FACULTY OF BIOSCIENCE ENGINEERING

DEPARTMENT OF FOOD TECHNOLOGY, SAFETY AND HEALTH
RESEARCH GROUP OF CEREAL AND FEED TECHNOLOGY

MAIZE MEAL FORTIFICATION AND ITS IMPACT ON MAIZE PORRIDGE QUALITY

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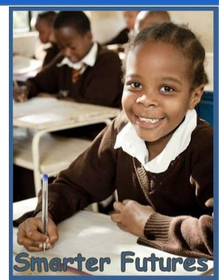
GHENT UNIVERSITY

vliruos SHARING MINDS, CHANGING LIVES

Global Minds Fund



FOOD FORTIFICATION

OIL

Vitamin
A,E

MILK

Vit A,D
Ca

CEREALS

Fe, Zn
Vit. B1, B2, B3, B6
Folic acid
Vitamin A

SALT

Iodine

SUGAR

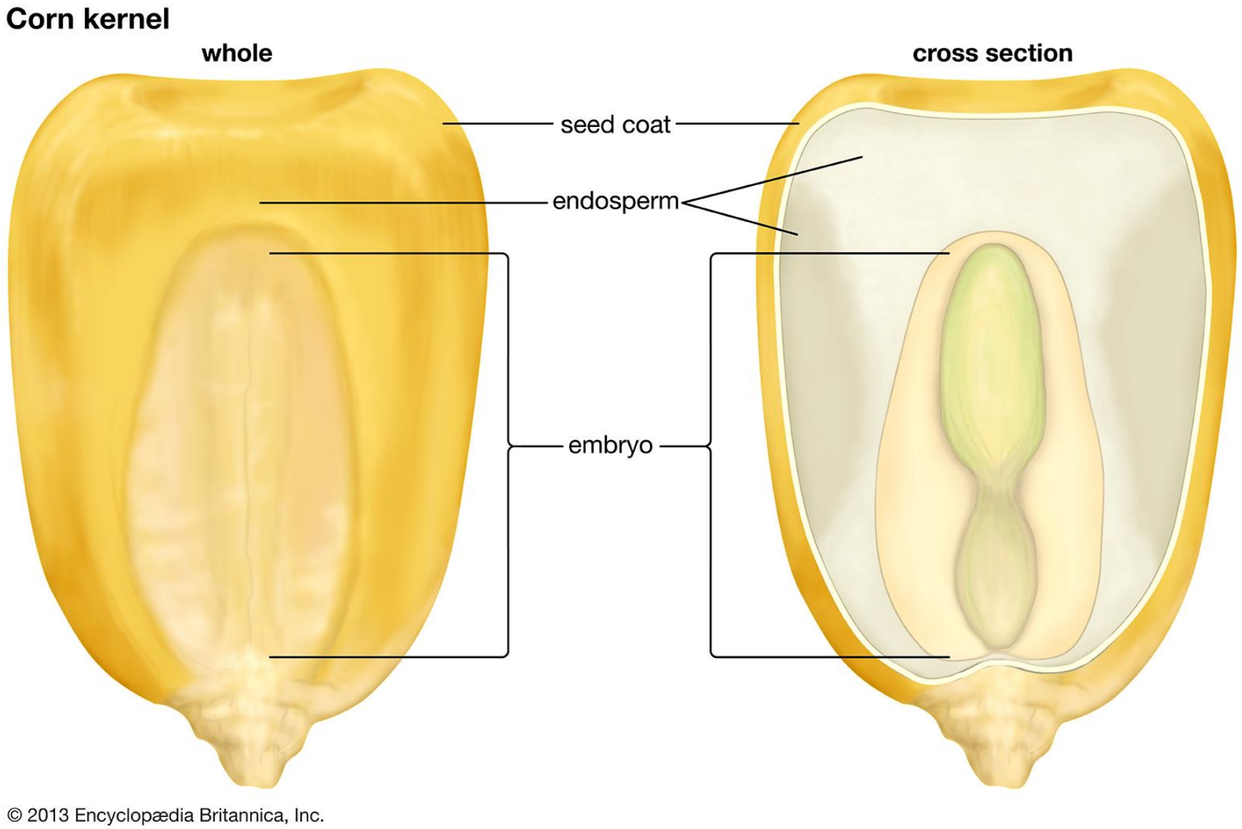
Vitamin
A

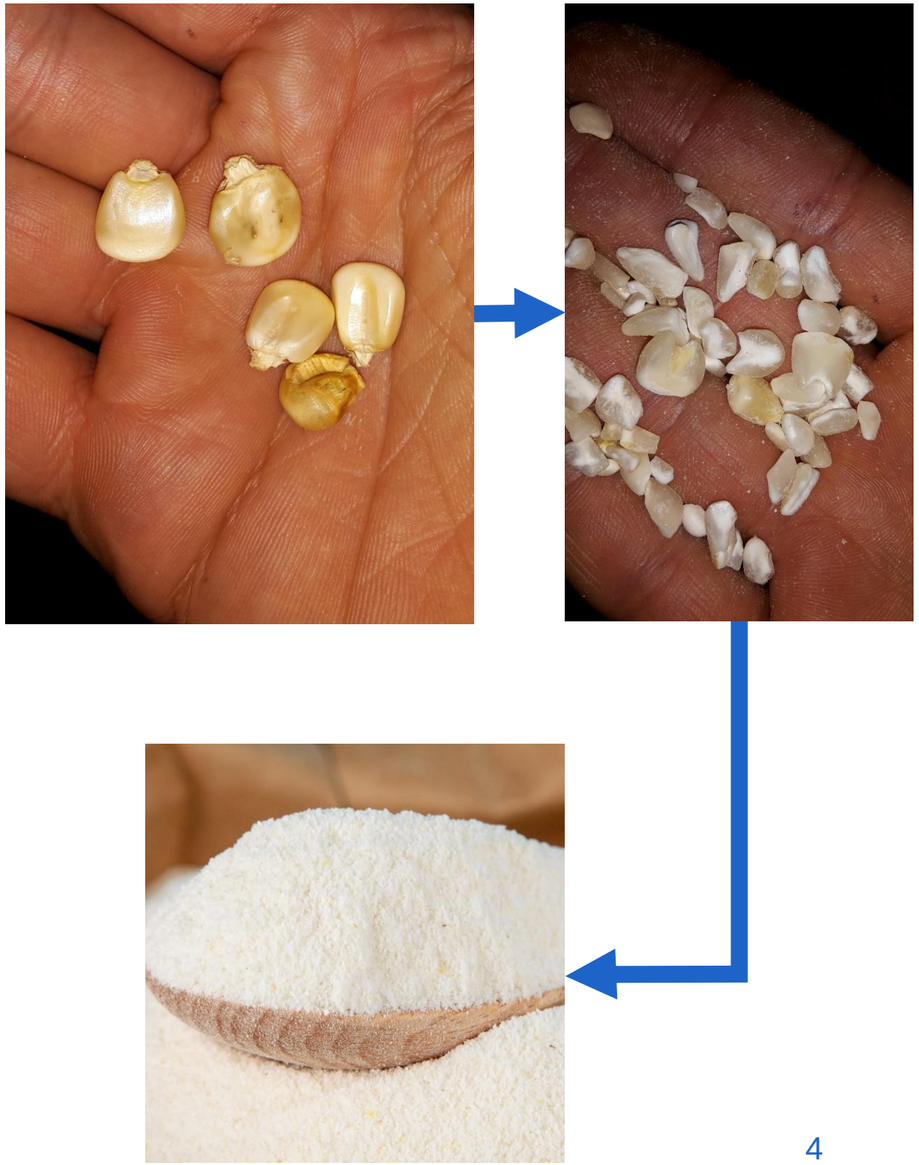
FORTIFICATION: MAIN ADVANTAGES

- Preventive population-wide approach
- Consistent delivery
- Safe in low daily doses
- Minimal behaviour change
- Low cost
- Multiple micronutrient delivery
- Enhances other health strategies

HOW IS MAIZE MEAL FORTIFIED?

