REPORT

MARKET SURVEY IN BURKINA FASO USING THE FORTIFICATION ASSESSMENT COVERAGE TOOLKIT (FACT)

MARCH 2018

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ACRONYMS

ABNORM	Agence Burkinabè de Normalisation, de la Métrologie et de la Qualité
CV	Coefficient of variance
FACT	Fortification Assessment Coverage Toolkit
GAIN	Global Alliance for Improved Nutrition
GTPOB	Groupement des Transformateurs de Produits Oléagineux du Burkina Faso
HKI	Helen Keller International
MCIA	Ministère du Commerce, de l'Industrie et de l'Artisanat
MOH	Ministère de la Santé
MU	Measurement uncertainty
PPM	Parts per million
QA	Quality assurance
QC	Quality control
SPSS	Statistical Package for the Social Sciences
USAID	United States Agency for International Development

1 Summary

Malnutrition remains an ongoing problem in Burkina Faso evidenced by high rates of stunting (33%), wasting (11%), and underweight (24%) among children under five (MOH, 2012), and underweight (16%) among women (NISD & ICF International, 2012). The 2010 Burkina Faso Demographic Health Survey (DHS) reported that 88% of children 6-59 months and 49% of women were anemic. No other nationally representative surveys have been conducted to assess other micronutrient deficiencies in Burkina Faso, however global estimates suggest that dietary micronutrient density is generally low in Sub-Saharan Africa (Beal et al. 2017). Large-scale food fortification is among the most sustainable medium-to-long-term strategies to combat vitamin and mineral deficiencies and is one of the most cost-effective public health strategies when implemented through centralized food industries, and adequately enforced. The potential for public health impact of food fortification in West Africa is high as the domestic production of foods such as vegetable oil and wheat flour is centralized. In Burkina Faso, legislation mandating that vegetable oils to be fortified with vitamin A, and wheat flour with iron and folic acid was introduced in 2010, while salt iodization has been mandated since the early 1990s (Ministere de l'Industrie du Commerce et de l'Artisanat 2013). Currently, there are limited data available on the performance of the fortification programs since they began. To contribute to filling this critical information gap, a cross-sectional market survey was conducted by the Global Alliance for Improved Nutrition (GAIN) with support from Helen Keller International (HKI) and in collaboration with the Ministry of Health (MOH) Nutrition Directorate and the Agence Burkinabè de Normalisation, de la Métrologie et de la Qualité (ABNORM) in Burkina Faso. The market assessment was carried out across eight market hubs strategically selected in different regions of the country. The assessment sought to 1) document the presence of fortified oil, salt, and wheat flour, and 2) to measure the micronutrient content in the fortified food vehicles and assess their compliance with national fortification standards.

Overall, 255 retail outlets (i.e. retail shops, supermarkets, wholesalers, and bakeries) were visited in the main marketplaces of the selected market hubs (Banfora, Bobo-Dioulasso, Dédougou, Ouagadougou, Kaya, Ouragye, Tenkodogo, and Fad N'Gourma) and available food vehicle brands were recorded. A total of 119 oil brands, 41 salt brands, and 31 wheat flour brands were identified. Across all food vehicles assessed, the highest varieties of brands were available in Bobo-Dioulasso and Ouagadougou. For all food vehicles, imported brands make up the majority of available brands on the market, i.e. oil (96%), salt (100%), and wheat flour (84%). However, no information on market share of the identified food vehicle brands was available at the time of the survey to determine which are the major brands.

Of the identified food vehicle brands, a total of 87 oil brands, 41 salt brands, and 26 wheat flour brands were analyzed to determine micronutrient content. Up to 12 food samples from different batches or retail outlets were collected for each brand and analyzed as a single composite sample to determine the average content of vitamin A (oil), iodine (salt), or iron (wheat flour). The laboratory results revealed that 34 brands (39%) of oil, 18 brands (44%) of salt, and 16 brands (62%) of wheat flour were fortified to some extent; however, only 20 brands (23%) of oil and 11 brands (27%) of salt were fortified in compliance with the mandated national standard range for Burkina Faso, while none of the wheat flour brands were fortified within the standard range. When examined by origin of production, results revealed that roughly half of all imported brands were not fortified to any extent, i.e. oil (54%), salt (56%), and wheat flour (48%). Among the locally produced food vehicles, nearly all oil brands (15 of 16, 94%) were not fortified while all five (100%) wheat flour brands were fortified but below the national standard range.

Overall, the fortification program for oil, salt, and wheat flour in Burkina Faso must be significantly improved if it is to contribute to increasing micronutrient intakes in the population. The major bottleneck in the fortification program identified by the survey is the high availability of foods at retail outlets that are not fortified or are fortified at amounts below national standards, despite the mandatory fortification legislation. The implementation and capacity of the regulatory monitoring system and relevant authorities should be assessed to ascertain what the barriers are to the monitoring and enforcement of fortified foods (both domestically produced and imported products). Given the high proportion of imported brands across all food vehicles assessed, considerations should be made to specifically target inspections at customs/border levels and future research should examine the feasibility of making foreign producers comply with the national fortification standards for imported foods and of monitoring the fortification content of those foods at customs/border levels. Furthermore, information is needed on market share of available brands of these food vehicles as it is critical to identify which brands make up a significant share of market and thus which producers should be targeted to ensure they are fortifying appropriately to have the highest availability of fortified foods in the market. Finally, investigation into the consumption and coverage of these food vehicles at household level is needed to assess the potential for impact of fortified foods among target populations.

2 Introduction

Malnutrition remains an ongoing problem in Burkina Faso evidenced by high rates of stunting (33%), wasting (11%), and underweight (24%) among children under five (MOH, 2012), and underweight (16%) among women (NISD & ICF International, 2012). The 2010 Burkina Faso Demographic Health Survey (DHS) reported that 88% of children 6-59 months and 49% of women were anemic. No other nationally representative surveys have been conducted to assess other micronutrient deficiencies in Burkina Faso, however global estimates suggest that dietary micronutrient density is generally low in Sub-Saharan Africa (Beal et al. 2017). Large-scale food fortification is among the most sustainable medium-to-long-term strategies to combat vitamin and mineral deficiencies and is one of the most cost-effective public health strategies when implemented through centralized food industries, and adequately enforced. The potential for public health impact of food fortification in West Africa is high as the domestic production of foods such as vegetable oil and wheat flour is centralized. In Burkina Faso, legislation mandating that vegetable oils to be fortified with vitamin A, and wheat flour with iron and folic acid was introduced in 2010, while salt iodization has been mandated since the early 1990s (Ministere de l'Industrie du Commerce et de l'Artisanat 2013). However, there is currently a dearth of information on the performance of the fortification programs since they began particularly related to the availability and quality of fortified foods at household and market levels, with the exception of salt. The 2010 DHS reported that 96% of households were using iodized salt (NISD & ICF International, 2012).

To contribute to filling this data gap, a cross-sectional market survey was conducted by the Global Alliance for Improved Nutrition (GAIN) with support from Helen Keller International (HKI) and in collaboration with the Ministry of Health (MOH) Nutrition Directorate and the Agence Burkinabè de Normalisation, de la Métrologie et de la Qualité (ABNORM) in Burkina Faso. The assessment sought to ascertain the presence of fortified oil, salt, and wheat flour, and to measure the micronutrient content in the fortified food vehicles and assess their compliance with national fortification standards. The findings of this survey will help to address the substantial gaps in data on the availability and compliance with fortification standards of these fortified foods at retail level across urban areas of Burkina Faso.

3 Objectives

The main objectives of the project were to determine the presence of fortified foods in select urban areas across all regions, to measure the micronutrient content of these foods, and to assess the compliance with the national fortification standards in Burkina Faso.

Specific objectives of the study were:

1. To assess the presence of brands and producers of food vehicles that are mandated to be fortified under the national fortification program (i.e. oil, salt, and wheat flour) across select market hubs in Burkina Faso;

2. To measure the average content of select nutrients in oil (vitamin A), salt (iodine), and wheat flour (iron) by brand and assess their compliance with the national fortification standards.

4 Methodology

The market assessment was implemented using GAIN's market survey methodology from the Fortification Assessment Coverage Toolkit (FACT). FACT is a population-based survey methodology that was developed by GAIN for carrying out coverage assessments of both population-based (large-scale food fortification) and targeted fortification programs that is comprised of two main components, a household survey and a market survey, that can be implemented simultaneously or independently. The toolkit was developed to help stakeholders achieve greater program impact by assessing coverage and compliance, and identifying program barriers and potential ways to address them (Friesen, VM. et al 2017).

4.1 Study design and selection of market sites

The market survey was designed to purposely sample retail outlets in key urban market hubs in geographically dispersed areas in the east and west of the country. Market hubs are agglomerations (higher population density, e.g. city, town, village) where larger volumes of food products are sold or pass through and are dispatched to other places. Market hubs are located on the nodes of the main supply routes for different food vehicles; we can expect to find a wider variety of products in these hubs than in the places they supply. Places supplied from these hubs are expected to have the same or a selection of the variety of brands available in the market hub from which they are supplied.

