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Iron fortified lentils for food security among adolescent girls in Bangladesh

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Lentil fortification research progress

- Development of fortification protocol - ***(published)***
- Bioavailability studies - ***(published)***
- Sensory analysis studies - ***(published)***
- Stakeholder consultation - ***(on-going)***
- Experimental trial - ***(manuscript draft)***
  - Feasibility study: Cross-over trial ***(completed)***
  - Efficacy trial: Double blind randomized controlled trial ***(completed)***
- Market research ***(in progress)***
  - Packaging
  - Consumer acceptance

Partnership/collaboration

- In Canada
  - Nutrition International
  - Global Institute for Food Security
  - Government of Saskatchewan
  - Interdisciplinary teams- academics, researchers, processors, graduate students
- In Bangladesh
  - BRAC University – Sensory analysis
  - BRAC (NGO) - Feasibility/efficacy studies
  - NI (Bangladesh office)- Market Research
  - ICDDR,B - Blood sample analysis

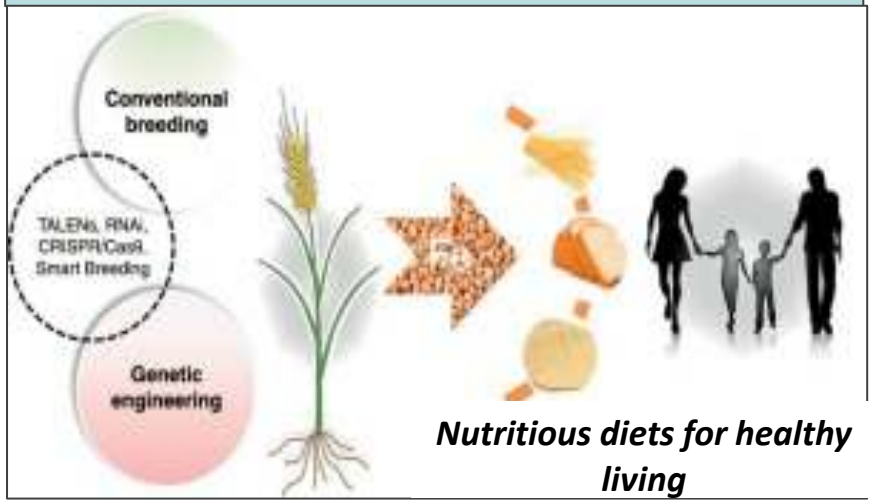
Lentil (Lens culinaris Medik.) – a source of iron

- Lentil is the fifth most important pulse crop (FAOSTAT, 2017)
- Good source of protein, fiber, vitamins, antioxidants and minerals (Zn, Fe, and Se)
- Canada is the world's largest lentil producer and exporter

Fe improvement in lentil

Biofortification

The process by which the **nutritional quality of food crops** is improved through agronomic practices, conventional plant breeding, or modern biotechnology. (WHO, 2016)



Nutritious diets for healthy living

Fortification

The practice of **deliberately increasing the content of an essential micronutrient**, i.e. vitamins and minerals, (WHO and FAO, 2005)

Fortification of lentil

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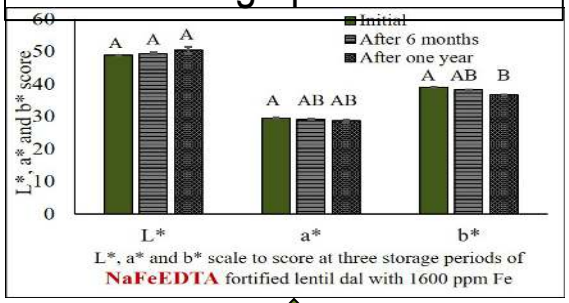
Unfortified lentil

