

Elemental iron release from Nepali karai (iron Pot) and rationale for field testing in Nepal

Short background deck for NHRC submission

Focus: Nepal anaemia context, lessons from Lucky Iron Fish, and laboratory evidence comparing aluminum, iron, and cast-iron karai before field selection.

1. Why anaemia matters in Nepal
2. Why a cookware approach is plausible
3. What Lucky Iron Fish teaches us
4. What the laboratory results show
5. What the laboratory results show
6. Which pot is most defensible for field testing

Why this matters in Nepal

Anaemia remains common, especially among women, adolescent girls, and young children.

43%

children under five with anaemia

34%

women age 15–49 with anaemia

39%

adolescent girls with anaemia

33%

pregnant women with anaemia

Why this is a public health problem

- Anaemia affects health across the life course, from child growth and development to pregnancy outcomes and work capacity.
- For Nepal, this is not a marginal issue. It is a mainstream nutrition and maternal-child health issue.

Important scientific caution

- Anaemia is not identical to iron deficiency.
- Iron deficiency is a major contributor, but infection, inflammation, hemoglobin disorders, and other causes also matter.
- That is why a cookware intervention should be tested, not assumed.

What this means for the project

- A low-cost household approach is worth exploring in Nepal.
- But the project must move stepwise: lab plausibility first, then field acceptability and biological outcomes.

Key message

The case for this study is strong because Nepal still has a substantial anaemia burden, while household cooking practices offer a practical entry point for a food-based intervention.

Why a cookware-based intervention is reasonable in Nepal

The intervention fits household routines better than a stand-alone external product.

Household integration

- The intervention is embedded in everyday cooking rather than requiring a separate daily pill-taking habit.
- It can reach shared household meals, not just one individual at one moment.

Nepali food context

- Dal, curry, gundruk, and dhindo are real foods people already prepare.
- That makes a Nepal-specific cookware test more relevant than importing a foreign product unchanged.

Acidic cooking matters

- Organic acids and vitamin C can enhance iron release and absorption.
- This is especially relevant because souring agents such as chuk, tomato, or lemon can be built into use instructions.

Project logic before field rollout

Cookware is used in daily life



Iron must actually leach into foods



Households must accept the pot and use it correctly



Then a field trial is justified

This makes the laboratory phase essential. It answers the narrow question first: does the pot release meaningful elemental iron into the kinds of foods Nepali households actually cook?

What Lucky Iron Fish teaches us

Useful precedent, but not a result we can simply copy-paste into Nepal.

What the evidence suggests

- An early Cambodia community trial found short-term improvement in iron status, especially when follow-up education supported adherence.
- A Guatemala study later reported significant hemoglobin improvement among participants who returned after one year of use.
- A systematic review concluded that cookware and ingot effects vary widely, and much of that variation appears tied to context and compliance.

Why caution is still necessary

- A later Cambodian randomized trial found no hemoglobin benefit in a population where iron deficiency was relatively low and genetic hemoglobin disorders were common.
- So, the correct lesson is not “the fish worked everywhere.” The correct lesson is “local biology and local use patterns decide whether an iron object helps.”
- That is exactly why Nepal needs its own lab and field evidence.

Translation lesson for Nepal

The Lucky Iron Fish was valuable because it proved a broader concept: a culturally acceptable iron object can be integrated into cooking. But it also proved that success depends on local fit, not branding. Nepal therefore needs a Nepali pot, Nepali foods, Nepali behavior support, and Nepali outcome data.

Why the laboratory phase was necessary

Before field implementation, the first question was whether common Nepali foods pick up elemental iron from the candidate pots.