The selection of market hubs was based on the following criteria: population size and density, geography and road networks. Market hubs located in areas of high population density and at intersection of roads used to dispatch the food vehicles from production or import sites towards populated areas were prioritised. Based on the above criteria, eight market hubs were selected across the east and west regions country, taking into consideration security and logistics. Figure 1 shows the location of all markets hubs selected.

Figure 1 Map of selected market hubs and roads in Burkina Faso

Data Sources (Shapefiles): Burkina Faso State Boundaries: GADM database (www.gadm.org), 2015; Roads: Digital Chart of the World (DCW), 2016.

In each market hub, up to three main marketplaces were selected, with a marketplace being defined as a large concentration of all types of retail outlets in a large geographic area within the market hub that allows buyers and sellers of the food vehicle to interact. Within each marketplace, the teams aimed to visit at least three retail outlets of each type (retail shop, supermarket, wholesaler and bakery) that sold at least one of the seven food vehicles of interest were visited.

4.2 Data collection

The market survey took place between August 14 and 25 and was implemented by two teams, one in the east and west market hubs, and jointly in the capital, Ouagadougou. Team were composed of four people each (one GAIN supervisor, one ABNORM supervisor, and two data collectors) who visited the selected market hubs in the eastern and western regions, respectively, spending approximately 1.5 to 2 days in each hub.

Background research was conducted by GAIN with support from HKI in order to understand and verify the structure of the Burkinabé food-based markets. Based on this, retail outlets likely to carry the food vehicles of interest were categorized into the following four types:

a) Retail shop (Détaillant): A small sale outlet, such as a convenience store or a stall in an open-air market, that offers a limited variety of goods to a local community of area;
b) Supermarket (Supermarché): a large store that sells a wider variety of goods;
c) Wholesale shop (Grossiste): an intermediary entity in the distribution channel that typically buys in bulk and sells to resellers rather than to consumers; and
d) Bakery (Boulangerie): a place where bread, cake and related products are made and sold.

4.2.1 Documentation of presence of food vehicles in the markets

Upon arrival in a market hub, three main marketplaces were identified in each hub. In each marketplace, retail outlets that sold at least one of the seven food vehicles of interest were identified. In each retail outlet visited, the name, location, and type of retail outlet were recorded on Form 1: Retail Outlet by Marketplace (Annex 8.1.1). In addition, information on the available brands per food vehicle, including the producer name and address, the distributer/importer name and address, and the packaging types and sizes for sale, was recorded on Forms 2a: General Brand Registration and 2b: Brand Registration by Retail Outlet Type (Annexes 8.1.2 and 8.1.3).

4.2.2 Collection of samples of food vehicles from retail outlets in the markets

For all brands of oil, salt, and wheat flour found in the retail outlets in the markets, up to 12 samples were collected. Every effort was made to collect the samples from different batches of production, as identified through production and expiration dates and/or batch numbers. If production and expiration dates were not visible on the container, efforts were made to collect samples from different sized containers and from different retail outlets and market hubs in order to increase the likelihood of obtaining different production batches. The following quantities were purchased per food vehicle: 300 mL of oil, 300 g of wheat flour, and 50 g of salt. The oil samples were transferred into clean, sturdy, sealable plastic containers, while the wheat flour and salt samples were transferred into clean, clear plastic bags. All samples were then placed in black bags and labeled to ensure proper identification. Information on the brand name, producer and production site, production and expiration dates, packaging type and size, price and if the package was labeled as fortified was documented on Form 3: Specimen Registration (Annex 8.1.4). Each sample was assigned a unique number, which was copied onto the label and onto Form 3.

The samples were transported and stored in closed cardboard boxes to ensure protection from sunlight and contamination throughout the duration of the data collection. After all market hubs had been visited, samples were sent to the HKI office in Ouagadougou where they continued to be stored in a temperature-controlled room until shipment to a laboratory in Germany for analysis.

4.3 Analysis of micronutrients in food vehicles

The samples were shipped to BioAnalyt Laboratories in Potsdam, Germany for analysis. Equal parts of each individual sample of a particular brand of food vehicle were mixed to create brand-specific composite samples. Salt samples were analyzed for total iodine content using iCheck Iodine. Salt brands were classified as fortified if total iodine content of the composite sample was greater than or equal to 5 mg/kg. Oil samples were analyzed for total vitamin A content using iCheck Chroma[1]. Brands were classified as fortified if total vitamin A content of the composite sample was greater than or equal to 3 mg RE/kg. Wheat flour samples were first analyzed individually using the iron spot test (AACC 40-40) to determine presence of added iron. Brands were classified as fortified if they tested positive for the iron spot test. Positive samples were then pooled by brand to create composite samples, which were analyzed for total iron content using iCheck Iron[2]. Individual samples that had negative iron spot tests (i.e. unfortified) were pooled together for each type of flour in order to determine the average content of intrinsic iron by type of flour. Quality of fortification was assessed by comparing the level of fortification by brand to the mandated national standards as shown in Table 1 (FASONORM 2010). The measurement uncertainty (MU) of the laboratory estimate is calculated based on the bias and coefficient of variation (CV): MU = bias + 2*CV. MU can be reported by the laboratory or calculated based on the

[1] Although reports claim reliability of this method, extending its use to different types of oil requires prior confirmation of its performance.

[2] The reliability of this method has not been confirmed yet, and therefore the results of iron content should be interpreted with caution.

quality control results of the analysis. For the results reported here, the MU for oil was reported by the laboratory and the MUs for salt and wheat flour were calculated.

Table 1 Burkina Faso national standards for fortification of oil, salt and wheat flour

Food vehicle	Micronutrient (compound)	Micronutrient content
Oil	Vitamin A (retinyl palmitate)	11-24 mg RE/kg
Salt	Iodine (not specified)	20-60 ppm
Wheat flour	Iron (ferrous sulfate or fumarate)	54-66 ppm (total)

4.4 Ethical considerations and survey administration

Approvals were obtained from the Direction Générale de la Santé, Direction de la Nutrition. Data were collected by two trained data collectors under the supervision of GAIN and ABNORM staff. All survey instruments were contextualized and adapted to the local context then translated into French. Survey instruments were pilot-tested prior to implementation to finalize language, wording, and flow of questions and response options. Data were collected on paper forms, which were reviewed daily by supervisors for completeness and correctness. All data collected as part of this survey are stored securely within the GAIN office, are only available to authorized individuals for analytical purposes and are handled in accordance with data protection best practices. Each brand/producer was assigned a unique identifier that was used to analyze the data. All anonymized data related to this survey will be made publicly available.

4.5 Data management and analysis

Data were entered into a database in Microsoft Excel 2010. Data quality was ensured by interactive checking for consistency, range, and legal values as well as verification of spellings, formatting and labelling of the variables. Data analyses were conducted using Microsoft Excel 2010 and the Statistical Package for the Social Sciences (Version 24).

4.6 Survey limitations

The market hubs were selected based on population density and geographic dispersion to cover key areas of the country, to the east and to the west. However, due to security and logistical considerations, the selection could not include cities or towns in the northern and far eastern areas deemed insecure by the Ministry of Foreign Affairs and International Development (Figure 2). In addition, smaller hubs could not be included due to time and cost restrictions. As a result, availability results may not be representative of all food vehicle brands available around the country.

Figure 2 Insecure regions in Burkina Faso

While the typology of retail outlets was verified and held true for Burkinabè markets, there were some outlets that functioned across two categories, such as supermarket and wholesaler, or small retail shop and wholesaler. In such instances, the outlet was registered as both types and the forms completed for both types of retail outlets.

Due to the nature of many of the retail marketplaces, whereby these food vehicles (oil, salt, and wheat flour) are purchased in bulk containers by vendors to be repackaged and sold to consumers in smaller quantities, some of the brand specimens were collected from already opened containers and therefore may have been exposed to heat and sunlight before collection. By contrast, other samples, particularly for brands predominantly sold in supermarkets, were collected from sealed packages at the point of retail. Since vitamin A is sensitive to heat and light, the conditions under which some specimens were collected may have affected the results of laboratory analysis.

It was not possible to collect 12 samples of each food vehicle brand identified due to limited availability and/or restrictions on batch numbers. As a result, composite samples of brands prepared with fewer numbers of single samples may have higher variation in the results than those that contained 12 samples.

The results for vitamin A analysis in oil may need verification as some samples caused an unusual background reaction with the reagents and a number of oils also had a turbid reddish coloration, what may be indicative of lower refinement.

Seasonality of production may have affected how many brands were available in the market at the time of the survey. In particular, the oil results may have been affected given that peak production of cotton oil in Burkina Faso falls in the month of January and sales decline continuously after that, with many of the smaller producers depleting their stocks after a few months of sales. Given that the survey was conducted in August, the extent of local production may not have been adequately captured and many local brands may not have been sampled and analysed.

Finally, no information on market share of the identified food vehicle brands present in the market was available at the time of the surveys. As a result, it was not possible to identify which are the major brands that make up a large market share and should be targeted to ensure they are fortifying appropriately to have the highest availability of fortified foods in the market and potential coverage at household level.

5 RESULTS

5.1 Retail outlets visited

In total, 255 retail outlets were visited in the eight market hubs selected for the market assessment. Table 2 presents an overview of the number of retail outlets visited in each market hub.