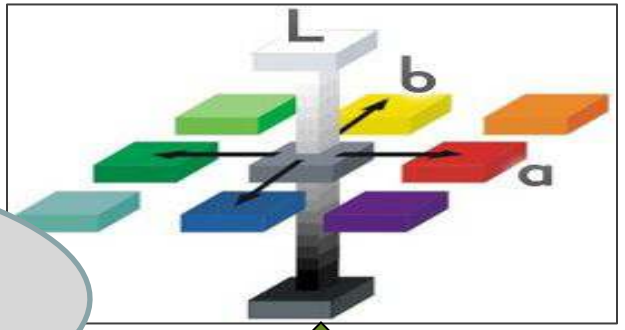
Fortified lentil

Stability analysis at different storage periods



L*, a* and b* scale to score at three storage periods of NaFeEDTA fortified lentil dal with 1600 ppm Fe

Colorimetric measurements



Appropriate dose of Fe solution to address RDA for humans

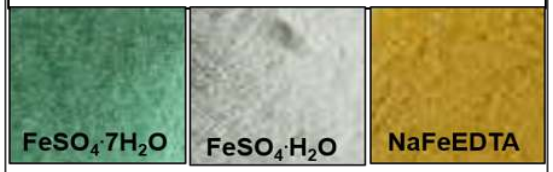
Assessment of pH of Fe solution

Estimation of Fe conc. in fortified lentil

Spraying shaking and drying

Appropriate method selection

Selection of Fe fortificant



Lentil Fortification Protocol

NaFeEDTA fortified lentils have the best appearance amongst all samples tested

Commonly used staples in fortification

- Wheat
- Maize
- Rice

In Bangladesh

- Edible Oil Vitamin A
- Mandatory iodized salt
- Rice –voluntary-in trial

Why Bangladesh? Why Adolescents? Boys/Girls?

- **Iron deficit at national level**
  - **9.5%** children of 12-14 years Iron deficit
  - **7.1%** Non-pregnant and non-lactating women of 15-49 years.
- **IDA at national level**
  - 1.8% of children 12-14 years (Hemoglobin <12.0 g/dL plus ferritin level <15.0 ng/mL)
  - 4.8% Non-pregnant and non-lactating women of 15-49 years.
- **Adolescents are nutritionally vulnerable**: significant growth, lifestyle and food habit (McNulty et al., 1996).
- Female adolescents are **more susceptible** to ID without anaemia due to menstrual losses of iron (Dellavalle & Haas, 2012b; Hinton, Giordano, Brownlie, & Haas, 2000; Murray-Kolb & Beard, 2007b; Y. I. Zhu & Haas, 1998a)
- Bangladeshis eat a lot of lentils (locally known as 'Daal')

Sensory Acceptability

Materials and Methods

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Bangladesh (BRAC University)

45 Panellists were recruited from staff and students at **U of S** (2 replications)

98 consumers were selected

Scale

A 9 point hedonic scale :

[9=like extremely;

7=like moderately;

5=neither like nor dislike;

3=dislike moderately and

1=dislike extremely]

Attributes	
Uncooked	**Cooked**
Appearance	Appearance
Odour	Taste
Overall Acceptability	Odour
	Texture
	Overall Acceptability

Lentil Fortification Publications

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nutrients MDPI

Nutrients. 2018 Mar; 10(3): 354.
Published online 2018 Mar 15. doi: 10.3390/nu10030354
PMCID: PMC5872772
PMID: 29543712

Relative Bioavailability of Iron in Bangladeshi Traditional Meals Prepared with Iron-Fortified Lentil Dal

Rajib Podder,[1] Diane M. DellaValle,[2] Robert T. Tyler,[3] Raymond P. Glahn,[4] Elad Tako,[4] and Albert Vandenberg[1,*]

Journal of Food Science
A Publication of the Institute of Food Technologists

Sensory & Food Quality

Sensory Acceptability of Iron-Fortified Red Lentil (*Lens culinaris* Medik.) Dal

Rajib Podder, Shaan M. Khan, Bunyamin Tar'an, Robert T. Tyler, Carol J. Henry, Chowdhury Jalal, Phyllis J. Shand, Albert Vandenberg

nutrients MDPI

Nutrients. 2017 Aug; 9(8): 863.
Published online 2017 Aug 11. doi: 10.3390/nu9080863
PMCID: PMC5579656
PMID: 28800117

