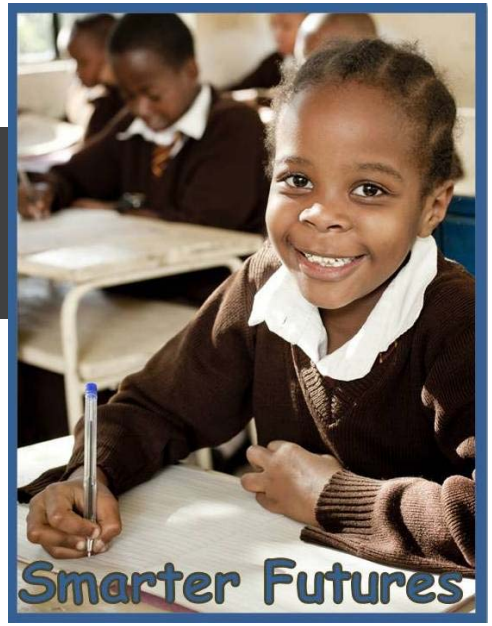
Baking trials with fortified flour



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Food Fortification Initiative
Enhancing Grains for Healthier Lives

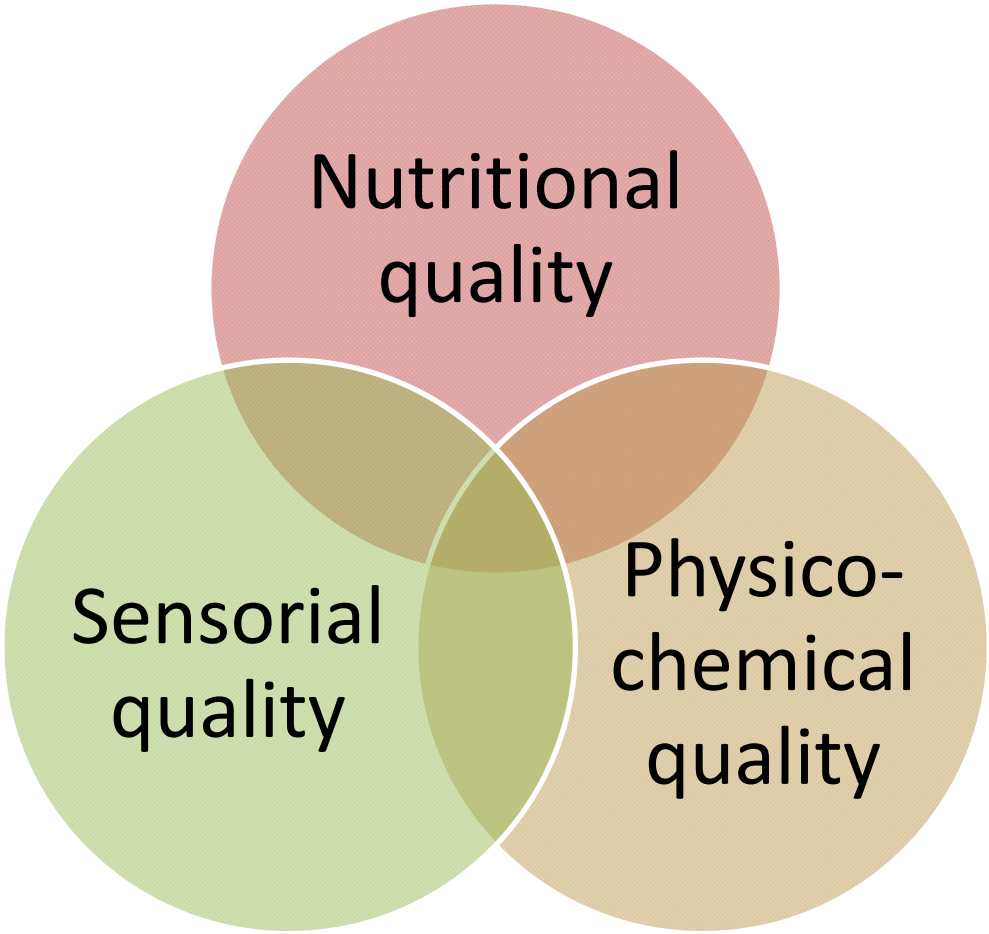
AkzoNobel

Helen Keller INTERNATIONAL

IFSBH

Ministerie van Buitenlandse Zaken

Food Quality



Breadmaking

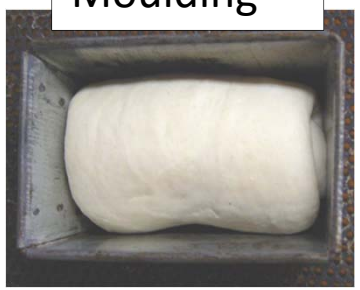
Mixing

wheat flour, water, yeast, salt
Oxidants, emulsifiers, enzymes, vital gluten, other flours

