vitamin A in fortified rice
Developing new testing methods

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Food fortification, or the addition of essential vitamins and minerals to foods, has long been established as a cost-effective method for fighting micronutrient deficiencies (1). Invisible to the naked eye, micronutrient deficiencies are a "hidden hunger" that affects nearly 2 billion people global and can lead to mental impairment, weakened immune system, reduced earning power and increased risk of early death (Global Nutrition Report, 2016).

Over 3.5 billion people, across Asia and increasingly West Africa and Latin America, depend on rice for up to 70 percent of their daily calories. This rice, however, is most often polished to remove the outer bran layer, depriving it of its minerals and vitamins. 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 vitamins and minerals through fortification. The cost of adding the recommended micronutrients to rice such as iron, zinc, vitamin A, and B vitamins, amounts to as little as USD 0.30 annually per person. The economic and health benefits, on the other hand, are increased productivity and decreased disease burden (2). The potential of rice, the world's number one staple food, as a fortification vehicle remains largely untapped.

Effectiveness of rice fortification

Food Fortification Initiative (FFI), an international partnership working to improve public health through fortification of industrially milled grain products such as wheat flour, maize flour, and rice, has reviewed the literature on rice fortification. FFI looked at close to 20 efficacy studies conducted in Costa Rica, India, Brazil, India, Mexico, the Philippines, and Thailand. These studies, with some limitations, have demonstrated that rice fortification does mitigate deficiencies in certain micronutrients particularly iron and vitamin A.

Fortification of staple foods such as flour, oil, and salt is a well-established global public health intervention. Rice fortification, on the other hand, is relatively new and limited. Only a handful of countries have legally mandated it. Five countries, Costa Rica, Papua New Guinea, Nicaragua, Panama, and the Philippines count among them, but only the first two are truly fortifying nearly all of their rice (2). Voluntary rice fortification is common in the USA and Ecuador as well as in Brazil.

It should be clear that more effectiveness studies on rice fortification are needed to demonstrate clear outcomes in terms of reducing micronutrient deficiencies. These could help make possible a wider adoption of rice fortification. To facilitate these studies, as well as for monitoring of fortified rice production, simple and fast techniques to test for the presence and levels of micronutrients in rice are desirable.

Rice fortification technologies: challenges and opportunities

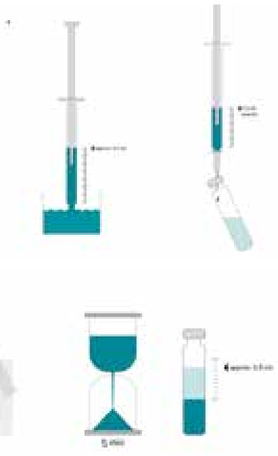
Staple food fortification is usually a straightforward process: dry or liquid micronutrient premix is added for blending into a staple food, such as flour, salt or oil at a defined ratio. Production of fortified rice, however, is technologically a more complex process.

One chief means of fortifying rice is dusting or coating of rice with micronutrient premix. A second method is cold or hot extrusion of fortified kernels for blending (3). Of these, hot extrusion technology is the most effective in retaining added micronutrients during storage and after the rice has been washed and cooked. The process involves mixing premix with rice flour and then reconstituting this powder using extrusion to mimic a regular rice kernel. These reconstituted rice kernels are added to normal rice at a ratio of anywhere between 0.5 – 5 percent but typically at 1 percent, meaning that one fortified, extruded kernel is added for every 99 normal rice kernels. The additional costs are estimated at USD3.00 per 100kg of rice (4).

One early problem was that fortified rice kernels appeared darker than normal rice. Perceiving these grains as impurities, consumers often plucked them out, diminishing the effectiveness of rice fortification. To address this challenge, DSM, a producer of vitamins and micronutrient premixes, and Bühler, a

iCheck™ Fluoro is a state-of-the-art portable fluorometer. It determines vitamin A quantitatively in food and biological fluids. Using innovative technology it measures the fluorescence of vitamin A in the sample. The vitamin A concentration is displayed in µg RE/l (RE=retinol equivalent)

Method of preparing a sample for testing



manufacturer of extrusion equipment, have further perfected the technology to deliver fortified rice kernels that look and taste like normal rice. This facilitates acceptance of fortified rice by the population, since consumers cannot tell the difference (5).