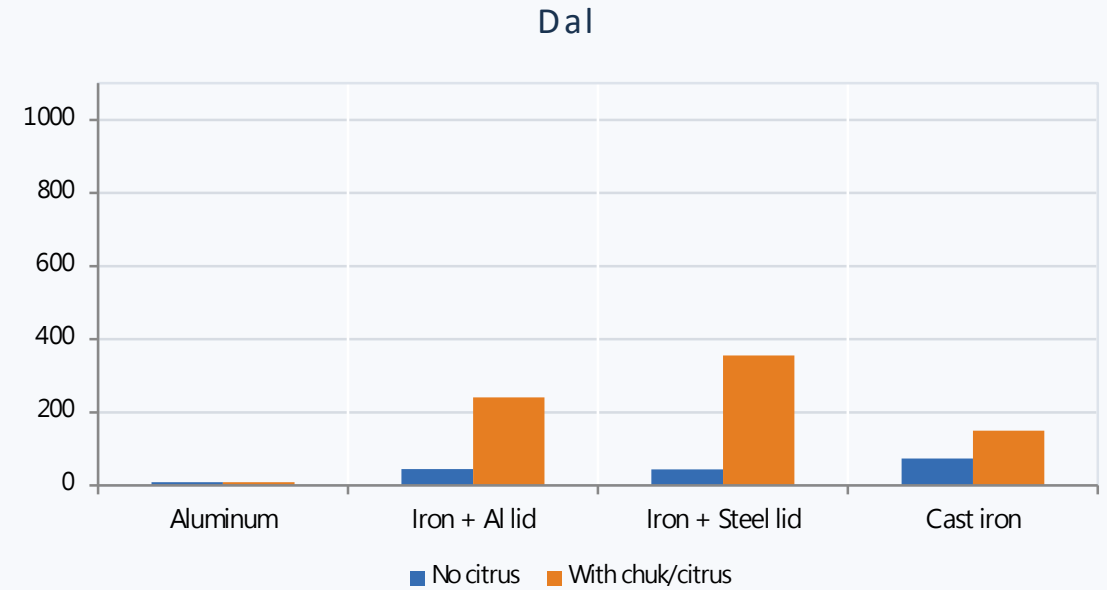
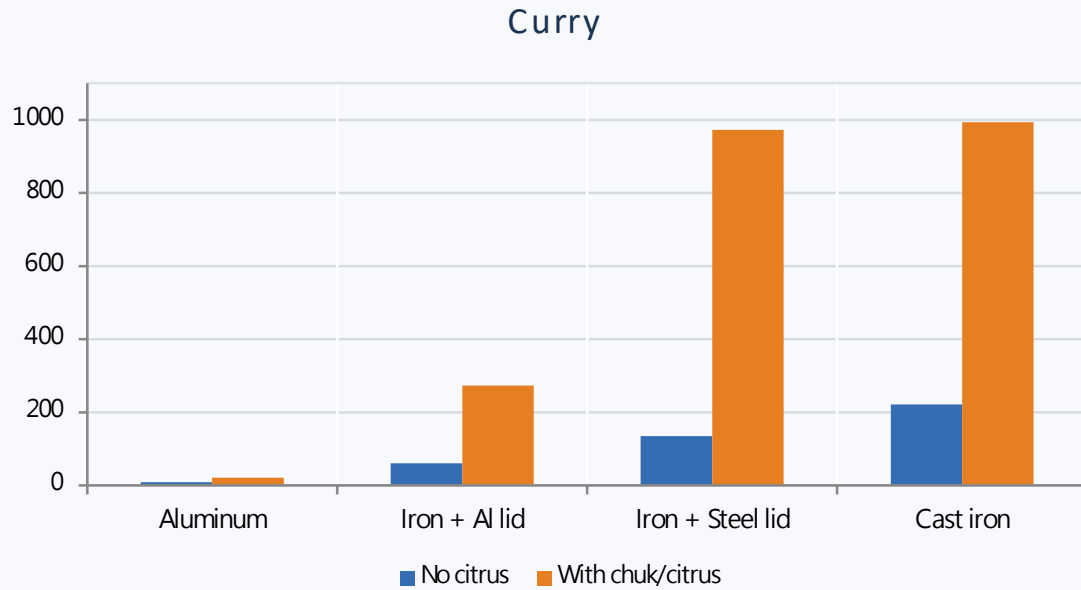
- 1 Standardized cooking** Foods cooked for 25 minutes under controlled conditions.
- 2 Four cookware conditions** Aluminum control, iron karai + aluminum lid, iron karai + stainless steel lid, and cast-iron karai + aluminum lid.
- 3 Acidic condition tested** Acidic food (lemon, Chok, Tomoato) was added in selected conditions to test whether acidity amplifies iron release.
- 4 Laboratory measurement** Elemental iron quantified at Zest Laboratories using AOAC 21st edition and in-house methods.

What this phase can and cannot tell us

It can show physical plausibility, which pot releases more iron, and how acidity changes release. It cannot prove clinical efficacy. Hemoglobin and iron status still need field testing.

Laboratory results: iron release increased sharply

Units shown as mg elemental iron per kg cooked food. In this context, the lab report ppm values are interpreted as approximately mg/kg



Dhindo, no citrus

Aluminum 3.9 | Iron + Al lid 22.6 |
Iron + Steel lid 131.1 | Cast iron 85.7

Gundruk, no citrus

Aluminum 18.7 | Iron + Al lid 386.0 |
Iron + Steel lid 329.2 | Cast iron 189.0

Main take-away

Acidity amplified release dramatically, especially in curry and dal. Pot type also changed results substantially.

