Can Providing Daily Iron-Fortified Lunches to School-Going Children Living in an Impoverished Community in Guatemala Improve Iron Status?

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Introduction

Iron deficiency anemia (IDA) remains one of the most common diet-related micronutrient deficiency disorders in the world. Exacerbated by poverty, IDA is particularly problematic in locales with limited access to food, healthcare, and remedial measures. Although iron supplementation can effectively improve iron status, all too often it is a short-term solution to this endemic, chronic health problem.

A Canadian enterprise developed a novel approach to treat IDA. Branded as Lucky Iron Fish® (LIF), this iron ingot provides an inexpensive approach to IDA remediation. When boiled in acidified water (pH 4) for 10 minutes, LIF release iron (~30 mg/L). The iron-enriched water is then used to prepare food. As food absorbs the iron from the iron-enriched water, the overall iron content of the meal is enhanced. The iron content of rice and beans, staple foods in many parts of the world, prepared with LIF nearly doubles compared to rice and beans prepared with tap water (unpublished data Beerman et al., 2020). The use of LIF, which are reusable and last for up to 5 years, can be easily utilized in regions of the world where IDA is most prevalent.

Studies have demonstrated that using LIF on a regular basis to prepare meals can improve iron status.1-3 Although the intended use of LIF was for household preparation of daily meals, its use in quantity food production has not been determined. If target iron-fortification concentrations can be achieved for large volumes of cooking water, LIF may offer a promising community-based method of iron delivery.

Purpose of the Study

The purpose of this study was to:
1. To develop the methodology to prepare large volumes of iron-fortified water that can be used for quantity food production.
2. To investigate the use of LIF to prepare 300 iron-fortified school lunches/day.
3. To determine if this methodology improves hemoglobin and hematocrit values in school-going children and adolescents from impoverished communities in Guatemala.

Methods

Study Participants: Study participants were students (aged 5–16 y) from economically disadvantaged families attending private schools in Jocotenango, Guatemala. Site selection was made on the basis that schools provided students with daily lunches prepared on-site and that schools served families with documented poverty. Because of ethical considerations associated with withholding treatment and the potential to improve iron status, a control group for comparison purposes was not utilized.

Food preparation: From baseline to follow-up (8 mo.), children were provided daily iron-fortified school lunches (5/wk). To prepare large quantities of food, laboratory measures of total iron release using multiple LIF and longer boiling times were determined. A priori laboratory analysis showed that total iron release using 10 LIF boiled for 1 hour yielded approximately 1 g of total iron in 5 L of acidified water (juice from 5 limes; pH 3.9). To achieve a designated target concentration of 30 mg iron/L of water, the iron-fortified water was diluted with the addition of 30 L of tap water. School lunches varied but primarily consisted of at least one or more of the following food items prepared with iron-fortified water; soup, stew, black beans, and/or rice.

Statistical analysis: Statistical analyses were performed using R (R Foundation for Statistical Computing) and significance levels were set at a P value of ≤0.05. A paired t-test was used to determine if there were overall significant differences in participants’ pre- and post-hemoglobin and hematocrit values (expressed as means ± SDs). The sample was then divided into quintiles (n=57) based on pre- hemoglobin and hematocrit values to determine if there were significant differences between pre- and post-iron status values when grouped by quintiles.

Results

A total of 287 (90%) children between the ages of 5 – 16 (y) completed the study. Subjects that dropped out of school or absent on retesting days were not included in the final analyses. Post- hemoglobin values were significantly higher than pre- hemoglobin values for quintiles 1, 2, and 3, whereas post- hematocrit values significantly increased for quintiles 1 and 2 (Table 1).

Table 1. t-Test: Paired two sample for means (values represent mean and standard deviation).

<table>
<thead>
<tr>
<th>Quintile 1 (n=57)</th>
<th>Quintile 2 (n=57)</th>
<th>Quintile 3 (n=57)</th>
<th>Quintile 4 (n=57)</th>
<th>Quintile 5 (n=58)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemoglobin (g/dL)</td>
<td>Pre</td>
<td>12.1±0.58</td>
<td>13.1±0.14</td>
<td>13.3±0.19</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>13.4±1.24</td>
<td>13.4±0.91</td>
<td>14.1±1.04</td>
</tr>
<tr>
<td>Hematocrit (%)</td>
<td>Pre</td>
<td>36.6±2.52</td>
<td>38.0±3.4</td>
<td>40.1±1.98</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>38.6±3.13</td>
<td>39.3±2.4</td>
<td>40.2±3.49</td>
</tr>
</tbody>
</table>

Discussion and Conclusions

Study results suggest that LIF can be used to prepare large quantities of food and that regular consumption of iron-fortified school lunches can improve iron status in children with marginal and/or impaired iron status. Equally important is the finding that iron-fortified meals do not negatively impact those with healthy iron values. Further studies are needed to quantify iron content of food prepared on a large-scale basis. This study also demonstrates that in addition to household use, LIF can be utilized as a community-based intervention to improve iron status in large population groups.

References


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