



FORTIFIED
WHOLE GRAIN
ALLIANCE



Fortified Whole Grain Maize Flour Processing Guide For Small & Medium Scale Millers

www.fwg-alliance.org

PREAMBLE

This technical guide is an initiative of the Fortified Whole Grain Alliance (FWGA) that seeks to provide essential information and serve as a guide to small and medium scale millers who are interested in processing fortified whole grain (FWG) flours.

Grains have historically represented a major component of human diets and were predominantly consumed in whole form until the first half of the 19th century, when a combination of technological innovations, market and trade dynamics made refined grains, until then a premium product, affordable and available to the masses. Grains still account for about half or more of caloric intake among vulnerable populations worldwide, and their dominant consumption in refined form turns a nutrient-dense and protective food into a nutrient-poor, calorie-

dense one, contributing to growing rates of obesity and Non-Communicable Diseases (NCDs).

Shifting a substantial portion of global grain consumption to whole grains is potentially one of the most significant and achievable improvements to diets and food systems worldwide. In countries with significant micronutrient deficiencies, a switch from refined to FWG foods can enable institutional channels such as school feeding to measurably improve menu and diet quality in a budget-neutral way.

Converting one quarter to one half of the current consumption of refined grains and products to whole grain can reduce the burden of death and disease from NCDs in Africa, help address undernutrition and



micronutrient deficiencies, and decrease the incidence of overweight and obesity across different population groups. National strategies to increase whole grain consumption can generate substantial government and societal gains due to reduced health care costs and increased labor productivity.

This guide will take you through what whole grains are and their importance in society, different ways in which you can process whole grains, the benefits of fortification, and how to fortify whole grain foods. One of the biggest challenges that whole grain foods face is shelf life, and this guide also covers how to overcome this challenge. By adopting production of FWG flour, a miller can add an extra revenue stream to their business. The FWGA has undertaken financial modelling that has shown FWG Maize Flour can be at the same profitability level or slightly better (EBITDA margin) compared to unfortified refined maize flour for a Rwandan medium scale maize millers. Furthermore three CAPEX investment scenarios have been reviewed for investors:-

1 New line: deploying an entirely new line for FWG production

2 Reconfigured path: reconfiguring an existing roller mill refined processing line to also accommodate FWG processing

3 Add path: creating a new path from an existing refined processing line by adding a hammer mill for FWG production

Adding a new path has increasingly become more popular with roller-based mill setups, whereas those with manual and less efficient operations prefer adopting a new line with the justification for the miller being improvement or modernizing/automation of their systems. CAPEX requirements vary across the three scenarios, with the key factors being the plant layout, technology in use, size of operation desired and presence/absence of a fortification system.

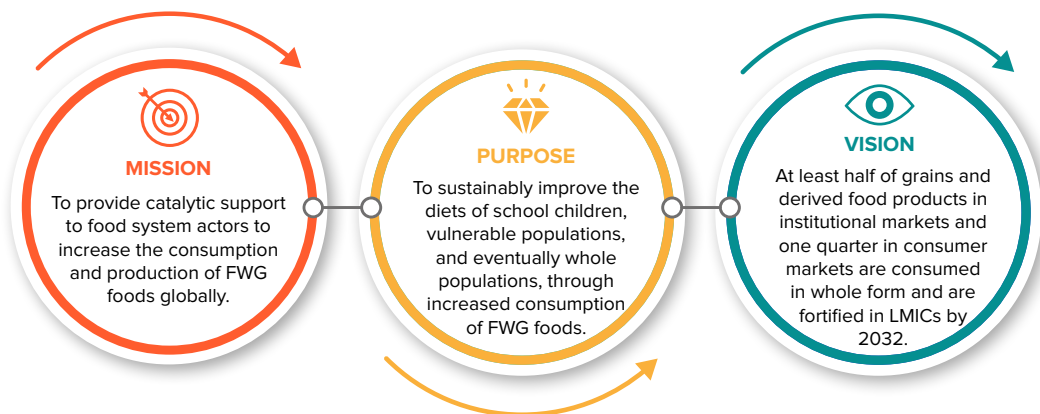
The cost savings provided by whole grains should be contextually leveraged for optimal public benefit in each country. For example, in the 45 African countries currently not mandating maize flour fortification, millers could absorb the relatively small incremental cost of fortification through the margin gain from whole grain flour's considerably higher extraction rates, making such flour even more nutritious at no additional cost to buyers. This approach can help catalyze large-scale fortification and its benefits in these countries. Flour millers play a crucial role in the food system by meeting and shaping product demand through product innovation, marketing, and distribution, as well as developing the supply chain around them.

We encourage grain flour millers to put this guide to good use and we look forward to it adding value to your business processes and to society by making available to as many consumers as possible a nutritious, affordable, and desirable food – fortified whole grains (FWG).

FORTIFIED WHOLE GRAIN ALLIANCE (FWGA) OVERVIEW

The Fortified Whole Grain Alliance (FWGA) is a coalition of stakeholders that span across the food system, including nonprofit and private sector partners and members. It is committed to delivering its stated mission, purpose, and vision by bringing together the collective expertise, resources, operations, funding, visibility, and convening power of its partners. It aims to provide catalytic support to food system actors to increase the production and consumption of fortified whole grain (FWG) foods globally.

The FWGA seeks to improve diets worldwide through the grain value chain, as defined by its mission, purpose, and vision:



The FWGA's initial focus is on the “big three” cereal grains – maize, rice and wheat – as an entry point to drive volume and impact, given existing consumption habits, supply chains, and affordability considerations. The FWGA's focus is on conversion of unfortified and refined grain-based products to FWG. Over time, the FWGA will expand to cover other grains such as sorghum, millets, and orphan or neglected crops (e.g., amaranth, teff, fonio, and quinoa), as well as blends incorporating them. Given the underutilized potential of sorghum and millets in Africa, these indigenous crops represent a vital opportunity to increase intake of whole grains and reach greater populations. Orphan crops, which are naturally well-adapted to unfavourable soil and weather conditions in their respective regions, are mostly cultivated by smallholder farmers and play an important role in their food security. Some orphan crops, including amaranth, quinoa, and cowpeas, provide the added nutritional benefit of edible leaves rich in micronutrients and proteins. Orphan crops also offer a rich gene pool for future crop improvement.

The FWGA will explore opportunities to engage with commercial mills of various sizes, both directly and through representative associations. The commercial segment plays an important role in meeting and shaping demand (e.g., through product innovation, marketing, distribution) as well as in developing the supply chain around them.

This guide is therefore for grain millers who are interested in producing and promoting FWG foods, and we encourage them to join us as members of the FWGA to drive the increased consumption of fortified whole grains.

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INTRODUCTION TO WHOLE GRAIN FOODS

“Whole grains” are all the components of the cereal grain, i.e. the Endosperm, the Bran (the outer layers of the grain, technically called the pericarp) and the Germ (also known as the embryo) – see Figure 1.