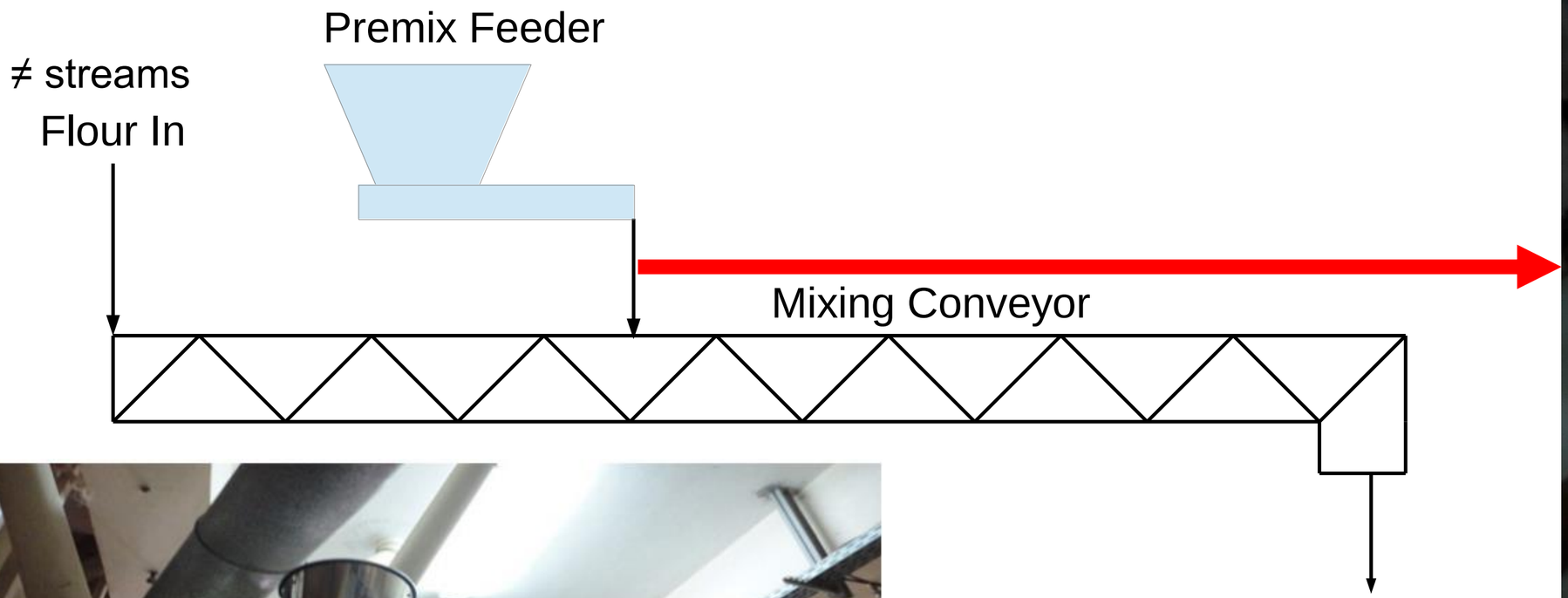
- Maize/corn





HOW IS MAIZE MEAL FORTIFIED?

– Flour fortification: large scale operations



FORTIFICATION PROGRAMMES:

- Fortification operation: relatively easy
- Setting up national fortification programmes: challenge!

gouvernement

Legislation
Technical standards
Inspection/control
Information

industry

Quality assurance
Quality control (fast methods)
Premix/feeder technology

distribution

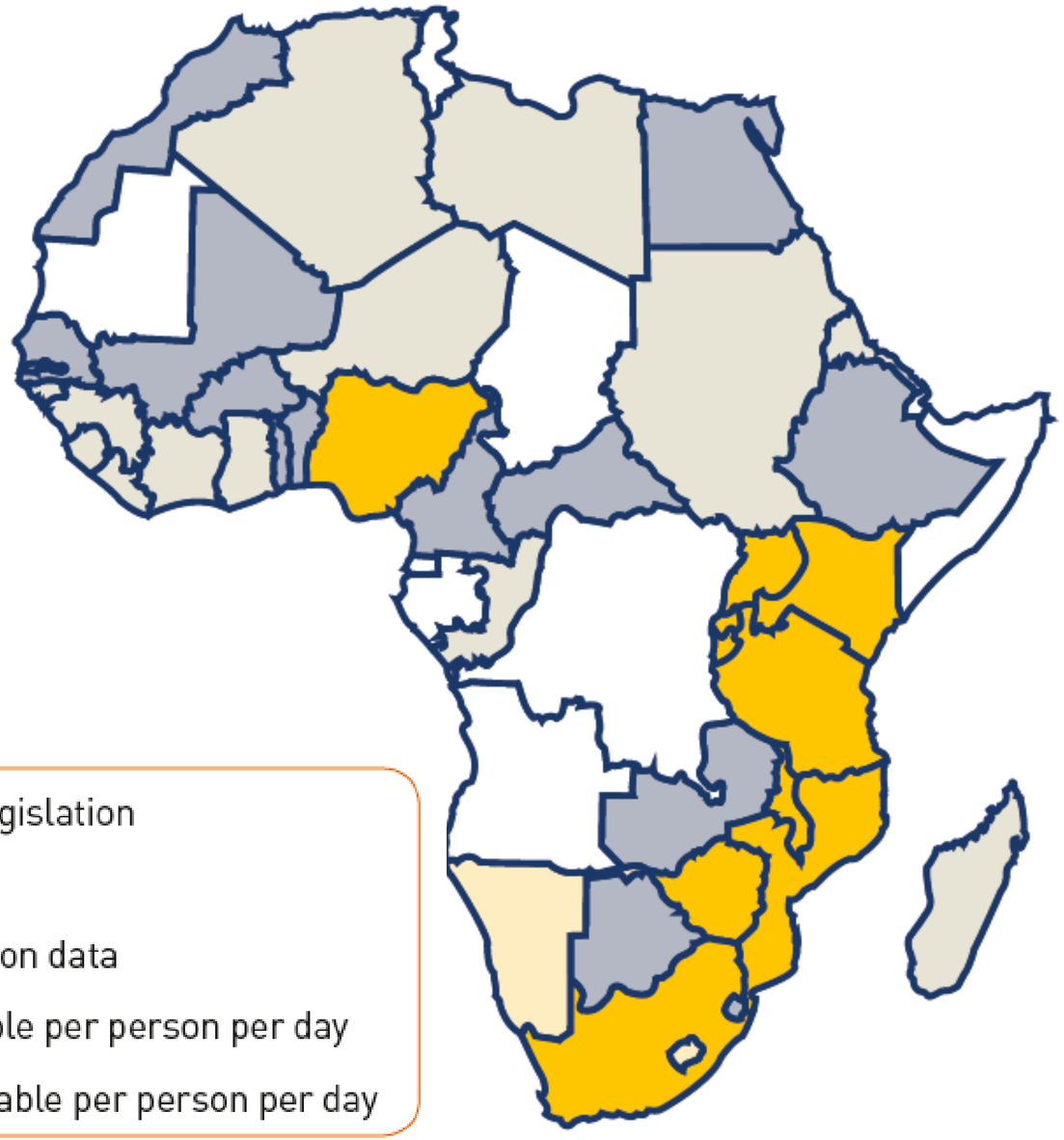
fortified

consumer

Are products accepted
Are products bought?
Are products consumed?
Micronutrient status?
=> Continuous **monitoring** system needed!

MAIZE FORTIFICATION IN AFRICA

Maize availability and Fortification Legislation



- Mandatory fortification legislation
- Voluntary legislation
- No availability or legislation data
- 75 or more grams available per person per day
- Less than 75 grams available per person per day

CONDITIONS OF A SUCCESFUL NATIONAL FORTIFICATION PROGRAM

- *Political support
- ***Industry support**
- ***Consumer acceptance**
- Mandatory legislation
- National implementation
- No cultural or other objection
- Availability of micronutrient premix
- Low cost economically sustainable

No organoleptic changes of the cooked product

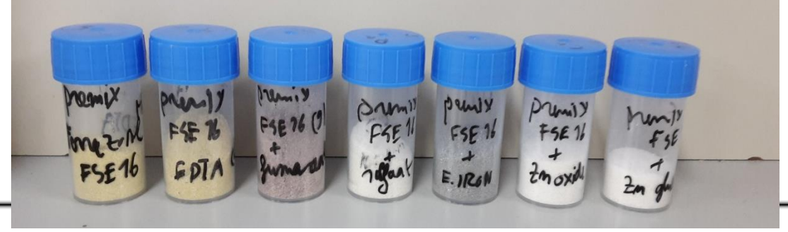
* Requires a private-public-civic partnership

WHICH FE SOURCE TO CHOOSE?

