BioAnalyt

Rapid Measurement of Vitamin A in Refined Edible Oils with iCheck Chroma

Background

Vitamin A Fortification of Edible Oils and Fats

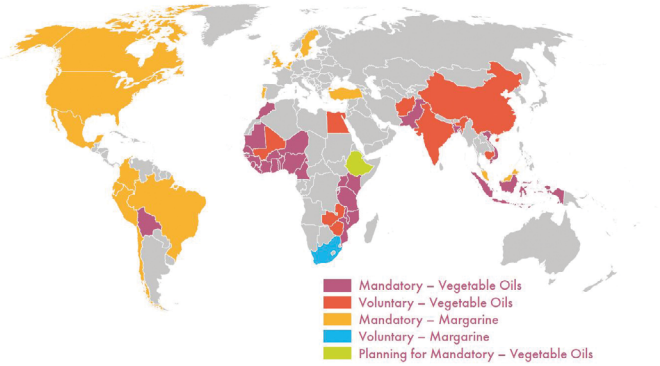
Vitamin A deficiency (VAD) affects 250 million preschool-age children and 20 million pregnant women worldwide. It is the leading cause of preventable blindness in children, resulting in at least 250,000 cases of blindness every year. VAD also leads to night blindness in pregnant women and increases the risk of maternal mortality.[1]

One of the most cost-effective public health interventions to reduce the risk of vitamin A deficiency is Large-Scale Food Fortification (LSFF). LSFF is the addition of vitamins and minerals (e.g. vitamin A, vitamin D, iron, zinc, and folic acid) to staple foods like wheat or maize flour, edible oils and fats, salt, sugar, and rice. Edible oils and fats are commonly fortified with the fat-soluble vitamins A, and D. LSFF works best where a food is 1) widely consumed by populations regardless of socioeconomic status; and 2) centrally manufactured or processed. Edible oils and fats are such foods, since they are consumed in almost every household worldwide in relatively small but consistent quantities of about 12-33 grams/ person/ day. Additionally, most countries process edible oils and fats centrally by medium- and large-scale producers, making fortification processes easier to implement and monitor.

Fortification of margarine with vitamin A was first mandated over 100 years ago in Denmark, which practically eliminated cases of xerophthalmia, an eye disease associated with Vitamin A deficiency. Vitamin D fortification had similar effect on the incidence of rickets associated with vitamin D deficiency. United States and Great Britain quickly followed Denmark and mandated fortification of margarine.[2] In the middle of 20th century, India and Pakistan also mandated fortification of edible oils with A and D in some provincial areas.[3] Today, 49 countries mandate the fortification of vegetable oils or fats.[4]

Fortification costs range from US$ 2 to 20 per metric tonne of oil for large-scale producers, which makes up around 0.3-3% of the purchase price or US$ 0.012-0.12 per person annually.[4,5] The costis mainly attributable to the cost of vitamin premix being added to edible oil or fat. Common commercial premix contains 1 -1.7 million International Units per gram (IU/g) of vitamin A as retinyl palmitate; or 1 - 1.1 million IU/g and 100,000 - 110,000 IU/g of vitamin D as cholecalciferol (D3) in an oily blend. The process of mixing additives during edible oil production is well known to oil producers. Antioxidants, such as BHA, BHT, and vitamins C and E are routinely added to oil to support shelf life and prevent oxidation. They can also protect vitamin A from degradation.

Countries with mandatory or voluntary fortification of edible oils.[4]



The benefit-to-cost ratio of fortified vegetable oil has been estimated at US$ 16-280 per DALY (disability-adjusted life year) or a ratio of as low as 50:1, for a cost of less than $ 2 per metric tonne.[4,5] Studies across several LMIC countries have shown that fortified oil can contribute 20-50% of the recommended dietary intake for vitamin A to the target population, leading to at least 15% decrease in the prevalence of VAD in children and women who are most at risk.[4,6]

References:

[1] WHO. Micronutrient deficiencies - Vitamin A deficiency. 2020.
[2] de Pee et al. Humana Press. 2017.
[3] Tata Trust. Oil Fortification. 2020.
[4] Hoogendoorn et al. 2FAS EC. 2016
[5] Walters et al. Matern Child Nutr. 2019
[6] Laillou et al. Food Nutr. Bull. 34 (2), 2013.

