Research Article

Can providing daily iron-fortified lunches to school-going children living in an impoverished Guatemalan community improve iron status?

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Keywords: iron, anemia, global, health

https://doi.org/10.29392/001c.75318

Journal of Global Health Reports

Vol. 7, 2023

Background

Iron deficiency anemia (IDA) remains one of the most common diet-related micronutrient deficiency disorders in the world. Although iron supplementation can effectively improve iron status, it is often a short-term solution to this endemic, chronic health problem. Lucky Iron Fish® (LIF) offers a novel, long-term approach to treat IDA that can be easily utilized in regions of the world where IDA is most prevalent. While the beneficial use of LIF for household preparation of meals has been demonstrated, its use in quantity food production has not been investigated. The purpose of this study was to develop methodology for large-scale iron fortification of cooking water and to assess changes in hemoglobin and hematocrit values in school-going children following 8 months of receiving iron-fortified school lunches prepared with LIF.

Methods

Laboratory studies were conducted to develop the protocol to prepare iron fortification of cooking water using LIF. Study participants were school-going children from economically, disadvantaged families attending private schools in Jocotenango, Guatemala. Baseline measures (weight, height, hemoglobin, and hematocrit) were taken at the start and completion of the academic calendar. The sample was divided into quintiles based on pre-hemoglobin and hematocrit values where quintile 1 had the lowest baseline hemoglobin and hematocrit values and quintile 5 had the highest baseline hemoglobin and hematocrit values. Paired t-tests were used to determine if there were overall significant pre- and post-differences in iron status values by quintile groupings.

Results

A total of 286 (77%) of children between the ages of 5 – 16 (y) completed the study. Post-hemoglobin values were significantly higher than pre-hemoglobin values for those in quintile 1, whereas post-hematocrit values significantly increased for quintiles 1 and 2.

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 status. Equally important is the finding that iron-fortified meals do not negatively impact those with healthy iron values.

Iron deficiency anemia (IDA) remains one of the most common diet-related micronutrient deficiency disorders in the world. It is estimated that at any one time, up to two billion people have impaired iron status.[1] Exacerbated by poverty, IDA is particularly problematic in locales with limited access to food, healthcare, and remedial measures. Subsequently, the World Health Organization (WHO) has identified IDA as a global health concern of high priority that requires a multifaceted approach to overcome barriers related to treatment.[2]

Although IDA is of concern during all stages of life, it is particularly problematic for pregnant women, infants, and children. Pregnant women with IDA are at increased risk of having babies born prematurely and/or with low birth weight.[3] During infancy and early childhood, iron is critical for normal growth and development. As such, children with impaired iron status may experience stunted growth, have delayed cognitive development, and may never reach full intellectual capacity.[4] Although iron supplementation is efficacious in terms of improved iron status, all too often it is a short-term solution to this endemic, chronic health problem. Thus, chronic IDA throughout childhood can perpetuate the cycle of poverty.

In 2012, a Canadian enterprise developed a novel approach to treat IDA. Branded as Lucky Iron Fish (LIF), this fish-shaped iron ingot provides an inexpensive and sustainable approach to IDA remediation. LIF, which are reusable and last for up to 5 y, utilize a methodology similar to the time-tested intervention of using cast iron cookware to increase the overall iron content of food.[5] Easily implemented in regions of the world where IDA is most prevalent, LIF release iron when boiled in acidified water, which in turn is used to prepare food. As food absorbs the iron from the iron-enriched water, the overall iron content of the meal is increased. For example, the iron content of rice and beans (staple foods in many parts of the world) prepared with LIF nearly doubles compared to soups, stews,[6] rice, and beans prepared with tap water.[7]

Studies have demonstrated that using LIF on a regular basis to prepare meals can improve iron status.[6] The sustainability and efficacy of such a solution is particularly beneficial in remote, impoverished regions where access and affordability often limit food resources. In rural Cambodia, researchers reported that iron status of women consuming traditional Cambodian diets improved by 46% after 6 months of regular use of LIF.[8] Similarly, a 52-week longitudinal study that assessed the efficacy of the LIF among those living in rural Guatemala reported improved hemoglobin and hematocrit values in nearly 80% of subjects.[9] Both studies concluded that regular use of LIF in food preparation substantially contributes to overall daily iron requirements and subsequent improvement in iron status.

