BioAnalyt

Rapid Measurement of **Iron** and **Vitamin A** in Flour with iCheck

September 2020

Fortification of Wheat and Maize Flours

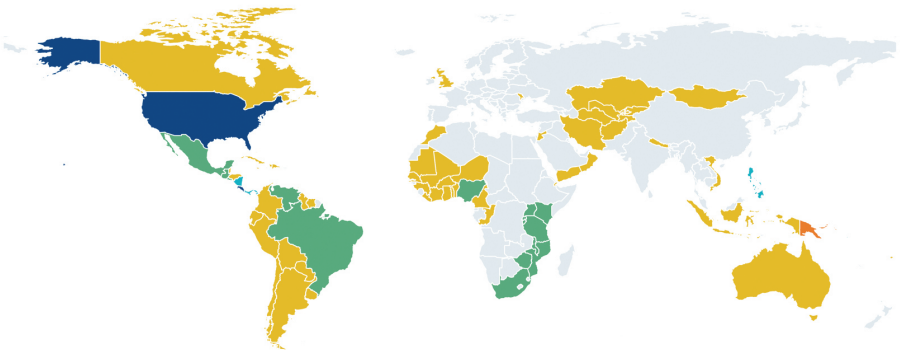
Wheat, maize, and rice are the most widely consumed grains around the world, present in about 95% of all diets. However, modern processing of these grains removes most of the bran and germ, the parts of the grains that are naturally rich in vitamins and minerals. People that rely on industrially processed wheat and maize flours, or polished rice to supply the majority of their daily energy needs are therefore at at a greater risk of developing micronutrient deficiencies.[1]

Large-Scale Food Fortification (LSFF) is the addition of vitamins and minerals (e.g. , iron, zinc, folic acid, vitamin A, and vitamin D) to staple foods such as wheat or maize flour, edible oils and fats, salt, sugar, and rice. LSFF is considered to be one of the most cost-effective public health interventions to increase the consumption of critical vitamins and minerals. Today cereal grains and flours are consumed at an average quantity of 200 grams/person/day, making these a suitable a suitable vehicle in many countries to deliver important micronutrients at the population level.[2]

In the early 1900s, deficiencies in B vitamins were prevalent in the USA as a result of widespread consumption of industrially processed wheat flour. To tackle these deficiencies, mandatory fortification of processed flours was introduced in 1939 in the USA. At that time, wheat flour and white bread were enriched with thiamine (B1), riboflavin (B2), niacin (B3), iron, and calcium.[3] A year later, in 1940, the United Kingdom also mandated fortification of wheat flour with thiamine. Denmark followed suit in 1953 by making the addition of thiamine, riboflavin, and iron to wheat flour mandatory.[1] Today, about 85 countries mandate wheat flour fortification, 17 countries mandate maize flour fortification, and 15 countries mandate both wheat and maize flour fortification.[4,5] Both flours are commonly fortified with iron, zinc, B vitamins, and sometimes with vitamin A.

Vitamin and mineral premix for flour fortification costs an average of US $4 per metric ton of flour for large-scale producers, which equals around US $0.05-0.07 per person per year. The process of mixing in additives during flour production is well known to flour millers, since adding flour improvers is a common practice. Consequently, the addition of micronutrients to the production process carries a negligible cost once the equipment for fortification put in place at a flour mill.[1,5]

Furthermore, the benefits of fortifying flour with micronutrients far outweighs the cost of fortification. For every dollar spent on flour fortification, US $84 is saved through reduction of anemia, a condition affecting one in three people globally.[5] Sustained flour fortification has also been associated with a 2.4% reduction in anemia prevalence among non-pregnant women of childbearing age, and an increase in serum retinol in populations from 0.94 to 1.06 µmol/L.[6,7]



One of the most visible effects of flour fortification is the reduction of neural tube defects in new born babies, which is caused by inadequate folic acid stores. After Chile mandated flour fortification with folic acid in 2000, hospitals recorded a steady decrease in neural tube defects from 18.6 per ten thousand births in 1999 to 8.39 per ten thousand in 2009.[5]

References:

[1] Hoogendoom et al. 2FAS EC. 2016.
[2] Klemm et al. Food Nutr. Bull. 2010.
[3] Bashai & Nalubola. EDCC. 2013
[4] GFDx. 2020.
[5] FFI, 2020.
[6] Barkley et al. Br. J. Nutr 2015.
[7] Dary, USAID. 2016.

How it works

Measuring Iron and Vitamin A in Flours with iChecks

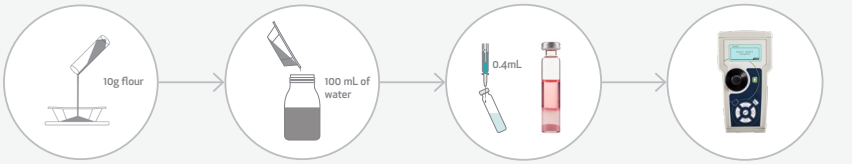
To facilitate the monitoring and quality control of flour fortification, BioAnalyt has developed iCheck devices which enable the reliable measurement of the concentrations of vitamin A and iron in wheat and maize flours.

iCheck Iron is a portable, single-wavelength photometer, that quantitatively measures iron in multiple food matrices. Similar to reference methods, iCheck iron measures total iron in food samples (i.e. intrinsic iron as well as iron added as either ferrous fumarate, ferrous sulfate, NaFeEDTA, and ferric pyrophosphate).