WHO guidelines on maize fortification (2016)

Nutrient[b]	Flour-extraction rate[c]	Compound	Nutrient concentration to be added by estimated availability/consumption (mg nutrient/kg maize flour)[d] <75 g/day[e]	75–149 g/day	150–300 g/day	Relative Bioavailability
Iron[f]	Low	NaFe-EDTA	40	40	20	>100
		Ferrous sulfate	60	60	30	100
		Ferrous fumarate	60	60	30	100
		Electrolytic iron	NR	NR	60	75
	High	NaFe-EDTA	40	40	40	
		Ferrous sulfate	60	60	60	
		Ferrous fumarate	60	60	60	
		Electrolytic iron	NR	NR	NR	
Folic acid	Low or high	Folic acid	5.0	2.6	1.3	
Vitamin A	Low or high	Vitamin A palmitate	6.0	3.0	1.5	
Zinc	Low	Zinc sulfate/zinc oxide[3]	95	55	40	
	High	Zinc sulfate/zinc oxide	100	100	80	
Vitamin B_{12}[h]	Low or high	Cyanocobalamin	0.04	0.02	0.01	

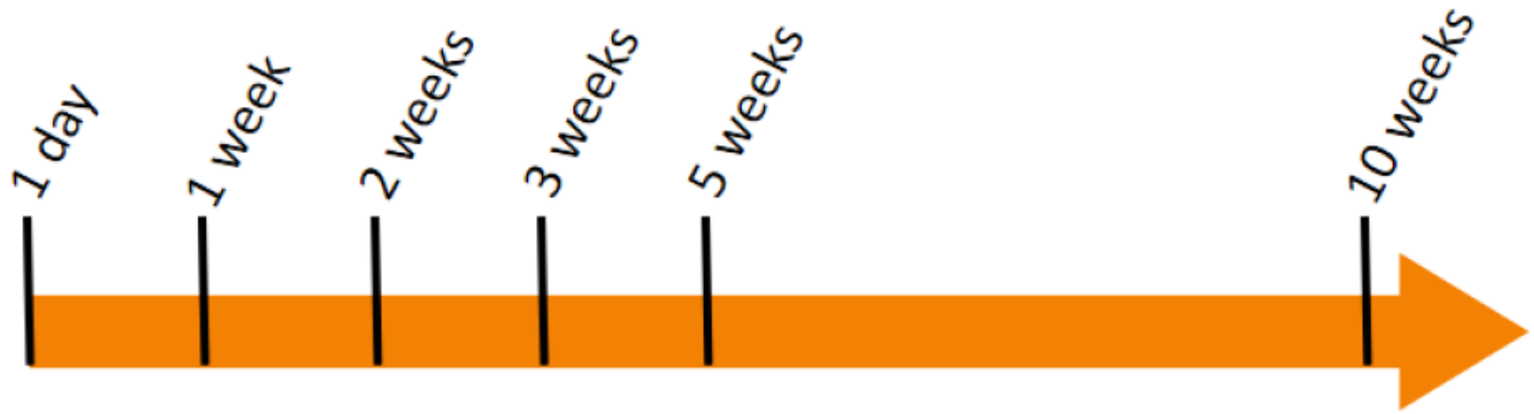
RESEARCH SETUP 1



	Blank	Fe sulfate	Fe fumarate	Fe EDTA (ferrazone)	Fe EDTA (chinese)	Fe electrolyt.	Zn oxide	Zn gluconate
SUPER	□	■	■	■	■	■	▦	▦
SPECIAL	□	■	■	■	■	■	▦	▦
120% dosage →		20 ppm	20 ppm	15 ppm	15 ppm	35 ppm	30 ppm	30 ppm

Storage conditions:

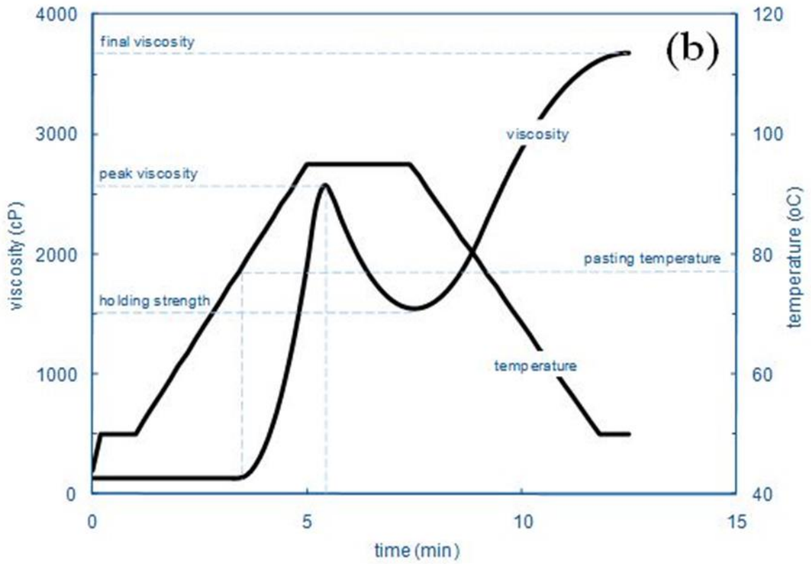
- 25°C
- 35% RH



RESEARCH SETUP 1

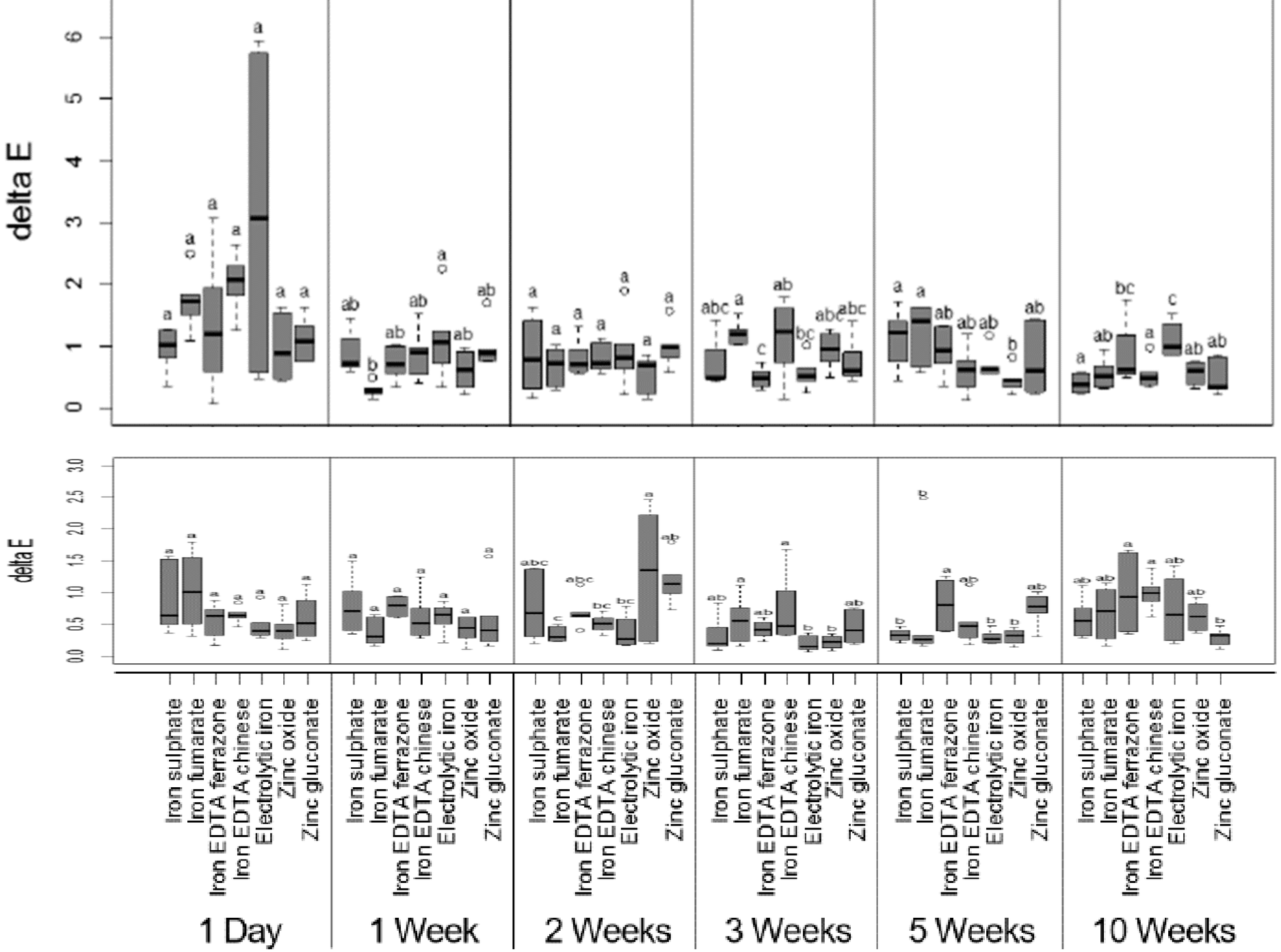
- Porridge evaluation
  - Cooking trials

