CAPACITY BUILDING OF SMALL MILLERS

TRAINING MANUAL

EXECUTIVE OVERVIEW

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Department: Health
REPUBLIC OF SOUTH AFRICA

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L'Initiative pour les micronutriments
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CAPACITY BUILDING OF SMALL MILLERS – TRAINING MANUAL

Background

Fortification of maize meal and bread flour with vitamins and minerals became mandatory in October 2003. In conjunction with this initiative the Department of Health: Nutrition supported by Micronutrient Initiative (MI), Global Alliance for Improved Nutrition (GAIN) and UNICEF have collated resource materials pertinent to the fortification process.

On the enclosed CD you will find a series of files in PDF format. To read the files you should need Adobe Acrobat Reader – if you do not have this programme it has also been loaded on the CD. These files have been collated from multiple sources and are intended to provide a single resource on maize meal and bread flour fortification. The files have been sourced in English and translated into Afrikaans. Below you will find a brief summary of the material on the CD. This executive summary has been translated from English into Afrikaans, Sotho and Tswana. Should you require further information please visit the Department of Health website at www.doh.gov.za, phone 012 312 0042/71 fax 012 312 3112 or contact your local Environmental Health Practitioner (EHP). Additional copies of the CD may be requested from the Department of Health by phone or fax at the numbers above.

Each of the files on the CD are a stand alone document. Folders have been established in which areas of broadly the same subject matter can be found together.

Overview

Fortification is the addition of specific amounts of one or more micronutrients (vitamins and/or minerals) to food, to improve the nutritional quality of the daily meals of the people who consume that food. The purpose of fortification is to correct a recognised population-wide micronutrient deficiency.

Micronutrients are essential vitamins and minerals that are needed in small amounts for various physiological functions, but which cannot be made in sufficient quantities in the body. Because the body cannot produce them they must be provided regularly in food. Micronutrients are important to the human body because they:

- Help our organs, including heart lungs, skin, muscles, pancreas, nervous and immune system to function properly;

- Reduce the risks of conditions such as arthritis, cancer, cardiovascular disease, cataracts, diabetes and infection. They also minimize the effects of aging and air pollution;
- Help to build strong bones and teeth;
- Make the blood healthy and boost the immune system to fight infections and disease;
- Help with brain development and function;
- Keep the muscles healthy and help them contract;
- Keep the eyes healthy; and
- Are critical for growth.

Many people in developing countries suffer from hidden form of hunger known as micronutrient malnutrition, caused by poor quality diets. These peoples' diets are low in animal and fish products, fruits, legumes and vegetables.

Worldwide, fortification of other staple foods such as flour, oils, sugar, condiments, dairy products and a range of processed foods with other minerals and vitamins is growing as an effort by countries to correct micronutrient deficiencies, also called micronutrient malnutrition.

Benefits of fortification

Food fortification provides significant levels of vitamins and minerals, while remaining safe for those who consume additional micronutrient rich food sources.

By adding low-cost vitamins and minerals to everyday staple products, food fortification will benefit the entire nation:

- Adults experience increased strength and mental ability resulting in managers/team leaders not needing to repeat instructions as often as before.
- There will be higher productivity.

- Expenses carried by the public health sector in caring for a variety of illnesses related to iron and vitamin deficiencies will be reduced.

- Children show increased survival and higher levels of both physical and mental development, which in turn results in improved mental function and improved school performance.

The Situation in South Africa

In 1995 South Africa became a signatory to several international nutrition and child development conventions committed to virtually eliminate Vitamin A, iodine deficiencies and reduce iron deficiency anemia by two-thirds. Reductions in these three micronutrient deficiencies lead to substantial decreases in maternal and childhood morbidity and death as well as mental retardation and blindness.

Studies have shown that in South Africa:

- One out of two children aged 1-9 years have an intake of less than half the recommended level of micronutrients such as Vitamin A, riboflavin, niacin, Vitamin B6, folate, iron and zinc.

- One out of five children aged 1-9 years suffer from stunted growth.

- One out of ten children aged 1-9 years are underweight.

- More than 90 percent of respondents said that children ate from the family pot; therefore the survey results also reflect the dietary patterns of adults.

The average South African does not earn enough money to address these deficiencies through their diet or taking vitamin or mineral supplements.

The Department of Health is committed to improving the nutrition of South Africans, and is implementing a combination of strategies to prevent and reduce micronutrient deficiencies, namely food fortification, micronutrient supplementation and dietary diversification (promotion of the production and consumption of micronutrient-rich foods).

overview

As maize and bread are the staple food for many South Africans, the government decided to make it mandatory to fortify all white and brown bread flour and maize meal (super, special, sifted and unsifted) with certain micronutrients in specific micronutrients in specified quantities from October 2003. These micronutrients are: Vitamin A, Thiamine (Vitamin B1), Riboflavin (Vitamin B2), Niacin, Folic Acid, Pyridoxine (Vitamin B6), Iron and Zinc.

Fortified maize meal and bread flour were tested to ensure that the colour, texture and taste of food does not change

The cost of fortification is very low, namely about 1cent per loaf of bread and 2cents per kilogram of maize meal.

Provisions of the Fortification Regulations

The regulations for the fortification of maize meal and bread flour are contained in the Foodstuffs, Cosmetics and Disinfectants Act (Act No. 54) of 1972. Food fortification regulations contain provisions that are relevant for both food vehicle manufacturers, such as millers, and fortification mix manufacturers.

Any person who manufactures, imports, or sells bread wheat flour and maize meal must fortify it. The compounds recommended by the Department of Health must be used as fortificants, at the specified rates.

Regulations require the fortification mix suppliers to:

- Provide a certificate of analysis for each fortification mix batch
- Register with the Department of Health

Regulations require millers to:

- Keep monthly records of the amount of fortification mixes used every month;
- Ensure that the micronutrient mixes are stored under the conditions laid down by the manufacturer;
- Ensure that strict stock rotation procedures are adhered to in order to prevent stock losing potency and to comply with the shelf life expiry date

All bread and maize flour must be labeled in a specific way. The use of the official fortification logo is voluntary.

The provisions of mandatory and uniform labeling are embodied in the labeling regulations as well as the Fortification Regulations R504 (7 April 2003) and are applicable to the whole industry affected by these regulations GN7634 (7April 2003).

The nutrition declaration table is compulsory when the fortification logo is used. The purpose of the nutrition declaration is to inform consumers about the micronutrient content of fortified products. A further purpose is to let consumers know what percentage of the RDA ('Recommended Dietary Allowance") for a particular micronutrient will be obtained from a daily serving of the fortified product or food vehicle. It is important for the information to be standardized so as to provide correct information on micronutrients to the consuming public and avoid confusion.

Penalties for non-compliance are in place:

- Any person who manufactures imports or sells foodstuffs identified as food vehicles which have not been fortified in accordance with these regulations shall be guilty of an offence.
- Any person who manufactures imports or supplies a fortification mix for the purpose of these regulations without being registered with the Department of Health shall be guilty of an offence.
- Fine of up to R125, 000 could be imposed upon millers who do not comply.

Fortification process

The fortification process involves adding standard quantities of fortification mix to a set quantity of food and mixing them together so as to achieve a uniform fortified food. The fortification mix is a mixture of micronutrients (vitamins and minerals) and a carrier, usually starch. It may also contain a free-flow agent, such as silica, to prevent caking. Fortification mixes are made by commercial companies, each batch of which will be accompanied by a certified analysis of micronutrient content, i.e. certificate of compliance. The manufacturers will also place on the outside of the packaging some basic storage instructions. Whilst the wording will vary from supplier to supplier that all require the miller to keep the fortification mix out of direct sunlight and dry. To do this it is recommended the miller places the fortification mix on a pallet in a shaded storage area

Stages of the fortification process include:

- Acquisition of appropriate equipment followed by mill infrastructure modification.
- Acquisition of fortification mixes from suppliers that have been registered by the Department of Health
- Adding the appropriate amount of fortification mix to the grain while it is being milled, or adding fortification mix to the product meal in a blender, after the grain is milled.

There are two main methods that are being used to fortify maize meal and bread flour in milling operations. They are continuous mixing and batch mixing.

Continuous mixing:

- Manual direct addition: the fortification mix is added either by weight or volumetric measure (calibrated scoop) to a known volume of weight of grain before milling. This method could be used in cyclone type hammer mills only.
- Continuous direct addition: a precision micro-ingredient powder feeder (dosifier) is attached to the mill and powered by the mill drive. The dosifier dispenses an amount proportional to the meal or flour. This is by far the most commonly used method because of its low cost and acceptable precision.

Batch mixing:

- The fortification mix is blended with maize meal or bread flour after the milling process is complete, before packaging. The product is batch mixed with a measured quantity of fortification mix. The fortified product is then packed for sale. The equipment used is not big and can be fitted very easily to most mills without major changes. Batch mixing is slower and more labour-intensive than other methods.

Fortification equipment

Technologically, small-scale food fortification is neither sophisticated nor does it require large investment in equipment to dispense and blend in the fortification mix. There are two major categories of equipment used in the fortification of cereal flour, namely blenders and feeders.

Blenders:

Blenders are used in blending the fortification mix with maize meal or bread flour after the milling process is complete. They are therefore ideal for the batch system of addition. The technology is very simple and many are not suitable for bigger operations.

Feeders:

Feeders (Dosifiers) have many different types of feeders that are available and they include screw type, revolving disc and drum type.

- *Screw feeder:*
  The screw-type feeder is powered by a variable speed motor, which is used to control the feed rate of the powder. The shape of the feed screw determines the feed rate capacity.

  Advantages of this type of feeder are that it sustains a constant addition rate, has a wider range of delivery rates and hopper capacity, uses few mechanical parts and are less expensive to build. They can be more sanitary and easier to maintain that the other types of feeder

- *Revolving disc feeder:*
  This older type of feeder uses a revolving disk equipped with a slide mechanism to control the rate of powder discharge. The disk revolves at a constant speed. This type of feeder is labour intensive and uses more mechanical components than the screw feeder.

- *Drum or roll type feeders:*
  This type of feeder operates by allowing the powder to pass between two revolving cylinders. Pulleys and wheels of different diameters can be used to make gross adjustments in the feed rate capacity. There is an adjustable gate, which is used to make fine adjustments in the rate of feed. This design requires more parts to operate and has high maintenance requirements. Sheer pins in the drive cause the feeder to stop working if large objects get stuck between the rolls.

The following step-by-step procedure should be followed in setting up feeders:

- Locate and install the feeder based on mill optimal configuration.

- Ensure there is adequate mixing of the maize meal or bread flour after the point of fortification addition.

- Install a voltage regulator if there is a large variation in electric voltage (+/- 20%).

- Install an electric interlock system either directly to meal collection conveyor or mill control panel.

- Check to see that the light indicating low premix level if hopper is operating.

The feeder then requires calibration and they are normally equipped with a variable speed drive that allows for different discharge rates. The feeder should be calibrated for each speed setting, from the slowest to full speed, so that the amount of material, in grams delivered per minute, can be calculated.

Feeders should be placed in a dry location away from sunlight. This will prevent the components from any potential interaction with sunlight. Vitamin A, riboflavin and folic acid are sensitive to light and atmospheric oxygen.

Quality Assurance

Quality assurance is the process of ensuring that food products are of the quality required for their intended use at consumer level. An effective quality assurance system is critical to maintain the quality of fortified foodstuffs as they are released into the market place.

overview

The standard procedures for mills, to ensure that maize meal and bread flour is properly fortified include:

- The use of quality and appropriate equipment and weighing units;
- Keeping correct fortification mix inventory records;
- Proper handling and storage of fortification mix
- Keeping correct production records;
- Conducting regular equipment inspection, once after every 8 hour shift;
- Conducting regular analytical tests to verify proper fortification

The following steps must be taken by the manufacturers of maize meal and bread flour:

- Purchase blending equipment and/or feeder(s) and weighing scales. Learn how to use the equipment properly;
- Purchase fortification mix from suppliers that have been registered with the Department of Health;
- Store fortification mix where it is protected from exposure to light and heat. Preferably, keep fortification mixes in their original containers.
- Obtain and keep on record, a certificate of compliance (COA) for every batch of fortification mix;
- Employ and adhere to strict stock rotation procedures in order to prevent old stock losing potency and to comply with the shelf life expiry date;
- Keep records of grain procurement;
- Keep records of fortification mix inventory and usage;

- Keep production records of the amount of fortified maize meal or bread flour produced;

- Keep monthly records of the amount of fortification mixes used every month;

- Ensure that all critical stages of the manufacturing process are monitored through the following measures:

  - Checking of fortification mix feeders at least once per shift to ensure that they are delivering at the correct dosage levels;

  - forming visual checks at least twice per shift to ensure that fortification mixes are being used and that no blockages have occurred and keeping record of this;

  - Performing regular iron spot tests on the maize meal or bread flour.

* Make these records available for inspection by the Environmental Health Practitioners (EHP) when required. EHPs are employed by municipalities and are responsible for compliance monitoring and enforcement of the fortification program – which includes issues such as ensuring the fortification mix, is properly labeled, packed and stored.

Health and safety

It is important to monitor fortification programmes to:

- Improve programme effectiveness;

- Ensure compliance with government standards;

- Identify problem points in the fortification process; and

- Ensure safety to the consumer.

Effective monitoring will ensure that the mineral content of the fortified food is within the desired range. The level of addition (after accounting for losses in processing, storage, distribution and preparation) of vitamins and minerals needs to be high enough to make a signifi-

cant contribution towards the requirements of those most in need. Conversely, the fortification level cannot be so high as to change the organoleptic character of the food product, add an inordinate
incremental cost, or provide too high a dose that might be toxic for those who consume large amounts.

The fortification mix in its concentrated form is capable of causing skin and respiratory irritations. Remember the fortification mix is 5,000 times more concentrated than the level of micronutrients in the finished product. The fortification mix is a very fine powder that is easily blown around.

When handling the fortification mix, the following precautions should be taken:

- Wear gloves and long sleeved shirts to avoid potential allergic skin reactions. A common occurrence is skin reddening caused by the vasodilatation effect of niacin. This effect is not dangerous but can be uncomfortable.

- Wear a dust mask to prevent inadvertent inhalation of the active ingredients. The mask can be obtained from most hardware shops;

- Immediately wash hands and skin areas that have been in contact with the fortification mix.

Even with the above, it is possible that repeated exposure to the fortification mix may cause an allergic reaction with some workers, in much the same way as some people develop allergic responses to the dust in wheat and maize mills. In such cases, a simple barrier cream from the pharmacy is often sufficient to alleviate the problem.

Equipment and fortification mix service providers

Fortification mix suppliers must be registered with the Department of Health. Registration is valid for one year after which they must reapply. The Department of Health maintains a register of service providers of fortification mix suppliers. Please visit the following website to obtain information on these suppliers:

www.doh.gov.za/department/foodcontrol/docs/registered.html

For more information contact:

The Directorate: Nutrition

Tel: (012) 312 0042/71
Fax: (012) 312 3112

Fortification Equipment Suppliers can be found on the CD – note this should not be considered an exclusive list nor inclusion as any form of endorsement by the Department of Health.

Subsidy Grant to Support the Food Fortification Programme (SFFP Grant)

The Department of Trade and Industry (DTI) has established a subsidy grant to support the Food Fortification Programme of the Department of Health.

This is a once-off subsidy to the grain milling industry for the purchasing and installation of fortification equipment needed to comply with the Fortification Regulations. The motivation is that the government introduced Fortification Regulations that had an additional once-off cost implication to the industry.

Firms eligible for benefits under the SFFP Grant may be micro, small, medium or large millers and can also be domestic or export market orientated.

For more information about the DTI grant contact:

Department of Health
The Directorate: Nutrition

Tel: (012) 3120042/71
Fax: (012) 312 3112

WHY MAIZE AND WHEAT FLOUR as food vehicles?

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WHY MAIZE AND WHEAT FLOUR AS FOOD VEHICLES?

Maize meal and bread flour were selected as food vehicles because either one or both, are consumed by almost every single person in South Africa on a daily basis. It has nothing to do with whether the nutritional value of maize or wheat has been altered by the milling process. It is about the fact that adding micronutrients to maize meal and bread flour enables virtually every single man, women and child of each and every ethnic and economic group to have affordable access to fortified food. This chapter explores the rationale behind the decision to use maize meal and bread flour.

The legislation describes food vehicle as:

"food vehicle" means dry and uncooked wheat flour, dry and uncooked maize meal and bread prepared with and containing at least 90% fortified wheat flour, excluding water;

This is a very dry definition required because we are using the term in a legal sense but it does answer the question as to why these vehicles were chosen.