Intrinsic iron is natural iron present in organic samples. In flour the intrinsic iron content may be between 10 and 60 mg/kg.

iCheck Fluoro is a portable, single-wavelength fluorometer that quantitatively measures vitamin A in foods and biological substances. iCheck Fluoro measures added vitamin A as retinyl palmitate and retinyl acetate.

IRON MEASUREMENT



Weigh 10 grams of a flour sample.

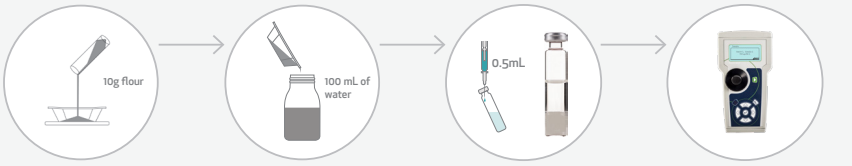
Transfer flour sample to a flask already filled halfway with water. Dilute to 100 mL with water.*

Proceed with measurement following iCheck Iron User Manual.

Multiply the result displayed with 10 (per dilution) to get the concentration of iron in the flour sample in mg/kg.

* For ferrous fumarate, ferrous sulphate, and ferric pyrophosphate iron fortificants, it is recommended that your flour sample be diluted in 0.2M-0.4M HCl solution. These iron fortificants are partially soluble or insoluble in water. NaFeEDTA fortificant is soluble in water, hence water can be used as a diluent. It is recommended also to measure intrinsic iron in flour samples using 0.2M - 0.4M HCl

VITAMIN A MEASUREMENT



Weigh 10 grams of a flour sample.**

Transfer flour sample to a flask already filled halfway with water. Dilute to 100 mL with water.

Proceed with measurement following iCheck Fluoro User Manual.

Multiply the result displayed with 10 (per dilution) to get the concentration of iron in the flour sample in mg/kg.

** When measuring vitamin A in flour, it is recommended to first measure an unfortified sample of the same flour to assess if the food matrix has innate fluorescence. This may cause iCheck Fluoro to display overestimated results.

Contact us to get **detailed protocol and training**:

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Method comparison

Performance of iCheck Iron and iCheck Fluoro are Comparable to Reference Methods

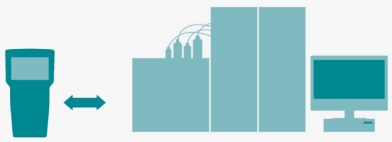
To ensure the reliability and accuracy of results, measurements obtained with iCheck devices are compared to results from traditional laboratory methodologies, such as High Performance Liquid Chromatography (HPLC) for vitamin A and mass spectrometry (ICP-MS) for iron.

Wheat and maize flours were fortified with vitamin A at 1.0 - 10.0 mg retinol equivalents per kg (mg RE/kg) and measured with iCheck Fluoro and HPLC in two different studies. A good linear relationship was obtained between results from the two methods and a correlation of R^2=0.91 to R^2 = 0.97 was observed.[8,9] In another study, iCheck Fluoro results were compared to expected concentrations in wheat and maize flour samples spiked with vitamin A premix at 1 to 6 ppm. Recovery for wheat flour was at 116 ± 2%, and for maize flour 113 ± 5%.[10]

Results with iCheck Iron were compared to results with ICP-MS in wheat flour spiked with ferrous fumarate. The samples were diluted in 0.2M HCl for analysis with iCheck Iron and the results showed excellent correlation with ICP-MS results (R^2=0.96) and a maximum coefficient of variation (CV) of 12% was observed. iCheck Iron results were compared to expected concentrations in wheat and maize flour samples spiked with NaFeEDTA at 15 to 90 ppm. The recovery of added iron for both types of flours was at 98 ± 3%. A maximum CV of 6% was observed for wheat flour and 5% for maize flour, respectively. Recovery and precision was further assessed in wheat flour samples spiked with premix containing ferrous sulfate at 20 to 50 ppm iron. The recovery of iron was 101±7% and the maximum CV observed was 8%.

References:
[8] Laillou et al, Food Nutr. Bull. 2014
[9] Jaeger A, FST Mag. 2014
[10] BioAnalyt internal data

Benefits of iCheck



- **Speed:** Results in 5 to 60 minutes.
- **Economy:** Cost is only 10% of conventional lab methods.
- **Easy implementation:** Only 1 day of training is required.
- **Scalability:** Portable, with no set-up calibration required.
- **Accuracy:** Performance is comparable to reference lab methods.

iChecks are manufactured in Germany, used in over 80 countries and validated against standard laboratory methods. Learn more at www.bioanalyt.com/products.