The Power of Portable Micronutrient Testing

Strengthening food fortification programs through improved monitoring tools

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Key messages

- To understand if a nutrition intervention has achieved its intended impact, the nutrients must be tracked at every point of the food value chain.
- In response to the challenges of transporting blood samples from remote field locations to the laboratory, BioAnalyt developed the field testing solution iCheck.
- *Sight and Life* has been a key partner of BioAnalyt, supporting the introduction of innovative testing in the field and acting as a catalyst for measuring impact.
- This article provides an overview of field methods for micronutrient testing.
- The biggest application area for this type of field test to date has been quality control of food fortification.
- BioAnalyt helps execute nutritional status surveys, delivering evidence on the nutritional status in populations. Its products enable the sharing of data with the population in real time.

There are numerous approaches to combat malnutrition, from the fortification of staple foods through diet diversification and vitamin supplementation to reducing infection.[1]

To understand if a nutrition intervention has achieved its intended impact, the nutrients must be tracked at every point of the food value chain from farm to fork – i.e., from production to human intake. Only thus can it be demonstrated that a nutrition program delivers its intended expected health benefit in a population. This is the challenge that BioAnalyt has taken on.

Bringing the lab to the sample

The company BioAnalyt was founded by Prof. Dr FJ Schweigert as a spin-off of the University of Potsdam, and initially provided analytical food testing services for researchers and NGOs. For a population study in Laos, for which hundreds of blood samples were to be tested for vitamin A,[2] it became clear that although complex, the most difficult part was not the sample analysis. Getting the samples safely from a remote village in Laos to the lab in Germany proved the biggest challenge. This sparked the idea of bringing the laboratory to the sample instead of transporting the sample to the laboratory, and the development of a mobile lab to simplify micronutrient analysis began.

> "Our solution was to create a miniature lab"

The solution was to miniaturize a lab, resulting in a small portable photometer using the latest LED technology and prefilled reagent vials, customized for the detection of specific micronutrients.

FIGURE 1: iCheck device and reagent vial

Sight and Life has partnered with BioAnalyt since the beginning, supporting the introduction of innovative testing in the field.

> "iCheck can be used by almost anyone, anywhere"

What is innovative about iCheck is that the measurement process was standardized and reduced to three steps, simplifying the logistics of ordering extra chemicals and meaning that this tool can be used by almost anyone, anywhere.

Field methods for micronutrient testing

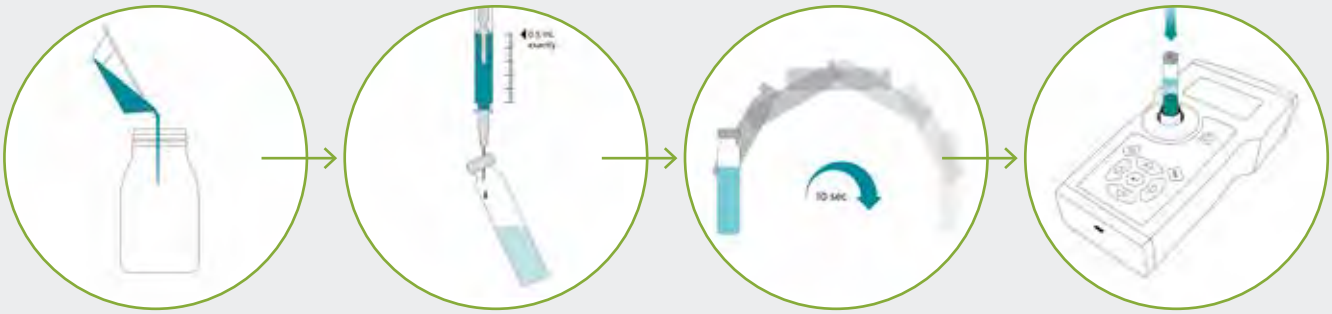
Making analytical equipment locally available is a critical step in the fight against micronutrient deficiencies in developing countries.