Whole grain flour consists of the endosperm, bran and germ in exactly the same proportions as present in the intact grain. This is unlike refined flour products such as sifted maize flour where a proportion of the bran and germ has been removed, which increases the relative proportion of endosperm.

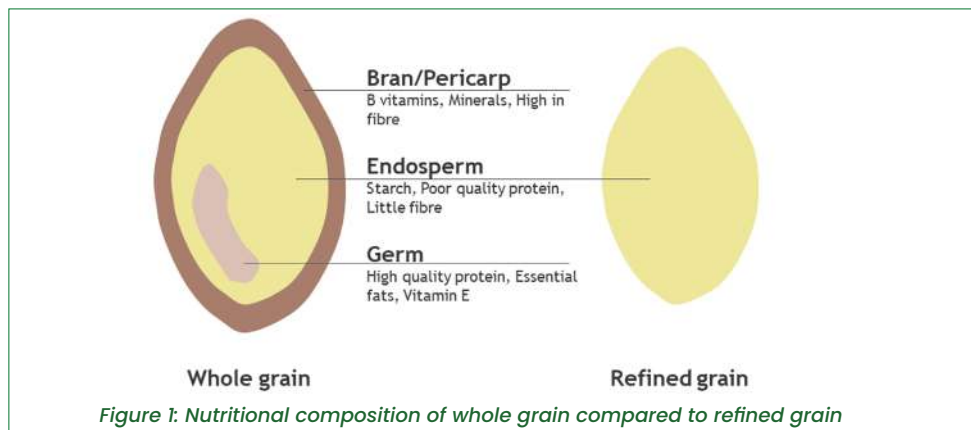
○ Benefits of whole grain foods

Whole grain foods were traditionally widely consumed in Africa and around the world until large-scale industrial milling was developed. Industrial milling greatly reduced the cost of producing refined flours, which resulted in a great increase in consumption of refined grain food products such as very white maize meal (ugali), white bread and white rice.

Over the past 15 years, however, there has been ever increasing interest in whole grain foods. This is because of recent indisputable scientific evidence that regular consumption of whole grain foods contributes to prevention of very common diseases such as obesity, Type 2 diabetes, coronary and cardiovascular diseases and certain cancers. These health benefits are primarily due to the much higher dietary fibre content of whole grain foods.

Additionally, whole grain foods contain substantially higher amounts of essential nutrients than refined-grain foods, most notably B-vitamins, Vitamin E, Iron, Zinc and other minerals, high quality proteins, essential fats and dietary fibre – see Figure 1. Most if not all of these nutrients are deficient in the diets of at-risk groups in Africa, especially children and women of childbearing age.

Furthermore, because the milling extraction rate for whole grain flour from cleaned grain is nearly 100%, the yield of flour per ton is much higher than with refined milling products, normally at least 20% higher. Also, the cost of their production can be somewhat lower than that of the equivalent refined milling products where the bran and germ by-products are generally sold by millers at a much lower price than the flour.



○ Issues in whole grain milling and flour quality

Whole grain milling presents certain challenges compared to milling refined-grain products. These require the miller to give attention to certain issues. However, from an overall perspective, milling whole grain flour is no more complex than producing refined grain products and the actual milling process itself is normally simpler.

Product safety and wholesomeness

As in refined-grain milling, the single most important issue is that the grain purchased and milled should be safe for human consumption – and most particularly it must conform to the legal maximum limits for aflatoxins. Aflatoxins are highly toxic chemical compounds produced by moulds – see Figure 2 (Maize cob infected by the *Aspergillus* fungus that produces aflatoxins. www.ip.iastate.edu). Aflatoxins are acute poisons and cause cancer if foods containing them are consumed regularly. The moulds that produce aflatoxins can grow on the living cereal plant during cultivation if proper control measures are not implemented and on the stored grain, especially if stored at a high moisture content.

Whole grain maize flour is more likely to be contaminated with aflatoxins than refined milling products as the moulds and aflatoxins are concentrated in the outer layers of the grain. Hence, very thorough sorting of the



Figure 2: *Aspergillus* infected maize cob

incoming consignments of grain to remove defective grain kernels is required.

Thorough cleaning of the incoming grain is also essential to ensure the wholesomeness of whole grain milling products. If this is not done, surface contaminants of the grain such as dirt and other undesirable materials like animal and bird excrement will go into the products.

Flour shelf life

The most important issue regarding whole grain flour quality is that of shelf life. This is because whole grain flour has a much higher content of fat compared to its refined-grain equivalents. After milling, the high content of fat in the whole grain flour can result in these products having rancid off-flavours. These are caused by the fat becoming oxidised during flour storage.

To provide whole grain flours with a similar shelf life to their refined equivalents, a heat treatment step is therefore required. This is most simply achieved by drying the grain with warm air directly before milling.

Figures 3 & 4 show an example of a suitable grain dryer that can be used for heat treatment of grains

Figure 3: Warm air dryer – Burner end section



Figure 4: Warm air dryer – Loading end section



WHOLE GRAIN PROCESSING

○ The Process

Food processing entails transforming agricultural products into food or simply one form of food into other forms. Some of the benefits include increased shelf life, preservation of nutritional value in some cases, reduction of waste, consumer convenience, and improved food safety among others. Development work by the FWGA to improve the shelf life of whole grain maize flours has shown that grain heat treatment is the most cost-effective method of increasing the shelf life of FWG maize flour from 20-25 days to 4.5 months.

As part of Good Manufacturing Practices (GMPs), processors should establish standard operating procedures (SOPs) to guide every operation for assurance on product quality and consistency: Quality Assurance (QA), Quality Control (QC) and Testing procedures are examples of GMPs.

Generally, a FWG Process flow involves six main unit operations – See Figure 5 below. Simplicity/complexity of the operations will differ owing to the extent of automation employed, technology in use and size of the mill.

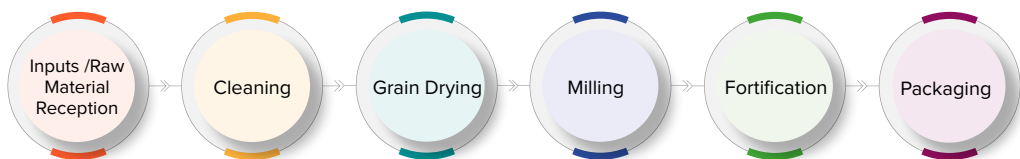


Figure 5: FWG process flow steps

The main process operations and the key aspects to monitor/control for realization of safe and quality product are highlighted below:

- a Raw materials** – Input grain should meet the country and/or regional established grain quality specifications. Mouldy grains should not be processed: Aflatoxin levels must be within acceptance levels (<10ppb). Overall grain quality should be suitable for production of whole grain flour.
- b Cleaning & Drying** – Suitable and efficient equipment should be in use for effective removal of contaminants. The cleaning system should eliminate soil dirt, cobs, stones, ferrous and any other contaminants before drying. Online magnet/s of suitable magnetic flux (min. 4,000 Gauss) should be in place to trap any ferrous metallic contaminants. To increase flour shelf life, cleaned grains should be further dried to lower moisture contents. From past accelerated shelf life studies, we can achieve a flour shelf life of 4.5 months by drying grains to a moisture content of maximum 11.5%. Therefore, it is recommended to dry grains earmarked for production of FWG from the typical moisture of maximum 14% to maximum 11.5% prior to milling.
- c Milling** – Equipment should be of hygienic engineering design and all surfaces in contact with food materials must be made of stainless steel. Particle reduction machinery should yield a flour of desirable granulation as per consumer preferences

and product specifications. The process should have a product on-line magnetic separator of minimum 6,000 Gauss (magnetic strength) to yield product free from ferrous metallic contamination.

d Fortification – Micronutrient addition should ensure the correct dosage rate and homogeneity in the final maize flour product. Positioning of the dosing equipment and overall length of the mixing conveyor (for continuous systems) is critical. Based on the mill capacity, the correct dosing of the fortificant premix to ensure good dispersion of the premix in the flour is important.

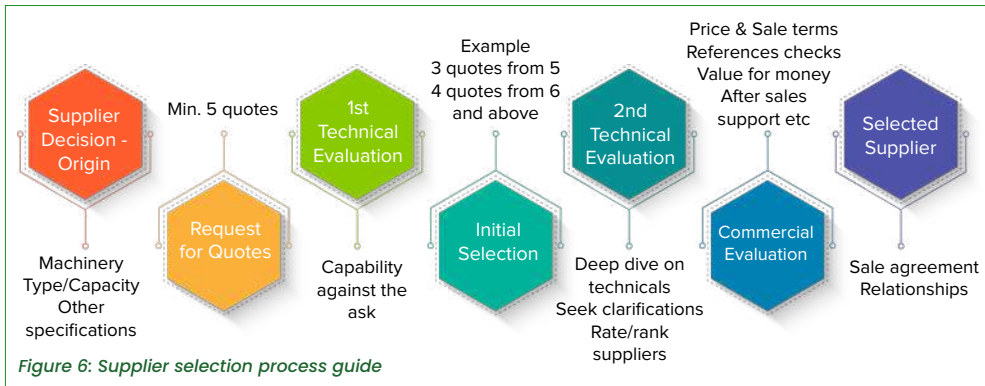
Equipment and Sourcing

Choice of equipment should consider among other criteria:

- **Suitability for application** – stainless steel for surfaces in contact with food, ease of cleaning, operation and maintenance and other hygiene engineering requirements
- **Capacity** – capability to deliver as per design and expectations
- **Power consumption** – power cost is a key cost contributor in milling as it significantly influences product costing
- **After sales support** – spare parts availability, sustainability of the investment
- **Robustness, Reliability and Repairability** – across electrical components, equipment demanding high precision like weighing scales as well as other mechanical and non-moving components/equipment
- **References** – customers supplied and using similar machinery
- **Automation level** – semi- or fully automatic systems minimize manual product handling and present minimal challenges with systems and quality certifications – ISO, HACCP etc.

Advice from an experienced resource should be highly considered as an important input influencing the choice of line equipment and the appropriate capacity as per the investment objectives. Right decisions at the start of the investment help avoid otherwise costly mistakes much later.

Milling machinery suppliers are diverse, offering varying technologies at different price points. Sourcing is commonly from Europe, Turkey and China. There are also locally based engineering establishments that source the key milling equipment, generally from China, then complete the line assembly using local fabrication. Once the decision of where to source from has been reached, it is recommended to obtain quotes from several credible suppliers for thorough technical due diligence by keenly evaluating the offers against the investment objectives. Technical capability evaluation should take precedence over price during the initial evaluations. Consider the diagram in Figure 6 as a general guide towards the supplier selection process:



Appendix A provides a list of some whole grain milling equipment suppliers.

The basic FWG processing machinery / equipment for maize and their functions is illustrated in the flow chart Figure 7 below.



Note: Ensure that 500 g retention samples are saved from each production batch

Figure 7: Process flow / equipment and their functions

Note:

In several African countries, importation of food processing equipment is duty exempted to promote and encourage growth of the manufacturing sector. It is recommended for a processor/importer to seek more information about and benefit from such waivers. The Government Trade Ministry or the Revenue Authority are typically the concerned agencies though this could differ across countries. An experienced clearing agent knowledgeable on the country's importation protocols should handle the application process to avoid unnecessary delays and penalties. Use of the correct/applicable HS codes relevant to the country's tariff code is important. HS codes refer to the Harmonized System which is an international standard way of naming and classifying products during trading. For example, the East Africa Common External Customs (CET) version 2022 booklet indicates 84.37.80.00 as the HS code that applies to maize processing machinery – the clearing agent should always confirm for accuracy and completeness as per country.

○ Raw Materials and Inputs Quality

Typical raw materials

The grains mostly used to manufacture FWG flours in the most African regions are maize, sorghum (both red and white), millets (mainly pearl and finger millet) and wheat. In some cases, root tubers like cassava are peeled, dried then ground into whole flours (without further refining) into whole flours or used to make flour blends with cereals.

The only other permitted ingredient in making FWG flours are micronutrients in the form of a Vitamins and Mineral premix (used as fortificants).

Packaging materials used are meant to maintain and protect the product quality, and the type and pack size (Stock Keeping Unit (SKU)) depends on consumer preference as well as the target market. The common ones include Polypropylene Polywoven sacks, Paper packs and Foil laminate packs.

Quality of inputs

a. **Grains** - Before receiving and accepting a consignment for milling, grains should be tested for various quality aspects against the relevant

country set criteria. For example, for Kenyan standards refer to Tables 2–4 in Appendix B.

b. **Vitamin and Mineral premix** - Considering that tests for vitamins and minerals are costly and sophisticated there is heavy reliance on the Certificate of Analysis (COA) received with each batch. The Iron spot test to detect and roughly quantify the amount of iron fortification is a simple qualitative test that can be administered at reception.