Laboratory results: elemental iron release by cookware and citrus

Units: mg elemental iron per kg cooked food (ppm approximated as mg/kg). n/a indicates not tested.

FOOD TYPE	Aluminum pot and lid		Iron Karai aluminum lid		Iron karai steel lid		Cast Iron Karai - Aluminum lid	
	without citrus	with citrus	without citrus	with citrus	without citrus	with citrus	without citrus	with citrus
Curry	8.5	21.09	60.6	272.7	135.08	972.6	221.8	993.2
Dal	8.7	9	45.07	240.8	43.9	355.23	73.2	149.4
Dhindo	3.9		22.6	n/a	131.1	n/a	85.6	
Gundruk	18.7		386.02	n/a	329.2	n/a	188.9	

Aluminum is lowest

Across foods, aluminum cookware shows the smallest iron contribution.

Citrus drives higher release

Adding citrus or souring agents sharply increases iron release from iron-based pots.

Highest values in curry

Curry shows the strongest jump, reaching the highest observed values with iron and cast iron.

Interpretation: both cookware type and food acidity materially change iron in the cooked food. This supports selecting an iron-based karai for household field testing, with use instructions t

Interpretation for field pot selection

The lab does not identify one perfect winner across every food, so selection must balance iron release with operational practicality.

Provisional recommendation: take the cast-iron karai with aluminum lid as the primary field pot, while explicitly noting that this is a lab-based choice that still requires acceptability and safety testing in households.

Criterion	Cast iron + Al lid	Iron + Steel lid	Iron + Al lid
Best observed result	Highest overall value in curry with citrus (993.2)	Very close second in curry with citrus (972.6)	Highest in gundruk without citrus (386.0)
Consistency	Strong in curry and dal without citrus	Strong in citrus dal and dhindo	Strong in gundruk and moderate elsewhere
Operational simplicity	Simpler one-pot configuration	Depends on a stainless-steel lid in the tested setup	Simpler one-pot configuration
Field defensibility	Most balanced primary option	Good comparator or secondary option	Interesting but less compelling as the main trial pot

Important caveat

A pot that releases more iron in a lab is not automatically the best field pot. Final selection must also consider weight, rusting, ease of cleaning, taste or color changes, household preference, safety, and adherence over time.

NHRC-facing conclusion and next step

The lab phase justifies a household field trial, but it should not be presented as proof of clinical efficacy.

What the lab phase establishes

- Iron release is real and substantial relative to aluminum control.
- Release changes by pot type, lid type, food type, and acidity.
- A Nepal-specific cookware approach is scientifically plausible.

What the field phase still must answer

- Will households actually use the pot correctly and consistently?
- What happens to taste, color, cleaning burden, and acceptability?
- Does higher iron release translate into better hemoglobin and iron status?

Suggested NHRC language

- This project first established laboratory plausibility of iron enrichment from selected Nepali cookware and foods.
- The next phase is a controlled household trial to test acceptability, adherence, safety, hemoglobin, ferritin, and related outcomes.

Bottom line: the laboratory evidence is strong enough to justify field testing, and the cast-iron karai with aluminum lid is the most defensible primary candidate for that next phase.

Appendix: analytical reports from Zest Laboratories

Included here as visual backup for the comparative laboratory evidence.

Iron karai + aluminum lid

DDA Reg.: 4863/2058

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ANALYTICAL REPORT

NAME OF PRODUCT : **Iron Karai With Aluminum Lid**
 Batch No. : Not available
 Mfg. Date : Not available
 Exp. Date : Not available
 Manufactured by : Not available
 Supplied by : Global Envirotech Initiative, Kathmandu, Nepal
 Received on : 12/06/2025
 Date of commencement : 17/06/2025
 Date of completion : 07/07/2025
 A.R. No. : Z-1147/2025
 Sample Qty. : 1 piece iron karai with aluminum lid
 Description of sample : Black coloured iron karai sample with aluminum lid.