While the beneficial use of LIF for household preparation of daily meals has been demonstrated, its use in quantity food production has not been investigated. 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. Based on previous results in our laboratory,[7] the amount of iron in black beans and rice prepared with iron-fortified water (compared to those prepared with tap water) nearly doubled (18.8 µg/g vs. 9.54 µg/g and 17.7 µg/g vs. 7.1 µg/g, respectively). This was used as a starting point to develop methodology for the current study; to formulate a large volume of iron-fortified cooking water for food production using LIF.

This study was conducted in two phases. The first phase was a laboratory study to develop protocols to develop the iron fortification solution, whereas the second phase was a field study to test the efficacy of LIF fortified food in improving iron status. The primary objectives of this study were to: 1) develop the methodology to prepare large volumes of iron-fortified water that can be used for quantity food production; 2) investigate the feasibility of using LIF to prepare iron-fortified school lunches; and 3) determine if this methodology improved iron status (change in hematocrit (%) and hemoglobin (g/dL) values) after 8 months of consuming iron-fortified meals prepared with LIF in school-going children and adolescents from impoverished communities in Guatemala. We hypothesized that the consumption of daily iron-fortified school lunches would increase hemoglobin and hematocrit values among children with low baseline values.

METHODS

LABORATORY METHODS

Tap water (TW) from Moscow, Idaho was utilized for sample solutions because it more accurately represents the water accessible to residents of rural Guatemala. It has also been established that deionized water (DI) is problematic for pH readings due to its low buffer capacity, sensitivity to contamination, and low electrical conductivity.[10] All analyses (pH and iron concentration measurements) were conducted at the University of Idaho Analytical Sciences Laboratory.

Five liters of water, acidified with the juice from 5 limes (approximately 150 mL), were brought to a boil. Once the boiling point was reached, 10 LIF were added to the pot, covered, and simmered for 60 minutes. The LIF were removed, and the water cooled to room temperature. Separate subsamples were collected for pH and total iron determination. pH measures were performed using a Thermo Scientific™ Triode™ combination electrode thoroughly cleaned with DI water between measurements. The pH meter was calibrated with Fisher Scientific™ buffers (pH 4.0, 7.0 and 10.0) and calibration verification standards were used prior to sample analysis. Solutions for iron determination were acidified to pH <2 with nitric acid prior to analysis. Total iron was quantified using a PerkinElmer 8300 Inductively Coupled Plasma Optical Emission Spectrometer (ICP-OES). Standard laboratory quality control was followed which included initial and continuing calibration verification, method blanks, sample duplicates, and certified reference materials. Each iron treatment was conducted and analyzed in triplicate.

FOOD PREPARATION

Both schools employed cooks to prepare daily school lunches. School personnel were trained on-site in the preparation of iron-fortification of cooking water, using familiar cooking utensils. 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. From baseline to follow-up, children were provided daily iron-fortified school lunches (5/wk). Because of ethical considerations associated with withholding treatment and the potential to improve iron status, a control group for comparison purposes was not used.

SUBJECTS

As no existing study protocols were available to formulate a power calculation, sample size was based solely on school enrollment at the onset of the academic year. Study participants were students (aged 5–16 y) from economically disadvantaged families attending private schools in Jocotenango, Guatemala. The combined enrollment of the two schools was approximately 371 students. Site selection was made on the basis that schools provided students with prepared daily lunches and that students were from poverty stricken families. To be eligible for the study, participants had to be in general good health, without any illness that impacted hemoglobin and/or hematocrit values, not taking iron supplements or medications that interfered with iron absorption, and not severely anemic (those with hemoglobin ⩽ 8.0 g/dL). School personnel held informational meetings to explain the purpose of the study to parents and to obtain consent. Once study consent was obtained, parents completed a questionnaire that provided biographical and background information (child's age, dietary patterns, nutrient supplement use, and existing health conditions). Parents agreed to have their child consume one school lunch per day prepared with iron-fortified water. All procedures were reviewed and approved by the Washington State Institutional Review Board.

ANTHROPOMETRIC MEASURES AND BLOOD COLLECTION

Standing height and body weight were measured at baseline and post-intervention (with light clothing and without shoes) using a measuring tape secured to the wall and a digital scale, respectively. Body mass index (BMI) was calculated (kg/m^2) and the World Health Organization growth charts (BMI-for-age) were used to categorize children as follows: 1) underweight; percentile BMI-for-age <5, 2) healthy weight; percentile BMI-for-age 5.1-84.9, 3) overweight; BMI-for-age 85.0-94.9, and 4) obese; ⩾ 95th percentile.