The most commonly used set of criteria for food vehicle selection was developed at the International Agricultural Centre, Wageningen, Holland by Merx et al. In this criterion they focussed on three main areas as follows:

Consumption

- High proportion of population consume the vehicle
- Consumption is regular and in relatively constant quantities
- Variation in consumption patterns is minimal between individuals
- An appropriate serving size to meet a significant portion of the daily requirement of the micronutrients is possible
- Consumption is not related to socio-economic status
- Low potential for excessive intake
- No change in consumer acceptability
- No change in quality

Processing and storage

- Centralised processing
- Simple, low cost technology
- High stability and bioavailability of the added micronutrient
- Minimal segregation of the fortificant and vehicle
- Good stability during storage
- No micronutrient interaction

Marketing

- Appropriate packaging to ensure stability
- Labeling to prescribed standards
- Adequate turnover rate

Experience has shown that the following products are suitable food fortification vehicles.

- Cereals - especially maize, wheat and rice
- Sugar
- Salt
- Spices
- Fats and oils

These are the most common food fortification vehicles and have been used successfully in fortification programmes in other countries.

Advantages of flour and maize meal as fortification vehicles

There are a number of good reasons why bread flour and maize meal are fortified with deficient micronutrients.

- They are food staples, consumed in significant quantities by all age groups and economic classes at nearly every meal. This makes them ideal vehicles for getting deficient nutrients to the general population.

- Most of the micronutrients being added are naturally present in the whole grain but greatly reduced by the milling refinement process. Many fortification programs simply call for restoring deficit nutrient levels to that contained in the whole grain, often called enrichment or restoration.

- Fortification at the flour or maize mill is fairly simple and easy to control and regulate.

- The mills producing the bulk of the flour and maize meal are large, modern and centrally located.

- Some micronutrients, like folic acid and other B vitamins, are ideally suited for addition to milled cereals. There is no other food staple as well suited for B vitamin fortification.

- Flour and maize meal have been fortified now for sixty years, so the concept, technology and sustainability are well established.

- The milling equipment, design and quality control procedures for flour fortification have all been developed and are readily available.

- There are a number of commercial concerns operating worldwide that supply fortification premix and mill equipment at reasonable prices due to heavy competition.

- Fortification of bread flour and maize meal is an established and proven public health measure with widespread support by the medical and milling communities.

- Cereal fortification is safe because a person cannot eat enough fortified flour or maize meal to exceed the upper safety levels of micronutrient intakes.

- Fortification at the mill is relatively inexpensive and affordable. It will not noticeably impact the cost of the food to the consumer; yet the public will eventually pay for it with a small, overall price increase.

The South African Process

South Africa embarked on establishing a food fortification programme with the knowledge that it would be necessary to know what the population ate, how much and how often. The result was a national food consumption survey[1] that remains a benchmark for the rest of the world.

The survey showed that the most commonly consumed foods among all income groups in South Africa were maize and sugar, followed by tea, whole meal bread, brown bread, rice, white bread and margarine i.e. in broad agreement with experiences worldwide.

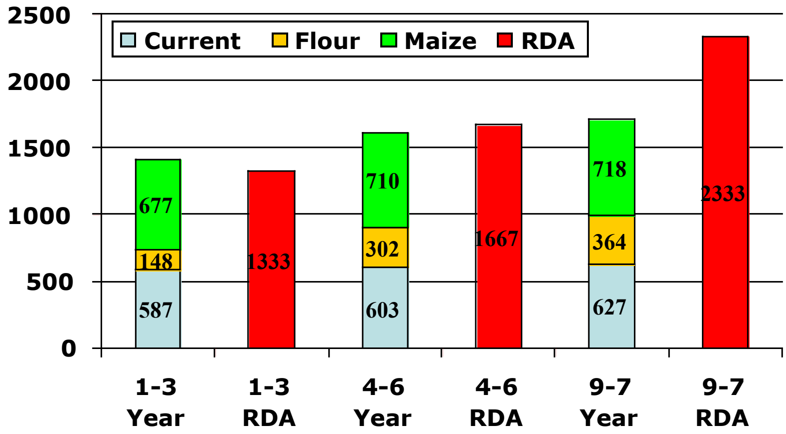
Technically it is possible to fortify all of the above foods but in terms of feasibility and cost the best options are maize meal, bread flour and sugar. From a regional trade perspective sugar was considered not viable as the added cost may have had significant impact on the South African economy due to loss of sales. Furthermore the entering of unfortified sugar into the country must be strictly monitored.

The survey also concluded that an average daily consumption of 200g per person per day was a valid guideline.

Impact of maize meal and bread flour in improving nutrition

The impact of maize meal and bread flour fortified with vitamin A and iron respectively have on nutritional improvement in the diet can be clearly seen in the two bar graphs below:

Vitamin A

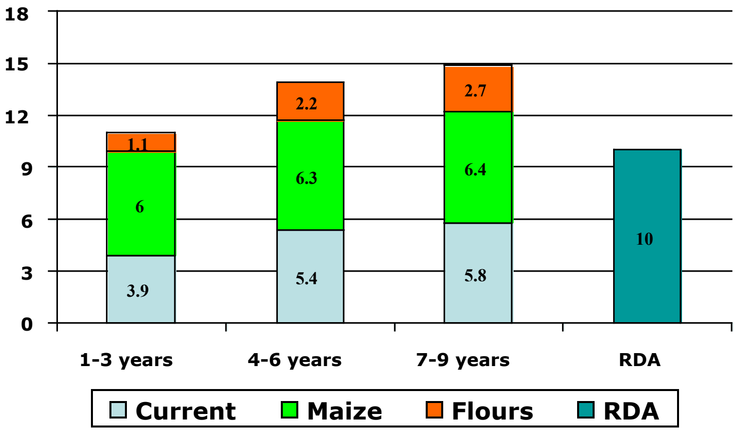


The light blue section clearly shows the average usual intake of Vitamin A was only about a third of the daily requirement. By fortifying bread flour the intake is increased to half of the daily requirement. By fortifying maize meal the total intake is very close to the requirement for children under 6 and shows significant improvement for the 7-9 age group.

Graph calculated from the National Food Consumption Survey (NFCS): Children aged 1-9 years, South Africa, 1999 led by the Department of Human Nutrition, Stellenbosch University.

[1.] The National Food Consumption Survey (NFCS): Children aged 1-9 years, South Africa, 1999 led by the Department of Human Nutrition, Stellenbosch University.

Iron



Using the same colours, it is clearly indicated that the usual iron intake was 40 to 60% of the required level. Fortification of bread flour adds another 10 to 25% iron to the diet but the fortification of maize meal adds over 60% additional iron.

Graph calculated from the National Food Consumption Survey (NFCS): Children aged 1-9 years, South Africa, 1999 led by the Department of Human Nutrition, Stellenbosch University.

Establishing there where no negative changes

Through a process of extensive consultation with the milling and baking industry, academia, fortification experts, health experts and consumer organisations, it was concluded that maize meal and bread flour met every single one of the above criteria.

This process was extensive, very thorough and time consuming. The milling industry in particular was extremely concerned that their product maize meal and bread flour not to be adversely affected in terms of colour and flavour changes.

Whilst they took note of experiences worldwide the milling industry insisted that the lack of colour and flavour changes be demonstrated and proven under South African conditions. Following initial laboratory trials by the CSIR, the milling industry generated fortified products – super, special, sifted and unsifted maize meal; white, brown and wholemeal bread flour at the current fortification levels. Several tests were conducted in rural and urban areas. These included consumer taste and colour preference tests and shelf life tests, available. An important finding was that consumers could not detect a preference in terms of colour and taste between fortified and unfortified food.

The shelf life tests included the distribution system i.e. the meal and flour were shipped around the country on the back of trucks as per normal practice. They checked that the fortificant did not segregate in the bag of product – by comparing the product at the top and the bottom of the bag in taste and visual tests before and after being processed through the distribution network. The industry then established how much of the vitamins and minerals survived the distribution process and the cooking i.e. maize meal into pap and bread flour into bread.

The data they generated broadly agreed with that concluded in other countries and formed the basis for how much fortificant we should and could add. These calculations included the need to take into account losses due to storage of the fortification mix, storage of the maize meal and wheat flour plus losses due to the cooking process.

This proactive response from the extensive consultation ensured that not only are we adding at levels the consumer cannot detect but we are adding quantities in safe amounts that are making a meaningful difference and consumed by the overall population.

Impact of milling on micronutrient levels

As mentioned in the opening paragraph the act of milling does reduce the nutrient value of the grain. The reduction is related to the degree of refining. The table below illustrates the level of reduction that takes place:

Influence of milling on the vitamin and mineral content of maize

Vitamin (mg/kg)	Whole maize	Dehulled	Degermed
Vitamin A	0	-	-
Thiamine (B1)	4.7	4.4	1.3
Riboflavin (B2)	0.9	0.7	0.4
Niacin	16.2	13.9	9.8
Pyridoxine (B6)	5.4	5.4	1.9
Vitamin E	0	-	-
Folate	0.3	0.2	0.1
Biotin	0.073	0.055	0.014
Minerals			
Calcium	30.8	26.7	14.5
Phosphorus mg/g	3,100	2,500	800
Zinc mg/kg	21.0	17.1	4.4
Iron mg/kg	23.3	19.7	10.8

Ref: Bauernfeind JC and DeRitter E (1991) Cereal Grain products in Nutrient Addition to Foods. Bauernfeind JC and Lachance PA (Eds). Food and Nutrition Press. Trumbull CT.

Note especially in the above table that there was no Vitamin A in the whole grain to start with.

A frequently heard comment from millers, especially small millers is that they are not taking anything out therefore, they don't need to add anything back. The following definitions of restoration, enrichment and fortification may help clarify the situation:

WHY MAIZE AND WHEAT FLOUR AS FOOD VEHICLES?

Restoration is the replacement of nutrients lost during food processing. The milling refinement of wheat into flour or maize into meal results in the concentration of vitamins and minerals in the mill feed or bran products and a corresponding lowering of the micronutrient content, from that contained in the whole kernel, in the flour and meal products that go to direct human consumption. The degree of these "losses" is dependent on the extraction rate. The lower the mill extraction rate, the greater the loss of micronutrients. In the United States and Canada, the enrichment standards are based on restoring flour to original levels present in whole wheat. In the UK standards are based on restoring levels to that of a 90% extraction flour.

Fortification is adding nutrients whether or not they are present in the food, or adding levels that are much higher than any natural content, for the purpose of improving the nutritional quality of the food of for correcting a demonstrated deficiency in the population. For example, vitamin A is added to maize meal and bread flour because maize and wheat do not contain vitamin A in its original state. The level of folic acid now being added to maize meal and bread flour a type of fortification is being added at much higher levels than normally found in maize and wheat to contribute to the reduction of certain birth defects.

The process of refining the grain removes anti-nutritional factors that are present in whole grain. For example pellagra is caused by niacin deficiency yet whole grain maize contains what appears to be adequate niacin. The niacin present is chemically bound in the maize therefore, unavailable to the body during the type of processing common in Sub-Saharan Africa – the central area of Angola has major problems with pellagra due to the fact that the diet consists almost totally of whole grain maize meal. In South America the maize is treated with lime, nixtamalisation, which releases the niacin so making it bioavailable.

Conclusion

Maize meal and bread flour perfectly match the criteria for fortification vehicle selection. They are both consumed frequently, in adequate quantities and remain affordable after fortification. They are both unaffected by the vitamins and minerals added and the micronutrients themselves remain stable right through to consumption. The situation benefits both the miller and the consumer.

ENVIRONMENTAL Health Practitioners

ENVIRONMENTAL HEALTH PRACTIONERS

The Department of Health has empowered Environmental Health Practitioners (EHP's) to monitor and enforce the mandatory food fortification programme.

One of the first assessments the EHP will do is look for the equipment and the fortification mix. They will inspect stock and your own records for evidence you have been fortifying. The inspector is entitled to take samples from any part of the premises and you are encouraged to be present with him/her at all times. The appropriate legislation (R2162) for inspections has been included at the end of this section.

The regulations do allow for penalties, fines and or imprisonment, to be applied.

The EHP's - have undergone a three-day training course on the fortification programme. The standardised course consisted of 3 lecture modules plus a visit to a local mill. A short open book examination completed the course.

The modules encompassed the following:

- Fortification Principles – concentrating on nutrition and nutrition disorders.
- Milling and the Fortification process
- Compliance Monitoring Systems – concentrating on the legislation

Each EHP should, therefore, be reasonably comfortable with what micronutrients you are adding and why. They should have a basic awareness of the milling process and the difficulties experienced by millers – especially small millers. Much of the material presented to the EHP's has been given to you,

Sampling:

Taking of samples to determine if the required quantity of each micronutrient is present in the maize meal or bread flour is not a simple task. An internationally accepted method - the ICC 130 methodology is a copyright document so is attached separately on the CD. The main point to notice is that under the ICC protocol a large number of sampling points are required.

Under the regulations quoted below only a single sampling point is required. Many countries around the world have similar, if not identical, legislation to the R2162. This is because the legislation was designed around patent (obvious) faults or contraventions of the relevant food law. Currently the law states that, any single package is seen as a “legal” sample.

The following is suggested:

- Attempt to persuade the EHP to sample from multiple packages and combine the resultant material.

- Alternatively request the EHP to to take the sample from the largest individual pack size you produce i.e. 50Kg

Preparation of the sample:

- Always ensure the sample is thoroughly mixed and divided into three (3) equal portions. Each portion should be sealed in light proof packaging and signed by all parties present.

- Keep a written record of all events that occur and persons present.

- Keep your sample in the refrigerator until notified of the State analysis results – who must attest they received the sample as sealed by yourselves i.e. all 17Kg.

- If a negative report is received send a portion of your sample to either the SABS (012 428 6373) or SAGL (012 349 2683) for analysis – their contact details are also on the CD. If your analysis results are satisfactory then you are entitled to have the third sample – which must be in the original sealed packaging and has been kept by the State – analysed by both laboratories and you can also negotiate for an independent third party to also participate.

Should the EHP decline to consider a 50Kg pack for a legal sample insist that he/she declares this in writing and is aware of the dangers of a smaller sample being unrepresentative of your production.

You can request that the EHP pay for the all the product used in the samples.

Note that this is a retyped copy of a protected PDF file that houses the only legal format of this document which can be found at www.doh.gov.za/docs/regulations/1973/reg2162.pdf

REGULATION - DUTIES OF INSPECTORS AND ANALYSIS

Published under Government Notice No. R. 2162 of 16 November 1973

The Minister of Health has, in terms of section 15(1) of the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act 54 of 1972), made the following regulation which shall apply with effect from the date of publication hereof.

Duties of Inspectors

(1) The following procedure shall be followed when a sample is taken by an inspector in terms of the powers conferred on inspectors under section 11(1) of the Act:

(a) The owner or his manager or agent or other person under whose care the relative article is shall, as soon as practicable after the sample has been obtained, be notified by the inspector of the sampling and of the purpose thereof. If the sample is not paid for, this notification shall be in writing.

(b) In the case of an article where the opening of the package would not hamper analysis or examination, the inspector shall, if the person referred to in (a) is present, offer to divide the sample into three approximately equal portions and to furnish him with one portion.

(i) If the offer is accepted, the sample shall be divided and each portion packed separately, sealed and labelled to indicate its nature and to identify it as a portion of the original sample. One of the portions shall be handed to the person referred to in (a), one sent to an analyst for analysis or examination and one carefully kept by the inspector until the case has been finalised. If the contents of one package are not sufficient for analysis or examination if divided as aforesaid, additional packages, the property of the same person, similarly labelled and purporting to contain a similar article, shall be obtained and the contents of two or more such packages shall then and there be mixed by the inspector and the mixture divided and dealt with as provided.

(ii) If the offer is not accepted, the undivided sample shall be packed, sealed, labelled with a special label to indicate its nature and to identify it and sent to an analyst for analysis or examination

(c) In the case of a perishable article in a sealed package or where no person referred to in (a) is present or where the opening of the package would hamper analysis or examination, a similar procedure to that described in (b) (ii) shall be followed.

(d) The label of every sample submitted for analysis shall indicate whether or not the sample was divided.

(e) The original label of the package, if any, or a copy thereof shall accompany the sample sent to the analyst.

(f) In the case of milk or cream, the preservative tricresol, issued by the Department of Health in sealed packets each containing three tubes of the preservative, may be added. Where the addition of a preservative is considered advisable and the sample is not divided the contents of all three tubes shall be added to the sample; where the sample is divided the contents of one tube shall be added to each portion of the divided sample. If a person referred to in (a) is present, the preservative shall be taken out of the sealed package and added to the sample in his presence and he shall be informed of the nature of the preservative.

