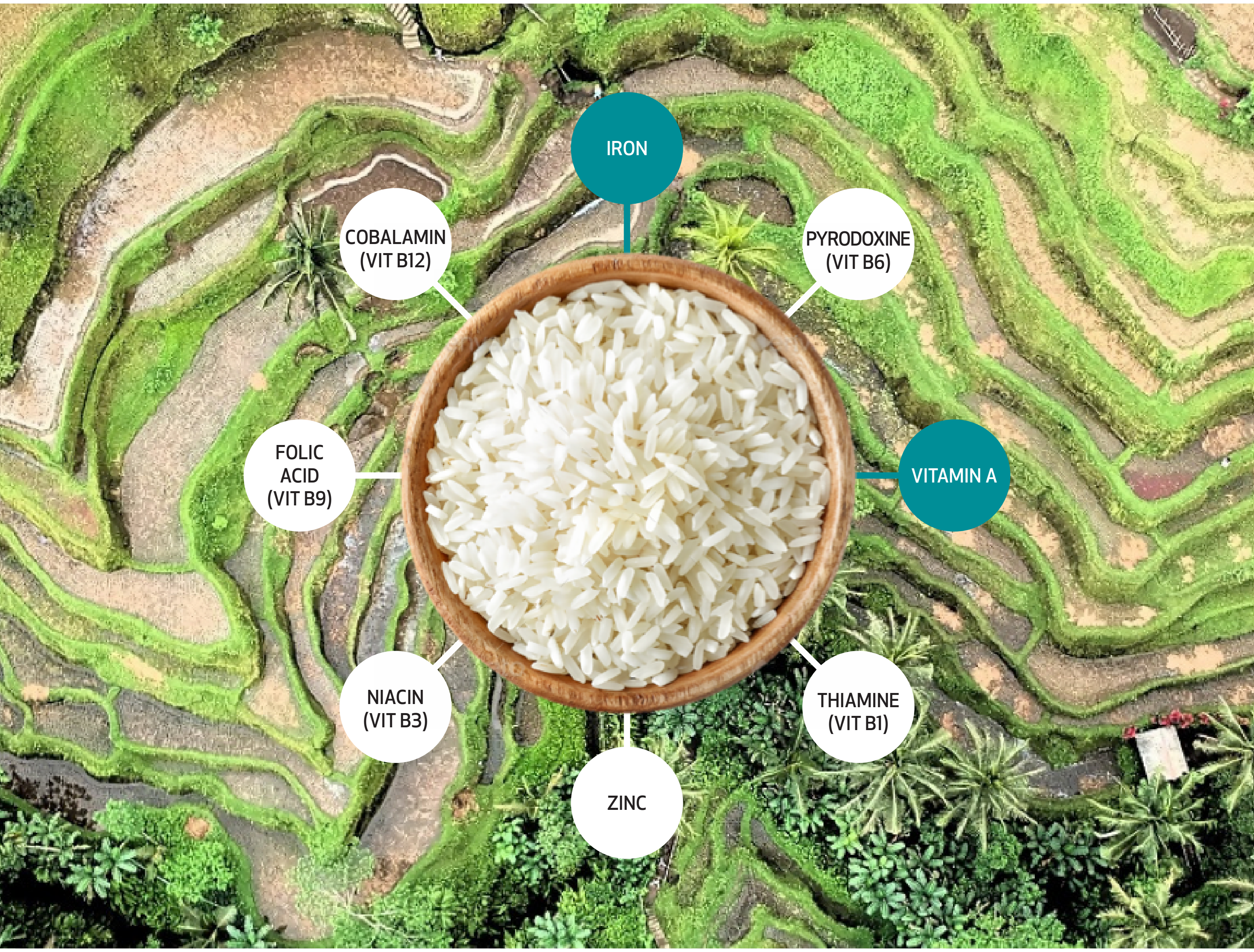
Rapid Measurement of Iron and Vitamin A in Fortified Kernels with iCheck



Rice Fortification

Over 3.5 billion people across Asia, Africa, and Latin America depend on rice for up to 20% of their daily calories.[1] This rice, however, is most often polished to remove the outer bran layer, depriving it of its naturally occurring vitamins and minerals. People that rely on rice to supply the majority of their daily energy needs are thus at high risk of developing deficiencies in these micronutrients.