Iodine in salt

Numerous field tests exist for determining the content of iodine in (iodized) salt. Qualitative or semiquantitative tests include spot tests, whereby a color reaction indicates the presence or absence of iodine.[3]

Quantitative test kits, on the other hand, can precisely determine the concentration of iodine in salt. A study performed in 2015 by Rohner et al assessed the performance of five available field kits, including iCheck Iodine.[4] The parameters of cost, ac-

FIGURE 2: iCheck 3-step measurement process



1. Sample Preparation | 2. Injection | 3. Reaction | 4. Measurement

TABLE 1: Comparison of the performance of five available field kits

You want to measure:	Vitamin A	Vitamin A in oil	Carotenoids	Iron	Iodine	Vitamin E (from Jan 2018) COMING SOON
In this sample:	Premix, milk, flour, sugar, milk powder, bouillon powder. Biological fluid: Breast milk, blood	Refined edible oils and fats of plant origin	Premix, roots (i.e. cassava), beverages, eggs, salmon flesh Biological fluid: Cattle blood and milk	Premix, flour, soy and fish sauces, beverages, Corn-Soya-Blend (CSB), Lipid-based Nutrient Supplement (LNS)	Salt	Biological fluid: Cattle blood
Use this product if:	**iCheck Fluoro**	**iCheck Chroma or Chroma 3**	**iCheck Carotene**	**iCheck Iron**	**iCheck Iodine**	**iCheck Vitamin E**
Vitamin or mineral form is:	Retinyl palmitate, retinyl acetate, retinol	Retinyl palmitate	Total carotenoids	Ferrous sulfate, ferrous fumarate, NaFeEDTA, intrinsic iron	Potassium iodate	Contact us for the information
Measurement range is*:	50 – 3000 µg RE/L	3.0 – 30.0 mg RE/kg	0.15 – 25.0 mg/L	1.5 – 12.0 mg/L	1.0 – 13.0 mg/L	–

*The upper limit of the measurement range can be increased by diluting the sample

curacy, and field usability were compared (Table 1), and iCheck Iodine was determined to be the most precise field method, followed closely by the IReader. The reference method for the study was iodometric titration.

Vitamin A in foods and humans

Vitamin A is critical for health, but complex to analyze. It is fat-soluble and difficult to extract from the matrix, as well as being light- and heat-sensitive. The standard method for measuring vitamin A is high-performance liquid chromatography. Though precise, it requires a fully equipped lab, extensive sample extraction and highly trained operators, making it unsuitable for use in the field or low-resource settings.

Colorimetric methods exist, but these require solvent handling and produce only qualitative results.[5]

To overcome these challenges, BioAnalyt developed two test kits using different approaches for measuring vitamin A: iCheck Fluoro, based on fluorescence, for foods and biological fluids, and iCheck Chroma, based on the vitamin A specific Carr-Price reaction, for edible oils. Both test kits have been compared to the standard reference methods, showing a good linearity between the results and comparable or slightly better intra-assay precision.[6,7]

Areas of application

The biggest application area to date has been food fortification – painting a clearer picture of where the nutrients really are. For years, the addition of micronutrients to staple foods and condiments – known as food fortification – has helped to deliver essential vitamins to the malnourished. While food fortification is cost-effective, scalable and can be effective in both industrialized and developing nations, measuring its impact has remained difficult. Part of the problem is that as food moves along the value chain, for example during transportation or in-home preparation, it can lose some or even all of its added nutritional value. Knowing where nutritional loss occurs, or whether food has been properly fortified in the first place, is therefore essential.