Measuring Vitamin A in Edible Oil with iCheck

As part of its efforts to simplify monitoring and quality control of edible oil fortification, BioAnalyt has developed two iCheck devices that enable measuring vitamin A concentrations in edible oils with a high degree of accuracy.

iCheck Chroma and iCheck Chroma 3 are both portable, rapid photometers that quantitatively measure vitamin A in refined edible oils and fats. iCheck Chroma 3 can be used with a wider range of oils and requires a smaller oil sample (0.1 mL) than iCheck Chroma (0.5 mL).

iCheck Chroma measures vitamin A concentration in following oils:

- Palm oil
- Sunflower oil
- Corn oil
- Peanut oil
- Rapeseed oil
- Coconut oil

iCheck Chroma 3 measures vitamin A concentration in following oils:

- Palm oil
- Sunflower oil
- Corn oil
- Peanut oil
- Rapeseed oil
- Coconut oil
- Soybean oil
- Cottonseed oil
- Rice bran oil
- Ghee

Consumables

Ready-to-use reagent vials come in a Test Kit box, containing 100 reagent vials for 100 analyses. The iCheck Chroma Test Kit can be used with both iCheck Chroma and iCheck Chroma 3 devices. The consumables have a 12-month shelf-life at room temperature.

HOW IT WORKS

Gently inject 0.5 mL (for iCheck Chroma) or 0.1 mL (for iCheck Chroma 3) of your oil sample into the reagent vial.

Two distinct layers should be observed inside the vial after injection.

Invert the vial with oil sample at the exact time indicated by the device to start the reaction.

Immediately insert the vial into the iCheck for measurement.

After 30 seconds the device will display the vitamin A concentration in mg RE/kg or in IU/g.

In order to obtain reliable results, the methods must be performed with extra caution. In particular, extra care must be taken during injection of sample into vial, timing of mixing, and timing of measurement. Therefore we strongly recommend to get trained by our technical team. See contact details below for more information.

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Method Comparison

Performance of iCheck Chroma (3) is Comparable to Reference Methods

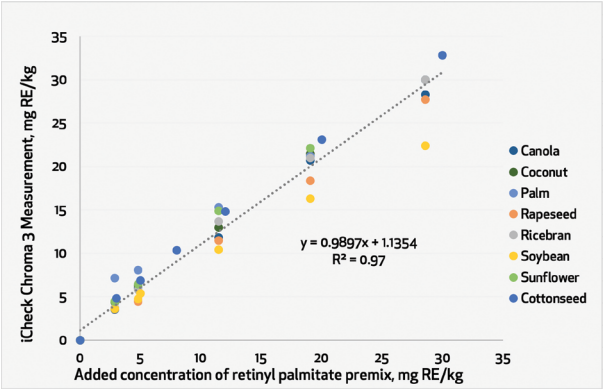
To ensure the reliability and accuracy of results, measurements obtained with iCheck devices are compared with results from traditional laboratory methodologies, such as HPLC (High-Performance Liquid Chromatography) and using samples spiked with a known concentration of vitamin A.

Results with iCheck Chroma were compared to HPLC in palm oil samples collected from commercial markets in West Africa, and show excellent correlation of R^2=0.99. In rapeseed, groundnut and soya oils correlation is also all above 0.96, although iCheck Chroma underestimates vitamin A content in soybean oil, for which we recommend iCheck Chroma 3.[7,8] Results with iCheck Chroma 3, in turn, were compared to expected concentration in different types of edible oil samples as well as improved recovery of vitamin A in soybean oil as compared to iCheck Chroma spiked with Vitamin A. The results show good correlation to expected values at R^2=0.97 (internal data).

Performance of iCheck Chroma 3 is also comparable to HPLC with oil samples fortified with retinyl acetate containing premix (see table below).

Added vitamin A as retinyl acetate. mg RE/kg	Measured Concentration mg RE/kg	
	HPLC ± SD	iCheck Chroma 3 ± SD
3.75	3.6 ± 0.5	3.7 ± 0.2
5	4.8 ± 0.7	4.8 ± 0.4
7.5	7.2 ± 1.0	7.6 ± 0.6
10	9.7 ± 1.5	9.8 ± 0.2
15	14.5 ± 2.0	15.4 ± 0.5

iCheck analysis was performed in-house at BioAnalyt, Germany. HPLC was performed at SGS lab Germany.



Edible oils were spiked with a retinyl palmitate premix at concentrations ranging from 3-30 mg RE/kg.

References:

[7] Rohner et. al. Vitam. Nutr. Res. 2011.
[8] Renaud et al. Int. J. Vitam. Nutr. Res. 2013

iCheck Connect App
Digital Assistant for iCheck Operation and Data Evaluation

iCheck Connect is a free companion web and mobile app. Data can be transferred from your iCheck device via a USB cable or wireless Bluetooth adapter. iCheck Connect can support analysis by:

- Recording, evaluating, and visualizing measurement results;
- Monitoring device performance;
- Monitoring your stock of consumables; and
- Logging and assessing your training efforts.

Contact us for more information about iCheck Connect!