(g) The sample may be delivered to the analyst by any convenient means provided the inspector's seal remains intact.

(h) Samples for bacteriological analysis shall be taken with sterilised equipment and transferred to sterile sample containers taking precautions to prevent the contamination of the samples. The sample container shall be stoppered and, within 15 minutes of the sample being taken, shall be surrounded by crushed ice or other suitable refrigerant w3hich comes into contact with the container and is capable of reducing the temperature of the sample to and maintaining it until delivered to an analyst at temperatures not exceeding 7°C. On arrival at the laboratory the temperature shall not be above 7°C. At no time shall the sample be frozen.

Duties of Analysts

(2) (a) Reports on samples analysed or examined in terms of section 12 (1) shall be on the form shown in the annexure.

(b) In the case of milk or cream, besides any other aspects which have to be investigated, it shall be determined and reported whether a preservative is present and, if so, whether it is a preservative prescribed by regulation for the purpose.

(c) In the case of a sample of an article which is not perishable and which is found on analysis or examination to be adulterated or falsely described or otherwise not comply with the requirements of the Act, and which was not divided by the inspector, the unused portion, if any, of the sample shall be closed, sealed and carefully retained by the analyst until after the conclusion of any prosecution in connection therewith.

ANNEXURE

REPUBLIC OF SOUTH AFRICA

CERTIFICATE IN TERMS OF SECTION 22(B) OF THE FOODSTUFFS, COSMETICS AND DISINFECTANTS ACT, 1972 (ACT 54 OF 1972)

Inspector's Serial No. of sample…………………. Laboratory No. of sample…………….............

CERTIFICATE OF ANALYST

To ………………………….

…………………………

…………………………

I, ……..

An analyst authorised under section 12(1) of the Foodstuffs, Cosmetics and Disinfect-ants act, 1972 (Act 54 of 1972), certify that on the ……………………………………………… day of 19…………….. I received from …………………………………… of …………………………………. a sample stated by him to be of ………………………….. that the sample was contained in an intact package bearing the inspector's number ………………….. and with the inspector's seal impressed (1) ………………………… which seal was intact, and with the label or copy of the label attached hereto (2); and that I have analysed the said sample and declare that the results of my analysis are as follows:

....

....

....

I am of opinion that the sample...

....

....

....

Place …………………………(Signed) ………………………………………………

Date …………………………..20………… Analyst ……………………………

(1) If seal is numbered, insert number, if not, describe seal.

(2) This refers to the label under which the article was sold. Strike out these words if no label (original or copy) is attached.

EQUIPMENT
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ABC Hansen Africa
P.O. Box 25354,
Monument Park, 0105
Mills, Paddle Blenders and Dosers
Tel: 012 804 2033
Contact: Mr Mario van Niekerk

Agrex Milling SA
P.O. Box 2040
Mount Edgecombe, 4300
Mills
Tel: 031 502 2690
Contact: Mr Sé Higgins

Buhler
P.O.Box 551
Cresta, 2118
Mills, Silo's, Paddle & Speed Mixers, Dosers, Weighers, Controllers and Constant Proportioning
Tel: 011 380 8000
Contact: Mr Toni Kolb

Gramec (Pty) Ltd.
P.O.Box 89380,
Lyndhurst, 2106
Packaging, High speed mixers and Constant Proportioning
Tel: 011 882 1914
Web. gramec@gramec.com
Contact: Mr Torb Ellefsen

Maizemaster
P.O. Box 430,
Kroonstad, 9500
Mills
Tel: 056 251 1660
Contact: Mr Andries Greyling

Maximill Rollermill
P.O. Box 322,
Kroonstad, 9500
Mills
Tel: 056 217 1580/1
Contact: Mr Willem Coetzee

Milling Consulting Services
P.O. Box 390,
Estcourt, 3310
Dosers
Tel: 036 352 1211
Contact: Mr Helge Schultz

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Mimbro Stainless Steel (Pty) Ltd
P.O. Box 1316
Rosettenville
2130
Dosers

Tel: 083 630 0106
Contact: Mr Bernard Mundy

Plantkor
P.O. Box 280
Winterton, 3340
Mills, Silo's, Paddle blenders, Constant Proportioning

Tel: 036 468 1309
Contact: Natie Labuschagne

Snell Africa Marketing (Pty) Ltd
P.O. Box 2439,
Kroonstad, 9500
Mills, Silo's, Paddle blenders

Tel: 056 212 2697
Contact: Mr Isak de Necker

Techmach Technology
P.O. Box 4163
Luiparkvlei, 1743
Mill engineers

Tel: 011 762 1091
Contact: Mr Corrie Cronje

Food Fortification
Principles

Department: Health
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FOOD FORTIFICATION PRINCIPLES

The objective of this section is to improve understanding of the concept of food fortification, and how it is the answer to the micronutrient deficiency situation in South Africa.

What is Food Fortification?

Fortification is the addition of specific amounts of one or more micronutrients (vitamins and/or minerals) to food, to improve the nutritional quality of the daily meals of the people who consume that food. The purpose of fortification is to correct a recognised population-wide micronutrient deficiency.

Micronutrients are important to the human body because they:

- Help our organs, including heart, lungs, skin, muscles, pancreas, nervous and immune system to function properly;
- Reduce the risk of conditions such as arthritis, cancer, cardiovascular disease, cataracts, diabetes and infection;
- Help to build strong bones and teeth;
- Necessary for red blood cell production and prevention of anemia;
- Help with brain development and function;
- Keep the muscles healthy and help them contract;
- Keep the eyes healthy;
- Critical for growth; and
- Improve quality of life and long-term survival of people living with HIV/AIDS.

Why do we need to Fortify our food?

Many people in developing countries suffer from a hidden form of hunger known as micronutrient malnutrition or vitamin and mineral deficiencies. It is caused by poor quality diets, characterised by high intakes of staple but low consumption of animal and fish products, fruits, legumes, and vegetables. Prolonged inadequate intake of micronutrients (vitamins and minerals) causes damage to the survival, health and well being of millions of people around the world. These deficiencies could be corrected through nutrient fortification of commonly consumed foods like maize meal and bread. Fortification has been recognised by many governments as an important strategy to help improve the health and nutritional status of millions of people. This is due to the fact that fortification, when imposed on existing food patterns, may not necessitate changes in the customary diet of the population and does not call for individual compliance. It can often be dove-tailed into existing food production and distribution systems. For these reasons, fortification can often be implemented and sustained over a long period of time, making it to be the most cost-effective way to overcome micronutrient malnutrition.

The concept of fortification was developed in the early part of the previous century as a means of addressing mineral and vitamin deficiency diseases then prevalent in Europe and North America. Today, more than 70 nations have voluntary or mandatory standards for wheat flour and maize meal. Fortification has been mandated in South Africa, Zambia and Nigeria; and fortified maize meal is available in Zimbabwe, Namibia, Malawi and other countries in the region.

Benefits of Food Fortification

The benefits of food fortification do not lie in the Rand value attached to the programme. The benefit lies in the value of lives that can be saved, which is immeasurable. By adding low-cost vitamins and minerals to everyday staple products, food fortification will benefit the entire nation as illustrated below:

- Adults will experience increased strength and cognitive ability, will be able to work longer and harder.
- There will be marked increase in work capacity by the healthier population. This will enhance the economic development of the nation.
- Expenses incurred by the public health sector in caring for a variety of illnesses related to iron and vitamin deficiencies will be reduced.
- Fewer children will get sick
- There will be improved school performance by children.

Why Food Fortification in South Africa?

In 1999, the Department of Health (DoH) went around South Africa speaking to people living in different cities, towns, informal settlements and farms. The DoH wanted to find out if South Africans are eating healthily. The most important findings were that:

- One out of two children aged 1-9 years have an intake of less than half the recommended level of micronutrients such as vitamin A, riboflavin, niacin, vitamin B6, folate, iron and zinc.
- One out of five children aged 1-9 years suffered from stunted growth
- One out of 10 children aged 1-9 years were underweight
- More than 90 percent of respondents said that children ate from the family pot; therefore the survey results reflect the dietary patterns of adults as well.

Government realised people do not get enough micronutrients in their daily meals and had to address the widespread micronutrient malnutrition. International experience shows that this kind of nutritional problem can be addressed through different interventions, namely: food fortification; supplementation; and dietary diversity. These interventions have also been adopted by the South African Government.

The potential role that food fortification can play in South Africa was identified and regulations passed that require maize meal (super, special, sifted and unsifted) and bread flour to be fortified with a specific mix of vitamins and minerals. Maize meal and bread are widely consumed and are ideal food vehicles to deliver daily, consistent and effective doses for a range of vitamins and minerals. This added nutrition is critical to the health and quality of life of people living in South Africa.

Note: Millers, big and small, are required by law to fortify all white and brown bread flour and maize meal from October 2003

Compounds Recommended by the Department of Health to be used in the fortification mix

The maize meal and bread flour are fortified by a mixture of six vitamins and two minerals at the mill. They include: Vitamin A; Thiamine (Vitamin B1); Riboflavin (Vitamin B2); Niacin; Folic Acid; Pyridoxine (Vitamin B6); Iron and Zinc.

Micronutrients and their Respective Functions	
Micronutrient	**Functions**
Vitamins	
Vitamin A	Important for the maintenance of good vision, normal growth and a healthy immune system.
Thiamine (Vitamin B1), Riboflavin (Vitamin B2), Niacin and Pyridoxine (Vitamin B6)	These B-vitamins enable the body to change eaten food into energy and are essential for growth. Thiamin contributes to a healthy nervous system.
Folic Acid	Helps to form body proteins, genetic material and red blood cells. Essential for the normal development of the unborn baby.
Minerals	
Iron	Helps maintain healthy red blood cells, which play a role in oxygen transportation. Required for a healthy immune system
Zinc	Essential for growth and maintains a healthy immune system

Feasibility of Cereal Flour Fortification

- Fortification has been implemented in roller mills since the 1930's, so the concept, technology and sustainability are well established
- Fortification of wheat flour and maize meal is fairly simple and easy to control and regulate.
- More than 30 countries are fortifying cereal flours.
- Fortification at the mill is relatively inexpensive and affordable. It will not noticeably impact on the cost of the food to the consumer, yet the public will eventually pay for it with a small overall price increase.
- It is economical i.e. cost effective in providing vitamins and minerals to the public.

Costs

The costs of fortification are very small at about 1 cent per loaf of bread, 2 cents per kilogram maize meal. The cost of food fortification will be incurred by the food manufacturers; as a result consumers may experience minimal price increase. Government and industry can share the initial investment, but ultimately the cost of the intervention can be passed on to the consumer.

Fortification
Addition

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ADDITION DURING MILLING

The most basic technique is to add the fortification mix to the grain being milled. This method is only really used in small hammer mill operations (usually only maize milling).

Traditionally the fortification mix is diluted with maize meal at dilutions varying from 1:50 to 1:250 on the premise that pre-dilution will lead to greater homogeneity. In situations such as this the centrifugal action of the hammer mill induces mixing of the fortification mix and the meal. In a Micronutrient Initiative (MI) funded study "Small Scale Milling" – Fortification using various dilution ratios[1]; 2004" this premise was questioned – a summary of the work is reproduced below with permission. Using dilution ratios of 1:50 and less it was demonstrated that the coefficient of variation was high, circa 50%. This is generally considered to be unacceptable. Whilst this may be so statistically it remains to be demonstrated whether such a high variation poses any health and/or organoleptic risks.

Experiment on fortificant mixing by using hammer Mill action.

Purpose

To attempt to add fortification mix at the time of milling and in so doing use the mill action as a mixer.

Methodology

Final product was produced using:

- Hand addition uniform – this involved sprinkling the fortification mix, by hand, on to the grain, with a mixing action, throughout the addition of the grain into the hammer mill for the 1:20, 1:30 and 1:50 dilutions. For the more concentrated dilutions i.e. 1:0, 1:2, 1:5 and 1:10 it was felt that premixing the fortification mix into the grain prior to the mill would prepare a more uniform product.

- Hand addition lazy – this involved "dumping" the fortification mix in 4 aliquots for the 1:20, 1:30 and 1:50 dilutions and 2 aliquots for the remaining dilutions. Following com ments by the local staff during the preliminary experiments the dumping was not in a single position but scattered haphazardly onto the grain i.e. some attempt at distribution being made. Note: the staff where quite adamant that "no one would just dump the vitamins in like that"

[1] "Small Scale Milling" – Fortification using various dilution ratios; 2004

Dilution Rate	Diluted Premix g	Grain g	Total Kg	200g/MT Equivalent
1:0	4	19996	20	200g
1:2	8	19992	20	200g
1:5	20	19980	20	200g
1:10	40	19960	20	200g
1:20	80	19920	20	200g
1:30	134	19866	20	200g
1:50	200	19800	20	200g

All variants were performed in triplicate i.e. 3 x 20Kg batches per variant. The final products were prepared in the direction using the most dilute i.e. 1:50 premix first and the 1:0 last. The uniform addition technique, at each dilution, was performed before the lazy addition technique. The sequence was, therefore, triplicate 1:50 uniform, triplicate 1:50 lazy, triplicate 1:30 uniform etc. The final product produced was collected in a 50 Kg bag attached to the outlet of the mill. After each run it was removed and with as little disturbance of the contents as possible 3 samples where removed from the bag from different places and from different depths. Each sample was identified using a 5 digit random number code.

Control samples – unfortified maize meal – were collected before and after the trials. The "after" control was taken following thorough flushing of the mill.

During the course of the experiments it was noted that the flow pattern of the grain in the mill hopper was not uniform but is was predictable. Grain flow was slowest at the back wall, fastest in the center of the front wall and increasing in speed back to front on the sidewalls. This observation needs to be taken forward. A hypothesis was developed, after the experiments had been concluded, that the flow dynamics could be used to counter lazy addition. Human nature being what it is it is unlikely we will ever prevent lazy addition but if the lazy addition is made at the back wall it is hypothesized the dynamics will moderate the addition practice. The back wall was also the easiest place to add the fortification mix in this case.

Additionally it was observed that the inlet hopper showed evidence of a gradual build up of powder which tasted like diluted fortification mix, maize meal and general dirt. There was insufficient material to take a sample for analysis.

During clean down of the equipment it was noted that the sock attached to the cyclone outlet contained approximately 250g of off-white very fine powder. Two sample where taken for analysis.

Results

The two batches of grain had high coefficients of variation of natural iron content at 38% and 51% respectively and the coefficients of variation within each trial where, with few exceptions, unacceptably high. Given that the target iron content in each case is 95 (grain at 60 plus 35 added) the trials achieved a mean final iron content of 81 with the cyclone sock (quantities of material in the sock was not significant) level at 105 ppm. The coefficient of variation (CV) of the uniform and dumped trials where of the same order of magnitude at 53.5 and 63.4 respectively.

Conclusions and Recommendations

This investigation has shown that the hammer mill is not as efficient a mixer as was generally believed. It has also, rather surprisingly, demonstrated that dilution of the fortification mix into a pre-blend up to 1:50 does not improve mixing efficiency. As with many experiments whose conclusions shatter commonly held beliefs this projects now asks more questions than it answers.

Firstly we need to question if the coefficient of variation of the iron analyses from the hammer mill trials is actually too high:

- None of the results in any of the trials came close to unsafe toxicology levels.

- The variation is sufficiently high that the possibility of a single sample having very high iron levels is very small.

- The data reflects iron levels in small sample sizes and not in portion sizes which would also have undergone additional mixing in the cooking pot.

Secondly we have learnt that the native iron content of maize is much more variable than is reported in literature. Further, from these trials, the iron content varies to such an extent that measurement of total iron content as a monitoring and/or enforcement measure could be questioned.

Risk Assessment

By revisiting the raw data from the hammer mill trials we note that:

- From the 125 data points (1 analysis was missing from 7 dilutions x 3 repeats x 2 conditions x 3 samples) only 1 sample exceeded the UL level for a 1-3 yr child.

Tolerable Upper Intake Level – Highest average intake that will not pose a risk of adverse health effects for virtually anyone in the population. This is set at 40mg of iron by the Institute of Medicine for children aged from 1 up to 13. Calculation is based on a daily intake of 200g of dry maize meal. It should be noted that the UL refers to “average” intake.

The nature of hammer mill operation is to add one measure of fortification mix to one unit size of grain. We can, therefore, assume that inter batch variation is controllable within the limits.

Intra batch variation has been shown to be high with variation statistics slightly higher in the meal than in the grain but, importantly, of the same order of magnitude. This is primarily due to variation of iron content in the grain itself.

The question that really requires answering is
"Is that variation of any practical significance?"