Iron Fortification of Lentil (*Lens culinaris* Medik.) to Address Iron Deficiency

Rajib Podder,[1] Bunyamin Tar'an,[1] Robert T. Tyler,[2] Carol J. Henry,[3] Diane M. DellaValle,[4] and Albert Vandenberg[1,*]

Iron fortified lentil efficacy trial

Research purpose

- This study aims to establish novel evidence on the efficacy of iron fortified lentil in improving body Fe status of non-pregnant adolescents of rural Bangladesh.

Source: Fakir Yunus, 2018

Research question

- How efficacious is iron fortified lentils in improving the iron status (Fe) of non-pregnant adolescent girls of rural Bangladesh?

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Feasibility study

- **WHAT** Dose? Amount!
- **WHICH** Preparation? Thick and thin! Or other items/snacks?
- **WHAT** Duration?
- **ARE** they Willing to consume?
- **WHEN** of the day? Frequencies
- **HOW** to serve? With or without rice?
- **WHO** to do it?
- **HOW** to implement?

- Carried out among 100 adolescent girls.
- 2016-2017
- 10-17 yrs adolescent girls in Bangladesh

We found

- An uncooked amount of raw iron-fortified lentils (37.5 g) cooked in thick preparation (as a portion size of 200g dal) using Bangladeshi recipe for the period of 12 weeks would be feasible intervention to carry out a future human efficacy trial to measure the effect of iron-fortified lentils on body iron status.

Yunus F. Feasibility of field implementation of fortified lentils to improve iron (Fe) status of adolescent girls in Bangladesh [Internet]. University of Saskatchewan; 2018. Available from: https://harvest.usask.ca/bitstream/handle/10388/8363/YUNUS-THESIS-2018.pdf?sequence=1&isAllowed=y

