vit B ₂ ppm	Vit B ₆ ppm	Vit B ₁₂ µg/kg	FA ppm	Niacin ppm	PA ppm	Vit C ppm	Iron ppm	Zinc ppm	Ca g/kg	Mg g/kg
Africa														
Cote d'Ivoire	P						1.5				80 E			
Congo	V						1.5				45 FS			
Ghana	P, M	6,666	6.0	4.0			2.0	40.0			45	20		
Morocco	M, LA		4.5	2.8			1.5	36.2			45			
Nigeria ^b	M	30,000	4.5	2.7				35.5			28.9			
South Africa	M, LA	5,950	1.9	1.8			1.4	23.7			35	15		
Sudan	P						1.5				40 FS			
Zambia ^b	V			3.3				35.5			28.9			
Western Europe														
UK	M		2.4					16.0			16.5		(2.35)	
Eastern Europe														
Russian Fed. ^b	V		4.5	2.0	4.5		0.4	40.0		16.0	30			
Ukraine	P, LA						2.2				35			
Central Asia / Caucasus														
Azerbaijan	V		3.3	2.8			1.5	18.0			55 E	25		
Kazakhstan	V		3.3	2.8			1.5	18.0			55 E	25		
Kyrgyzstan	V		3.3	2.8			1.5	18.0			55 E	25		
Mongolia	V		3.3	2.8			1.5	18.0			55 E	25		
Tajikistan	V		3.3	2.8			1.5	18.0			55 E	25		
Uzbekistan	V		3.3	2.8			1.5	18.0			55 E	25		
Middle East														
Afghanistan	P, S										30 FS/60 R			
Bahrain	M		6.4	4.0			1.5	52.9			30 FS/60 R		2.1	
Egypt	P										not defined			
Iran	M						1.5				30 FS			
Israel	P, LA		5.8	4.0			1.5	46.0			30 FS			
Jordan	P	5,000	3.6	3.6	4.4	7.0	1.5	35.0			40 FS	20		
Kuwait	M, LA		6.4	4.0			1.5	52.9			60			
Libya	P													
Oman	M						1.5				30			
Qatar	M		1.5								60			
Saudi Arabia	M		6.4	4.0			1.5	52.9			36.3		2.1	
Turkey	S													
United Arab Emirates	V													
Yemen	M						1.6				60 E			
Asia														
Bangladesh	P	10,000	6.4	4.0			1.5	53.0			66 R	33		
Cambodia	P													
China	P	6,666	3.5	3.5			1.5	35.0			20	25	1.0	
India	P						1.5				30 FS/60R			
Malaysia	V		4.2	6.7				46.0			42			
Taiwan	P		6.4	4.8	3.0	10.0	1.5	55.0			45 R			
The Philippines ^b	M, LA	10,000									70 R, 50 FF/FS			
Vietnam	P		2.5	4.0			2.0				60	30		
Oceania														
Australia	M		6.4											
Fiji	P		6.0	2.0			1.5	55.0			60	30		
New Zealand	M		6.4											

^a Abbreviations, see box on page 219 ^b Minimum level in flour

^c Iron and folic acid are mandatory, the other nutrients are voluntary, but proposed as mandatory

When several micronutrients have to be added to flour it is practically impossible to add each mineral and vitamin separately. The easiest way is to add them together as premix. Premix manufacturers can produce high quality mixtures because of their knowledge of micronutrients and blending technology, and the desired nutrient content of the premix can be guaranteed by their quality control system.

Premixes of micronutrients should not be combined with other flour improvers, especially chemical agents such as bromate, benzoyl peroxide, azodicarbonamide or ascorbic acid. Reactions with the nutrient premix may occur and result in degradation of some of the nutrients.

Micronutrients, and particularly vitamins, are more or less sensitive to heat, light, humidity, oxidation, acids and alkalis. Care must therefore be taken when handling vitamin premixes. For as long as possible they should be stored in a cool, dry place in their original sealed packing. Heat, moisture and direct sunlight should be avoided while nutrients are in the dosing system.

Abbreviations in Tab. 85:

<i>V</i>	=	<i>Voluntary</i>
<i>FA</i>	=	<i>Folic acid</i>
<i>M</i>	=	<i>Mandatory</i>
<i>PA</i>	=	<i>Pantothenic acid</i>
<i>P</i>	=	<i>Proposed or projected</i>
<i>Ca</i>	=	<i>Calcium</i>
<i>S</i>	=	<i>Required for specific regions, provinces or states</i>
<i>Mg</i>	=	<i>Magnesium</i>
<i>LA</i>	=	<i>Level added</i>

Iron types specified under regulations:

<i>E</i>	=	<i>Electrolytic reduced iron or equivalent</i>
<i>FS</i>	=	<i>Ferrous sulphate</i>
<i>FF</i>	=	<i>Ferrous fumarate</i>
<i>R</i>	=	<i>Reduced iron or equivalent</i>