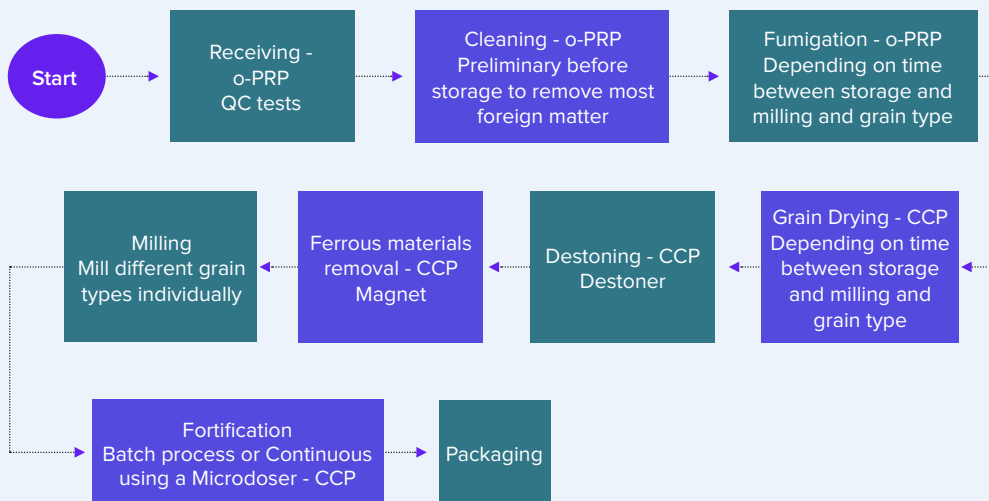
c. **Packaging Material** - The packaging materials should be subjected to a number of tests that include:

- Verification of artworks including Standardisation-mark (S-mark) and barcodes
- Inspection of the seals integrity
- Grammage inspections
- Other visual inspections

d. **Process GMP's** - Critical Control Points (CCPs) and Operational Pre-requisite Programmes (o-PRPs)

Figure 8 below is the basic quality process illustration in the manufacture of FWG flour indicating the o-PRPs and CCPs.

Figure 8: Quality process flow



e. Laboratory Operations & Testing Methods

It is important to have a laboratory to carry out basic tests of raw materials and packaging and for in-process and final product specifications. Table 1 below is a list of the most important laboratory tests:

Table 1: Summary of important lab tests

Material and process stage	Test parameters	Specifications	Internal test methods	Remarks
Raw materials (at receipt)	Mycotoxins (Aflatoxins-Total and Aflatoxin B1, Fumonisin total)	As per government quality regulator standards (see Appendix B-Kenya example)	Quantitative total aflatoxin lateral flow ELISA test kit assay	Others normally QA by outside lab
			Moisture meter	
			Weighing of bags Visual inspection of grain	Chemical tests such as fat content normally QA by outside lab
	Fortificant Premix		Reference to COA per consignment	Normally QA by outside lab

Material and process stage	Test parameters	Specifications	Internal test methods	Remarks
Packaging Materials (at receipt)	Packaging-grammage, seals, labelling and artwork	As per government quality regulator standards (see Appendix C) and internally approved artwork and specifications	Weighing and visual inspection, Seals integrity checks	
In-process	Grain moisture	As per internally approved control limits	Moisture meter	
Finished Goods (prior to dispatch)	Flour granulation	As per customer requirement	Sieve analysis	
	Moisture	As per government quality regulator standards (see Appendix C)	Moisture meter Or Oven method	
	Fat acidity		Acid-base titration method	ISO Method 7305, Can be QA by outside lab
	Mycotoxins			By outside lab when required
	Grammage (weight), Batch number, Best before date		Weighing of packed bags and Visual inspection	
	Fortificant contents		Iron - Spot test or ICheck Iron, Vitamin A-ICheck Fluoro	QA by outside lab
Retention Samples (monthly analysis over stated shelf life of flour)	Moisture)			Moisture meter or Oven
	Microbiological (normally Total plate count, Coliforms, E. coli, Yeasts and moulds)	As per government quality regulator standards (see Appendix C)		Normally QA by outside lab
	Sensory (Organoleptic) quality		Visual appearance, Odour and Taste of flour against fresh reference standard	
	Fortificant content			QA by outside lab, if deemed necessary

Appendix D provides a list of some accredited labs that analyze cereals and their products.

FORTIFICATION

Fortification is the addition of essential vitamins and minerals to staple foods during food manufacture. Fortification is normally performed under and according to government regulation and is increasingly becoming mandatory across Africa.

Fortification involves adding vitamins and minerals in their chemical form and blending them in foodstuffs such as maize flour, wheat flour and even sugar. Typically, several different vitamins and minerals are added, for example Vitamin A, Vitamins B1, B2, B3, B6, B9 and B12, iron and zinc. They are added in the form of a premix powder, which must be obtained from a list of approved suppliers. These premixes are inexpensive and only marginally increase the cost of manufacturing the flour. Appendix E provides a list of some dry premix manufacturers approved by the Global Alliance for Improved Nutrition (GAIN).

Special automated dosing and blending equipment have been developed to ensure that the vitamins and minerals added are at the correct concentration and uniformly distributed throughout the flour. Suitable dosing and blending equipment is widely available, reliable, simple to use and relatively inexpensive.

○ Nutritional benefits of fortification

A high proportion of children and women of childbearing age in Africa are at high risk of diseases caused by insufficient micronutrients (vitamins and minerals) in their diets, for example night-blindness caused by vitamin A deficiency and anemia caused by insufficient iron. In addition, vitamin and mineral deficiencies are partly responsible for other very common childhood diseases such as diarrhea, which also causes long-term damage to children's physical and mental development.

A shortage of essential vitamins and minerals in the diet is termed "Micronutrient Malnutrition" as opposed to a shortage of nutrients such as carbohydrates, protein, and fats which is normally referred to simply as undernutrition. Micronutrient malnutrition is commonly referred to as the "Hidden Hunger" as its effect on health is not immediate as would be the case with, for example, insufficient energy in the diet. However, its adverse effects are slow and insidious.

Over the past 30 years, many studies have shown that vitamin and mineral fortification of staple foodstuffs is highly effective in improving the nutrient status of at-risk groups in developing countries. Consequently, food fortification is today the major strategy of the

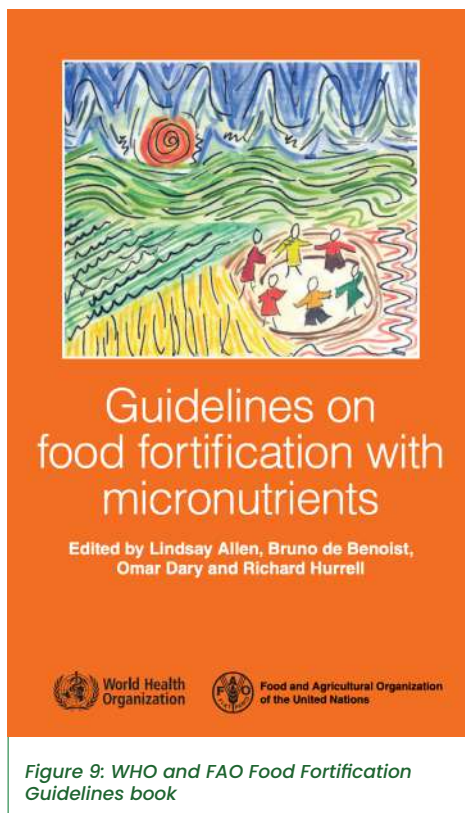


Figure 9: WHO and FAO Food Fortification Guidelines book

World Health Organization (WHO) as well as the Food and Agriculture Organization (FAO) for combatting micronutrient malnutrition. Figure 9 is a representation of the WHO and FAO food fortification guidelines book.