Table 2 Number of retail outlets visited by market hub

Ville	Retail Outlet Type				Total
	Small retail shop	Supermarket	Wholesaler	Bakery	
Banfora	30	6	4	2	42
Bobo-Dioulasso	52	6	13	8	79
Dédougou	12	5	6	2	25
Ouagadougou	24	11	16	3	54
Kaya	14	5	4	3	26
Ourgaye	12	0	8	1	21
Tenkodogo	4	4	1	1	10
Fada N'Gourma	8	5	5	3	21
Total	**155**	**33**	**44**	**23**	**255**

5.2 Presence of food vehicle brands in markets

The following profiles present the presence of brands by food vehicle in the markets in Burkina Faso. They provide general information such as the number of brands present in the markets, the breakdown of types, packaging characteristics, and the distribution across the market hubs, as well as specific information of interest per food vehicle related to disaggregation by origin of production and/or importation versus local production.

As noted in section 4.6, local oil production peaks in January and as a result, the extent of local production may not be fully captured in this profile. For example, from the list of registered oil producers in the Groupement des Transformateurs de Produits Oléagineux du Burkina Faso (GTPOB), only 12 of the 29 were found during this survey. However, it should also be noted that an additional 11 local brands *were* found during this survey that were not on the registered list, pointing to the fact that registration with GTPOB is voluntary.

A Profile of Burkina Faso's Oil Market

General

Brands by oil type	**N**	**%**
Sunflower Oil	2	1.7
Cotton Oil	8	6.7
Palm Olein Oil	19	16.0
Palm Oil	8	6.7
Soybean Oil	8	6.7
Vegetable Oil	9	7.6
Rapeseed Oil	14	11.8
Corn Oil	1	0.8
Blended Oil	8	6.7
Peanut Oil	33	27.7
Red Palm Oil	9	7.6

Presence

Total brands: 119

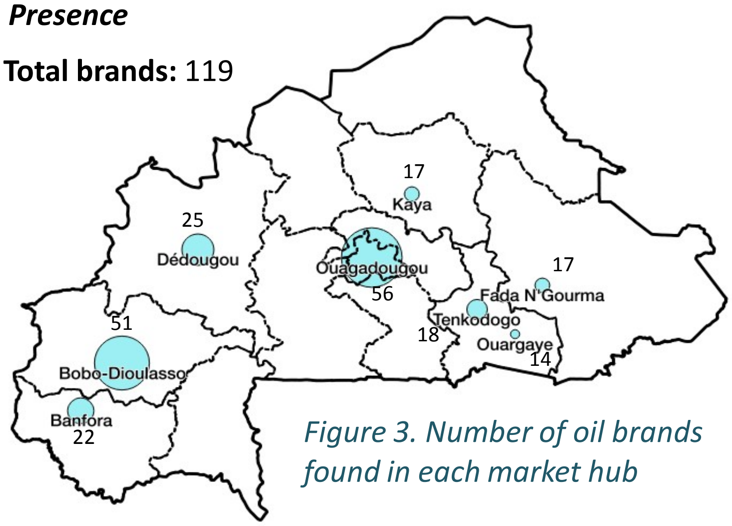


Figure 3. Number of oil brands found in each market hub

By Origin of production

Imported

N = 96 brands (81%)

Oil types
Half of the imported brands are either sunflower oil (31 brands) or palm olein oil (14 brands). The rest of the brands (52), the types are fairly evenly split between vegetable, palm oil, corn oil, rapeseed oil, corn oil, blended oils (mostly made up of palm oil), and soybean oil.

Production origin
The majority of producers are located in Malaysia (17% of imported brands), Italy and France (each 13% of imported brands).

Outlets & market dispersion Imported brands tend to be found in supermarkets (78% of imported brands) and small retail shops (35%). Only 17% are found in wholesale shops. Of the 96 imported brands, 2 were seen across all 8 market hubs and 5 were seen in 6 hubs. The majority were seen in just one hub (65%).

Packaging types*
Packaging in 1 liter bottles is the most common for imported brands (about ½ of the available brands can be found in 1L bottles). A quarter of the brands are available 5L jerry cans. 29% of the imported brands are available in 20L or 25L jerry cans. The majority are only found in packaging size (73%), although 9 brands are found in 2 sizes, and 9 other brands are found in 3 sizes.

Local

N = 23 brands (19%)

Oil types
Of the local brands, 19 are cotton oil, due to extensive cotton production in western Burkina Faso. Of remaining 4 locally produced brands, 2 are soybean oil and 2 are sunflower oil. A major limitation to this analysis however is the seasonality of production (see section 4.6).

Production origin
Of the local producers, 16 are located in Bob-Dioulasso, 5 are in Ouagadougou, and 2 are in Dédougou.

Outlets & market dispersion
Locally produced brands tend to be found in in small retail shops(14 of the 23 brands) and wholesale shops (12 of the 23 brands) more than in supermarkets (5 of the 23 brands). Given the local production of cotton oil in the west of the country, it is not surprising that the majority of local brands are found in western market hubs. One local brand is found across all 8 hubs, while the rest are found in 3 or fewer hubs (61% are found in just 1 hub).

Packaging types*
Local brands are mostly available in 20L jerry cans (19 of 23 brands), with 5 of the 23 brands available in 5L containers. Only 2 brands are sold in more than one size.

*An interesting observation was that oil in large volumes was predominantly sold in 25L jerry cans out east versus 20L jerry cans out west. Seven brands that were found in both eastern and western market hubs were packaged in both 25L and 20L containers.

Presence

Total brands: 41

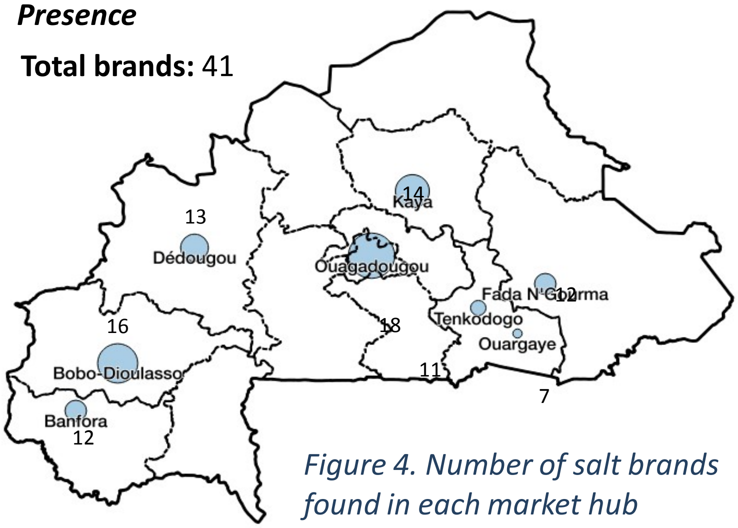


Figure 4. Number of salt brands found in each market hub

Production origin of brands

	N	%
France	16	39.0
Ghana	3	7.3
India	4	9.8
Italy	1	2.4
Lebanon	1	2.4
Senegal	5	12.2
Spain	3	7.3
Tunisia	1	2.4
Unknown	7	17.1

All Imported

Imported from Europe

France, Spain, Italy, Lebanon (21, 51%)

Market dispersion

Brands imported from Europe tend to have even spread across the market hubs. One European brand is found in all 8 market hubs, 2 are found in 7 market hubs, while 13 are found in just 1 hub.

Packaging trends

Brands imported from France and Spain particularly tend to be packaged in 250g, 500g, and 750g tubes as well as some 1kg boxes. The brands from Italy (1) and Lebanon (1) were found in 1 kg boxes.

Imported from India

India (4, 10%)

Market dispersion

Brands imported from India tend to have even spread across the market hubs. One brand has wide dispersion, found in all 8 market hubs; 1 was found in 4 hubs and 2 were found in 1 hub each.

Packaging trends

Two of the brands imported from India are sold in small plastic bags of 100g, 250g, and 500g, while 1 is sold in 1 kg plastic bags. The fourth Indian brand seen in the market is sold in 25kg PET sacs.

Imported from African Nations

Ghana, Senegal, Tunisia (9, 22%)

Market dispersion

Brands imported from Ghana tend to show up in eastern markets, particularly Fada-Ngourma, Tenkodougo, and Ourgaye (all 3 Ghanaian brands found), with one Ghanaian brand found in Ouagadougou and Kaya. Senegalese brands tend to show up in western markets (2 to 3 Senegalese brands in each western market hub versus just 1 in each of the eastern hubs).

Packaging trends

All of the brands from African nations are sold on the market in 25kg and 50kg PET sacs. Wholesale shops usually sell to local vendors and small scale retail shops in bulk, who then open the bulk sacs and re-sell to customers in plastic bags.