Double-blind community-based cluster-randomized controlled trial

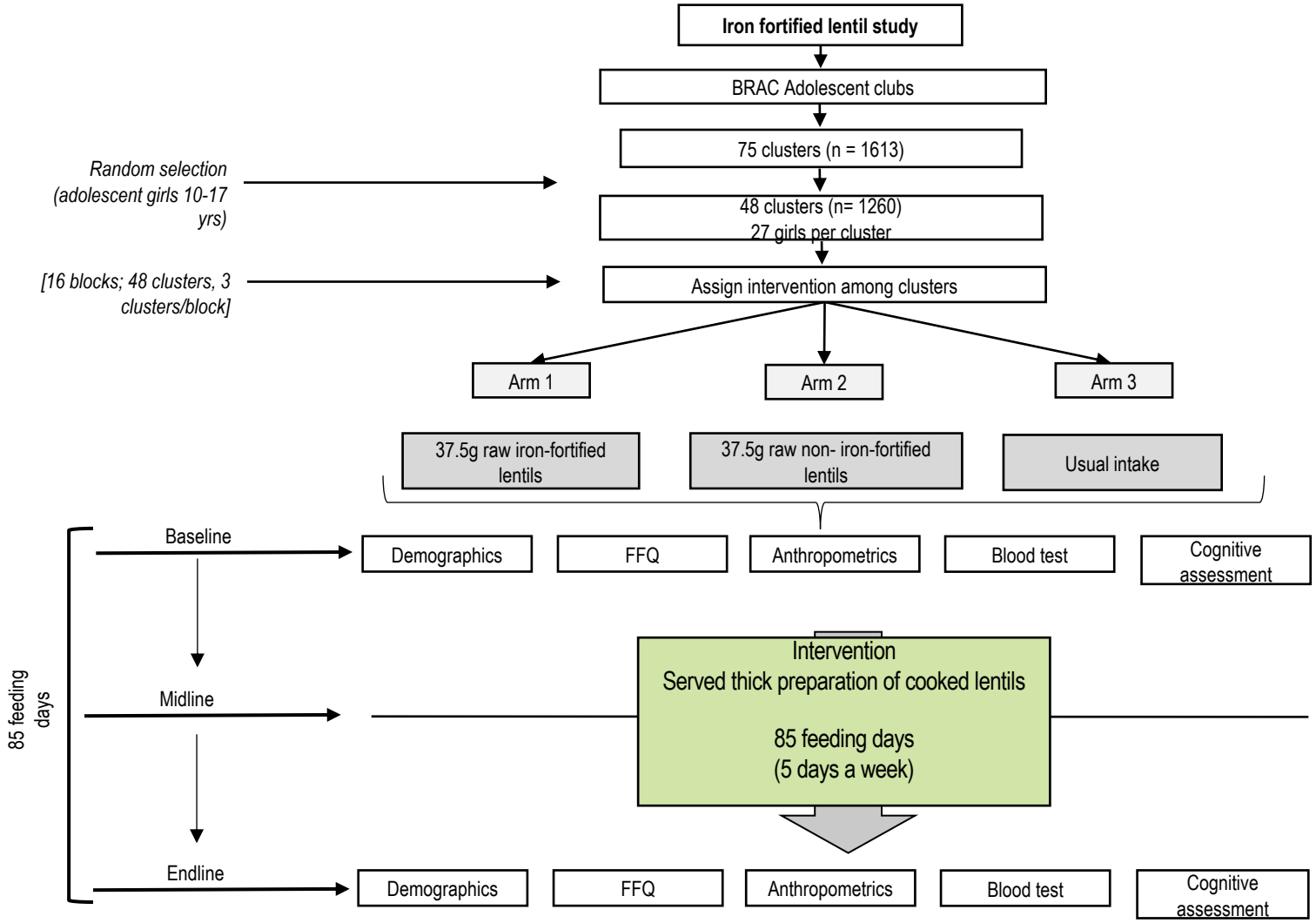

Fig 1: Flow chart of the 85 days iron-fortified lentils feeding trial; Demographics, FFQ, Anthropometrics; Blood test; Cognitive assessment.

Yunus et al. 2019

NIH U.S. National Library of Medicine

ClinicalTrials.gov

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Save this study

Iron-fortified Lentils to Improve Iron (Fe) Status in Bangladesh

ClinicalTrials.gov Identifier: NCT03516734

Recruitment Status : Recruiting
First Posted : May 4, 2018
Last Update Posted : October 11, 2018

See Contacts and Locations

Sponsor:
Carol Henry

Collaborators:
Brac
Marywood University
Nutrition International

Information provided by (Responsible Party):
Carol Henry, University of Saskatchewan

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Protocol paper publication

Yunus *et al. Trials* (2019) 20:251
https://doi.org/10.1186/s13063-019-3309-4

Trials

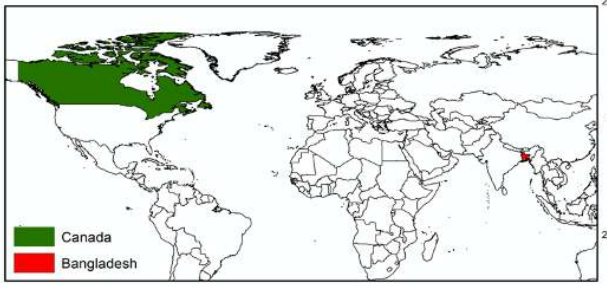
STUDY PROTOCOL Open Access

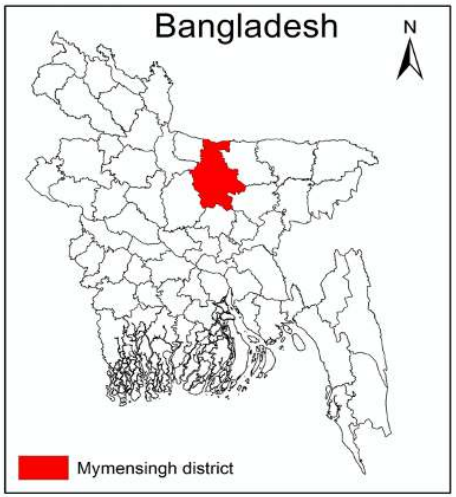
Iron-fortified lentils to improve iron (Fe) status among adolescent girls in Bangladesh - study protocol for a double-blind community-based randomized controlled trial