The Introduction to Food Fortification with the Micronutrients Guidelines book stresses the health benefits of whole grains because of their much higher contents of several essential vitamins and minerals and other nutrients when compared to refined-grain foods.

Why then is it necessary to fortify both whole grain flours and blended whole flours?

Sadly, the fact of the matter is that the diets of many people in Africa are so deficient that even consuming whole grain foods does not provide them with sufficient vitamins and minerals. Furthermore, Vitamin A, which is one of the most important vitamins, is normally not present in grains and hence, it is included as a fortificant.

micronutrients can help prevent malnutrition and address nutrient deficiencies. This can lead to a range of benefits, including improved cognitive function, better school performance, reduced morbidity and mortality, and improved overall health outcomes. In addition, FWG flour can help address food insecurity by providing a more nutrient-dense food source that can easily be incorporated into the local diet.

Fortifying whole grain flours with essential

○ Fortification costs and benefits to the miller

In some instances, the cost of fortification equipment and that of the micronutrient premix may be subsidised by government or Non-governmental Organizations (NGOs). However, such a subsidy, even if provided, is normally only short-term and it would be unwise to rely on it. Millers should therefore use the fact that their products have been fortified for improved nutrition and health as a marketing strategy to promote sales. In this regard, nutrition and health has been noted as one of the four major drivers of consumer food purchase in Africa, together with cost, affordability, and taste.

○ Monitoring, Testing and Control

Quality assurance of premix receipt, storage, and delivery

Objectives and accountability - The objectives of the quality assurance of premix receipt, storage and delivery are to ensure that:

- The factory always has enough supply of premix in properly labelled bags to maintain production.
- The premix meets the specifications established for maize (or wheat) flour fortification and contains the micronutrient

levels declared in the label as verified in the Certificate of Analysis (COA).

- The premix is stored under suitable conditions and is used on a “first-in, first-out” (FIFO) basis.

Persons assigned responsibility for this activity shall keep records upon reception of premix or whenever internal checks of storage conditions are done.

Procedure

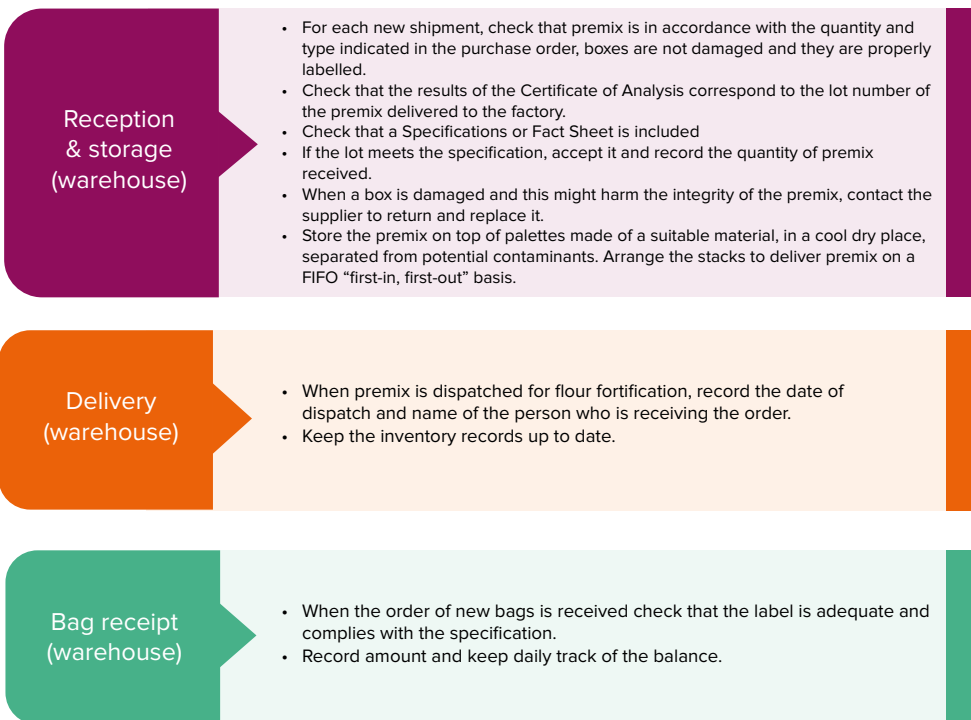


Figure 10: Premix quality assurance procedure

Quality assurance of the maize flour fortification process

Objectives and Accountability - The purpose of the quality assurance of the Maize flour fortification process is to ensure that:

- Premix is continuously and properly added to the unfortified Maize flour.
- The feeder is working consistently, and the amount of premix discharged is in accordance with the flow of Maize flour.
- The ratio of Maize flour produced/premix used is close to the theoretical ratio calculated.

Persons directly responsible for this activity are the Production Personnel assigned to the area where fortification is taking place,

with supervision by the Quality Assurance Department, and daily or weekly reporting to the Production Manager.

Records and Reporting

The Production team should update and file the records of feeder verification, amounts of flour produced and amounts of premix used, and description of actions taken during production to keep the fortification process performing as expected. The Quality Assurance Department verifies the amount of flour produced and amount of premix used from the production records. A copy of these should be kept along with the quality control ones.

Procedure



Figure 11: Maize flour fortification quality assurance procedure

Quality control of fortified maize flour

Objectives and accountability - The purpose of the quality control of the fortified maize flour is to ensure that:

- Maize flour samples are collected and tested to verify product is fortified as per the national standards.
- Quality Control Department has direct responsibility for this component and should send daily reports to the Head of Production.

Records and Reporting

- Review all records and report any areas of

concern.

- Once every quarter, send a composite quarterly sample to an external reference laboratory for the quantitative determination of iron, vitamin A and the other micronutrients.
- Review and file the external laboratory's findings.
- Send reports to the General Manager that include the overall performance of the fortification process, results from the external laboratory, problems found, and corrective or preventive actions taken.

Procedure

Supervision and sampling (By personnel from Quality Control Department)

- Make unannounced checks on the feeder to ensure it has been calibrated, contains a proper level of premix, and is working properly. Record completion of this supervision.
- Check that personnel at production site are taking 250g samples of the fortified flour once a day for the iron spot test or i-Check test (simple qualitative technique to determine the presence of added iron in fortified flour), to confirm that the premix is being blended with the flour.
- Ensure that personnel in the production site are taking 500g samples of the fortified flour every week, to be used for preparing monthly composite samples.
- Once a month, mix four weekly 500g samples to create a monthly composite sample. Retain 1kg of this monthly composite sample. Label it with the date and store in an air-tight and opaque container in the sample storeroom.
- Every 3 months (quarterly), mix 3 monthly composite samples to create a quarterly composite sample. This will create a sample of 3kg. Label it with the date and store in an air-tight and opaque container in the sample storeroom.
- Retain the quarterly sample until a new, more recent quarterly sample can replace it. 500g of the quarterly sample should be used for laboratory testing, and 1kg should be provided to the relevant regulatory body in the event of an inspection visit. At least 500g of the remaining flour should be retained by the mill for its own records.