The technique of hand addition has been used extensively in countries such as Malawi with no adverse effects being reported. It must also be recognised that the consumer further mixes the maize meal during the cooking process so further eliminating any localised concentration of fortification mix. As each batch of maize meal is milled separately we are not facing a situation in which one batch of maize meal is heavily fortified and another has very little fortification mix present.

With care to ensure that the correct quantity of fortification mix is added to each batch of grain then the risks can be considered minimal – with thorough mixing of the maize meal after milling the risks are almost non existent.

FORTIFICATION MIX Suppliers

FORTIFICATION MIX SUPPLIERS

Fortification Mix Suppliers

Fortification mix is sold in units of 25Kg and 20Kg packs usually in brown corrugated cardboard boxes with a thick plastic or foil inner bag. A few suppliers do pack their fortification mix in an inert atmosphere

The regulations require millers to procure their supplies of fortification mix from suppliers who are registered with the Department of Health as indicated below:

Manufacturers and importers of food vehicles

a) may only obtain the fortification mix from companies that have registered with the Department; and

(b) shall keep on record a certificate of compliance for every batch of fortification mix in the format specified in Annexure IV.

Registration is a fluid process. Should a new supplier wish to enter the marketplace the Government considers this positively as this leads to increased competition which has a downward effect on prices. The Government recognises that fortification mix production is a complex process and has established mechanisms to ensure that the registered suppliers not only reach the high standard required but maintain that standard. Failure to meet the standard may result in de-registration.

As the registration list is constantly updated the contact details of those currently registered are available at the following web site:

www.doh.gov.za/department/foodcontrol/docs/registered.html

The site also details the authorised agents of the suppliers.

Additionally millers can contact the Department of Health on:

Telephone: (012) 312 0042/71 or

Fax: (012) 312 3112

HEALTH and Safety

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HEALTH AND SAFETY

The objective of this section is to improve understanding of possible health hazards of the fortification mix and precautionary measures to be taken to avoid these problems to ensure safety of both the millers and consumers

Mill Safety Procedures

The fortification pre-mix is a highly concentrated vitamin and mineral powder. The concentration levels can cause breathing difficulties – such as asthma, allergic reactions and skin irritation. It is advisable to follow the following precautions in order to minimize the risks when handling the fortification mix:

- Wear shoes, long sleeved shirts and trousers or full coveralls. This will minimize the skin area exposed to the pre-mix and help to prevent any skin irritation.
- Wear rubber gloves.
- Wear a dust mask. The fortification mix is a powder and can be easily inhaled.
- Wash hands and face immediately after handling the fortification mix.
- Rinse repeatedly any areas of the body that the fortification mix has come into contact with, especially if there is any itching, tingling or irritation.

Even with the above it is possible that repeated exposure to fortification mix may cause an allergic type reaction to some workers – in much the same way as some people develop allergic responses to the “dust” in wheat and maize mills. In such cases a simple barrier cream from the local pharmacy is often enough to alleviate the problem.

If any fortification mix is swallowed, the person should be taken to a medical professional immediately and the doctor should be given a copy of the Certificate of Analysis from the fortification mix supplier.

Consumer Safety

There are two main safety concerns that have to be taken into consideration during food fortification.

- The first is that the levels of micronutrients must be low enough to guarantee that no one will accidentally take in high levels of vitamins and minerals over a long period of time. Large amounts of micronutrients over a period of time can cause health problems of their own.

- The second concern is that the level, although too low to be toxic, is high enough to provide the needed nutrients to the targeted population.

Putting too little micronutrients into the bread flour or maize meal carries the risk of making the entire operation senseless as it will carry no great benefit to the consumers. Under fortifying also puts the mill at risk of contravening the law.

In the event of a large over fortification of the bread flour or maize meal, there is likely to be a difference in the colour as well as the flavour of the product that will make it unacceptable to the consumer. Normal quality control testing would quickly indicate any over fortification and this would involve a small amount of flour or meal. This could happen if the fortification feeder was kept running after the mill stream had stopped flowing. Equipment and procedures for preventing this are available - and discussed in several other sections i.e. Micro feeder calibration control; Quality assurance and Addition methods.

Over 50 years of experience in food fortification has proven it to be very safe with hazards that can be easily prevented through established quality assurance and quality control procedures.

NUTRITIONAL labeling

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NUTRITIONAL LABELLING

Consumers are increasingly demanding to know of the nutritional content of what they are eating. Without labelling control it is very easy for the consumer to become confused or misled. The Government has issued standard labels to be used for the nutritional labelling of maize meal, bread flour and bread.

Note that nutritional labelling is not ingredient labelling which is mandatory. However, if the official fortification logo and claim is used the nutrition declaration table must be indicated on the packaging.

Ingredient declaration may be as simple as "maize meal, vitamins and minerals" or can specify the vitamins and minerals. However, the fortification regulations require that for the compound names of the minerals should be specified in the ingredients list, eg electrolytic iron, zinc oxide and that the elemental names of the minerals be indicated in the nutrition declaration table.

The tables below provide examples of nutritional labels of maize meal, bread flour and bread.

TABLE 2: BROWN WHEAT FLOUR

TYPICAL NUTRITONAL INFORMATION				
Serving size: 100g flour (uncooked)Serving size: 100g flour (uncooked)				
		Per serving	% RDA*	% RDA**
Energy	(kJ)	1450	-	-
Protein	(g)	11.8	21 %	35 %
Glycemic (available) carbohydrate	(g)	63.2	-	-
Total fat	(g)	-	-	-
...Saturated fat	(g)	0.3	-	-
...Trans fatty acids	(g)	0	-	-
Total dietary fibre	(g)	7.9	-	-
Sodium	(mg)	3	-	-
Vitamin A	(mcg)	142	16%	24 %
Thiamin	(mg)	0.38	32 %	42 %
Riboflavin	(mg)	0.20	15 %	22 %
Niacin	(mg)	5.48	34 %	46 %
Pyridoxine	(mg)	0.31	24%	31 %
Folic acid	(mcg)	124	31 %	41 %
Iron	(mg)	4.80	27 %	60 %
Zinc	(mg)	2.67	24 %	33 %
*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**				
RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)				

TABLE 3: WHITE BREAD					
TYPICAL NUTRITONAL INFORMATION					
Serving size: 100g flour (uncooked)Serving size: 100g flour (uncooked)					
		Per 100g	Per serving	% RDA*	% RDA**
Energy	(kJ)	1010	-	-	-
Protein	(g)	8.0	12.0	35 %	21 %
Glycemic (available) carbohydrate	(g)	46.6	69.9	-	-
Total fat	(g)	1.7	2.5	-	-
...Saturated fat	(g)	0.3	0.4	-	-
...Trans fatty acids	(g)	<0.05	<0.05	-	-
Total dietary fibre	(g)	2.9	4.3	-	-
Sodium	(mg)	460	690	-	-
Vitamin A	(mcg)	80	120	13%	20%
Thiamin	(mg)	0.25	0.37	31%	41%
Riboflavin	(mg)	0.14	0.21	16%	23%
Niacin	(mg)	2.79	4.19	26%	35%
Pyridoxine	(mg)	0.21	0.32	25%	35%
Folic acid	(mcg)	74	110	28%	37%
Iron	(mg)	3.23	4.84	27 %	60 %
Zinc	(mg)	1.53	2.30	21%	29%
*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**					
RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)					

TABLE 4: BROWN BREAD

TYPICAL NUTRITONAL INFORMATION

Serving size: 100g flour (uncooked)Serving size: 100g flour (uncooked)

		Per 100g	Per serving	% RDA*	% RDA**
Energy	(kJ)	980	-	-	-
Protein	(g)	8.3	12.4	36%	22%
Glycemic (available) carbohydrate	(g)	42.3	63.4	-	-
Total fat	(g)	1.9	2.8	-	-
...Saturated fat	(g)	0.4	0.6	-	-
...Trans fatty acids	(g)	<0.05	<0.05	-	-
Total dietary fibre	(g)	6.3	9.4	-	-
Sodium	(mg)	435	652	-	-
Vitamin A	(mcg)	70	105	12%	17%
Thiamin	(mg)	0.25	0.38	32%	42%
Riboflavin	(mg)	0.14	0.21	16%	23%
Niacin	(mg)	4.16	0.21	39%	52%
Pyridoxine	(mg)	0.21	0.32	25%	35%
Folic acid	(mcg)	74	110	28%	37%
Iron	(mg)	3.47	5.20	29%	65%
Zinc	(mg)	2.10	3.01	27%	38%

*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**

RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)

TABLE 5: SUPER MAIZE MEAL

TYPICAL NUTRITONAL INFORMATION

Serving size: 100g maize meal (uncooked)

		Per serving	% RDA*	% RDA**
Energy	(kJ)	1430	-	-
Protein	(g)	6.8	20%	12%
Glycemic (available) carbohydrate	(g)	72.2	-	-
Total fat	(g)	1.6	-	-
...Saturated fat	(g)	0.2	-	-
...Trans fatty acids	(g)	0	-	-
Total dietary fibre	(g)	3.2	-	-
Sodium	(mg)	2	-	-
Vitamin A	(mcg)	188	21%	31%
Thiamin	(mg)	0.31	26%	34%
Riboflavin	(mg)	0.18	14%	20%
Niacin	(mg)	2.97	19%	25%
Pyridoxine	(mg)	0.39	30%	39%
Folic acid	(mcg)	189	47%	63%
Iron	(mg)	3.73	21%	47%
Zinc	(mg)	1.89	17%	24%

*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**

RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)

TABLE 6: SPECIAL MAIZE MEAL				
TYPICAL NUTRITONAL INFORMATION				
Serving size: 100g maize meal (uncooked)				
		Per serving	% RDA*	% RDA**
Energy	(kJ)	1495	-	-
Protein	(g)	7.0	20%	12%
Glycemic (available) carbohydrate	(g)	73.6	-	-
Total fat	(g)	2.6	-	-
...Saturated fat	(g)	0.3	-	-
...Trans fatty acids	(g)	0	-	-
Total dietary fibre	(g)	3.8	-	-
Sodium	(mg)	2	-	-
Vitamin A	(mcg)	188	21%	31%
Thiamin	(mg)	0.39	32%	43%
Riboflavin	(mg)	0.19	15%	21%
Niacin	(mg)	3.19	20%	27%
Pyridoxine	(mg)	0.43	33%	42%
Folic acid	(mcg)	191	48%	64%
Iron	(mg)	4.01	22%	50%
Zinc	(mg)	2.25	20%	28%
*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**				
RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)				

TABLE 7: SIFTED MAIZE MEAL

TYPICAL NUTRITONAL INFORMATION				
Serving size: 100g maize meal (uncooked)				
		Per serving	% RDA*	% RDA**
Energy	(kJ)	1525	-	-
Protein	(g)	7.3	21%	13%
Glycemic (available) carbohydrate	(g)	72.8	-	-
Total fat	(g)	3.4	-	-
...Saturated fat	(g)	0.5	-	-
...Trans fatty acids	(g)	0	-	-
Total dietary fibre	(g)	4.9	-	-
Sodium	(mg)	2	-	-
Vitamin A	(mcg)	188	21%	31%
Thiamin	(mg)	0.48	40%	53%
Riboflavin	(mg)	0.20	15%	22%
Niacin	(mg)	3.46	22%	29%
Pyridoxine	(mg)	0.48	37%	48%
Folic acid	(mcg)	193	48%	64%
Iron	(mg)	4.43	25%	55%
Zinc	(mg)	2.66	24%	33%
*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**				
RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)				

TABLE 8(a): UNSIFTED MAIZE MEAL

TYPICAL NUTRITONAL INFORMATION

Serving size: 100g maize meal (uncooked)

		Per serving	% RDA*	% RDA**
Energy	(kJ)	1546	-	-
Protein	(g)	7.7	23%	14%
Glycemic (available) carbohydrate	(g)	71.2	-	-
Total fat	(g)	24.5	-	-
...Saturated fat	(g)	0.5	-	-
...Trans fatty acids	(g)	0	-	-
Total dietary fibre	(g)	5.0	-	-
Sodium	(mg)	2	-	-
Vitamin A	(mcg)	188	21%	31%
Thiamin	(mg)	0.56	46%	62%
Riboflavin	(mg)	0.21	16%	23%
Niacin	(mg)	3.82	32%	32%
Pyridoxine	(mg)	0.54	42%	54%
Folic acid	(mcg)	194	48%	65%
Iron	(mg)	5.04	28%	63%
Zinc	(mg)	3.02	27%	38%

*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**

RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)

TABLE 8(b): UNSIFTED MAIZE MEAL				
TYPICAL NUTRITONAL INFORMATION				
Serving size: 100g maize meal (uncooked)				
		Per serving	% RDA*	% RDA**
Energy	(kJ)	1546	-	-
Protein	(g)	7.7	23%	14%
Glycemic (available) carbohydrate	(g)	71.2	-	-
Total fat	(g)	24.5	-	-
...Saturated fat	(g)	0.5	-	-
...Trans fatty acids	(g)	0	-	-
Total dietary fibre	(g)	5.0	-	-
Sodium	(mg)	2	-	-
Vitamin A	(mcg)	188	21%	31%
Thiamin	(mg)	0.56	46%	62%
Riboflavin	(mg)	0.21	16%	23%
Niacin	(mg)	3.82	32%	32%
Pyridoxine	(mg)	0.54	42%	54%
Folic acid	(mcg)	194	48%	65%
Iron	(mg)	5.04	28%	63%
Zinc	(mg)	3.02	27%	38%
*RDA=Recommended Dietary Allowance for individuals 13 years and older **(mandatory)**				
RDA = Recommended Dietary Allowance for individuals between 4 and 13 years **(voluntary)				

Note:

1. The nutritional information table can be positioned either on the SIDE OR BACK panel.
2. Must be in letters at least 1mm in height for the smallest lower case letters OR a bigger letter size in the case of woven polypropylene.
3. The information must be easily legible.

The use of a uniform daily serving for the Milling and Baking Industries would be beneficial for consumers as they would not have to compare different RDA figures for different estimates of daily servings. It is recommended that the Milling and Baking Industries standardise on a daily serving of 100 g for maize meal, 100 g for wheat flour, and 150g for bread.

LABORATORY
Services

health
Department: Health
REPUBLIC OF SOUTH AFRICA

gain
Global Alliance for Improved Nutrition

L'Initiative pour les micronutriments
The Micronutrient Initiative

unicef

Laboratory Services

Contact details of independent analytical laboratories with demonstrated competence in vitamin and mineral analysis in the fortification programme are given below. Note this list is not exhaustive and more laboratories every day are gaining the necessary skills to satisfy this opening market.

Each of the laboratories is capable of analysing fortification mix and the fortified product.

Each of the laboratories offers a "complete package" i.e. all legislated micronutrients or "specific micronutrients" i.e. selected analyses only.

The complete package is approximately ZAR 4, 000. The lead time for analysis may take several weeks.

When sending samples to the laboratory please remember sample preparation is very important. Ensure the following:

- That you have taken a representative sample - see ICC 130 "Sampling of Milled Products" attached as a separate document on the CD.
- The sample is placed in an airtight and light proof package.
- Clearly identify the sample as being either maize or wheat so the laboratory can help you identify deviations from the regulations.

SABS (South African Bureau of Standards)	Contact: Ms Hanli Hendriksz
Tel: (012) 428 6873	e-mail: hendrih@sabs.co.za
SAGL (South African Grain Laboratory)	Contact: Ms Corlia Buitendag
Tel: (012)349 2683	e-mail: sagl@mweb.co.za

METHODS OF Addition

METHODS OF ADDITION

Many millers take for granted that mixing, homogeneous mixing will occur simply because the bread flour or maize meal is being moved around the mill. This attitude pervades the suppliers of equipment – all have methods of addition, few have methods of mixing – or even mention the issue. This section will, therefore, discuss both addition and mixing.

Blenders and Mixers

The next simplest technique is to use some form of mixer to blend the fortification mix into the carrier bread flour or maize meal.

These mixers vary from the simple Odjob Mixer to the sophisticated double helix mixer.