A Profile of Burkina Faso's Wheat Flour Market

General

Production origin of brands

	N	%
Burkina Faso	5	16.1
Côte d'Ivoire	3	9.7
France	9	29.0
Germany	2	6.5
Ghana	1	3.2
Italy	2	6.5
Lebanon	4	12.9
Mali	1	3.2
Thailand	1	3.2
Tunisia	1	3.2
Unknown	2	6.5

Presence

Total brands: 31

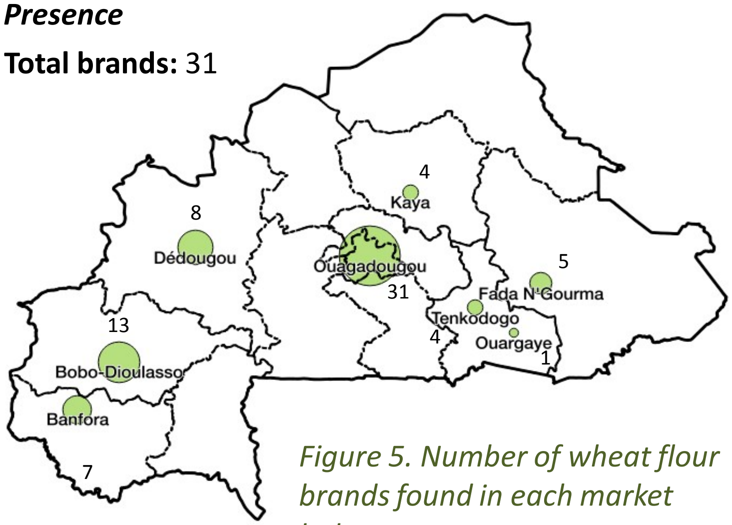


Figure 5. Number of wheat flour brands found in each market hub

By Origin of production

Imported

N = 26 brands (84%)

Production origin

The producers of the majority of brands are located in France (9 of the 26 of imported brands), following by Lebanon (4) and Cote d'Ivoire (3).

Outlets & market dispersion

Imported wheat flour brands are predominantly found in supermarkets, with 22 of the 26 brands sold in supermarkets. Seven brands were also noted in bakeries, while just 5 brands were seen in wholesale shops and 4 in small retail shops. Most are also seen in the two major cities of Ouagadougou (19) and Bobo-Dioulasso (11), with representation in smaller cities falling markedly to less than 6 imported brands. One brand was found across 6 of the 8 market hubs and 2 were seen in 5 market hubs each. The rest were seen in 3 or fewer market hubs (3 brands in 3 hubs each, 5 in 2 hubs, and 15 brands in one hub each).

Packaging trends

Most of the imported brands (22 of the 26) are available in 900g or 1kg plastic or paper sacks. Eight brands are available in 50 kg PET sacs used mostly in bakeries.

Local

N = 5 brands (16%)

Production origin

Of the locally produced brands, 2 are produced in Ouagadougou and 1 in Bobo-Dioulasso, and 2 brands are unknown.

Outlets & market dispersion

By contrast to imported flour brands, only 2 of the 5 local brands were seen in supermarkets. Most (4 of the 5 brands) were found in small retail shops and 3 were used in bakeries. At least one local brands was found in every market hub. One local brand was found in all 8 market hubs and another one was found in 3 hubs, but the rest (3 brands) were found in just one market hub each.

Packaging trends

Only 1 of the local brands was seen for sale only in a 1kg plastic bag. The other 4 brands were available in either 25 or 50kg PET sacs.

5.3 Micronutrient content and fortification compliance of foods by brand

This section presents the micronutrient content results of food vehicle brands analyzed by the laboratory and their compliance with the national fortification standards (for further detailed results see Annex 8.3).

5.3.1 Sample collection of food vehicles

Samples were taken for a total of 87 oil brands, 41 salt brands, and 26 wheat flour brands found in the eight surveyed market hubs. While the goal was to collect up to 12 specimens of each available brand where possible from different batches or retail outlets, the limited availability and of many brands meant that fewer than 12 samples were collected. For the three different food vehicles, 12 specimens were collected for five oil brands, nine salt brands, and two wheat flour brands, respectively. One sample was collected for 53 oil brands, 15 salt brands, and 12 wheat flour brands, and two samples were collected for 15 oil brands, seven salt brands, and six wheat flour brands, respectively.

It should be noted that for oil brands imported from Europe with no visible marking, statement or logo indicating enrichment with vitamin A or any other vitamin (26 oil brands), the decision was made to take only one sample to confirm the suspected lack of fortification. As expected, of the 26 European brands collected, 25 were confirmed to not be fortified and one was confirmed to be fortified but below the Burkina Faso national standard range. For the rest of the oil brands with only one sample (27 out of 53 brands), this was due to the lack of availability across the markets and retail outlets. This was particularly an issue for some locally produced brands likely with smaller production capacity that, by this time in the year, had exhausted their supply (see section 4.6).

5.3.2 Micronutrient content and fortification compliance of food vehicle brands

Among the brands for which specimens were collected, Figure 6 and Figure 7 present the average micronutrient content per brand compared to the national fortification standards for each food vehicle.

Oil: Among oil brands analyzed for vitamin A content, 53 brands (61%) were not fortified, 14 brands (16%) were below the standard, 20 brands (23%) were fortified within the standard range, and no brands were fortified above the standard range. In total, 34 brands (39%) of oil were fortified to some extent.

Salt: Among salt brands analyzed for iodine content, 23 brands (56%) were not iodized, five brands (12%) were iodized below the standard, 11 (27%) brands were iodized within the standard range, and two (5%) brands were iodized above the standard. In total, 18 brands (44%) of salt were iodized to some extent.

Wheat flour: Among wheat flour brands analyzed for iron content, 10 brands (38%) were not fortified, 15 brands (58%) were fortified below standard, no brands were fortified within the standard range, and one (4%) brand was fortified above the standard. In total, 16 (62%) brands were fortified to some extent.

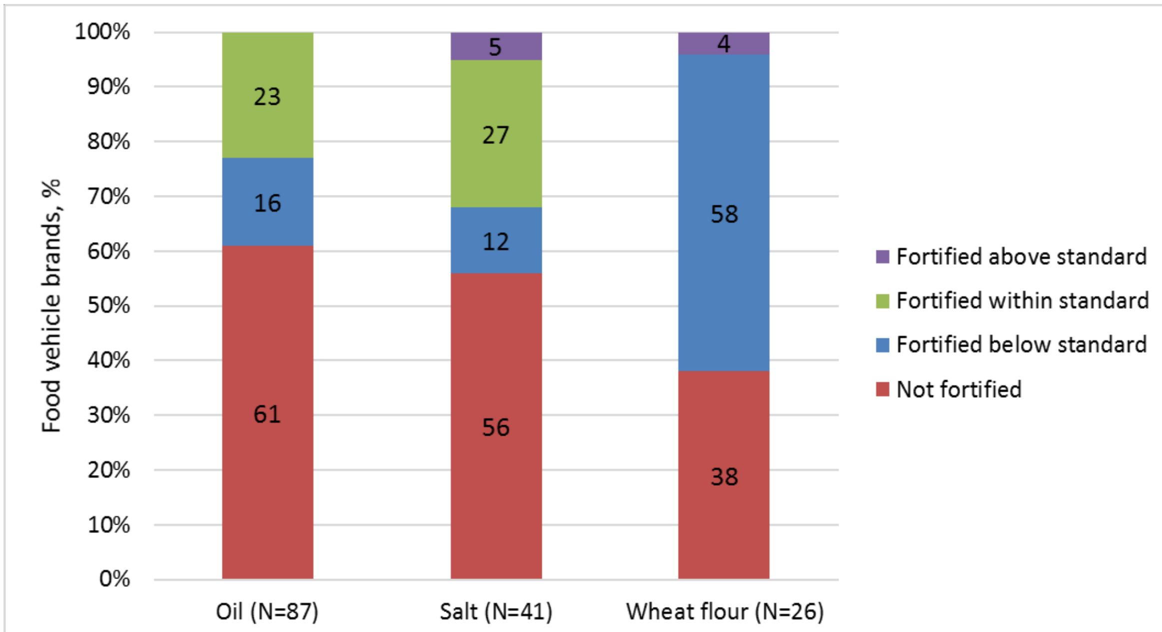
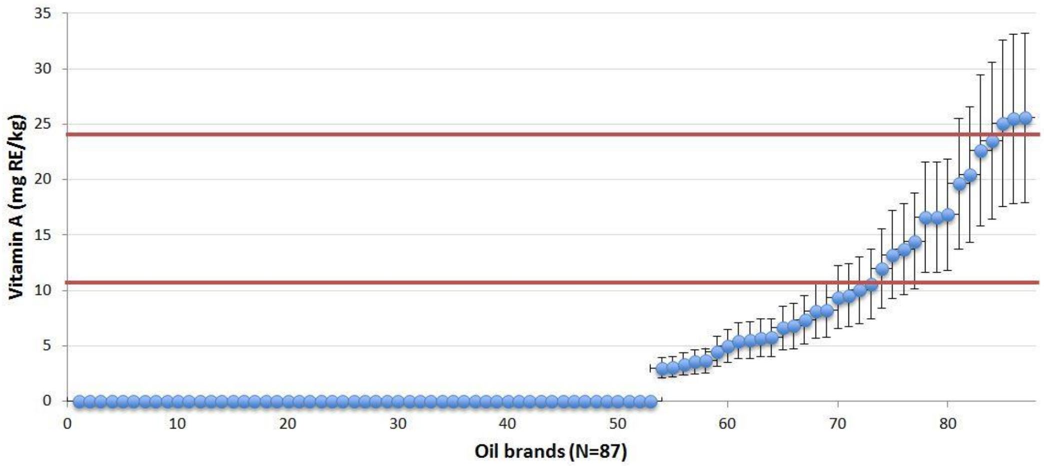