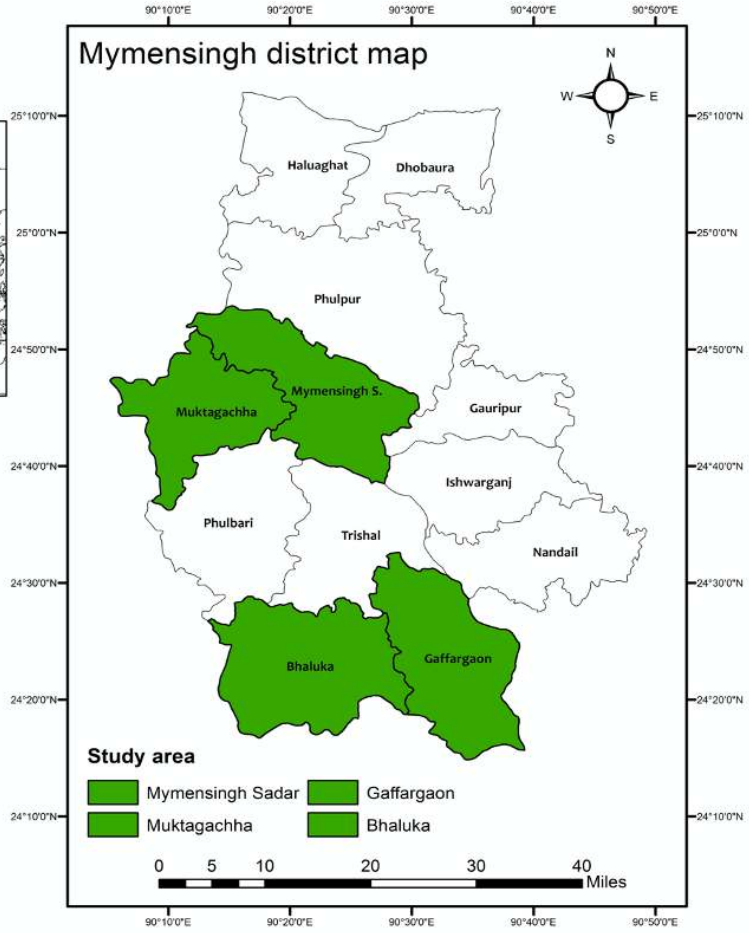
Fakir Md Yunus[1], Chowdhury Jalal[2], Kaosar Afsana[3], Rajib Podder[4], Albert Vandenberg[4] and Diane M. DellaValle[5*]