Odjob Mixer

Typical Double Helix Mixer

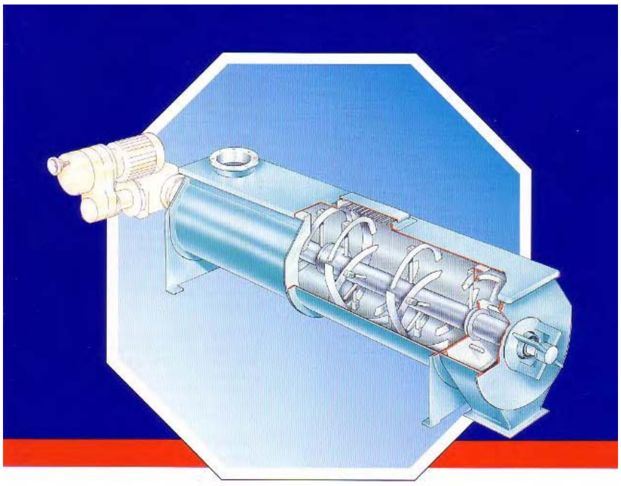
Whilst the Odjob mixer requires no power supply it is less user-friendly as the lid is difficult to both put on and take off. Power driven mixers may mix using paddle arms, spirals, horizontal or inclined plane, single helix or double helix (to name but a few variants) and are supplied in varying volumetric sizes from 50 L upwards – a common size in the grains industry is the 500 L model. Equally important as the volume is the power of the electric motor and its attendant gearbox. A 500 L mixer commonly comes with a 5 KW motor and gearbox. This is capable of adequately mixing 500 Kg of bread flour but, due to the higher bulk density, only 400 Kg of maize meal. Increasing the motor and gearbox to 7.5 KW permits the mixing of 500 Kg of maize meal but doubles the cost of the mixer itself. Mixing times are usually in the order of 20 to 30 minutes.

If time and low mixing variation is an issue then the Gramec-Forberg mixer below is an alternative. As mixing to below a 5% variation can be performed in less than 30 seconds (typically 15-290 seconds) it is not necessary to have a large volume mixer. Price wise they are comparable to a 500 L double helix mixer.

Gramec-Fosberg Mixer

Continuous Mixers

Also highly effective are continuous mixing systems as shown below. In such systems the flow of all the ingredients is controlled (for our situation it would be bread flour or maize meal and the fortification mix) and are proportionately fed into the mixer. Mixing ratio's as high as 1:100,000 are possible with this system and residence time can be as low as 30 seconds.



Schematic of a Continuous Mixer

Micro feeders

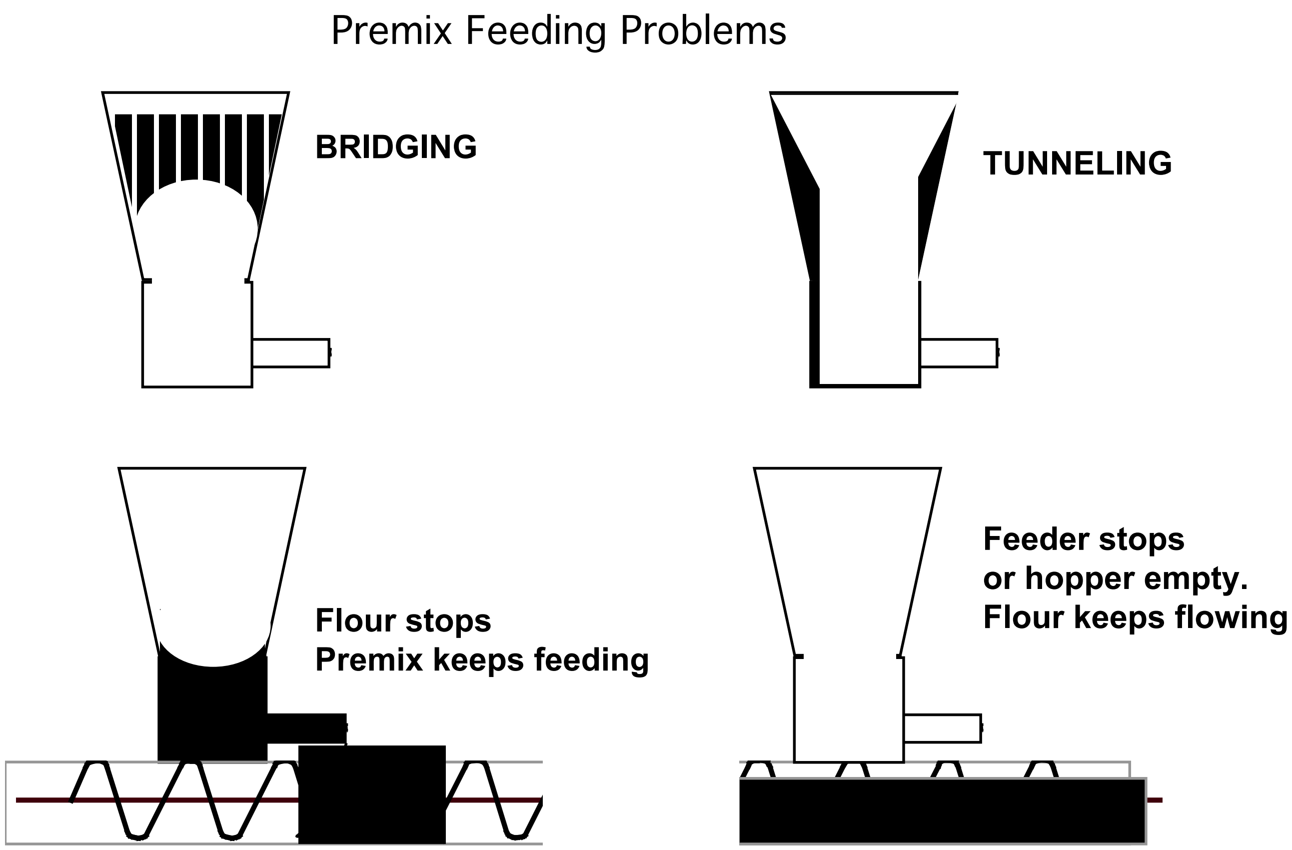
The most common technique for adding fortification mix to maize meal and bread flour amongst the medium and large scale millers is using some form of micro feeder.

In the food industry the most common form of micro feeder is one that uses the principle of volume i.e. the machine dispenses a pre-determined volume of fortification mix per unit time. The reason they are so popular is one of price. Volumetric feeders are considerably cheaper than gravimetric (dispense by weight) feeders. This has important repercussions for the miller. Firstly volumetric feeders need to be calibrated i.e. determine the appropriate feed to dispense the volume that equates to the necessary weight of fortification mix; and secondly, and not generally recognised, that fortification mixes from the various suppliers differ significantly – by as much as 20% - in their specific gravity i.e. their weight per unit volume. Calibration is dealt with as a separate section.

Within the group of volumetric feeders there are numerous suppliers, a plethora of techniques to ensure consistent fortification mix density and flow of fortification mix and a wide range of prices to match. Regrettably there are some very cheap and tatty instruments in the market and even some of the more expensive models offer more than they often supply.

Micro feeder Problems

The following pictures illustrate some of the problems that can occur during micro feeder operations:



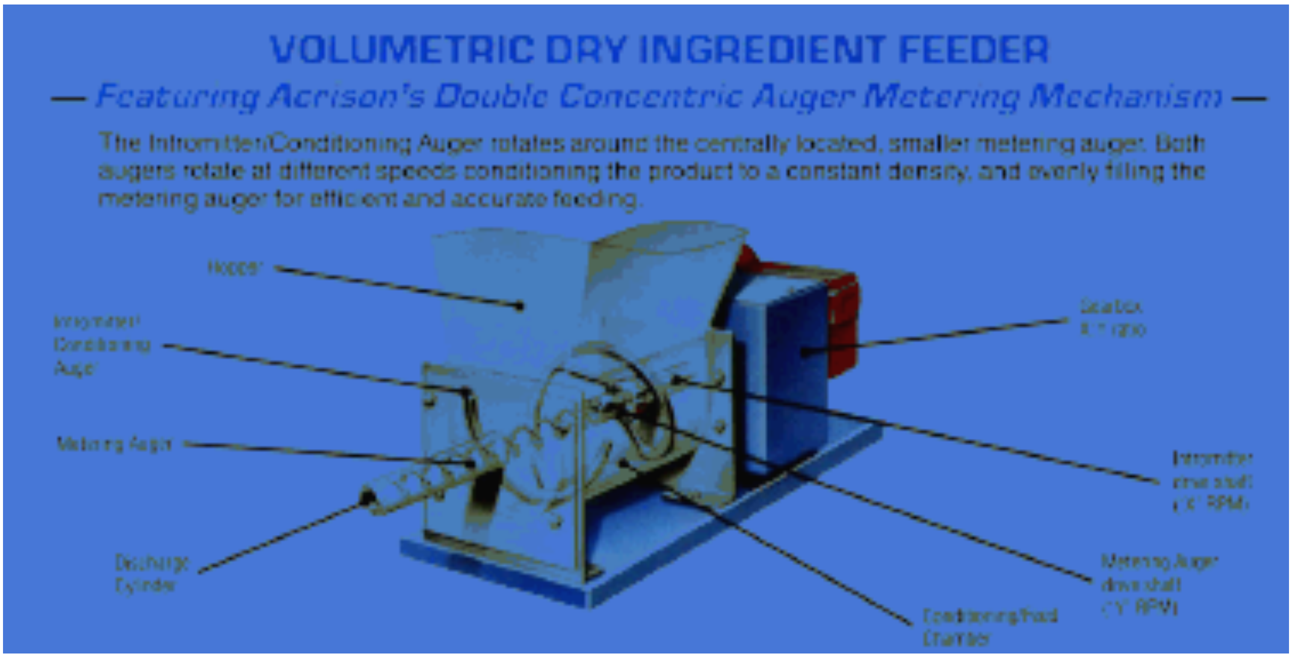
Common problems with micro feeders

- Bridging, or rat holing, is very common due to the hygroscopic nature of the fortification mix. In this scenario the hopper appears full and the assumption is made that the feeder must be feeding. Unless the outlet is checked, which it should be, this problem can go unnoticed for some considerable time. This problem also occurs most frequently in mills that do not operate continuously i.e. operate only 1 or 2 shifts, or operate only 5 days per week.

- Tunneling is more readily seen and is more a result of poor machine design than the fortification mix.

Design Considerations

Both problems are overcome, within reason, by the use of varying designs of conditioning screws and/or vibrating plates. One of the more sophisticated variants is illustrated below:



Cut away diagram of a micro feeder

A further benefit of these design features is that they keep the specific density of the fortification mix constant so facilitating even flow and even weight delivery of the fortification mix (if the specific gravity is constant and the machine delivers a constant volume then the weight delivery will be constant).

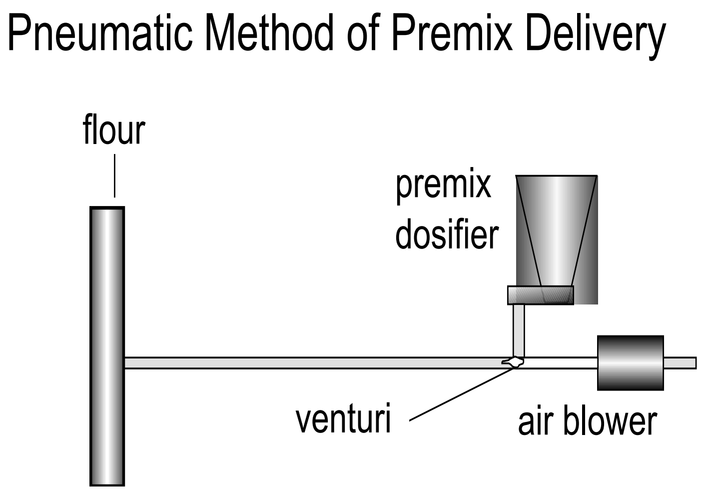
Also important to efficient operation is the design of the feed screw or screws. The choice of feed screws is critical: factors such as single or double screw and constant or variable pitch need to be considered both in terms of cost and efficiency of operation.

The other two common faults illustrated above also require addressing. In the case of the maize meal or bread flour meal ceasing to flow and the micro feeder continues to operate we have a situation in which too much fortification mix will be mixed with the carrier. Whilst there is minimal risk of poisoning the consumer – the taste will be terrible – the miller does run the risk of losing a client. The most common solution to this problem is to link the power supply for the micro feeder to that of the plansifter (larger mills) or to that of the rolls or product conveyor (medium and small mills).

The reverse scenario in which the micro feeder runs empty is mitigated by regular inspection – which should be implemented anyway – and in many micro feeder designs by a low level alarm on the unit itself.

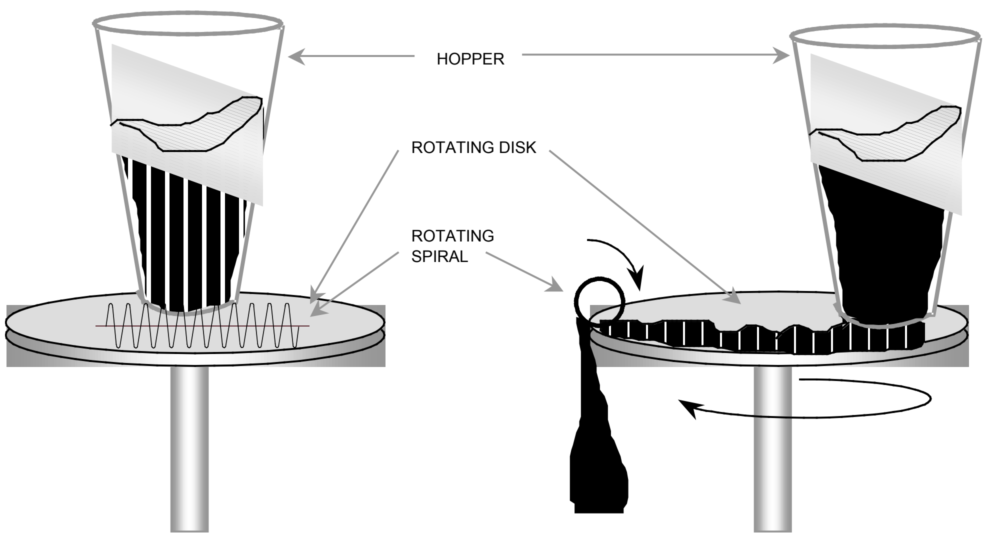
Other Types of Micro feeders

Rarely seen these days are delivery systems based on the Venturi principle in which a blower creates a vacuum resulting in the fortification mix being sucked into the air stream and so delivered to the bread flour or maize meals. The principle is illustrated below:

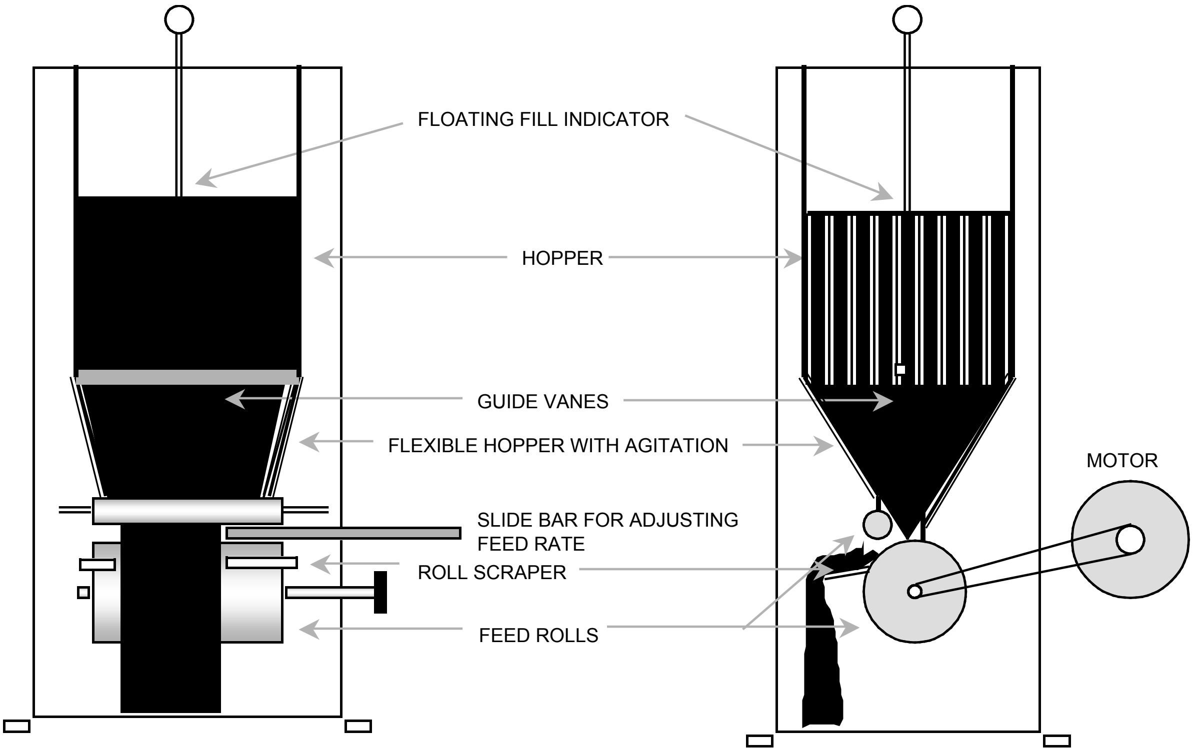


Schematic of the Venturi system

Also rarely seen are the disc feeder and the belt feeder types:



Schematic of the disc feeder system



Schematic of the belt feeder system

Cost Implications

Capital cost is not the only cost implication. Whilst the highly automated systems are the most expensive to purchase they have the lowest on going cost component for labour and quality assurance. Measuring the flow rate of flour or meal in the mill is a time consuming process and one which, regrettably, many small millers do not consider important enough to incorporate into their quality control protocols. Many consumer complaints could be prevented through such measures. Similarly accurately weighing by hand the required addition of fortification mix requires a relatively expensive balance that is very portable (and therefore subject to theft), and check procedures have to incorporated to prevent accidental omission or double dosing. The miller needs to be urged to take a holistic approach and itemise (with costs) every additional component they need i.e. another auger, a holding bin, a balance etc and then make the decision regarding which option to take. They are urged to get the supplier to install the equipment – many a simple and expensive error can be avoided.