- Pasting experiments: rheometer



$$\Delta E^* = \sqrt{\Delta L^2 + \Delta a^2 + \Delta b^2}$$

ΔE



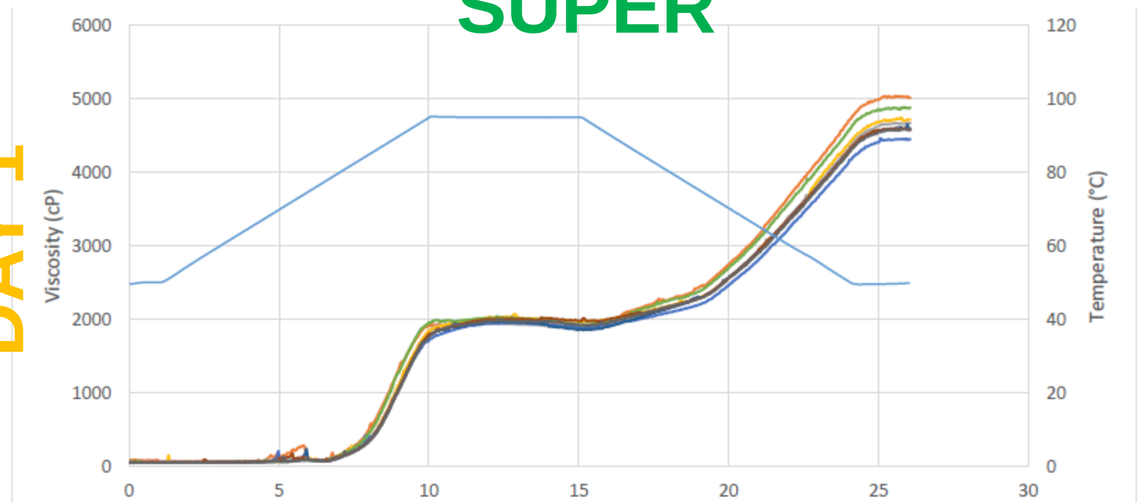
SUPER

SPECIAL

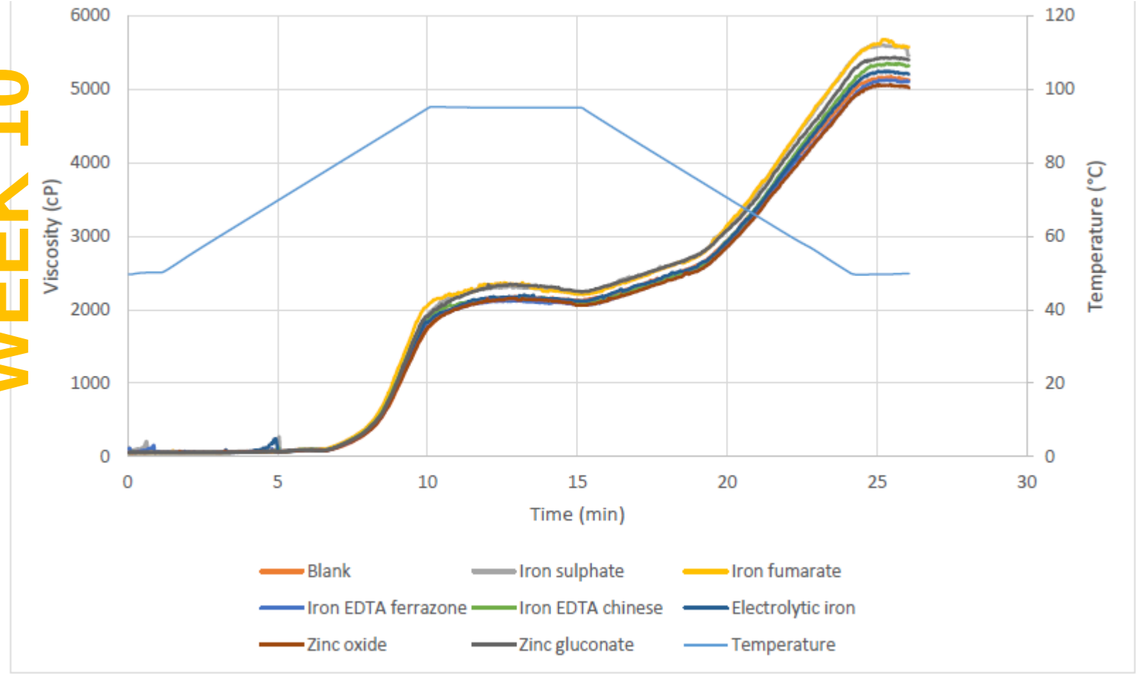
PASTING PROFILE

SUPER

DAY 1



WEEK 10



CONCLUSIONS RESEARCH SETUP 1

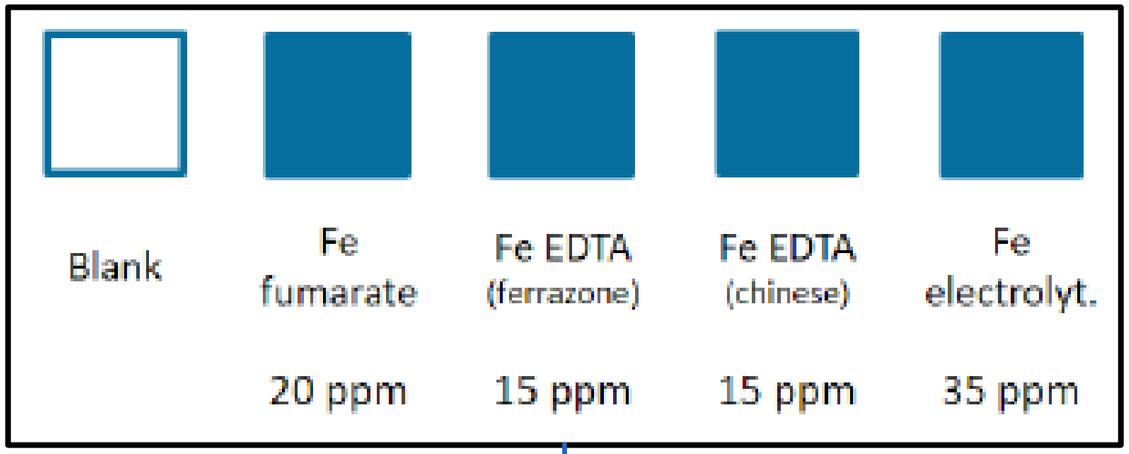
- No systematic differences in porridge colour or pasting behaviour due to
  - Iron or zinc source
  - Storage time

However:

- porridge was made with demi-water => reality = tap water!
- No full premix was used