Dough rest

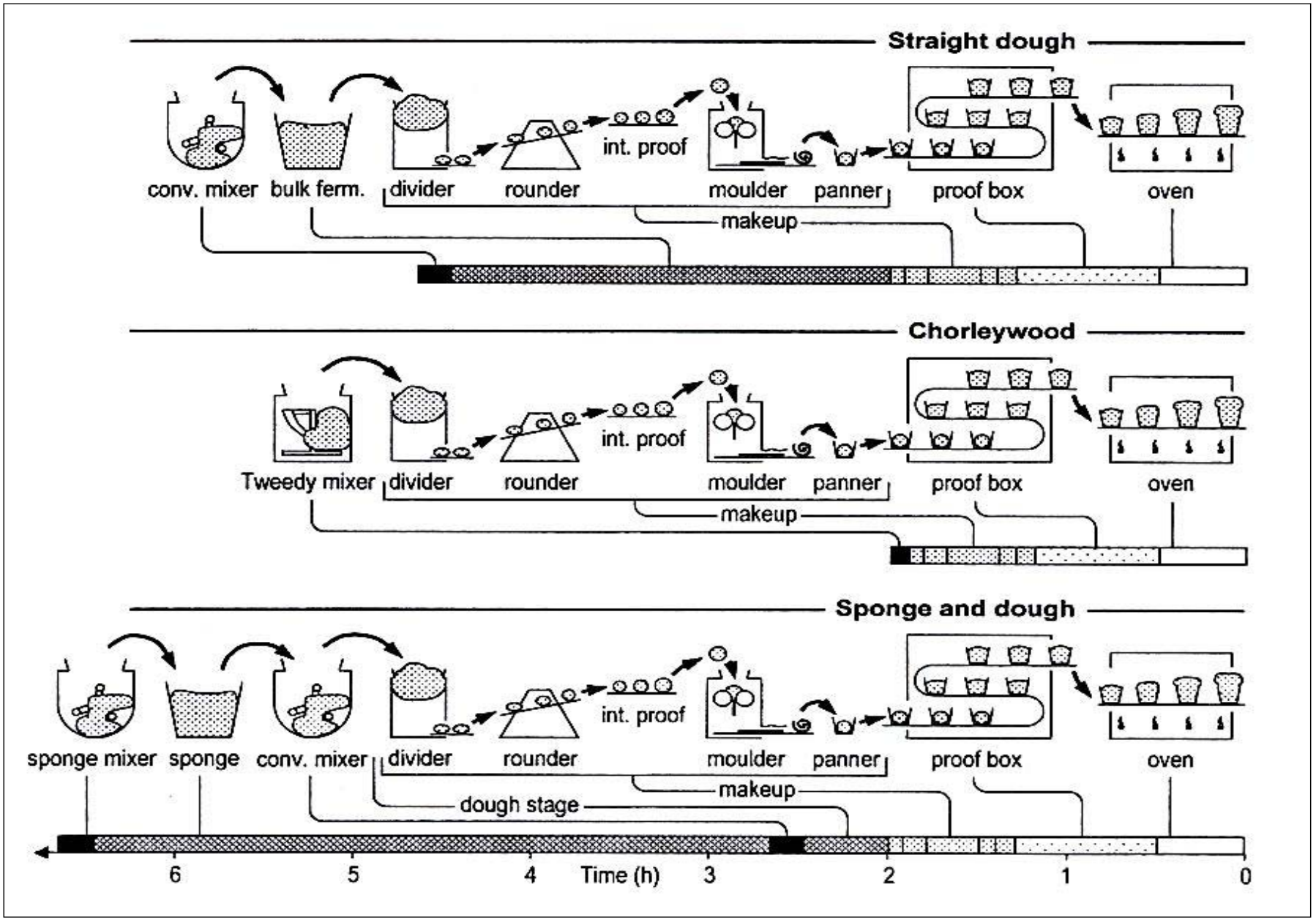
1st fermentation

Moulding



2nd fermentation

Baking


Straight dough
conv. mixer
bulk ferm.
divider
rounder
int. proof
moulder
panner
proof box
oven
makeup
Chorleywood
Tweedy mixer
divider
rounder
int. proof
moulder
panner
proof box
oven
makeup
Sponge and dough
sponge mixer
sponge
conv. mixer
divider
rounder
int. proof
moulder
panner
proof box
oven
makeup
dough stage
6
5
4
Time (h)
3
2
1
0

Porridges

- Maize meal + water
- Cooking

$\Rightarrow$ Ugali, pap, Uji,

Stywe Pap - we cheated - we cooked it in a non-stick pot - all the better to get to the toasted crust at the bottom - delicious with butter and a grinding of Hot Rocks!

Problem statement

Factors that may limit the amount of fortificants that can be added to a single food vehicle

Nutrient	Technological/sensory	Safety	Cost
Vitamin A	X	XXX	XXX[a]
Vitamin D	–	X	X
Vitamin E	–	X	XXX
Vitamin C	XX	X	XXX[b]
Thiamine (vitamin B_1)	–	–	–
Riboflavin (vitamin B_2)	XX	–	–
Niacin (vitamin B_3)	–	XXX[c]	X
Vitamin B_6	–	X	–
Folic acid	–	XXX[d]	–
Vitamin B_{12}	–	–	X
Iron[e]	XXX	XX	X
Zinc	XX	XXX	X
Calcium	X	XX	XXX[f]
Selenium	–	X	X
Iodine	X	XXX	–

–, no constraint; X, a minor constraint; XX, moderate constraint; XXX, major constraint.

[a] If an oil-based form is used to fortify oils or fats, costs can be reduced.

[b] Cost constraints are mainly a consequence of losses during manufacturing, storage, distribution and cooking which mean that a considerable overage is required.

[c] Much less of a concern if niacinamide, as opposed to nicotinic acid, is used as the fortificant.

[d] The risk of adverse effects is minimized by the co-addition of vitamin B_{12}.