Iron spot test or i-Check Test

- Once a day, carry out the iron spot test or i-Check Test using the 250g daily sample of fortified flour.
- Record results.

Corrections

- If abnormalities are found, discuss immediately with the Production Supervisor the measures to be implemented to correct them.
- Record the measures taken.

Figure 12: Maize flour quality control procedure

○ Packaging & Labelling

Packaging

The packaging used for the FWG flour must be new and of food grade. Note that this applies for all food products. The exact packaging material used for the flour depends on the requirements of each particular market.

Bulk packaging for maize flours, 20 kg and upwards, is almost always woven polypropylene “sacks”. Some customers require that the sacks have a polyethylene liner to make it moisture resistant.

Retail packaging can be Kraft paper, polyethylene film, polypropylene film, biaxially

oriented polypropylene (BoPP) or laminated metalized plastic film. Polyethylene is the cheapest and is moisture proof. The drawback of polyethylene is that the oil in whole grain flour seeps into the plastic film during storage making it greasy and unpleasant to touch and accelerates the development of rancid off-flavours. The same applies to polypropylene film. The advantage of polypropylene film over polyethylene film is that it is stronger. The properties of BoPP are intermediate between those of woven polypropylene and polypropylene film in that it provides good protection against moisture and can

be pigmented to provide some protection against light. This is useful as light accelerates the development of rancid off-flavours. Kraft paper has the advantages that it is “breathable”, which allows many of the rancid flavour chemicals to escape and provides some protection against light. In addition, some consumers associate paper packaging with quality. Its major drawback is moisture porosity and hence the bag and maize flour can become damp or even wet if incorrectly stored. Laminated metalized plastic film has excellent moisture- light- and oxygen barrier properties and is very visually attractive. Its drawback is its high cost.

Labelling

The labelling on the maize flour packages should conform to the Codex Alimentarius Standard, General Standard for the Labelling of Pre-packaged Foods (CODEX STAN 1-1985). All countries and regional bodies adhering to the Codex, for example as East African Standard EAS 38 of 2014, have accepted this standard. Additionally, there are normally some country-specific labelling requirements such as size and type of lettering and required nutritional information. You should obtain these regulations from the responsible governmental agency in your country. Further, specific regional and national regulations apply to nutrition labelling, which in many countries and regions is now mandatory, for example in the East African Community, if you wish to make a nutritional claim about the product, you can refer to the East African Standards EAS 803:2014 Nutritional Labelling–Requirements, EAS 804:2014, for claims on foods requirements and EAS 805:2014 for use of Nutrition and Health claims requirements.

Labelling requirements are categorised into Mandatory and Optional requirements.

MANDATORY

- **The name of the food** – where the name shall indicate the true nature of the food and should normally be specific e.g. “FWG maize flour”
- **List of ingredients** - these should be listed in descending order of weight in the food
- **Net contents** – these must be declared in metric units
- **Name and address** – this must be the responsible organization, e.g. manufacturer, packager, importer, vender, normally the physical (street) address and telephone number
- **Country of origin**
- **Lot/Batch identification** – in code or clearly identifying the factory and the production batch
- **Date marking** – either best before or use by, often plus date of manufacture
- **Storage instructions** – the correct storage conditions required to meet the stated best before or use by date
- **Instructions for use** – e.g. how to make the flour into ugali, porridge etc.

OPTIONAL

- **Nutritional information** – a Table stating the typical contents of the macronutrients and micronutrients in grams, milligrams, or micrograms (as appropriate) per 100 grams of the food as sold
- **Nutrient claims** – generally where the food is a “Source of”, i.e. contains 15% or more of the Nutrient Reference Value of a particular nutrient. This should apply for all the vitamins and minerals that are added to the whole grain maize flour in the form of the fortificant premix

Whether the maize flour is from genetically modified ingredients

Appendix C provides a list of useful standards and specifications for maize flour, its packaging and labelling.



FORTIFIED WHOLE GRAIN BLENDS

○ Introduction and Highlights

Fortified whole grain blend (FWB) flours consisting of blends of maize, sorghum, and millets have numerous benefits, particularly in addressing malnutrition and improving overall health outcomes, especially in Africa. The major benefits of blending different whole grain cereals are:

- Meeting the cultural and sensory demands of particular communities
- Providing a consistent supply of flour at an affordable price under conditions where the supply of a particular grain is constrained

Additionally, substantial nutritional benefits with respect to protein are attained if these cereals are blended with pulses or other protein sources such as fish meal.

Whole grain sorghum and millets contain more bioactives (also known as phytochemicals) than whole grain maize. These bioactives have been associated with prevention of diseases that can be triggered by oxidative stress such as cardiovascular disease, type-2 diabetes, and

certain cancers such as colorectal cancers.

The use of fortified blended flour can also contribute to the local economy by creating a market for local smallholder farmers, which can help reduce poverty and improve livelihoods. This can also promote the use of indigenous crops, such as sorghum and millets, which are often overlooked in favour of more popular crops like maize.

Promoting a transition towards fortified whole grains & blends is however a multi-step journey. A sustainable approach, as shown in Figure 13 below, will entail in the short term, making the “Big 3” grains affordable, followed by incorporating secondary grains such as sorghum and millet. Following this, the medium to long term strategy will entail blending the “Big 3” with legumes & pulses then neglected grains & other nutrient dense foods. This will be a viable tool for addressing malnutrition and improving health outcomes, particularly in Africa.

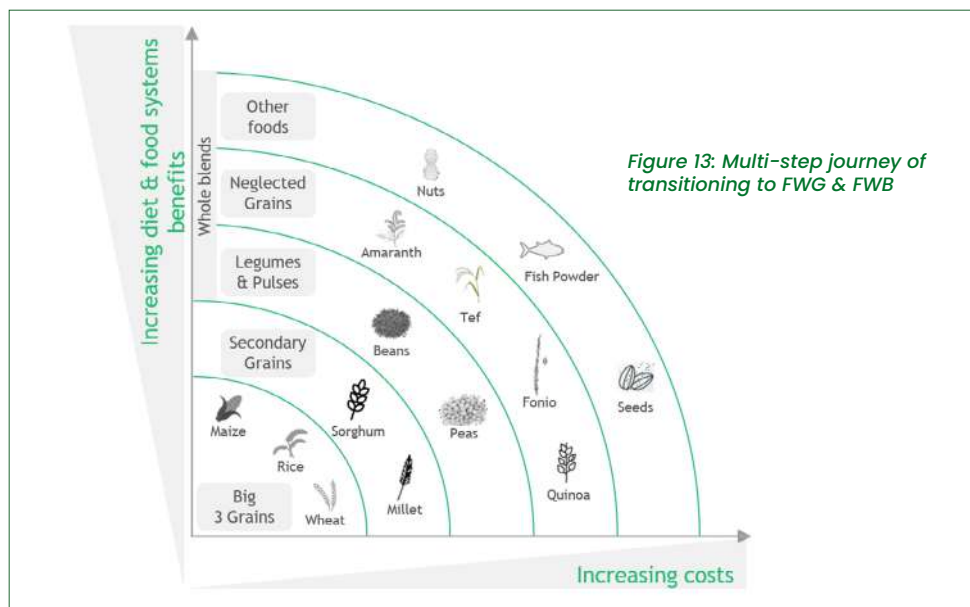


Figure 13: Multi-step journey of transitioning to FWG & FWB

APPENDICES

A. Whole Grain milling equipment suppliers

◆ ABC (Anyang Best Complete) Machinery Engineering Co. Ltd, China

- ☎ Phone number: +86 186 03726130
- ✉ E-mail: vz@kingmanplant.com
- 👤 Name of contact person: Jenny Du
- 🌐 Website: <https://www.abcmach.com>

