Impact of Flour Fortification
With Other Essential Micronutrients

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Addressing Micronutrient Deficiencies Through Flour Fortification
In the CEE/CIS Region
Other micronutrients

- **Vitamins:**
  - B Group:
    - Thiamine (vitamin B1),
    - Riboflavin (vitamin B2)
    - Niacin (vitamin B3)
    - Pyridoxine (vitamin B6)
  - Vitamin D

- **Minerals:**
  - Calcium,
  - Magnesium
Flour Milling Depletes Whole Grain of Natural Vitamins & Minerals

Loss of vitamins and minerals during milling of wheat

- Thiamin
- Riboflavin
- Vit. B6
- Folate
- Iron
- Niacin

Degree of milling

Nutrient retention

% Retention vs. Degree of Milling
Consequences of deficiency:

- **Thiamine (vitamin B1)**
  - Beriberi

- **Riboflavin (vitamin B2)**
  - Non-specific signs in mild deficiency including weakness, mouth pain, itching
  - Severe deficiency causes dermatitis, angular stomatitis, brain dysfunction & anaemia

- **Niacin (vitamin B3)**
  - Pellagra, oral lesions, vomiting, diarrhoea, neurological signs

- **Pyridoxine (vitamin B6)**
  - Non-specific: neurological disorders, skin changes, possibly anaemia
B group vitamin fortification:

- Thiamine (B1), Riboflavin (B2), Niacin B3 added as restitution or restoration to whole grain wheat levels.
- Some or all Mandatory in the Americas, Indonesia, Jordan, Central Asian countries, Morocco, Nigeria, Saudi Arabia, South Africa, UK.
- In Canada, USA and UK historically added to address B group deficiencies considered to be public health problems
# Premix specification:
## To meet US/Canada regulations

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount per kg Flour:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamine B1</td>
<td>5.2 mg</td>
</tr>
<tr>
<td>Riboflavin B2</td>
<td>3.6 mg</td>
</tr>
<tr>
<td>Niacin B3</td>
<td>42 mg</td>
</tr>
<tr>
<td>Folic Acid</td>
<td>1.5 mg</td>
</tr>
<tr>
<td>Iron, electro</td>
<td>35 mg</td>
</tr>
<tr>
<td>Dosage</td>
<td>160 g per MT flour</td>
</tr>
<tr>
<td>Premix Cost</td>
<td>$10.80 per kg (Nov 2009)</td>
</tr>
<tr>
<td>Fortification cost</td>
<td>$1.73 per MT</td>
</tr>
</tbody>
</table>
Premixes and Standards

Standards in US and Canada are set based on addition plus natural levels e.g.:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Added</th>
<th>Natural</th>
<th>Total</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>5.2</td>
<td>1.3</td>
<td>6.5</td>
<td>6.3</td>
</tr>
<tr>
<td>B2</td>
<td>4.0</td>
<td>0.4</td>
<td>4.4</td>
<td>4.0</td>
</tr>
<tr>
<td>B3</td>
<td>46</td>
<td>12</td>
<td>58</td>
<td>52</td>
</tr>
<tr>
<td>FA</td>
<td>1.5</td>
<td>0.2</td>
<td>1.7</td>
<td>1.5</td>
</tr>
<tr>
<td>Iron</td>
<td>38</td>
<td>11</td>
<td>49</td>
<td>44</td>
</tr>
</tbody>
</table>
Central Asia: KAP Complex Restores Nutritional Profile of White Flour

- **Thiamine**: 20 mg/kg (Whole Wheat), 20 mg/kg (White Flour), 41 mg/kg (KAP Level Added)
- **Riboflavin**: 4 mg/kg (Whole Wheat), 30 mg/kg (White Flour), 41 mg/kg (KAP Level Added)
- **Niacin**: 10 mg/kg (Whole Wheat), 10 mg/kg (White Flour), 48 mg/kg (KAP Level Added)
- **Iron**: 12 mg/kg (Whole Wheat), 39 mg/kg (White Flour), 50 mg/kg (KAP Level Added)
- **Folic Acid (ug)**: 2.5 ug (Whole Wheat), 15 ug (White Flour), 4.4 (KAP Level Added)

* Factor x 10
Flour Fortification in the USA
Deaths from Niacin Deficiency by Year
Flour Fortification in Canada (started in 1944) Vitamin B Deficiencies

- % B1 Deficient: 18.8% in 1944, 0.6% in 1948
- % B2 Deficient: 10.4% in 1944, 0.6% in 1948
VITAMIN D
Vitamin D

- Deficiency results in rickets and osteomalacia
- Vit D enhances calcium absorption. Deficiency contributes to osteoporosis
- Recent studies implicate vitamin D deficiency in some cancers, diabetes and heart disease
- May be implicated in multiple sclerosis which is more prevalent in northern countries (Canada, Scotland, Germany) and far south countries (New Zealand)
- Jordan research shows high levels of rickets in children and women
- Other Middle East countries such as Egypt investigating vitamin D deficiencies
Vitamin D

- Known as the “sunshine” vitamin as it is metabolized in the skin layers in the presence of sunlight.
- Exists in liquid fat D2 and D3 forms (cholecalciferol)
- If there is limited sunlight exposure Vitamin D requirements for adolescents is 5000 IU per day (Vitamin D Council*)

www.vitamindcouncil.org
Vitamin D fortification options

- Vegetable oil: D plus vitamin A
- Margarine: 530 IU per kg plus vitamin A
- Milk products: D at 400 IU per liter plus A
- Wheat flour: Feasible
- Maize flour: Feasible

Powder form used for flour fortification is 10% spray dried form containing 100,000 IU per gram
Flour fortification experience

- UK: Vitamin D was added together with calcium in 1930s. Later, it was removed from flour and put into milk
- Jordan: Vitamin D (550 IU per kg flour) included in the flour fortification premix since June 2009
- Gulf Countries Council Wheat Flour Standard GS194 includes vitamin D at 550 IU per kg
- Used in many complementary food fortification products such as corn-soy blend
Vitamin D Fortification Cost

- Adding 550 IU per kg (14 parts per billion) of flour adds $0.04-0.05 per MT of flour
- The form used in flour fortification is Vitamin D₃
MINERALS
Consequences of deficiency:

• Calcium
  – Decreased bone mineralization, osteoporosis

• Magnesium
  – Deficiency uncommon. Possible heart rhythm disturbances, neurological problems
Minerals

- Calcium: Mandatory in the UK, voluntary in Canada and USA at 1400 mg per kg flour (1400 ppm)
- Magnesium: Voluntary in Canada at 1900 mg per kg flour (1900 ppm)
For additional information, visit:

http://www.ffinetwork.org/plan/standards.html

www.ffinetwork.org