Hemoglobin and hematocrit measures were taken at the start and completion of the academic calendar year (8 mo). A small amount of blood (10 - 20 mL) was obtained by gently massaging the finger, filling both a capillary tube and a cuvette. The HemoCue® Hb 201 System (HemoCue America, Brea, California, CA, USA) was used to measure hemoglobin (g/dL), and a microcentrifuge (HemataStatII; EKF Diagnostics for Life, Boerne, Texas, TX, USA) was used to measure hematocrit values (%). Quality control measures using known standards were used to ensure instrumentation consistency prior to screening. Subjects were living at sea level thus adjustment of hemoglobin values was not necessary. Although red blood cells have a lifespan of 120 days (4 months), an 8-month intervention was used to coincide with the academic calendar. It was also important to ascertain the impact of a longer intervention period to emulate continued use of iron supplementation, which is reflective of intended use.

STATISTICAL ANALYSIS

Statistical analyses were performed using R (R Foundation for Statistical Computing) and significance levels were set at a 2-sided *P* value of 0.05. The sample was divided into quintiles based on low to high ranked order of pre- hemoglobin and pre- hematocrit values (expressed as means ± SD). For each quintile, a paired t-test was used to determine if there were overall significant differences in participant's pre- and post-hemoglobin and pre-hematocrit values (expressed means ± SDs).

RESULTS

OBJECTIVE 1: DEVELOP THE METHODOLOGY TO PREPARE LARGE VOLUMES OF IRON-FORTIFIED WATER THAT CAN BE USED FOR QUANTITY FOOD PRODUCTION

Laboratory analysis showed that adding the juice of 5 limes to 5 L water resulted in a pH of 2.2. Boiling 10 LIF for 1 hour yielded, on average, approximately 1.2 g of total iron. To scale to a large volume of cooking water, the 5 L of the concentrated iron solution was diluted to 35 L by the addition of 30 L of tap water. This resulted in a final concentration of ~33 mg iron/L.

OBJECTIVE 2: INVESTIGATE THE FEASIBILITY OF USING LIF TO PREPARE IRON-FORTIFIED SCHOOL LUNCHES

To ascertain the acceptability of lunches prepared with LIF, qualitative information provided by teachers, staff, and cooks indicated that children detected a metallic taste when beverages were prepared with LIF. For this reason, using iron-fortified water to prepare beverages was discontinued early in the study. However, children did not express dissatisfaction with regards to the taste of iron-fortified foods served for lunch. Reportedly, the preparation of iron-fortified cooking water substantially impacted kitchen time, prolonging workdays by a few hours. However, this was resolved by preparing the iron-fortified cooking water at the end of the school day rather than in the morning. This enabled the cooks to begin meal preparation at the start of the school day and allowed lunches to be served on schedule.

OBJECTIVE 3: DETERMINE IF THIS METHODOLOGY IMPROVED IRON STATUS (CHANGE IN HEMATOCRIT (%) AND HEMOGLOBIN (G/DL) VALUES) AFTER 8 MONTHS OF CONSUMING IRON-FORTIFIED MEALS PREPARED WITH LIF IN SCHOOL-GOING CHILDREN AND ADOLESCENTS FROM IMPOVERISHED COMMUNITIES IN GUATEMALA

A total of 371 children were enrolled at the beginning of the school year (school A; n=137 and school B; n= 234). Although nearly 100% of the parents gave permission for their children to participate in the study, full data sets were collected from 286 students representing a 23% loss to-follow up. Although the loss-to-follow up was not rigorously studied, students that dropped out of school, were taking a nutrient supplement that included iron, and/or were absent the scheduled days of testing/retesting were not included in the final analysis (school A; n=38;27.7% and school B; n=47; 20.1%). A total of 286 (77%) children (166 girls; 58% and 120 boys; 42%) between the ages of 5 – 17 (y) completed the study, with a mean age of 10.3 (y) ± 2.9. No significant differences (*P*>0.05) in age, sex, and pre-BMI values (kg/m^2) between the two schools were found and therefore data from both schools were combined.

Anthropometric data and other baseline characteristics from student participants are shown in Table 1. No significant differences ($P \geqslant 0.05$) were found between baseline and post-intervention calculated body mass index values (kg/m^2). Most children (198;69.2%) were classified in the healthy weight range (percentile BMI-for-age 5.0-84.9 kg/m^2) whereas 39 children (13.6%) met the criteria for obese ($\geqslant$ 95th percentile). Based on parents' self-reported estimates of meat consumption (categorized as beef/pork and poultry/fish), most families consumed meat at least once per week. However, 17% of families consumed meat less than once per month. Based on parents self-reported estimates, nearly one-third of children consumed 1-3 servings of sugar sweetened drinks per day. The average number of children per household was 3 (± 2.11).