[e] Refers to the more bioavailable forms.

[f] Cost constraints are mainly a consequence of the need to add such large amounts.

Fortification of wheat flour and maize meal with different iron compounds: Results of a series of baking trials

Philip Randall, Quentin Johnson, and Anna Verster

Abstract

Background. *Wheat and maize flour fortification is a preventive food-based approach to improve the micronutrient status of populations. In 2009, the World Health Organization (WHO) released recommendations for such fortification, with guidelines on the addition levels for iron, folic acid, vitamin B_{12}, vitamin A, and zinc at various levels of average daily consumption. Iron is the micronutrient of greatest concern to the food industry, as some believe there may be some adverse interaction(s) in some or all of the finished products produced from wheat flour and maize meal.*

Objective. *To determine if there were any adverse interactions due to selection of iron compounds and, if differences were noted, to quantify those differences.*

Methods. *Wheat flour and maize meal were sourced in Kenya, South Africa, and Tanzania, and the iron compound (sodium iron ethylenediaminetetraacetate [NaFeEDTA], ferrous fumarate, or ferrous sulfate) was varied and dosed at rates according to the WHO guidelines for consumption of 75 to 149 g/day of wheat flour and > 300 g/day of maize meal and tested again for 150 to 300 g/day for both. Bread,* chapatti, ugali *(thick porridge), and* uji *(thin porridge) were prepared locally and assessed on whether the products were acceptable under industry-approved criteria and whether industry could discern any differences, knowing that differences existed, by academic sensory analysis using a combination of trained and untrained panelists and in direct side-by-side comparison.*

Results. *Industry (the wheat and maize milling sector) scored the samples as well above the minimal standard, and under academic scrutiny no differences were reported. Side-by-side comparison by the milling industry did indicate some slight differences, mainly with respect to color, although these differences did not correlate with any particular iron compound.*

Conclusions. *The levels of iron compounds used, in accordance with the WHO guidelines, do not lead to changes in the baking and cooking properties of the wheat flour and maize meal. Respondents trained to measure against a set benchmark and/or discern differences could not consistently replicate perceived difference observations.*

Key words: Ferrous fumarate, ferrous sulfate, maize meal, NaFeEDTA, wheat flour, WHO guidelines

Introduction

National fortification requires the support of a variety of stakeholders, including stakeholders from industries who use fortification premixes in their wheat flour and maize meal products.

Following the Second Technical Workshop on Wheat Flour Fortification: Practical Recommendations for National Application, the World Health Organization (WHO) [1] issued its "Recommendations on wheat and maize flour fortification meeting report: Interim Consensus Statement" in 2009, which was followed by the publication of the deliberations of the various working groups as a supplement to the *Food and Nutrition Bulletin* [2–9]. In this statement and the Supplement, guidelines were issued on the addition levels for iron, folic acid, vitamin B_{12}, vitamin A, and zinc at various levels of average daily consumption of wheat flour and maize meal (< 75, 75 to 149, 150 to 300, and > 300 g/day).

Of all of the micronutrients discussed, iron was the one of greatest concern to the food industry, as some industry delegates believed there may be some

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Fortification of **wheat flour** and **maize meal** with **different iron** compounds

Philip Randall, Quentin Johnson, Anna Verster

Food and Nutrition Bulletin, vol. 33, n°4

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Objective of the study

- Determine if there were any adverse interactions due to the selection of **iron** compounds in the finished products produced from wheat flour or maize meal, and if differences were noted, to quantify those differences.

Kenya

- UNGA Mills
- Kenyatta University

Tanzania

- Bakhresa Mills
- Tanzania Food and Nutrition Centre

South-Africa

- Southern African Grain laboratories (SAGL)

Flour Fortification

- Locally sourced wheat flour and maize meal: medium to high extraction
- Iron compounds:
  - Wheat flour: @75-149 g/day consumption (WHO guideline level)
    - NaFeEDTA: 40 ppm Fe
    - Ferrous fumarate ($FeC_4H_2O_4$): 60 ppm Fe
    - Ferrous sulfate ($FeSO_4$): 60 ppm Fe
  - Maize meal: @>300 g/day consumption (WHO guideline level)
    - NaFeEDTA: 15 ppm Fe (and 20 ppm)
    - Ferrous fumarate ($FeC_4H_2O_4$): 25 ppm Fe