RESEARCH SETUP 2

SPECIAL MAIZE MEAL

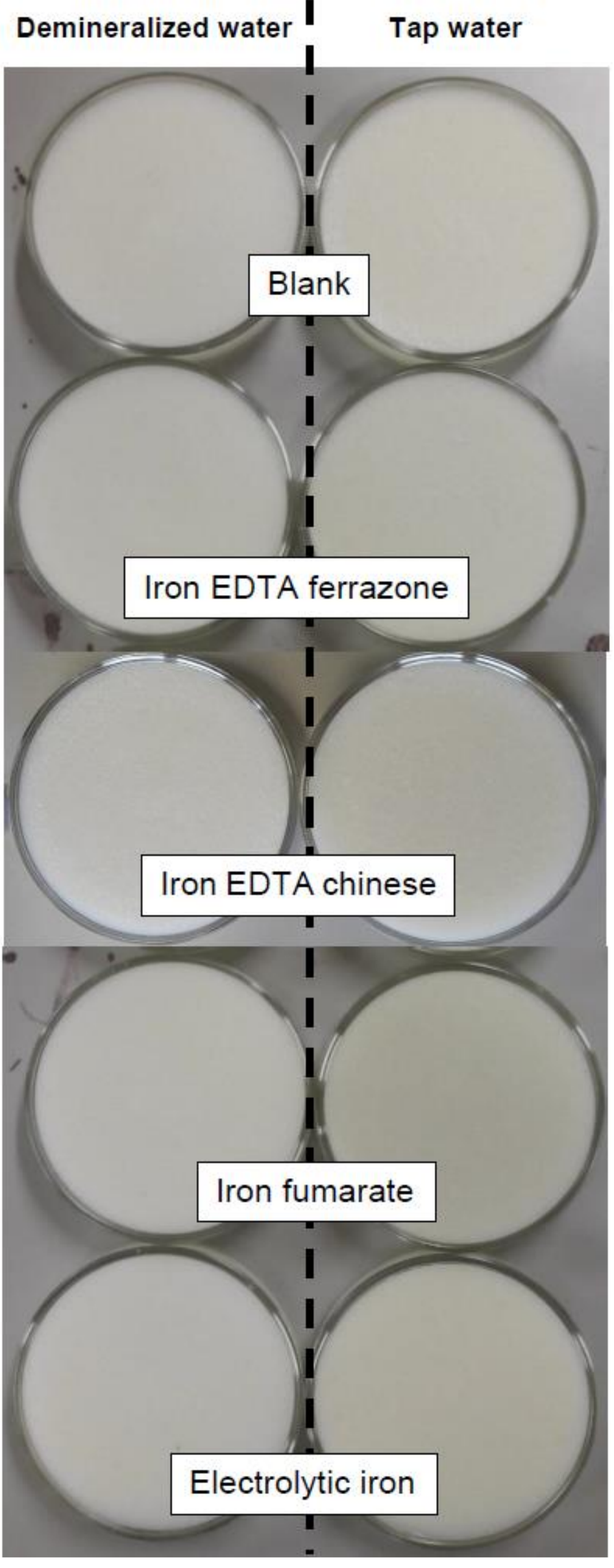


- 1 week storage
- 25°C
- 35% RH

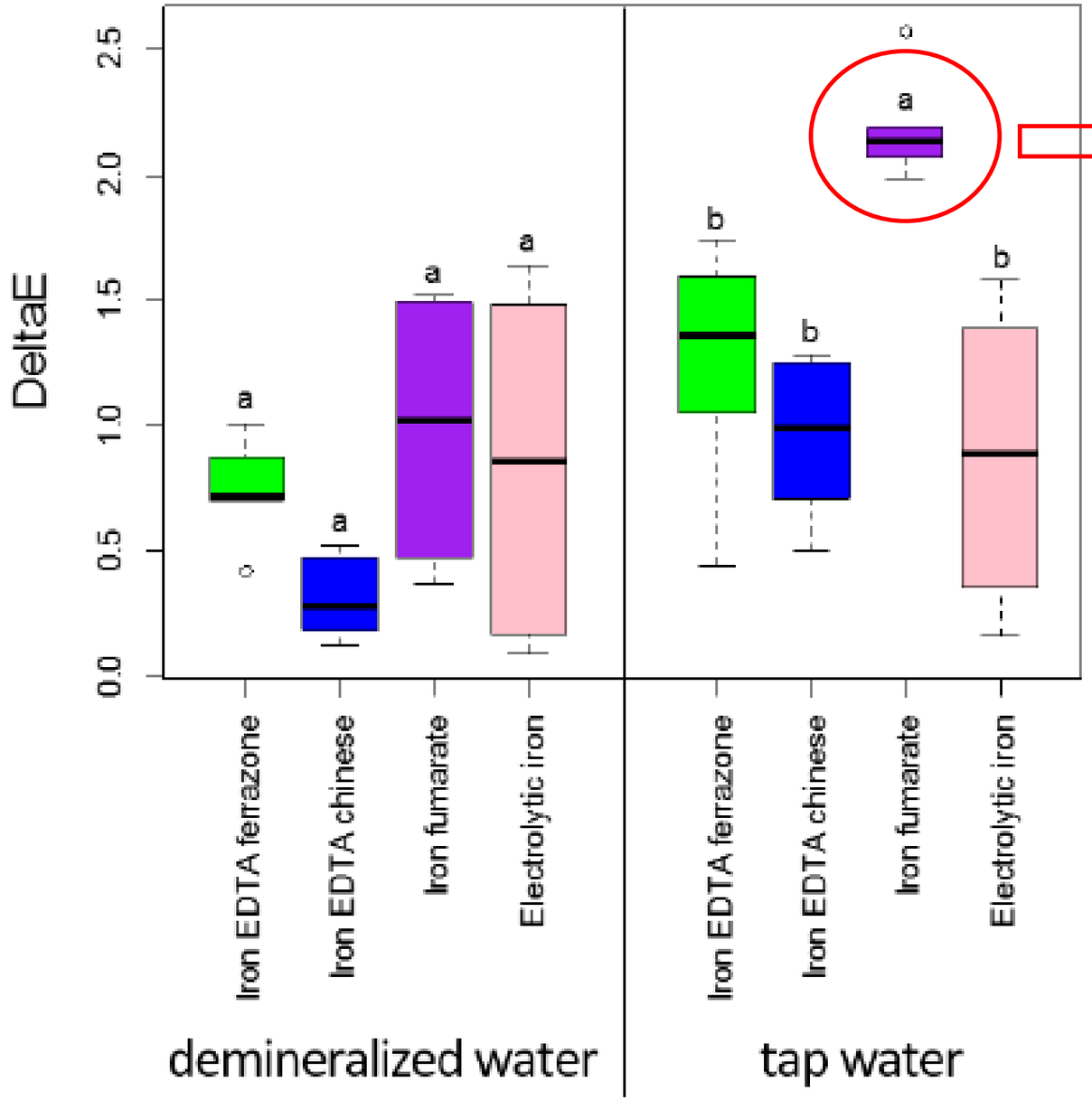
Demi-water

Tap water

- Cooking trials
- Pasting experiments


Demineralized water
Tap water
Blank
Iron EDTA ferrazone
Iron EDTA chinese
Iron fumarate
Electrolytic iron