When grouped by age (Table 2), paired t-test results showed significant differences between baseline and post-intervention hematocrit and hemoglobin values except for hemoglobin values among those between the ages 5-11 (y). The greatest increase in hemoglobin and hematocrit values was observed in children 15 years of age or older.

The overall prevalence of iron deficiency anemia was lower than expected (6.9% and 5.6% based on age-related hemoglobin and hematocrit values, respectively). This difference is likely due to the school-meals program made available to the children. It was therefore inappropriate to categorize the population by level of anemia (no anemia; mild anemia; moderate anemia and severe anemia). For statistical purposes, the group was split into quintiles based on ranked order of low to high pre-hemoglobin and pre-hematocrit values.

Paired t-test (baseline vs. post-intervention) hemoglobin and hematocrit results are presented in Table 3. Post-hemoglobin levels significantly increased for those in quintile 1. No significant change was noted for quintiles 2, 3, 4, and 5. Post-hematocrit values were significantly higher than pre- hematocrit values for quintiles 1 and 2, while no change was found for quintiles 3 and 4. Quintile 5 showed a significant decrease in post-hematocrit values.

Table 1. Baseline characteristics of study participants

Characteristics	n (%)
Age (y) Mean ± Standard Deviation 10.3 ± 3.0	
≤6	31 (10.8)
7-8	49 (17.1)
9-10	76 (26.6)
11-12	48 (16.8)
13-14	50 (17.5)
≥15	32 (11.2)
Sex	
Boys	120 (42)
Girls	166 (58)
BMI-for-age classification (baseline)	
Underweight (<5th percentile)	4 (1.4)
Healthy (5.0-84.9 percentile)	198 (69.2)
Overweight (85.0-94.4 percentile)	45 (15.7)
Obese (>95th percentile)	39 (13.6)
BMI-for-age classification (post-intervention)	
Underweight (<5th percentile)	4 (1.4)
Healthy (5.0-84.9 percentile)	195 (68.2)
Overweight (85.0-94.4 percentile)	49 (17.1)
Obese (>95th percentile)	38 (13.6)
Meat (beef/pork) consumption*	
≤1	49 (18.0)
2-3	35 (12.9)
4-5	125 (45.0)
≥6	63 (23.2)
No response	14 (4.9)
Meat (poultry/fish) consumption	
≤1	34 (12.3)
2-3	37 (13.4)
4-5	104 (37.5)
≥6	102 (36.8)
No response	9 (3.1)
Sugar-sweetened beverages†	
<1	199 (73.4)
1	53 (20.4)
2-3	15 (5.8)
No response	15 (5.2)
Number of children household **Mean ± SD 3.0 ± 2.1**	
1-2	95 (34)
3-4	148 (53)
5-6	20 (7.2)
7-8	11 (3.9)
≥9	5 (1.8)
No response	5 (1.7)

*Servings/m
†Servings/d

DISCUSSION

The primary objectives of this study were to: 1) develop the methodology to prepare large volumes of iron-fortified water that can be used for quantity food production; 2) investigate the feasibility of using LIF to prepare iron-fortified school lunches; and 3) determine if this methodology improved iron status (change in hematocrit (%) and hemoglobin (g/dL) values) after 8 months of consuming iron-fortified meals prepared with LIF in school-going children and adolescents from impoverished communities in Guatemala.

Regional isolation, economic constraints, and limited access to iron-rich foods are just a few of the obstacles that

Table 2. Baseline and post-intervention hemoglobin and hematocrit values by age group. Comparisons associated with *P* values > 0.05 are not significantly different.