Products

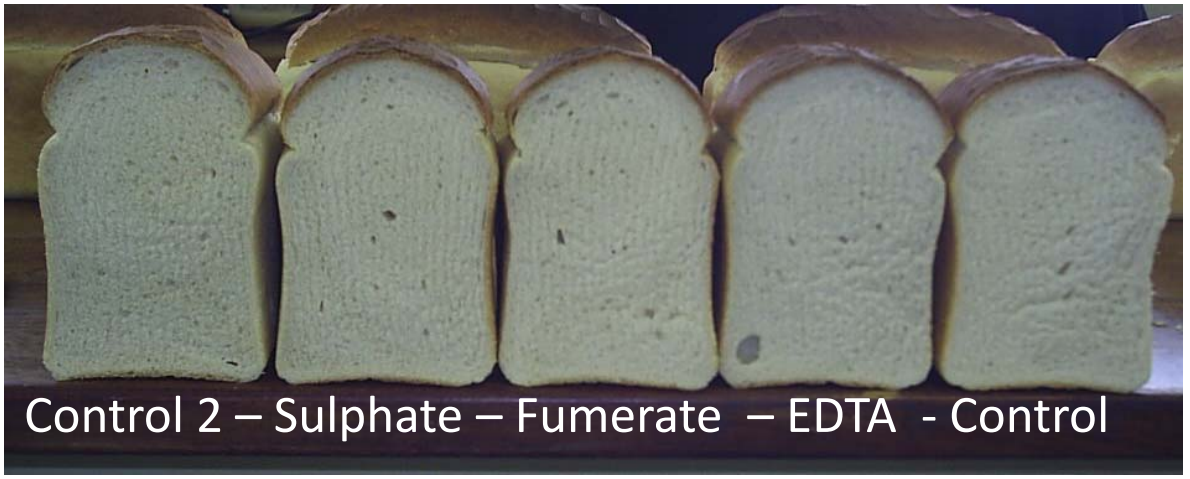
Kenya	Tanzania	South-Africa
Bread UNGA: sponge and dough Kenyatta: straight dough	Bread Bakhresa: straight dough Food centre: straight dough	Bread Chorleywood bread process
Chappati	Chappati	
Ugali	Ugali	
Uji	Uji	

- Preparation and evaluation under ‘local rules’
- Retention samples for re-evaluation after 3 or 6 months

Assessment

- Were the products acceptable under industry approved criteria?
- Were the products acceptable under academic sensory analysis using a combination of trained and untrained panelists?
- In direct side-by-side comparison, could milling industry assessment discern any differences, knowing that differences existed?

Control 2 – Sulphate – Fumerate – EDTA - Control



Control 2 – Sulphate – Fumerate – EDTA - Control

Results wheat flour

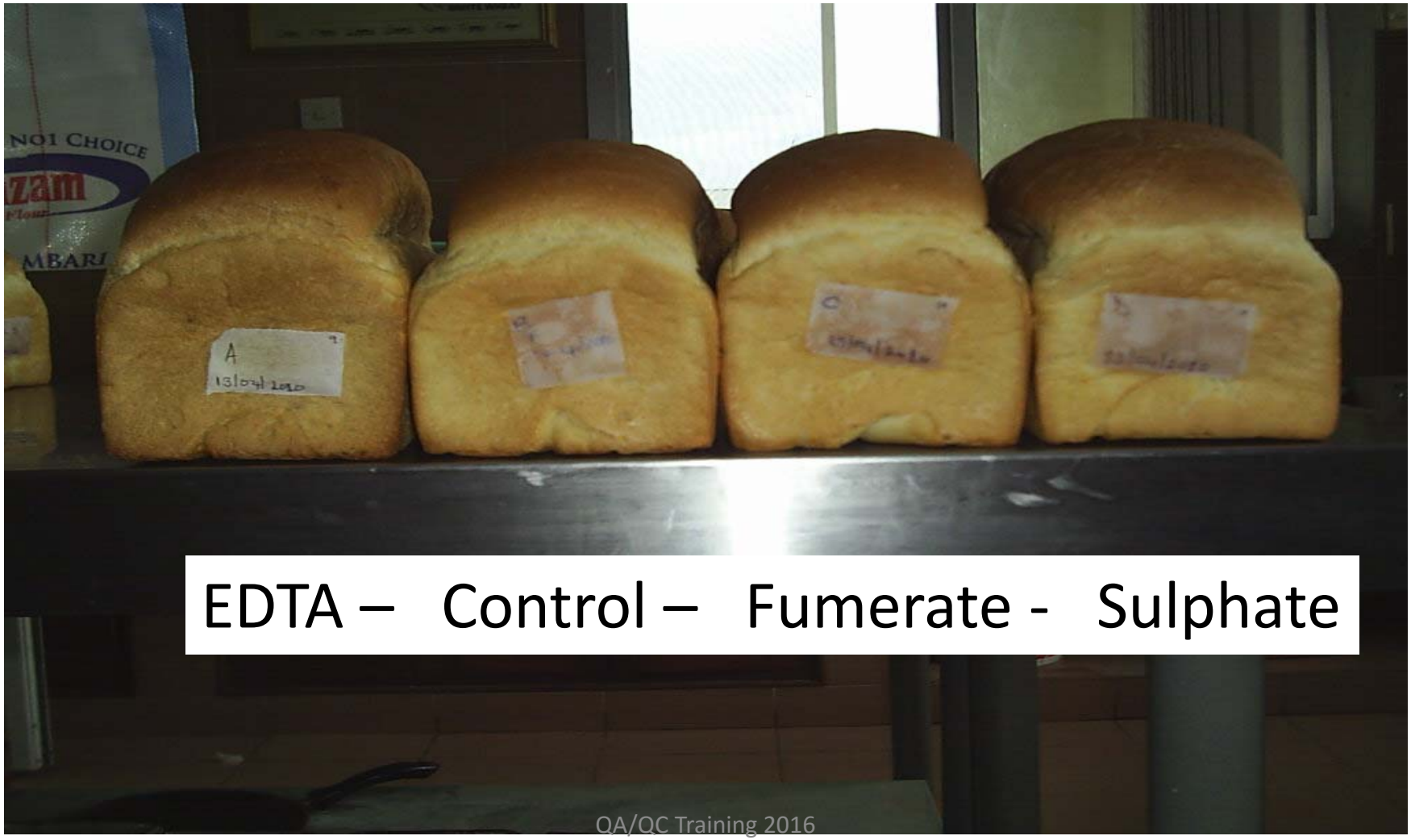
- Bread score: SAGL

TABLE 3. Southern African Grain Laboratories (SAGL): Results for bread — original samples