Due to its ubiquitous consumption, rice offers an excellent vehicle for delivering essential micronutrients through fortification. Experience has shown that the cost of adding these essential micronutrients to rice (e.g. iron, zinc, vitamin A, folic acid, and other B vitamins) could amount to less than US $1 annually per person, and can contribute to significant health and economic benefits, such as increased productivity and decreased disease burden.[2,3]

Food fortification is generally a straightforward process: dry or liquid micronutrient premix is added for blending into a staple food, such as flour, salt, or oil at a defined ratio. Production of fortified rice, however, is technologically more complex.

One method involves dusting or coating rice with a micronutrient premix. A second technology is cold or hot extrusion of fortified kernels (FK) which are blended into polished rice. Of these, warm and hot extrusion technology is the most effective in retaining added micronutrients during storage and after the rice has been washed and cooked.

FK are made by mixing micronutrient premix with rice flour and then reconstituting the mix through extrusion to mimic a regular rice kernel. These fortified reconstituted kernels are blended in with regular rice at a ratio between 0.5-2%, most frequently at 1%. A 1% blending ratio means that 1 g FK is added to every 99 g regular rice. FK are indistinguishable from regular rice, however it is possible to visualize FK that have been fortified with vitamin A using ultraviolet light (see figure to the left).

Vitamin A fortified kernels fluorescing under ultraviolet light

Additional costs to fortify rice with fortified kernels are context-specific. Based on experience in 15 countries the retail price for fortified rice may rise by anywhere between 1 and 10%. For example, in Mali additional cost of fortification sums up to US $2 per 100 kg of rice. [4] As rice fortification expands, production and distribution can achieve economies of scale and reduce costs.

1. http://ricepedia.org/rice-as-food/the-global-staple-rice-consumers.
2. Guyondet C. et al. Scaling up Rice Fortification in West Africa. Mali Case Study: Generating Evidence for New Operative Model. Sight&Life and WFP, Supplement 18, p. 94-101, 2018.
3. Muthayya S. et al. Rice fortification: an emerging opportunity to contribute to the elimination of vitamin and mineral deficiency worldwide. Food Nutr Bull. 33(4), 2012.
4. Milani P. et al. Scaling up Rice Fortification in West Africa: Introduction to Rice Fortification. Sight&Life and WFP, Supplement 18, p. 48-54, 2018.

Measuring Iron and Vitamin A in Fortified Kernels with iChecks

To support the implementation of rice fortification, BioAnalyt has partnered with DSM to develop and optimize a sample preparation method for FK. iCheck Iron is a portable, single-wavelength photometer and iCheck Fluoro is a portable, single-wavelength fluorometer. Both are pre-calibrated for quantitative measurement of iron and vitamin A, respectively, in various food matrices, including many types of flour.

To ensure a reliable result with iCheck Iron and iCheck Fluoro, FK samples require a customized sample preparation protocol. First, the FK is ground into a fine, flour-like powder. Then a diluted sodium hydroxide solution is added. In some cases digestion with amylase enzyme may be required. The basic environment induces swelling of the starch, while enzymes help break down the starch matrix of ground FK what helps to release the embedded micronutrients within the kernels for efficient extraction of Iron and Vitamin A.

SAMPLE PREPARATION

Grind the FK into a fine, flour-like powder using a lab mill or coffee grinder.

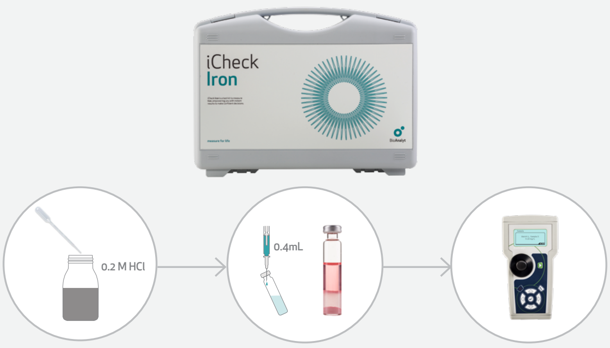
Transfer the ground FK to a beaker and dilute to a 0.4% sodium hydroxide solution. Pre-digestion with amylase may be required.