Density (Specific Gravity) Variation

The density (mass per unit volume) of the fortification mix is relatively consistent – within a single supplier but does vary between suppliers. The density of the maize meal or bread flour is anything, but consistent. Factors such as atmospheric humidity, moisture content, temperature, use of pneumatic transfer systems, condition of rollers and sieves, simple vibration and many other parameters can significantly affect the density of the bread flour or maize meal. This occurs not only between different mills, but also within the same mill over a relatively short period of time. It is not just the flow rate (mass per unit time) that is inconsistent.

The variability of your production can be easily calculated by weighing, rather than counting the production bags, over a fixed period of time i.e. 30 minutes. This exercise should be repeated over several days, preferably at different times of the day. The production rate in kilograms per minute can then be calculated for each occasion. The variation in this rate will also be apparent, as will the magnitude of the variation compared to the average production rate. Smaller mills (less than 500 kg per hour) will probably find they have a higher percentage variation than the larger millers.

The density of the production can be ascertained in a similar manner. The following suggestion is taken from the determination of hectolitre mass (hektolitermassa) many will be familiar with:

1. Take a fixed volume container i.e. a bucket and weigh it while empty. Fill the container with water and reweigh. As water has a density of 1.000, the volume of the container in liters is simply the weight of water in kilograms.

2. Place the container (dry) underneath the flour or meal outlet at some fixed distance below that outlet. The distance should not be too great or the product may bounce out of the bucket; it should also not be too close or the bucket will not fill up in its entirety. Let the bucket fill completely to overflow level and gently remove it from under the flow outlet without knocking it in any way. Gently, but firmly, scrape the excess product off the top of the bucket. Weigh the container and the product and the weight of product in the container can now be calculated and the density determined.

3. Repeat this procedure over several days, preferably at different times of the day. Smaller mills (producing less than 500 kg per hour) will probably find that they have a higher percentage variation than larger millers.

Mixing

Mixing, as stated earlier, is often overlooked. In the photograph below (showing the inner workings of a Snell 3-in-1) it can be seen that on the right hand side of the photograph the system consists of the familiar auger whereas the left hand side contains paddle arms. Auger move product along – they do not mix very effectively at all. The paddle arms, which are adjustable, do mix and very effectively. In a length as short as 1 metre some effective mixing can occur – with two metres the mixing is very effective indeed. The system starts with the auger then changes to the paddles as shown below.

Auger into paddle mixer from a Snell 3-in-1

The default system in mill conveyors is the auger system – as the conveyors are normally covered and screwed down many millers have no idea what is actually inside the conveyor. A common mistake.

This type of mixer with a micro feeder can, therefore, be incorporated into almost any type of milling operation – even hammer mill systems. Once the grain has been milled AND (very importantly) sieved the mixing paddles and the micro feeder are placed in the line leading to the packing station. The miller could even have a flour/meal silo as an interim buffer stock holding facility (which would also aid in producing a more consistent product) and then fortify out of that silo.

Positioning the Micro feeder

The positioning a micro feeder is also important. If the micro feeder is placed too early in the system then there will be too little stock (maize meal or bread flour) in the system. Too late in the system and the time for mixing is inadequate. In a mill with multiple streams entering the conveyor then a reasonable guideline would be half to two-thirds of the way down the system; in a mill with few streams the miller is forced to add after the entry point for the streams but to ensure the distance between addition and packing is at least one metre and to adjust the paddle angles for maximum displacement.

MICROFEEDERS

Calibration & Control

health
Department: Health
REPUBLIC OF SOUTH AFRICA

gain
Global Alliance for Improved Nutrition

L'Initiative pour les micronutriments
The Micronutrient Initiative

unicef

CALIBARTION AND CONTROL

Initial calibration

Firstly obtain an insight into the delivery capabilities of the micro feeder by carrying out the following:

- Half fill the hopper with maize meal or bread flour (this has a similar density to the fortification mix).
- Turn the adjusting dial to 90% of maximum and let the machine run for 1 minute.
- Place a bowl under the outlet and collect the meal or flour coming out of the micro feeder for exactly 60 seconds.
- Weigh the meal or flour.
- Turn the adjusting dial to 10% of maximum and let the machine run for 1 minute.
- Place a bowl under the outlet and collect the meal or flour coming out of the micro feeder for exactly 120 seconds.
- Weigh the meal or flour.
- Calculate the results as “quantity delivered in 1 hour” – remember that the result on setting 10 was taken over 2 minutes and not 1 minute as for setting 90

Draw a graph (put the machine settings 10 and 90 on the “x” axis (the horizontal line) and the quantity delivered on the “y” axis (the vertical line) of the results and join the two points.

The formula for calculating how much “fortification mix” an individual mill will require is:

(A / 1000) x B = quantity of fortification mix required per hour

Where A is the amount of fortification mix, in grams, required to fortify 1 MT (1000Kg) of maize meal or bread flour. This amount is prescribed by the fortification mix supplier, in conjunction with the Department of Health, and will be clearly indicated on the container of the fortification mix.

Where B is the quantity of maize meal or bread flour being produced in 1 hour.

For example a mill producing 3,200Kg of maize meal or bread flour an hour and using a fortification mix requiring 250g to be added per MT the micro feeder should be set to deliver

(250 g / 1000 Kg) x 3200 Kg = 800 g

Look up 800 on the y axis and read off the corresponding value on the x axis. This is the setting the micro feeder should be set to so as to deliver 800g.

NOTE: We have taken 10 and 90 as our extreme points as there is a chance, particularly at very low settings, that the micro feeder will have higher errors. Many manufacturers will specify the operating range and there values should be used.

Final calibration

For the final calibration it is important we use the actual fortification mix. Three settings need to be chosen and, at each setting, we need to take multiple readings.

The most important setting is close to the one that the mill will be routinely using i.e. the one calculated above to deliver 800 g. Choose a setting that is easily made i.e. the target setting is 43 so choose a setting of 40 (the dial is usually calibrated in units of 10, though some have thumb wheels). Then choose 2 other settings equidistant around the above setting i.e. 10 and 70 (30 either side of 40).

The full calibration method is as follows:

1. Set the micro feeder on the lowest setting and let it equilibrate for 60 seconds.
2. Place a receptacle under the outlet and catch the delivered fortification mix for 120 seconds.
3. Weigh the delivered fortification mix and multiply that weight by 30 to get the weight delivered in 1 hour.
4. Record the result
5. Repeat 2, 3 and 4 four more times so that you have 5 results in total.
6. Check the results do not vary significantly – you should not have a variation of more than 2% between the lowest and the highest values. If you do have a wide variability then repeat 2, 3 and 4 at least one more time.
7. Average the results obtained and plot on the graph “setting X quantity delivered in 1 hour Y”

8. Set the micro feeder on the highest setting and equilibrate for 60 seconds.

9. Place a receptacle under the outlet and catch the delivered fortification mix for 120 seconds.

10. Weigh the delivered fortification mix and multiply that weight by 30 to get the weight delivered in 1 hour.

11. Record the result

12. Repeat 9, 10 and 11 four more times so that you have 5 results in total.

13. Again check the results do not vary significantly – you should not have a variation of more than 2% between the lowest and the highest values. If you do have a wide variability then repeat 9, 10 and 11 at least one more time.

14. Average the results obtained and plot on the graph "setting X quantity delivered in 1 hourY"

15. Set the micro feeder on the middle setting and equilibrate for 60 seconds.

16. Place a receptacle under the outlet and catch the delivered fortification mix for 120 seconds.

17. Weigh the delivered fortification mix and multiply that weight by 30 to get the weight delivered in 1 hour.

18. Record the result

19. Repeat 16, 17 and 18 four more times so that you have 5 results in total.

20. Again check the results do not vary significantly – you should not have a variation of more than 2% between the lowest and the highest values. If you do have a wide variability then repeat 16, 17 and 18 at least one more time.

21. Average the results obtained and plot on the graph "setting X quantity delivered in 1 hourY"

22. You should be able to draw a straight line through all 3 points.

23. Clearly enter the following information on the graph

- Date
- Name of person performing the calibration
- Fortification mix details – Supplier and Batch Number

This now a valid calibration curve for this particular batch of fortification mix.

From experience it has been noted that batch to batch variation from the same fortification mix supplier is very small if at all. Changing suppliers does, however, usually require a new calibration curve being generated. This is because different suppliers use different diluents (carrier) i.e. calcium carbonate, maltodextrin etc

If you replace any part of the micro feeder then recalibration is required.

It is recommended that the calibration be routinely redeveloped at least every 6 months.

Using the calibration curve

The calibration curve can now be used in conjunction with mill production data using the equation shown earlier:

The repeatability above measures only the variability of the discharge – it does not provide information about whether the feeder is delivering, on average, the targeted rate.

The formula for calculating how much "fortification mix" an individual mill will require is:

(A / 1000) x B = quantity of fortification mix required per hour

Where A is the amount of fortification mix, in grams, required to fortify 1 MT (1000Kg) of bread flour. This amount is prescribed by the fortification mix supplier, in conjunction with the Department of Health, and will be clearly indicated on the container of the fortification mix.

Where B is the quantity of maize meal or bread flour being produced in 1 hour.

From the formula and the graph you will be able to determine the setting required for the micro feeder.

Final adjustment

The above calculations have resulted in an estimate of the setting required on the micro feeder. It is very important that setting be checked and that the checking be repeated as indicated in QA Protocols.

- Set the micro feeder to the setting estimated above and let the micro feeder equilibrate for 60 seconds.

- Place a receptacle under the outlet and catch the delivered fortification mix for 120 seconds.

- Weigh the delivered fortification mix and multiply that weight by 30 to get the weight delivered in 1 hour.

- Compare the achieved result with the result actually required.

- Adjust the micro feeder setting and repeat if required.

QA protocol

It is important that the micro feeder performance be checked on a regular basis. Adding too little fortification mix is against the regulations and will not delivery the expected nutritional improvement to the customer. Adding excessive amounts of fortification mix will be detrimental financially. Over dosing of fortification mix is unlikely to pose any dangers to the consumer. This is because the maize meal and bread flour products i.e. bread, will have a strange taste that the consumer will object to. This occurs at dosage levels well below those likely to cause toxicity. Whereas the consumer will not be harmed they will, however, be unhappy and unhappy consumers do not, usually, become repeat customers – as a result business suffers.

Routine Checks

The following checks should be performed every two hours and the results of such checks properly and formally logged. This log will provide evidence of “due diligence” to the relevant inspectorate.

- Check the product delivery from the micro feeder by weighing the quantity delivered in 120 seconds and comparing it to the targeted delivery rate. Adjust if necessary and recheck delivery a few minutes later.

- Perform the spot test on the flour at some suitable point after the end of the meal or flour collection conveyor.

The methodology for the spot test is given in the section on Rapid Test Methods on the CD.

QUALITY Assurance

QUALITY ASSURANCE

The objectives of this section are to:

- Provide information on what needs to be done to ensure that regulatory and consumer requirements are met.
- Improve knowledge regarding record-keeping and monitoring procedures that have to be instituted to be compliant with the quality assurance scheme.
- Improve understanding of different elements of the inspection procedure to be followed.

Control and Monitoring Systems

Quality assurance / quality control is the total of the organised arrangements made with the objective of ensuring that food products are of the quality required for their intended use at consumer level. Implementation of quality control within the National Food Fortification Programme (NFFP) lies with the manufacturer and government (national, provincial and local levels). It is important to ensure quality control processes comply with food fortification regulations.

Mill Quality Assurance and Quality Control

An effective quality assurance / control system is vital to maintain the quality of fortified food stuffs as they are released in the market place. The standard procedures for mills to ensure maize meal and bread flour are properly fortified include:

- The use of quality and appropriate equipment and weighing units.
- Keeping correct fortification mix inventory records.
- Proper handling and storage of fortification mix.
- Keeping correct production records.
- Conducting regular equipment inspection, once every 8 hour shift.

- Conducting regular analytical tests of maize meal samples to verify that they have been properly fortified.

- Proper labeling and packaging.

Implementation of quality assurance and quality control systems requires full cooperation of millers and government enforcement units

The following steps must be taken by the manufacturers of fortified maize meal and bread flour to ensure quality control of the fortification process:

- Purchase blending equipment and / or feeder(s), weighing scales, and learn how to use the equipment properly – this is dealt with in more detail in the sections on Addition methods and Micro feeders Questions to ask.

- Purchase fortification mix from suppliers that have been registered with the DoH – more details provided in the section on Fortification mix suppliers.

- Store fortification mix in air-tight containers well protected from exposure to light or under the conditions laid down by the manufacturer. It is ideal to keep fortification mixes in their original containers. Once opened, exposure to the light and air should be minimized to prevent product degradation.

- Obtain and keep on record a certificate of compliance (CoA) for every batch of fortification mix.

- Employ, and adhere to, strict stock rotation procedures to prevent old stock losing potency and to comply with the shelf life expiry date. It is recommended you employ and implement the first in, first out (FIFO) system for this purpose.

- Keep records of grain procurement;

- Keep records of fortification mix inventory and usage;

- Keep production records of the amount of fortified maize meal and bread flour produced;

- Keep monthly records of the amount of fortification mixes used every month. These records shall correspond with the monthly production records;

- Ensure that all critical stages of the manufacturing process are monitored to ensure the correct dosage levels are maintained through the following measures:

- Checking of fortification mix feeders at least once a day to ensure they are delivering the correct dosage levels. This can be done by measuring the weight of fortification mix discharged over a specific time (1 or 2 minutes) and comparing the measurements with the target weight of fortification mix.

- Performing visual checks at least twice per shift to ensure fortification mixes are being used and that no blockages have occurred, and keeping record of this.

- Performing iron spot tests on the maize meal or bread flour at the start and end of each production run to ensure the product has been dosed correctly.

- Make all of these records available for inspection by environment health practitioners (EHP) when required. EHPs are responsible for monitoring the fortification program and in implementing inspection or monitoring systems for all fortified food products.

Quality Assurance Forms

The forms that follow are examples of tools that can be used to establish a quality assurance protocol that will indicate to an EHP that the mill is doing its best to comply with regulations. These can be used as they are or can be modified to suit the miller's particular needs.

Fortification mix procurement and receival

- Keep a track of all aspects of your fortification mix procurement.

- Who you procured from, when and what.

EXAMPLE OF A FORTIFICATION MIX RECEIVAL RECORD

Supplier				
Type Maize / Wheat				
Batch Number				
Certificate of Ananlysis				
Quantity				
Delivery Date				
Order Number				
Invoice Number				
Invoice Amount				
Issue Date				
Voucher Number				
Signature				

Instructions mix receival record

Completion of the form

A duly authorised person in administration should complete this form.

Supplier:

Note that under the Foodstuffs, Cosmetics and Disinfectants Act, 1972 (Act No 54 of 1972), regulations governing the fortification of foodstuffs R-504 7th April 2003 suppliers of pre-mix must be registered with the Department of Health. The onus is on you, the buyer, to ascertain that the supplier is actually registered. See fortification mix supplier section for details.

Type:

The maize meal and bread flour fortification mixes have different formulations and should no be used and should not be interchanged.

Batch number and certificate of analysis:

Registered suppliers have been instructed to retain adequate records to prove compliance with the specifications laid down for each fortification mix. Retaining the copies issued with each delivery reduces the administrative liability placed on the buyer. Copies of "Certificate of Analysis", batch numbers and invoice tracking should be kept for 6 months.

Voucher number:

It is strongly recommended that a requisition system be utilised to monitor the fortification mix. As a concentrate, the product has a limited shelf life.

Order number, invoice number and amount:

Such records facilitate audit control.