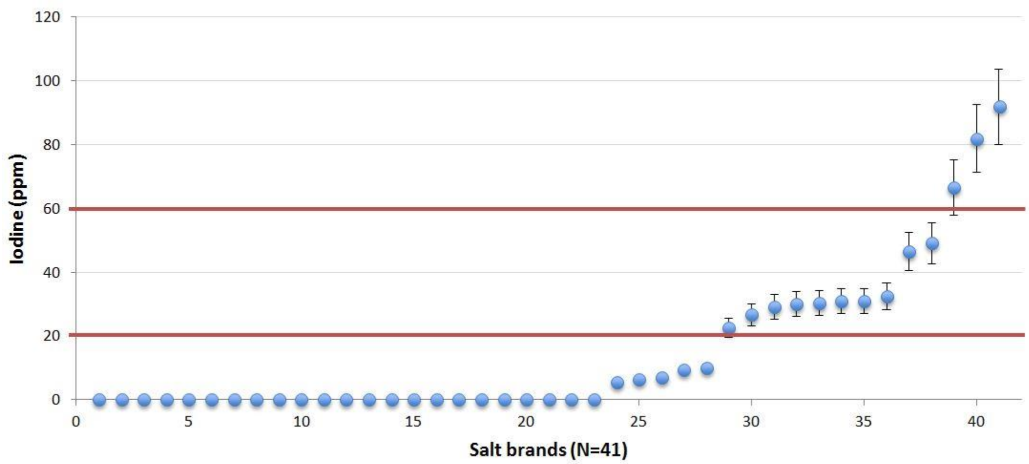
Figure 6 Summary of food vehicles by brand classified according to Burkina Faso national standards

For oil, "not fortified" is <3 mg RE/kg, "fortified below standard" is 3 to <11 mg RE/kg, "fortified within the standard range" is 11-24 mg RE/kg, "fortified above standard" is >24,000 mg RE/kg of vitamin A; For salt, "not fortified" is <5 ppm, "fortified below standard" is 5 to <20 ppm, "fortified within the standard range" is 20-60 ppm, "fortified above standard" is >60 ppm of iodine; For wheat flour, "not fortified" is negative spot test, "fortified below standard" is 0 to <54 ppm, "fortified within standard range" is 54-66 ppm, "fortified above standard" is >66 ppm of total iron.

a. Oil



b. Salt



c. Wheat flour

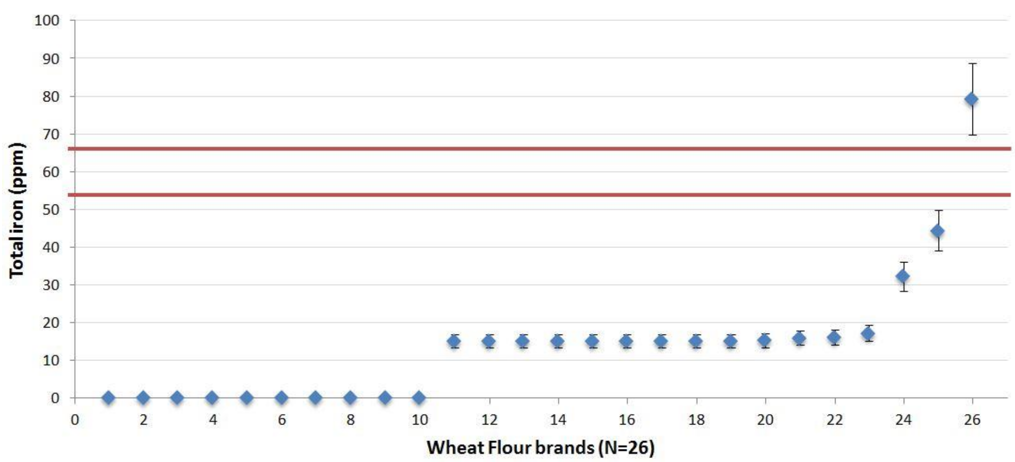


Figure 7 Micronutrient content of oil, salt and wheat flour by brand compared to Burkina Faso national standards

Solid lines indicate the mandatory fortification range according to the most recent Burkinabè national standards, i.e. for oil, 11-24 mg RE/kg of vitamin A; for salt, 20-60 ppm of iodine; for wheat flour, 54-66 ppm of total iron. Error bars indicate laboratory measurement uncertainty, i.e. ±30% for oil, ±13% for salt, and ± 12% for wheat flour.

5.3.3 Fortification compliance of food vehicle brands by origin of production

Each brand was also analyzed for compliance with fortification standards by origin of production (Table 3).

Oil: Among oil brands analyzed for vitamin A content, 71 brands (82%) were imported and 16 brands (18%) were locally produced. Imported brands were produced in a variety of countries across Europe, West/North Africa, and the Middle East. Of the imported oil brands, about half (38 brands, 54%) were not fortified, while 14 brands (20%) were fortified below standard, 19 brands (27%) were fortified within the standard range and no brands (0%) were fortified above the standard. Of the local brands, 15 of the 16 brands (94%) were not fortified and one brand was fortified above the standard range.

Salt: Among salt brands analyzed for iodine content, all 41 (100%) brands were imported. Imported brands were produced in a variety of countries across Europe, West Africa and India. Disaggregated of origin of production by region (Europe, West/North Africa, or India) revealed that European salt brands tended to be less likely to be iodized. Among brands imported from France and Spain, 14 of the 17 brands were not iodized, two brands were iodized below the standard range, and one brand was iodized within the standard range. Among brands imported from African countries (Senegal, Ghana, or Tunisia), four of the nine brands were not iodized, while one brand was iodized below the standard, three brands were within the standard range, and one brand was above the standard range. All four brands imported from India were iodized to some extent, with one brand below the standard range and three brands within the standard range.

Wheat flour: Among wheat flour brands analyzed for iron content, 21 (81%) were imported and five (19%) were locally produced. Of the imported brands, ten brands (48%) were not fortified, ten brands (48%) were fortified below standard and one (4%) brand was fortified above the standard range. Of the local brands, all five (100%) were fortified but below standard.

Table 3 Summary of brands by food vehicle and origin of producer classified according to Burkina Faso national fortification standards[1]

Country of Origin	Total (N)	Fortification status, N (%)			
		Not fortified	Fortified below standard	Fortified within standard range	Fortified above standard range
Oil					
Burkina Faso	16	15 (94)	0 (0)	1 (6)	0 (0)
Algeria	1	1 (100)	0 (0)	0 (0)	0 (0)
Côte d'Ivoire	3	0 (0)	0 (0)	3 (100)	0 (0)
France	11	7 (64)	0 (0)	4 (36)	0 (0)
Germany	4	4 (100)	0 (0)	0 (0)	0 (0)
Ghana	3	0 (0)	0 (0)	3 (100)	0 (0)
Hungary	1	1 (100)	0 (0)	0 (0)	0 (0)
Indonesia	3	1 (33)	2 (67)	0 (0)	0 (0)
Italy	10	10 (100)	0 (0)	0 (0)	0 (0)
Lebanon	1	1 (100)	0 (0)	0 (0)	0 (0)
Malaysia	13	4 (31)	6 (46)	3 (23)	0 (0)
Morocco	4	1 (25)	2 (50)	1 (25)	0 (0)
Oman	4	0 (0)	2 (50	2 (50)	0 (0)
Togo	1	0 (0)	0 (0)	1 (100)	0 (0)
Tunisia	1	0 (0)	0 (0)	1 (100)	0 (0)
Turkey	3	3 (100)	0 (0)	0 (0)	0 (0)
Ukraine	3	3 (100)	0 (0)	0 (0)	0 (0)
United Arab Emirates	1	0 (0)	0 (0)	1 (100)	0 (0)
Unknown	4	2 (50)	2 (50)	0 (0)	0 (0)
Total	**87**	**53 (61)**	**14 (16)**	**20 (23)**	**0 (0)**
Salt					
France	14	11 (79)	2 (14)	1 (7)	0 (0)
Ghana	3	2 (67)	1 (33)	0 (0)	0 (0)
India	4	0 (0)	1 (25)	3 (75)	0 (0)
Lebanon	1	1 (100)	0 (0)	0 (0)	0 (0)
Senegal	5	2 (40)	0 (0)	2 (40)	1 (20)
Spain	3	3 (100)	0 (0)	0 (0)	0 (0)
Tunisia	1	0 (0)	0 (0)	1 (100)	0 (0)
Unknown	10	4 (40)	1 (10)	4 (40)	1 (10)
Total	**41**	**23 (56)**	**5 (12)**	**11 (27)**	**2 (5)**
Wheat flour					
Burkina Faso	5	0 (0)	5 (100)	0 (0)	0 (0)
Côte d'Ivoire	3	0 (0)	3 (100)	0 (0)	0 (0)
France	7	5 (71)	2 (29)	0 (0)	0 (0)
Germany	2	0 (0)	2 (100)	0 (0)	0 (0)
Ghana	1	0 (0)	0 (0)	0 (0)	1 (100)
Italy	1	1 (100)	0 (0)	0 (0)	0 (0)
Lebanon	4	3 (75)	1 (25)	0 (0)	0 (0)
Mali	1	0 (0)	1 (100)	0 (0)	0 (0)
Unknown	2	1 (50)	1 (50)	0 (0)	0 (0)
Total	**26**	**10 (38)**	**15 (58)**	**0 (0)**	**1 (4)**

For oil, “not fortified” is <3 mg RE/kg, “fortified below standard” is 3 to <11 mg RE/kg, “fortified within the standard range” is 11-24 mg RE/kg, “fortified above standard” is >24,000 mg RE/kg of vitamin A; For salt, “not fortified” is <5 ppm, “fortified below standard” is 5 to <20 ppm, “fortified within the standard range” is 20-60 ppm, “fortified above standard” is >60 ppm of iodine; For wheat flour, “not fortified” is negative spot test, “fortified below standard” is 0 to <54 ppm, “fortified within standard range” is 54-66 ppm, “fortified above standard” is >66 ppm of total iron.