◆ Alapala, Turkey

- ☎ Phone number: +90 212 4656040
- ✉ E-mail: info@alapala.com
- 👤 Name of contact person: Benedict
- 🌐 Website: <https://www.alapala.com>

◆ Buhler Group, Switzerland

- ☎ Phone number: +254 720 180011/ +254 775 180011/3
- ✉ E-mail: irene.wangeci@buhlergroup.com / buhler.nairobi@buhlergroup.com
- 👤 Name of contact person: Irene Wangeci
- 🌐 Website: <https://www.buhlergroup.com>

◆ Hebei Africa Machinery Co. Ltd, China

- ☎ Phone number: +86 311 85329191/ +254 727 745763
- ✉ E-mail: hbamachinery@china-hba.com
- 👤 Name of contact person: David Njeru
- 🌐 Website: <https://www.china-hba.com>

◆ Hebei Pingle Flour Machinery Group Co. Ltd, China

- ☎ Phone number: +86 152 31139903 / +254 742 355811
- ✉ E-mail: pingle@pingle.com / candyrenna@163.com
- 👤 Name of contact person: Candy Ren
- 🌐 Website: <https://www.pinglemachine.com>

◆ Hebei Tehold International Ltd. , China

- ☎ Phone number: +86 311 85360250/+86 151 32476161
- ✉ E-mail: bran@sugomill.com / hbsugo@outlook.com
- 👤 Name of contact person: Bran
- 🌐 Website: <https://www.hbtonghe.en.china.cn>

◆ Roff Milling – South Africa

- ☎ Phone number: +27 83 2974042/+27 56 2122697
- ✉ Email: kjordaen@roffmilling.com
- 👤 Name of contact person: Koot Jordaan
- 🌐 Website: <https://www.roff.co.za>

◆ Shangdong Xingfeng Flour Machinery Co. Ltd, China

- ☎ Phone number: +86 158 54746699
- ✉ E-mail: export1@xfmfj.cc / flourmachine@xfmfj.cc
- 👤 Name of contact person: Lilian Leung
- 🌐 Website: <https://www.xingfeng.en.made-china.com>

◆ Shijiazhuang Hongdefa Machinery Co. Ltd, China

- ☎ Phone number: +86 139 33068531/ +86 311 85528086 / +86 136 73181716
- ✉ E-mail: vanisa@hdfmill.com / helen@hdfmill.com
- 👤 Name of contact person: Vanisa Li /Helen Guo
- 🌐 Website: <https://www.hongdefa.cn>

◆ Shijiazhuang Huanpai Machine Co. Ltd, China

- ☎ Phone number: +86 137 22990009
- ✉ E-mail: huangpai413@126.com
- 🌐 Website: <https://huangpai.en.china.cn>

◆ Shijiazhuang Jinngu Machinery Trading Co. Ltd – Manufacturing, China

- ☎ Phone number: +86 138 32128785
- ✉ E-mail: fabor@jinggumachinery.com / jinggumachinery@qq.com
- 👤 Name of contact person: Fabor
- 🌐 Website: <https://jinggumachinery.com>

◆ Tanis Milling Technologies, Turkey

- ☎ Phone number: +90 (342) 337 22 22
- ✉ E-mail: info@tanismilling.com/ gaziantep@tanis.com.tr
- 👤 Name of contact person: Erhan
- 🌐 Website: <https://tanismilling.com>

B. Grain Quality specifications – Kenya Example

Table ii: Typical maize grain quality specifications for milling industry (Ref. KS EAS 2:2017)

No.	Parameter	Specifications
1	Moisture content (%)	13.5%
2	Foreign matter (organic & inorganic) (%)	1%
3	Inorganic matter (sand, soil, glass) (%)	0.5%
4	Broken grains (%)	4%
5	Pest damaged grains (%)	3%
6	Other colored grains (%)	2%
7	Discolored grains (%)	1%
8	Red tips (%)	2%
9	Shriveled grains (%)	2%
10	Diseased and rotten grains (%)	4%
11	Mouldy grains	Absent
12	Infestation	Absent
13	Aflatoxin (ppb)	10ppb
14	Sprouted (%)	0.5%
15	Smell/ Odour	Free from foreign odour
16	Vehicle hygiene	Free from contaminants

Table iii: Typical Finger and Pearl millet grain quality tests and specification (Ref. KS EAS 758:2019)

No.	Parameter	Specifications
1	Moisture Content (%)	14% max
2	Variety	As per typical colour of variety and approved sample.
3	1000 Kernel weight (g)	5.0g min
4	One-Litre weight (g/l)	750g/l min
5	Foreign matter (Organic & inorganic) (%)	1% max
6	Other edible grains (%)	3% max
7	Damaged grains (%)	4% max
8	Immature/Shriveled (%)	4% max
9	Weevilled grains-by count (%)	0.4% max
10	Infestation	Absent
11	Recovery (%)	87.6% min
12	Smell / Odour	Free from foreign odour
13	Vehicle hygiene	Free from contaminants
14	Sprouted (%)	0.5%



Table iv: Typical wheat grain quality control parameters and specification (Ref. KS EAS 51:2017)

S/N	Parameter		Grade			
			1	2	3	4
1	Moisture, (%) m/m, max		14.0			
2	Bulk density/mass per hectolitre	Minimum test weight (g/0.5 L) kg/hl	395 79	375 76	350 72	325 70
3	Protein, (%) m/m, min. N × 5.7 at 11 % Moisture basis	Hard/strong wheat	13.0	12.0	11.0	10.0
		Soft wheat	8.0			
4	Foreign matter (% m/m, max.)	Total	1.5	1.5	1.5	1.5
5.	Falling number, (seconds)		300	250	230	230
6.	Shrunken and broken kernels, (% m/m, max.)		5.0	5.0	5.0	5.0
7.	Edible grains other than wheat (whole or identifiably broken), (% m/m, max.)		0.5	1.5	2.0	3.0
8.	Germinated grains, (m/m, max)		2.0	2.5	3.0	4.0
	Pest damaged, (m/m, max)		1.0	1.5	2.0	3.0
9.	Diseased and weather damaged, (m/m, max)		1.0	2.0	3.0	4.0
10.	Heat damaged, (m/m, max)		1.0	2.0	3.0	4.0