Study area map

Mymensingh, Bangladesh





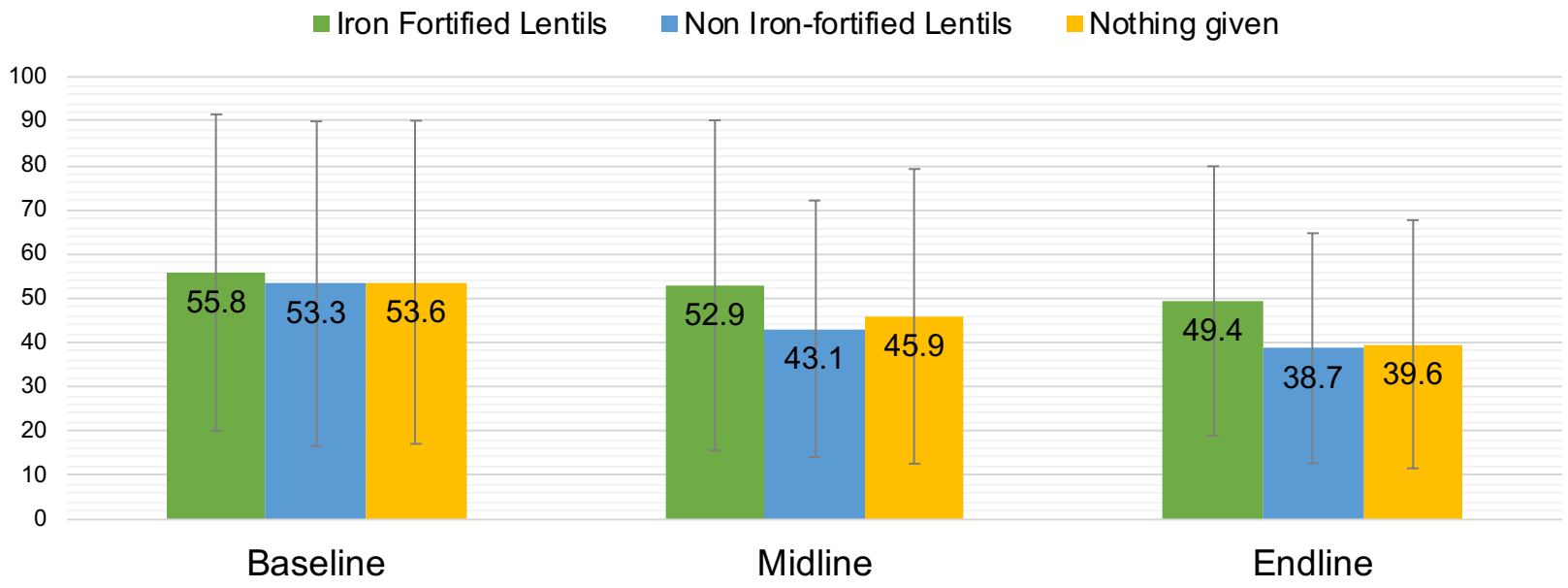


Cooked lentils (Dal) was served as late afternoon snacks

Cooked lentils (Dal) that served

Organizing cooked lentils before serving

Mean serum ferritin (SD) among 3 intervention arms in 3 data points



In the iron-fortified lentil (IFL) arm, serum ferritin status was maintained from baseline to endpoint (55.8 vs 49.4 ng/mL; p=0.562), compared to a decline in serum ferritin status observed in non-iron-fortified lentil (NIFL) arm (53.3 vs 38.6 ng/mL; p <0.01) and usual intake arm (53.6 vs 39.5 ng/mL; p <0.01).

Body iron store maintained in IFL group compare to other group

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Key findings:

- Average serum ferritin level significantly **increased by 21.9% in IFL** compare Usual Intake (UI) group after adjusting inflammation and holding upazilla as random effect factors and age constant.

- IFL consumption group had about 51% less chance of developing clinical IDA (sFer <15 ng/ml and Hb <12 g/dL)

- IFL consumption group had about 70% less chance of developing sub-clinical IDA (sFer 15 to <30 ng/ml and Hb <12 g/dL)