6 Key findings and recommendations

The findings of this survey contribute to filling a critical information gap on the presence and compliance of fortified oil, salt, and wheat flour at retail level across urban areas of Burkina Faso. Overall, the fortification program for oil, salt, and wheat flour in Burkina Faso must be significantly improved if it is to contribute to increasing micronutrient intakes in the population in accordance with the program's objectives. The major bottleneck in the fortification program identified by the survey is the high availability of foods at retail outlets that are not fortified or are fortified at amounts below national standards.

Several priority recommendations can be made to improve the availability of appropriately fortified foods in markets:

1. The implementation and capacity of the regulatory monitoring system and relevant authorities should be assessed to ascertain what the barriers are to the monitoring and enforcement of fortified foods (both domestically produced and imported products);

2. The feasibility of making foreign producers comply with the national fortification standards for imported foods and of monitoring the fortification content of those foods at customs/border levels should be examined to better understand the viability of the fortification program given the high proportion of imported brands across all food vehicles;

3. Information on market share of available brands of fortified food vehicles should be compiled to identify which brands make up a significant share of market and thus which producers should be targeted to ensure they are fortifying appropriately to have the highest availability of fortified foods in the market; and

4. Investigation into the consumption and coverage of these food vehicles at household level is needed to assess the potential for impact of fortified foods among target populations.

These results will be shared with nutrition stakeholders in the country to further guide programming efforts and nutrition policy recommendations.

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8 Annexes

8.1 Market forms

8.1.1 Form 1 “Retail Outlet by Marketplace”

MARCHES & POINTS DE VENTE par nœud commercial et marché (FORM 1)	Date de la visite au marché (dd/mm/yyyy)	_____ / _____ / 2017

Instructions: Completer 1 page par marché situé au sein de la nœud commercial. Puisqu'il peut y avoir jusqu'à 3 marchés, vous aurez 3 feuilles maximum par nœud commercial. Tous les points de ventes parcourus doivent figurer sur la liste.

Nom d'enqueteur:		Equipe ID:		Code du types de point de vente: Grossiste = G Détailant = D Supermarché = S Boulangerie = B

Code du nœud commercial	Ouagadougou = OUA Fada Ngourma = FAD Ouargaye = OUR Dédougou = DED Bobo-Dioulasso = BOB Banfora = BAN Zorgho = ZOR Kaya = KAY	Code du nœud commercial (voir à gauche)	Numero du Marché visité (1, 2, 3)	Nom du marché	Emplacement du marché (address, administrative)

Point de vente visité	Nom du point de vente	Type de point de vente par code (voir ci-dessus)	Point de vente visité	Nom du point de vente	Type de point de vente par code (voir ci-dessus)
1			31		
2			32		
3			33		
4			34		
5			35		
6			36		
7			37		
8			38		
9			39		
10			40		
11			41		
12			42		

8.1.2 Form 2a “General Brand Registration”

BRAND REGISTRE DES MARQUES (FORMULAIRE 2) par vecteur alimentaire et nœud commercial GENERAL

Instructions: Compléter 1 formulaire par vecteur alimentaire (farine de blé huile, sel, riz, concentré de tomate, bouillon, farine de maïs) par nœud commercial.

Nœud commercial	Type de vecteur alimentaire	
Bobo-Dioulasso = BOB	Huile raffinee:	de coton = CT
Banfora = BAN	de palme = PM	de maïs = MA
Dédougou = DED	de palmiste = PL	de colza = CZ
Fada Ngourma = FAD	de palme rouge = PR	de coco = CO
Kaya = KAY	de Palm olein = PO	d'arachide = AR
Ouargaye = OUR	de soja = SJ	de moutarde = MO
Ouagadougou = OUA	de tournesol = TS	de vegetale = VG
		Ghee = GH

Equipe ID	Code du nœud commercial (utiliser les codes à gauche)	Vecteur alimentaire	Date de la visite (dd/mm/yyyy)
		Huile	_____ / _____ / 2017

Code de marque	Marque: Générique	Marque: Spécifique	Type de vecteur alimentaire (utiliser deux premiers codes en haut)	Producteur/ conditionneur	Pays et site producteur/ conditionneur	Adresse du site de production/ conditionneur (Ville)	Distributeur/ importeur	Pays du distributeur/ importeur	Local ou importé Local = L importé = I
H1									
H2									
H3									
H4									
H5									
H6									
H7									
H8									
H9									
H10									

8.1.3 Form 2b “Brand Registration by Retail Outlet Type”

BRAND REGISTRE DES MARQUES (FORMULAIRE 2) par vecteur alimentaire, nœud commercial, et point de vente

Equipe ID	Code du nœud commercial (utiliser les codes à gauche)	Vecteur alimentaire	Type de point de vente (grossiste, supermarché, détaillant)	Date de la visite (dd/mm/yyyy)
		Huile		_____ / _____ / 2017

Nœud commercial
Bobo-Dioulasso = BOB
Banfora = BAN
Dédougou = DED
Fada Ngourma = FAD
Kaya = KAY
Ouargaye = OUR
Ouagadougou = OUA

Instructions: Compléter 1 formulaire par vecteur alimentaire (farine de blé huile, sel, riz, concentré de tomate, bouillon, farine de maïs) par type de point de vente (grossiste, supermarché, détaillant, bouangerie). Vous aurez 25 pages pour chaque noeud commercial.
Pour huile il faut remplir 3 formulaires (grossiste, supermarché, détaillant)

Code de marque	Marque		Type d'emballage (cocher tous ceux que vous voyez)					Taille de l'emballage (cocher tous ceux que vous voyez)										
	Générique	Spécifique	Sachet	bouteille plastique	Bidon	Boîte en métal		750 ml	900 ml	1 L	1,5L	3 L	3,5L	5L	10 L	20L	25L	
H1																		
H2																		
H3																		
H4																		
H5																		
H6																		
H7																		
H8																		
H9																		
H10																		

8.1.4 Form 3 “Specimen Registration”

REPERTOIRE DES ECHANTILLONS	Vecteur alimentaire	Huile	Date de la visite (dd/mm/yyyy)	___ / ___ / 2017	ID de l'équipe		Type de vecteur alimentaire

Type de vecteur alimentaire
Huile raffinee :
de palme = PM
de palmiste = PS
de palme rouge = PR
de soja = SJ
de tournesol = TS
de cotton = CT
de mais = MA
de colsa = CZ
de coco = CO
d'arachide = AR
de moutard= MO
Ghee = GH

Instructions: Compléter 1 page par vecteur alimentaire et par plateforme centrale (c-à-d. 1 page sel, 1 page WF et 1 page huile). Vous avez 3 pages par équipes pour toute l'évaluation. Le numéro unique séquentiel devrait changer selon le vecteur alimentaire.

A remplir sur l'étiquette de l'échantillon						Pays de production	Adresse du site de production (ville)	Type de vecteur alimentaire (utiliser les codes ci-dessus)	Code unique de l'échantillon	Date de production (dd/mm/yyy)	Date de péremption (dd/mm/yyyy)	Type d'emballage	Taille de l'emballage	Unité de l'embal-lage (ml, l, g, kg)	Signalé comme enrichit? (Phrase = FS Logo = FL Phrase & Logo = FSL Pas signalé = N	Code Nœud commercial (utiliser les codes)	Prix (CFA)
Code unique de l'échantillon			Marque		Nom du producteur												
Unique No.	Code de la marque	Echantillon	Général	Spécifique													
2000		1							2000-H1-1								
2001		2							2001-H1-2								
2002		3							2002-H1-3								
2003		4							2003-H1-4								
2004		5							2004-H1-5								
2005	H1	6							2005-H1-6								
2006		7							2006-H1-7								
2007		8							2007-H1-8								
2008		9							2008-H1-9								
2009		10							2009-H1-10								
2010		11							2010-H1-11								
2011		12							2011-H1-12								
2012		1							2012-H2-1								
2013		2							2013-H2-2								
2014		3							2014-H2-3								
2015		4							2015-H2-4								
2016		5							2016-H2-5								
2017	H2	6							2017-H2-6								
2018		1							2018-H2-1								
2019		2							2019-H2-2								
2020		3							2020-H2-3								
2021		4							2021-H2-4								
2022		5							2022-H2-5								
2023		6							2023-H2-6								

8.2 Laboratory sample analysis report

Authors: Dr. Anna Zhenchuk and Dipl. Biochem. Katrin Steinbrenner, BioAnalyt GmbH
Date: 2017-11-08

1. Introduction

GAIN has collected samples of staple foods from markets and households in Burkina Faso to assess the coverage of fortified foods and the levels of micronutrients in these foods. The samples of salt, oil and wheat flour were sent to BioAnalyt for the measurement of iodine, vitamin A and iron levels. The samples were analyzed for added or total micronutrient content using the iCheck technology. Students were trained in the use of the iCheck and performed the analysis under supervision from BioAnalyt.