C. Relevant Codex Alimentarius Standards, East African Standards and World Food Programme Specifications

CODEX ALIMENTARIUS STANDARD NUMBER	TITLE
CXS 1-1985	General standard for the labelling of prepackaged foods revised in 2018
CXS 153-1985	Codex standard for maize (corn)
CXS 154-1985	Standard for whole maize (corn) meal amended in 2019
EAST AFRICAN STANDARD NUMBER	TITLE
EAS 2: 2011	Maize grains — Specification
EAS 44: 2011	Milled maize (corn) products — Specification
EAS 38: 2014	Labelling of pre-packaged foods — General requirements
EAS 803: 2014	Nutrition labelling — Requirements
EAS 804: 2014	Claims on foods — Requirements
EAS 805: 2014	Use of nutrition and health claims — Requirements
EAS 768: 2019	Fortified milled maize (corn) products — Specification (2nd edition)
WORLD FOOD PROGRAMME (WFP) SPECIFICATIONS	
V.1 July 2020	Technical Specifications for 4.5 to 90 kg PP woven bag specification with or without PE inner liner
V.1 30 April 2021	Technical Specifications for the manufacture of: Fortified Whole Maize Meal – Eastern Africa Community (EAC)

D. Accredited laboratories that analyze cereals and their products

1 BUREAU VERITAS, KENYA

- 📍 Physical address: 1st Floor, North Belgravia Place, Zanzibar Road, Shimanzi, Mombasa Kenya
- ☎ Phone number: +254(41)2220866/67
- ✉ E-mail: laboratory.mombasa@bureaveritas.com
- 🌐 Website: <https://www.bureauveritas.ke/>
- 👤 Name of contact person: Edwin Senengo
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds: Yes, Yes
- ❌ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin: No
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes, Yes
- ❌ Vitamin and Mineral fortificants – In flours, In fortificant premixes: No

2 CHEMIPHAR UGANDA LIMITED, UGANDA

- 📍 Physical address: Plot 224-226, Kyeeyune Road, Kiggundu Zone, Kansanga, Uganda, P.O. Box 25525 Kampala Uganda.
- ☎ Phone number: +256392268832
- ✉ E-mail: info@chemiphar.net
- 🌐 Website: <http://www.chemiphar.net/>
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds: Yes
- ✅ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin: Yes
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes
- ✅ Vitamin and Mineral fortificants – In flours, In fortificant premixes: Yes

3 INTERFIELD FOOD TESTING LABORATORIES, KENYA

- 📍 Physical address: Biashara Street, Soy Afric Building, Opposite Angels Hair Addition, New Godowns, Gate D – Ruiru, Nairobi, Kenya.
- ☎ Phone number: +254723872168
- ✉ E-mail: knancy@interfieldlabs.co.ke
- 🌐 Website: <https://interfieldlabs.co.ke/>
- 👤 Name of contact person: Nancy Kariuki
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds: Yes
- ✅ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin: Yes
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes
- ✅ Vitamin and Mineral fortificants – In flours, In fortificant premixes: Yes

4 MERIEUX NUTRSCIENCES

- 📍 Physical address: Chelab SRL, Via Fratta 25, 31023 Resana (TV), Italy
- ☎ Phone number: +390423717031
- ✉ E-mail: contact.italy@mxns.com / irene.danieli@mxns.com
- 🌐 Website: <https://www.merieuxnutrisciences.com/>
- 👤 Name of contact person: Irene Danieli
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds: Yes
- ✅ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin: Yes
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes
- ✅ Vitamin and Mineral fortificants – In flours, In fortificant premixes: Yes

5 POLUCON SERVICES LTD

- 📍 Physical address: Polucon house, Nyati Road, Off Links Road Nyali, Mombasa and Sameer Industrial Park, Nairobi
- ☎ Phone number: +254720598964/+25472 2229944/+254733229945
- ✉ E-mail: sales@polucon.com
- 🌐 Website: <https://www.polucon.co.ke/>
- 👤 Name of contact person: Irene Mwebi
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds: Yes
- ✅ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin: Yes
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes
- ✅ Vitamin and Mineral fortificants – In flours, In fortificant premixes: Yes

6 SAGL, SOUTH AFRICA

- 📍 Physical address: 477 Witherite Street, Grain Building – Agri-Hub Office Park The Willows, Pretoria, 0040, South Africa
- ☎ Phone number: +27(0)128074019
- ✉ E-mail: Odille.Marshall@sagl.co.za / Lebohang.Maruping@sagl.co.za
- 🌐 Website: <https://sagl.co.za/>
- 👤 Name of contact person: Odille Marshall / Lebohang Maruping
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds:
- ✅ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin:
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes
- ✅ Vitamin and Mineral fortificants – In flours, In fortificant premixes: Yes

7 SGS KENYA LABORATORY SERVICES, KENYA

- 📍 Physical address: SGS Kenya Limited, SGS House, Ali Punjani Street, P.O. Box 90264, 80100 Mombasa Kenya
- ☎ Phone number: +254(41)222 667-9/+254722202145/+254733611105
- ✉ E-mail: lab.kenya@sgs.com / John.Mungai@sgs.com
- 🌐 Website: <https://www.sgs.com/en-ke/service-groups/laboratory-services>
- 👤 Name of contact person: John Mungai
- ✅ Is the laboratory accredited? Yes

Analyses performed and whether accredited for that particular analysis

- ✅ Microbiological, e.g. Total plate count, Coliforms, Yeasts and Moulds: Yes
- ✅ Aflatoxins, e.g. Total aflatoxins, Aflatoxin B1, Fumonisin: Yes
- ✅ Proximate analysis, e.g. Moisture, Fat, Ash: Yes
- ✅ Vitamin and Mineral fortificants – In flours, In fortificant premixes: Yes

E. Premix suppliers

Below is the list of some of the dry premix manufactures approved by the Global Alliance for Improved Nutrition (GAIN) – an organization launched at the United Nations in 2002 to tackle human suffering caused by Malnutrition

- DSM Nutritional Products AG
<https://www.dsm.com>
- Coalescence, LLC
<https://coalescencellc.com>
- Mirpain Gida San. ve Tic. A.S.
<https://mirpain.com>
- Nutralia S.R.L
<https://www.dnb.com>
- Hexagon Nutrition Pvt Ltd
<https://hexagonnutrition.com>
- Glanbia Nutritionals Ltd
<https://www.glanbianutritionals.com>
- Mühlenchemie / SternVitamin
<https://muehlenchemie.com>

In some cases, a country might have a list of accredited premix manufacturers, and thus it is important to confirm with the relevant government body/agency before choosing the premix manufacturer.

FWGA Partners



CONTACT US:

info@fwg-alliance.org 

www.fwg-alliance.org 

Sanlam Towers 4th Floor, Nairobi 



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