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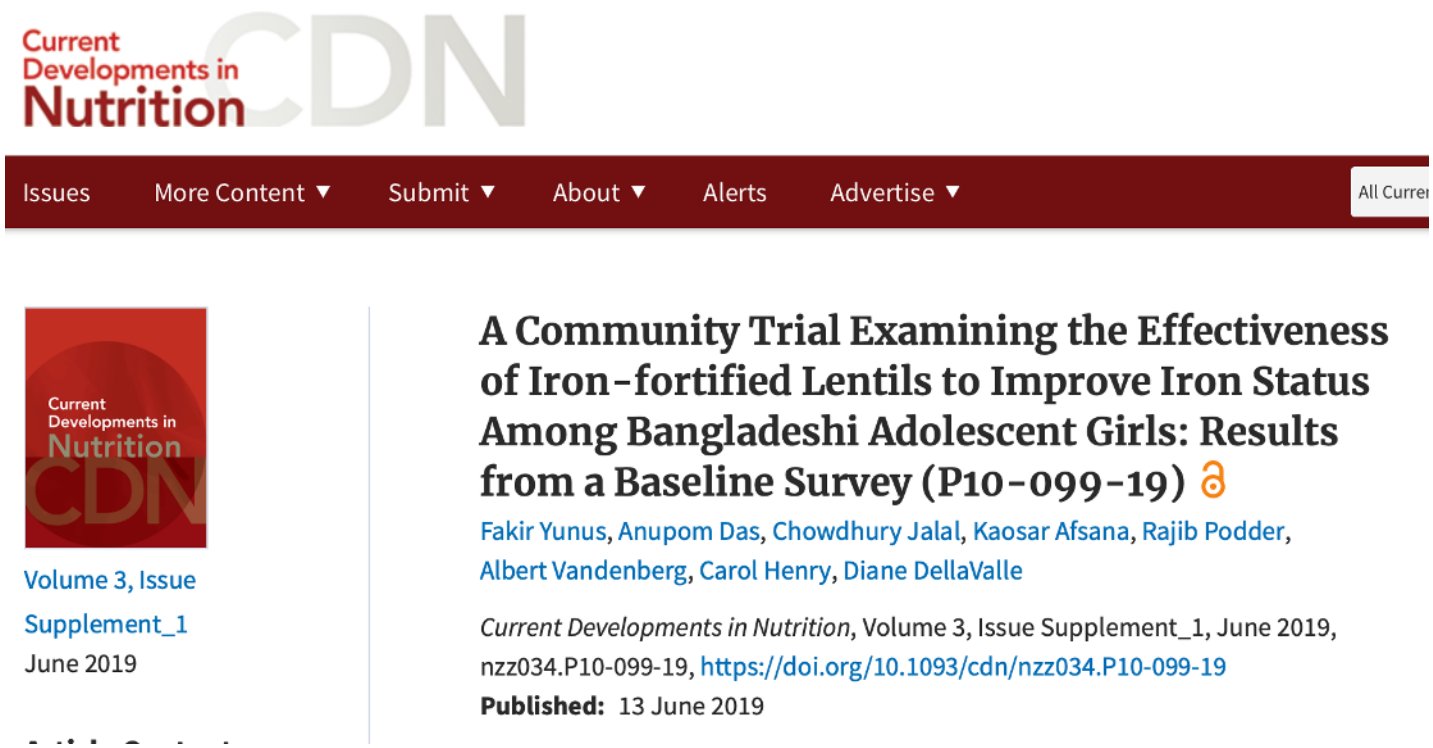
Abstract publication (presented in ASN 2019)



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Current Developments in Nutrition CDN

Volume 3, Issue Supplement_1
June 2019

A Community Trial Examining the Effectiveness of Iron-fortified Lentils to Improve Iron Status Among Bangladeshi Adolescent Girls: Results from a Baseline Survey (P10-099-19)

Fakir Yunus, Anupom Das, Chowdhury Jalal, Kaosar Afsana, Rajib Podder, Albert Vandenberg, Carol Henry, Diane DellaValle

Current Developments in Nutrition, Volume 3, Issue Supplement_1, June 2019, nzz034.P10-099-19, https://doi.org/10.1093/cdn/nzz034.P10-099-19

Published: 13 June 2019

Market Research/ Consumer studies

- Packaging
- Acceptance
- Consultations on going

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Iron-fortified lentils efficacy trial team

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Collaborators and partners

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Acknowledgement for financial assistance

2018 IDRC Doctoral Research Award

Canada

Agriculture Development Fund

Thank you

Question & Answers