Development of Meat-containing Infant Porridges to Prevent Iron Deficiency

Abstract No. 3923

Helena Pachón[1], María Reyna Liria Domínguez[2], Hilary Creed-Kanashiro[2], Raymond P. Glahn[3], Rebecca J. Stoltzfus[1]

[1]Division of Nutritional Sciences, Cornell University, Ithaca NY 14853 [2]Instituto de Investigación Nutricional, Av. La Molina 685, Lima 12 Peru

[3]US Plant, Soil and Nutrition Laboratory, Tower Road, Ithaca NY 14853

ABSTRACT

In developing nations, infant foods often have low iron bioavailability. We developed & tested infant porridges with lyophilized meat powder & iron-fortified foods via 1) ingredient-screening for cultural appropriateness (recipe trials with Peruvian mothers) & *in vitro* iron bioavailability (*in vitro* digestion/Caco-2 cell method), 2) acceptability testing with mothers & infants, 3) microorganism and pesticide-screening & 4) final *in vitro* bioavailability testing. Flour combined with chicken liver had more bioavailable iron than flour alone ($P<0.001$). Mothers' acceptability scores were highest for no-meat followed by lower- & higher-meat porridges (e.g. 4.5 no-meat, 3.7 low-liver & 3.3 high-liver for taste on a 1-5 scale $P=0.0001$). However, infants' intake of meat (68 g liver, 62 g thigh) & no-meat porridges (61 g) was the same ($P=0.7$). Microorganism levels were acceptable/marginally acceptable; no pesticide residues were detected. With respect to *in vitro* iron bioavailability, we tested three porridges: no-meat, chicken thigh (with 3 g of meat powder), and chicken liver (with 1 g of meat powder). Compared to the no-meat porridge, the chicken thigh porridge had more bioavailable iron ($P=0.01$), whereas the chicken liver porridge was the same ($P>0.05$). The chicken thigh porridge can provide more bioavailable iron to infants' diets. Addition of liver to the liver porridge may increase its iron bioavailability.

Funding: Cornell (DNS, Einaudi, LASP/Tinker, PIN), Gerber Foundation/ASNS, Hispanic Scholarship Fund/Pfizer, USDA SCRP, Kraft Foods, NIH (5 T32 K07158-28).

OBJECTIVE

Using locally available, affordable and acceptable ingredients, develop an infant food to prevent iron deficiency in infants 6-12 mo of age

METHODS

1. Develop the concept
2. Screen ingredients
3. Create and test acceptability of porridges
4. Evaluate safety of porridges
5. Assess *in vitro* iron bioavailability of porridges

METHODS AND RESULTS

1. Develop the concept

- *Lyophilized* beef powder added to a $FeSO_4$-fortified whole wheat gruel increased by 85% the absorption of non-heme iron (Hallberg et al., Pediatrics 2003)
- Meat contributes nutrients often limiting in the diets of infants in developing countries: iron, zinc, vitamin B12
- Peruvian infants consume meat and iron-fortified foods
- Therefore: To increase infants' iron intake, produce an infant food that combines *lyophilized* meat with an iron-fortified food

2. Screen ingredients

- Based on
  - -Cultural acceptability (via recipe-creation exercises)
  - -Price (via market survey)
  - -*In vitro* iron bioavailability (via an *in vitro* digestion / Caco-2 cell method)

Recipe-creation Exercise

- Selected as the principal ingredients
  - -Fortified wheat flour
  - -Chicken liver
  - -Chicken thigh

Market Survey

METHODS AND RESULTS (continued)

3. Create and test acceptability of porridges

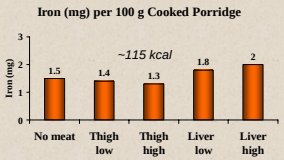
A. Recipe-creation Exercises

- Objective: Create palatable recipes that combine lyophilized chicken powder with fortified wheat flour
- Convenience sample: 21 women of infants <12 months
- Findings:
  - -More milk helps mask taste of meat
  - -Developed iso-caloric recipes for
    - No-meat porridge
    - Thigh porridge (low or high concentrations of meat)
    - Liver porridge (low or high concentrations of meat)