Tests	Test Condition	Cooked in Aluminum Pot	Observations [Cooked in iron karai (25min.) with aluminum lid]
Curry	Without citrus	8.585ppm elemental iron	60.698ppm elemental iron
	With citrus	21.092ppm elemental iron	272.725ppm elemental iron
Dal	Without citrus	8.733ppm elemental iron	45.079ppm elemental iron
	With citrus	9.046ppm elemental iron	240.819ppm elemental iron
Dhindo	Without citrus	3.941ppm elemental iron	22.603ppm elemental iron
Gundruk	Without citrus	18.726ppm elemental iron	386.028ppm elemental iron

Note: Party asked for above test only.
 (The above mentioned test parameter is done as per AOAC 21st Edition and In House Method)
 *Test condition with citrus: 1g. chuk diluted in 50ml distilled water and used 2ml while cooking.

End of Report

Analysed by: *S. Bishwakoti*
 Name: S. Bishwakoti
 Date: 07/07/2025
 ANALYST

Approved by: *B. Khattiwada*
 Name: B. Khattiwada
 Date: 07/07/2025
 AUTHORIZED SIGNATURE

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 2. Samples will be destroyed after one month from the date of issue of test certificate unless otherwise specified.
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 4. *Marked Parameters are not covered under the scope of accreditation.

Iron karai + stainless-steel lid

DDA Reg.: 4863/2058

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ANALYTICAL REPORT

NAME OF PRODUCT : **Iron Karai With Stainless Steel Lid**
 Batch No. : Not available
 Mfg. Date : Not available
 Exp. Date : Not available
 Manufactured by : Not available
 Supplied by : Global Envirotech Initiative, Kathmandu, Nepal
 Received on : 12/06/2025
 Date of commencement : 17/06/2025
 Date of completion : 07/07/2025
 A.R. No. : Z-1148/2025
 Sample Qty. : 1 piece iron karai with stainless steel lid
 Description of sample : Black coloured iron karai sample with stainless steel lid.

Tests	Test Condition	Cooked in Aluminum Pot	Observations [Cooked in iron karai (25min.) with stainless steel lid]
Curry	Without citrus	8.585ppm elemental iron	135.086ppm elemental iron
	With citrus	21.092ppm elemental iron	972.640ppm elemental iron
Dal	Without citrus	8.733ppm elemental iron	43.903ppm elemental iron
	With citrus	9.046ppm elemental iron	355.236ppm elemental iron
Dhindo	Without citrus	3.941ppm elemental iron	131.138ppm elemental iron
Gundruk	Without citrus	18.726ppm elemental iron	329.234ppm elemental iron

Note: Party asked for above test only.
 (The above mentioned test parameter is done as per AOAC 21st Edition and In House Method)
 *Test condition with citrus: 1g. chuk diluted in 50ml distilled water and used 2ml while cooking.

End of Report

Analysed by: *S. Bishwakoti*
 Name: S. Bishwakoti
 Date: 07/07/2025
 ANALYST

Approved by: *B. Khattiwada*
 Name: B. Khattiwada
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Cast-iron karai + aluminum lid

DDA Reg.: 4863/2058

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ANALYTICAL REPORT

NAME OF PRODUCT : **Cast Iron Karai With Aluminum Lid**
 Batch No. : Not available
 Mfg. Date : Not available
 Exp. Date : Not available
 Manufactured by : Not available
 Sample Submitted by : Global Envirotech Initiative, Kathmandu, Nepal
 Received on : 12/06/2025
 Date of commencement : 17/06/2025
 Date of completion : 07/07/2025
 A.R. No. : Z-1149/2025
 Sample Qty. : 1 piece cast iron karai with aluminum lid
 Description of sample : Black coloured cast iron karai sample with aluminum lid.

Tests	Test Condition	Cooked in Aluminum Pot	Observations [Cooked in cast iron karai (25min.) with aluminum lid]
Curry	Without citrus	8.585ppm elemental iron	221.884ppm elemental iron
	With citrus	21.092ppm elemental iron	993.232ppm elemental iron
Dal	Without citrus	8.733ppm elemental iron	73.208ppm elemental iron
	With citrus	9.046ppm elemental iron	149.449ppm elemental iron
Dhindo	Without citrus	3.941ppm elemental iron	85.657ppm elemental iron
Gundruk	Without citrus	18.726ppm elemental iron	188.954ppm elemental iron

Note: Party asked for above test only.
 (The above mentioned test parameter is done as per AOAC 21st Edition and In House Method)
 *Test condition with citrus: 1g. chuk diluted in 50ml distilled water and used 2ml while cooking.

End of Report

Analysed by: *S. Bishwakoti*
 Name: S. Bishwakoti
 Date: 07/07/2025
 ANALYST

Approved by: *B. Khattiwada*
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