Certificate of fortification mix compliance (CoA)

The format of the fortification mix Certificate of Analysis is prescribed in Annexure IV of the legislation

The actual appearance of the CoA differs from one fortification mix supplier to another but all the essential information is still provided.

The CoA is a very important document as it forms the first line of quality assurance and of the monitoring and enforcement programme. This document recognizes that millers have neither the time nor the necessary skills to test the fortification mix to ensue it meets specification. As such Government have placed the onus of the supplier to guarantee that the fortification mix you have procured will meet the necessary standards until such time as the package is opened (the mix could now be tampered with) or until the expiry/use before date on the package.

Suppliers have to register each year and provide independent verification that they are complying with the legislation. Should the contents of the fortification mix not meet the stated specification then the supplier, not the miller, will be deemed to be at fault. Your only requirement is to procure from registered suppliers, or their agents, with the onus on yourself to ensure they are registered – more details of this process can be found in the section on Fortification Mix suppliers on the CD.

Having demonstrated that the correct fortification mix has been procured from a registered upplier or their agent it is now only necessary to demonstrate that the fortification mix is being added as required by the regulations.

Process quality control

One possible technique is given below – it is recommended that a single person per shift be allocated this specific duty:

Example of an On-line process control sheet

Date:					
Time	Operator	Low	Target	High	Comments

Instructions

Use one sheet per shift rotation period i.e. 24 hours.

Indicate spot test result, compared to photographs, with an ‘X’ – typical photographs are illustrated below for convenience.

Use comment section for any action taken i.e. “feeder adjusted”

Any millers like to take a sample o their production over an extended period of time so that they can submit some to a laboratory for confirmatory wet chemical analysis. Should you wish to follow that example then the steps below are the ones commonly used.

Retain one teaspoon of product from each hour’s production

Blend above samples to produce a 24 hour composite sample

Blend 7 daily samples to produce a weekly composite sample and retain +/- 500 grams of this weekly sample. Discard remainder of the weekly composite sample

Blend 4 weekly samples to produce a monthly composite sample and retain +/- 500g of this monthly sample. Discard the remainder of the monthly composite sample.

Example of iron spot test on flour with different levels of added iron.

No added iron **30 ppm** **50 ppm**

Bagging and stock control

Many mills have complex bagging and stock control systems. Inventory control forms a crucial part of establishing "due diligence" and, therefore, compliance with the regulations governing fortification. It also proves vital in financial control and establishing whether stricter stock control measures are necessary.

For many millers, inventory control once a week may be adequate, for others a daily report may be deemed essential. For "due diligence" once per week (minimum) is required.

The form below has been demonstrated useful:

Example of an inventory control record

PERIOD START	DATE		TIME			
					CONCENTRATE TYPE	
PERIOD END	DATE		TIME			

Opening Concentrate Stock in Kilograms Physical stock as at Period Start – being the number of sealed boxes multiplied by 25kg plus the total actual weight of opened boxes.	A			
Concentrate Stock Received in Kilograms Total stock received between Period Start and Period End – being the number of boxes received multiplied by 25kg	B		TOTAL 1 A + B	
Closing Concentrate Stock in Kilograms Physical stock as at Period End - being the number of sealed boxes multiplied by 25kg plus the total actual weight of opened boxes.	C			
Concentrate Stock Loss in Kilograms Total stock loss between Period Start and Period End due to returns, damage etc.	D		TOTAL 2 C + D	
E. TOTAL WEIGHT OF CONCENTRATE USED FOR PERIOD TOTAL 1 – TOTAL 2				

BAG TICKET NUMBER	ROW 1	ROW 2	ROW 3	ROW 4	ROW 5
Finish The last bag number used during period					
Start The first bag number used during period					
Total Bags per Row Finish bag number minus Start bag number plus one					
Bag Size I.e. 65kg/ 50kg/ 15kg/ 125kg/ 10kg etc					
F Total Row Production Total Bags per Row for the period multiplied by Bag Size	F1	F2	F3	F4	F5
G. TOTAL WEIGHT OF PRODUCTION FOR PERIOD **F1 + F2 + F3 + F4 + F5**					

Total Theoretical Concentrate Usage Total Production for Period divided by the optimum concentrate dosage per kilogram G ÷ 0.02	H		
Total Actual Concentrate Usage As calculated for total E	I		
DIFFERENCE BETWEEN THEORETICAL CONCENTRATE USAGE AND ACTUAL CONCENTRATE USAGE **H – I**			

QUESTIONS ON

Micro feeders

health
Department:
Health
REPUBLIC OF SOUTH AFRICA

gain
Global Alliance for
Improved Nutrition

L'Initiative pour les micronutriments
The Micronutrient Initiative

unicef

MICRO FEEDERS - QUESTIONS TO ASK YOURSELF AND THE SUPPLIERS

How accurate is the micro feeder?

Feeder accuracy, in itself, is not a single determinant. It is a function of repeatability, linearity and stability. Repeatability is consistency of feed at a given setting; linearity is how accurately the feeder discharges across the operating range and stability is performance drift over time.

- **Repeatability**
  Commonly termed precision this factor is the most familiar to users and is a measure of the short term consistency of the discharge rate. It is important to quality assurance because it measures the variability of the discharge feed and hence of the final product.

  Repeatability is measured by taking a series of timed samples from the discharge stream, weighing them, calculating the standard deviation and expressing that deviation as a percentage of the mean value of the samples taken (coefficient of variation). Given a coefficient of variation of 0.2% a variation of 1 deviation (±) means that in 68.4% of cases the variation from the mean will be ± 0.2%; for 2 deviations 95.5% will be mean ± 0.4%. Traditionally 2 deviations (sigma) are considered acceptable.

  A definition of repeatability should include both the variability and the method used to determine that variability assessment i.e. ± 0.5% of average @ 2 sigma based on 20 samples of 1 minute.

  Repeatability measures only the variability of the discharge – it does not provide information about whether the feeder is delivering, on average, the targeted rate.

- **Linearity**
  To perform linearity several groups of samples need to be taken across the stated operating range, and these values then averaged to produce a single value. Again average values and deviations are calculated. A linearity statement would, therefore, look something like ± 0.2% based on 5 samples of 1 minute over a range of 5% to 100%

- **Stability**
  This is perhaps the most important criteria, and the one most overlooked. Many factors contribute to drift – some are the characteristics of the fortification mix the rest are feeder related. Drift is checked by calibration checks – the more often and severe the drift the more checks, and adjustments, are required. This is a hidden on-going cost to the miller and out of specification product (which carries its own economic consequences).

You should ask the supplier about the above factors. Remember however, the tighter the variation the higher the cost is likely to be.

Note 1: this does not include the variation in the flow rate of the mill product i.e. the maize meal or bread flour.

Note 2: this will typically be 5 to 100% but millers should be wary of using a feeder that is operating so close to the limits of its capability.

A Hypothetical Example				
Product Produced per Hour Kg	Fortification Mix Required	Gives 1% overage	Gives 2% overage	Gives 5% overage
1000	200	202	204	210
5000	1000	1010	1020	1050
10000	2000	2020	2040	2100
15000	3000	3030	3060	3150
Cost of Fortification Mix per Kg Rands	Cost of Fortification Mix per g Rands	Cost of 1% overage per shift (8 hrs) Rands	Cost of 2% overage per shift (8 hrs) Rands	Cost of 5% overage per shift (8 hrs) Rands
150	0.15	2.40	4.80	12.00
150	0.15	12.00	24.00	60.00
150	0.15	24.00	48.00	120.00
150	0.15	36.00	72.00	180.00
Shifts per day @ 1% overage	Cost per Month 20 days	Cost per Month 30 days	Cost per year 220 days 30 per month	Cost per day 360 days 30 per month
1	48.00	72.00	528.00	864.00
2	96.00	144.00	1056.00	1728.00
3	144.00	216.00	1584.00	2592.00
Shifts per day @ 2% overage	Cost per Month 20 days	Cost per Month 30 days	Cost per year 220 days	Cost per day 360 days
1	96.00	144.00	1056.00	1728.00
2	192.00	288.00	2112.00	3456.00
3	288.00	432.00	3168.00	5184.00
Shifts per day @ 5% overage	Cost per Month 20 days	Cost per Month 30 days	Cost per year 220 days	Cost per day 360 days
1	240.00	360.00	2640.00	4320.00
2	480.00	720.00	5280.00	8640.00
3	720.00	1080.00	7920.00	12960.00

One of the best ways to establish if really minimal variation is necessary is to look at the cost in terms of fortification mix. The variability will be both positive and negative but it tends to shift towards the negative (give higher overages) as the fortification mix becomes compacted.

The more QA checks that are put in place the more frequently the overage is reset to zero but costs can rapidly spiral out of control. Obviously the higher the volume the greater the potential losses but even with the cheapest volumetric feeder on the market and a low overage with single shift and a five day week the loss is potentially 7.5% of the initial capital outlay per year. Volumetric or Gravimetric?

Gravimetric feeders

By definition gravimetric feeders measure the weight and adjust output to maintain the desired discharge; volumetric feeders do not weigh the discharge they deliver a set volume of material per unit time (based on the constraints mentioned above) which is translated to an inferred weight based on the manual calibration.

Volumetric feeders

Volumetric are simple and cheaper but cannot detect or adjust to variations in the fortification mix. For materials that do not vary significantly in density this is not an issue. Fortification mixes do vary. Variation in density between individual suppliers can be accounted for in the calibration. Variation in density over time requires that the feeder minimise the effect. The mill is constantly vibrating causing compaction of the fortification mix and, therefore, an increased weight per unit volume discharge. Conditioning augers and various other techniques are crucial to the minimisation of this density effect.

Volumetric feeders are the most common in the food industry but such density variation must be addressed. This density variation will be clearly seen in the stability tests.

What type of screw feeder?

Volumetric feeders deliver a set volume per unit time. Altering the flow rate is accomplished by altering the screw speed. As indicated in the section "Methods of Addition" and above a range of screw designs, sizes and geometries plus agitation systems are used (or not in some cheaper systems) to optimise discharge characteristics.

Three main factors influence screw feeder accuracy, namely the consistency of the delivered volume per screw revolution, the accuracy of screw speed control and the material density variation.

Free flowing materials fill the screw consistently – as the fortification mix is slightly hygroscopic- this flow ability must be protected by the miller taking suitable care of the fortification mix. Materials can also be too free flowing – termed floodable – and flow uncontrollably through the screw. Back stream blockages are likely to remain undetected for considerable time unless suitable protocols are instituted i.e. visual check of discharge.

The supplier is in the best position to advise the best configuration for the fortification mix – the technology behind single or double spiral, single or double auger, fixed or variable pitch etc has been developed for a reason; they each work best in specific circumstances. Suppliers should be in a position to offer alternatives and always insist on a demonstration.

What are the main trouble shooting and maintenance issue?

- **Training**

  Assuming the feeder was properly selected and engineered then most problems arise from improper installation, inadequate maintenance, lack of operator and maintenance training and changes in the fortification mix or operating conditions.

  Many micro feeders look "plug and play" and suppliers usually offer installation as a "costed extra". Many problems can be avoided both at the outset and in the future by ensuring staff receive adequate training and problem solving skills and supplier installation should be viewed as insurance for the future.

- **Fortification Mix**

  If a feeder was selected, engineered and configured to handle a particular fortification mix changes to the fortification mix or operational requirements can cause unanticipated problems. As changing the fortification mix may alter flow characteristics outside the anticipated range you may find that changing back to the original fortification mix supplier may be the most viable option. Increasing the capacity of the mill may take the discharge rate outside the feeders capabilities – many feeders have the capability to be re-ranged, something to consider if expansion is on the horizon. Variation in ambient temperature and/or vibration can also lead to problems – the supplier is often the best source of advice.

- **Speed Control**

  With volumetric feeders the most common cause of problems is the integrity of the speed control and a change in the volume per revolution relationship.

  If the speed sensor does not perform accurately then control is impossible. Depending on the specifics of the mechanism then cleaning or replacing is usually required. It is always best to first check if its not a loose connection (see the importance of supplier installation and training).

  If the screw speed control is not the problem then the most likely cause is the volume per revolution relationship. The most likely reason is a build up preventing consistent flow. The short term solution is to strip and clean the screw and/or discharge tube. The more permanent solution may require a change in screw design, bin design, or agitation or even something else. Such modifications are usually more expensive than procuring the correct feeder in the first place.

Check that adequate training is offered and confirm with staff that the training has been absorbed.

Some things to look for

- Interchangeable screws, hoppers etc
- Easy cleaning through quick disassembly
- Minimal moving parts with durable seals
- Material handling mechanisms to minimise compaction and maximize screw fill
- Accuracy
- Low operating cost
- Easy maintenance.

Much of the above, and recommended further reading, came from:
Feeder Accuracy and Performance Timescales; Feeding Technology for Plastics Processing[3]

[3]Documents available from K-Tron Soder e-mail ka@ktron.com

RAPID
test methods

health
Department: Health
REPUBLIC OF SOUTH AFRICA

gain
Global Alliance for Improved Nutrition

L'Initiative pour les micronutriments
The Micronutrient Initiative

unicef

RAPID TEST METHODS

Annxure II (4c) in the regulations relating to fortification require that the millers should

perform two-hourly spot checks to ensure that the product has been dosed correctly by determining one of the components of a fortification mix according to the appropriate analytical method.

Analysis of vitamins and minerals is a time consuming and expensive process. For this reason rapid tests have been developed that give basic information about one of the components in the fortification mix. Below you will find three rapid tests to perform the two hourly spot checks. The most commonly used, worldwide, is the iron spot test. Two variants of this test are given below.

Photographs of typical results are in the section on **Quality Assurance.**

Of the three only the potassium thiocyanate method for iron, is suitable for use in a maize or wheat mill.

Types

Iron spot test – potassium thiocyanate and potassium ferricyanide

The thiocyanate method is the recommended method until the iron source used in South Africa is changed to a more bioavailable form. The method is included as the form of iron used in the fortification mix is being reconsidered. If this change takes place then the ferricyanide method will be the preferred choice as it uses fewer chemicals and is safer to use. The ferricyanide method does not work effectively with electrolytic iron so should not be used at present. When the iron source is changed you will be advised so by the fortification mix suppliers and by the Department of Health.

Vitamin A rapid test

The Vitamin A spot test is not recommended for use in the mill though this method is being used by various laboratories.. This method is not recommended because dichloromethane is very volatile which makes “field” use difficult Trichloroacetic acid is highly irritant if you get any on your skin. Secondly the transitory colour change is very rapid in “field” conditions a matter of seconds which often leads to a false negative conclusion. Finally the sample size is as small as that used in more conventional wet chemical analysis but the operator is expected to "solubilise" the Vitamin A (solution A is water) very rapidly – Vitamin A is light sensitive – which proves very difficult with fine maize meals and especially with wheat flour (you can alleviate this slightly by adding the meal to the water rather than the other way round) due to clumping.

Source of the chemicals

The spot test requires three chemicals plus you will need plastic not glass measuring cylinders and some bottles. Hydrogen peroxide may be obtained at your local pharmacy.

Note you get different strengths of hydrogen peroxide. Look for the 30% solution. Hydrochloric acid and Potassium thiocyanate you can obtain from any of the big chemical suppliers such as:

Merck (tel: 011-345 9000) has regional offices in Johannesburg, Durban, Bloemfontein, Cape Town and Port Elizabeth and stock chemicals as well as plastic ware.

Sigma-Aldrich also a major supplier of chemicals (tel: 011-979 1188), Head office in Kempton Park, but delivers throughout S.A.

For plastic ware you can also contact C.C. Immelman (tel: 011 680 5670/1)

Another source may be your local High School Chemistry Department. You may be able to include the fortification of maize meal and bread flour into one of the classes in school where the children bring in maize meal from home and test it to see who is having fortified maize meal – good publicity.

Important safety issues

All chemicals should be treated with considerable respect as they can be dangerous. This particularly applies when diluting concentrated hydrochloric acid.

ALWAYS add acid to water, never the other way round. It is advisable to wear some eye protection e.g. goggles when carrying this out. Dilute acid is relatively stable so you can make up 5 litres at a time. The hydrogen peroxide solution must be made up daily.

Methodology

Iron spot tests[1]

References:
AOAC Methods. 12 ed. Ferrous salts. Official Final Action (7.74).AACC Method 40-40.
Iron–Qualitative Method. First approval 5-5-60; reviewed 10-27-82.