2. Technology

iCheck is a test kit for the quantitative determination of micronutrients. It consists of two units, a portable photometer or fluorimeter (iCheck) and the disposable reagent vials in which the reaction is performed.

The validation protocol for each iCheck and matrix combines assessment of precision, trueness and a comparison to a reference method. iCheck and iCheck reagent vials are produced according to quality management system (DIN EN ISO 9001:2008) certified by TÜV Nord in Germany.

3. Methodology

For the hands on training for each iCheck analysis method, the student analysts read the user manuals and received a demonstration of the entire analysis procedure. Finally, they independently analyzed a sample 10 times to assess precision and repeatability. The analyst with the most consistent results was then selected to perform the analysis.

3.1 Analysis of Vitamin A in Edible Oil

iCheck Chroma 3 was used for the determination of vitamin A in cooking oil. The determination of vitamin A is based on a color reaction in which the reagents in the vial turn a brilliant blue (Carr-Price reaction), the intensity of which is dependent on retinol concentration. The device measures the absorption of the color in the reagent vial at 3 different wavelengths, over the course of 30 seconds. The device then calculates the vitamin A content through a sophisticated algorithm and displays the result in mg Retinol equivalents/kg. The linear range of the device is 3 –30 mg retinol equivalents (RE)/kg of oil. This method has been validated against the reference method of HPLC (1, 2).

Solidified oil samples were warmed to 40°C in an incubator and shaken for 5 minutes to ensure that they were homogeneous. All samples of one brand were pooled by mixing equal parts of all oils on a horizontal shaker at a shaking frequency of 100/ min for 15 minutes. The liquid composite oil samples were directly injected into the reagent vial and measured with iCheck Chroma 3 according to the user manual. Every 10th sample was analyzed in duplicate to assess precision.

As a quality control, the emitter and receptor of the iCheck Chroma 3 device were controlled by using a standard density glass filter (Chroma 3 Standard) at the beginning of each set of measurements. Additionally, a standard oil sample spiked with a known concentration of retinol palmitate was run every ten measurements as a control.

3.2 Analysis of Iodine in Salt

iCheck Iodine was used for the measurement of iodine in salt. The principle of this colorimetric method is based on the reaction of potassium iodate from a salt sample with potassium iodide in the reagent vial added in excess. Chemically, iodide (I^-) forms iodine (I_2) and triiodide (I_3^-), resulting in a blue-purple complex in a starch solution. The absorption of the blue color is dependent on the concentration of the solution and is measured at 565 nm in the iCheck device. The method has been validated against the reference method of iodometric titration (3).

Before weighing in, the salt samples were mixed thoroughly to ensure homogeneity. The salt samples of one brand were pooled before analyzing. Therefore the target final weigh of 65g is composed of equal parts of the single salt samples of one brand. The composite salt samples were completely diluted with water to a final volume of 250 mL (dilution factor 1:3.85) to ensure that the iodine concentration of the final solution was within the linear range of iCheck Iodine (1.0 - 13.0 mg/L). The salt solutions were injected and analyzed according to iCheck Iodine user manual. Salt samples with concentration of iodine above iCheck Iodine linear range (>13.0 mg/L) were reanalyzed with higher dilution factor of 1:7.7 and 1:19.2. Every 10th sample was analyzed in duplicate to assess precision.

As a quality control, a standard density glass filter (Iodine Standard) was measured to control emitter and receptor before each set of measurements. Additionally, a standard iodized salt sample was analyzed to control the measurement process at regular intervals.

Please note, to calculate the iodine concentration in the salt samples the measured concentrations were adjusted with the dilution factor (DF).

3.3 Analysis of Iron in Wheat Flour

Spot Test Method

A spot test is used to estimate the iron content in wheat flour, which should contain added ferrous fumarate. The modified qualitative method AACC Method 40-40 was used for all individual flour samples. Before weighing in, the flour samples were mixed thoroughly to ensure homogeneity. 5g of each sample were weighed in in hexagonal weighing dishes. The surface was made flat by pressing down with the bottom of a small beaker. Freshly mixed HCL/ thiocyanate reagent was sprayed on the surface to wet the whole surface. After 5 minutes, hydrogen peroxide was sprayed on the surface. The samples were left to stand for 2 more minutes. If added iron compounds were present they showed up as red spots on the surface.

If there is ferric iron (i.e. NaFeEDTA present) the spots would appear after HCl/thiocyanate reagent. If ferrous iron (ferrous fumarate or sulfate) is present new spots would appear after hydrogen peroxide addition. Photos were taken after each step.

Based on the results of the spot test, the positive flour samples were pooled by brand. Additionally all negative flours of all brands were pooled to estimate the intrinsic iron content of wheat flour. Before weighing in, the flour samples were mixed thoroughly to ensure homogeneity. A target final weight of 20g is composed of equal parts of the single wheat flour samples of one brand or the negative wheat flour samples.

<u>iCheck Iron Method</u>

iCheck Iron was used for the measurement of Iron in pooled wheat flour. The principle of the method is colorimetric, in which reagents react with the iron to form a bright reddish-pink color. The disposable reagent vials contain 2 mL of reagents and when the sample solution is injected, a water phase and an organic solvent phase are formed. Ferric iron is reduced to ferrous iron, which is subsequently extracted into the upper organic phase. Ferrous iron forms a red-colored chelate with bathophenanthroline (bphen):

3 bphen + Fe2+ → [Fe(bphen)3]2+

When the reaction is complete, the vial is placed in the portable device, the absorption is measured at 525 nm and the concentration is displayed in mg Fe/L. The total iron content, both the intrinsic iron from the food matrix and added iron from fortification of the sample is determined.

The samples were diluted 1:10 with 0.2M hydrochloric acid to ensure that the iron concentration of the final solution was within the linear range of iCheck Iron, 1.5 - 12.0 mg Fe/L. Hydrochloric acid was used to ensure added and intrinsic iron is well solubilized for the reaction with the chemicals in the iCheck Iron vial.

The flour slurry were injected and analyzed according to iCheck Iron user manual. Every 10th sample was analyzed in duplicate to assess precision. The injected samples were incubated in the vials for 1 hour and then measured with iCheck Iron.

A spiked wheat flour sample was used to control the accuracy of the results by the analyst. The spiked flour was measured at the beginning of each set of measurements and every 10-20 measurements. In addition, when first switched on, the device conducts an auto-control to verify that the emitter and receptor are working correctly.

4. Results

All the measurement results were and delivered to the customer in excel files.

Oil:

A total of 214 oil samples were pooled to 91 composite samples and analyzed. Samples with a measured vitamin A concentration of less than 3 mg RE/kg (below linear range of iCheck Chroma 3) were classified as below detection range.

The coefficient of variation (CV, relative standard deviation), as assessed by measuring 2 composite oil samples in duplicates, and controls 4 times is 0.9-2.7%. The trueness, as assessed by the mean recovery with spiked control oil sample, is 95%±1%. The average precision, as assessed by measuring 2 pooled oil samples in duplicates is 98%±1%.

NOTE: The results for vitamin A in oil may need verification as the oils from this study (i.e. Burkina Faso) caused an unusual background reaction with the reagents. A number of oils also had a turbid reddish coloration, what may be indicative of lower refinement.

Preliminary test was run to verify the impact of this background reaction on the vitamin A results. Two randomly chosen oils with reddish coloration were spiked with retinyl palmitate at vitamin A concentration levels of 15 mg RE/kg and measured using iCheck Chroma 3. The analysis of the spiked oils (ID: 2367-H31-8 & 2637-H54-2) results in a measured recovery of 58% and 62%.

Further verification of the iCheck Chroma 3 results is recommended, as background may be leading to underestimation of results in a number of oil.

Salt:
A total of 204 salt samples were pooled to 43 composite samples and analyzed. It is recommended to classify samples with measured iodine concentration below 5 ppm as "iodine content of below 5 ppm", and not as non-iodized.

The CV, as assessed by measuring 2 composite salt samples in duplicate is 0.0- 4.0%. The trueness, as assessed by the recovery with iodized salt control sample, is 91%. The precision, as assessed by measuring 2 pooled salt samples in duplicates is 95-101%.

Wheat Flour:
A total of 86 wheat flour samples were analyzed by spot test for added iron content. 17 composite samples (1 declared negative and 16 samples declared positive by spot test) were analyzed by iCheck Iron. Some samples had very faint spots and were classified as fortified. The quantitative results for iron content also were very close between samples classified as unfortified and fortified but with few or just one spot. Comments to these samples can be found in the results excel file.