Hemoglobin*	Baseline†	Post-intervention‡	*P* value§
5-11 ‖ (n=184)	13.5±1.1	13.6±1.1	*P*>0.05
12-14 (n=75)	14.5±1.2	14.8±1.2	*P*≤0.02
≥15 (n=27)	14.4±1.5	15.0±1.2	*P*≤0.01
Hematocrit¶			
5-11 (n=179)	38.4±3.2	39.1±3.2	*P*≤0.01
12-14 (n=75)	41.5±3.1	42.7±3.4	*P*≤0.003
≥15 (n=27)	41.7±3.3	43.1±3.8	*P*≤0.01

* g/dL
† Mean±Standard Deviation at week 0
‡ Mean±Standard Deviation at week 32
§ Significance set at *P*≤ 0.05
||Age (y) at baseline
¶Ratio of packed cells to total volume expressed as percent

Table 3. T-Test: Paired two sample for means

	Quintile 1 (n=57)	Quintile 2 (n=57)	Quintile 3 (n=57)	Quintile 4 (n=57)	Quintile 5 (n=58)
Hemoglobin (g/dL) – pre vs. post*	12.7 vs. 13.5†	13.3 vs. 13.5	13.7 vs. 13.8	14.2 vs.14.4	15.1 vs. 15.0
Hematocrit (%) – pre vs. post*	34.8 vs. 38.9†	37.6 vs. 39.0‡	39.4 vs. 39.6	41.4 vs. 41.2	44.5 vs. 43.3§

*Mean value
†*P* < 0.0001
‡ P< 0.005
§*P* < 0.03

make it difficult to address the global health crisis of IDA. Whereas iron fortification of food is used in many countries to increase iron intake, this approach is not always successful in reaching people who do not have access to commercially prepared foods.[11] Similarly, breeding crops to increase the iron levels in staple foods such as rice and beans has also proven to be challenging.[12] Thus, results of this study are highly meaningful and demonstrate a novel approach to improve iron status among those most vulnerable. Although not having a control group for the purpose of comparison, this study showed the plausibility of community-based interventions to improve iron status. Future studies that utilize randomized research designs can provide a deeper understanding of the association between providing iron-fortified meals and iron status in large-group settings.

While this study was unable to take samples of the prepared lunches for the purpose of iron analyses, based on calculations, it was estimated that each lunch provided approximately 15 mg iron of iron/serving. This estimate considers both the iron naturally occurring in foods as well as iron provided by LIF. Future studies should address this issue by quantifying the amount of iron in meals prepared using conventional methods and those prepared with iron-fortified water. In addition, to better evaluate taste satisfaction, utilization of a questionnaire to provide quantified measures of hedonic properties such as taste, smell, and mouth feel is recommended.

It is also important to recognize that methodology utilized in this study required boiling LIF in acidified water for 1 hour. This posed a significant challenge because it required large amounts of costly fuel. To alleviate this burden, the added fuel costs were paid for by the study. Methodology that eliminates the need to boil LIF for an extended period prior to meal preparation should be explored. Soaking LIF in acidifying agents such as citric acid or acetic acid may offer a cost-effective, more efficient, and easily implemented alternative to extensive boiling. It was also noted that by study completion, the LIF were becoming thin, which may have been due to increased boiling time. As such, there may have been a decline in iron release towards the end of the study. LIF replacement on a more regular basis may therefore be necessary. To determine if this is the case, repeated boiling studies in acidified water are needed.

Although iron status improved in children considered to have marginal iron status, a lower-than expected number of children met the World Health Organization criteria for IDA. While the estimated prevalence of IDA among school-aged children in Guatemala is approximately 32%, in this study only 6.9% and 5.6% were below the World Health Organization criteria for IDA for hemoglobin and hematocrit values, respectively.[13] It is likely that the prevalence of IDA is lower among Guatemalan children attending private schools compared to those attending public schools. Moreover, there are also likely differences in the prevalence of IDA between urban and rural settings. Future studies testing the efficacy of LIF should target schools and other population groups with known high prevalence of IDA.

It is unlikely that confounding variables might affect the outcomes of the study. The school children come from similar deprived backgrounds with similar lifestyles, the prevalence of hemoglobinopathies and thalassemia in the population is negligible, and those receiving iron supplementation were excluded from the final analyses. Furthermore, the school children were treated with anthelmintics prior to the beginning of the study to reduce the burden of intestinal parasites that can cause intestinal bleeding and subsequent iron loss.[14]

The schools participating in this study were unique and may not reflect practices of public schools in Guatemala. For example, both schools offered full-day classes and employed cooks to prepare daily lunches. Furthermore, the schools provided families with tuition incentives if children continued their education and graduated. For this reason, the number of older students in this study may not be typical of public schools. While state schools in Guatemala are free, education is compulsory only through the sixth grade. The added costs of uniforms, supplies and transportation can make the burden of staying in school untenable for many families.