Characteristic	Perfect score	Control 1	Ferrous fumarate	Ferrous sulfate	NaFeEDTA	Control 2	SAGL internal control
External characteristics							
Subtotal	40	26	27	27	22	29	29
Internal characteristics							
Subtotal	60	49	49	51	47	50	51
Total	100	75	76	78	69	79	80
Loaf volume (cm^3)		2,990	2,975	3,065	3,065	3,075	2,990
Water absorption (%)		60	60	60	59	58	60

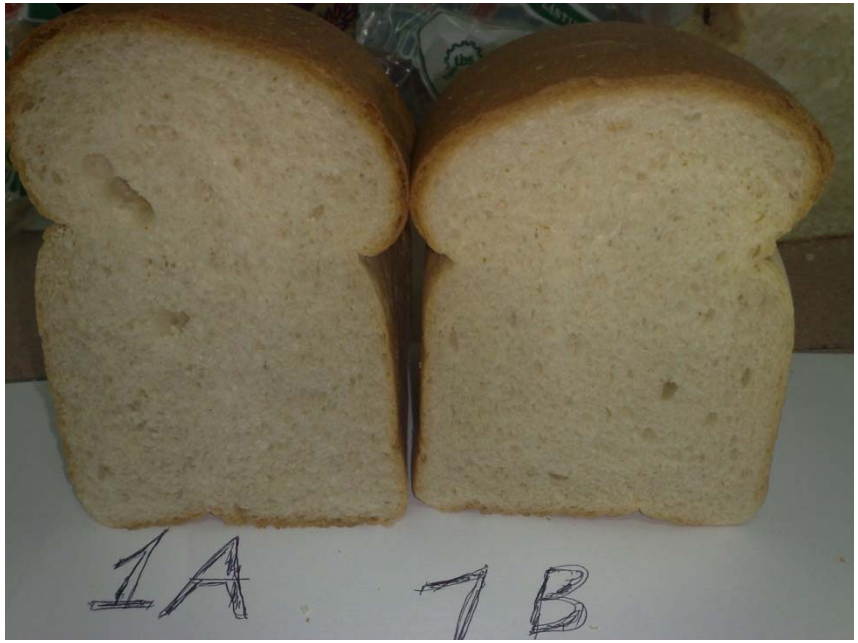
- Retention samples: score of all Fe-sources = 70

Tanzanian Wheat Flour - Mill

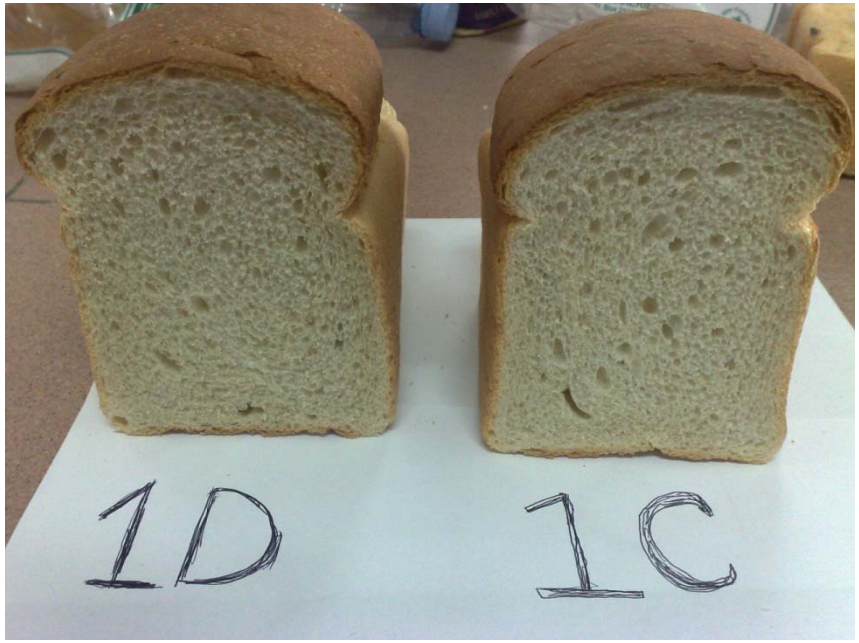


Tanzanian Wheat Flour - Mill

EDTA - Control



Fumerate - Sulphate



Results wheat flour

- Bread score: Kenyatta University, Kenya

Characteristic	Control	Ferrous fumarate	Ferrous sulfate	NaFeEDTA
Original samples				
Appearance	7.3 (1.2)	6.9 (1.5)	7.4 (0.9)	6.9 (1.4)
Color	7.2 (1.4)	6.9 (1.3)	7.3 (0.9)	7.1 (1.4)
Odor	6.3 (1.6)	6.9 (1.7)	6.9 (1.6)	6.9 (1.2)
Texture	6.8 (1.8)	6.9 (1.5)	6.8 (1.3)	7.0 (1.4)
Taste	6.6 (1.6)	7.0 (1.5)	6.6 (1.7)	6.9 (1.5)
Overall	7.0 (0.7)	7.1 (1.3)	6.8 (1.4)	6.9 (1.4)
Retention samples				
Appearance	7.1 (1.7)	6.9 (1.3)	6.4 (1.7)	6.1 (1.6)
Color	6.8 (1.4)	7.2 (1.6)	6.4 (1.7)	6.2 (1.6)
Odor	6.6 (1.6)	6.7 (1.6)	6.3 (1.7)	6.2 (1.8)
Texture	6.7 (1.5)	6.6 (1.6)	6.1 (2.1)	5.6 (1.9)
Taste	6.7 (1.6)	6.3 (2.1)	6.3 (2.0)	5.8 (1.7)
Overall	7.0 (1.3)	6.5 (1.6)	6.2 (1.7)	5.8 (1.6)