Identification of the Iron Type Using Two Spot Tests			
Iron Type	KSCN/1 N-HCl	K3Fe(CN)6 / 0.003 N HCl	KSCN/ HCl-1N + H2O2
Fe (+3) NaFeEDTA	Red diffused spots	Greenish or brownish spots	Red spots
Fe (+2) – Ferrous sulfate	-	Intense blue spots (1 -2 minutes)	Red spots
Fe (+2) - Ferrous fumarate	-	Blue small spots (6-7 minutes)	Red spots
Fe (o) Electrolytic	-	Blue small spots (6-7 minutes)	Red spots
Fe (o) reduced iron	-	?	Red spots

Iron spot test method using potassium thiocyanate:

Principle:

Ferric iron, in an acidic medium, reacts with a solution of potassium thiocyanate (KSCN) to form an insoluble red pigment. Other types of iron, such as ferrous iron and elemental iron can also produce this reaction if they are oxidized to the ferric form.

Materials:

- Filter paper Whatman # 1
- Manual sieve.
- Watch glass.

[1] The following methodology has been extracted from a document and assays optimized by Hana Ali from the Palestinian University of Birzeit, with technical assistance from Dr Omar Dary, MOST, the USAID Micronutrient Program.

Reagents:

- HCl – 2 N. To a 500 ml beaker, add 100 ml distilled water. Then pour slowly 17 ml of concentrated HCl, and finally 83 mL more of water.
- Potassium Thiocyanate-10%. Dissolve 10 g of KSCN in 100 ml water. Previous to use, mix 10 mL of this solution with 10 mL of HCl-2 N.
- H2O2-3% (only when iron is as elemental iron or as a ferrous salt). Add 5 ml concentrated H2O2 (30%) to 45 ml distilled water. Prepare daily. Discard after finishing the analysis.

Procedure:

1. Place the filter paper over the watch glass.
2. Wet the surface of the filter paper with the acidic solution of potassium thiocyanate. Let the liquid penetrate the fibers of the paper.
3. Using a hand sieve, sift portion of the flour sample in order to load a think layer over the entire wet area. Take out any excess.
4. Add a little more of the acidic solution of potassium thiocyanate over the flour.
5. Let a few minutes for the reaction to occur.
6. Red color spots identify the presence of a ferric salt, such as NaFeEDTA.
7. To the negative cases add the solution of H2O2. Red spots reveal the presence of iron added from any source.

Interpretation:

Number and distribution of spots are indicative of the homogeneity and iron level of the sample. Use samples with known amounts of the same type of iron that is expected to make a comparative assessment.

Iron spot test method using potassium ferricyanide:

Principle:

Ferrous iron, in an acidic medium, reacts with a solution of potassium ferricyanide (K3Fe(CN)6) to form an insoluble bright blue pigment called Turnbull's blue. Nevertheless, the reaction is slow –if any- with ferrous fumarate because the low solubility of this salt in water. Reaction may occur with electrolytic iron, but slowly due to the oxidation of this iron to Fe2+.

Materials:

- Filter paper Whatman # 1
- Manual sieve.
- Watch glass.

Reagents:

- HCl –0.006 N. To a 500 ml beaker, add 1.5 ml of 2 N-HCl. Fill to volume with distilled water.
- Potassium Ferricyanide-10%. Dissolve 2.5 g of K3Fe(CN)6 in 25 ml water. Prepare just before use, because this solution is unstable.

Procedure:

1. Place the filter paper over the watch glass.
2. Wet the surface of the filter paper with the solution of potassium ferricyanide. Let the liquid penetrate the fibers of the paper.
3. Using a hand sieve, sift portion of the sample in order to load a think layer over the entire wet area. Take out any excess.
4. Add a little more of the potassium ferricyanide solution over the flour.
5. Add the 0.006 N-HCl solution.
6. Let a few minutes for the reaction to occur.

Interpretation:

Blue spots would identify presence of ferrous iron. Brownish to greenish spots are indicative of ferric iron. Number and distribution of spots are indicative of the homogeneity and iron level of the sample. Use samples with known amounts of iron to make a comparative assessment. Ferrous sulfate reacts in 2 minutes, whereas ferrous fumarate or electrolytic iron in 6-7 minutes or longer.

V A Rapid Test[1]

MATERIALS AND METHODS

Materials

Screw-capped Kimax culture tubes (16x125mm)
Test tubes (15x100mm)
25mL Brown glass reagent bottles (screw-capped, PTFE insert)
Fibre glass filter paper discs (15mm diameter)
Glass rods
Plastic Pasteur pipettes (3mL graduated with bulb)

[1.] The following has been extracted from a document prepared by the University of Stellenbosch – Department of Human Nutrition – entitled "A kit for the semiquantitative determination of vitamin a levels in maize meal" by I M Moodie B.Sc., Ph.D, F.R.S.C., C.Chem. and D Labadarios B.Sc., M.B.Ch. B., Ph.D., F.A.C.N. Department of Human Nutrition, University of Stellenbosch and Tygerberg Hospital, P.O. Box 19063, Tygerberg, South Africa.

Reagents:

Dichloromethane (Burdick and Jackson, High Purity solvent)
Trichloroacetic acid (Merck)

Solutions:

Trichloroacetic acid (TCA) reagent: Dissolve trichloroacetic acid (60gm) in dichloromethane (30mL).
Store in a solvent resistant self-sealing bottle in the dark at room (>20oC) temperature.

Composition of vitamin A test kit:

10 x Test tubes
1 x Solution A (Distilled water)
1 x Solution B (TCA reagent)
30 x Fibre glass filter discs
3 x Plastic Pasteur pipettes
1 x Glass rod
1 x Colour-match card (Figure 1)
Instruction sheet

This kit may be used for up to ten tests. However, it can be scaled up for a larger number of determinations.

Colour chart depicting the shades of blue colour in relation to concentrations of vitamin A (IU/100g maize) in maize meal.

Procedure:

1. Add approximately 1gm maize meal to a test tube (or add maize meal to test tube to a level ±12mm from base of tube) and then add solution A (0.5mL); agitate the tube vigorously until the meal is thoroughly wetted.
2. Rapidly add solution B (3mL) and shake the tube for a few seconds to ensure mixing
3. Place three fibre glass discs into mouth of the test tube and, using the glass rod, depress the discs gently down the tube keeping them level so as to sweep the solid suspended material to the base of the tube.
4. Carefully withdraw the glass rod and place the tube in front of the colour card.

5. Determine from the colour card which colour shade is the closest match to the sample's blue colour in order to assess the approximate vitamin A level in the maize meal.
6. **NB**: Following addition of the TCA solution, work as rapidly as possible, since the blue colour fades and disappears after approximately 2 minute. If crushed ice is available, immersion of the tube containing the wetted maize meal in water/ice to chill the sample prior to TCA addition prolongs the colour stability and allows more time for colour shade comparison.

ADDITIONAL
Equipment

ADDITION EQUIPMENT

What type of addition equipment is suitable for me?

Not an easy question to provide a general answer to but the following guidelines may assist. Remember that by addition equipment we are including methods to generate a homogeneous mix of the fortification mix in the maize meal and the bread flour.

As classification of millers, for fortification equipment purposes, into small, medium and large is rather confusing we have to devise a method of distinction based around the implementation of fortification equipment technology.

Starting with the preferred technology micro feeders we can move down (generally not directly) the levels of sophistication – note this is not necessarily cost, in which I include not only capital upfront cost but also ongoing running costs.

Collection Conveyor

For a micro feeder to be viable the maize meal or bread flour must be moving in a stream that is virtually complete and will not undergo any further processing other than passing over a redresser prior to packing. Pneumatic conveying from point of addition to point of packing is permitted but should be of limited length and negative pressure is preferred over positive pressure systems (negative pressure is more common these days and leads to reduced levels of segregation). In essence we are looking for a meal or flour conveyor or – if one is not present in the mill (the collection conveyor) – a place to put one.

Most hammer mills pack directly off the mill. The same type of situation applies for most small roller mills only in their case they pack shortly after a basic sifter system that differentiates some of the mill products. The point of commonality is that there is no place or time to add plus mix between the last process (milling or sieving) and packaging. This does not have to be the case. It is a quite simple matter to place a suitable length of mixer/conveyor between the outlet from the mill or sieve and the packing head.

The technique that works best involves the use of an auger at the very head of the conveyor to generate a head of stock prior to the addition of the fortification mix. Once added the auger must be replaced by a mechanism designed for mixing i.e. a paddle system. A minimum of 1 metre of mixing is required – closer to 2 metres would be better. The mechanism of mixing is not the critical issue here it is that mixing must take place and an auger, on its own, does not mix. Systems do exist in which "throw back" is used within the auger – in this system the thread of the auger is reversed for a short period causing the product to be thrown back. Frequently several repeats of this reversal are used though they have to be reasonably spaced apart.

If the conveyor is in place, or can be put in place, then a micro feeder becomes the equipment of choice.

Which micro feeder is down to the individual miller but the following factors must be taken into account prior to procurement:

- Repeatability, linearity and stability (as discussed in Questions on Microfeeders).
- Maintenance and spares
- The level of input required to keep the micro feeder operational – some micro feeders can not handle the fortification mix at the most commonly available addition rate i.e. 200g per MT and require the fortification mix to be diluted (see the end of this section for some more comments on dilution) which is a significant on going operational cost.
- The present and future capacity of the mill

The above list is by no means all inclusive.

Continuous Mixer

A continuous mixer is essentially, if procured as a complete package, a method of measuring both the fortification mix and the bread flour or maize meal and proportionately dosing them into the mixer area. Such mixers range from relatively complex systems to the more relatively simplistic Snell 3-in-1.

The more complex continuous mixers handle large quantities of product whereas the Snell currently has a maximum capacity of 5 MT per hour.

The continuous mixer systems are not, however, suitable for strict identity preserved milled products so often required in service milling. This is because such mixers have a natural dead volume capable of holding several kilograms of product and the difficulty of switching on and off (particularly the latter) the fortification mix addition to coincide with the maize meal or bread flour flow.

Batch Mixer

An alternative to the conveyor system is to include a batch mixer system. This system will work in any mill though those with higher throughputs are more likely to take the choice above.

The advantage of the batch mixer is that identity preserved product can be maintained. This is critical in the case of service milling, regardless of scale[1] of production, as most service mill clients want their grain milled and their product afterwards. This attitude is particularly prevalent amongst the small scale service mill clients.

Direct Addition

This type of addition is the most basic of all and involves the lowest level of technology transfer. In this system the fortification mix is added using some form of basic measuring device e.g. teaspoon or cups per basic measure of grain or samp e.g. bucket. The mill itself mixes the fortification mix into the product. Whilst mixing is rather crude it should be remembered that at household level further mixing occurs during the food preparation stage.

This methodology is dealt with as a separate topic as, whilst it is the cheapest and most simple of techniques, it does pose some potential problems that can be easily overcome but only by being aware that they may exist.

Diluting Fortification mix

The regulations require that millers procure their fortification mix from registered suppliers and the amendments to the regulations allow for variation in the addition rate provided that the final product (maize meal or bread flour) complies with the minimum levels of micronutrients as indicated in Tables 3 and 4 of the regulations. This implies that diluting fortification mix is permissible provided certain conditions are adhered to. Diluting fortification mix is, however, more complex than many think. It requires as strict a process control as that carried out by the original suppliers, mixers of a similar capability (and cost) and is both time and space consuming.

It was originally envisioned that some small entrepreneurs may set up local dilution distribution depots so opening up the opportunity for low cost feeders to be used. This concept was not made provision for in the regulations and, in fact, the regulations specifically preclude procurement of diluted fortification mix unless it is from one of the registered suppliers. You are allowed to dilute for yourself but not for anyone else and you must be able to prove you are in compliance with the regulations after dilution.

Diluting has several other drawbacks in that diluted material means higher distribution costs, higher labour costs, extra quality assurance, quality control and administrative costs.

[1] Some service mill operations are small scale i.e. client walks in with 10-20 Kg of cleaned grain or samp for milling. Other operations involve the mill periodically milling large quantities of grain (that has been stored either off premises or on the mill site) owned by the client and kept identity preserved.

USEFUL Websites

health
Department: Health
REPUBLIC OF SOUTH AFRICA

gain
Global Alliance for Improved Nutrition

L'Initiative pour les micronutriments
The Micronutrient Initiative

unicef

usefulWEBSITES

National Chamber of Milling - NCM

www.grainmilling.org

It is a misnomer that the National Chamber of Milling is "only for the big guys". Membership is currently 50c per MT of grain milled. The NCM it caters for both the larger industry as well as the smaller millers and does take concerns raised seriously.

The NCM website provides useful and user friendly information. It is also important to note that information regarding any single miller is never released – the information available is about the industry and not an individual.

Most of the website is in English though the section on "Grain Contracts" – which contains various examples of contracts used in South Africa, does contain Afrikaans versions as well.

* HOME PAGE
* BUSINESS FOCUS
* CONTACT DETAILS
* INDUSTRY STATISTICS
* GMF TRAINING
* CULTIVARS
* GMO's
* FORTIFICATION
* INDUSTRY SUPPLIERS
* AGM SPONSORSHIP
* MEDIA RELEASES
* DOCUMENTS
* INDUSTRY LINKS
* GRAIN CONTRACTS
* SAAPA

useful

WEBSITES

South African Grain Information Service – SAGIS

www.sagis.org.za

This is a website that is absolutely essential to any miller as this organisation collates information from producers, traders and millers and reformats the information into a user friendly format. Access to SAGIS information is "free" – the quotation is deliberate as SAGIS does require the submission of returns (information about grain usage etc) on a regular basis. Information regarding any single miller is never released – the information available is about the industry and not an individual.

SAGIS is mandated to collate and report information received from producers, traders, millers etc and it is the law that these returns must be made. Most returns have to be submitted monthly and the form looks, at first glance, daunting. This from has, hover, been designed to cover all contingencies and very few sections apply to the millers. Furthermore SAGIS is mindful of the administrative problems many, especially small, millers are under. As such SAGIS whilst it can not provide exemption status to any miller it is willing to negotiate the frequency of return. For example millers with a very low turnover may be required to submit returns half yearly or quarterly. Returns MUST however be submitted. The relevant regulations are also included on the CD as SAGIS Returns.

The SAGIS website provides information not only on maize and wheat but also on barley, canola, groundnuts, oats, sorghum, soybean and sunflower seed.

SAGIS INFORMATION

Introduction to SAGIS
Monthly Bulletin
Monthly Info: Progressive
Weekly Producer Deliveries
Weekly Imports/Exports
Weekly Bulletin
Import Parity Prices
Export Parity PricesImport Tariffs
Historic Database

Reliability Articles
Application for Registration
Blank Return Forms
Manual: SAGIS Returns
List of Associations
List of Co-workers
List of Premises Codes

South African Grain Information Service – SAGIS continued

NON-SAGIS INFORMATION

CEC: Crop Estimates (NDA)
SARS: Tariff lines
Historic Prices
Stats SA: Consumer prices
SADC Information
Local Weather
International Weather
Conversion Table
Economic Indicators
Useful Links

More detailed information about SAGIS services are given in the dual language information sheet attached as SAGIS English Afrikaans

Also attached is a typical report of the Crop Estimates Committee, in Afrikaans and English – a valuable insight into whether the crop is likely to larger or smaller than the previous season; examples in Afrikaans, English, Tswana and Sotho of the monthly bulletin may be found in the folder SAGIS Monthly Bulletin and a typical weekly bulletin issued by SAGIS covering a wide range of news in an easily digested form – SAGIS Weekly Bulletin.

useful WEBSITES

SABS

www.sabs.co.za is the home page for the South African Bureau of Standards whereas www.sabs.co.za/sectors/food_and_health/index.aspx provides more detailed information on the services available from the laboratory.

This page has been attached as a PDF document – Laboratory SABS.pdf

SAGL

www.sagl.co.za is the home page for the Southern African Grains Laboratory and is produced in both English and Afrikaans. The home page has been attached as a PDF document – LABORATORY SAGL. This site is particularly useful to millers as it not only provides details of laboratory services provided but it also provides valuable information relating to the latest harvest of maize and wheat for each growing region in South Africa.

SAFEX

www.safex.co.za is the home page for the South African Futures Exchange. SAFEX is important to millers in that this is the mechanism by which grain prices are arrived at.

This site is designed to assist the professional commodities trader and is generally rather complex and technical. All of the information relevant to the miller is extracted from this site and reproduced in a more user friendly format by SAGIS.

Agricultural Products Market

The Agricultural Market of SAFEX was established in 1995 as a separate division to the existing financial derivatives market. The opportunity for a grains futures market was made possible by deregulation of all the Grain Marketing Boards from late 1994. South Africa's grain industry operates in a totally free market environment.

In August 2001 the JSE bought over SAFEX and today the Agricultural Products Market operates as a division within the JSE. The brand name SAFEX was kept due to the significant value it had built up as an efficient derivative market in South Africa.

The Division recently celebrated its 10th anniversary of providing efficient price risk management to the grains industry!

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