Heat the solution to 40 °C and mix it for 30 min using magnetic stirrer.

Once prepared, the FK flour slurry can be analyzed by both iCheck Iron and iCheck Fluoro.

iCheck consists of 2 parts: a measurement device and a ready-to-use reagent vial. The prepared sample solution is injected into the reagent vial where the target nutrient is extracted. The vial is inserted into the device that quantitatively measures nutrient concentration.

IRON MEASUREMENT

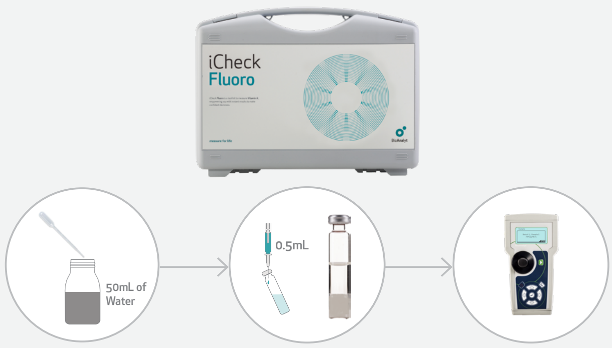


Transfer part of the FK slurry to a new flask and acidify with 0.2 M HCl

Proceed with analysis following iCheck Iron User Manual.

Multiply the displayed result with the corresponding dilution factor to get iron concentration in FK in **mg/kg**.

VITAMIN A MEASUREMENT



Transfer 1 mL of FK slurry to a new flask and fill up to 50 mL with water.

Proceed with analysis following iCheck Fluoro User Manual.

Multiply the displayed result with the corresponding dilution factor to get vitamin A concentration in FK in **mg/kg**.

Contact us to get **detailed protocol and training**: Email: support@bioanalyt.com WhatsApp: +49 3328 35150034

Results with iChecks are Comparable to Reference Methods

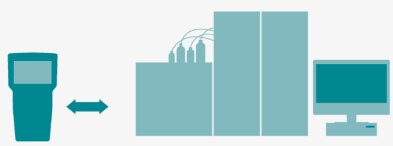
All iCheck devices are compared to traditional laboratory methodologies to ensure reliability and accuracy of measurements. For FK, iCheck methods were compared to mass spectrometry (ICP-MS) reference methods for iron and high-performance liquid chromatography (HPLC) reference methods for vitamin A.

Both iron and vitamin A concentrations measured with iChecks were comparable to FK product specifications and the reference laboratory methods.

	Vitamin A			Iron		
Warm and Hot Extruded FK Samples	Specified vitamin A level (mg/kg)	Vitamin A results measured with HPLC by 2 different accredited laboratories (mg/kg)	iCheck Fluoro Results (mg/kg)	Specified iron level (mg/kg)	Iron results measured with ICP-MS by accredited laboratory (mg/kg)	iCheck Iron Results (mg/kg)
Sample 1	233	146 - 234	186 ± 5	not added	6.3 ± 0.6	below range
Sample 2	167	77 - 167	140 ± 1	not added	33 ± 3.3	below range
Sample 3	185 - 336	90 - 180	111 ± 3	5000-9000	7699 ± 769	7317 ± 461
Sample 4	240	207 - 249	156 ± 1	2400	4100 ± 410	3538 ± 115
Sample 5	120	100 - 120	92 ± 1	2100	2944 ± 294	1758 ± 153
Sample 6	183	81 - 114	90 ± 2	3800	4495 ± 449	4335 ± 35
Sample 7	183	85 - 98	99 ± 2	3800	4472 ± 447	3962 ± 421
Sample 8	175	40 - 53	48 ± 1	4000	4563 ± 456	3678 ± 288
Sample 9	120	159 - 220	185 ± 2	2380	1980 ± 198	2317 ± 90

Table1: Samples are up to 2 years old, stored under different conditions. iCheck analysis was performed in-house at BioAnalyt, Germany. HPLC and ICP-MS were performed in accredited labs in Switzerland and Germany. Extended measurement uncertainty for iron with ICP -MS is 10% and for vitamin A with HPLC 15%. iCheck results are reported with standard deviation of triplicate measurement.

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.

measure for life

For orders, technical assistance, or any other inquiries contact BioAnalyt at:
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