The average measured intrinsic iron content of the flour is 15.3 ppm (mg Fe/kg). This value was obtained by a composite sample of spot-test negative wheat flour samples.

The CV, as assessed by measuring 2 composite wheat flour samples in duplicates is 0.9-7.1%. The trueness for iron analysis, as assessed by the recovery with spiked wheat flour sample, is 104%±11%. The average precision, as assessed by measuring 2 pooled wheat flour samples in duplicates is 96%±4%.

References:

1. Renaud et al. "Quantification of vitamin A in fortified rapeseed, groundnut and soya oils using a simple portable device: comparison to high performance liquid chromatography." International Journal for Vitamin and Nutrition Research, vol. 83, no. 2, 2013.

2. Rohner et al. "Quantification of Vitamin A in Palm Oil Using a Fast and Simple Portable Device: Method Validation and Comparison to High-Performance Liquid Chromatography." International Journal for Vitamin and Nutrition Research, vol. 81, no. 5, 2011.

3. Rohner et al. "Validation of a user-friendly and rapid method for quantifying iodine content of salt." Food and Nutrition Bulletin, vol. 33, no. 4 (suppl.), 2012.

4. Dr. John M. Rowland (AkzoNobel) and Dr. Anna Zhenchuk (BioAnalyt). AkzoNobel validation of iCheck IRON for NaFeEDTA. (Unpublished), 2013.

8.3 Laboratory analysis of food samples results

Table 4 Micronutrient content and fortification status of oil samples by brand

Group ID from lab	Number of samples in composite	Vitamin A (mg RE/kg)	Measurement uncertainty	Fortification classification (11-24 mg RE/kg)
2	1	< 3.00	± 30%	not fortified
4	1	< 3.00	± 30%	not fortified
5	1	< 3.00	± 30%	not fortified
6	1	< 3.00	± 30%	not fortified
7	3	< 3.00	± 30%	not fortified
12	1	< 3.00	± 30%	not fortified
13	2	< 3.00	± 30%	not fortified
17	1	< 3.00	± 30%	not fortified
18	1	< 3.00	± 30%	not fortified
19	8	< 3.00	± 30%	not fortified
22	1	< 3.00	± 30%	not fortified
23	2	< 3.00	± 30%	not fortified
28	2	< 3.00	± 30%	not fortified
29	4	< 3.00	± 30%	not fortified
31	1	< 3.00	± 30%	not fortified
32	1	< 3.00	± 30%	not fortified
34	1	< 3.00	± 30%	not fortified
35	1	< 3.00	± 30%	not fortified
36	6	< 3.00	± 30%	not fortified
38	1	< 3.00	± 30%	not fortified
39	2	< 3.00	± 30%	not fortified
41	1	< 3.00	± 30%	not fortified
42	7	< 3.00	± 30%	not fortified
44	2	< 3.00	± 30%	not fortified
48	1	< 3.00	± 30%	not fortified
49	1	< 3.00	± 30%	not fortified
50	1	< 3.00	± 30%	not fortified
56	2	< 3.00	± 30%	not fortified
57	1	< 3.00	± 30%	not fortified
58	1	< 3.00	± 30%	not fortified
59	1	< 3.00	± 30%	not fortified
62	7	< 3.00	± 30%	not fortified
65	3	< 3.00	± 30%	not fortified
67	1	< 3.00	± 30%	not fortified
68	1	< 3.00	± 30%	not fortified
69	1	< 3.00	± 30%	not fortified
70	7	< 3.00	± 30%	not fortified
72	1	< 3.00	± 30%	not fortified

73	1	< 3.00	± 30%	not fortified
74	5	< 3.00	± 30%	not fortified
76	2	< 3.00	± 30%	not fortified
77	2	< 3.00	± 30%	not fortified
79	1	< 3.00	± 30%	not fortified
81	1	< 3.00	± 30%	not fortified
82	1	< 3.00	± 30%	not fortified
84	1	< 3.00	± 30%	not fortified
85	1	< 3.00	± 30%	not fortified
86	1	< 3.00	± 30%	not fortified
87	1	< 3.00	± 30%	not fortified
89	1	< 3.00	± 30%	not fortified
90	1	< 3.00	± 30%	not fortified
91	1	< 3.00	± 30%	not fortified
46	1	< 3.00	± 30%	not fortified
47	1	3.01	± 30%	below standard
61	1	3.11	± 30%	below standard
52	1	3.37	± 30%	below standard
55	5	3.56	± 30%	below standard
66	1	3.66	± 30%	below standard
40	1	4.50	± 30%	below standard
30	1	4.98	± 30%	below standard
11	1	5.45	± 30%	below standard
78	1	5.55	± 30%	below standard
63	1	5.70	± 30%	below standard
43	1	5.75	± 30%	below standard
75	1	6.62	± 30%	below standard
37	1	6.84	± 30%	below standard
54	1	7.34	± 30%	below standard
83	1	8.14	± 30%	within standard range
80	1	8.22	± 30%	within standard range
9	12	9.39	± 30%	within standard range
20	12	9.57	± 30%	within standard range
64	2	10.02	± 30%	within standard range
60	1	10.56	± 30%	within standard range
14	12	11.94	± 30%	within standard range
1	2	13.23	± 30%	within standard range
10	3	13.74	± 30%	within standard range
15	2	14.43	± 30%	within standard range
33	1	16.60	± 30%	within standard range
88	2	16.63	± 30%	within standard range
3	12	16.83	± 30%	within standard range
45	1	19.64	± 30%	within standard range
26	1	20.42	± 30%	within standard range

71	3	22.43	± 30%	within standard range
8	12	23.51	± 30%	within standard range
24	2	25.05	± 30%	within standard range
21	1	25.49	± 30%	within standard range
25	2	25.56	± 30%	within standard range

Table 5 Micronutrient content and fortification status of salt samples by brand

Group ID from lab	Number of samples in composite	Iodine (ppm)	Measurement uncertainty	Fortification classification (20-60 ppm)
3	2	< 5.00	±13%	not iodized
4	2	< 5.00	±13%	not iodized
5	9	< 5.00	±13%	not iodized
6	12	< 5.00	±13%	not iodized
7	12	< 5.00	±13%	not iodized
8	1	< 5.00	±13%	not iodized
9	6	< 5.00	±13%	not iodized
10	12	< 5.00	±13%	not iodized
14	1	< 5.00	±13%	not iodized
16	2	< 5.00	±13%	not iodized
17	12	< 5.00	±13%	not iodized
19	1	< 5.00	±13%	not iodized
20	2	< 5.00	±13%	not iodized
24	12	< 5.00	±13%	not iodized
25	1	< 5.00	±13%	not iodized
28	2	< 5.00	±13%	not iodized
29	1	< 5.00	±13%	not iodized
31	1	< 5.00	±13%	not iodized
32	1	< 5.00	±13%	not iodized
33	1	< 5.00	±13%	not iodized
34	1	< 5.00	±13%	not iodized
35	4	< 5.00	±13%	not iodized
43	1	< 5.00	±13%	not iodized
38	1	5	±13%	below standard
30	1	6	±13%	below standard
26	12	7	±13%	below standard
27	1	9	±13%	below standard
12	2	10	±13%	below standard
13	12	22	±13%	within standard range
23	1	27	±13%	within standard range
15	5	29	±13%	within standard range
18	12	30	±13%	within standard range
40	1	30	±13%	within standard range
36	11	31	±13%	within standard range
42	12	31	±13%	within standard range
1	2	32	±13%	within standard range
39	4	46	±13%	within standard range
22	7	49	±13%	within standard range
41	8	67	±13%	within standard range
21	3	82	±13%	above standard

37	8	92	±13%	above standard

Table 6 Micronutrient content and fortification status of wheat flour samples by brand

Group ID from lab	Number of samples in composite	Spot test result	Total iron (ppm)	Measurement uncertainty	Fortification classification (54-66 ppm)
6	1	negative	0.00	-	not fortified
7	2	negative	0.00	-	not fortified
8	1	negative	0.00	-	not fortified
9	2	negative	0.00	-	not fortified
10	2	negative	0.00	-	not fortified
16	2	negative	0.00	-	not fortified
17	1	negative	0.00	-	not fortified
23	1	negative	0.00	-	not fortified
24	1	negative	0.00	-	not fortified
25	1	negative	0.00	-	not fortified
1	2	positive	< 15.00	±12%	below standard
2	1	positive	< 15.00	±12%	below standard
4	12	positive	< 15.00	±12%	below standard
5	12	positive	< 15.00	±12%	below standard
12	1	positive	< 15.00	±12%	below standard
19	1	positive	< 15.00	±12%	below standard
20	2	positive	< 15.00	±12%	below standard
21	1	positive	< 15.00	±12%	below standard
22	1	positive	< 15.00	±12%	below standard
11	3	positive	15.20	±12%	below standard
26	1	positive	15.80	±12%	below standard
15	9	positive	16.00	±12%	below standard
18	4	positive	17.10	±12%	below standard
14	5	positive	32.20	±12%	below standard
13	10	positive	44.30	±12%	below standard
3	7	positive	79.20	±12%	above standard