Results wheat flour

- Bread acceptability: Kenyatta University, Kenya

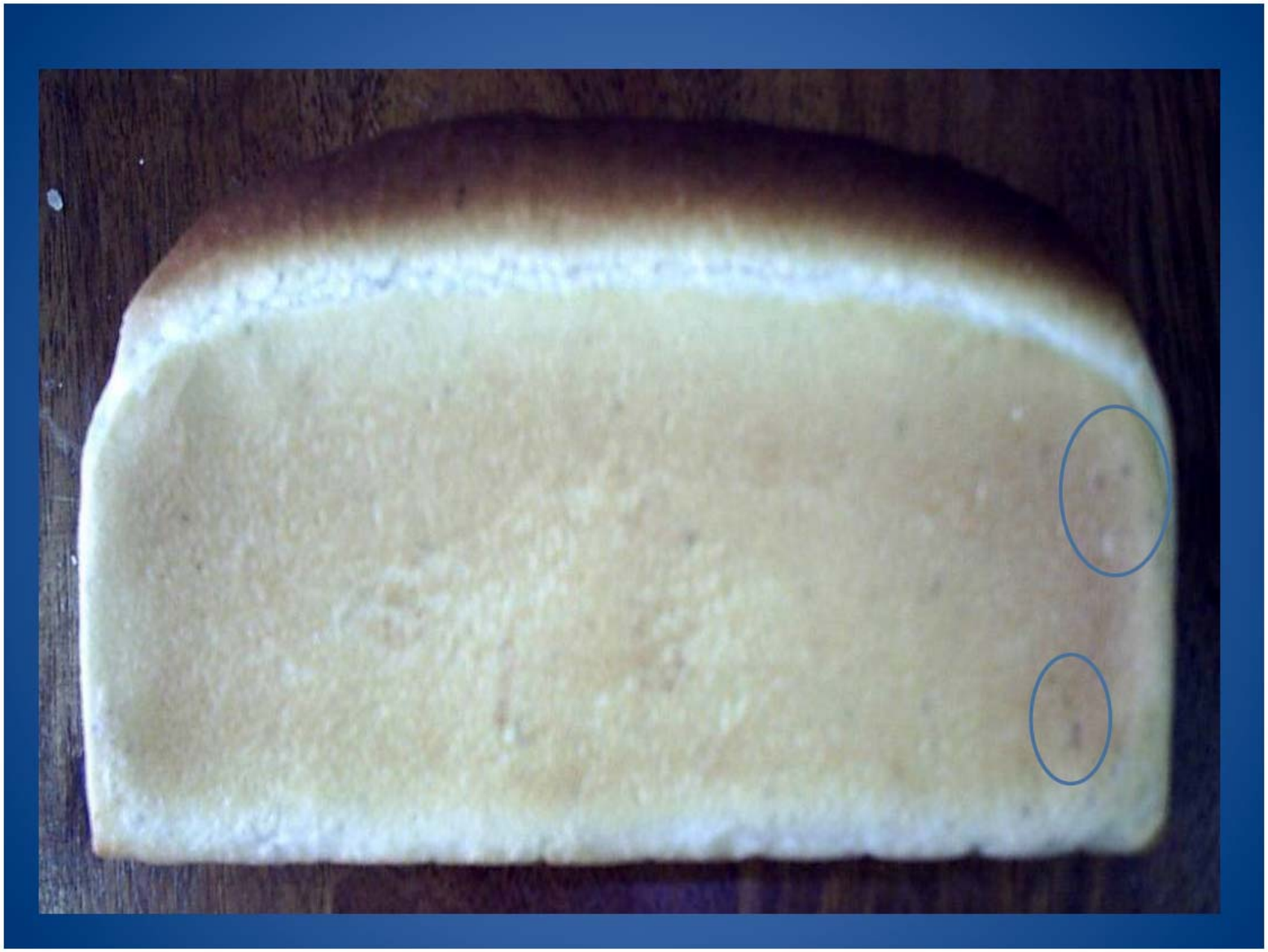
Question	Control	Ferrous fumarate	Ferrous sulfate	NaFeEDTA
Original samples (n=20)				
Is this product generally ACCEPTABLE ?	1.1 (0.3)	1.1 (0.3)	1.1 (0.3)	1.1 (0.3)
Would you BUY this product if it was commercially available ?	1.1 (0.3)	1.1 (0.3)	1.1 (0.3)	1.1 (0.4)
Would you BUY the product knowing it contained health benefits?	1.1 (0.3)	1.1 (0.3)	1.1 (0.3)	1.0 (0.0)
Retention samples (n=19)				
Is this product generally ACCEPTABLE?	1.1 (0.3)	1.2 (0.4)	1.2 (0.4)	1.3 (0.5)
Would you BUY this product if it was commercially available?	1.1 (0.2)	1.2 (0.4)	1.3 (0.5)	1.4 (0.5)
Would you BUY this product knowing it contained health benefits?	1.0 (0.0)	1.1 (0.3)	1.1 (0.3)	1.1 (0.2)