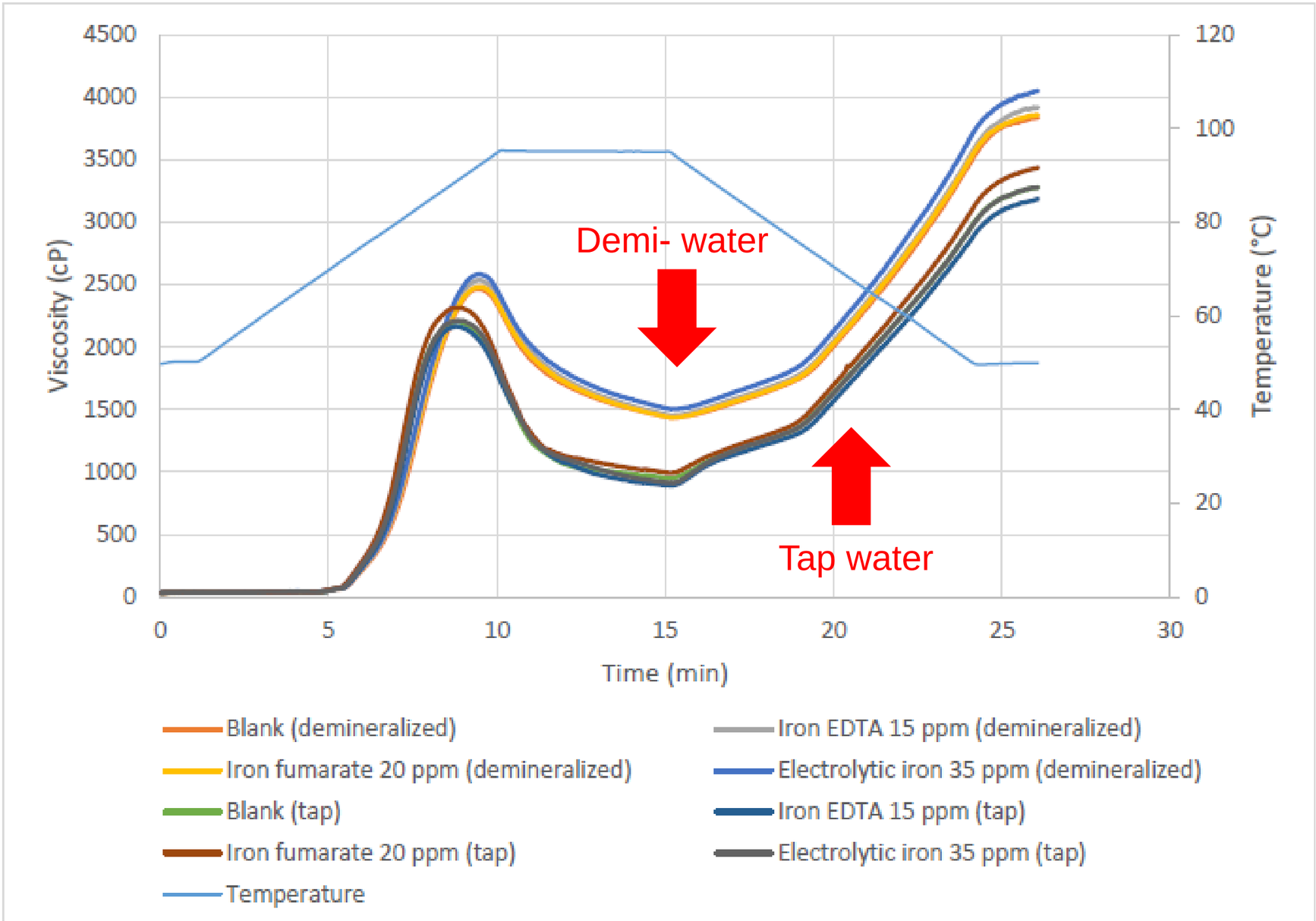
ΔE



Significantly different from other Fe sources

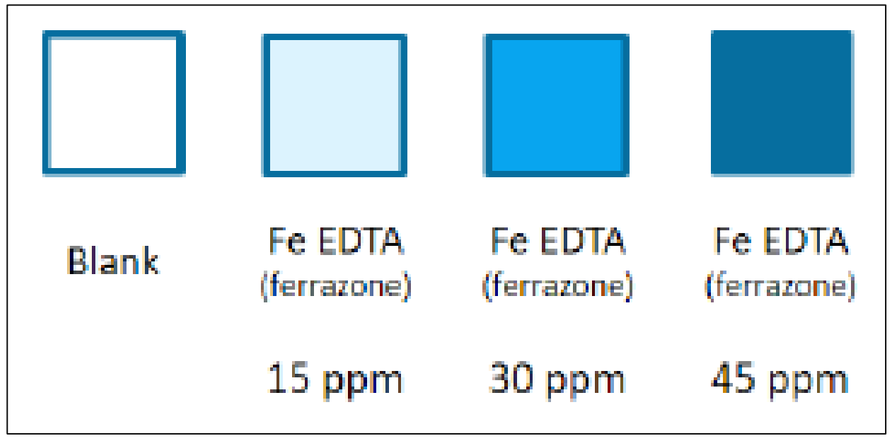
ΔE = 2 -> visible colour difference in porridge
-> in contrast with Haybech et al. (2016): visible colour change only from ΔE > 3

PASTING


Viscosity (cP)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Temperature (°C)
120
100
80
60
40
20
0
0
5
10
15
20
25
30
Time (min)
Demi- water
Tap water
Blank (demineralized)
Iron fumarate 20 ppm (demineralized)
Blank (tap)
Iron fumarate 20 ppm (tap)
Temperature
Iron EDTA 15 ppm (demineralized)
Electrolytic iron 35 ppm (demineralized)
Iron EDTA 15 ppm (tap)
Electrolytic iron 35 ppm (tap)