> "Knowing where nutritional loss occurs is essential"

Biofortification – Rapid screening of β-carotene in cassava

Biofortification is the process of enriching plants with vitamins and minerals through selection and breeding. In the case of

TABLE 2: Comparison of quantitative test kits for measuring iodine in salt (modified from Rohner et al)

Device name	Method principle	Description of test kit contents	Analytical performance	Overall rating
iCheck Iodine	Reduction of iodate to iodine by potassium iodide, followed by the formation of pentaiodide anions that inside the helical β-amylose chain of starch form a blue color that is linear with the iodine concentration. Colorimetric quantification of the concentration using photospectrometry.	Device, scale and power plug come with the device kit; activation solution, reagent vials, syringes and needles come with the reagent kits. Only purified water and plastic flasks required.	4.5	4.1
ID-ERTK	NA	Device comes with power plug, scale, quartz cuvette, and some other lab hardware. Reagent solutions need to be prepared by the user.		3.4
IReader	NA	Device comes with pyrex tubes and tubeholder, disposable pipettes and small dosage spoons (to measure the salt volumetrically rather than by weight), and a basic reagent stock (two bottles, sufficient for approx. 330 analyses). Scale not included.	4.3	4.3
saltPAD	Iodate is reduced to triiodide using potassium iodide. Thiosulfate is used to titrate a predetermined amount of triiodide. Excess triiodide reacts with starch to form a blue color that can be calibrated for visual or computerized image analysis.	This device is not yet commercially available; beta-testing version was used for this evaluation. Besides the testing cards that were delivered by the developer, a light box had to be constructed to take pictures for automated analysis. A standard calibration series also had to be prepared for calibration of the software to the specific light conditions.	3.5	3.6
WYD iodine checker	NA	Same as iCheck, ID-ERTK and IReader. Test kit comes with device and power plug, some lab hardware and a manual. Scale not included. Reagent solutions need to be prepared by the user.	3.8	3.6

Table adapted from Rohner et al[4]

cassava, the challenge in breeding biofortified roots is the large numbers of genotypes that need to be evaluated for their total carotene content (TCC) to then select the promising genotypes for advancement to the next breeding cycle.[8] Our technology makes it possible to test pro-vitamin A profiles of crops to accelerate the selection and breeding process.

Food fortification monitoring

Food fortification can only be successful if industry and government are fully equipped and committed. Working closely with local food producers and governments in the context of testing fortified foods, it became apparent that the capacity gap was much bigger than merely the need for a portable lab/test kit. A system surrounding the monitoring of fortified foods was missing. In collaboration with other organizations, we help build up the support system for food testing. Since 2013, BioAnalyt has trained over 650 stakeholders in over 30 countries on Quality Control and Assurance. In collaboration with food producers and vitamin premix suppliers, who use iCheck together with their systems, we work out the optimal processes to ensure correct dosing.

TABLE 3: Comparison of iCheck to standard lab method for testing vitamin A

Resource	Standard Laboratory Method (HPLC)	iCheck
Equipment	Fully equipped laboratory	iCheck device
	Analytical instruments	
	Stable power supply	
	Refrigerator	
Chemicals	Chemicals and standards	iCheck reagent vial
Personnel	Highly educated lab technician	1-day trained operator
Cost per sample	50–200 US$	5 –15 US$
Time per sample	1 day – 2 weeks	5 – 10 minutes

In the market and in the household – Coverage and market surveys

An essential part of every nutrition intervention is the process of monitoring and evaluation. In order to assess the success of large-scale food fortification programs, food samples from markets and households must be tested for fortification levels. Test kits such as iCheck make the analysis of large sample sizes of up to 10,000 affordable, and what's more important, possible in a specific country, cutting out the need for extensive logistics. The Global Alliance for Improved Nutrition (GAIN) partnered with BioAnalyt to assess the coverage of fortified foods (FACT) in ten countries, testing thousands of samples for micronutrient levels.[9]

In humans – nutritional status surveys

We help execute nutritional status surveys, delivering evidence on the nutritional status in populations. Our products enable the sharing of data with the population in real time.

We would love to hear from you: What field methods are needed in your work?

About BioAnalyt

BioAnalyt is a product innovation company based in Berlin, Germany, with a global reach and drive to improve nutrition through transparency. Tracking nutrients at every point along the food value chain enables better management of nutrition programs. Our products and services help organizations to measure impact and, therefore, to spend their funds effectively. In doing so, we help improve the nutritional status of millions of people around the world.

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FIGURE 3: Application areas along the food value chain

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