Porridge Ingredients (g/100 g Cooked Porridge)

	No meat	*Thigh low*	*Thigh high*	*Liver low*	*Liver high*
Milk powder	12	9.5	8	10.5	9.5
Wheat flour	9	7	7	8	8
Brown sugar	6	7	7.5	7.2	7.7
Vanilla powder	0.02	0.04	0.06	0.06	0.08
Chicken powder	0	3	4	1	1.5

Iron Concentration (mg/100 g Cooked Porridge)



- Less meat than hoped for was used in the recipes because of
  - -Organoleptic changes to porridges when meat is added
  - -Estimated vitamin A content of ~2 g chicken liver powder approached infant Tolerable Upper Intake Level (UL)

B. Maternal Acceptability

- Objective: Determine porridge acceptability using sensory methods
- Sample: 90 women with infants 5-11 months
- Method: Scored porridges for smell, color, taste, texture, consistency and overall

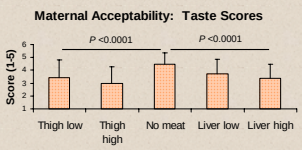


Figure: Mothers preferred porridges with no meat > less meat > more meat

C. Infant Acceptability

- Objective: Assess acceptability based on in-home intake of porridges (3 porridges X 3 days each)
- Sample: 53 mother-infant pairs (age 6-9 months)

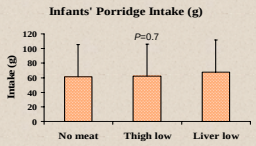


Figure: Infants had same preference for porridges with or without meat

Intake adjusted for:

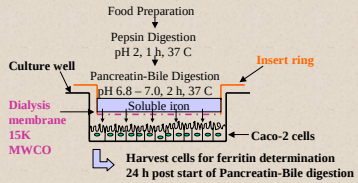
- *-Time since last food/drink/breastfeed*
- *-Infant's appetite*
- *-Infant's age*
- *-If infant had previously eaten meat*
- *-Porridge energy density*

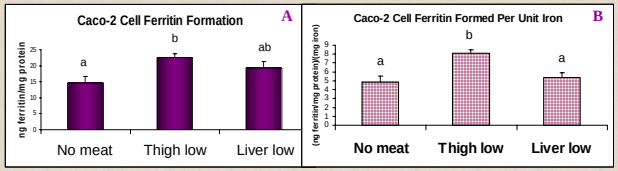
METHODS AND RESULTS (continued)

4. Evaluate safety of porridges

- Objective: Evaluate the safety of the porridges and their ingredients
- Methods: Presence of pesticide residues (Covance Lab, Inc.) and microbiological quality (IIN laboratory)
- Results:
  - -Organochlorinated and organophosphates→ Not detected
  - -Microbiological quality acceptable except for molds/yeasts of dry ingredients (marginally acceptable)

5. Assess *in vitro* iron bioavailability of porridges





Figures: A. Compared to the no-meat porridge, the chicken thigh porridge had more bioavailable iron, whereas the chicken liver porridge was comparable. B. More cell ferritin was formed per unit iron for the chicken thigh porridge compared to the no-meat and liver porridges.

SUMMARY

- Using laboratory- and field-based methods, we developed
  - -Safe porridges with culturally appropriate ingredients for Peruvian infants
  - -Meat-containing porridges that were more acceptable to infants than mothers
  - -Porridges with less chicken powder and iron concentration than hoped
  - -A chicken thigh porridge with more bioavailable iron than the no-meat porridge due to an enhancing effect of the thigh
  - -A chicken liver porridge with comparable iron bioavailability as the no-meat porridge

CONCLUSIONS

- Maternal acceptability does not predict infant acceptability of food
- The chicken thigh porridge can provide more bioavailable iron to infants' diets
- Addition of liver to the liver porridge may increase its bioavailable iron