RESEARCH SETUP 3

SPECIAL MAIZE MEAL

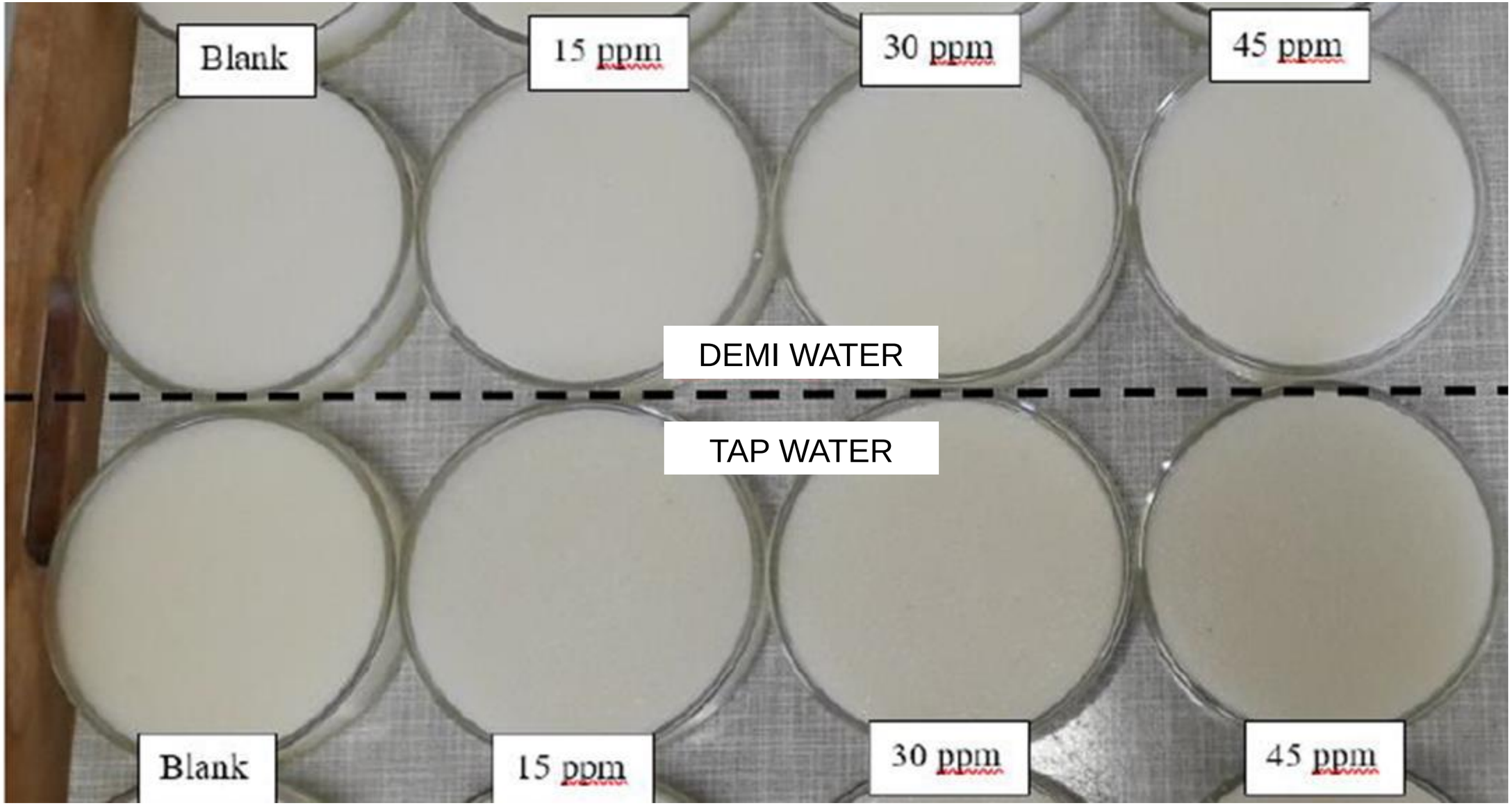


- 1 week storage
- 25°C
- 35% RH

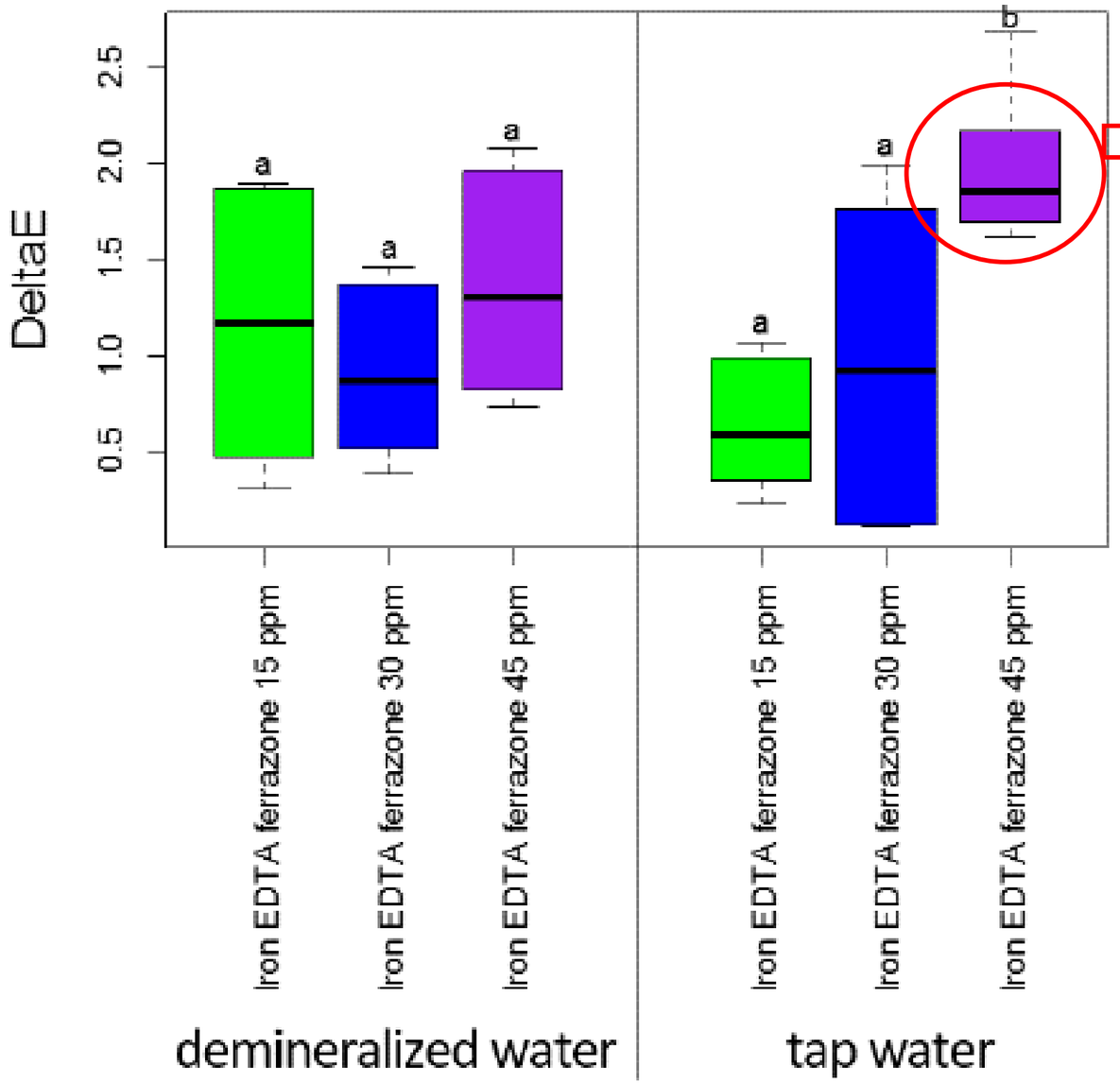
Demi-water Tap water

- Cooking trials

ΔE


Blank
15 ppm
30 ppm
45 ppm
DEMI WATER
TAP WATER
Blank
15 ppm
30 ppm
45 ppm

ΔE



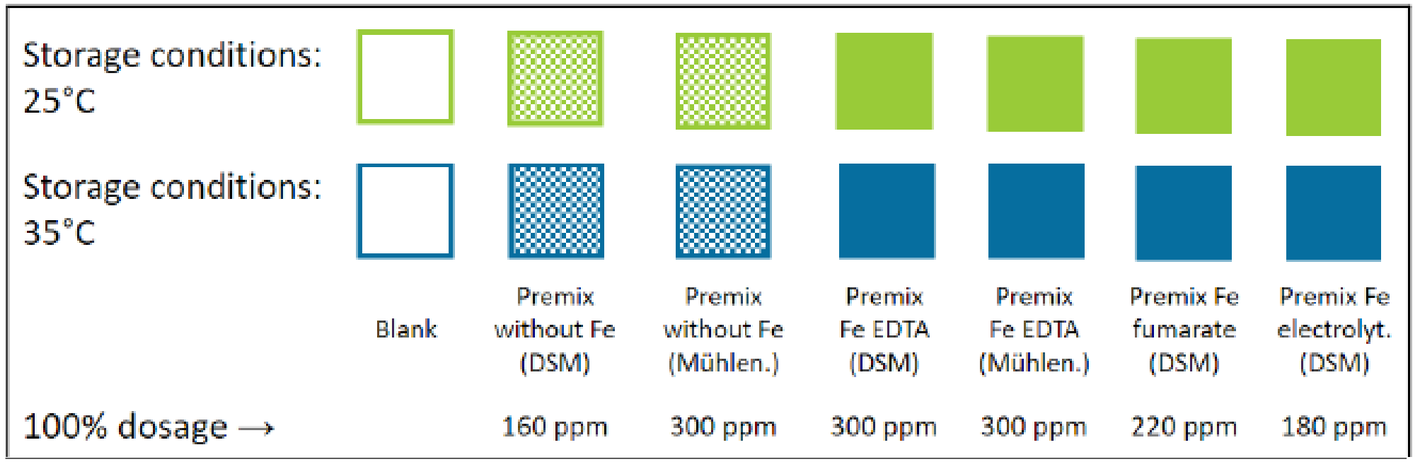
Significantly different
ΔE = 2 -> visible colour difference in porridge
-> in contrast with Haybech (2016): visible colour change only from ΔE > 3

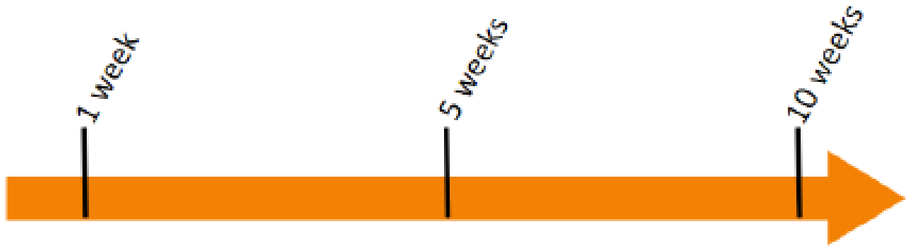
CONCLUSIONS RESEARCH SETUP 2&3

- Differences in porridge colour or pasting behaviour due to
  - Water composition (demi or tap)
  - Interaction Fe-source and tap water
    - Fe fumarate (20 ppm Fe)
    - NaFeEDTA (45 ppm Fe)