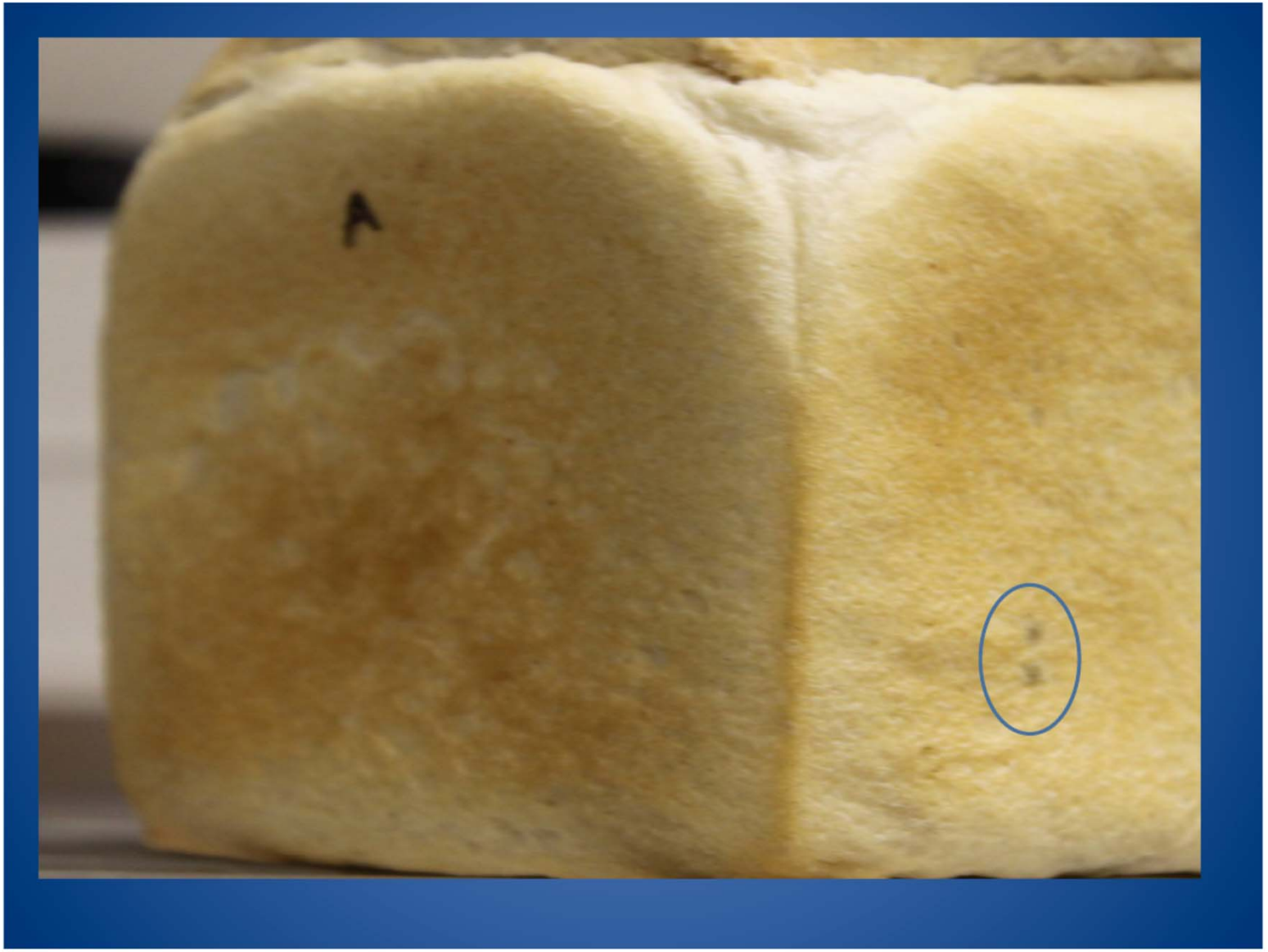
Conclusion BREAD

- All breads passed minimum requirements for overall bread quality
- 20 ppm NaFeEDTA no problem (extra trials)
- Spotting was observed

  -> but would you really notice?

  -> caused by iron source?

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Tanzanian Wheat Flour - Mill

EDTA - Control

Sulphate - Control

Tanzanian Wheat Flour - Mill

Fumerate - Control

Results: wheat flour

- Chapatti score:
  - Bakhresa Mills (Tanzania)
    - Slight differences in colour (original and retention)
    - Eating quality = normal
  - Food and Nutrition Centre (Tanzania)
    - No differences (panel scoring)
  - UNGA Mills
    - No differences

Conclusion Chapatti

- Slight differences in colour but not related to a particular iron source
- Chapatti quality = normal