While few students presented with iron deficiency anemia, students 12 years of age and older experienced the largest increases in hemoglobin and hematocrit values. As these ages coincide with adolescent growth spurts and menarche, adequate iron intake during these stages of life is particularly important. It is therefore important to advocate for school lunch programs, especially those that can easily utilize this approach to improve iron status.[15]

While concerns have been raised that routine iron fortification of food may be harmful in iron replete children, this is unlikely among those living in resource-constrained regions of the world.[16] Our study showed insignificant change in hemoglobin and hematocrit values in children grouped in the highest quintiles. This lends support to the viability of public health measures that utilize food fortification to combat iron deficiency anemia. The risk of long-term and potentially negative impacts is negligible. The levels of adventitious iron are within the limits of a diverse iron-rich diet recommended by the United Nations Food Fortification Initiative (https://www.ffinetwork.org/). The genetic variant for hemochromatosis is found exclusively in the descendants with Celtic heritage, and hence not applicable to this study group.[17]

Whereas this study tested the utility of preparing large quantities of iron-fortified meals using LIF in schools, this methodology can also be implemented in a variety of congregate meal settings that care for other vulnerable populations. For example, limited food resources, impaired health, and abandonment are some of the major problems faced by the elderly in Guatemala. Non-profit organizations help to bridge this void by providing community feeding centers that serve daily nutritious meals to older adults. The ability to provide added iron to meals is important at every stage of life.

CONCLUSION

The strength of this study was that lunches were prepared in a consistent manner such that children were fed the same meals prepared by cooks trained to use LIF for quantity food production. This differs from previous studies that relied on household members' abilities to use LIF properly, which raises methodological concerns that could result in inconsistency and variability.[18] For example, inadequate water acidification, which greatly impacts the amount of iron released from LIF, is a potential source of error that could contribute to erroneous results. Whereas each child in this study received standardized food portions, self-report food intake by household members' is often unreliable and difficult to quantify, especially among those not familiar with units of measure.

As previously noted, this study did not utilize a control group for comparison purposes. Although this would have been optimal, both schools stressed the importance for all students to receive added iron in their daily lunch. While it is fully recognized that placebo-controlled, randomized, clinical trials are the gold standard for studying an intervention, it is not always possible. Nonetheless, studies that utilize these important design measures are encouraged when feasible.

It is imperative to note that the results of this study reflect a very specific group of generally healthy children and may not be generalized to other regions or population groups in Guatemala. Differences in dietary patterns, food customs, religious practices and food preferences can influence the acceptability of using LIF to prepare meals. In Guatemala, as in other regions of the world where extreme poverty and isolation exist, it is a challenge to fully understand a system of patchwork healthcare that is often influenced by spiritual practices, superstitious beliefs, and cultural customs. As such, further testing of the LIF in a variety of community-dwelling settings is warranted before widespread programs can be implemented.

In conclusion, study results suggest that LIF can be used to prepare large quantities of iron fortified food, which has the potential to provide iron-fortified meals to hundreds of people at congregate meal sites. Furthermore, it was demonstrated that regular consumption of iron-fortified school lunch can improve iron status in children with marginal iron status. Equally important is the finding that iron-fortified meals do not negatively impact those with healthy iron values. Additional studies are needed to quantify iron content of meals prepared with LIF.

ACKNOWLEDGEMENTS

This study would not have been possible without the support of many individuals and organizations. First, we are grateful to the schools (Escuela Integrada and Escuela La Esperanza), teachers, and school staff for their logistical support and study participation. We also want to thank the parents that allowed their children to be part of this study. We greatly appreciate the nonprofit organization Strawberry Jam for their financial support (Tcmitchell1@strawberryjam.com) and Lucky Iron Fish® (https://luckyironfish.com) for providing guidance with the implementation of this study.

ETHICS STATEMENT

This study was approved by the Institutional Review Board at Washington State University. Informed consent was obtained from parents of students participating in this study.

DATA AVAILABILITY

Access to data can be made available by contacting the corresponding author (Beerman@wsu.edu).

FUNDING

A financial contribution from Strawberry Jam https://strawberryjamngo.org provided partial funding for this study. Publication charges were paid for by the School of Biological Sciences, Washington State University.

AUTHORSHIP CONTRIBUTIONS

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DISCLOSURE OF INTEREST

The authors completed the ICMJE Disclosure of Interest Form (available upon request from the corresponding author) and disclose no relevant interests

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Submitted: January 26, 2023 GMT, Accepted: May 02, 2023 GMT

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