Effectiveness of Flour Fortification on Iron Status and Anemia: A Systematic Review

Helena Pachón1,2 Rebecca Spohrer2 Zizhu Mei3 Mary Serdula4
Food Fortification Initiative 2Emory University 3Global Alliance for Improved Nutrition 4Centers for Disease Control and Prevention

Introduction

- The efficacy of wheat flour fortification for increasing serum ferritin and hemoglobin levels and decreasing the risk of iron deficiency and anemia has been reviewed.
- The effectiveness of folate fortification of wheat flour for reducing the birth prevalence of neural tube defects has been reviewed.
- No such reviews exist for the effectiveness of other nutrients added to flour, such as iron.

Objectives

- Review published and gray literature on the public health impact of flour fortification on iron status and anemia
- Identify and test key criteria for program effectiveness against program results
- Fortification regulations, compliance and coverage

Methods

Identifying documents for review (Figure 1):
- Searched 17 databases for the term "wheat flour"
- Sent two email appeals to a listerv of 2500 individuals
- Obtained 1881 documents
- Reviewed them per the inclusion criteria
- 13 documents remained

Analyzing documents:
- Statistically significant decreases were documented in the prevalence of low serum ferritin and anemia from the pre-fortification to post-fortification period.
- Countries’ fortification programs were compared to WHO (2009) recommendations for flour fortification with iron (Figure 2).
- Countries’ fortification compliance and coverage were assessed.

Results

Table 1. Description of fortification programs (n=13).

Table 2. Description of studies (n=13).

Table 3. Fortification compliance and coverage information provided (n=13).

Table 4. Summary of statistically significant decreases from the pre-fortification to post-fortification period by age sub-groups: children<15 years of age and women of reproductive age (WRA).  

Table 5. Summary of statistically significant decreases in the prevalence of low ferritin and anemia from the pre-fortification to the post-fortification period by whether programs followed WHO (2009) recommendations for flour fortification with iron.

Table 6. Linkage of health impact (ferritin, anemia) with program design (whether follow WHO recommendations) and program implementation (compliance & coverage).

Issues raised

The cross-sectional nature and lack of a comparison group for most studies mean we cannot attribute health benefits to fortification.

Some fortification programs were poorly implemented or provided no documentation. Such information could strengthen arguments that fortification contributed to the health impacts observed.

In addition to reporting on coverage and compliance, it is important that programs report on flour consumption and the iron compound and levels added during fortification. This information is needed to assess whether programs are following WHO recommendations.

Conclusions

Few studies have assessed the effectiveness of flour fortification vis-à-vis iron status and anemia.

Limited evidence suggests that when key program criteria* are fulfilled, positive health impact is achieved.

For future evaluation reports, program design and implementation should be documented.

Acknowledgements

- FFI’s Sarah Zimmermann
- Emory librarian Barbara Abu Zaid
- CDC librarian Deirdre Mallett
- People who sent documents
- Helena Pachón’s time was supported by an appointment to the Research Participation Program at the United States (US) Centers for Disease Control and Prevention (CDC) administered by the Oak Ridge Institute for Science and Education through an interagency agreement between the US Department of Energy and CDC.

- * Fortification regulations, compliance and coverage

Figure 1. Study methods.

Figure 2. World Health Organization recommendations on wheat and maize flour fortification (WHO 2009): iron recommendations

Figure 3. World Health Organization recommendations on wheat and maize flour fortification (WHO 2009): iron recommendations

<table>
<thead>
<tr>
<th>Fortification Status</th>
<th>Compound</th>
<th>Level of nutrients to be added in parts per million (ppm) by estimated average per capita wheat flour availability (g/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>per million (ppm)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75-149 g/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>150-300 g/day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt;300 g/day</td>
</tr>
<tr>
<td>Low</td>
<td>NaFeEDTA</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Ferrous Sulfate</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Ferrous Fumarate</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Electrolytic Iron</td>
<td>NR1</td>
</tr>
<tr>
<td>High</td>
<td>NaFeEDTA</td>
<td>40</td>
</tr>
</tbody>
</table>

NR1: Assuming adherence per capita consumption of <75 g/day does not allow for addition of sufficient level of fortificant to cover micronutrients needs for women of childbearing age. Fortification of additional food vehicles and other interventions should be considered.
NR2: Not recommended because very high levels of electrolytic iron needed could negatively affect sensory properties of fortified flour.