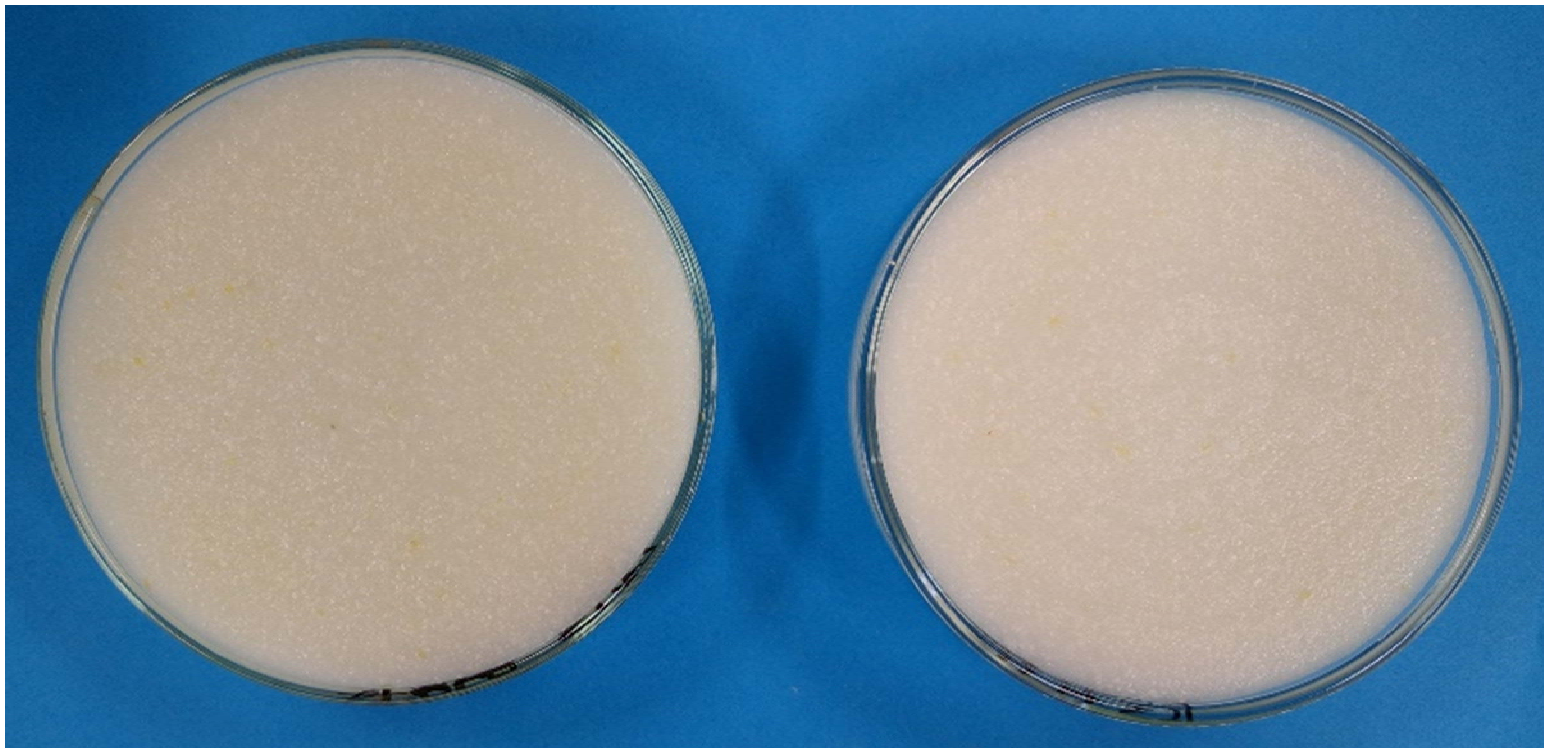
Tanzanian Maize Meal – Mill (uji)

EDTA - Control

Control - Fumerate

Tanzanian Maize Meal - TFNC

Tanzanian Maize Meal – TFNC - ugali



SuperSun - Iwisa

Results: Maize meal

- Bakhresa Mills (Tanzania) => Ugali
  - Slight differences in colour (original and retention)
  - Taste = normal
- Food and Nutrition Centre (Tanzania)=> Ugali and Uji
  - No differences

Results: maize meal

- Ugali acceptability: Kenyatta University, Kenya

Question	Control	Ferrous fumarate	NaFeEDTA
Original samples			
Is this product generally ACCEPTABLE?	1.2 (0.4)	1.1 (0.2)	1.1 (0.2)
Would you BUY this product if it was commercially available?	1.1 (0.3)	1.1 (0.2)	1.1 (0.3)
Would you BUY this product knowing it contained health benefits?	1.1 (0.3)	1.0 (0.0)	1.1 (0.2)
Retention samples			
Is this product generally ACCEPTABLE?	1.2 (0.4)	1.2 (0.4)	1.2 (0.4)
Would you BUY this product if it was commercially available?	1.2 (0.4)	1.2 (0.4)	1.3 (0.5)
Would you BUY this product knowing it contained health benefits?	1.1 (0.3)	1.2 (0.4)	1.1 (0.3)

Conclusion Porridge

- Slight differences in colour but not related to a particular iron source
- Quality = normal
- All acceptible

General Conclusion of the study

- WHO Guidelines for fortification of flour do not lead to changes in the baking and cooking properties of wheat flour and maize meal.
- Some differences only noticeable with hypercritical eye
- Further research needed for a broader range of concentrations and products

What to do when starting with fortifying?

- Before starting up with fortifying -> check impact on product quality
- Make sure premix specifications (types, conc, quality…) are set right and clear from the beginning
- Use slightly higher concentrations (overage taking into account variation)
- Use in-land procedures and products
- Act smart: do we observe a difference? -> Is this difference acceptable
- Interact with local research institutes