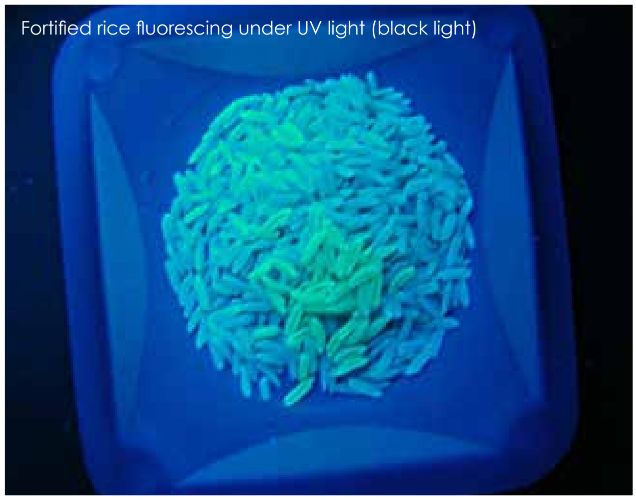
Several other factors play a key role in effectively delivering vitamins and minerals to the population through rice fortification. In addition to fortified rice kernel production technology, these are quality of vitamins and minerals, storage, as well as proper monitoring of the industry producing fortified rice.

Quality control of rice fortification

Testing solutions specifically developed for fortified rice kernels are not easily available. All are bound to a well-equipped laboratory. Having a rapid test for the micronutrients in fortified rice would ensure that adequate levels are added at production and retained throughout the value chain up to the fork.

BioAnalyt, a developer of micronutrient testing solutions for fortified foods, together with DSM, addressed this gap, by co-developing a protocol for measuring vitamin A in extruded rice kernels (6). To perform the measurement, only basic lab equipment in addition to the iCheck Fluoro test kit is required.

iCheck Fluoro uses ultraviolet (UV) light to cause vitamin A molecules to fluoresce (= emit light), and then measures that light and converts it to vitamin A concentration. The device is portable and runs on batteries, making it field-friendly. The test kit comes with pre-filled reagent vials protecting the user from exposure



Fortified rice fluorescing under UV light (black light)

to any hazardous chemicals and simplifying sample preparation procedure. The protocol co-developed by BioAnalyt with DSM describes how to prepare fortified rice kernels so that the vitamin A in rice kernels could be measured with iCheck Fluoro. Measurement results are comparable to the standard method, High Performance Liquid Chromatography (HPLC), while requiring less than one hour as opposed to days to obtain results compared to the standard method. The protocol can be viewed and downloaded from BioAnalyt website (6).

Vitamin A is one of the most sensitive vitamins in fortified rice, so tracking the stability of this vitamin allows for best prediction of retention in regards to other micronutrients. An additional protocol, for the accurate determination of iron in fortified rice with the BioAnalyt iCheck Iron test kit is currently being tested by DSM.

By rolling out these new methods, BioAnalyt and DSM aim to reduce technical barriers to rice fortification, thus making it an increasingly feasible solution for reducing hidden hunger globally.

About BioAnalyt

BioAnalyt's mission is to empower individuals, companies and organizations with tools to ensure food quality. In partnership with organizations such as DSM, BASF, GAIN, HKI and FFI, the iCheck labs have been implemented in over 30 countries across Africa and Asia, making the monitoring of fortified foods possible, from border control to in-factory controls to market surveys.

References:

1. *http://www.who.int/elena/titles/rice_fortification/en/*
2. *http://www.ffinetwork.org/*
3. *http://www.gainhealth.org/knowledge-centre/rice-fortificationwhat-are-the-methods-to-fortify/*
4. *https://www.ncbi.nlm.nih.gov/pubmed/23424896*
5. *https://www.dsm.com/products/nip/en_US/productsservices/productsservices-nutririce.html*
6. *http://www.bioanalyt.com/products/icheck-fluoro-and-iex-mila/vitamin-a-in-rice*

The vitamin A concentration is displayed in µg RE/l (RE=retinol equivalent)