RESEARCH SETUP 4

SPECIAL MAIZE MEAL



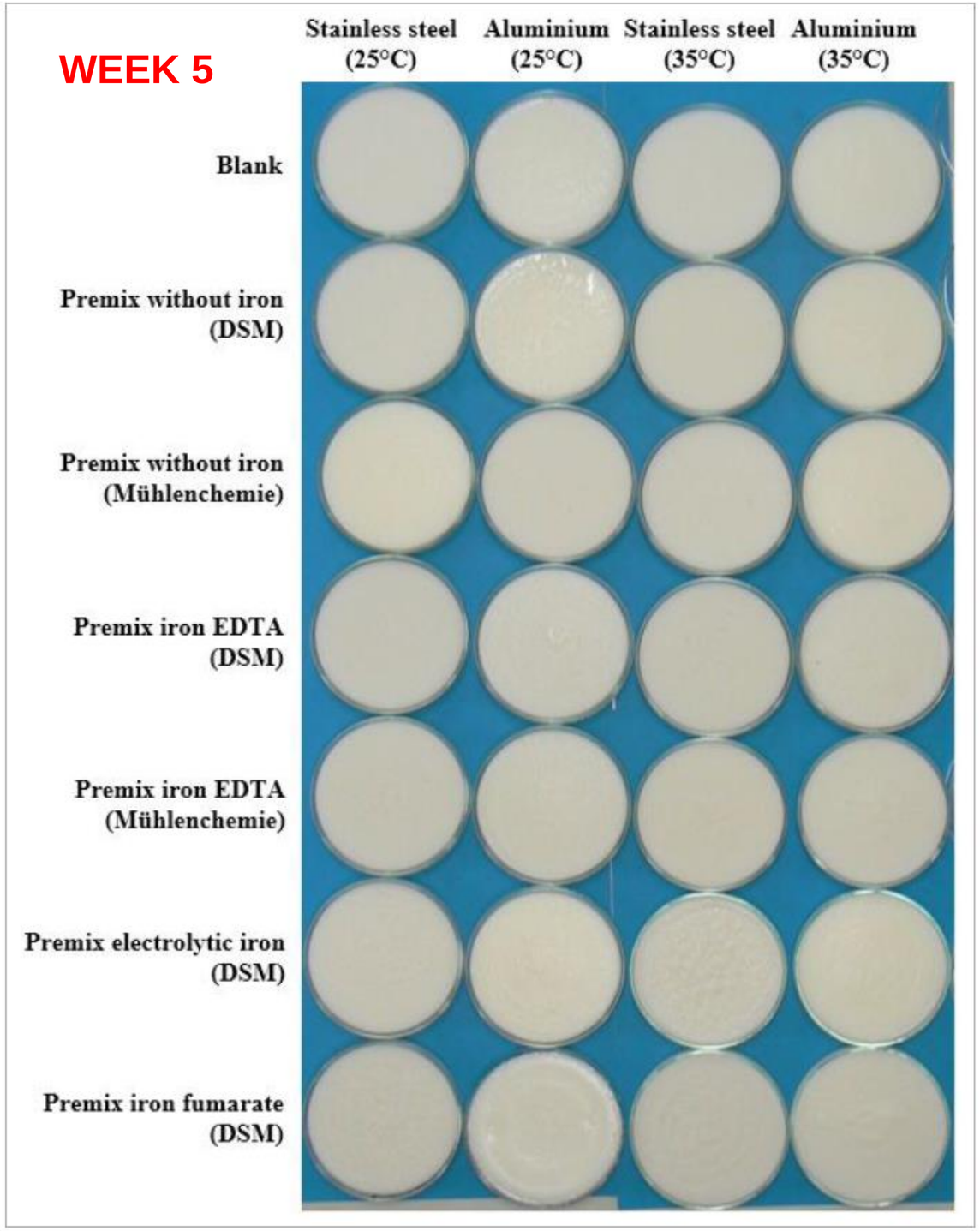


- Cooking trials

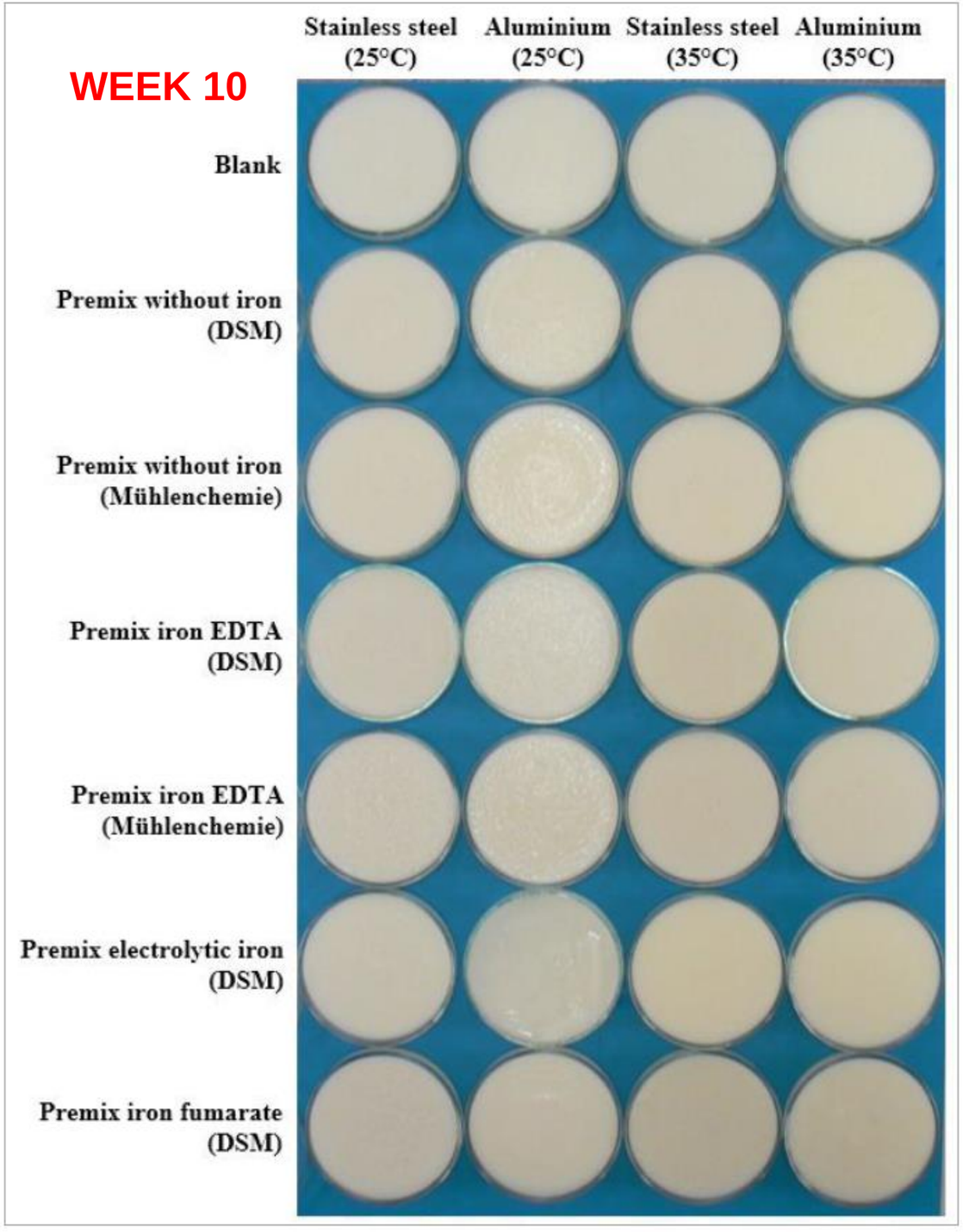
Stainless steel

Aluminum

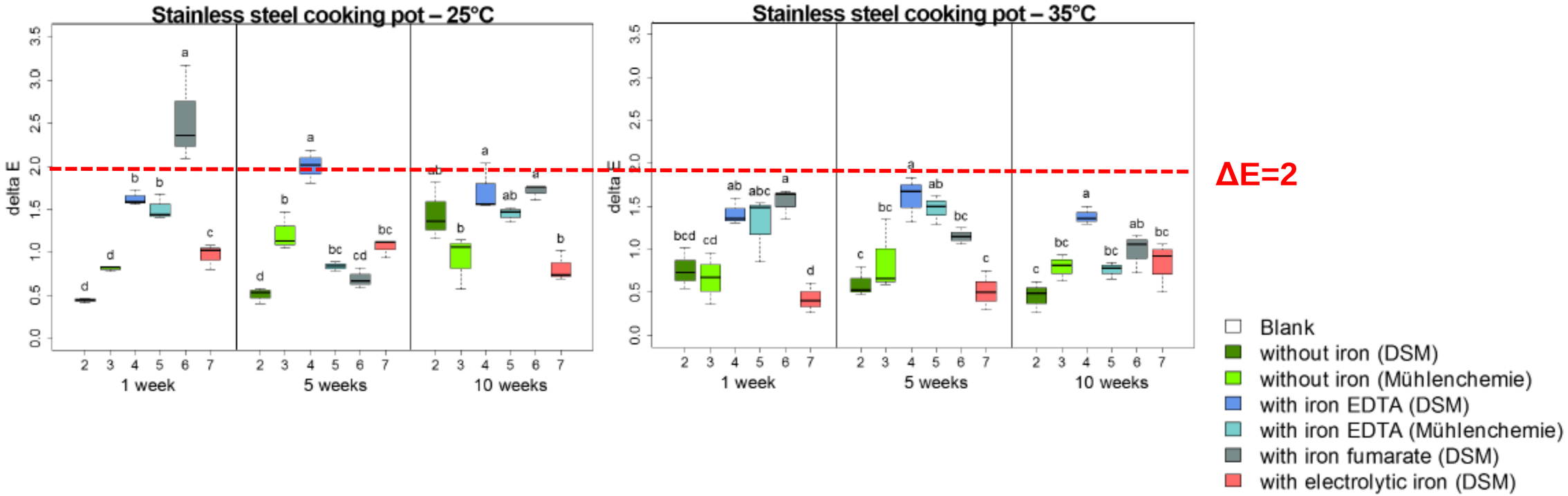
WEEK 5



WEEK 10



ΔE


Stainless steel cooking pot – 25°C
Stainless steel cooking pot – 35°C
delta E
1 week
5 weeks
10 weeks
ΔE=2
Blank
without iron (DSM)
without iron (Mühlenchemie)
with iron EDTA (DSM)
with iron EDTA (Mühlenchemie)
with iron fumarate (DSM)
with electrolytic iron (DSM)

TAKE HOME MESSAGES

- Visible colour change in ‘pap’: $\Delta E \sim 2$
- Porridge colour influenced by many factors:

  $\Rightarrow$Storage conditions of maize meal, maize composition, premix composition, water composition and type of cooking pot
- Interaction between Fe-source and minerals in tap water was observed
- NaFeEDTA can be applied without major discoloration below 40 ppm of Fe

ACKNOWLEDGEMENTS

- **Smarter Futures team & supporting partners**

  ⇒www.smarterfutures.net

- **Fortification Working Group of South Africa**

- **VLIR-UOS – Global Mind Fund**: capacity building

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