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

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Introduction
Flour fortification is a preventive food-based approach to improve the micronutrient status of populations. In 2009, the World Health Organization (WHO) released guidelines on addition levels for iron, folic acid, vitamin B12, vitamin A, and zinc at various levels of average daily consumption.

Objectives
To address food industry concerns about possible adverse effects from iron compounds, baking trials were undertaken to determine possible adverse interactions. If any adverse interactions occurred, an objective was 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, and other products were prepared locally and assessed on whether the products were acceptable under industry-approved criteria, by academic sensory analysis using a combination of trained and untrained panellists and in direct side-by-side comparison. Products tested using local products and assessed using local criteria to answer the following questions:

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

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. Specific results include the following:

- **SAGL (Bread only)** - In all cases within acceptance criteria; retention samples acceptable but scored down due to excessive volume (undesirable in South Africa)
- **Bakhresa Bread** - All flours exceeded the standard minimum, with a slight decline in the scores for the retention samples, which was most evident in general appearance, over spring, and crumb color.
- **TFNC** - Five-point hedonic scale for taste, color, texture, and general acceptability showed no differences in the initial trial. Retention sample was too infused by Tribolium species to be used.
- **Bakhresa Chapatti** - Initial trials, the NaFeEDTA and ferrous sulfate samples were both noted to be slightly different in color. Retention samples, the same observation was made for the ferrous sulfate and fumarate samples. In all cases, the eating quality was described as normal.
- **TFNC** - Five-point hedonic scale for taste, color, texture, and general acceptability reported no differences.
- **UNGA Bread** - Six-point hedonic scale own internal control, ferrous sulfate, and NaFeEDTA scored 07.7, with the control and ferrous fumarate scoring 5.3 each. Concluded that no differences were found. Retention sample was too infused by Indian flour moth to be used.
- **Kenya University Bread** - Nine-point hedonic scale all acceptable and marked the retention samples very slightly down.
- **Kenya University Chapatti** - Nine-point hedonic scale indicated the ferrous sulfate sample moved from being viewed slightly more favorably initially to being viewed more negatively in the retention sample. No differences were indicated in the other samples, either within each trial or between trials.
- **Kenya University** when asking “Would you buy the product knowing it contained health benefits?” found increased acceptance scores. This would tend to suggest that any perceived negative was more an issue of looking for a fault rather than any actual consumer resistance, and thus advocacy may be all that is required to overcome any perceived differences in quality.
- **Bakhresa Maize** - Ferrous fumarate and the NaFeEDTA have a slightly different color to control than the control sample, with all having normal taste in the initial trial. Retention sample, the ferrous fumarate sample and the control were judged to have slightly different color with, again, normal taste.

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. Even with the hyper-critical eye of respondents trained to measure against a set benchmark and discern differences, and knowing that differences are there to be found, these perceived differences could not be consistently replicated.

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